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## CHAPTER

# 1

# SOME BASIC CONCEPTS OF CHEMISTRY

### FACT/DEFINITION TYPE QUESTIONS

- A mixture of sand and iodine can be separated by
  - crystallisation
  - distillation
  - sublimation
  - fractionation
- Difference in density is the basis of
  - ultrafiltration
  - molecular sieving
  - molecular attraction
  - gravity separation
- Which of the following is an example of a heterogeneous substance?
  - Bottled water
  - Table salt
  - Pieces of copper
  - Candle
- Which of the following substances cannot be separated in to its constituents by physical methods?
  - Sugar and water solution
  - Salt and sugar
  - Solid glucose
  - Both (a) and (b)
- Which of the following pair of substances contain element and compound within a pair ?
 

(A) $O_2$ , $CH_4$	(B) $H_2$ , $O_2$
(C) $N_2$ , $CO_2$	(D) $Na$ , $CO$
(a) A, C, D	(b) B only
(c) C and D	(d) All of these
- Which of the following statements about a compound is incorrect?
  - A molecule of a compound has atoms of different elements.
  - A compound cannot be separated into its constituent elements by physical methods of separation.
  - A compound retains the physical properties of its constituent elements.
  - The ratio of atoms of different elements in a compound is fixed.
- Choose the correct combination
 

Element	Compound	Mixture
(a) Ammonia	Sodium	Air
(b) Water	Sugar	Aqueous sugar solution
(c) Hydrogen	Oxygen	Water
(d) Silver	Water	Air
- Choose the correct statement.
  - The particles in liquids are more closely held than gases but less free to move than solids.
  - The particles of solids are arranged in orderly fashion but they can move as freely as liquids.
  - The particles of gases are far apart as compared to solids and liquids and their movement is easy and fast.
  - The particles of gases moves faster than liquids only when the gases are heated.
- A mixture contains two or more substances in \_\_\_\_\_ which are called its \_\_\_\_\_.
  - fixed ratio, compounds
  - fixed ratio, elements
  - any ratio, components
  - any ratio, elements
- Which one of these is not a pure compound?
 

(a) $O_3$	(b) $H_2O_2$
(c) $H_2O$	(d) Sucrose solution
- One fermi is
 

(a) $10^{-15}$ cm	(b) $10^{-13}$ cm
(c) $10^{-10}$ cm	(d) $10^{-12}$ cm
- The prefix  $10^{18}$  is
 

(a) giga	(b) kilo
(c) exa	(d) nano
- The prefix zepto stands for (in m)
 

(a) $10^9$	(b) $10^{-12}$
(c) $10^{-15}$	(d) $10^{-21}$
- The unit  $J Pa^{-1}$  is equivalent to
 

(a) $m^3$	(b) $cm^3$
(c) $dm^3$	(d) None of these
- Which has highest weight ?
 

(a) $1 m^3$ of water	(b) A normal adult man
(c) 10 litre of Hg	(d) All have same weight
- Which one of the following set of units represents the smallest and largest amount of energy respectively?
 

(a) J and erg	(b) erg and cal
(c) cal and eV	(d) eV and L-atm

17. A measured temperature on Fahrenheit scale is 200 °F. What will this reading be on Celsius scale ?  
 (a) 40° C (b) 94° C  
 (c) 93.3 °C (d) 30° C
18. Which of the following is not a SI unit?  
 (a) metre (b) candela  
 (c) mole (d) litre
19. The prefix 10<sup>-24</sup> is  
 (a) yotta (b) zeta  
 (c) yocto (d) zepto
20. Many countries use Fahrenheit scale for expressing temperature of atmosphere. If temperature in any such country is measured 41°F then what is its value in celcius scale and would you expect hot or cold atmosphere in that country?  
 (a) 15°C, cold (b) 25°C, normal  
 (c) 5°C, cold (d) 41°C, hot
21. A sample was weighted using two different balances. The results were  
 (i) 3.929 g (ii) 4.0 g  
 How would the weight of the sample be reported?  
 (a) 3.93 g (b) 3g  
 (c) 3.9 g (d) 3.929 g
22. Two students performed the same experiment separately and each one of them recorded two readings of mass which are given below. Correct reading of mass is 3.0 g. On the basis of given data, mark the correct option out of the following statements.
- | Students | Readings  |
|----------|-----------|
|          | (i) (ii)  |
| A        | 3.01 2.99 |
| B        | 3.05 2.95 |
- (a) Results of both the students are neither accurate nor precise.  
 (b) Results of student A are both precise and accurate.  
 (c) Results of student B are neither precise nor accurate.  
 (d) Results of student B are both precise and accurate.
23. 0.00016 can be written as ...A... in scientific notaiton. Here, A refers to  
 (a)  $1.6 \times 10^{-4}$  (b)  $24.50 \times 10^{-9}$   
 (c)  $2.450 \times 10^{-8}$  (d)  $24.50 \times 10^{-7}$
24. If the true value for an experimental result is 6.23 and the results reported by three students X, Y and Z are :  
 X: 6.18 and 6.28  
 Y: 6.20 and 6.023  
 Z: 6.22 and 6.24  
 Which of the following option is correct :  
 (a) X precise, Y accurate, Z precise and accurate.  
 (b) X precise and accurate, Y not precise, Z precise  
 (c) Both X & Z precise & accurate, Y not precise.  
 (d) Both X & Y neither precise nor accurate, Z both precise and accurate.
25. In the final answer of the expression  

$$\frac{(29.2 - 20.2)(1.79 \times 10^5)}{1.37}$$
 the number of significant figures is :  
 (a) 1 (b) 2  
 (c) 3 (d) 4
26. The number of significant figures for the three numbers 161 cm, 0.161 cm, 0.0161 cm are  
 (a) 3, 4 and 5 respectively (b) 3, 4 and 4 respectively  
 (c) 3, 3 and 4 respectively (d) 3, 3 and 3 respectively
27. Given P=0.0030m, Q=2.40m, R=3000m, Significant figures in P, Q and R are respectively  
 (a) 2, 2, 1 (b) 2, 3, 4  
 (c) 4, 2, 1 (d) 4, 2, 3
28. If the density of a solution is 3.12 g mL<sup>-1</sup>, the mass of 1.5 mL solution in significant figures is \_\_\_\_\_.  
 (a) 4.7 g (b)  $4680 \times 10^{-3}$  g  
 (c) 4.680 g (d) 46.80 g
29. In which of the following number all zeros are significant?  
 (a) 0.0005 (b) 0.0500  
 (c) 50.000 (d) 0.0050
30. The correctly reported answer of addition of 29.4406, 3.2 and 2.25 will have significant figures  
 (a) 3 (b) 4  
 (c) 2 (d) 5
31. The number of significant figures in 10.3106 g is  
 (a) 2 (b) 3  
 (c) 1 (d) 6
32. Choose the correct option that represents the result of the given calculation to the appropriate number of significant figures:  

$$\frac{43.0 \times 0.0243}{0.340 \times 4}$$
 (a) 0.768 (b) 0.77  
 (c) 0.76 (d) 0.7683
33. Arrange the numbers in increasing no. of significant figures. 0.002600, 2.6000, 2.6, 0.260  
 (a)  $2.6 < 0.260 < 0.002600 < 2.6000$   
 (b)  $2.6000 < 2.6 < 0.002600 < 0.260$   
 (c)  $0.260 < 2.6 < 0.002600 < 2.6000$   
 (d)  $0.002600 < 0.260 < 2.6 < 2.6000$
34. Dimension of pressure are same as that of  
 (a) Energy (b) Force  
 (c) Force per unit volume (d) Energy per unit volume
35. n g of substance X reacts with m g of substance Y to form p g of substance R and q g of substance S. This reaction can be represented as, X + Y = R + S. The relation which can be established in the amounts of the reactants and the products will be  
 (a)  $n - m = p - q$  (b)  $n + m = p + q$   
 (c)  $n = m$  (d)  $p = q$

36. 20 g of  $\text{CaCO}_3$  on heating gave 8.8 g of  $\text{CO}_2$  and 11.2 g of  $\text{CaO}$ . This is in accordance with  
 (a) The law of conservation of mass.  
 (b) The law of constant composition.  
 (c) The law of reciprocal proportion.  
 (d) None of these
37. Which of the following is the best example of law of conservation of mass?  
 (a) 12 g of carbon combines with 32 g of oxygen to form 44 g of  $\text{CO}_2$   
 (b) When 12 g of carbon is heated in a vacuum there is no change in mass  
 (c) A sample of air increases in volume when heated at constant pressure but its mass remains unaltered  
 (d) The weight of a piece of platinum is the same before and after heating in air
38. Which of the following statements is correct about the reaction given below ?  

$$4\text{Fe(s)} + 3\text{O}_2\text{(g)} \longrightarrow 2\text{Fe}_2\text{O}_3\text{(g)}$$
  
 (a) Total mass of iron and oxygen in reactants = total mass of iron and oxygen in product therefore, it follows law of conservation of mass.  
 (b) Total mass of reactants = total mass of product; therefore, law of multiple proportions is followed.  
 (c) Amount of  $\text{Fe}_2\text{O}_3$  can be increased by reducing the amount of any one of the reactants (iron or oxygen).  
 (d) Amount of  $\text{Fe}_2\text{O}_3$  produced will decrease if the amount of any one of the reactants (iron or oxygen) is taken in excess.
39. In an experiment 4.2 g of  $\text{NaHCO}_3$  is added to a solution of acetic acid weighing 10.0 g, it is observed that 2.2 g of  $\text{CO}_2$  is released into the atmosphere. The residue left behind is found to weigh 12.0 g  
 The above observations illustrate  
 (a) law of definite proportions.  
 (b) law of conservation of mass  
 (c) law of multiple proportions  
 (d) None of these
40. In one experiment, 4g of  $\text{H}_2$  combine with 32g of  $\text{O}_2$  to form 36g of  $\text{H}_2\text{O}$ . In another experiment, when 50g of  $\text{H}_2$  combine with 400g of  $\text{O}_2$  then 450g of  $\text{H}_2\text{O}$  is formed. Above two experiments follow  
 (a) The law of conservation of mass  
 (b) The law of constant composition  
 (c) Both (a) and (b)  
 (d) Neither (a) nor (b)
41. Irrespective of the source, pure sample, of water always yields 88.89% mass of oxygen and 11.11% mass of hydrogen. This is explained by the law of  
 (a) conservation of mass (b) multiple proportions  
 (c) constant composition (d) constant volume
42. The percentage of copper and oxygen in samples of  $\text{CuO}$  obtained by different methods were found to be the same. The illustrate the law of  
 (a) constant proportions (b) conservation of mass  
 (c) multiple proportions (d) reciprocal proportions
43. The law of definite proportions was given by –  
 (a) John Dalton (b) Humphry Davy  
 (c) Proust (d) Michael Faraday
44. Which one of the following pairs of compounds illustrate the law of multiple proportions ?  
 (a)  $\text{H}_2\text{O}$  and  $\text{Na}_2\text{O}$  (b)  $\text{MgO}$  and  $\text{Na}_2\text{O}$   
 (c)  $\text{Na}_2\text{O}$  and  $\text{BaO}$  (d)  $\text{SnCl}_2$  and  $\text{SnCl}_4$
45. Among the following pairs of compounds, the one that illustrates the law of multiple proportions is  
 (a)  $\text{NH}_3$  and  $\text{NCl}_3$  (b)  $\text{H}_2\text{S}$  and  $\text{SO}_2$   
 (c)  $\text{CS}_2$  and  $\text{FeSO}_4$  (d)  $\text{CuO}$  and  $\text{Cu}_2\text{O}$
46. Two samples of lead oxide were separately reduced to metallic lead by heating in a current of hydrogen. The weight of lead from one oxide was half the weight of lead obtained from the other oxide. The data illustrates  
 (a) law of reciprocal proportions  
 (b) law of constant proportions  
 (c) law of multiple proportions  
 (d) law of equivalent proportions
47. In compound A, 1.00g of nitrogen unites with 0.57g of oxygen. In compound B, 2.00g of nitrogen combines with 2.24g of oxygen. In compound C, 3.00g of nitrogen combines with 5.11g of oxygen. These results obey the following law  
 (a) law of constant proportion  
 (b) law of multiple proportion  
 (c) law of reciprocal proportion  
 (d) Dalton's law of partial pressure
48. Which of the following statements indicates that law of multiple proportion is being followed.  
 (a) Sample of carbon dioxide taken from any source will always have carbon and oxygen in the ratio 1 : 2.  
 (b) Carbon forms two oxides namely  $\text{CO}_2$  and  $\text{CO}$ , where masses fo oxygen which combine with fixed mass of carbon are in the simple ration 2 : 1.  
 (c) When magnesium burns in oxygen, the amount of magnesium taken for the reaction is equal to the amount of magnesium in magnesium oxide formed.  
 (d) At constant temperature and pressure 200 mL of hydrogen will combine with 100 mL oxygen to produce 200 mL of water vapour.
49. The molecular weight of  $\text{O}_2$  and  $\text{SO}_2$  are 32 and 64 respectively. At  $15^\circ\text{C}$  and 150 mm Hg pressure, one litre of  $\text{O}_2$  contains 'N' molecules. The number of molecules in two litres of  $\text{SO}_2$  under the same conditions of temperature and pressure will be :  
 (a)  $\text{N}/2$  (b)  $1\text{N}$   
 (c)  $2\text{N}$  (d)  $4\text{N}$

50. 10 dm<sup>3</sup> of N<sub>2</sub> gas and 10 dm<sup>3</sup> of gas X at the same temperature contain the same number of molecules, the gas X is  
 (a) CO<sub>2</sub> (b) CO  
 (c) H<sub>2</sub> (d) NO
51. One mole of a gas occupies a volume of 22.4 L. This is derived from  
 (a) Berzelius' hypothesis (b) Gay-Lussac's law  
 (c) Avogadro's law (d) Dalton's law
52. One of the following combination which illustrates the law of reciprocal proportions ?  
 (a) N<sub>2</sub>O<sub>3</sub>, N<sub>2</sub>O<sub>4</sub>, N<sub>2</sub>O<sub>5</sub> (b) NaCl, NaBr, NaI  
 (c) CS<sub>2</sub>, CO<sub>2</sub>, SO<sub>2</sub> (d) PH<sub>3</sub>, P<sub>2</sub>O<sub>3</sub>, P<sub>2</sub>O<sub>5</sub>
53. Equal volumes of two gases A and B are kept in a container at the same temperature and pressure. Avogadro's law is invalid if  
 (a) the gases are reactive  
 (b) the gases are non-reactive  
 (c) gas A has more number of molecules than gas B.  
 (d) None of these
54. Molecular mass is defined as the  
 (a) mass of one atom compared with the mass of one molecule  
 (b) mass of one atom compared with the mass of one atom of hydrogen  
 (c) mass of one molecule of any substance compared with the mass of one atom of C-12  
 (d) None of the above
55. 1 amu is equal to  
 (a)  $\frac{1}{14}$  of O-16 (b)  $\frac{1}{12}$  of C-12  
 (c) 1 g of H<sub>2</sub> (d)  $1.66 \times 10^{-23}$  kg
56. The modern atomic weight scale is based on  
 (a) O<sup>16</sup> (b) C<sup>12</sup>  
 (c) H<sup>1</sup> (d) C<sup>13</sup>
57. The percentage weight of Zn in white vitriol [ZnSO<sub>4</sub>·7H<sub>2</sub>O] is approximately equal to (Zn = 65, S = 32, O = 16 and H = 1)  
 (a) 33.65 % (b) 32.56 %  
 (c) 23.65 % (d) 22.65 %
58. The average atomic mass of neon based on following data is:  

Isotope	Relative abundance
<sup>20</sup> Ne	0.9051
<sup>21</sup> Ne	0.0027
<sup>22</sup> Ne	0.0922

 (a) 0.33 u (b) 20.187 u  
 (c) 6.729 u (d) 18.058 u
59. What is the average atomic mass of bromine from the following data : (abundance is in %)  

Isotope	Mass	Abundance
<sup>79</sup> Br	78.9183361	50.69
<sup>81</sup> Br	80.916289	49.31

 (a) 79.9 (b) 76.6  
 (c) 75.9 (d) 69.9
60. What is the mass of an atom of oxygen (in gm)?  
 (a)  $2.656 \times 10^{-23}$  (b)  $1.567 \times 10^{-22}$   
 (c)  $2.0 \times 10^{-22}$  (d)  $3.5 \times 10^{-23}$
61. If the mass of the one atom is found to be  $2.324784 \times 10^{-23}$  g, then this atom can be ?  
 (a) Oxygen (b) Carbon  
 (c) Fluorine (d) Nitrogen
62. What is the mass of 1 molecule of CO.  
 (a)  $2.325 \times 10^{-23}$  (b)  $4.65 \times 10^{-23}$   
 (c)  $3.732 \times 10^{-23}$  (d)  $2.895 \times 10^{-23}$
63. Calculate the volume at STP occupied by 240 gm of SO<sub>2</sub>.  
 (a) 64 (b) 84  
 (c) 59 (d) 73
64. At S.T.P. the density of CCl<sub>4</sub> vapours in g/L will be nearest to:  
 (a) 6.87 (b) 3.42  
 (c) 10.26 (d) 4.57
65. The number of gram molecules of oxygen in  $6.02 \times 10^{24}$  CO molecules is  
 (a) 10 gm molecules (b) 5 gm molecules  
 (c) 1 gm molecules (d) 0.5 gm molecules
66. The number of oxygen atoms in 4.4 g of CO<sub>2</sub> is  
 (a)  $1.2 \times 10^{23}$  (b)  $6 \times 10^{22}$   
 (c)  $6 \times 10^{23}$  (d)  $12 \times 10^{23}$
67. Which has maximum number of molecules?  
 (a) 7 gm N<sub>2</sub> (b) 2 gm H<sub>2</sub>  
 (c) 16 gm NO<sub>2</sub> (d) 16 gm O<sub>2</sub>
68. Number of atoms in 558.5 gram Fe (at. wt. of Fe = 55.85 g mol<sup>-1</sup>) is  
 (a) twice that in 60 g carbon  
 (b)  $6.023 \times 10^{22}$   
 (c) half that in 8 g He  
 (d)  $558.5 \times 6.023 \times 10^{23}$
69. The number of molecules in 16 g of methane is  
 (a)  $3.0 \times 10^{23}$  (b)  $\frac{16}{6.02} \times 10^{23}$   
 (c)  $6.023 \times 10^{23}$  (d)  $\frac{16}{3.0} \times 10^{23}$
70. Number of g of oxygen in 32.2 g Na<sub>2</sub>SO<sub>4</sub>·10 H<sub>2</sub>O is  
 (a) 20.8 (b) 2.24  
 (c) 22.4 (d) 2.08

71. The number of moles of oxygen in one litre of air containing 21% oxygen by volume, under standard conditions are  
(a) 0.0093 mole (b) 0.21 mole  
(c) 2.10 mole (d) 0.186 mole
72. The number of molecules in 8.96 litre of a gas at  $0^{\circ}\text{C}$  and 1 atm. pressure is approximately  
(a)  $6.023 \times 10^{23}$  (b)  $12.04 \times 10^{23}$   
(c)  $18.06 \times 10^{23}$  (d)  $24.08 \times 10^{22}$
73. The mass of a molecule of water is  
(a)  $3 \times 10^{-25}$  kg (b)  $3 \times 10^{-26}$  kg  
(c)  $1.5 \times 10^{-26}$  kg (d)  $2.5 \times 10^{-26}$  kg
74. One mole of  $\text{CO}_2$  contains :  
(a) 3 g atoms of  $\text{CO}_2$   
(b)  $18.1 \times 10^{23}$  molecules of  $\text{CO}_2$   
(c)  $6.02 \times 10^{23}$  atoms of O  
(d)  $6.02 \times 10^{23}$  atoms of C
75. Volume of a gas at NTP is  $1.12 \times 10^{-7} \text{cm}^3$ . The number of molecules in it is :  
(a)  $3.01 \times 10^{12}$  (b)  $3.01 \times 10^{24}$   
(c)  $3.01 \times 10^{23}$  (d)  $3.01 \times 10^{20}$
76. How many atoms are contained in one mole of sucrose ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ )?  
(a)  $20 \times 6.02 \times 10^{23}$  atoms/mol  
(b)  $45 \times 6.02 \times 10^{23}$  atoms/mol  
(c)  $5 \times 6.02 \times 10^{23}$  atoms/mol  
(d) None of these
77. One litre oxygen gas at S.T.P will weigh :  
(a) 1.43 g (b) 2.24 g  
(c) 11.2 g (d) 22.4 g
78. Number of moles of NaOH present in 2 litre of 0.5 M NaOH is :  
(a) 1.5 (b) 2.0  
(c) 1.0 (d) 2.5
79.  $\text{O}_2$ ,  $\text{N}_2$  are present in the ratio of 1 : 4 by weight. The ratio of number of molecules is :  
(a) 7 : 32 (b) 1 : 4  
(c) 2 : 1 (d) 4 : 1
80. How many moles of  $\text{Al}_2(\text{SO}_4)_3$  would be in 50 g of the substance ?  
(a) 0.083 mole (b) 0.952 mole  
(c) 0.481 mole (d) 0.140 mole
81. The mass of 1 mole of electrons is  
(a)  $9.1 \times 10^{-28}$  g (b) 1.008 mg  
(c) 0.55 mg (d)  $9.1 \times 10^{-27}$  g
82. 10 g of hydrogen and 64 g of oxygen were filled in a steel vessel and exploded. Amount of water produced in this reaction will be:  
(a) 3 mol (b) 4 mol  
(c) 1 mol (d) 2 mol
83. Which has the maximum number of molecules among the following ?  
(a) 44 g  $\text{CO}_2$  (b) 48 g  $\text{O}_3$   
(c) 8 g  $\text{H}_2$  (d) 64 g  $\text{SO}_2$
84. The weight of one molecule of a compound  $\text{C}_{60}\text{H}_{122}$  is  
(a)  $1.2 \times 10^{-20}$  gram (b)  $1.4 \times 10^{-21}$  gram  
(c)  $5.025 \times 10^{23}$  gram (d)  $6.023 \times 10^{23}$  gram
85. The simplest formula of a compound containing 50% of element X (atomic mass 10) and 50% of element Y (atomic mass 20) is  
(a) XY (b)  $\text{XY}_3$   
(c)  $\text{X}_2\text{Y}$  (d)  $\text{X}_2\text{Y}_3$
86. Empirical formula of hydrocarbon containing 80% carbon and 20% hydrogen is :  
(a)  $\text{CH}_3$  (b)  $\text{CH}_4$   
(c) CH (d)  $\text{CH}_2$
87. The empirical formula of a compound is  $\text{CH}_2$ . One mole of this compound has a mass of 42 grams. Its molecular formula is :  
(a)  $\text{C}_3\text{H}_6$  (b)  $\text{C}_3\text{H}_8$   
(c)  $\text{CH}_2$  (d)  $\text{C}_2\text{H}_2$
88. A compound contains 54.55 % carbon, 9.09% hydrogen, 36.36% oxygen. The empirical formula of this compound is  
(a)  $\text{C}_3\text{H}_5\text{O}$  (b)  $\text{C}_4\text{H}_8\text{O}_2$   
(c)  $\text{C}_2\text{H}_4\text{O}_2$  (d)  $\text{C}_2\text{H}_4\text{O}$
89. In a hydrocarbon, mass ratio of hydrogen and carbon is 1:3, the empirical formula of hydrocarbon is  
(a)  $\text{CH}_4$  (b)  $\text{CH}_2$   
(c)  $\text{C}_2\text{H}$  (d)  $\text{CH}_3$
90. An organic compound contains carbon, hydrogen and oxygen. Its elemental analysis gave C, 38.71% and H, 9.67%. The empirical formula of the compound would be :  
(a)  $\text{CH}_3\text{O}$  (b)  $\text{CH}_2\text{O}$   
(c) CHO (d)  $\text{CH}_4\text{O}$
91. A hydrocarbon is composed of 75% carbon. The empirical formula of the compound is  
(a)  $\text{CH}_2$  (b)  $\text{CH}_3$   
(c)  $\text{C}_2\text{H}_5$  (d)  $\text{CH}_4$
92. 12 gm of Mg (atomic mass 24) will react completely with hydrochloric acid to give  
(a) One mol of  $\text{H}_2$   
(b)  $1/2$  mol of  $\text{H}_2$   
(c)  $2/3$  mol of  $\text{O}_2$   
(d) both  $1/2$  mol of  $\text{H}_2$  and  $1/2$  mol of  $\text{O}_2$



93. 20.0 kg of  $N_{2(g)}$  and 3.0 kg of  $H_{2(g)}$  are mixed to produce  $NH_{3(g)}$ . The amount of  $NH_{3(g)}$  formed is  
(a) 17 kg (b) 34 kg  
(c) 20 kg (d) 3 kg
94. 20.0 kg of  $H_{2(g)}$  and 32 kg of  $O_{2(g)}$  are reacted to produce  $H_2O(l)$ . The amount of  $H_2O(l)$  formed after completion of reaction is  
(a) 62 kg (b) 38 kg  
(c) 42 kg (d) 72 kg
95. What is the weight of oxygen required for the complete combustion of 2.8 kg of ethylene ?  
(a) 2.8 kg (b) 6.4 kg  
(c) 9.6 kg (d) 96 kg
96. In the reaction  
 $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(l)$   
When 1 mole of ammonia and 1 mole of  $O_2$  are made to react to completion,  
(a) 1.0 mole of  $H_2O$  is produced  
(b) 1.0 mole of  $NO$  will be produced  
(c) all the oxygen will be consumed  
(d) all the ammonia will be consumed
97. What is the molarity of 0.2N  $Na_2CO_3$  solution?  
(a) 0.1 M (b) 0 M  
(c) 0.4 M (d) 0.2 M
98. The molar solution of  $H_2SO_4$  is equal to :  
(a) N/2 solution (b) N solution  
(c) 2N solution (d) 3N solution
99. Volume of water needed to mix with 10 mL 10N  $HNO_3$  to get 0.1 N  $HNO_3$  is :  
(a) 1000 mL (b) 990 mL  
(c) 1010 mL (d) 10 mL
100. One kilogram of a sea water sample contains 6 mg of dissolved  $O_2$ . The concentration of  $O_2$  in the sample in ppm is  
(a) 0.6 (b) 6.0  
(c) 60.0 (d) 16.0
101. A 5 molar solution of  $H_2SO_4$  is diluted from 1 litre to a volume of 10 litres, the normality of the solution will be :  
(a) 1N (b) 0.1N  
(c) 5N (d) 0.5N
102. With increase of temperature, which of these changes?  
(a) Molality (b) Weight fraction of solute  
(c) Molarity (d) Mole fraction
103.  $6.02 \times 10^{20}$  molecules of urea are present in 100 ml of its solution. The concentration of urea solution is  
(a) 0.02 M (b) 0.01 M  
(c) 0.001 M (d) 0.1 M  
(Avogadro constant,  $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ )
104. Two solutions of a substance (non electrolyte) are mixed in the following manner. 480 ml of 1.5 M first solution + 520 ml of 1.2 M second solution. What is the molarity of the final mixture?  
(a) 2.70 M (b) 1.344 M  
(c) 1.50 M (d) 1.20 M

### STATEMENT TYPE QUESTIONS

105. Which of the following statements are correct ?  
(i) Both solids and liquids have definite volume.  
(ii) Both liquids and gases do not have definite shape.  
(iii) Both solids and gases take the shape of the container.  
(a) (i) and (iii) (b) (ii) and (iii)  
(c) (i) and (ii) (d) (i), (ii) and (iii)
106. Choose correct option based on following statements. Here T stands for true statement and F for false statement.  
(i) Homogeneous mixture has uniform composition throughout.  
(ii) All components of a heterogeneous mixture are observable to naked eyes.  
(iii) All solutions are homogeneous in nature.  
(iv) Air is an example of heterogeneous mixture.  
(a) T T F F (b) T F T F  
(c) F F T T (d) T F F F
107. Read the following and choose the incorrect statements.  
(i) Both weight and mass are same quantities used for measurement of amount of matter present in a substance  
(ii) Mass and weight of a substance vary from one place to another due to change in gravity.  
(iii) SI unit of mass is kilogram and while SI unit of weight is gram.  
(a) (i) and (iii) (b) (ii) and (iii)  
(c) (i) and (ii) (d) All of these
108. Moon takes 27.3 days to complete one orbit around the Earth. Now read the following statements and choose the correct code. Here T is for true statement and F is for 'False statement'.  
(i) Moon takes 655.2 hours to complete one orbit around the Earth.  
(ii) Moon takes 39312 seconds to complete one orbit around the earth.  
(iii) Moon takes 1638 minutes to complete one orbit around the Earth.  
(a) F T F (b) T T T  
(c) T F F (d) T F T

109. Give the correct order of initials T or F for following statements. Use T if statement is true and F if it is false.

- Gay-Lussac's law of gaseous volumes is actually the law of definite proportion by volume.
  - Law of conservation of mass is true for physical change, but not for chemical change.
  - The percentage of oxygen in  $\text{H}_2\text{O}_2$  is different from that in  $\text{H}_2\text{O}$ . Hence, it violates law of definite proportions.
  - Fixed mass of A reacts with two different masses of B (say  $x$  and  $y$ ), then the ratio of  $x/y$  can be any positive integer.
  - At STP, 5 mL of  $\text{N}_2$  and  $\text{H}_2$  have different no. of molecules.
- (a) TTFTF (b) FTTFT  
(c) TFFTF (d) TFTTF

110. Consider the following statements.

- Atoms of H, O, N and C have identical properties but different mass.
- Matter is divisible into atoms which are further indivisible.
- The ratio of N: H in  $\text{NH}_3$  is 1 : 3 and N : O in nitric oxide is 2 : 1.
- Dalton's atomic theory support law of conservation of mass.

Which of the following pairs of statements is true according to Dalton's atomic theory ?

- (a) (i) and (ii) (b) (ii) and (iii)  
(c) (ii) and (iv) (d) (i) and (iv)

111. Choose the correct option based on following statements. Here 'T' stands for true and 'F' stands for false statement.

- Molecular mass of cane sugar ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ) is 182 amu.
  - 1 mole of cane sugar contains  $6.022 \times 10^{23}$  molecules of cane sugar.
  - 34.20 g of cane sugar contains  $6.022 \times 10^{21}$  molecules of cane sugar.
- (a) TTF (b) TFT  
(c) FTF (d) FTT

### MATCHING TYPE QUESTIONS

112. Match the items of Column I, II and III appropriately and choose the correct option from the codes given below.

Column I (Multiple)	Column II (Prefix)	Column III (Symbol)
(A) $10^{-15}$	(p) Kilo	(i) m
(B) $10^{-3}$	(q) yotta	(ii) f
(C) $10^3$	(r) milli	(iii) k
(D) $10^{24}$	(s) femto	(iv) Y
(a) A – (s), (ii); B – (r), (i); C – (p), (iii); D – (q), (iv)		
(b) A – (p), (ii); B – (q), (iii); C – (r), (i); D – (s), (iv)		
(c) A – (q), (iv); B – (p), (ii); C – (p), (i); D – (r), (iii)		
(d) A – (r), (iii); B – (p), (ii); C – (s), (i); D – (q), (iv)		

113. Match the columns

Column-I (Number)	Column-II (Significant figures)
(A) 29900.	(p) 2
(B) 290	(q) 1
(C) $1.23 \times 1.331$	(r) 4
(D) 20.00	(s) 3
(E) $2.783 - 1$	(t) 5
(a) A – (r), B – (q), C – (t), D – (p), E – (s)	
(b) A – (t), B – (p), C – (s), D – (r), E – (q)	
(c) A – (p), B – (t), C – (s), D – (r), E – (q)	
(d) A – (t), B – (s), C – (r), D – (q), E – (p)	

114. Match the columns

Column-I (Laws of chemical combinations)	Column-II (Scientist)
(A) Law of definite proportions	(p) Antoine Lavoisier
(B) Law of multiple proportions	(q) Gay Lussac
(C) Law of conservation of mass	(r) Dalton
(D) Law of gaseous volumes	(s) Joseph Proust
(a) A – (s), B – (r), C – (p), D – (q)	
(b) A – (p), B – (r), C – (s), D – (q)	
(c) A – (r), B – (p), C – (s), D – (q)	
(d) A – (q), B – (s), C – (r), D – (p)	

115. Match the columns

Column-I	Column-II
(A) $\text{C}_6\text{H}_5\text{NH}_2$	(p) 84
(B) $\text{C}_6\text{H}_6$	(q) 100
(C) $\text{C}_6\text{H}_{12}$	(r) 93
(D) $\text{CaCO}_3$	(s) 78
(a) A – (p), B – (r), C – (q), D – (s)	
(b) A – (r), B – (s), C – (p), D – (q)	
(c) A – (r), B – (p), C – (q), D – (s)	
(d) A – (r), B – (q), C – (s), D – (p)	

116. Match the columns.

Column-I	Column-II
(A) 88 g of $\text{CO}_2$	(p) 0.25 mol
(B) $6.022 \times 10^{23}$ molecules of $\text{H}_2\text{O}$	(q) 2 mol
(C) 5.6 litres of $\text{O}_2$ at STP	(r) 1 mol
(D) 96 g of $\text{O}_2$	(s) $6.022 \times 10^{23}$ molecules
(E) 1 mol of any gas	(t) 3 mol
(a) A – (q), B – (r), C – (p), D – (t), E – (s)	
(b) A – (r), B – (q), C – (p), D – (t), E – (s)	
(c) A – (q), B – (p), C – (r), D – (t), E – (s)	
(d) A – (q), B – (r), C – (p), D – (s), E – (t)	

117. Match the mass of elements given in Column I with the number of moles given in Column II and mark the appropriate choice. Choose the correct codes from the options given below.

Column-I	Column-II
(A) 28 g of He	(p) 2 moles
(B) 46 g of Na	(q) 7 moles
(C) 60 g of Ca	(r) 1 mole
(D) 27 g of Al	(s) 1.5 mole
(a) A – (s), B – (r), C – (q), D – (p)	
(b) A – (p), B – (r), C – (q), D – (s)	
(c) A – (r), B – (q), C – (p), D – (s)	
(d) A – (q), B – (p), C – (s), D – (r)	

118. Match the columns.

Column-I (Physical quantity)	Column-II (Unit)
(A) Molarity	(p) mol
(B) Mole fraction	(q) Unitless
(C) Mole	(r) mol L <sup>-1</sup>
(D) Molality	(s) mol kg <sup>-1</sup>
(a) A – (r), B – (q), C – (s), D – (p)	
(b) A – (r), B – (p), C – (q), D – (s)	
(c) A – (r), B – (q), C – (p), D – (s)	
(d) A – (q), B – (r), C – (p), D – (s)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

119. **Assertion :** Significant figures for 0.200 is 3 whereas for 200 it is 1.

**Reason :** Zero at the end or right of a number are significant provided they are not on the right side of the decimal point.

120. **Assertion :** 1.231 has three significant figures.

**Reason :** All numbers right to the decimal point are significant.

121. **Assertion :** One atomic mass unit is defined as one twelfth of the mass of one carbon - 12 atom.

**Reason :** Carbon-12 isotope is the most abundant isotope of carbon and has been chosen as standard.

122. **Assertion :** Volume of a gas is inversely proportional to the number of moles of gas.

**Reason :** The ratio by volume of gaseous reactants and products is in agreement with their mole ratio.

123. **Assertion :** Equal moles of different substances contain same number of constituent particles.

**Reason :** Equal weights of different substances contain the same number of constituent particles.

124. **Assertion :** The empirical mass of ethene is half of its molecular mass.

**Reason :** The empirical formula represents the simplest whole number ratio of various atoms present in a compound.

### CRITICAL THINKING TYPE QUESTIONS

125. What are the significant figure(s) in a broken “ruler” show below?



- (A) 1 (B) 2  
 (C) 3 (D) 0  
 (a) A, B and C (b) A, B, D  
 (c) A only (d) A and B
126. Which one of the following sets of compounds correctly illustrate the law of reciprocal proportions?  
 (a) P<sub>2</sub>O<sub>3</sub>, PH<sub>3</sub>, H<sub>2</sub>O (b) P<sub>2</sub>O<sub>5</sub>, PH<sub>3</sub>, H<sub>2</sub>O  
 (c) N<sub>2</sub>O<sub>5</sub>, NH<sub>3</sub>, H<sub>2</sub>O (d) N<sub>2</sub>O, NH<sub>3</sub>, H<sub>2</sub>O
127. If we consider that 1/6, in place of 1/12, mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of a substance will  
 (a) decrease twice  
 (b) increase two fold  
 (c) remain unchanged  
 (d) be a function of the molecular mass of the substance
128. The maximum number of molecules are present in  
 (a) 15 L of H<sub>2</sub> gas at STP (b) 5 L of N<sub>2</sub> gas at STP  
 (c) 0.5 g of H<sub>2</sub> gas (d) 10 g of O<sub>2</sub> gas
129. How many moles of magnesium phosphate, Mg<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub> will contain 0.25 mole of oxygen atoms?  
 (a) 1.25 × 10<sup>-2</sup> (b) 2.5 × 10<sup>-2</sup>  
 (c) 0.02 (d) 3.125 × 10<sup>-2</sup>
130. Volume occupied by one molecule of water (density = 1 g cm<sup>-3</sup>) is :  
 (a) 9.0 × 10<sup>-23</sup> cm<sup>3</sup> (b) 6.023 × 10<sup>-23</sup> cm<sup>3</sup>  
 (c) 3.0 × 10<sup>-23</sup> cm<sup>3</sup> (d) 5.5 × 10<sup>-23</sup> cm<sup>3</sup>
131. The number of atoms in 0.1 mol of a triatomic gas is : (N<sub>A</sub> = 6.02 × 10<sup>23</sup> mol<sup>-1</sup>)  
 (a) 6.026 × 10<sup>22</sup> (b) 1.806 × 10<sup>23</sup>  
 (c) 3.600 × 10<sup>23</sup> (d) 1.800 × 10<sup>22</sup>



132. 1 c.c.  $N_2O$  at NTP contains :
- $\frac{1.8}{224} \times 10^{22}$  atoms
  - $\frac{6.02}{22400} \times 10^{23}$  molecules
  - $\frac{1.32}{224} \times 10^{23}$  electrons
  - All of the above
133. How much time (in hours) would it take to distribute one Avogadro number of wheat grains if  $10^{20}$  grains are distributed each second ?
- 0.1673
  - 1.673
  - 16.73
  - 167.3
134. Arrange the following in the order of increasing mass (atomic mass: O = 16, Cu = 63, N = 14)
- one atom of oxygen
  - one atom of nitrogen
  - $1 \times 10^{-10}$  mole of oxygen
  - $1 \times 10^{-10}$  mole of copper
- II < I < III < IV
  - I < II < III < IV
  - III < II < IV < I
  - IV < II < III < I
135. If 1.5 moles of oxygen combines with Al to form  $Al_2O_3$ , the mass of Al in g [Atomic mass of Al = 27] used in the reaction is
- 2.7
  - 54
  - 40.5
  - 81
136. Which one of the following is the lightest?
- 0.2 mole of hydrogen gas
  - $6.023 \times 10^{22}$  molecules of nitrogen
  - 0.1 g of silver
  - 0.1 mole of oxygen gas
137. In a compound C, H and N atoms are present in 9 : 1 : 3.5 by weight. Molecular weight of compound is 108. Molecular formula of compound is
- $C_2H_6N_2$
  - $C_3H_4N$
  - $C_6H_8N_2$
  - $C_9H_{12}N_3$
138. The empirical formula of an acid is  $CH_2O_2$ , the probable molecular formula of acid may be :
- $C_3H_6O_4$
  - $CH_2O$
  - $CH_2O_2$
  - $C_2H_4O_2$
139. A gaseous hydrocarbon gives upon combustion 0.72 g of water and 3.08 g. of  $CO_2$ . The empirical formula of the hydrocarbon is :
- $C_2H_4$
  - $C_3H_4$
  - $C_6H_5$
  - $C_7H_8$
140. Which of the following is the correct empirical and molecular formulae of a compound, if the molecular mass of a compound is 80 and compound contains 60% of C, 5% of H and 35% of N ?
- $C_2H_2N$  ;  $C_4H_4N_2$
  - $C_3H_4N_2$  ;  $C_6H_8N_4$
  - $C_2H_4N_2$  ;  $C_4H_8N_4$
  - $C_2H_2N$  ;  $C_2H_2N$
141. Which of the following is the correct empirical and molecular formulae of a compound, if the molecular mass of a compound is 93 and compound containing 77.43% of C, 7.53% of H and 15.05% of N ?
- $C_3H_{3.5}N_{1.5}$  and  $C_6H_7N$
  - $C_6H_7N$  and  $C_6H_7N$
  - $C_3H_3N$  and  $C_6H_7N$
  - $C_3H_3N$  and  $C_6H_6N_2$
142. Liquid benzene ( $C_6H_6$ ) burns in oxygen according to the equation  $2C_6H_6(l) + 15O_2(g) \longrightarrow 12CO_2(g) + 6H_2O(g)$   
How many litres of  $O_2$  at STP are needed to complete the combustion of 39 g of liquid benzene? (Mol. wt. of  $O_2$  = 32,  $C_6H_6$  = 78)
- 74 L
  - 11.2 L
  - 22.4 L
  - 84 L
143. Assuming fully decomposed, the volume of  $CO_2$  released at STP on heating 9.85 g of  $BaCO_3$  (Atomic mass, Ba = 137) will be
- 2.24 L
  - 4.96 L
  - 1.12 L
  - 0.84 L
144. The mass of  $BaCO_3$  produced when excess  $CO_2$  is bubbled through a solution of 0.205 mol  $Ba(OH)_2$  is :
- 81 g
  - 40.5 g
  - 20.25 g
  - 162 g
145. For the reaction  $Fe_2O_3 + 3CO_2 \rightarrow 2Fe + 3CO_2$ , the volume of carbon monoxide required to reduce one mole of ferric oxide is
- $67.2 \text{ dm}^3$
  - $11.2 \text{ dm}^3$
  - $22.4 \text{ dm}^3$
  - $44.8 \text{ dm}^3$
146. How many moles of lead (II) chloride will be formed from a reaction between 6.5 g of  $PbO$  and 3.2 g of  $HCl$  ?
- 0.044
  - 0.333
  - 0.011
  - 0.029
147. Fat is an important source of energy and water, this is important for the desert animals like camel which store fat in its hump and provide water and energy. How many grams and moles of  $H_2O$  are produced from the combustion of fat  $C_{57}H_{110}O_6$  from 450 gram of fat stored in hump of camel ?
- $$C_{57}H_{110}O_6 + \frac{163}{2}O_2 \rightarrow 57CO_2 + 55H_2O$$
- 500.56, 27.80
  - 450, 26.80
  - 580, 25.0
  - 400, 26.6

- 148.** Which of the following option represents correct limiting reagents in reactions (i), (ii) and (iii) respectively.
- (i)  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$   
(26g) (20g)
- (ii)  $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$   
(60g) (80g)
- (iii)  $\text{P}_4 + 3\text{O}_2 \rightarrow \text{P}_4\text{O}_6$   
(100g) (200g)
- (a) C, N<sub>2</sub>, O<sub>2</sub> (b) C, N<sub>2</sub>, P<sub>4</sub>  
(c) O<sub>2</sub>, H<sub>2</sub>, P<sub>4</sub> (d) O<sub>2</sub>, N<sub>2</sub>, P<sub>4</sub>
- 149.** 10 mL of 2(M) NaOH solution is added to 200 mL of 0.5 (M) of NaOH solution. What is the final concentration ?
- (a) 0.57 (M) (b) 5.7 (M)  
(c) 11.4 (M) (d) 1.14 (M)
- 150.** If maximum fluoride ion presence was set to be 4 ppm number of moles of fluoride in 10 ml drinking water ?
- (a)  $2.10 \times 10^{-3}$  (b)  $2.10 \times 10^{-2}$   
(c)  $3.10 \times 10^{-3}$  (d)  $3.3 \times 10^{-2}$
- 151.** The increasing order of molarity with 25 gm each of NaOH, LiOH, Al(OH)<sub>3</sub>, KOH, B(OH)<sub>3</sub> in same volume of water?
- (a)  $\text{Al(OH)}_3 < \text{B(OH)}_3 < \text{KOH} < \text{NaOH} < \text{LiOH}$   
(b)  $\text{LiOH} < \text{NaOH} < \text{KOH} < \text{B(OH)}_3 < \text{Al(OH)}_3$   
(c)  $\text{LiOH} < \text{NaOH} < \text{B(OH)}_3 < \text{KOH} < \text{Al(OH)}_3$   
(d)  $\text{NaOH} < \text{LiOH} < \text{B(OH)}_3 < \text{Al(OH)}_3 < \text{KOH}$

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (c) By sublimation since  $I_2$  sublimes.
2. (d) It forms the basis of gravity separation.
3. (d) Candle is a heterogeneous mixture of wax and threads. Copper is an element while bottled water and table salt are compounds.
4. (c) Glucose is a pure substance hence its constituents cannot be separated by simple physical method.
5. (a) In case of B, none of  $O_2$  and  $H_2$  is a compound since compound consist of two or more different atoms.
6. (c)
7. (d) Silver is an element, water is a compound and air is a mixture.
8. (c) Attraction between particles in solid is maximum and hence their movement is minimum amongst the phases.  
Attraction between particles in gases is minimum and hence their movements is maximum amongst the three phases.  
Attraction between the particles and their movements in liquids is intermediate i.e., between solids and gases.
9. (c) A mixture may contain any number of components in any ratio.  
e.g. air is a mixture of various gases.
10. (d) It is a solution and is a mixture of sucrose and water.
11. (b) One fermi is  $10^{-13}$  cm.
12. (c) Exa =  $10^{18}$
13. (d) 1 zepto =  $10^{-21}$
14. (a) Joule is the unit of work and Pascal is unit of pressure.  
$$JPa^{-1} = \frac{J}{Pa} = \frac{Work}{Pressure} = \frac{Nm}{Nm^{-2}} = m^3$$
15. (a)  $1 m^3$  of water  $10^6 cm^3$  of water  
 $\therefore$  Mass of  $10^6 cm^3$  water  
 $= 10^6 cm^3 \times 1 g cm^{-3}$  ( $\because$  density of  $H_2O = 1 g cm^{-3}$ )  
 $= 10^6 g = \frac{10^6}{10^3} kg = 10^3 kg = 1000 kg$   
(b) Weight of normal adult man = 65 kg  
 $\therefore$  Weight of  $1 m^3$  of water is highest.  
(c) Density of Hg =  $13.6 g cm^{-3}$   
Volume of Hg =  $10 L = 10 \times 1000 = 10^4 cm^3$   
 $\therefore$  Weight of Hg =  $13.6 \times 10^4 = 136000 g = 136 kg$
16. (d) Smallest and largest amount of energy respectively are eV and L-atm.  
 $1 eV = 1.6 \times 10^{-19} J$   
 $1 L-atm = 101.325 J$
17. (c)
18. (d) Litre (L) is not an SI unit. It is used for measurement of volume of liquids.
19. (c) yocto =  $10^{-24}$
20. (c)  $^{\circ}C = \frac{5}{9}(^{\circ}F - 32) = \frac{5}{9}(41 - 32) = 5^{\circ}C$   
It will be cold.
21. (a) Out of two 3.929 g is more accurate and will be reported as 3.93 after rounding off.
22. (b)
23. (a) 0.00016 can be written as  $1.6 \times 10^{-4}$  in scientific notation.
24. (d) Both Y and X are neither precise nor accurate as the two values in each of them are not close. With respect to X & Y, the values of Z are close & agree with the true value. Hence, both precise & accurate.
25. (c) On calculation we find  
$$\frac{(29.2 - 20.2)(1.79 \times 10^5)}{1.37} = 1.17 \times 10^6$$
  
As the least precise number contains 3 significant figures therefore, answers should also contains 3 significant figures.
26. (d) We know that all non-zero digits are significant and the zeros at the beginning of a number are not significant. Therefore number 161 cm, 0.161 cm and 0.0161cm have 3, 3 and 3 significant figures respectively.
27. (b) Given  $P = 0.0030m$ ,  $Q = 2.40m$  &  $R = 3000m$ . In  $P(0.0030)$  initial zeros after the decimal point are not significant. Therefore, significant figures in  $P(0.0030)$  are 2. Similarly in  $Q(2.40)$  significant figures are 3 as in this case final zero is significant. In  $R = (3000)$  all the zeros are significant hence, in  $R$  significant figures are 4 because they come from a measurement.
28. (a)
29. (c) If zero is used to locate the decimal point it is considered as a significant figure. In 50.000 all zero are significant.
30. (a) Sum of the figures 29.4406, 3.2 and 2.25 is 34.8906. The sum should be reported to the first place of decimal as 3.2 has only one decimal place. After rounding off the sum is 34.9. Hence number of significant figures is three.
31. (d) 10.3106 g has 6 significant figures. Since all non-zero digits are significant and a zero becomes significant if it appears between two non-zero digits.
32. (b) 
$$\frac{43.0 \times 0.0243}{0.340 \times 4} = 0.7683088$$
  
The least precise term has two significant figures (leaving the exact number). Hence after rounding off correct answer is 0.77.

33. (a) 2.6 has two significant figures.  
0.260 has three significant figures.  
0.002600 has four significant figures.  
2.6000 has five significant figures.
34. (d)  $\frac{\text{Energy}}{\text{volume}}$  which can be shown  
Pressure  
$$= \frac{\text{Force}}{\text{area}} = \frac{\text{Work (energy/distance)}}{\text{Area}} = \frac{\text{Energy}}{\text{Volume}}$$
35. (b)  $X + Y \rightleftharpoons R + S$   
 $\text{ng mg} \quad \text{pg qg}$   
 $n + m = p + q$  by law of conservation of mass.
36. (a)  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$   
20 g      8.8 g    11.2 g  
mass of reactant = mass of products = 20g.  
Hence the law of conservation of mass is obeyed.
37. (a) 38. (a)
39. (b)  $\text{NaHCO}_3 + \text{CH}_3\text{COOH} \longrightarrow \text{Residue} + \text{CO}_2 \uparrow$   
4.2g      10.0g      12.0g    2.2g  
Mass of reactants = 4.2 + 10.0 = 14.2 g  
Mass of products = 12.0 + 2.2 = 14.2 g  
Hence, given reaction illustrate law of conservation of mass.
40. (c) I experiment :  $\frac{\text{mass of H}_2 \text{ combined}}{\text{mass of O}_2 \text{ combined}} = \frac{4}{32} = \frac{1}{8}$   
II experiment :  $\frac{\text{mass of H}_2 \text{ combined}}{\text{mass of O}_2 \text{ combined}} = \frac{50}{400} = \frac{1}{8}$   
Hence both law of conservation of mass and constant composition is obeyed.
41. (c) The H : O ratio in water is fixed, irrespective of its source. Hence it is law of constant composition.
42. (a) Constant proportions according to which a pure chemical compound always contains same elements combined together in the same definite proportion of weight.
43. (c)
44. (d)  $\text{SnCl}_2$        $\text{SnCl}_4$   
119 : 2 × 35.5      119 : 4 × 35.5  
Chlorine ratio in both compounds is  
= 2 × 35.5 : 4 × 35.5 = 1 : 2
45. (d) In CuO and Cu<sub>2</sub>O the O : Cu is 1 : 1 and 1 : 2 respectively.  
This is law of multiple proportion.
46. (c)
47. (b) Law of multiple proportion. As the ratio of oxygen which combine with fix weights of 1 g of nitrogen bears a simple whole number ratio  
0.57 : 1 : 12 : 1.7031 : 2 : 3
48. (b)
49. (c) According to Avogadro's law "equal volumes of all gases contain equal number of molecules under similar conditions of temperature and pressure". Thus if 1 L of one gas contains N molecules, 2 L of any other gas under the same conditions of temperature and pressure will contain 2N molecules.
50. (b) The number of molecules of N<sub>2</sub> and X are same. Hence they must have the same molecular weights.  
∴ X is CO.
51. (c)
52. (c) In law of reciprocal proportions, the two elements combining with the third element, must combine with each other in the same ratio or multiple of that Ratio of S and O when combine with C is 2 : 1. Ratio of S and O is SO<sub>2</sub> is 1 : 1
53. (d) Avogadro's law is independent of the reactive or unreactive nature of the gases.  
According to Avogadro's law equal volumes of gases at the same temperature and pressure should contain equal number of molecules.
54. (c)
55. (b)  $1 \text{ amu} = \frac{1}{12}$  of the mass of C-12.
56. (b) The modern atomic weight scale is based on C<sup>12</sup>.
57. (d) Molecular weight of ZnSO<sub>4</sub>·7H<sub>2</sub>O  
= 65 + 32 + (4 × 16) + 7(2 × 1 + 16) = 287.  
∴ percentage mass of zinc (Zn)  
$$= \frac{65}{287} \times 100 = 22.65\%$$
58. (b) Average atomic mass of neon  
= 20 × 0.9051 + 21 × 0.0027 + 22 × 0.0922  
= 20.187 u
59. (a) (78.918361) × (0.5069) + (80.916289) × (0.4931)
60. (a) Mass of oxygen atom is 15.995 amu, because 1 amu = 1.66056 × 10<sup>-24</sup> g, hence 15.995 × value of 1 amu give the value equal to option (a).
61. (d)  $\frac{2.824784 \times 10^{-23}}{1.66056 \times 10^{-24}} = 14 \text{ amu}$   
Where 1.66056 × 10<sup>-24</sup> is equal to one atomic mass (amu)
62. (b) Gram molecular weight of CO = 12 + 16 = 28 g  
6.023 × 10<sup>23</sup> molecules of CO weight 28 g  
1 molecule of CO weighs =  $\frac{28}{6.02 \times 10^{23}} = 4.65 \times 10^{-23} \text{ g}$
63. (b) Molecular weight of SO<sub>2</sub> = 32 + 2 × 16 = 64  
64 g of SO<sub>2</sub> occupies 22.4 litre at STP  
240 g of SO<sub>2</sub> occupies =  $\frac{22.4}{64} \times 240 = 84 \text{ litre at STP}$
64. (a) 1 mol CCl<sub>4</sub> vapour = 12 + 4 × 35.5  
= 154 g ≡ 22.4 L at STP  
∴ Density =  $\frac{154}{22.4} \text{ gL}^{-1} = 6.875 \text{ gL}^{-1}$
65. (b) 6.02 × 10<sup>23</sup> molecules of CO = 1 mole of CO  
6.02 × 10<sup>24</sup> CO molecules = 10 moles CO  
= 10 g atoms of O = 5 g molecules of O<sub>2</sub>

66. (a)  $4.4 \text{ g CO}_2 = \frac{4.4}{44} = 0.1 \text{ mol CO}_2$  (mol. wt. of  $\text{CO}_2 = 44$ )  
 $= 6 \times 10^{22} \text{ molecules} = 2 \times 6 \times 10^{22} \text{ atoms of O.}$

67. (b) 2g of  $\text{H}_2$  means one mole of  $\text{H}_2$ , hence contains  $6.023 \times 10^{23}$  molecules. Others have less than one mole, so have less no. of molecules.

68. (a)  $\text{Fe (no. of moles)} = \frac{558.5}{55.85} = 10 \text{ moles} = 10N_A \text{ atoms.}$   
 No. of moles in 60 g of C =  $60/12 = 5 \text{ moles} = 5N_A \text{ atoms.}$

69. (c) 16 g  $\text{CH}_4$  is 1 mol. Hence number of molecules = Avogadro number =  $6.023 \times 10^{23}$ .

70. (c) M. Wt of  $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$  is 322 g which contains 224 g oxygen.  
 $\therefore 32.2 \text{ g will contain } 22.4 \text{ g oxygen.}$

71. (a) 21% of 1 litre is 0.21 litre.  
 22.4 litres = 1 mole at STP

$$\therefore 0.21 \text{ litre} = \frac{0.21}{22.4} = 0.0093 \text{ mol}$$

72. (d) At S.T.P. 22.4 litre of gas contains  $6.023 \times 10^{23}$  molecules  
 $\therefore$  molecules in 8.96 litre of gas

$$= \frac{6.023 \times 10^{23} \times 8.96}{22.4} = 24.08 \times 10^{22}$$

73. (b) Mass of one molecule of Water

$$= \frac{18}{6.023 \times 10^{23}} = 3 \times 10^{-23} \text{ g} = 3 \times 10^{-26} \text{ Kg}$$

74. (d) 1 molecule of  $\text{CO}_2$  has one atom of C and two atoms of oxygen.

$$\therefore 1 \text{ mole of } \text{CO}_2 \text{ has} = 6.02 \times 10^{23} \text{ atoms of C} \\ = 2 \times 6.02 \times 10^{23} \text{ atoms of O}$$

75. (a) Given,  $V = 1.12 \times 10^{-7} \text{ cm}^3$   
 $22400 \text{ cm}^3 \text{ at NTP} = 6.02 \times 10^{23} \text{ molecules}$

$$\therefore 1.12 \times 10^{-7} \text{ cm}^3 \text{ at NTP} = \frac{6.02 \times 10^{23}}{22400} \times 1.12 \times 10^{-7} \\ = 3.01 \times 10^{12} \text{ molecules.}$$

76. (b) Total atoms in 1 molecule of  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$   
 $= 12 + 22 + 11 = 45$

$$\therefore \text{Total atoms in 1 mole of } \text{C}_{12}\text{H}_{22}\text{O}_{11} \\ = 45 \times 6.02 \times 10^{23} \text{ atoms/mol.}$$

77. (a) 22.4 L of  $\text{O}_2$  at STP = 32 g

$$\therefore 1 \text{ L of } \text{O}_2 \text{ at STP} = \frac{32}{22.4} \times 1 = 1.428 \text{ g} = 1.43 \text{ g}$$

78. (c) Given  $V = 2 \text{ L}$ , Molarity = 0.5M, Moles = ?

$$\text{Molarity} = \frac{\text{No. of moles of solute}}{V \text{ of solution in L}} \text{ or } 0.5 = \frac{\text{Moles}}{2}$$

$$\therefore \text{Moles} = 2 \times 0.5 = 1.0$$

79. (a) Let mass of  $\text{O}_2 = 1 \text{ g}$

$$\therefore \text{Mass of } \text{N}_2 = 4\text{g}$$

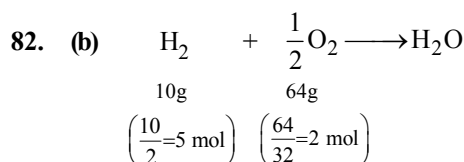
$$\text{No. of molecules of } \text{O}_2 = \frac{1}{32}$$

$$\text{No. of molecules of } \text{N}_2 = \frac{4}{28}$$

$$\text{Ratio of no. of molecules} = \frac{1}{32} : \frac{4}{28} = \frac{1}{32} : \frac{1}{7} = 7 : 32$$

80. (d)  $\text{No. of moles} = \frac{\text{weight}}{\text{mol. wt.}} = \frac{50}{342} = 0.14 \text{ mole}$

81. (c) Mass of 1 electron =  $9.11 \times 10^{-28} \text{ g}$   
 $\therefore$  Mass of 1 mole ( $6.02 \times 10^{23}$ ) electrons  
 $= 9.11 \times 10^{-28} \times 6.02 \times 10^{23} \text{ g}$   
 $= 55 \times 10^{-5} \text{ g} = 55 \times 10^{-5} \times 10^3 \text{ mg} = 0.55 \text{ mg.}$



In this reaction oxygen is the limiting agent. Hence amount of  $\text{H}_2\text{O}$  produced depends on the amount of  $\text{O}_2$  taken

$$\therefore 0.5 \text{ mole of } \text{O}_2 \text{ gives } \text{H}_2\text{O} = 1 \text{ mol}$$

$$\therefore 2 \text{ mole of } \text{O}_2 \text{ gives } \text{H}_2\text{O} = 4 \text{ mol}$$

83. (c) **No. of molecules**

$$\text{Moles of } \text{CO}_2 = \frac{44}{44} = 1 \quad N_A$$

$$\text{Moles of } \text{O}_3 = \frac{48}{48} = 1 \quad N_A$$

$$\text{Moles of } \text{H}_2 = \frac{8}{2} = 4 \quad 4N_A$$

$$\text{Moles of } \text{SO}_2 = \frac{64}{64} = 1 \quad N_A$$

84. (b) Molecular weight of  $\text{C}_{60}\text{H}_{122} = (12 \times 60) + 122 = 842$ .  
 Therefore weight of one molecule

$$= \frac{\text{Molecular weight of } \text{C}_{60}\text{H}_{122}}{\text{Avagadro's number}}$$

$$= \frac{842}{6.023 \times 10^{23}} = 1.4 \times 10^{-21} \text{ g}$$

85. (c) 50% of X (Atomic mass 10), 50% of Y (Atomic mass 20).

$$\text{Relative number of atoms of X} = \frac{50}{10} = 5 \text{ and than}$$

$$Y = \frac{50}{20} = 2.5$$

Simple Ratio 2 : 1. Formula  $\text{X}_2\text{Y}$

86. (a) Element	%	Atomic mass	Relative no. of atoms	Simple ratio of atoms
C	80	12	$\frac{80}{12} = 6.66$	$\frac{6.66}{6.66} = 1$
H	20	1	$\frac{20}{1} = 20.0$	$\frac{20.0}{6.66} = 3$

$\therefore$  Empirical formula is  $\text{CH}_3$

87. (a) Empirical formula of compound =  $\text{CH}_2$   
Molecular mass of the compound = 42  
 $\therefore n = 42/14 = 3$   
 $\therefore$  Hence molecular formula =  $\text{C}_3\text{H}_6$
88. (d) C 54.55      54.55/12 = 4.5      4.5/2.27 = 2  
H 9.099, 0.09/1 = 9.09      9.09/2.27 = 4  
O 36.36      36.36/16 = 2.27      2.27/2.27 = 1  
Hence empirical formula of the compound =  $\text{C}_2\text{H}_4\text{O}$
89. (a) Mass ratio of H : C = 1 : 12  
However, given mass ratio of H : C = 1 : 3  
Therefore, for every C atom, there are 4 H atoms, hence empirical formula =  $\text{CH}_4$
90. (a) 

Element	Percentage	Atomic weight	Atomic ratio	Simple ratio
C	38.71	12	$\frac{38.71}{12} = 3.23$	$\frac{3.23}{3.23} = 1$
H	9.67	1	$\frac{9.67}{1} = 9.67$	$\frac{9.67}{3.23} = 3$
O	$100 - (38.71 + 9.67) = 51.62$	16	$\frac{51.62}{16} = 3.23$	$\frac{3.23}{3.23} = 1$

  
Thus empirical formula is  $\text{CH}_3\text{O}$ .
91. (d) 

Element	%	At. Mass	Rel.No. of Atoms	Simple Ratio
C	75	12	$75/12 = 6.25$	1
H	25	1	$25/1 = 25$	4

  
 $\therefore$  Empirical formula is  $\text{CH}_4$ .
92. (b)  $\text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2 \uparrow$   
 $\frac{1}{2}$  mole       $\frac{1}{2}$  mole (12g of Mg =  $\frac{1}{2}$  mol)
93. (a) We know that  
 $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$   
 28 g    6 g    34 g  
 14 g    3 g    17 g  
 Here given  $\text{H}_2$  is 3 kg and  $\text{N}_2$  is 20 kg but 3 kg of  $\text{H}_2$  can only react with 14 g of  $\text{N}_2$  and thus the obtained  $\text{NH}_3$  will be of 17 kg.
94. (d)  $2\text{H}_2 + \text{O}_2 \longrightarrow 2\text{H}_2\text{O}$   
 4g    32g    36g  
 4kg    32 kg    36kg
95. (c)  $\text{C}_2\text{H}_4 + 3\text{O}_2 \longrightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$   
 28 g    96 g  
 $\therefore$  28 g of  $\text{C}_2\text{H}_4$  undergo complete combustion by = 96 g of  $\text{O}_2$   
 $\therefore$  2.8 kg of  $\text{C}_2\text{H}_4$  undergo complete combustion by = 9.6 kg of  $\text{O}_2$ .
96. (c) According to stoichiometry they should react as follow  
 $4\text{NH}_3 + 5\text{O}_2 \longrightarrow 4\text{NO} + 6\text{H}_2\text{O}$   
 4 mole of  $\text{NH}_3$  requires 5 mole of  $\text{O}_2$ .

1 mole of  $\text{NH}_3$  requires =  $\frac{5}{4} = 1.25$  mole of  $\text{O}_2$ .

Hence  $\text{O}_2$  is consumed completely.

97. (a)  $\text{Molarity} = \text{Normality} \times \frac{\text{Equivalent mass}}{\text{Molecular mass}}$

$$= 0.2 \times \frac{M}{2 \times M} = 0.1 \text{ M}$$

98. (a)  $\text{Molarity} = \frac{\text{Normality}}{\text{Replaceable hydrogen atom}}$

$\therefore \text{H}_2\text{SO}_4$  is dibasic acid.

$\therefore$  Molar solution of  $\text{H}_2\text{SO}_4 = \text{N}/2 \text{ H}_2\text{SO}_4$

99. (b) Given  $N_1 = 10\text{N}$ ,  $V_1 = 10 \text{ ml}$ ,  $N_2 = 0.1\text{N}$ ,  $V_2 = ?$

$$N_1V_1 = N_2V_2$$

$$\text{or } 10 \times 10 = 0.1 \times V_2$$

$$\text{or } V_2 = \frac{10 \times 10}{0.1}, V_2 = 1000 \text{ ml}$$

$$\text{Volume of water to be added} = V_2 - V_1 = 1000 - 10 = 990 \text{ ml.}$$

100. (b)  $\text{ppm} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 10^6$

$$\therefore \text{ppm} = \frac{6 \times 10^{-3}}{1000} \times 10^6 = 6.$$

101. (a)  $5 \text{ M H}_2\text{SO}_4 = 10 \text{ N H}_2\text{SO}_4$ ,  
 ( $\because$  Basicity of  $\text{H}_2\text{SO}_4 = 2$ )

$$N_1V_1 = N_2V_2,$$

$$10 \times 1 = N_2 \times 10 \text{ or } N_2 = 1 \text{ N}$$

102. (c) Among all the given options molarity is correct because the term molarity involve volume which increases on increasing temperature.

103. (b) Moles of urea present in 100 ml of sol. =  $\frac{6.02 \times 10^{20}}{6.02 \times 10^{23}}$

$$\therefore M = \frac{6.02 \times 10^{20} \times 1000}{6.02 \times 10^{23} \times 100} = 0.01 \text{ M}$$

[  $\because$  M = Moles of solute present in 1L of solution ]

104. (b) From the molarity equation.

$$M_1V_1 + M_2V_2 = MV$$

Let M be the molarity of final mixture,

$$M = \frac{M_1V_1 + M_2V_2}{V} \text{ where } V = V_1 + V_2$$

$$M = \frac{480 \times 1.5 + 520 \times 1.2}{480 + 520} = 1.344 \text{ M}$$

### STATEMENT TYPE QUESTIONS

105. (c) Both solids and liquids have definite volume, but gases do not.  
 Solids have their own shape, but liquids and gases takes the shape of the container in which they are put in.



106. (b) For statement (ii), it is not necessary that all components of a heterogeneous mixture are observable to naked eyes for example blood is a heterogeneous mixture whose components are not visible to naked eyes. For statement (iv) air is a homogeneous mixture of various gases.
107. (d) Mass of a substance is the amount of matter present in it while weight is the force exerted by gravity on an object.  
Mass is constant while weight may vary from one place to another due to gravity.  
SI unit of both mass and weight is kilogram.
108. (c)  $27.3 \text{ days} = 27.3 \times 24 \text{ hours}$   
 $= 655.2 \text{ hours}$   
 $27.3 \text{ days} = 27.3 \times 24 \times 60 \text{ minutes}$   
 $= 39312 \text{ minutes}$   
 $27.3 \text{ days} = 27.3 \times 24 \times 60 \times 60 \text{ seconds}$   
 $= 2358720 \text{ seconds}$
109. (c) For statement (i), T = The other name of Gay-Lussac's law is law of definite proportions by volume.  
For statement (ii), F = Law of conservation of mass is valid for both physical and chemical change.  
For statement (iii), F = Law of definite proportion is valid for each compound individually and not for comparing two different compounds.  
For statement (iv),  $T = x/y$  must be a simple whole number ratio and must be a positive integer.  
For statement (v), F = Equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules.
110. (c) For statement (i) : H, O, C, N = All have different chemical properties.  
For statement (ii) : It is true as per Dalton's postulate.  
For statement (iii) : N : O = 1 : 1 (NO)  
For statement (iv) : Dalton's postulates says, atoms can neither be created nor destroyed.
111. (c) Molecular mass of cane sugar ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ )  
 $= 12 \times 12 + 22 \times 1 + 11 \times 16$   
 $= 342 \text{ amu}$   
1 mole of cane sugar ( $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ ) = 342 g  
(Molecular mass of cane sugar = 342 g)  
342 g of cane sugar contain =  $6.022 \times 10^{23}$  molecules  
 $34.20 \text{ g of cane sugar contain} = \frac{6.022 \times 10^{23}}{342} \times 34.20$   
 $= 6.022 \times 10^{22} \text{ molecules.}$

**MATCHING TYPE QUESTIONS**

112. (a)
113. (b) Terminal zeros are not significant if there is no decimal i.e., 290 contains two significant figures whereas in 29900, there are 5 significant figures;  $1.23 \times 1.331 = 1.63713$  but keeping the mind the 1.23 has only few significant figures i.e., only three significant figures, so result should also be reported in three significant figures only. Thus 1.6373 should be rounded off to 1.64. Value 1.783 is rounded off to 2, so has only one significant figure.

114. (a)      115. (b)      116. (a)
117. (d)  $A : 28 \text{ g of He} = \frac{28}{4} = 7 \text{ mol}$   
 $B : 46 \text{ g of Na} = \frac{46}{23} = 2 \text{ mol}$   
 $C : 60 \text{ g of Ca} = \frac{60}{40} = 1.5 \text{ mol}$   
 $D : 27 \text{ g of Al} = \frac{27}{27} = 1 \text{ mol}$

118. (c)

**ASSERTION- REASON TYPE QUESTIONS**

119. (c)
120. (d) 1.231 has four significant figures all no. from left to right are counted, starting with the first digit that is not zero for calculating the no. of significant figure.
121. (b)
122. (d) We know that from the reaction  $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$  that the ratio of the volume of gaseous reactants and products is in agreement with their molar ratio. The ratio of  $\text{H}_2 : \text{Cl}_2 : \text{HCl}$  volume is 1 : 1 : 2 which is the same as their molar ratio. Thus volume of gas is directly related to the number of moles. Therefore, the assertion is false but reason is true.
123. (c) Equal moles of different substances contain same number of constituent particles but equal weights of different substances do not contain the same number of constituent particles.
124. (a)

**CRITICAL THINKING TYPE QUESTIONS**

125. (b) For, 0.0 significant figure is zero. For 0.1 to 0.9 significant figure will be 1 whereas from 1.0 to 2.0 significant figures will be 2.
126. (a) In law of reciprocal proportions, the two elements combining with the third element, must combine with each other in the same ratio or multiple of that ratio.  $\text{P}_2\text{O}_3$ ,  $\text{PH}_3$  and  $\text{H}_2\text{O}$  correctly illustrate the law of reciprocal proportions. Ratio in the number of atoms of hydrogen and oxygen combining with one P is 3 : 1.5 i.e., 2 : 1.
127. (a) Relative atomic mass  
 $= \frac{\text{Mass of one atom of the element}}{1/12^{\text{th}} \text{ part of the mass of one atom of Carbon} - 12}$   
or  $\frac{\text{Mass of one atom of the element}}{\text{mass of one atom of the C} - 12} \times 12$   
Now if we use  $1/6$  in place of  $1/12$  the formula becomes  
Relative atomic mass =  $\frac{\text{Mass of one atom of element}}{\text{Mass of one atom of carbon}} \times 6$   
 $\therefore$  Relative atomic mass decrease twice

128. (a) No. of molecules in different cases

$$(a) \therefore 22.4 \text{ litre at STP contains} \\ = 6.023 \times 10^{23} \text{ molecules of } H_2$$

$$\therefore 15 \text{ litre at STP contains} = \frac{15}{22.4} \times 6.023 \times 10^{23} \\ = 4.03 \times 10^{23} \text{ molecules of } H_2$$

$$(b) \therefore 22.4 \text{ litre at STP contains} \\ = 6.023 \times 10^{23} \text{ molecules of } N_2$$

$$\therefore 5 \text{ litre at STP contains} = \frac{5}{22.4} \times 6.023 \times 10^{23} \\ = 1.344 \times 10^{23} \text{ molecules of } N_2$$

$$(c) \therefore 2 \text{ gm of } H_2 = 6.023 \times 10^{23} \text{ molecules of } H_2$$

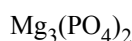
$$\therefore 0.5 \text{ gm of } H_2 = \frac{0.5}{2} \times 6.023 \times 10^{23} \\ = 1.505 \times 10^{23} \text{ molecules of } H_2$$

$$(d) \text{ Similarly } 10 \text{ g of } O_2 \text{ gas} \\ = \frac{10}{32} \times 6.023 \times 10^{23} \text{ molecules of } O_2 \\ = 1.88 \times 10^{23} \text{ molecules of } O_2$$

Thus (a) will have maximum number of molecules

129. (d) 1 Mole of  $Mg_3(PO_4)_2$  contains 8 mole of oxygen atoms  
 $\therefore$  8 mole of oxygen atoms  $\equiv$  1 mole of  $Mg_3(PO_4)_2$

$$0.25 \text{ mole of oxygen atom} \equiv \frac{1}{8} \times 0.25 \text{ mole of}$$



$$= 3.125 \times 10^{-2} \text{ mole of } Mg_3(PO_4)_2$$

$$130. (c) \text{ Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$1 \text{ gram cm}^{-3} = \frac{1 \text{ gram}}{\text{cm}^3}$$

$$\text{Volume} = \frac{\text{Mass}}{\text{Density}} = \frac{1 \text{ gram}}{1 \text{ gram cm}^{-3}} = 1 \text{ cm}^3$$

$\therefore$  Volume occupied by 1 gram water =  $1 \text{ cm}^3$   
 or Volume occupied by

$$\frac{6.023 \times 10^{23}}{18} \text{ molecules of water} = 1 \text{ cm}^3$$

$$[\therefore 1 \text{ g water} = \frac{1}{18} \text{ moles of water}]$$

Thus volume occupied by 1 molecule of water

$$= \frac{1 \times 18}{6.023 \times 10^{23}} \text{ cm}^3 = 3.0 \times 10^{-23} \text{ cm}^3$$

$$131. (b) \text{ The number of atoms in } 0.1 \text{ mole of a triatomic gas} \\ = 0.1 \times 3 \times 6.023 \times 10^{23} \\ = 1.806 \times 10^{23}$$

132. (d) At NTP 22400 cc of  $N_2O = 6.02 \times 10^{23}$  molecules

$$\therefore 1 \text{ cc } N_2O = \frac{6.02 \times 10^{23}}{22400} \text{ molecules}$$

$$= \frac{3 \times 6.02 \times 10^{23}}{22400} \text{ atoms} = \frac{1.8}{224} \times 10^{22} \text{ atoms}$$

No. of electrons in a molecule of  $N_2O = 7 + 7 + 8 = 22$

Hence no. of electrons

$$= \frac{6.02 \times 10^{23}}{22400} \times 22 \text{ electrons} = \frac{1.32 \times 10^{23}}{224}$$

133. (b) If  $10^{20}$  grains are distributed in one sec,  $6.023 \times 10^{23}$  grains will be distributed in

$$\frac{6.023 \times 10^{23} \times 1}{10^{20} \times 60 \times 60} = 1.673 \text{ hrs}$$

134. (a) Mass of  $6.023 \times 10^{23}$  atoms of oxygen = 16 g  
 Mass of one atom of oxygen

$$= \frac{16}{6.023 \times 10^{23}} = 2.66 \times 10^{-23} \text{ g}$$

Mass of  $6.023 \times 10^{23}$  atoms of nitrogen = 14 g

Mass of one atom of nitrogen

$$= \frac{14}{6.023 \times 10^{23}} = 2.32 \times 10^{-23} \text{ g}$$

Mass of  $1 \times 10^{-10}$  mole of oxygen =  $16 \times 10^{-10}$

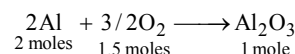
Mass of 1 mole of copper = 63 g

Mass of 1 mole of oxygen = 16 g

$$\text{Mass of } 1 \times 10^{-10} \text{ mole of copper} = 63 \times 1 \times 10^{-10} \\ = 63 \times 10^{-10}$$

So, the order of increasing mass is II < I < III < IV.

135. (b) The equation for the formation of  $Al_2O_3$  can be represented as



Thus, 1 mole of alumina is obtained by the reaction of 1.5 moles of oxygen and 2 moles of aluminium. Thus, the amount of aluminium

$$= 2 \times 27 \text{ g} = 54 \text{ g. [mol. mass of Al} = 27]$$

136. (c) (a) Weight of  $H_2$  = mole  $\times$  molecular wt.

$$= 0.2 \times 2 = 0.4 \text{ g}$$

$$(b) 6.023 \times 10^{23} = 1 \text{ mole}$$

$$\text{Thus } 6.023 \times 10^{22} = 0.1 \text{ mole}$$

$$\text{Weight of } N_2 = 0.1 \times 28 = 2.8 \text{ g}$$

$$(c) \text{ Weight of silver} = 0.1 \text{ g}$$

$$(d) \text{ Weight of oxygen} = 32 \times 0.1 = 3.2 \text{ g}$$



137. (c)	Percentage	R.N.A	Simplest ratio
C	9	$\frac{9}{12} = \frac{3}{4}$	3
H	1	$\frac{1}{1} = 1$	4
N	3.5	$\frac{3.5}{14} = \frac{1}{4}$	1

Empirical formula =  $C_3H_4N$

$(C_3H_4N)_n = 108$

$(12 \times 3 + 4 \times 1 + 14)_n = 108$

$(54)_n = 108$

$n = \frac{108}{54} = 2$

$\therefore$  molecular formula =  $C_6H_8N_2$

138. (c) The acid with empirical formula  $CH_2O_2$  is formic acid,  $H-COOH$ .

139. (d)  $\therefore$  18 gm,  $H_2O$  contains = 2 gm H

$\therefore$  0.72 gm  $H_2O$  contains =  $\frac{2}{18} \times 0.72$  gm = 0.08 gm H

$\therefore$  44 gm  $CO_2$  contains = 12 gm C

$\therefore$  3.08 gm  $CO_2$  contains =  $\frac{12}{44} \times 3.08 = 0.84$  gm C

$\therefore$  C : H =  $\frac{0.84}{12} : \frac{0.08}{1} = 0.07 : 0.08 = 7 : 8$

$\therefore$  Empirical formula =  $C_7H_8$

140. (a) Let 100 g of compound be there.

Number of moles of Nitrogen =  $\frac{35}{14} = 2.5$

Number of moles of Hydrogen =  $\frac{5}{1.008} = 4.9$

Number of moles of Carbon =  $\frac{60}{12.01} = 4.9$

Since 2.5 is the smallest value division by it give ratio

N : H : C

1 : 1.96 : 1.96

= 1 : 2 : 2

Empirical formula =  $C_2H_2N$

Empirical formula weight =  $2 \times 12 + 2 + 14 = 40$

Molecular mass = 80

Molecular formulae =  $n (C_2H_2N)$

=  $2 (C_2H_2N) \left( n = \frac{80}{40} \right) = C_4H_4N_2$

141. (b) Let 100 g of compound be there.

Number of moles of C =  $\frac{77.43g}{12.01g/mol} = 6.44$

Number of moles of H =  $\frac{7.53g}{1.008g/mol} = 7.47$

Number of moles of N =  $\frac{15.05}{14.00g/mol} = 1.075$

1.074 is the smallest value, division by it gives a ratio of C : H : N

= 5.9 : 6.9 : 1

= 6 : 7 : 1

Empirical formula =  $C_6H_7N$

Empirical formula weight =  $6 \times 12 + 7 + 14 = 93$

$n = \frac{\text{Molecular mass}}{\text{Empirical formula weight}} = 1$

Molecular formula =  $1 \times C_6H_7N = C_6H_7N$

142. (d)  $2C_6H_6 + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(g)$

$\therefore$  156 gm of benzene required oxygen =  $15 \times 22.4$  litre

$\therefore$  1 gm of benzene required oxygen =  $\frac{15 \times 22.4}{156}$  litre

$\therefore$  39 gm of Benzene required oxygen

=  $\frac{15 \times 22.4 \times 39}{156} = 84.0$  litre

143. (c)  $BaCO_3 \rightarrow BaO + CO_2$

$\therefore$  197 gm of  $BaCO_3$  released carbon dioxide = 22.4 litre at STP

$\therefore$  1 gm of  $BaCO_3$  released carbon dioxide =  $\frac{22.4}{197}$  litre

$\therefore$  9.85 gm of  $BaCO_3$  released carbon dioxide

=  $\frac{22.4}{197} \times 9.85 = 1.12$  litre

144. (b)  $Ba(OH)_2 + CO_2 \rightarrow BaCO_3 + H_2O$

$n \text{ mol } Ba(OH)_2 = n \text{ mol } BaCO_3$

$\therefore$  0.205 mol  $Ba(OH)_2 \equiv 0.205$  mol  $BaCO_3$

Wt. of substance = No. of moles  $\times$  Molecular mass  
=  $0.205 \times 197.3 = 40.5$  g

145. (a)  $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

( $\therefore$  vol% = mol%)

One gram mol of any gas occupies 22.4 litre at NTP. 1 mol of  $Fe_2O_3$  requires 3 mol of CO for its reduction i.e., 1 mol of  $Fe_2O_3$  requires  $3 \times 22.4$  litre or  $67.2 \text{ dm}^3$  CO to get itself reduced.

146. (d) Writing the equation for the reaction, we get

$PbO + 2HCl \rightarrow PbCl_2 + H_2O$

No. of moles of  $PbO = \frac{6.5}{223} = 0.029$

No. of moles of  $HCl = \frac{3.2}{36.5} = 0.0877$

Thus  $PbO$  is the limiting reactant 1 mole of  $PbO$  produce 1 mole  $PbCl_2$ .

0.029 mole  $PbO$  produces 0.029 mole  $PbCl_2$ .

147. (a)  $C_{57}H_{110}O_6 + \frac{163}{2}O_2 \rightarrow 57CO_2 + 55H_2O$   
 890 gram of fat produces 990 gram of  $H_2O$   
 450 gram fat produces  $\left(\frac{990}{890} \times 450\right)$   
 $= 500.56 \text{ g of } H_2O$   
 Moles of  $H_2O = \frac{500.56 \text{ g}}{18 \text{ g/mol}} = 27.80$

148. (d)  $n_C = \frac{26 \text{ g}}{12 \text{ g/mol}} = 2.16$

$n_{O_2} = \frac{20 \text{ g}}{32 \text{ g/mol}} = 0.625$

$O_2$  will be a limiting reagent in reaction (i)

$n_{N_2} = \frac{60 \text{ g}}{28 \text{ g/mol}} = 2.14$

$n_{H_2} = 40$

According to balanced equation,

1 mol of  $N_2$  requires 3 mole of  $N_2$

2.14 mol of  $N_2$  require 6.42 mol of  $N_2$

$N_2$  will be a limiting reagent in reaction (ii)

$n_{P_4} = \frac{100 \text{ g}}{4 \times 31} = 0.86 \quad n_{O_2} = 6.25$

According to balanced equation

1 mol of  $P_4$  require 3 mol of  $O_2$

0.86 mol of  $P_4$  require 2.58 mol of  $O_2$

So  $P_4$  is a limiting reagent in reaction (iii)

149. (a) From molarity equation  
 $M_1V_1 + M_2V_2 = MV_{(\text{total})}$   
 $2 \times \frac{10}{1000} + 0.5 \times \frac{200}{1000} = M \times \frac{210}{1000}$   
 $120 = M \times 210$   
 $M = \frac{120}{210} = 0.57 \text{ M}$

150. (a) 1 ppm = 1 mg / 1 litre (for liquids)  
 4 ppm = 4 mg / 1 litre  
 1 litre contains 4 mg of fluoride ions  
 10 ml contains  $\frac{4}{1000} \times 10 = 0.04 \text{ mg}$

Number of moles of fluoride =  $\frac{0.04 \text{ g}}{19 \text{ g/mol}}$   
 $= 2.10 \times 10^{-3}$

151. (a) Molarity (M) =  $\frac{\text{No. of moles of solute}}{\text{Volume of solution in litres}}$   
 Molarity  $\propto n_{\text{solute}}$

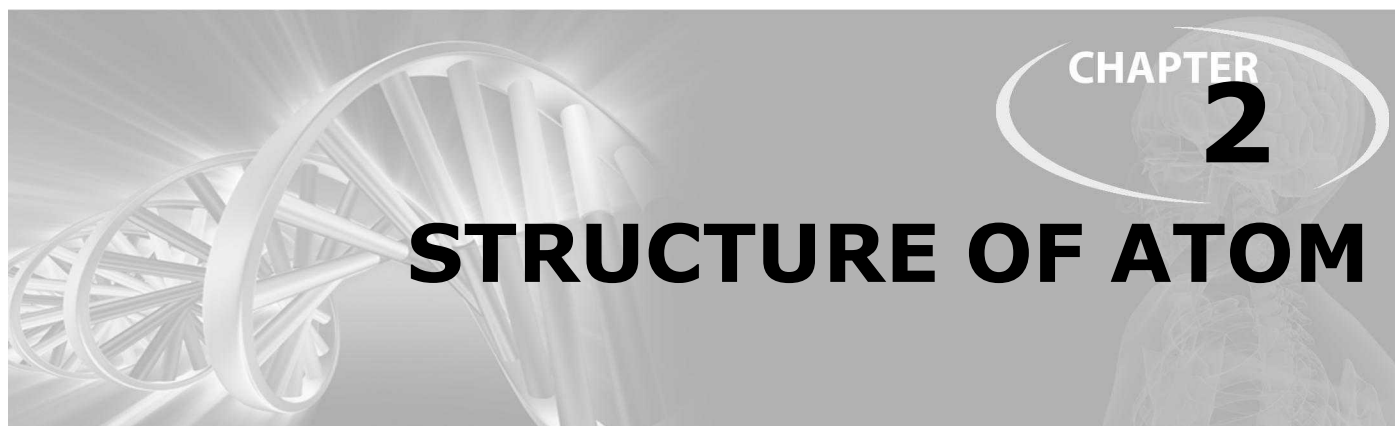
$n_{NaOH} = \frac{25}{40} = 0.625$

$n_{LiOH} = \frac{25}{24} = 1.04$

$n_{Al(OH)_3} = \frac{25}{(17 + 3 \times 17)} = 0.32$

$n_{KOH} = \frac{25}{(39 + 17)} = 0.45$

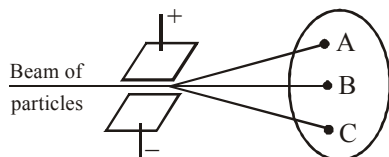
$n_{B(OH)_3} = \frac{25}{(11 + 17 \times 3)} = 0.403$



### FACT/DEFINITION TYPE QUESTIONS

- Which of the scientist were able to prove that atom is no longer non-divisible?
  - Dalton
  - Michael Faraday
  - Thomson
  - Chadwick
- Which of the following is never true for cathode rays ?
  - They possess kinetic energy.
  - They are electromagnetic waves.
  - They produce heat.
  - They produce mechanical pressure.
- Cathode rays are deflected by
  - an electric field only
  - magnetic field only
  - by both
  - by none
- Which of the following statement is not correct about the characteristics of cathode rays?
  - They start from the cathode and move towards the anode.
  - They travel in straight line in the absence of an external electrical or magnetic field.
  - Characteristics of cathode rays do not depend upon the material of electrodes in cathode ray tube.
  - Characteristics of cathode rays depend upon the nature of gas present in the cathode ray tube.
- Which of the following statements about the electron is incorrect?
  - It is negatively charged particle
  - The mass of electron is equal to the mass of neutron.
  - It is a basic constituent of all atoms.
  - It is a constituent of cathode rays.
- While performing cathode ray experiments, it was observed that there was no passage of electric current under normal conditions. Which of the following can account for this observation ?
  - Dust particles are present in air
  - Carbon dioxide is present in air
  - Air is a poor conductor of electricity under normal conditions
  - None of the above
- Which is not true with respect to cathode rays?
  - A stream of electrons
  - Charged particles
  - Move with speed same as that of light
  - Can be deflected by magnetic fields
- What is the optimum conditions required to study the conduction of electricity through gases.
  - High pressure and low voltage
  - High pressure and high voltage
  - Low pressure and high voltage
  - Low pressure and low voltage
- In discharge tube experiment stream of negatively charged particles travel from
  - anode to cathode
  - cathode to anode
  - Both (a) and (b)
  - Electrons does not travel
- Millikan performed an experiment method to determine which of the following ?
  - Mass of the electron
  - Charge of the electron
  - $e/m$  ratio of electron
  - Both (a) and (b)
- The discovery of neutron became very late because :
  - neutrons are present in nucleus
  - neutrons are chargeless
  - neutrons are fundamental particles
  - all of the above
- Which is correct statement about proton ?
  - Proton is nucleus of deuterium
  - Proton is  $\alpha$ -particle
  - Proton is ionized hydrogen molecule
  - Proton is ionized hydrogen atom
- The lightest particle is :
  - $\alpha$ -particle
  - positron
  - proton
  - neutron
- When beryllium is bombarded with alpha particles (Chadwick's experiment) extremely penetrating radiations, which cannot be deflected by electrical or magnetic field are given out. These are :
  - A beam of protons
  - Alpha rays
  - A beam of neutrons
  - A beam of neutrons and protons

15. Neutron is discovered by  
(a) Chadwick (b) Rutherford  
(c) Yukawa (d) Dalton
16. Suppose beam containing all three fundamental subatomic particles are allowed to pass through an electric field as shown in figure. The subatomic particles detected at three points A, B and C on the screen respectively are ?



- (a) Protons, neutrons, electrons  
(b) Electrons, neutrons, protons  
(c) Electrons, protons, neutrons  
(d) Neutrons, protons, electrons
17. Which of the following properties of atom could be explained correctly by Thomson Model of atom?  
(a) Overall neutrality of atom.  
(b) Spectra of hydrogen atom.  
(c) Position of electrons, protons and neutrons in atom.  
(d) Stability of atom.
18. Arrange the following in terms of penetrating power.  
 $\alpha$ -rays,  $\beta$ -rays,  $\gamma$ -rays  
(a)  $\alpha > \beta > \gamma$  (b)  $\alpha < \beta < \gamma$   
(c)  $\alpha > \beta < \gamma$  (d)  $\alpha > \gamma > \beta$
19. Which of the rays are not deflected by the electric and magnetic field ?  
(a)  $\gamma$ -rays (b) X-rays  
(c)  $\beta$ -rays (d) Both (a) and (b)
20. Rutherford's experiment on the scattering of  $\alpha$ -particles showed for the first time that the atom has :  
(a) electrons (b) protons  
(c) nucleus (d) neutrons'
21. When atoms are bombarded with alpha particles, only, a few in million suffer deflection, others pass out undeflected. This is because  
(a) the force of repulsion on the moving alpha particle is small  
(b) the force of attraction between alpha particle and oppositely charged electrons is very small  
(c) there is only one nucleus and large number of electrons  
(d) the nucleus occupies much smaller volume compared to the volume of the atom
22. Rutherford's  $\alpha$ -particle dispersion experiment concludes  
(a) all positive ions are deposited at small part  
(b) all negative ions are deposited at small part  
(c) proton moves around the electron  
(d) neutrons are charged particles.
23. Rutherford's experiment which established the nuclear model of the atom used a beam of  
(a)  $\beta$ -particles which impinged on a metal foil and got absorbed

- (b)  $\gamma$ -rays which impinged on a metal foil and ejected electrons  
(c) helium atoms, which impinged on a metal foil and got scattered  
(d) helium nuclei, which impinged on a metal foil and got scattered
24. Which of the following scientists explained his model on the basis of centrifugal force ?  
(a) Thomson (b) Dalton  
(c) Millikan (d) Rutherford
25. The number of neutrons in dipositive zinc ion with mass number 70 is  
(a) 34 (b) 36  
(c) 38 (d) 40
26. The number of electrons in  $^{40}_{19}\text{K}^{+1}$  is  
(a) 20 (b) 40  
(c) 18 (d) 19
27. Which of the following does not contain number of neutrons equal to that of  $^{40}_{18}\text{Ar}$  ?  
(a)  $^{41}_{19}\text{K}$  (b)  $^{43}_{21}\text{Sc}$   
(c)  $^{40}_{21}\text{Sc}$  (d)  $^{42}_{20}\text{Ca}$
28. Number of protons, neutrons and electrons in the element  $^{231}_{89}\text{X}$  is  
(a) 89, 89, 242 (b) 89, 142, 89  
(c) 89, 71, 89 (d) 89, 231, 89
29. An element has atomic number 11 and mass number 24. What does the nucleus contain?  
(a) 11 protons, 13 neutrons  
(b) 11 protons, 13 neutrons, 13 electrons  
(c) 13 protons, 11 neutrons  
(d) 13 protons, 11 electrons
30. The number of electrons and neutrons of an element is 18 and 20 respectively. Its mass number is  
(a) 2 (b) 17  
(c) 37 (d) 38
31. 'A' represents mass no. and Z represents atomic no. then  $\alpha$ -decay is characterized by  
(a) Z increases by 2, A decreases by 4  
(b) Z decreases by 2, A increases by 4  
(c) Z decreases by 2, A decreases by 4  
(d) Z increases by 2, A increases by 4.
32. Nucleons are  
(a) only neutrons  
(b) neutrons + protons  
(c) neutrons + protons + electrons  
(d) neutrons + electrons
33. Atoms with same mass number but different atomic numbers are called  
(a) isotopes (b) isobars  
(c) isochores (d) None of these

34. Which of the following pairs will have same chemical properties ?

- (a)  $^{14}_6\text{C}$  and  $^{15}_7\text{N}$  (b)  $\text{O}^{2-}$  and  $\text{F}^-$   
 (c)  $^{40}_{18}\text{Ar}$  and  $^{40}_{19}\text{K}$  (d)  $^{35}_{17}\text{Cl}$  and  $^{37}_{17}\text{Cl}$

35. What is the difference between two species if one has atomic mass = 14 and atomic number = 7 whereas the other has atomic mass = 14 and atomic number = 6 ?

- (a) Neutrons (b) Protons  
 (c) Electrons (d) All of these

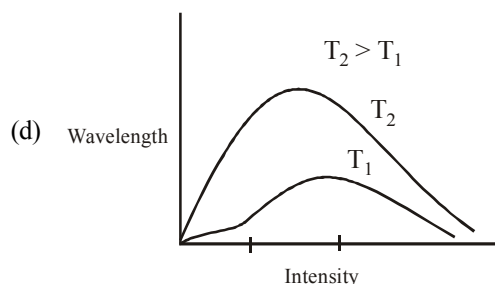
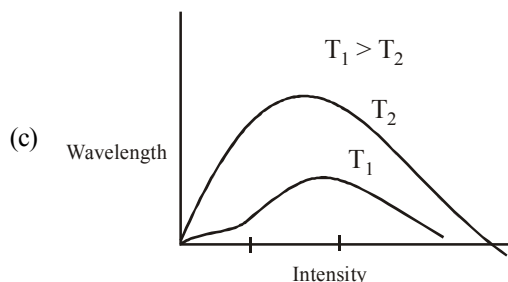
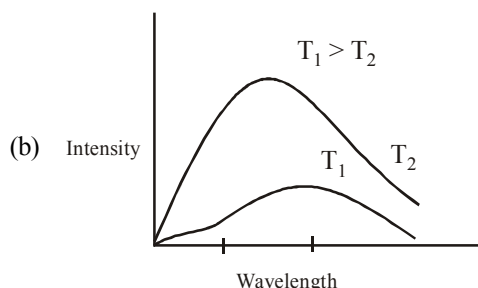
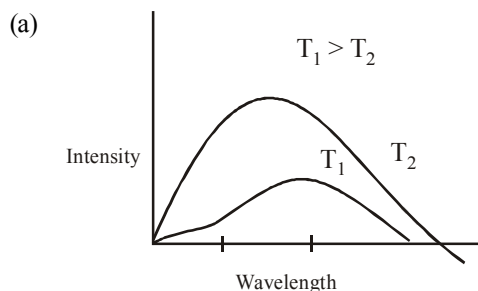
36. From the data given below A, B, C and D respectively are,

- (A)  $10\text{e}^-$ , atomic no. 11 (B)  $10\text{e}^-$ , atomic no. 6  
 (C)  $10\text{e}^-$ , atomic no. 10 (D)  $10\text{e}^-$ , atomic no. 9  
 (a)  $\text{Na}^+$ ,  $\text{C}^{4-}$ ,  $\text{Ne}$ ,  $\text{F}^-$  (b)  $\text{C}^{4-}$ ,  $\text{Ne}$ ,  $\text{Na}^+$ ,  $\text{F}^-$   
 (c)  $\text{F}^-$ ,  $\text{Na}^+$ ,  $\text{Ne}$ ,  $\text{C}^{4-}$  (d)  $\text{F}^-$ ,  $\text{Na}^+$ ,  $\text{C}^{4-}$ ,  $\text{Ne}$

37. If the wavelength of the electromagnetic radiation is increased to thrice the digital value, then what will be the percent change in the value of frequency of the electromagnetic radiation.

- (a) Increases by 33% (b) Decreases by 33%  
 (c) Increases by 66% (d) Decreases by 66%

38. Which is the correct schematic representation of the graph of black body radiation.



39. The ideal body, which emits and absorbs radiations of all frequencies, is called a black body and the radiation emitted by such a body is called

- (a) white body radiation (b) black body radiation  
 (c) black body emission (d) None of these

40. Which one of the following is not the characteristic of Planck's quantum theory of radiation ?

- (a) The energy is not absorbed or emitted in whole number or multiple of quantum  
 (b) Radiation is associated with energy  
 (c) Radiation energy is not emitted or absorbed continuously but in the form of small packets called quanta  
 (d) This magnitude of energy associated with a quantum is proportional to the frequency.

41. Which of the following is related with both wave nature and particle nature ?

- (a) Interference (b)  $E = mc^2$   
 (c) Diffraction (d)  $E = h\nu$

42. The value of Planck's constant is  $6.63 \times 10^{-34}$  Js. The velocity of light is  $3.0 \times 10^8$  m s $^{-1}$ . Which value is closest to the wavelength in nanometers of a quantum of light with frequency of  $8 \times 10^{15}$  s $^{-1}$  ?

- (a)  $3 \times 10^7$  (b)  $2 \times 10^{-25}$   
 (c)  $5 \times 10^{-18}$  (d)  $4 \times 10^1$

43. In the photo-electron emission, the energy of the emitted electron is

- (a) greater than the incident photon  
 (b) same as than of the incident photon  
 (c) smaller than the incident photon  
 (d) proportional to the intensity of incident photon

44. When a metal surface is exposed to solar radiations

- (a) The emitted electrons have energy less than a maximum value of energy depending upon frequency of incident radiations  
 (b) The emitted electrons have energy less than maximum value of energy depending upon intensity of incident radiation  
 (c) The emitted electrons have zero energy  
 (d) The emitted electrons have energy equal to energy of photons of incident light

45. In photoelectric effect, at which frequency electron will be ejected with certain kinetic energy ( $\nu_0$  = threshold frequency).

- (a)  $\nu > \nu_0$  (b)  $\nu_0 > \nu$   
 (c)  $\nu_0 \geq \nu$  (d)  $\nu \geq \nu_0$

46. In continuous spectrum light of (i) wavelength is deviated the ii  
 (a) (i) = longest, least (b) (ii) = shortest, least  
 (c) (i) = shortest, most (d) (i) = longest, most
47. Which of the following statements do not form a part of Bohr's model of hydrogen atom?  
 (a) Energy of the electrons in the orbits are quantized  
 (b) The electron(s) in the orbit nearest to the nucleus has the lowest energy  
 (c) Electrons revolve in different orbits around the nucleus  
 (d) The position and velocity of the electrons in the orbit cannot be determined simultaneously
48. An electron from one Bohr stationary orbit can go to next higher orbit  
 (a) by emission of electromagnetic radiation  
 (b) by absorption of any electromagnetic radiation  
 (c) by absorption of electromagnetic radiation of particular frequency  
 (d) without emission or absorption of electromagnetic radiation
49. For a Bohr atom angular momentum  $M$  of the electron is ( $n = 0, 1, 2, \dots$ ):  
 (a)  $\frac{nh^2}{4\pi}$  (b)  $\frac{n^2 h^2}{4\pi}$   
 (c)  $\frac{\sqrt{nh^2}}{4\pi}$  (d)  $\frac{nh}{2\pi}$
50. According to Bohr's theory, the angular momentum of an electron in 5<sup>th</sup> orbit is  
 (a)  $10 h / \pi$  (b)  $2.5 h / \pi$   
 (c)  $25 h / \pi$  (d)  $1.0 h / \pi$
51. In Bohr's model, atomic radius of the first orbit is  $y$ , the radius of the 3<sup>rd</sup> orbit, is  
 (a)  $y / 3$  (b)  $y$   
 (c)  $3y$  (d)  $9y$
52. The radius of 1<sup>st</sup> Bohr's orbit for hydrogen atom is ' $r$ '. The radius of second Bohr's orbit is  
 (a)  $4r$  (b)  $r^3$   
 (c)  $4r^2$  (d)  $r^{1/3}$
53. The third line of the Balmer series, in the emission spectrum of the hydrogen atom, is due to the transition from the  
 (a) fourth Bohr orbit to the first Bohr orbit  
 (b) fifth Bohr orbit to the second Bohr orbit  
 (c) sixth Bohr orbit to the third Bohr orbit  
 (d) seventh Bohr orbit to the third Bohr orbit
54. Which one of the following pairs is not correctly matched?  
 (a) Rutherford-Proton  
 (b) J.J. Thomson-Electron  
 (c) J.H. Chadwick-Neutron  
 (d) Bohr-Isotopes
55. If  $r$  is the radius of the first orbit, the radius of  $n^{\text{th}}$  orbit of H-atom is given by  
 (a)  $rn^2$  (b)  $rn$   
 (c)  $r/n$  (d)  $r^2 n^2$
56. The radius of hydrogen atom in the ground state is  $0.53 \text{ \AA}$ . The radius of  $\text{Li}^{2+}$  ion (atomic number = 3) in a similar state is  
 (a)  $0.17 \text{ \AA}$  (b)  $0.265 \text{ \AA}$   
 (c)  $0.53 \text{ \AA}$  (d)  $1.06 \text{ \AA}$
57. The energy of an electron in the  $n^{\text{th}}$  Bohr orbit of hydrogen atom is  
 (a)  $-\frac{13.6}{n^4} \text{ eV}$  (b)  $-\frac{13.6}{n^3} \text{ eV}$   
 (c)  $-\frac{13.6}{n^2} \text{ eV}$  (d)  $-\frac{13.6}{n} \text{ eV}$
58. The energy of second Bohr orbit of the hydrogen atom is  $-328 \text{ kJ mol}^{-1}$ ; hence the energy of fourth Bohr orbit would be:  
 (a)  $-41 \text{ kJ mol}^{-1}$  (b)  $-82 \text{ kJ mol}^{-1}$   
 (c)  $-164 \text{ kJ mol}^{-1}$  (d)  $-1312 \text{ kJ mol}^{-1}$
59. In a hydrogen atom, if energy of an electron in ground state is  $13.6 \text{ eV}$ , then that in the 2<sup>nd</sup> excited state is  
 (a)  $1.51 \text{ eV}$  (b)  $3.4 \text{ eV}$   
 (c)  $6.04 \text{ eV}$  (d)  $13.6 \text{ eV}$
60. The energy of an electron in second Bohr orbit of hydrogen atom is:  
 (a)  $-5.44 \times 10^{-19} \text{ eV}$  (b)  $-5.44 \times 10^{-19} \text{ cal}$   
 (c)  $-5.44 \times 10^{-19} \text{ kJ}$  (d)  $-5.44 \times 10^{-19} \text{ J}$
61. The energy of electron in first energy level is  $-21.79 \times 10^{-12} \text{ erg per atom}$ . The energy of electron in second energy level is:  
 (a)  $-54.47 \times 10^{-12} \text{ erg atom}^{-1}$   
 (b)  $-5.447 \times 10^{-12} \text{ erg atom}^{-1}$   
 (c)  $-0.5447 \times 10^{-12} \text{ erg atom}^{-1}$   
 (d)  $-0.05447 \times 10^{-12} \text{ erg atom}^{-1}$
62. The ionisation potential of a hydrogen atom is  $-13.6 \text{ eV}$ . What will be the energy of the atom corresponding to  $n = 2$ .  
 (a)  $-3.4 \text{ eV}$  (b)  $-6.8 \text{ eV}$   
 (c)  $-1.7 \text{ eV}$  (d)  $-2.7 \text{ eV}$
63. The line spectrum of  $\text{He}^+$  ion will resemble that of  
 (a) hydrogen atom (b)  $\text{Li}^+$  ion  
 (c) helium atom (d) lithium atom
64. What does negative sign in the electronic energy for hydrogen atom convey.  
 (a) Energy of electron when  $n = \infty$   
 (b) The energy of electron in the atom is lower than the energy of a free electron in motion  
 (c) The energy of electron in the atom is lower than the energy of a free electron of rest  
 (d) The energy of electron decreases as it moves away from nucleus
65. In which of the following Bohr's stationary state, the electron will be at maximum distance from the nucleus?  
 (a) II<sup>nd</sup> (b) I<sup>st</sup>  
 (c) V<sup>th</sup> (d) III<sup>rd</sup>

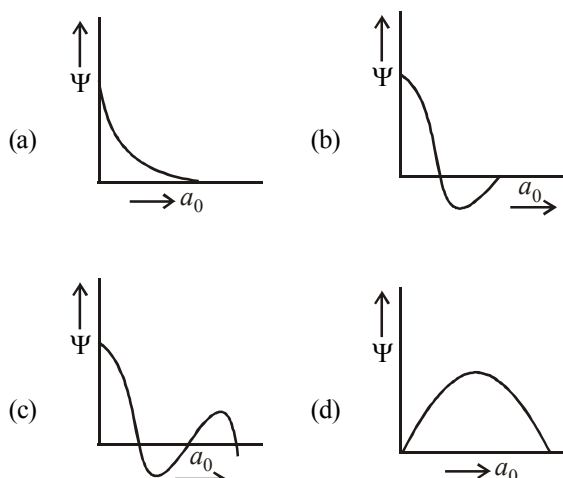


66. The wavelength of the radiation emitted, when in a hydrogen atom electron falls from infinity to stationary state 1, would be (Rydberg constant =  $1.097 \times 10^7 \text{ m}^{-1}$ )  
 (a) 406 nm (b) 192 nm  
 (c) 91 nm (d)  $9.1 \times 10^{-8} \text{ nm}$
67. The frequency of radiation emitted when the electron falls from  $n = 4$  to  $n = 1$  in a hydrogen atom will be (Given : ionization energy of H =  $2.18 \times 10^{-18} \text{ J atom}^{-1}$  and  $h = 6.625 \times 10^{-34} \text{ J s}$ )  
 (a)  $1.54 \times 10^{15} \text{ s}^{-1}$  (b)  $1.03 \times 10^{15} \text{ s}^{-1}$   
 (c)  $3.08 \times 10^{15} \text{ s}^{-1}$  (d)  $2.00 \times 10^{15} \text{ s}^{-1}$
68. Which of the following transitions of electrons in the hydrogen atom will emit maximum energy?  
 (a)  $n_5 \rightarrow n_4$  (b)  $n_4 \rightarrow n_3$   
 (c)  $n_3 \rightarrow n_2$  (d) all will emit same energy
69. The first emission line of hydrogen atomic spectrum in the Balmer series appears is ( $R$  = Rydberg constant)  
 (a)  $\frac{5}{36} R \text{ cm}^{-1}$  (b)  $\frac{3}{4} R \text{ cm}^{-1}$   
 (c)  $\frac{7}{144} R \text{ cm}^{-1}$  (d)  $\frac{9}{400} R \text{ cm}^{-1}$
70. According to the Bohr theory, which of the following transitions in the hydrogen atom will give rise to the least energetic photon?  
 (a)  $n = 6$  to  $n = 1$  (b)  $n = 5$  to  $n = 4$   
 (c)  $n = 6$  to  $n = 5$  (d)  $n = 5$  to  $n = 3$
71. The wavelength (in cm) of second line in the Lyman series of hydrogen atomic spectrum is (Rydberg constant =  $R \text{ cm}^{-1}$ )  
 (a)  $\left(\frac{8R}{9}\right)$  (b)  $\left(\frac{9}{8R}\right)$   
 (c)  $\left(\frac{4}{3R}\right)$  (d)  $\left(\frac{3R}{4}\right)$
72. The shortest wavelength in hydrogen spectrum of Lyman series when  $R_H = 109678 \text{ cm}^{-1}$  is  
 (a) 1002.7 Å (b) 1215.67 Å  
 (c) 1127.30 Å (d) 911.7 Å
73. What is the expression of frequency ( $\nu$ ) associated with absorption spectra of the photon.  
 (a)  $\nu = \frac{R_H}{h} \left( \frac{1}{n_i^2} - \frac{1}{n_f^2} \right) n_i > n_f$   
 (b)  $\nu = \frac{R_H}{h} \left( \frac{1}{n_i^2} - \frac{1}{n_f^2} \right) n_f > n_i$   
 (c)  $\nu = -\frac{R_H}{h} \left( \frac{1}{n_i^2} - \frac{1}{n_f^2} \right) n_f > n_i$   
 (d) All the above are correct
74. Bohr model can explain :  
 (a) the solar spectrum  
 (b) the spectrum of hydrogen molecule  
 (c) spectrum of any atom or ion containing one electron only  
 (d) the spectrum of hydrogen atom only
75. Which of the following statements do not form a part of Bohr's model of hydrogen atom?  
 (a) Energy of the electrons in the orbits are quantized  
 (b) The electron in the orbit nearest the nucleus has the lowest energy  
 (c) Electrons revolve in different orbits around the nucleus  
 (d) The position and velocity of the electrons in the orbit cannot be determined simultaneously.
76. Bohr's theory can be applied to which of the following ions.  
 (a)  $\text{Na}^+$  (b)  $\text{Be}^{2+}$   
 (c)  $\text{Li}^+$  (d)  $\text{Li}^{2+}$
77. Bohr's model is not able to account for which of the following.  
 (a) Stability of atom.  
 (b) Spectrum of neutral helium atom.  
 (c) Energy of free electron at rest.  
 (d) Calculation of radii of the stationary states.
78. If electron, hydrogen, helium and neon nuclei are all moving with the velocity of light, then the wavelength associated with these particles are in the order  
 (a) Electron > hydrogen > helium > neon  
 (b) Electron > helium > hydrogen > neon  
 (c) Electron < hydrogen < helium < neon  
 (d) Neon < hydrogen < helium < electron
79. The de Broglie wavelength of a tennis ball of mass 60 g moving with a velocity of 10 metres per second is approximately  
 (a)  $10^{-31}$  metres (b)  $10^{-16}$  metres  
 (c)  $10^{-25}$  metres (d)  $10^{-33}$  metres  
 Planck's constant,  $h = 6.63 \times 10^{-34} \text{ Js}$
80. If the energy difference between the ground state of an atom and its excited state is  $4.4 \times 10^{-4} \text{ J}$ , the wavelength of photon required to produce the transition :  
 (a)  $2.26 \times 10^{-12} \text{ m}$  (b)  $1.13 \times 10^{-12} \text{ m}$   
 (c)  $4.52 \times 10^{-16} \text{ m}$  (d)  $4.52 \times 10^{-12} \text{ m}$
81. The mass of a photon with a wavelength equal to  $1.54 \times 10^{-8} \text{ cm}$  is  
 (a)  $0.8268 \times 10^{-34} \text{ kg}$  (b)  $1.2876 \times 10^{-33} \text{ kg}$   
 (c)  $1.4285 \times 10^{-32} \text{ kg}$  (d)  $1.8884 \times 10^{-32} \text{ kg}$
82. If the Planck's constant  $h = 6.6 \times 10^{-34} \text{ Js}$ , the de Broglie wavelength of a particle having momentum of  $3.3 \times 10^{-24} \text{ kg ms}^{-1}$  will be  
 (a) 0.002 Å (b) 0.5 Å  
 (c) 2 Å (d) 500 Å

83. The values of Planck's constant is  $6.63 \times 10^{-34}$  Js. The velocity of light is  $3.0 \times 10^8$  m s<sup>-1</sup>. Which value is closest to the wavelength in nanometres of a quantum of light with frequency of  $8 \times 10^{15}$  s<sup>-1</sup>?
- (a)  $5 \times 10^{-18}$  (b)  $4 \times 10^1$   
(c)  $3 \times 10^7$  (d)  $2 \times 10^{-25}$
84. The de Broglie wavelength of a car of mass 1000 kg and velocity 36 km/hr is :
- (a)  $6.626 \times 10^{-34}$  m (b)  $6.626 \times 10^{-38}$  m  
(c)  $6.626 \times 10^{-31}$  m (d)  $6.626 \times 10^{-30}$  m
85. Heisenberg uncertainty principle can be explained as
- (a)  $\Delta x \geq \frac{\Delta P \times h}{4\pi}$  (b)  $\Delta x \times \Delta P \geq \frac{h}{4\pi}$   
(c)  $\Delta x \times \Delta P \geq \frac{h}{\pi}$  (d)  $\Delta P \geq \frac{\pi h}{\Delta x}$
86. Heisenberg's uncertainty principle is applicable to
- (a) atoms only (b) electron only  
(c) nucleus only (d) any moving object
87. The position of both, an electron and a helium atom is known within 1.0 nm. Further the momentum of the electron is known within  $5.0 \times 10^{-26}$  kg ms<sup>-1</sup>. The minimum uncertainty in the measurement of the momentum of the helium atom is
- (a) 50 kg ms<sup>-1</sup> (b) 80 kg ms<sup>-1</sup>  
(c)  $8.0 \times 10^{-26}$  kg ms<sup>-1</sup> (d)  $5.0 \times 10^{-26}$  kg ms<sup>-1</sup>
88. Uncertainty in the position of an electron (mass =  $9.1 \times 10^{-31}$  kg) moving with a velocity 300 ms<sup>-1</sup>, accurate upto 0.001% will be ( $h = 6.63 \times 10^{-34}$  Js)
- (a)  $1.92 \times 10^{-2}$  m (b)  $3.84 \times 10^{-2}$  m  
(c)  $19.2 \times 10^{-2}$  m (d)  $5.76 \times 10^{-2}$  m
89. The uncertainty in the position of an electron (mass =  $9.1 \times 10^{-28}$  g) moving with a velocity of  $3.0 \times 10^4$  cm s<sup>-1</sup> accurate upto 0.01% will be
- (a) 1.92 cm (b) 7.68 cm  
(c) 0.175 cm (d) 3.84 cm.
90. The Heisenberg uncertainty principle will be most significant for which of the following object?
- (a) Object A of mass  $9.11 \times 10^{-30}$  kg  
(b) Object B of mass  $9.11 \times 10^{-28}$  g  
(c) Object C of mass  $9.11 \times 10^{-24}$  mg  
(d) Object D of mass  $9.11 \times 10^{-28}$  kg
91. The orientation of an atomic orbital is governed by
- (a) Spin quantum number  
(b) Magnetic quantum number  
(c) Principal quantum number  
(d) Azimuthal quantum number
92. For which one of the following sets of four quantum numbers, an electron will have the highest energy?
- | n     | l | m  | s    |
|-------|---|----|------|
| (a) 3 | 2 | 1  | 1/2  |
| (b) 4 | 2 | -1 | 1/2  |
| (c) 4 | 1 | 0  | -1/2 |
| (d) 5 | 0 | 0  | -1/2 |
93. Which of the following sets of quantum numbers is correct for an electron in 4f orbital?
- (a)  $n = 4, l = 3, m = +1, s = +1/2$   
(b)  $n = 4, l = 4, m = -4, s = -1/2$   
(c)  $n = 4, l = 3, m = +4, s = +1/2$   
(d)  $n = 3, l = 2, m = -2, s = +1/2$
94. What is the correct orbital designation of an electron with the quantum number,  $n = 4, l = 3, m = -2, s = 1/2$ ?
- (a) 3s (b) 4f  
(c) 5p (d) 6s
95. Which of the following represents correct set of the four quantum numbers for an electron in a 4d subshell?
- (a) 4, 2, 1, 0 (b) 4, 2, 1, -1/2  
(c) 4, 3, 2, +1/2 (d) 4, 3, -2, -1/2
96. The total number of electrons that can be accommodated in all orbitals having principal quantum number 2 and azimuthal quantum number 1 is
- (a) 2 (b) 4  
(c) 6 (d) 8
97. For azimuthal quantum number  $l = 3$ , the maximum number of electrons will be
- (a) 2 (b) 6  
(c) 0 (d) 14
98. Which of the following is **not** permissible arrangement of electrons in an atom?
- (a)  $n = 5, l = 3, m = 0, s = +1/2$   
(b)  $n = 3, l = 2, m = -3, s = -1/2$   
(c)  $n = 3, l = 2, m = -2, s = -1/2$   
(d)  $n = 4, l = 0, m = 0, s = -1/2$
99. Which of the following sets of quantum numbers represents the highest energy of an atom?
- (a)  $n = 3, l = 0, m = 0, s = +1/2$   
(b)  $n = 3, l = 1, m = 1, s = +1/2$   
(c)  $n = 3, l = 2, m = 1, s = +1/2$   
(d)  $n = 4, l = 0, m = 0, s = +1/2$
100. Which set of quantum numbers are not possible?
- | n     | l | m  | s    |
|-------|---|----|------|
| (a) 3 | 2 | 0  | +1/2 |
| (b) 2 | 2 | 1  | +1/2 |
| (c) 1 | 0 | 0  | -1/2 |
| (d) 3 | 2 | -2 | +1/2 |
101. What will be the sum of all possible values of  $l$  and  $m$  for  $n = 5$ ?
- (a) 12 (b) 13  
(c) 4 (d) 9
102. The following quantum numbers are possible for how many orbital(s)  $n = 3, l = 2, m = +2$ ?
- (a) 1 (b) 3  
(c) 2 (d) 4
103. The orbitals are called degenerate when
- (a) they have the same wave functions  
(b) they have the same wave functions but different energies  
(c) they have different wave functions but same energy  
(d) they have the same energy





- 104.** The number of spherical nodes in 3p orbitals are  
(a) one (b) three  
(c) two (d) None of these
- 105.** Which of the following graph correspond to one node




106. If there are five radial nodes, then what can be the correct representation of the orbital for  $n = 8$ .
- (a) 8d (b) 8s  
(c) 8p (d) 8f
107. What can be the representation of the orbital having 3 angular nodes and  $n = 5$ .
- (a) 5d (b) 5f  
(c) 5p (d) 5s
108. The number of orbitals present in the fifth shell will be
- (a) 25 (b) 10  
(c) 50 (d) 20
109. Arrange the orbital of same shell in the increasing order of shielding strength of the outer shell of electrons.
- s, f, d, p
- (a)  $s < p < d < f$  (b)  $s > p < d < f$   
(c)  $s > p > d < f$  (d)  $s > p > d > f$

- 110.** Which of the following is not correct for electronic distribution in the ground state ?

(a) Co [Ar] 

(b) Ni [Ar] 

(c) Cu [Ar] 

- (d) All of the above
- 111.** The electronic configuration of gadolinium (Atomic number 64) is
- (a)  $[\text{Xe}] 4f^8 5d^0 6s^2$       (b)  $[\text{Xe}] 4f^3 5d^5 6s^2$   
(c)  $[\text{Xe}] 4f^6 5d^2 6s^2$       (d)  $[\text{Xe}] 4f^7 5d^1 6s^2$

- 112.** The order of filling of electrons in the orbitals of an atom will be

- (a)  $3d, 4s, 4p, 4d, 5s$       (b)  $4s, 3d, 4p, 5s, 4d$   
(c)  $5s, 4p, 3d, 4d, 5s$       (d)  $3d, 4p, 4s, 4d, 5s$

113. The number of *d*-electrons retained in  $\text{Fe}^{2+}$

(At. no. of Fe = 26) ion is

- [illegible]

- 114.** The electronic configuration of an element is  $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^1$ . This represents its

- (a) excited state                      (b) ground state  
(c) cationic form                      (d) anionic form

- 115.** Number of unpaired electrons in  $\text{N}^{2+}$  is

- [illegible]

- 116.** An ion has 18 electrons in the outermost shell, it is

- (a)  $\text{Cu}^+$  (b)  $\text{Th}^{4+}$   
(c)  $\text{Cs}^+$  (d)  $\text{K}^+$

- 117.** In a given atom no two electrons can have the same values for all the four quantum numbers. This is called

- (a) Hund's Rule                      (b) Aufbau principle  
(c) Uncertainty principle        (d) Pauli's exclusion principle

- 118.** The electronic configuration of Cu (atomic number 29) is

- (a)  $1s^2, 2s^2 2p^6, 3s^2 3p^6, 4s^2 3d^9$   
 (b)  $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^1$   
 (c)  $1s^2, 2s^2 2p^6, 3p^2 3p^6, 4s^2 4p^6, 5s^2 5p^1$   
 (d)  $1s^2, 2s^2 2p^6, 3p^2 3p^6, 4s^2 4p^6 3d^3$

- 119.** The orbital diagram in which the Aufbau principle is violated is:

**$2s$**

(a) 

↑↓
----

(b) 

↑
---

(c) 

↑↓
----

(d) 

↑↓
----

**$2p$**

↑↓	↑	
----	---	--

↑↓	↑	↑
----	---	---

↑	↑	↑
---	---	---

↑↓	↑	↑
----	---	---

- 120.** If  $n = 6$ , the correct sequence for filling of electrons will be :

- (a)  $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$   
 (b)  $ns \rightarrow (n-1)d \rightarrow (n-2)f \rightarrow np$   
 (c)  $ns \rightarrow (n-2)f \rightarrow np \rightarrow (n-1)d$   
 (d)  $ns \rightarrow np \rightarrow (n-1)d \rightarrow (n-2)f$

- 121.** Maximum number of electrons in a subshell of an atom is determined by the following:

- (a)  $2l+1$  (b)  $4l-2$   
(c)  $2n^2$  (d)  $4l+2$

- 122.** The correct order of increasing energy of atomic orbitals is

- (a)  $5p < 4f < 6s < 5d$       (b)  $5p < 6s < 4f < 5d$   
(c)  $5p < 5d < 4f < 6s$       (d) None of these

123. For which element, the valence electron will be present in the highest energy orbital.

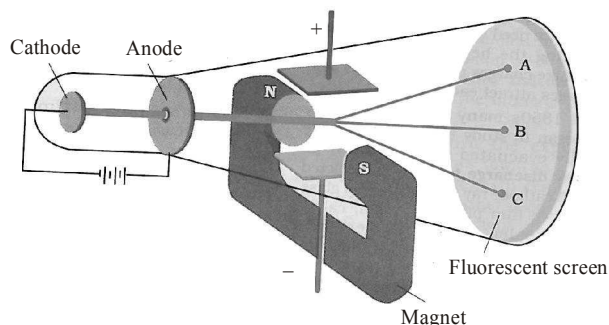
- (a)  ${}_3\text{Li}$  (b)  ${}_{16}\text{S}$   
(c)  ${}_{20}\text{Ca}$  (d)  ${}_{21}\text{Sc}$

124. Which of the following electronic configuration of d-orbital will have highest affinity for gaining an electron?

- (a)  $\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow$   
(b)  $\uparrow\downarrow \uparrow\downarrow \uparrow \uparrow \uparrow$   
(c)  $\uparrow\downarrow \uparrow \uparrow \uparrow \uparrow$   
(d)  $\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow$

### STATEMENT TYPE QUESTIONS

125. On the basis of figure given below which of the following statement(s) is/are correct ?



- (i) At point B, when only electric field is applied.  
(ii) At point C, when both electric and magnetic field is applied.  
(iii) At point B, when both electric and magnetic fields are balanced.  
(iv) At point C, when only magnetic field is applied.

Which of the following is/are correct?

- (a) (i) and (ii) (b) only (iii)  
(c) (iii) and (iv) (d) (i) and (iii)

126. Which of the following statements are not correct about electromagnetic radiation ?

- (i) Electromagnetic waves require medium to travel.  
(ii) Different electromagnetic radiations travel at same speed in vacuum.  
(iii) The oscillating electric and magnetic fields produced by oscillating charged particles are perpendicular to each other, but not to the direction of propagation.  
(iv) The oscillating electric field and magnetic field are perpendicular to each other, and also to the direction of propagation.

- (a) (i), (ii) and (iii) (b) (ii) and (iii)  
(c) (i) and (iii) (d) (i) and (iv)

127. Which of the following statement(s) is/are incorrect regarding photoelectric effect?

- (i) The number of electrons ejected is proportional to the intensity of light.  
(ii) There is some time lag between the striking of light beam on the metal surface and the ejection of electrons.  
(iii) The kinetic energy of ejected electrons depends upon the brightness of light.  
(iv) The kinetic energy of the ejected electron is proportional to the frequency of the incident radiation.

- (a) (i) and (ii) (b) (ii) and (iii)  
(c) (ii) only (d) (ii) and (iv)

128. For Balmer series in the spectrum of atomic hydrogen, the

wave number of each line is given by  $\bar{\nu} = R_H \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

where  $R_H$  is a constant and  $n_1$  and  $n_2$  are integers. Which of the following statement(s) is (are) correct?

- (i) As wavelength decreases, the lines in the series converge.  
(ii) The integer  $n_1$  is equal to 2.  
(iii) The ionization energy of hydrogen can be calculated from the wave number of these lines.  
(iv) The line of longest wavelength corresponds to  $n_2 = 3$ .

- (a) (i), (ii) and (iii) (b) (ii), (iii) and (iv)  
(c) (i), (i) and (iv) (d) (ii) and (iv)

129. Which of the following statements of quantum mechanics was in agreement with Bohr's model?

- (i) The path of an electron in an atom can never be determined accurately.  
(ii) The energy of electrons in atom is quantized i.e., can only have specific values.  
(iii) An orbital cannot contain more than two electrons.

- (a) Only (i) (b) (i) and (ii)  
(c) Only (ii) (d) (ii) and (iii)

130. Which of the following statements concerning the quantum numbers are correct ?

- (i) Angular quantum number determines the three-dimensional shape of the orbital.  
(ii) The principal quantum number determines the orientation and energy of the orbital.  
(iii) Magnetic quantum number determines the size of the orbital.  
(iv) Spin quantum number of an electron determines the orientation of the spin of electron relative to the chosen axis.

The correct set of option is

- (a) (i) and (ii) (b) (i) and (iv)  
(c) (iii) and (iv) (d) (ii), (iii) and (iv)

### MATCHING TYPE QUESTIONS

131. Match the columns.

Column-I	Column-II
(A) ${}^1_1\text{H}$ , ${}^2_1\text{H}$ and ${}^3_1\text{H}$	(p) Isobars
(B) ${}^{14}_6\text{C}$ and ${}^{14}_7\text{N}$	(q) Isotopes
(C) $\text{Na}^+$ and $\text{Mg}^{2+}$	(r) Isoelectronic species
(a) A – (p), B – (q), C – (r)	
(b) A – (q), B – (p), C – (r)	
(c) A – (r), B – (q), C – (p)	
(d) A – (p), B – (r), C – (q)	

132. Match the columns.

Column-I	Column-II
(A) X-rays	(p) $\nu = 10^0 - 10^4 \text{ Hz}$
(B) UV	(q) $\nu = 10^{10} \text{ Hz}$
(C) Long radio waves	(r) $\nu = 10^{16} \text{ Hz}$
(D) Microwave	(s) $\nu = 10^{18} \text{ Hz}$
(a) A – (s), B – (r), C – (p), D – (q)	
(b) A – (r), B – (s), C – (p), D – (q)	
(c) A – (s), B – (p), C – (r), D – (q)	
(d) A – (s), B – (r), C – (q), D – (p)	

133. Match the columns.

Column-I	Column-II
(A) $ \Psi ^2$	(p) Energy can be emitted or absorbed in packets
(B) de Broglie	(q) Significant only for motion of microscopic objects.
(C) Heisenberg	(r) The probability of finding an electron at a point within an atom
(D) Planck's	(s) Every object in motion has a wave character.
(a) A – (q), B – (s), C – (r), D – (p)	
(b) A – (r), B – (p), C – (q), D – (s)	
(c) A – (r), B – (s), C – (q), D – (p)	
(d) A – (s), B – (p), C – (r), D – (q)	

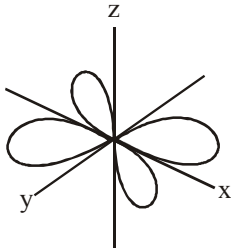
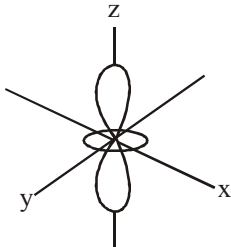
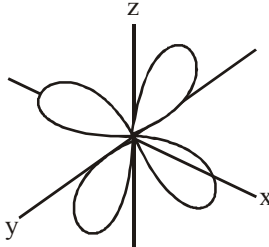
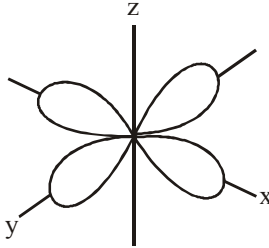
134. Match the columns.

Column-I (Quantum number)	Column-II (Information provided)
(A) Principal quantum number	(p) orientation of the orbital
(B) Azimuthal quantum number	(q) energy and size of orbital
(C) Magnetic quantum number	(r) spin of electron
(D) Spin quantum number	(s) shape of the orbital
(a) A – (q), B – (s), C – (p), D – (r)	
(b) A – (s), B – (q), C – (p), D – (r)	
(c) A – (q), B – (p), C – (s), D – (r)	
(d) A – (q), B – (s), C – (r), D – (p)	

135. Match the columns.

Column-I (Sub shell)	Column-II (Number of orbitals)	Column-III (Angular/Azimuthal Quantum Number)
(A) d	(p) 1	(i) 1
(B) f	(q) 3	(ii) 2
(C) s	(r) 5	(iii) 0
(D) p	(s) 7	(iv) 3
(a) A – (r) – (ii), B – (s) – (iv), C – (p) – (iii), D – (q) – (i)		
(b) A – (q) – (i), B – (s) – (iv), C – (p) – (iii), D – (r) – (ii)		
(c) A – (p) – (iii), B – (s) – (iv), C – (r) – (ii), D – (q) – (i)		
(d) A – (r) – (ii), B – (p) – (iii), C – (s) – (iv), D – (q) – (i)		

136. Match the columns.

Column-I	Column-II
(A) $d_{x^2-y^2}$	(p) 
(B) $d_{xy}$	(q) 
(C) $d_{yz}$	(r) 
(D) $d_{z^2}$	(s) 
(a) A – (p), B – (s), C – (r), D – (q)	
(b) A – (s), B – (p), C – (r), D – (q)	
(c) A – (s), B – (p), C – (q), D – (r)	
(d) A – (s), B – (r), C – (p), D – (q)	

137. Match the columns

Column-I (Rules)	Column-II (Statements)
(A) Hund's Rule	(p) No two electrons in an atom can have the same set of four quantum numbers.
(B) Aufbau Principle	(q) Half-filled and completely filled orbitals have extra stability.
(C) Pauli Exclusion Principle	(r) Pairing of electrons in the orbitals belonging to the same subshell does not take place until each orbital is singly occupied.
(D) Heisenberg's Uncertainty Principle	(s) It is impossible to determine the exact position and exact momentum of a subatomic particle simultaneously.
	(t) In the ground state of atoms, orbitals are filled in the order of their increasing energies.
(a) A – (r), B – (p), C – (t), D – (s)	
(b) A – (r), B – (t), C – (s), D – (p)	
(c) A – (r), B – (t), C – (p), D – (s)	
(d) A – (t), B – (r), C – (p), D – (s)	

138. Match the columns.

Column-I (Atom / Ion)	Column-II (Electronic configuration)
(A) Cu	(p) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$
(B) $Cu^{2+}$	(q) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
(C) $Zn^{2+}$	(r) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$
(D) $Cr^{3+}$	(s) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$
	(t) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$
(a) A – (s), B – (r), C – (p), D – (t)	
(b) A – (r), B – (s), C – (p), D – (t)	
(c) A – (r), B – (s), C – (t), D – (p)	
(d) A – (r), B – (s), C – (p), D – (s)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

139. **Assertion :** The position of an electron can be determined exactly with the help of an electron microscope.

**Reason :** The product of uncertainty in the measurement of its momentum and the uncertainty in the measurement of the position cannot be less than a finite limit.

140. **Assertion :** The radius of the first orbit of hydrogen atom is  $0.529\text{\AA}$ .

**Reason :** Radius of each circular orbit ( $r_n$ ) -  $0.529\text{\AA} (n^2/Z)$ , where  $n = 1, 2, 3$  and  $Z$  = atomic number.

141. **Assertion :** All isotopes of a given element show the same type of chemical behaviour.

**Reason :** The chemical properties of an atom are controlled by the number of electrons in the atom.

142. **Assertion :** Black body is an ideal body that emits and absorbs radiations of all frequencies.

**Reason :** The frequency of radiation emitted by a body goes from a lower frequency to higher frequency with an increase in temperature.

143. **Assertion :** It is impossible to determine the exact position and exact momentum of an electron simultaneously.

**Reason :** The path of an electron in an atom is clearly defined.

### CRITICAL THINKING TYPE QUESTIONS

144. What is the ratio of mass of an electron to the mass of a proton?

- (a) 1 : 2 (b) 1 : 1  
 (c) 1 : 1837 (d) 1 : 3

145. The increasing order for the values of  $e/m$  (charge/mass) is

- (a)  $e, p, n, \alpha$  (b)  $n, p, e, \alpha$   
 (c)  $n, p, \alpha, e$  (d)  $n, \alpha, p, e$

146. In which of the following the amount of deviation from their path in the presence of electric and magnetic field will be maximum?

- (a)  $N^{2-}$  (b)  $N^{3-}$   
 (c)  $N^-$  (d)  $N$

147. The deflection of the particles from their path in presence of electric and magnetic field will be maximum in which of the following.

- (a) O (b) N  
 (c) U (d) He

148. Which of the following pairs have identical values of  $e/m$ ?

- (a) A proton and a neutron  
 (b) A proton and deuterium  
 (c) Deuterium and an  $\alpha$ -particle  
 (d) An electron and  $\gamma$ -rays

149. If the alpha-particles are projected against the following atoms Fe, Be, Mg, Al then increasing order in which the alpha-particle feel repulsion will be

- (a) Be, Mg, Al, Fe (b) Be, Al, Mg, Fe  
 (c) Mg, Al, Mg, Fe (d) Al, Mg, Fe, Be

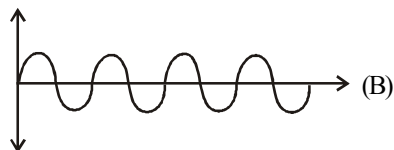
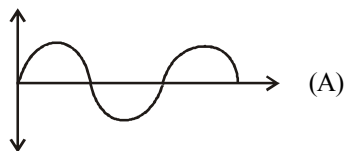
150. Chlorine exists in two isotopic forms, Cl-37 and Cl-35 but its atomic mass is 35.5. This indicates the ratio of Cl-37 and Cl-35 is approximately

- (a) 1 : 2 (b) 1 : 1  
 (c) 1 : 3 (d) 3 : 1

151. The number of electrons, neutrons and protons in a species are equal to 10, 8 and 8 respectively. The proper symbol of the species is

- (a)  $^{16}O_8$  (b)  $^{18}O_8$   
 (c)  $^{18}Ne_{10}$  (d)  $^{16}O_8^{2-}$

152. What will be the difference between electromagnetic radiation shown in A and B respectively ?



- (i) Velocity (ii) Wavelength  
(iii) Frequency (iv) Energy  
(a) (ii) only (b) (ii) and (iv)  
(c) (ii), (iii) and (iv) (d) (iv) only
153. Arrange the electromagnetic radiations a, b, c, d and e in increasing order of energy. Frequencies of a, b and c are  $10^{15}$ ,  $10^{14}$  and  $10^{17}$  respectively whereas wavelength of (d) and (e) are 350 nm and 100 nm respectively ?  
(a) a, b, c, d, e (b) a, b, d, e, c  
(c) a, d, b, e, c (d) b, d, a, e, c
154. An electron,  $e_1$  is moving in the fifth stationary state, and another electron  $e_2$  is moving in the fourth stationary state. The radius of orbit of electron,  $e_1$  is five times the radius of orbit of electron,  $e_2$  calculate the ratio of velocity of electron  $e_1$  ( $v_1$ ) to the velocity of electron  $e_2$  ( $v_2$ ).  
(a) 5 : 1 (b) 4 : 1  
(c) 1 : 5 (d) 1 : 4
155. The  $\text{Li}^{2+}$  ion is moving in the third stationary state, and its linear momentum is  $7.3 \times 10^{-34} \text{ kg ms}^{-1}$ . Calculate its angular momentum.  
(a)  $1.158 \times 10^{-45} \text{ kg m}^2\text{s}^{-1}$   
(b)  $11.58 \times 10^{-48} \text{ kg m}^2\text{s}^{-1}$   
(c)  $11.58 \times 10^{-47} \text{ kg m}^2\text{s}^{-1}$   
(d)  $12 \times 10^{-45} \text{ kg m}^2\text{s}^{-1}$
156. The Bohr orbit radius for the hydrogen atom ( $n = 1$ ) is approximately  $0.530 \text{ \AA}$ . The radius for the first excited state ( $n = 2$ ) orbit is (in  $\text{\AA}$ )  
(a) 0.13 (b) 1.06  
(c) 4.77 (d) 2.12
157. According to Bohr's theory the energy required for an electron in the  $\text{Li}^{2+}$  ion to be emitted from  $n = 2$  state is (given that the ground state ionization energy of hydrogen atom is 13.6 eV)  
(a) 61.2 eV (b) 13.6 eV  
(c) 30.6 eV (d) 10.2 eV
158. Among species H,  $\text{Li}^{2+}$ ,  $\text{He}^+$ ,  $\text{Be}^{3+}$  and  $\text{Al}^{3+}$  Bohr's model was able to explain the spectra of  
(a) All of these  
(b) None of these  
(c) all other species except  $\text{Be}^{3+}$   
(d) all other species except  $\text{Al}^{3+}$
159. Which of the following levels of H and  $\text{He}^+$  have same energy respectively ?  
(A) 1, 2 (B) 3, 4  
(C) 2, 4 (D) 3, 6  
(a) A and D (b) A and B  
(c) C and D (d) A, C and D
160. Bohr radius of  $n$ th orbit of an atom is given by the expression:  
(a)  $r = \frac{n^2 h^2}{4\pi^2 m e^2}$  (b)  $r = \frac{nh}{4\pi^2 m Z e^2}$   
(c)  $r = \frac{n^2 h^2}{4\pi^2 m Z}$  (d)  $r = \frac{n^2 h^2}{4\pi^2 m e^2 Z}$
161. The ratio between kinetic energy and the total energy of the electrons of hydrogen atom according to Bohr's model is  
(a) 2 : 1 (b) 1 : 1  
(c) 1 : -1 (d) 1 : 2
162. The potential energy of electron present in ground state of  $\text{Li}^{2+}$  ion is represented by :  
(a)  $\frac{+3e^2}{4\pi\epsilon_0 r}$  (b)  $\frac{-3e}{4\pi\epsilon_0 r}$   
(c)  $\frac{-3e^2}{4\pi\epsilon_0 r^2}$  (d)  $\frac{-3e^2}{4\pi\epsilon_0 r}$
163. In hydrogen atomic spectrum, a series limit is found at  $12186.3 \text{ cm}^{-1}$ . Then it belong to  
(a) Lyman series (b) Balmer series  
(c) Paschen series (d) Brackett series
164. Which transition in the hydrogen atomic spectrum will have the same wavelength as the transition,  $n = 4$  to  $n = 2$  of  $\text{He}^+$  spectrum?  
(a)  $n = 4$  to  $n = 3$  (b)  $n = 3$  to  $n = 2$   
(c)  $n = 4$  to  $n = 2$  (d)  $n = 2$  to  $n = 1$
165. Arrange the following elements in the order of ease of detection of wave properties, in the de Broglie experiment. H, Li, Be, B, K  
(a)  $\text{H} < \text{Be}, \text{B} < \text{Li} < \text{K}$ . (b)  $\text{H} > \text{Li} > \text{K} > \text{Be} > \text{B}$   
(c)  $\text{H} > \text{Li} > \text{Be} > \text{B} > \text{K}$  (d)  $\text{H} < \text{Li} < \text{Be} < \text{B} < \text{K}$
166. A 600 W mercury lamp emits monochromatic radiation of wavelength 331.3 nm. How many photons are emitted from the lamp per second ? ( $h = 6.626 \times 10^{-34} \text{ Js}$ ; velocity of light  $= 3 \times 10^8 \text{ ms}^{-1}$ )  
(a)  $1 \times 10^{19}$  (b)  $1 \times 10^{20}$   
(c)  $1 \times 10^{21}$  (d)  $1 \times 10^{23}$
167. Calculate the velocity of ejected electron from the metal surface when light of frequency  $2 \times 10^{15} \text{ Hz}$  fall on the metal surface and the threshold frequency is  $7 \times 10^{14} \text{ Hz}$  for metal ?  
(a)  $1.37 \times 10^6$  (b)  $1.26 \times 10^6$   
(c)  $1.45 \times 10^7$  (d)  $1.37 \times 10^7$
168. What is the wavelength (in m) of the electron emitted in the above question (Q. no. 167) ?  
(a)  $5.308 \times 10^{-10}$  (b)  $5.89 \times 10^{-11}$   
(c)  $4.37 \times 10^{-13}$  (d)  $3.98 \times 10^{-10}$



169. The velocity of particle A is  $0.1 \text{ ms}^{-1}$  and that of particle B is  $0.05 \text{ ms}^{-1}$ . If the mass of particle B is five times that of particle A, then the ratio of de-Broglie wavelengths associated with the particles A and B is  
(a) 2 : 5 (b) 3 : 4  
(c) 6 : 4 (d) 5 : 2
170. Two fast moving particles X and Y are associated with de Broglie wavelengths 1 nm and 4 nm respectively. If mass of X is nine times the mass of Y, the ratio of kinetic energies of X and Y would be  
(a) 3 : 1 (b) 9 : 1  
(c) 5 : 12 (d) 16 : 9
171. Uncertainty in position of a  $n$  electron (mass =  $9.1 \times 10^{-28} \text{ g}$ ) moving with a velocity of  $3 \times 10^4 \text{ cm/s}$  accurate upto 0.001% will be (use  $h/4\pi$ ) in uncertainty expression where  $h = 6.626 \times 10^{-27} \text{ erg-second}$ .  
(a) 1.93 cm (b) 3.84 cm  
(c) 5.76 cm (d) 7.68 cm
172. The measurement of the electron position is associated with an uncertainty in momentum, which is equal to  $1 \times 10^{-18} \text{ g cm s}^{-1}$ . The uncertainty in electron velocity is, (mass of an electron is  $9 \times 10^{-28} \text{ g}$ )  
(a)  $1 \times 10^9 \text{ cm s}^{-1}$  (b)  $1 \times 10^6 \text{ cm s}^{-1}$   
(c)  $1 \times 10^5 \text{ cm s}^{-1}$  (d)  $1 \times 10^{11} \text{ cm s}^{-1}$
173. In an atom, an electron is moving with a speed of 600 m/s with an accuracy of 0.005%. Certainty with which the position of the electron can be located is ( $h = 6.6 \times 10^{-34} \text{ kg m}^2 \text{ s}^{-1}$ , mass of electron,  $m_e = 9.1 \times 10^{-31} \text{ kg}$ )  
(a)  $5.10 \times 10^{-3} \text{ m}$  (b)  $1.92 \times 10^{-3} \text{ m}$   
(c)  $3.84 \times 10^{-3} \text{ m}$  (d)  $1.52 \times 10^{-4} \text{ m}$
174. If uncertainty in position and momentum are equal, then uncertainty in velocity is :  
(a)  $\frac{1}{2m} \sqrt{\frac{h}{\pi}}$  (b)  $\sqrt{\frac{h}{2\pi}}$   
(c)  $\frac{1}{m} \sqrt{\frac{h}{\pi}}$  (d)  $\sqrt{\frac{h}{\pi}}$
175. Which of the following sets of quantum numbers is correct?  
(a)  $n = 5, l = 4, m = 0, s = +\frac{1}{2}$   
(b)  $n = 3, l = 3, m = +3, s = +\frac{1}{2}$   
(c)  $n = 6, l = 0, m = +1, s = -\frac{1}{2}$   
(d)  $n = 4, l = 2, m = +2, s = 0$
176. Which combinations of quantum numbers,  $n, \ell, m$  and  $s$  for the electron in an atom does not provide a permissible solution of the wave equation ?  
(a)  $3, 2, 1, \frac{1}{2}$  (b)  $3, 1, 1, -\frac{1}{2}$   
(c)  $3, 3, 1, -\frac{1}{2}$  (d)  $3, 2, -2, \frac{1}{2}$
177. An electron has principal quantum number 3. The number of its (i) subshells and (ii) orbitals would be respectively  
(a) 3 and 5 (b) 3 and 7  
(c) 3 and 9 (d) 2 and 5
178. The electrons identified by quantum numbers  $n$  and  $\ell$  :  
(A)  $n = 4, \ell = 1$  (B)  $n = 4, \ell = 0$   
(C)  $n = 3, \ell = 2$  (D)  $n = 3, \ell = 1$   
can be placed in order of increasing energy as :  
(a) (C) < (D) < (B) < (A) (b) (D) < (B) < (C) < (A)  
(c) (B) < (D) < (A) < (C) (d) (A) < (C) < (B) < (D)
179. The five  $d$ -orbitals are designated as  $d_{xy}, d_{yz}, d_{xz}, d_{x^2-y^2}$  and  $d_{z^2}$ . Choose the correct statement.  
(a) The shapes of the first three orbitals are similar but that of the fourth and fifth orbitals are different  
(b) The shapes of all five  $d$ -orbitals are similar  
(c) The shapes of the first four orbitals are similar but that of the fifth orbital is different  
(d) The shapes of all five  $d$ -orbitals are different
180. If the nitrogen atom has electronic configuration  $1s^7$ , it would have energy lower than that of the normal ground state configuration  $1s^2 2s^2 2p^3$ , because the electrons would be closer to the nucleus. Yet  $1s^7$  is not observed because it violates.  
(a) Heisenberg uncertainty principle  
(b) Hund's rule  
(c) Pauli exclusion principle  
(d) Bohr postulate of stationary orbits

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (b)
2. (b) Cathode rays are never electromagnetic waves.
3. (c) Cathode rays are made up of negatively charged particles (electrons) which are deflected by both the electric and magnetic fields.
4. (d)      5. (b)      6. (c)      7. (c)
8. (c) The electrical discharge through the gases could be observed only at low pressure and high voltage.
9. (b) The cathode rays (negatively charged particles stream) originates from cathode and move towards anode.
10. (b) Millikan determined the value of charge on the electron by using oil drop experiment.
11. (b)
12. (d) Proton is the nucleus of H-atom (H-atom devoid of its electron)
13. (b) Positron (positive electron,  $+_1e^0$ ) is positively charged electron without any mass, so it is the lightest particle among given choices.
14. (c) As the neutron is a chargeless particle, hence, the beam of neutrons is not deflected by electrical or magnetic field.
15. (a) James Chadwick in 1932 discovered the neutrons.
16. (b) Since electrons are negatively charged particles they got deflected toward positively charged electrode whereas proton being positively charged will get deflected toward negative electrode. Since neutrons are neutral, so they went straight.
17. (a)
18. (b)  $\alpha$ -rays have the least penetrating power, followed by  $\beta$ -rays (100 times that of  $\alpha$ -rays) and  $\gamma$ -rays (1000 times that of  $\alpha$ -rays).
19. (d) X- and  $\gamma$ -rays are not deflected by the electric and magnetic field.
20. (c) Rutherford's  $\alpha$ -ray scattering experiment first showed the existence of a small positively charged entity in the centre of atom, called nucleus.
21. (d) The nucleus occupies much smaller volume compared to the volume of the atom.
22. (a) All positive ions are deposited at small part. (nucleus of atom).
23. (d) Rutherford used doubly charged helium particle. ( $\alpha$  - particle)
24. (d) Electrons are revolving around the nucleus, and centrifugal force is balancing the force of attraction.
25. (d) Number of neutrons = Mass number – Atomic number  
 $= 70 - 30 = 40$ .
26. (a)  $19 + 1e^- = 20$  electrons.
27. (c)  $_{18}\text{Ar}^{40}$  contains 22 neutrons and  $_{21}\text{Sc}^{40}$  contains 19 neutrons. The number of neutrons =  $(A - Z)$
28. (b) Number of p = number of  $e^- = 89$  and neutrons  $231 - 89 = 142$ .
29. (a)  $Z = 11$ ,  $A = 24$ . Hence protons = 11 the neutrons  $(24 - 11) = 13$ .
30. (d) For neutral atom . No. of p = No. of  $e^- = 18$  and  $A = Z + \text{No. of neutrons} = 18 + 20 = 38$ .
31. (c) When an alpha particle is emitted from a nucleus its atomic number decreases by two and its atomic mass decreases by four e.g.  

$${}_Z X^A \xrightarrow{-\alpha} {}_{Z-2} X^{A-4}$$
32. (b) Nucleons are total number of protons and neutrons. Both of these are collectively known as nucleons.
33. (b) Atoms with mass number but different atomic numbers are called isobars. Examples;  ${}^{14}_6\text{C}$ ,  ${}^{14}_7\text{N}$  are isobars.
34. (d)  ${}^{35}_{17}\text{Cl}$  and  ${}^{37}_{17}\text{Cl}$  are isotopes, so they will have same chemical properties.
35. (d) Atomic number is equal to number of protons or number of electrons. Thus if two species have different atomic number they must contain different number of protons and electrons. Number of neutrons = Atomic mass – Atomic number. Therefore due to difference of atomic numbers two species also have different number of neutrons.
36. (a)
37. (d)  $v_1 = \frac{c}{\lambda_1}$   

$$v_2 = \frac{c}{\lambda_2} = \frac{c}{3\lambda_1}$$
  

$$\% \text{ change in frequency} = \frac{v_2 - v_1}{v_1} \times 100$$
  

$$= \frac{\frac{c}{3\lambda_1} - \frac{c}{\lambda_1}}{\frac{c}{\lambda_1}} \times 100 = \frac{-\frac{2c}{3\lambda_1}}{\frac{c}{\lambda_1}} \times 100$$
  

$$= -66\%$$
38. (b)
39. (b) The ideal body, which emits and absorbs radiations of all frequencies, is called a black-body and the radiation emitted by such a body is called black-body radiation.
40. (a) Energy is always absorbed or emitted in whole number or multiples of quantum.

41. (d) (i) Interference and diffraction support the wave nature of electron.  
(ii)  $E = mc^2$  supports the particle nature of electron.  
(iii)  $E = h\nu = \frac{hc}{\lambda}$  is de-Broglie equation and it supports both wave nature and particle nature of electron.
42. (d)  $E = h\nu = \frac{hc}{\lambda}$  or  $\lambda = \frac{c}{\nu}$   
 $\Rightarrow \lambda = \frac{3 \times 10^8}{8 \times 10^{15}} = 3.75 \times 10^{-8} \text{ m}$   
In nanometer  $\lambda = 3.75 \times 10$   
which is closest to  $4 \times 10^1$
43. (c) K.E. of emitted electron  
 $= h\nu - h\nu_0$  (i.e. smaller than  $h\nu$ ).
44. (a)
45. (a) At a frequency  $\nu > \nu_0$ , the ejected electrons come out with certain kinetic energy.
46. (a)
47. (d) This statement is known as uncertainty principle which was given by Heisenberg it is not a Bohr's postulate.
48. (c) Since the energy difference between two consecutive Bohr orbits is quantized and the energy of higher orbit is more than that of lower orbit, so an electron from one Bohr stationary orbit can go to next higher orbit by absorption of electromagnetic radiation of particular wavelength or frequency.
49. (d) For a Bohr atom, angular momentum  $M$  of the electron  
 $= \frac{nh}{2\pi}$ .
50. (b) Angular momentum of an electron in  $n^{\text{th}}$  orbit is given by  
 $mvr = \frac{nh}{2\pi}$   
For  $n = 5$ , we have  
Angular momentum of electron  $= \frac{5h}{2\pi} = \frac{2.5h}{\pi}$
51. (d)  $y \propto n^2$   
For 1<sup>st</sup> orbit  $y = 1$   
For III<sup>rd</sup> orbit  $y \propto 3^2 = 9$   
So it will  $9y$ .
52. (a)  $r_n = r_1 \times n^2$  (for hydrogen atom)  
 $r_n = r \times n^2$   
as  $r_1 = r$  (given)  
 $r_2 = r \times 2^2$  ( $n = 2$ , for second Bohr's orbit)  
 $= 4r$
53. (b) 54. (d)
55. (a) Radius of  $n^{\text{th}}$  orbit  $= r_1 n^2$ . (for H-atom)
56. (a) For hydrogen atom ( $n = 1$ ) (due to ground state)  
Radius of hydrogen atom ( $r$ )  $= 0.53 \text{ \AA}$ .
- Atomic number of Li ( $Z$ )  $= 3$ .  
Radius of  $\text{Li}^{2+}$  ion  $= r_1 \times \frac{n^2}{Z} = 0.53 \times \frac{(1)^2}{3} = 0.17$
57. (c) Energy of an electron in Bohr's orbit is given by the relationship.  $E_n = -\frac{13.6}{n^2} \text{ eV}$ .
58. (b) We know that  $E_n = -\frac{1312}{n^2} \text{ kJ mol}^{-1}$   
 $n = 4$  (Fourth Bohr orbit)  
Given  $E_4 = -\frac{1312}{4^2} = -82 \text{ kJ mol}^{-1}$
59. (a) 2<sup>nd</sup> excited state will be the 3<sup>rd</sup> energy level.  
 $E_n = \frac{13.6}{n^2} \text{ eV}$  or  $E = \frac{13.6}{9} \text{ eV} = 1.51 \text{ eV}$ .
60. (d) For H atom,  $E_n = -\frac{13.6Z^2}{n^2} \text{ eV}$   
For second orbit,  $n = 2$   
 $Z = \text{At. no.} = 1$  (for hydrogen)  
 $\therefore E_2 = -\frac{13.6 \times (1)^2}{(2)^2} = -\frac{13.6}{4} \text{ eV}$   
 $= \frac{-13.6 \times 1.6 \times 10^{-19}}{4} \text{ J} = -5.44 \times 10^{-19} \text{ J}$
61. (b) If we assume the atom to be hydrogen like, energy of  $n^{\text{th}}$  energy level  
 $E_n = \frac{E_1}{n^2}$  where  $E_1$  is energy of first energy level  
 $E_2 = -\frac{E_1}{2^2} = -\frac{E_1}{4} = \frac{-21.79 \times 10^{-12}}{4}$   
 $= -5.447 \times 10^{-12} \text{ erg per atom}$ .
62. (a) Energy of an electron  $E = \frac{-E_0}{n^2}$   
For energy level ( $n = 2$ )  
 $E = -\frac{13.6}{(2)^2} = -\frac{13.6}{4} = -3.4 \text{ eV}$ .
63. (a)  $\text{H}, \text{He}^+$  and  $\text{Li}^{2+}$  are single electron species thus show similar line spectra.
64. (c)
65. (c)  $V^{\text{th}}$  stationary state, as radii of stationary state is given as  $r_n = n^2 \times a_0 \Rightarrow n = 5$
66. (c)  $\frac{1}{\lambda} = R \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$   
 $\frac{1}{\lambda} = 1.097 \times 10^7 \left( \frac{1}{1} - \frac{1}{\infty} \right) = 1.097 \times 10^7 \text{ m}^{-1}$   
 $\lambda = 91.15 \times 10^{-9} \text{ m} \approx 91 \text{ nm}$



$$67. (c) \quad v = \frac{1}{h} \times IE \times \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

$$= \frac{2.18 \times 10^{-18}}{6.625 \times 10^{-34}} \times \left[ \frac{1}{1} - \frac{1}{16} \right] = 3.08 \times 10^{15} \text{ s}^{-1}$$

$$68. (c) \quad \Delta E \text{ for two energy levels} = 21.79 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{ J/atom}$$

$$69. (a) \quad \Delta E = R \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right];$$

First line in Balmer series results in the transition :  
 $n_2 = 3$  to  $n_1 = 2$ .

70. (c) Energy of photon obtained from the transition  $n = 6$  to  $n = 5$  will have least energy.

$$\Delta E = 13.6Z^2 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$71. (a) \quad \bar{\nu} = \frac{1}{\lambda} = R \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

For second line in Lyman series  
 $n_2 = 3$

$$\therefore \frac{1}{\lambda} = R \left[ \frac{1}{1^2} - \frac{1}{3^2} \right] = R \left[ \frac{1}{1} - \frac{1}{9} \right] = \frac{8R}{9}$$

72. (d) The shortest wavelength in hydrogen spectrum of Lyman series is given by formula :

$$\frac{1}{\lambda} = \frac{R_H}{n^2} = \frac{R_H}{1^2} = \frac{109678}{1}$$

$$\Rightarrow \lambda = 9.117 \times 10^{-6} \text{ cm}$$

$$= 911.7 \times 10^{-10} \text{ m} = 911.7 \text{ \AA}$$

73. (b)

74. (c) Bohr model can explain spectrum of any atom or ion containing one electron only (that is H-like species)

75. (d) Uncertainty principle which was given by Hiesenberg and not Bohr's postulate.

76. (d) Bohr's model can be applied to one electron system only.

77. (b) Bohr model can only explain one electron system

78. (a)  $\lambda = h/mv$  ; for the same velocity,  $\lambda$  varies inversely with the mass of the particle.

$$79. (d) \quad \lambda = \frac{h}{mv} = \frac{6.6 \times 10^{-34}}{60 \times 10^{-3} \times 10} = 10^{-33} \text{ m}$$

80. (d) Given  $\Delta E = 4.4 \times 10^{-4} \text{ J}$ ,  $\lambda = ?$

$$\lambda = \frac{hc}{\Delta E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{4.4 \times 10^{-4}} = 4.5 \times 10^{-22} \text{ m}$$

81. (c) We know that  $\lambda = \frac{h}{mv}$ ;  $\therefore m = \frac{h}{v\lambda}$

The velocity of photon ( $v$ ) =  $3 \times 10^8 \text{ m sec}^{-1}$

$$\lambda = 1.54 \times 10^{-8} \text{ cm} = 1.54 \times 10^{-10} \text{ meter}$$

$$\therefore m = \frac{6.626 \times 10^{-34} \text{ Js}}{1.54 \times 10^{-10} \text{ m} \times 3 \times 10^8 \text{ m sec}^{-1}}$$

$$= 1.4285 \times 10^{-32} \text{ kg}$$

$$82. (c) \quad \lambda = \frac{h}{p} = \frac{6.6 \times 10^{-34}}{3.3 \times 10^{-24}} = 2 \times 10^{-10} \text{ m} = 2 \text{ \AA}$$

$$83. (b) \quad E = h\nu = \frac{ch}{\lambda}; \text{ and } \nu = \frac{c}{\lambda}$$

$$8 \times 10^{15} = \frac{3.0 \times 10^8}{\lambda}$$

$$\therefore \lambda = \frac{3.0 \times 10^8}{8 \times 10^{15}} = 0.37 \times 10^{-7} = 37.5 \times 10^{-9} \text{ m} = 4 \times 10^1 \text{ nm}$$

$$84. (b) \quad \lambda = \frac{h}{mv}$$

$$h = 6.6 \times 10^{-34} \text{ J/s}$$

$$m = 1000 \text{ kg}$$

$$v = 36 \text{ km/hr} = \frac{36 \times 10^3}{60 \times 60} \text{ m/sec} = 10 \text{ m/sec}$$

$$\therefore \lambda = \frac{6.6 \times 10^{-34}}{10^3 \times 10} = 6.6 \times 10^{-38} \text{ m}$$

85. (b) Heisenberg uncertainty principle can be explained by the relation

$$\Delta x \cdot \Delta p \Rightarrow \frac{h}{4\pi}$$

where  $\Delta x$  = uncertainty in position

$\Delta p$  = uncertainty in momentum

86. (d) Heisenberg's uncertainty Principle is applicable to any moving object.

87. (d) By Heisenberg uncertainty Principle  $\Delta x \times \Delta p = \frac{h}{4\pi}$  (which is constant)

As  $\Delta x$  for electron and helium atom is same thus momentum of electron and helium will also be same therefore the momentum of helium atom is equal to  $5 \times 10^{-26} \text{ kg. m.s}^{-1}$ .

88. (a) Given  $m = 9.1 \times 10^{-31} \text{ kg}$   
 $h = 6.6 \times 10^{-34} \text{ Js}$

$$\Delta v = \frac{300 \times .001}{100} = 0.003 \text{ ms}^{-1}$$

From Heisenberg's uncertainty principle

$$\Delta x = \frac{6.62 \times 10^{-34}}{4 \times 3.14 \times 0.003 \times 9.1 \times 10^{-31}} = 1.92 \times 10^{-2} \text{ m}$$

89. (c)  $\Delta x \cdot \Delta p = \frac{h}{4\pi}$  or  $\Delta x \cdot m\Delta v = \frac{h}{4\pi}$ ;  
 $\Delta v = \frac{0.011}{100} \times 3 \times 10^4 = 3.3 \text{ cms}^{-1}$   
 $\Delta x = \frac{6.6 \times 10^{-27}}{4 \times 3.14 \times 9.1 \times 10^{-28} \times 3.3} = 0.175 \text{ cm}$
90. (b)  $\Delta x \cdot \Delta v$  value will be large for object of smallest mass and is therefore the most significant for calculating uncertainty.
91. (b) Magnetic quantum no. represents the orientation of atomic orbitals in an atom. For example  $p_x$ ,  $p_y$  &  $p_z$  have orientation along X-axis, Y-axis & Z-axis
92. (b) The sub-shell are  $3d$ ,  $4d$ ,  $4p$  and  $4s$ ,  $4d$  has highest energy as  $n + \ell$  value is maximum for this.
93. (a) The possible quantum numbers for  $4f$  electron are  
 $n = 4$ ,  $\ell = 3$ ,  $m = -3, -2, -1, 0, 1, 2, 3$  and  $s = \pm \frac{1}{2}$   
 Of various possibilities only option (a) is possible.
94. (b)  $n = 4$  represents  $4^{\text{th}}$  orbit  
 $\ell = 3$  represents  $f$  subshell  
 $m = -2$  represents orientation of  $f$ -orbital  
 $s = 1/2$  represents direction of spin of electron.  
 $\therefore$  The orbital is  $4f$ .
95. (b) For  $4d$  orbitals,  $n = 4$ ,  $\ell = 2$   
 $\left[ \begin{array}{l} \text{For } s \text{ orbital } \ell = 0 \\ \text{For } p \text{ orbital } \ell = 1 \\ \text{For } d \text{ orbital } \ell = 2 \end{array} \right]$   
 $m = -2, -1, 0, +1 \text{ or } +2$   
 $s = +\frac{1}{2} \text{ and } -\frac{1}{2}$   
 Thus choice  $b$  having  $n = 4$ ,  $\ell = 2$ ,  $d = 1$  and  $s = \frac{1}{2}$  is correct.
96. (c)  $n = 2$ ,  $\ell = 1$  means  $2p$ -orbital. Electrons that can be accommodated = 6 as  $p$  sub-shell has 3 orbital and each orbital contains 2 electrons.
97. (d)  $\ell = 3$  means  $f$ -subshell. Maximum no. of electrons =  $4\ell + 2 = 4 \times 3 + 2 = 14$
98. (b)  $m = -\ell$  to  $+\ell$ , through zero thus for  $\ell = 2$ , values of  $m$  will be  $-2, -1, 0, +1, +2$ .  
 Therefore for  $\ell = 2$ ,  $m$  cannot have the value  $-3$ .
99. (c) (a)  $n = 3$ ,  $\ell = 0$  means  $3s$ -orbital and  $n + \ell = 3$   
 (b)  $n = 3$ ,  $\ell = 1$  means  $3p$ -orbital  $n + \ell = 4$   
 (c)  $n = 3$ ,  $\ell = 2$  means  $3d$ -orbital  $n + \ell = 5$   
 (d)  $n = 4$ ,  $\ell = 0$  means  $4s$ -orbital  $n + \ell = 4$   
 Increasing order of energy among these orbitals is  
 $3s < 3p < 4s < 3d$   
 $\therefore 3d$  has highest energy.
100. (b) Value of  $\ell = 0$  .....  $(n - 1)$   
 $\ell$  cannot be equal to  $n$ .
101. (b) For  $n = 5$ ,  $\ell = n - 1 = 5 - 1 = 4$   
 $m = 2\ell + 1 = 2(4) + 1 = 9$   
 Sum of values of  $\ell$  and  $m = 9 + 4 = 13$
102. (a) Quantum number  $n = 3$ ,  $\ell = 2$ ,  $m = +2$  represent an orbital with  
 $s = \pm \frac{1}{2} \left( 3d_{xy} \text{ or } 3d_{x^2-y^2} \right)$   
 which is possible only for one electron.
103. (d) The orbitals which have same energy are called degenerate orbitals eg.  $p_x$ ,  $p_y$  and  $p_z$ .
104. (a) No. of radial nodes in  $3p$ -orbital =  $(n - \ell - 1)$   
 [for  $p$  orbital  $\ell = 1$ ]  
 $= 3 - 1 - 1 = 1$
105. (b)
106. (a) As  $n - \ell - 1 = 5$  or  $8 - \ell - 1 = 5 \Rightarrow \ell = 2$ .
107. (b) According to given information  $n = 5$  and  $\ell = 3$ .
108. (a) The number of allowed orbitals are given by  $n^2$ .  
 Thus when  $n = 5$   
 $(5)^2 = 25$
109. (d) Spherical shaped  $s$ -orbital shields the outer shell electrons move effectively than  $p$ -orbital, which in turn shields more effectively than  $d$ -orbital and so on.
110. (d) According to Hund's rule electron pairing in  $p$ ,  $d$  and  $f$  orbitals cannot occur until each orbital of a given subshell contains one electron each or is singly occupied.
111. (d) We know that atomic number of gadolinium is 64. Therefore the electronic configuration of gadolinium is  $[\text{Xe}] 4f^7 5d^1 6s^2$ . Because the half filled and fully filled orbitals are more stable.
112. (b) The sub-shell with lowest value of  $(n + \ell)$  is filled up first. When two or more sub-shells have same  $(n + \ell)$  value the subshell with lowest value of ' $n$ ' is filled up first therefore the correct order is  

orbital	$4s$	$3d$	$4p$	$5s$	$4d$
$n + \ell$	$4 + 0$	$3 + 2$	$4 + 1$	$5 + 0$	$4 + 2$
value	$= 4$	$= 5$	$= 5$	$= 5$	$= 6$
113. (c)  $\text{Fe}^{++} (26 - 2 = 24) = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^6$  hence no. of  $d$  electrons retained is 6. [Two  $4s$  electron are removed]
114. (b) This configuration represents ground state electronic configuration of Cr.  
 $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$
115. (c)  $\text{N}(7) = 1s^2 2s^2 2p^3$   
 $\text{N}^{2+} = 1s^2 2s^2 2p^1$   
 Unpaired electrons = 1.
116. (a)  $\text{Cu}^+ = 29 - 1 = 28 e^-$   
 thus the electronic configuration of  $\text{Cu}^+$  is  
 $\text{Cu}^+(28) = 1s^2 2s^2 2p^6 \underbrace{3s^2 3p^6 3d^{10}}_{18e^-}$
117. (d) This is as per the definition of Pauli's exclusion principle.

## STRUCTURE OF ATOM

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118. (b) Electronic configuration of Cu (29) is  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^1$  and not  $1s^2, 2s^2 2p^6 3s^2 3p^6 3d^9 4s^2$  due to extra stability of fully filled orbitals.
119. (b) According to Aufbau principle, the orbital of lower energy (2s) should be fully filled before the filling of orbital of higher energy starts.
120. (a)  $ns \rightarrow (n-2)f \rightarrow (n-1)d \rightarrow np$  [n = 6]
121. (d) The number of sub shell is  $(2l + 1)$ . The maximum number of electrons in the sub shell is  $2(2l + 1) = (4l + 2)$ .
122. (b)
- |         | 5p    | 4f    | 6s    | 5d    |
|---------|-------|-------|-------|-------|
| (n + l) | 5 + 1 | 4 + 3 | 6 + 0 | 5 + 2 |
|         | 6     | 7     | 6     | 7     |
- Hence the order is  $5p < 6s < 4f < 5d$
123. (d)
124. (d) The d-orbital represented by option (d) will become completely filled after gaining an electron. Therefore option (d) is correct.

## STATEMENT TYPE QUESTIONS

125. (c) When both electric and magnetic field is applied, electron strikes at point B, and at point C when only magnetic field is applied.
126. (c)
127. (b) For statement (ii) there is no time lag between striking of light beam and the ejection of electrons. For statement (iii) refer statement (iv).
128. (c) (i) Beyond a certain wavelength the line spectrum becomes band spectrum.  
(ii) For Balmer series  $n_1 = 2$   
(iii) For calculation of longest wavelength use nearest value of  $n_2$ . Hence for longest wavelength in Balmer series of hydrogen spectrum,  
 $n_1 = 2$  &  $n_2 = 3$ .
129. (c) Statement (i) is related to Heisenberg's uncertainty principle. Statement (iii) belongs to Pauli's exclusion principle.
130. (b) Angular quantum number determines the 3d shape of the orbital.  
Spin quantum number of an electron determines the orientation of the spin of electron relative to the chosen axis.

## MATCHING TYPE QUESTIONS

131. (b) Isotopes have same atomic number. Isobars have same mass number, whereas isoelectronic species have same number of electrons although the (A) has same number of electrons but the protons they carry are same while in case of isoelectronic species number of protons they carry are different.
132. (a) 133. (c) 134. (a)

135. (a) For d-subshell  $\Rightarrow$  Number of orbitals = 5,  $l = 2$   
f-subshell  $\Rightarrow$  Number of orbitals = 7,  $l = 3$   
s-subshell  $\Rightarrow$  Number of orbitals = 1,  $l = 0$   
p-subshell  $\Rightarrow$  Number of orbitals = 3,  $l = 1$

136. (b) 137. (c) 138. (b)

## ASSERTION-REASON TYPE QUESTIONS

139. (d) The statement-1 is false but the statement-2 is true exact position and exact momentum of an electron can never be determined according to Heisenberg's uncertainty principle. Even not with the help of electron microscope because when electron beam of electron microscope strikes the target electron of atom, the impact causes the change in velocity and position of electron.
140. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

$$\text{Radius, } r_n = \frac{n^2 h^2}{4\pi e^2 m Z} = \frac{n^2}{Z} \times 0.529 \text{ \AA} \cdot r_n$$

For first orbit of H-atom  
 $n = 1$

$$r_1 = \frac{(1)^2}{1} \times 0.529 \text{ \AA} = 0.529 \text{ \AA}$$

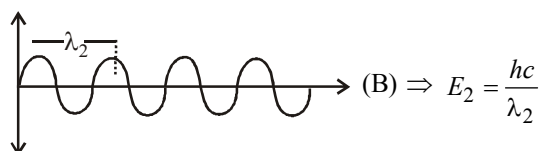
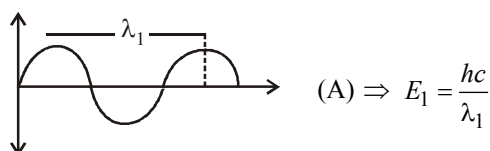
141. (a) 142. (b) 143. (c)

## CRITICAL THINKING TYPE QUESTIONS

144. (c)
145. (d)  $\frac{e}{m}$  for (i) neutron  $= \frac{0}{1} = 0$   
(ii)  $\alpha$ -particle  $= \frac{2}{4} = 0.5$   
(iii) proton  $= \frac{1}{1} = 1$   
(iv) electron  $= \frac{1}{1/1837} = 1837$
146. (b)  $N^{3-}$  The amount of deviation depends upon the magnitude of negative charge on the particle.
147. (d) The lesser is the mass of particle, greater is the deflection.
148. (c) Deuterium and an  $\alpha$ -particle have identical values of  $e/m$ .
149. (a) Considering the core of an atom, higher the positive charge concentrated in the nucleus, greater the repulsion for an alpha-particle.
- Coulombic force of repulsion  $= \frac{kq_1(z_e)}{r^2}$   
 $q_1$  = charge on  $\alpha$ -particle  
 $(z_e)$  = charge on nucleus of atom
150. (c)

151. (d) Atomic number = No. of protons = 8  
Mass number = No. of protons + No. of neutrons  
= 8 + 8 = 16  
Since the no. of electrons are two more than the no. of protons, hence, it is a bivalent species. Thus, the species is  $^{16}\text{O}_8^{2-}$ .

152. (c) e/m waves shown in figure A has higher wavelength in comparison to e/m waves shown in figure B. Thus these waves also differ in frequency and energy.  $\nu = \frac{c}{\lambda}$



153. (d)  $\lambda_1 > \lambda_2 \Rightarrow E_1 < E_2$   
 $E = h\nu$

and  $\nu = \left(\frac{c}{\lambda}\right)$

$\nu_a = 10^{15}$ ,  $\nu_b = 10^{14}$ ,  
 $\nu_c = 10^{17}$ ,  $\nu_d = 0.85 \times 10^{15}$

and  $\nu_e = 10 \times 10^{15}$ ,

154. (d) From the expression of Bohr's theory, we know that

$$m_e v_1 r_1 = n_1 \frac{h}{2\pi}$$

$$\& m_e v_2 r_2 = n_2 \frac{h}{2\pi}$$

$$\frac{m_e v_1 r_1}{m_e v_2 r_2} = \frac{n_1}{n_2} \times \frac{h}{2\pi} \times \frac{2\pi}{h}$$

Given,  $r_1 = 5 r_2$ ,  $n_1 = 5$ ,  $n_2 = 4$

$$\frac{m_e \times v_1 \times 5 r_2}{m_e \times v_2 \times r_2} = \frac{5}{4}$$

$$\Rightarrow \frac{v_1}{v_2} = \frac{5}{4 \times 5} = \frac{1}{4} = 1:4$$

155. (b)  $Z = 3$  for  $\text{Li}^{2+}$  ions

So  $r_n = \frac{52.9 \times n^2}{Z}$

$n = 3$ ,  $Z = 3$

$$r_n = \frac{52.9 \times (3)^2}{3} \text{ pm}$$

$$= 158.7 \text{ pm}$$

Also, linear momentum ( $mv$ ) =  $7.3 \times 10^{-34} \text{ kg ms}^{-1}$

Then angular momentum will be

$$\omega = (mv) \times r$$

$$= (7.3 \times 10^{-34} \text{ kg ms}^{-1}) (158.7 \text{ pm})$$

$$= 7.3 \times 10^{-34} \text{ kg ms}^{-1} \times (158.7 \times 10^{-12} \text{ m})$$

$$= 11.58 \times 10^{-48} \text{ kg m}^2 \text{ s}^{-1}$$

$$= 11.58 \times 10^{-45} \text{ g m}^2 \text{ s}^{-1}$$

156. (d) Given : Radius of hydrogen atom =  $0.530 \text{ \AA}$ , Number of excited state ( $n$ ) = 2 and atomic number of hydrogen atom ( $Z$ ) = 1. We know that the Bohr radius.

$$(r) = \frac{n^2}{Z} \times \text{Radius of atom} = \frac{(2)^2}{1} \times 0.530$$

$$= 4 \times 0.530 = 2.12 \text{ \AA}$$

157. (c) Energy of electron in 2<sup>nd</sup> orbit of  $\text{Li}^{+2} = -13.6 \frac{Z^2}{n^2}$

$$= \frac{-13.6 \times (3)^2}{(2)^2} = -30.6 \text{ eV}$$

Energy required =  $0 - (-30.6) = 30.6 \text{ eV}$

158. (d) Except  $\text{Al}^{3+}$  all contain one electron and Bohr's model could explain the spectra for one electron system, Bohr's model was not able to explain the spectra of multielectron system.

159. (d)  $E_n^{\text{H}} = -2.18 \times 10^{-18} \left( \frac{Z^2}{n_{\text{H}}^2} \right) \text{ J} = \frac{-2.18 \times 10^{-18}}{n_{\text{H}}^2} \text{ J}$

$$E_n^{\text{He}^+} = -2.18 \times 10^{-18} \left( \frac{Z^2}{n_{\text{He}^+}^2} \right) \text{ J} = \frac{-2.18 \times 10^{-18} \times 4}{n_{\text{He}^+}^2} \text{ J}$$

$$E_n^{\text{H}} = E_n^{\text{He}^+} \Rightarrow \frac{1}{n_{\text{H}}^2} = \frac{4}{n_{\text{He}^+}^2} \Rightarrow n_{\text{He}^+} = 2 \times n_{\text{H}}$$

If  $n_{\text{H}} = 1$  Then  $n_{\text{He}^+} = 2$

If  $n_{\text{H}} = 2$  Then  $n_{\text{He}^+} = 4$

If  $n_{\text{H}} = 3$  Then  $n_{\text{He}^+} = 6$

160. (d) Radius of  $n^{\text{th}}$  orbit =  $\frac{n^2 h^2}{4\pi^2 m e^2 Z}$

where  $n$  = no. of orbit

$h$  = Plank's constant

$e$  = charge on one electron

$m$  = mass of one electron

$Z$  = atomic number

161. (c)

162. (d) In S.I. units the P.E. =  $\frac{-Ze^2}{4\pi\epsilon_0 r}$

For  $\text{Li}^{2+}$ ,  $Z = 3$ .

$$\therefore \text{P.E.} = \frac{-3e^2}{4\pi\epsilon_0 r}$$

163. (c) Series limit is the last line of the series, i.e.  $n_2 = \infty$ .

$$\therefore \bar{\nu} = \frac{1}{\lambda} = R \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right] = R \left[ \frac{1}{n_1^2} - \frac{1}{\infty^2} \right] = \frac{R}{n_1^2}$$

$$\therefore \bar{\nu} = 12186.3 = \frac{109677.76}{n_1^2}$$

$$\Rightarrow n_1^2 = \frac{109677.76}{12186.3} = 9 \Rightarrow n_1 = 3$$

$\therefore$  The line belongs to Paschen series.

164. (d) For  $\text{He}^+$  ion,  $\frac{1}{\lambda} = Z^2 R \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$

$$(2)^2 R \left[ \frac{1}{2^2} - \frac{1}{4^2} \right] = \frac{3R}{4}$$

$$\text{For hydrogen atom, } \frac{1}{\lambda} = R \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right]$$

$$\frac{3R}{4} = R \left[ \frac{1}{n_1^2} - \frac{1}{n_2^2} \right] \text{ or } \frac{1}{n_1^2} - \frac{1}{n_2^2} = \frac{3}{4}$$

$$n_1 = 1 \text{ and } n_2 = 2.$$

165. (c) The wavelengths of elements decreases with increase

$$\text{in their mass. } \left( \because \lambda = \frac{h}{mv} \right)$$

166. (c) Energy of a photon,  $E = \frac{hc}{\lambda}$

$$= \frac{6.626 \times 10^{-34} (\text{Js}) \times 3 \times 10^8 (\text{ms}^{-1})}{331.3 \times 10^{-9} (\text{m})} = 6 \times 10^{-19} \text{ J}$$

No. of photons emitted per second

$$= \frac{600 (\text{J})}{6 \times 10^{-19} (\text{J})} = 10^{21}$$

167. (a)  $\frac{1}{2}mv^2 = h\nu - h\nu_0$

$$\Rightarrow \frac{1}{2}mv^2 = h(\nu - \nu_0)$$

$$\Rightarrow v = \sqrt{\frac{2h}{m}(\nu - \nu_0)}$$

168. (a) According to de-Broglie,

$$\lambda = \frac{h}{mv}$$

where  $m$  = mass of electron,  $v$  = velocity

169. (d) Given,  $v_A = 0.1 \text{ ms}^{-1}$  and  $v_B = 0.05 \text{ ms}^{-1}$  also,  $m_B = 5m_A$

$$\text{de-Broglie wavelength, } \lambda = \frac{h}{mv}$$

$$\begin{aligned} \therefore \frac{\lambda_A}{\lambda_B} &= \frac{h/m_A v_A}{h/m_B v_B} = \frac{m_B v_B}{m_A v_A} \\ &= \frac{5m_A \times 0.05}{m_A \times 0.1} = 5 \times 0.5 = 2.5 = 5/2 \\ \therefore \lambda_A : \lambda_B &= 5 : 2 \end{aligned}$$

170. (d) de Broglie wavelength  $\lambda = \frac{h}{mv}$

$$\frac{\lambda_1}{\lambda_2} = \frac{m_2 v_2}{m_1 v_1}; \frac{1}{4} = \frac{1}{9} \times \frac{v_2}{v_1}$$

$$\frac{v_2}{v_1} = \frac{9}{4}$$

$$\frac{v_1}{v_2} = \frac{4}{9}$$

$$\text{KE} = \frac{1}{2}mv^2$$

$$\frac{\text{KE}_1}{\text{KE}_2} = \frac{m_1}{m_2} \times \frac{v_1^2}{v_2^2} = \frac{9}{1} \times \left( \frac{4}{9} \right)^2 = \frac{16}{9}$$

171. (a) Given mass of an electron ( $m$ ) =  $9.1 \times 10^{-28} \text{ g}$ ;

$$\text{Velocity of electron } (v) = 3 \times 10^4 \text{ cm/s};$$

$$\text{Accuracy in velocity} = 0.001\% = \frac{0.001}{100};$$

Actual velocity of the electron

$$(\Delta v) = 3 \times 10^4 \times \frac{0.001}{100} = 0.3 \text{ cm/s.}$$

$$\text{Planck's constant } (h) = 6.626 \times 10^{-27} \text{ erg-sec.}$$

$\therefore$  Uncertainty in the position of the electron

$$\begin{aligned} (\Delta x) &= \frac{h}{4\pi m \Delta v} = \frac{6.626 \times 10^{-27} \times 7}{4 \times 22 \times (9.1 \times 10^{-28}) \times 0.3} \\ &= 1.93 \text{ cm} \end{aligned}$$

172. (a)  $\Delta p = m \Delta v$

Substituting the given values of  $\Delta x$  and  $m$ , we get  $1 \times 10^{-18} \text{ g cm s}^{-1} = 9 \times 10^{-28} \text{ g} \times \Delta v$

$$\begin{aligned} \text{or } \Delta v &= \frac{1 \times 10^{-18}}{9 \times 10^{-28}} \\ &= 1.1 \times 10^9 \text{ cm s}^{-1} \approx 1 \times 10^9 \text{ cm s}^{-1} \\ \text{i.e. option (a) is correct.} \end{aligned}$$

173. (b) According to Heisenberg uncertainty principle.

$$\Delta x \cdot m \Delta v = \frac{h}{4\pi} \quad \Delta x = \frac{h}{4\pi m \Delta v}$$

$$\text{Here } \Delta v = \frac{600 \times 0.005}{100} = 0.03$$

$$\text{So, } \Delta x = \frac{6.6 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 0.03} \\ = 1.92 \times 10^{-3} \text{ meter}$$

174. (a) We know  $\Delta p \cdot \Delta x \geq \frac{h}{4\pi}$

since  $\Delta p = \Delta x$  (given)

$$\therefore \Delta p \cdot \Delta p = \frac{h}{4\pi}$$

$$\text{or } m \Delta v \cdot m \Delta v = \frac{h}{4\pi} \quad [\because \Delta p = m \Delta v]$$

$$\text{or } (\Delta v)^2 = \frac{h}{4\pi m^2}$$

$$\text{or } \Delta v = \sqrt{\frac{h}{4\pi m^2}} = \frac{1}{2m} \sqrt{\frac{h}{\pi}}$$

Thus option (a) is the correct option.

175. (a) For  $n = 5$ ,  $l$  may be 0, 1, 2, 3 or 4  
For  $l = 4$ ,  $m = 2l + 1 = 2 \times 4 + 1 = 9$   
 $= -4, -3, -2, -1, 0, +1, +2, +3, +4$   
For  $m = 0$ ,  $s = +\frac{1}{2}$

Hence, (a) is correct option.

- (b) For any value of  $n$ , the value of  $l$  cannot be equal or greater than value of  $n$ , hence it is incorrect.
- (c) For  $l = 0$ ,  $m = 0$  hence it is incorrect.
- (d) The value of  $s$  can never be zero. Thus this option is also incorrect.

176. (c) Possible values of  $\ell$  and  $m$  depend upon the value of  $n$   
 $\ell = 0$  to  $(n - 1)$   
 $m = -\ell$  to  $+\ell$  through zero

$$s = +\frac{1}{2} \text{ and } -\frac{1}{2}$$

Thus for  $n = 3$ ,  
 $\ell$  may be 0, 1 or 2; but not 3  
 $m$  may be  $-2, -1, 0, +1$  or  $+2$

$$s \text{ may be } +\frac{1}{2} \text{ or } -\frac{1}{2}$$

177. (c)

178. (b) (A)  $4p$  (B)  $4s$   
(C)  $3d$  (D)  $3p$

According to Bohr Bury's  $(n + \ell)$  rule, increasing order of energy will be (D) < (B) < (C) < (A).

**Note :** If the two orbitals have same value of  $(n + \ell)$  then the orbital with lower value of  $n$  will be filled first.

179. (c) First four orbitals contain four lobes, while fifth orbital consists of only two lobes. The lobes of  $d_{xy}$  orbital lie between  $x$  and  $y$  axis. Similarly in the case of  $d_{yz}$  and  $d_{zx}$  their lobes lie between  $yz$  and  $zx$  axis respectively. Four lobes of  $d_{x^2-y^2}$  orbital are lying along  $x$  and  $y$  axis while two lobes of  $d_{z^2}$  orbital are lying along  $z$ -axis.

180. (c) As per Pauli exclusion principle "no two electrons in the same atom can have all the four quantum numbers equal or an orbital cannot contain more than two electrons and it can accommodate two electrons only when their directions of spin are opposite".



CHAPTER

3

# CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

## FACT/DEFINITION TYPE QUESTIONS

- Periodic classification of elements is used to examine the
  - periodic trends in physical properties of elements
  - periodic trends in chemical properties of elements
  - Both (a) and (b)
  - None of the above
- Cl, Br, I, if this is Dobereiner's triad and the atomic masses of Cl and I are 35.5 and 127 respectively the atomic mass of Br is
  - 162.5
  - 91.5
  - 81.25
  - 45.625
- If the two members of a Dobereiner triad are phosphorus and antimony, the third member of this triad is
  - arsenic
  - sulphur
  - iodine
  - calcium
- The law of triads is applicable to a group of
  - Cl, Br, I
  - C, N, O
  - Na, K, Rb
  - H, O, N
- In 1800, only ....X.... elements were known. Here, X refers to
  - 63
  - 31
  - 114
  - 92
- Johann Dobereiner gave the idea of trends among physical and ...X... of several groups of three elements. Here, X refers to
  - atomic number
  - atomic mass
  - chemical properties
  - None of these
- Which of the following is the correct set of elements to Dobereiner's triads?
 

(a) $\begin{matrix} \text{Li} & \text{Na} & \text{K} \\ 7 & 23 & 39 \end{matrix}$	(b) $\begin{matrix} \text{Br} & \text{Cl} & \text{I} \\ 80 & 35.5 & 127 \end{matrix}$
(c) $\begin{matrix} \text{Fe} & \text{Ni} & \text{Co} \\ 55.85 & 58.71 & 58.93 \end{matrix}$	(d) Data insufficient
- On which of the following Dobereiner's Triad law is not applicable?
  - Cl, Br, I
  - Ca, Sr, B
  - F, Cl, Br
  - Li, Na, K
- Newlands could classify elements only upto –
  - copper
  - chlorine
  - calcium
  - chromium
- According to Newlands theory, when elements are arranged in the order of increasing atomic weight which number element had similar properties to the first element.
  - third
  - seventh
  - eighth
  - sixth
- Lothar Meyer plotted the physical properties such as atomic volume, melting point and ...X... against atomic weight. Here, X refers to
  - mass
  - boiling point
  - surface tension
  - None of these
- The most significant contribution towards the development of periodic table was made by
  - Mendeleev
  - Avogadro
  - Dalton
  - Cavendish
- Noble gases were included in Mendeleev's periodic table in the
  - 1st group
  - 7th group
  - 8th group
  - None of these
- Mendeleev classified elements in
  - increasing order of atomic groups
  - eight periods and eight groups
  - seven periods and nine groups
  - eight periods and seven groups
- Select the correct chronological order for the discoveries of the following scientists.  
Dobereiner, Newlands, Chancourtois, Mendeleev
  - Chancourtois, Dobereiner, Newlands, Mendeleev
  - Dobereiner, Chancourtois, Newlands, Mendeleev
  - Dobereiner, Newlands, Chancourtois, Mendeleev
  - Chancourtois, Newlands, Dobereiner, Mendeleev
- The molecular formula of chloride of Eka-Aluminium and Eka-Silicon respectively are
  - $\text{GaCl}_3$  and  $\text{SiO}_4$
  - $\text{GaCl}_3$  and  $\text{AlCl}_3$
  - $\text{AlCl}_3$  and  $\text{SiCl}_4$
  - $\text{GaCl}_3$  and  $\text{GeCl}_4$
- Who developed long form of the periodic table?
  - Lothar Meyer
  - Neils Bohr
  - Mendeleev
  - Moseley
- At present, how many elements are known
  - 110
  - 112
  - 113
  - 118

19. Which of the scientists given below discovered that periodic table should be based on the atomic number ?  
(a) Mendeleev (b) Newlands  
(c) Moseley (d) Lothar Meyer
20. How many elements are there in 6<sup>th</sup> period of periodic table?  
(a) 18 (b) 8  
(c) 30 (d) 32
21. Modern periodic table is based on the atomic number of the elements. The experiment which proved the significance of the atomic number was  
(a) Mulliken's oil drop experiment  
(b) Mosley's work on X-ray spectra  
(c) Bragg's work on X-ray diffraction  
(d) Discovery of X-rays by Rontgen
22. The period number in the periodic table corresponds to the ...A... principal quantum number (n) of the elements. Here, A refers to  
(a) lowest (b) highest  
(c) middle (d) None of these
23. The symbol and IUPAC name for the element with atomic number 120, respectively are  
(a) Ubn and unbnilium (b) Ubn and unbiunium  
(c) Ubn and unnibium (d) Ubn and unnilium
24. Element with which of the following atomic number was named by American Society as Rutherfordium, while by Soviet Society it was named as Kurchatovium?  
(a) 108 (b) 104  
(c) 114 (d) 110
25. What is the IUPAC name of the element with atomic number 114?  
(a) Unununnium (b) Unnilquadium  
(c) Ununquadium (d) Unnilennium.
26. Element with electronic configuration  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6 4d^{10} 5s^2 5p^3$  belongs to the following group of the periodic table  
(a) 2nd (b) 5th  
(c) 3rd (d) 7th
27. The long form of periodic table consists of  
(a) seven periods and eight groups  
(b) seven periods and eighteen groups  
(c) eight periods and eighteen groups  
(d) eighteen periods and eight groups
28. All the members in a group in long form of periodic table have the same  
(a) valence  
(b) number of valence electrons  
(c) chemical properties  
(d) All of the above
29. Elements of which group form anions most readily?  
(a) Oxygen family (b) Nitrogen family  
(c) Halogens (d) Alkali metals
30. Element having atomic no. of 56 belongs to which of the following block of periodic table?  
(a) p- block (b) d-block  
(c) f- block (d) s-block
31. In the modern periodic table one of the following does not have appropriate position –  
(a) transition elements  
(b) inert gases  
(c) inner transition elements  
(d) halogens
32. If the atomic number of an element is 33, it will be placed in the periodic table in the  
(a) First group (b) Third group  
(c) Fifth group (d) Seventh group.
33. An atom has electronic configuration  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$ , you will place it in which group?  
(a) Fifth (b) Fifteenth  
(c) Second (d) Third
34. Which of the following is not an actinoid ?  
(a) Curium (Z=96) (b) Californium (Z=98)  
(c) Uranium (Z=92) (d) Terbium (Z=65)
35. The period number in the long form of the periodic table is equal to  
(a) magnetic quantum number of any element of the period.  
(b) atomic number of any element of the period.  
(c) maximum Principal quantum number of any element of the period.  
(d) maximum Azimuthal quantum number of any element of the period.
36. The electronic configuration of four elements are given below. Which elements does not belong to the same family as others?  
(a)  $[\text{Xe}]4f^{14} 5d^{10} 1s^2$  (b)  $[\text{Kr}]4d^{10} 5s^2$   
(c)  $[\text{Ne}]3s^2 3p^5$  (d)  $[\text{Ar}] 3d^{10} 4s^2$
37. The elements with atomic numbers 9, 17, 35, 53 and 85 belong to  
(a) alkali metals (b) alkaline earth metals  
(c) halogens (d) noble gases
38. Which of the following pairs has both members from the same period of the periodic table.  
(a) Na – Ca (b) Na – Cl  
(c) Ca – Cl (d) Cl – Br
39. The elements which are characterized by the outer electronic configuration  $ns^1$  to  $ns^2 np^6$  are collectively called  
(a) Transition elements  
(b) Representative elements  
(c) Lanthanides  
(d) Inner transition elements
40. f-block elements are called inner transition elements because  
(a) they have properties similar to those of transition elements  
(b) they exist in between transition elements  
(c) the last electron enters into the f-orbital of the penultimate shell  
(d) the last electron enters into any orbital of penultimate shell

41. An element, which belongs to third period and group 16 in the periodic table has electronic configuration.  
 (a)  $1s^2, 2s^2 2p^6, 3s^2 3p^3$  (b)  $1s^2, 2s^2 2p^6, 3s^2 3p^4$   
 (c)  $1s^2, 2s^2 2p^6, 3s^2 3p^5$  (d)  $1s^2, 2s^2 2p^4$
42. Which of the following is non-metallic ?  
 (a) B (b) Be  
 (c) Mg (d) Al
43. Which group of the periodic table contains coinage metal ?  
 (a) IIA (b) IB  
 (c) IA (d) None of these
44. The only non-metal which is liquid at ordinary temperature is  
 (a) Hg (b)  $Br_2$   
 (c)  $NH_3$  (d) None of these
45. Which is a metalloid?  
 (a) Pb (b) Sb  
 (c) Bi (d) Zn
46. In the long form of the periodic table all the non-metals are placed in  
 (a) *s*-block (b) *p*-block  
 (c) *f*-block (d) *d*-block
47. Arrange the following elements in the order of their increasing non-metallic character  
 Li, O, C, Be, F  
 (a)  $F < O < C < Be < Li$  (b)  $Li < Be < C < O < F$   
 (c)  $F < O < C < Be < Li$  (d)  $F < O < Be < C < Li$
48. Which is the correct order of ionic sizes (At. No. : Ce = 58, Sn = 50, Yb = 70 and Lu = 71) ?  
 (a)  $Ce > Sn > Yb > Lu$  (b)  $Sn > Ce > Yb > Lu$   
 (c)  $Lu > Yb > Sn > Ce$  (d)  $Sn > Yb > Ce > Lu$
49. The order of increasing sizes of atomic radii among the elements O, S, Se and As is :  
 (a)  $As < S < O < Se$  (b)  $Se < S < As < O$   
 (c)  $O < S < As < Se$  (d)  $O < S < Se < As$
50. In the ions  $P^{3-}$ ,  $S^{2-}$  and  $Cl^-$ , the increasing order of size is  
 (a)  $Cl^-, S^{2-}, P^{3-}$  (b)  $P^{3-}, S^{2-}, Cl^-$   
 (c)  $S^{2-}, Cl^-, P^{3-}$  (d)  $S^{2-}, P^{3-}, Cl^-$
51. Which of the following is correct ?  
 (a) Isoelectronic ions have same nuclear charge  
 (b) Isoelectronic ions have same neutrons  
 (c) Isoelectronic ions have same number of electrons  
 (d) All are correct
52. On going down a main sub-group in the periodic table (example *Li* to *Cs* in IA or *Be* to *Ra* in IIA), the expected trend of changes in atomic radius is a  
 (a) continuous increase  
 (b) continuous decrease  
 (c) periodic one, an increase followed by a decrease  
 (d) decrease followed by increase
53. Why the size of an anion is larger than the parent atom?  
 (a) Due to increased repulsion among the electrons.  
 (b) Due to decrease in effective nuclear charge.  
 (c) Due to increased in effective nuclear charge.  
 (d) Both (a) and (b)
54. Which ionisation potential (IP) in the following equations involves the greatest amount of energy ?  
 (a)  $Na \rightarrow Na^+ + e^-$  (b)  $K^+ \rightarrow K^{2+} + e^-$   
 (c)  $C^{2+} \rightarrow C^{3+} + e^-$  (d)  $Ca^+ \rightarrow Ca^{2+} + e^-$
55. Arrange S, P, As in order of increasing ionisation energy  
 (a)  $S < P < As$  (b)  $P < S < As$   
 (c)  $As < S < P$  (d)  $As < P < S$
56. The statement that is not correct for periodic classification of elements is :  
 (a) The properties of elements are periodic function of their atomic numbers.  
 (b) Non-metallic elements are less in number than metallic elements.  
 (c) For transition elements, the *3d*-orbitals are filled with electrons after *3p*-orbitals and before *4s*-orbitals.  
 (d) The first ionisation enthalpies of elements generally increase with increase in atomic number as we go along a period.
57. Consider the following changes  
 $A \rightarrow A^+ + e^- : E_1$  and  $A^+ \rightarrow A^{2+} + e^- : E_2$   
 The energy required to pull out the two electrons are  $E_1$  and  $E_2$  respectively. The correct relationship between two energies would be  
 (a)  $E_1 < E_2$  (b)  $E_1 = E_2$   
 (c)  $E_1 > E_2$  (d)  $E_1 \geq E_2$
58. Of the given electronic configurations for the elements, which electronic configuration indicates that there will be abnormally high difference in the second and third ionization energy for the element?  
 (a)  $1s^2 2s^2 2p^6 3s^2$  (b)  $1s^2 2s^2 2p^6 3s^1$   
 (c)  $1s^2 2s^2 2p^6 3s^2 3p^1$  (d)  $1s^2 2s^2 2p^6 3s^2 3p^2$
59. Alkali metals are powerful reducing agents because  
 (a) these are metals  
 (b) their ionic radii are large  
 (c) these are monovalent  
 (d) their ionisation potential is low
60. Which of the following metals requires the radiation of highest frequency to cause the emission of electrons ?  
 (a) Na (b) Mg  
 (c) K (d) Ca
61. Halogens and chalcogens family have highly ...P.. electron gain enthalpy. Here, P refers to  
 (a) negative (b) positive  
 (c) zero (d) infinity
62. Which of the following represents the correct order of increasing electron gain enthalpy with negative sign for the elements O, S, F and Cl ?  
 (a)  $Cl < F < O < S$  (b)  $O < S < F < Cl$   
 (c)  $F < S < O < Cl$  (d)  $S < O < Cl < F$
63. The electron affinity for the inert gases is –  
 (a) zero (b) high  
 (c) negative (d) positive
64. The element with positive electron gain enthalpy is  
 (a) hydrogen (b) sodium  
 (c) oxygen (d) neon

65. Which of the following will have the least negative electron gain enthalpy?  
 (a) P (b) S  
 (c) Cl (d) F
66. Which is the correct order of electronegativity?  
 (a)  $F > N < O > C$  (b)  $F > N > O > C$   
 (c)  $F > N > O < C$  (d)  $F < N < O = C$
67. The correct order of decreasing electronegativity values among the elements I-beryllium, II-oxygen, III-nitrogen and IV-magnesium is  
 (a)  $II > III > I > IV$  (b)  $III > IV > II > I$   
 (c)  $I > II > III > IV$  (d)  $I > II > IV > III$
68. An element having electronic configuration  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$  forms  
 (a) Acidic oxide (b) Basic oxide  
 (c) Amphoteric oxide (d) Neutral oxide
69. Diagonal relationship is shown by  
 (a) All elements with their diagonally downward elements towards right  
 (b) Most of the elements of second period  
 (c) All 3d series elements  
 (d) None of the above
70. In any period the valency of an element with respect to oxygen  
 (a) Increases one by one from IA to VIIA  
 (b) Decreases one by one from IA to VIIA  
 (c) Increases one by one from IA to IVA and then decreases from VA to VIIA one by one  
 (d) Decreases one by one from IA to IVA and then increases from VA to VIIA one by one
71. What will be the formula of the compound formed by the silicon and bromine?  
 (a)  $SiBr_2$  (b)  $SiBr_4$   
 (c)  $SiBr_3$  (d)  $SiBr$
72. Which of the following sequence correctly represents the decreasing acidic nature of oxides?  
 (a)  $Li_2O > BeO > B_2O_3 > CO_2 > N_2O_3$   
 (b)  $N_2O_3 > CO_2 > B_2O_3 > BeO > Li_2O$   
 (c)  $CO_2 > N_2O_3 > B_2O_3 > BeO > Li_2O$   
 (d)  $B_2O_3 > CO_2 > N_2O_3 > Li_2O > BeO$
74. Which of the following statement(s) about the modern periodic table is/are incorrect?  
 (i) The elements in the modern periodic table are arranged on the basis of their decreasing atomic number  
 (ii) The elements in the modern periodic table are arranged on the basis of their increasing atomic masses  
 (iii) Isotopes are placed in adjoining group(s) in the periodic table  
 (iv) The elements in the modern periodic table are arranged on the basis of their increasing atomic number  
 (a) (i) only (b) (i), (ii) and (iii)  
 (c) (i), (ii) and (iv) (d) (iv) only
75. Consider the following statements:  
 (i) The discovery of inert gases later on did not disturb Mendeleev's arrangement.  
 (ii) In the present periodic table, periodicity in the properties of elements is related to the periodicity in their electronic configurations.  
 Which of these statement(s) is/are correct?  
 (a) (i) only (b) (ii) only  
 (c) Both (i) and (ii) (d) Neither (i) nor (ii)
76. Which of the following statements are correct?  
 (i) The second period ( $n = 2$ ) starts with lithium and third electron enters the  $2s$  orbital. The next element, beryllium has four electrons and has the electronic configuration  $1s^2 2s^2$ . From the next element boron, the  $2p$  orbitals are filled with electrons when the L shell is completed at neon ( $2s^2 2p^6$ ). Thus there are 8 elements in the second period.  
 (ii) Successive filling of  $3s$  and  $3p$  orbitals gives rise to the third period of 8 elements from sodium to argon.  
 (iii) The fourth period ( $n = 4$ ) starts at potassium and the added electron fill up the first  $4s$  and  $4p$  orbitals than  $3d$  orbital is filled.  
 (iv) Fifth period begins with rubidium with the filling of  $5s$  orbital and ends at xenon with the filling up of the  $5p$  orbital.  
 (a) (i) and (ii) (b) (i), (ii) and (iii)  
 (c) (iii) and (iv) (d) (i), (ii) and (iv)
77. With reference to the chemical element with atomic number 17, consider the following statements:  
 (i) It belongs to second period in the periodic table of chemical elements.  
 (ii) It forms anion with unit negative charge.  
 Which of the statement(s) given above is/are correct?  
 (a) (i) only (b) (ii) only  
 (c) Both (i) and (ii) (d) Neither (i) nor (ii)
78. Choose the correct codes for the following statements related to  $s$ -block elements. Here 'T' stands for true and F stands for false statement.  
 (i) They are all reactive metals with low ionization enthalpies.  
 (ii) Their metallic character and reactivity increase as we go down the group.  
 (iii) They are found in pure form in nature.  
 (iv) All the compounds of  $s$ -block elements are ionic in nature.  
 (a) TTFF (b) TTFT  
 (c) TFFF (d) TFFF

### STATEMENT TYPE QUESTIONS

73. Choose the correct coding for following statements. Here T stands for True and F stands for False statement.  
 (i) Mendeleev left several gaps in his periodic table for the undiscovered elements.  
 (ii) The gap under aluminium and a gap under silicon was left and these elements were called Eka aluminium and Eka silicon.  
 (iii) Germanium was placed in place of Eka-aluminium and gallium was placed in place of Eka silicon.  
 (a) TTT (b) TFF  
 (c) TTF (d) TFT



79. Consider the following statements:
- The elements silicon, germanium and arsenic are called metalloids.
  - Metalloids have properties quite different from those of metals and non-metals.

Which of these statement(s) is/are correct ?

- (i) only
- (ii) only
- Both (i) and (ii)
- Neither (i) nor (ii)

80. Consider the following statements:

- Metals will be found on the right side of the periodic table.
- The element P, S and O belong to the same period.

Which of these statement(s) is/are correct ?

- (i) only
- (ii) only
- Both (i) and (ii)
- Neither (i) nor (ii)

81. Consider the following statements:

- Atomic radii decreases across a row of the periodic table when we move from left to right.
- Atomic radii increases down the column as we move from top to bottom.
- Although the order of elements is based on atomic numbers, vertical families share similar chemical properties.

Which of the statement(s) given above is/are correct?

- (i) and (ii)
- (i) and (iii)
- (ii) and (iii)
- (i), (ii) and (iii)

82. Consider the following statements:

- Fluorine has the highest electron affinity in the periodic table.
- Noble gases are placed extremely left in periodic table.
- Magnesium is more metallic in nature than sodium.

Which of these statement(s) is/are correct ?

- (i) and (ii)
- (i) and (iii)
- Only (i)
- Only (ii)

83. Which of the following statement(s) is/are incorrect?

- Ionization enthalpy is expressed in units of  $\text{kJ mol}^{-1}$ .
- Ionization enthalpy is always positive.
- Second ionization enthalpy will be higher than the third ionization enthalpy.

- Only (ii)
- Only (iii)
- (ii) and (iii)
- None of these

84. Consider the following statements:

- There are 16 groups and 7 periods in the modern periodic table.
- Electro-positive character decreases on moving down a group.
- Electro-negativity in a period increases right from the alkali metal to the inert gas element.

Which of these statement(s) is/are correct ?

- (i) and (ii)
- (i) and (iii)
- All are correct
- All are incorrect

85. Read the following three statements and choose the correct option. Here T stands for true and F stands for false statement.

- Boron has a smaller first ionization enthalpy than beryllium.
- Nitrogen has smaller first ionization enthalpy than oxygen.
- The first ionization enthalpy increases across a period.

- FTT
- TFT
- TFF
- FFT

86. Consider the following statements

- The radius of an anion is larger than that of the parent atom.
- The ionization energy generally increases with increasing atomic number in a period.
- The electronegativity of elements increases on moving down across a group.

Which of the above statements is/are correct?

- (i) alone
- (ii) alone
- (i) and (ii)
- (ii) and (iii)

### MATCHING TYPE QUESTIONS

87. Match the Column-I and Column-II and select correct answer by given codes.

#### Column-I (Year)

- 1800
- 1865
- At present
- A – (q), B – (p), C – (r)
- A – (r), B – (p), C – (q)
- A – (q), B – (r), C – (p)
- A – (r), B – (q), C – (p)

#### Column-II (The number of elements discovered)

- 118
- 63
- 31

88. Match the columns.

#### Column-I

- Newland law of octaves
- Mendeleev
- Electronic configuration
- Lothar Meyer

#### Column-II

- Atomic mass vs Atomic volume
- Li, Na, K
- One to seven groups subdivided into group A and B
- Periodic repetition of properties of elements
- Only 56 elements known

- A – (t); B – (s); C – (r); D – (p); E – (q)
- A – (t); B – (r); C – (s); D – (p); E – (q)
- A – (t); B – (r); C – (s); D – (q); E – (p)
- A – (r); B – (t); C – (s); D – (p); E – (q)

89. Match the columns :

- | Column-I   | Column-II        |
|--|------------------|
| (A) On arranging in order of atomic weights, physical and chemical properties are repeated at regular intervals. | (p) Mendeleev    |
| (B) Elements are arranged in the order of increasing atomic weights.   | (q) Lothar Meyer |
| (C) Elements were arranged on the basis of similar properties ignoring order of atomic weights                   | (r) Moseley      |
| (D) Atomic number is a more fundamental property of an element than its atomic mass                              | (s) Chancourtois |
| (a) A – (p), B – (q), C – (s), D – (r)   |                  |
| (b) A – (r), B – (s), C – (r), D – (p)   |                  |
| (c) A – (q), B – (p), C – (s), D – (r)   |                  |
| (d) A – (q), B – (s), C – (p), D – (r)   |                  |

90. Match Column-I (IUPAC nomenclature of element) with Column-II (IUPAC official name).

- | Column-I                               | Column-II        |
|--|------------------|
| (A) Unnilhexium                        | (p) Lawrencium   |
| (B) Unniltrium                         | (q) Dubnium      |
| (C) Unnilunium                         | (r) Seaborgium   |
| (D) Unnilpentium                       | (s) Mendeleevium |
| (a) A – (s), B – (p), C – (r), D – (q) |                  |
| (b) A – (r), B – (p), C – (s), D – (q) |                  |
| (c) A – (r), B – (s), C – (p), D – (q) |                  |
| (d) A – (q), B – (r), C – (p), D – (s) |                  |

91. Match the columns.

- | Column-I<br>(Name of element)                   | Column-II<br>(Group of element) |
|---|---------------------------------|
| (A) Nitrogen                                    | (p) 15                          |
| (B) Aluminium                                   | (q) 16                          |
| (C) Chlorine                                    | (r) 17                          |
| (D) Oxygen                                      | (s) 13                          |
| (E) Copper                                      | (t) 11                          |
| (a) A – (p), B – (s), C – (r), D – (q), E – (t) |                                 |
| (b) A – (s), B – (p), C – (r), D – (q), E – (t) |                                 |
| (c) A – (p), B – (s), C – (q), D – (r), E – (t) |                                 |
| (d) A – (p), B – (s), C – (r), D – (t), E – (q) |                                 |

92. Match the columns.

- | Column-I<br>(Name of element)                   | Column-II<br>(Period of element) |
|---|----------------------------------|
| (A) Hydrogen                                    | (p) 3                            |
| (B) Sodium                                      | (q) 4                            |
| (C) Calcium                                     | (r) 6                            |
| (D) Barium                                      | (s) 1                            |
| (E) Iodine                                      | (t) 5                            |
| (a) A – (p), B – (s), C – (q), D – (r), E – (t) |                                  |
| (b) A – (s), B – (p), C – (q), D – (r), E – (t) |                                  |
| (c) A – (s), B – (q), C – (p), D – (r), E – (t) |                                  |
| (d) A – (s), B – (p), C – (q), D – (t), E – (r) |                                  |

93. Match the columns.

- | Column-I                               | Column-II |
|--|-----------|
| (A) 's' block elements                 | (p) Cr    |
| (B) 'p' block elements                 | (q) Na    |
| (C) 'd' block elements                 | (r) Ce    |
| (D) 'f' block elements                 | (s) Si    |
| (a) A – (s), B – (q), C – (p), D – (r) |           |
| (b) A – (q), B – (s), C – (r), D – (p) |           |
| (c) A – (q), B – (p), C – (s), D – (r) |           |
| (d) A – (q), B – (s), C – (p), D – (r) |           |

94. Match the columns.

- | Column-I   | Column-II    |
|--|--------------|
| (A) Element with largest size in second period       | (p) Boron    |
| (B) Element with smallest size in group 13           | (q) Fluorine |
| (C) Element with maximum non-metallic character      | (r) Bromine  |
| (D) Element with smallest size in fourth period      | (s) Lithium  |
| (E) Element with most metallic character in group 14 | (t) Lead     |
| (a) A – (s), B – (p), C – (q), D – (t), E – (r)      |              |
| (b) A – (p), B – (s), C – (q), D – (r), E – (t)      |              |
| (c) A – (s), B – (q), C – (p), D – (r), E – (t)      |              |
| (d) A – (s), B – (p), C – (q), D – (r), E – (t)      |              |

95. Match the columns.

- | Column-I   | Column-II                    |
|--|------------------------------|
| (A) Electronegativity  | (p) Isotopes                 |
| (B) Lanthanides  | (q) increases along a period |
| (C) Transition elements                                      | (r) f-group of elements      |
| (D) Ionisation energy  | (s) d-group of elements      |
| (E) Elements of same atomic number but different mass number | (t) decreases along a group  |
| (a) A – (q), B – (r), C – (s), D – (p), E – (t)              |                              |
| (b) A – (r), B – (q), C – (s), D – (t), E – (p)              |                              |
| (c) A – (q), B – (r), C – (s), D – (t), E – (p)              |                              |
| (d) A – (q), B – (s), C – (r), D – (t), E – (q)              |                              |

96. Match Column-I with Column-II and select the correct answer by the given codes.

- | Column-I<br>(Atoms)                    | Column-II<br>(Properties)     |
|--|-------------------------------|
| (A) He                                 | (p) High electronegative      |
| (B) F                                  | (q) Most electropositive      |
| (C) Rb                                 | (r) Strongest reducing agent  |
| (D) Li                                 | (s) Highest ionisation energy |
| (a) A – (s), B – (q), C – (r), D – (p) |                               |
| (b) A – (p), B – (s), C – (q), D – (r) |                               |
| (c) A – (s), B – (p), C – (r), D – (q) |                               |
| (d) A – (s), B – (p), C – (q), D – (r) |                               |



97. Match the Column-I and Column-II and select the correct answer by given codes.

Column-I (Elements)	Column-II (Properties)
(A) $\text{Li}^+ < \text{Al}^{3+} < \text{Mg}^{2+} < \text{K}^+$	(p) DEA (Electron affinity)
(B) $\text{Li}^+ > \text{Al}^{3+} > \text{Mg}^{2+} > \text{K}^+$	(q) Ionic radii
(C) $\text{Cl} > \text{F} > \text{Br} > \text{I}$	(r) EN (Electronegativity)
(D) $\text{F} > \text{Cl} > \text{Br} > \text{I}$	(s) Effective nuclear charge
(a) A – (q), B – (s), C – (r), D – (p)	
(b) A – (q), B – (s), C – (p), D – (r)	
(c) A – (s), B – (q), C – (r), D – (p)	
(d) A – (s), B – (q), C – (p), D – (r)	

98. Match the columns on the basis of diagonal relationship between elements.

Column-I	Column II
(A) Li	(p) Na
(B) Be	(q) Al
(C) B	(r) Si
	(s) Mg
(a) (A) – (s), B – (r), C – (p)	
(b) (A) – (s), B – (q), C – (r)	
(c) (A) – (s), B – (q), C – (p)	
(d) (A) – (q), B – (s), C – (p)	

99. Match the columns

Column-I	Column-II
(A) $[\text{BF}_4]^-$	(p) 7, +7
(B) $[\text{AlF}_6]^{3-}$	(q) 4, +4
(C) $\text{OF}_2$	(r) 6, +3
(D) $\text{SiF}_4$	(s) 2, +2
(E) $\text{IF}_7$	(t) 4, +3
(a) A – (s), B – (q), C – (t), D – (r), E – (p)	
(b) A – (t), B – (r), C – (s), D – (q), E – (p)	
(c) A – (q), B – (r), C – (t), D – (s), E – (p)	
(d) A – (r), B – (q), C – (s), D – (p), E – (t)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
- (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
- (c) Assertion is correct, reason is incorrect
- (d) Assertion is incorrect, reason is correct.
100. **Assertion :** In a triad, the three elements present have same gaps of atomic masses.  
**Reason :** Elements in a triad have similar properties.
101. **Assertion :** According to Mendeleev, periodic properties of elements is a function of their atomic number.  
**Reason :** Atomic number is equal to the number of protons.
102. **Assertion :** Atomic number of the element ununbium is 112.  
**Reason :** Name for digits 1 and 2 is un- and bi-respectively in latin words.

103. **Assertion :** Second period consists of 8 elements.

**Reason :** Number of elements in each period is four times the number of atomic orbitals available in the energy level that is being filled.

104. **Assertion :** Helium is placed in group 18 along with p-block elements.

**Reason :** It shows properties similar to p-block elements.

105. **Assertion :** Hydrogen can be placed in group 1.

**Reason :** Hydrogen can gain an electron to achieve a noble gas arrangement.

106. **Assertion :** Atomic size increases along a period.

**Reason :** Effective nuclear charge increases as the atomic number increases resulting in the increased attraction of electrons to the nucleus.

107. **Assertion :** Second ionization enthalpy will be higher the first ionization enthalpy.

**Reason :** Ionization enthalpy is a quantitative measure of the tendency of an element to lose electron.

108. **Assertion :** Alkali metals have least value of ionization energy within a period.

**Reason :** They precede alkaline earth metals in periodic table.

109. **Assertion :** Electron gain enthalpy can be exothermic or endothermic.

**Reason :** Electron gain enthalpy provides a measure of the ease with which an atom adds an electron to form anion.

110. **Assertion :** Smaller the size of an atom greater is the electronegativity.

**Reason :** Electronegativity refers to the tendency of atom so share electrons with other atom.

### CRITICAL THINKING TYPE QUESTIONS

111. Which fact is not valid for Dobereiner's triads?

- (a) The atomic weight of middle element is roughly average of the other two elements
- (b) The properties of middle element is roughly average of the other two elements
- (c) The elements of triads belong to the same group of modern periodic table
- (d) The elements of triads have same valency electrons.

112. In the Mendeleev periodic table, which of the following element instead of having lower atomic weight was placed after the element of higher atomic weight thereby ignoring the order of increasing atomic weights.

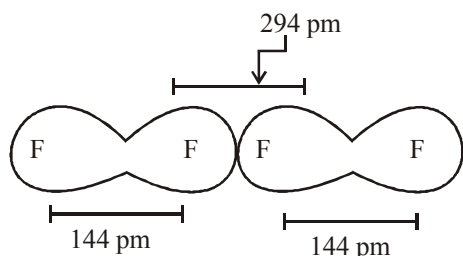
- (a) Iodine (b) Antimony  
(c) Bromine (d) Molybdenum

113. Which of the following is correct about Eka-Aluminium and Eka-Silicon ?

- (a) Oxides of Eka-Aluminium is  $\text{Al}_2\text{O}_3$  and Eka-Silicon is  $\text{Si}_2\text{O}_3$
- (b) Oxides of Eka-Aluminium is  $\text{Ga}_2\text{O}_3$  and Eka-Silicon is  $\text{GeO}_2$
- (c) Melting point of Eka-Aluminium is lower than the melting point of Eka-Silicon
- (d) Both (a) and (c)

114. Which of the following elements are found in pitch blende?  
 (a) Actinium and protoactinium  
 (b) Neptunium and plutonium  
 (c) Actinium only  
 (d) Both (a) and (b)
115. Which of the following period contain most of the man-made radioactive elements?  
 (a) Seventh (b) Fifth  
 (c) Sixth (d) Both (a) and (c)
116. The electronic configuration of an element is  $1s^2 2s^2 2p^6 3s^2 3p^3$ . What is the atomic number of the element, which is just below the above element in the periodic table?  
 (a) 33 (b) 34  
 (c) 36 (d) 49
117. Which of the following elements show the given properties?  
 (i) All elements are metals.  
 (ii) Most of the elements form coloured ions, exhibit variable valence and paramagnetism.  
 (iii) Oftenly used as catalysts.  
 (a) Chalcogens  
 (b) Transition elements  
 (c) Inner transition elements  
 (d) Representative elements
118. Which of the given elements A, B, C, D and E with atomic number 2, 3, 7, 10 and 30 respectively belong to the same period?  
 (a) A, B, C (b) B, C, D  
 (c) A, D, E (d) B, D, E
119. According to Mendeleev's periodic classification, the electronic configuration of hydrogen atom resembles that of alkali metals, which are given below as :  
 $H = 1s^1, Li = 2s^1, Na = 3s^1, K = 4s^1$   
 On the other hand like halogens, hydrogen also exist as diatomic molecules, such as :  $H_2, Cl_2, Br_2, I_2$ , etc.  
 On the basis of above information hydrogen can be placed with :  
 (a) Alkali metals (b) Halogens  
 (c) Both (a) and (b) (d) None of these
120. Which of the following statements is **incorrect** from the point of view of modern periodic table ?  
 (a) Elements are arranged in the order of increasing atomic number  
 (b) There are eighteen vertical columns called groups  
 (c) Transition elements fit in the middle of long periods  
 (d) Noble gases are arbitrarily placed in eighteenth group
121. Element X forms a chloride with the formula  $XC l_2$ , which is a solid with a high melting point. X would most likely be in the same group of the periodic table as –  
 (a) Na (b) Mg  
 (c) Al (d) Si
122. An element X belongs to fourth period and fifteenth group of the periodic table. Which one of the following is true regarding the outer electronic configuration of X ? It has  
 (a) Partially filled  $d$ -orbitals and completely filled  $s$ -orbitals  
 (b) Completely filled  $s$ -orbital and completely filled  $p$ -orbitals  
 (c) Completely filled  $s$ -orbital and half-filled  $p$ -orbitals  
 (d) Half-filled  $d$ -orbitals and completely filled  $s$ -orbitals
123. An element has electronic configuration  $1s^2 2s^2 2p^6 3s^2 3p^4$ .  
 (a) Period = 3<sup>rd</sup>, block = p, group = 16  
 (b) Period = 5<sup>th</sup>, block = s, group = 1  
 (c) Period = 3<sup>rd</sup>, block = p, group = 10  
 (d) Period = 4<sup>th</sup>, block = d, group = 12
124. The periodic table of elements does not  
 (a) include the inert gases  
 (b) tell us about the arrangement of atoms in a molecule  
 (c) allow us to make accurate guess of the properties of undiscovered elements  
 (d) reveal regularities in the occurrence of elements with similar properties
125. The lightest liquid metal is  
 (a) Hg (b) Ga  
 (c) Cs (d) Fr
126. The correct sequence which shows decreasing order of the ionic radii of the elements is  
 (a)  $Al^{3+} > Mg^{2+} > Na^+ > F^- > O^{2-}$   
 (b)  $Na^+ > Mg^{2+} > Al^{3+} > O^{2-} > F^-$   
 (c)  $Na^+ > F^- > Mg^{2+} > O^{2-} > Al^{3+}$   
 (d)  $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$
127. The ionic radii (Å) of  $C^{4-}$  and  $O^{2-}$  respectively are 2.60 and 1.40. The ionic radius of the isoelectronic ion  $N^{3-}$  would be  
 (a) 2.6 (b) 1.71  
 (c) 1.4 (d) 0.95
128. Which of the following species will have the smallest and the largest size?  
 $Cl, Na, Cl^-, Al^{3+}, Mg^{2+}, Na^+$   
 (a) Smallest =  $Na^+$ , Largest =  $Cl^-$   
 (b) Smallest =  $Al^{3+}$ , Largest =  $Cl^-$   
 (c) Smallest =  $Al^{3+}$ , Largest =  $Cl$   
 (d) Smallest =  $Na$ , Largest =  $Cl$
129. Covalent radii of atoms varies in range of 72 pm to 133 pm from F to I while that of noble gases He to Xe varies from 120pm to 220pm. This is because in case of noble gases  
 (a) covalent radius is very large  
 (b) van der Waal radius is considered  
 (c) metallic radii is considered  
 (d) None of these

130. The van der Waal and covalent radii of fluorine atom respectively from the following figure are.



- (a) 219pm, 72pm (b) 75pm, 72pm  
(c) 147pm, 72pm (d) 147pm, 144pm
131. Arrange the following in increasing order of ionic radii?  
 $C^{4-}$ ,  $N^{3-}$ ,  $F^-$ ,  $O^{2-}$
- (a)  $C^{4-} < N^{3-} < O^{2-} < F^-$   
(b)  $N^{3-} < C^{4-} < O^{2-} < F^-$   
(c)  $F^- < O^{2-} < N^{3-} < C^{4-}$   
(d)  $O^{2-} < F^- < N^{3-} < C^{4-}$
132. The first ( $\Delta_1 H_1$ ) and second ( $\Delta_1 H_2$ ) ionization enthalpies (in  $\text{kJ mol}^{-1}$ ) and the electron gain enthalpy ( $\Delta_{eg} H$ ) (in  $\text{kJ mol}^{-1}$ ) of the elements I, II, III, IV and V are given below

Element	$\Delta_1 H_1$	$\Delta_1 H_2$	$\Delta_{eg} H$
I	520	7300	-60
II	419	3051	-48
III	1681	3374	-328
IV	1008	1846	-295
V	2372	5251	+48

The most reactive metal and the least reactive non-metal of these are respectively

- (a) I and V (b) V and II  
(c) II and V (d) IV and V
133. Among the following transition elements, pick out the element/elements with highest second ionization energy.
- (A) V (At. no = 23) (B) Cr (At. no = 24)  
(C) Mn (At. no = 25) (D) Cu (At. no = 29)  
(E) Zn (At. no = 30)
- (a) (A) and (C) (b) (B) and (D)  
(c) (B) and (E) (d) Only (D)
134. As we move across the second period from C to F ionisation enthalpy increases but the trend from C to F for ionisation enthalpy is  $C < O < N < F$  why it is not  $C < N < O < F$ . This is because
- (a) atomic radii of O > atomic radii of N  
(b) electronic configuration of N is more stable than electronic configuration of O  
(c) atomic radii of N > atomic radii of O  
(d) None of these

135. If ionisation enthalpy of oxygen is lesser than nitrogen because of two of the four 2p- electrons occupy same 2p-orbital than why such case is not possible with fluorine which contain greater no of paired electrons because.

- (a) greater size of atomic orbitals  
(b) smaller size of orbitals  
(c) nuclear charge overpower electronic repulsions.  
(d) None of these
136. Which of the following statements is wrong ?
- (a) van der Waal's radius of iodine is more than its covalent radius  
(b) All isoelectronic ions belong to same period of the periodic table  
(c) I.E.<sub>1</sub> of N is higher than that of O while I.E.<sub>2</sub> of O is higher than that of N  
(d) The electron gain enthalpy of N is almost zero while that of P is  $74.3 \text{ kJ mol}^{-1}$
137. Which one of the following statements is incorrect ?
- (a) Greater the nuclear charge, greater is the electron affinity  
(b) Nitrogen has zero electron affinity  
(c) Electron affinity decreases from fluorine to iodine in 17th group  
(d) Chlorine has highest electron affinity
138. The elements with zero electron affinity are
- (a) Boron and Carbon  
(b) Beryllium and Helium  
(c) Lithium and Sodium  
(d) Fluorine and Chlorine
139. Which of the following property of element is directly related to electronegativity?
- (a) Atomic radius (b) Ionization enthalpy  
(c) Non-metallic character (d) None of these
140. Which is not the correct order for the stated property.
- (a)  $Ba > Sr > Mg$  ; atomic radius  
(b)  $F > O > N$  ; first ionization enthalpy  
(c)  $Cl > F > I$  ; electron affinity  
(d)  $O > Se > Te$  ; electronegativity
141. In which of the following arrangements, the order is NOT according to the property indicated against it?
- (a)  $Li < Na < K < Rb$  :  
Increasing metallic radius  
(b)  $I < Br < F < Cl$  :  
Increasing electron gain enthalpy (with negative sign)  
(c)  $B < C < N < O$   
Increasing first ionization enthalpy  
(d)  $Al^{3+} < Mg^{2+} < Na^+ < F^-$   
Increasing ionic size
142. The compounds of the s-block elements, with the exception of lithium and ...X... are predominantly ionic. Here, X refers to
- (a) hydrogen (b) helium  
(c) magnesium (d) beryllium

143. Among  $\text{Al}_2\text{O}_3$ ,  $\text{SiO}_2$ ,  $\text{P}_2\text{O}_3$  and  $\text{SO}_2$  the correct order of acid strength is

- (a)  $\text{Al}_2\text{O}_3 < \text{SiO}_2 < \text{SO}_2 < \text{P}_2\text{O}_3$
- (b)  $\text{SiO}_2 < \text{SO}_2 < \text{Al}_2\text{O}_3 < \text{P}_2\text{O}_3$
- (c)  $\text{SO}_2 < \text{P}_2\text{O}_3 < \text{SiO}_2 < \text{Al}_2\text{O}_3$
- (d)  $\text{Al}_2\text{O}_3 < \text{SiO}_2 < \text{P}_2\text{O}_3 < \text{SO}_2$

144. Observe the following periodic table :

H 1								He 2
Li 2, 1	Be 2, 2		B 2, 3	C 2, 4	Y 2, 5	O 2, 6	F 2, 7	Ne 2, 8
Na 2, 8, 1	Ag 2, 8, 2		Al 2, 8, 3	Z 2, 8, 4	P 2, 8, 5	S 2, 8, 6	Cl 2, 8, 7	Ar 2, 8, 8
K 2, 8, 8, 1	X 2, 8, 8, 2							

Arrange the following elements X, Y, Z in increasing order of their valencies :

- (a)  $X > Z > Y$
- (b)  $Y > Z > X$
- (c)  $Z > Y > X$
- (d)  $X > Y > Z$

145. Which of the following is the reason for the different chemical behaviour of the first member of a group of elements in the *s*- and *p*-blocks compared to that of the subsequent members in the same group?

- (i) Small size
- (ii) Large charge / radius ratio
- (iii) Low electronegativity of the element
- (a) (i) and (iii)
- (b) (i), (ii) and (iii)
- (c) (i) and (ii)
- (d) (ii) and (iii)

146. Which of the following statement(s) is/are correct ?

- (i) Aluminium react with HCl to form  $\text{Al}^{3+}$  and  $\text{H}_2$  is liberated
- (ii) Aluminium dissolve in NaOH to form  $\text{NaAl}(\text{OH})_4$  and  $\text{H}_2$
- (a) (i) and (ii)
- (b) Only (ii)
- (c) Only (i)
- (d) Neither (i) nor (ii)

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (c) Periodic classification of elements follow a logical consequence of electronic configuration of atoms which is used to examine the physical and chemical properties of the elements.
2. (c) According to Dobereiner's triad the atomic mass of Br will be average of the atomic masses of Cl & I  

$$= \frac{35.5 + 127}{2} = 81.25$$
3. (a)
4. (a) According to the law of triads the atomic wt of the middle element is arithmetic mean of I and III.  

$$\text{At wt of Br} = \frac{\text{At.wt of Cl} + \text{At wt of I}}{2}$$
5. (b) In 1800, only 31 elements were known by 1865 the number of identified elements had more than doubled to 63. At present 116 elements are known. Of them the recently discovered elements are man-made.
6. (c) Johann Dobereiner in early 1800's was the first to consider the idea of trends among properties of elements. By 1829 he noted a similarity among the physical and chemical properties of several groups of three elements (triads).  

$$\begin{array}{ccc} \text{Li} & \text{Na} & \text{K} \\ \downarrow & \downarrow & \downarrow \\ \frac{39 + 7}{2} & = & \frac{46}{2} = 23 \end{array}$$
7. (a) According to law of triad,  

$$\frac{19 + 80}{2} = 49.5$$
  
 Atomic mass of Cl = 35.5  
 $\therefore$  Arithmetic mean of atomic masses of F and Br  $\neq$  Atomic mass of Cl.
8. (c) Arithmetic mean of atomic mass of F and Br  

$$= \frac{19 + 80}{2} = 49.5$$
  
 Atomic mass of Cl = 35.5  
 $\therefore$  Arithmetic mean of atomic masses of F and Br  $\neq$  Atomic mass of Cl.
9. (c)
10. (c) Every eighth element had the similar properties to the first element.
11. (b) Lothar Meyer plotted the physical properties such as atomic volume, melting point and boiling point against atomic weight and obtained a periodically repeated pattern.
12. (a) 13. (d) 14. (c)
15. (b) Correct order is Dobereiner, Chancourtois, Newlands, Mendeleev.
16. (d) Chloride formulas  
 (i) Eka-Aluminium =  $\text{GaCl}_3$  ( $\text{ECl}_3$ )  
 (ii) Eka-Silicon =  $\text{GeCl}_4$  ( $\text{ECl}_4$ )  
 Mendeleef arranged elements in horizontal rows and vertical columns of a table in order to their increasing atomic weights.
17. (b)
18. (d) 118 elements are known at present. The recently discovered elements are man-made.
19. (c) Moseley discovered that atomic number is more fundamental property than atomic mass.
20. (d) 6<sup>th</sup> period consists of 32 elements.
21. (b)
22. (b) The period number corresponds to the highest principal quantum number (n) of the element.
23. (a) Atomic number (Z) = 120  
 IUPAC name = Unbinilium  
 Symbol = Ubn
24. (b) Element with atomic number 104 was named by American society as Rutherfordium and Kurchatovium by soviet society.
25. (c)

Digit	Name
1	un
4	quad

 Using above notation IUPAC name of element 114 is Ununquadium.
26. (b) Its valence shell has 5 electrons ( $ns^2, np^3$ ). It belongs to 5th group of the periodic table.
27. (b)
28. (d) Because of the presence of same number of valence electrons the elements of same group have similar chemical properties.
29. (c) Halogens are most electronegative elements i.e., they are likely to form anions most readily.
30. (d) Barium has atomic number 56. It is an alkaline earth metal i.e., found in s-block.
31. (c)
32. (c) Element with Z = 33  
 $(1s^2 2s^2 2p^6 3s^2 3p^6 4d^{10} 4s^2 4p^3)$  lies in fifth (or 15th) group.
33. (a) The electronic configuration clearly suggest that it is a d-block element (having configuration  $(n-1)d^{1-10} ns^{0-2}$ ) which starts from III B and goes till II B. Hence with  $d^3$  configuration it would be classified in the group.
34. (d) 35. (c)



36. (c) Elements (a), (b) and (d) belong to the same group since each one of them has two electrons in the s sub shell. In contrast, element (c) has seven electrons in the valence shell and hence does not lie in the same group in which elements (a), (b) and (d) lie.
37. (c)
38. (b) Na and Cl both belongs to III period.
39. (b) 40. (b)
41. (b)  $1s^2, 2s^2 2p^6, 3s^2 3p^4$   
 $\downarrow$   
 Number of shell = 3  
 (Principal quantum number)  
 Number of period = 3  
 Valence electrons = 6 i.e., 2 + 4  
 Number of group = 16
42. (a) Metallic character decreases down group and increases along a period.
43. (b) Cu, Ag and Au are coinage metals. They belong to group IB (d-block) of periodic table.
44. (b) 45. (b)
46. (b) Non-metals are mainly placed in p-block elements.
47. (b) Non-metallic character increases on moving from left to right in a period.
48. (b) Correct order of ionic size is  $\text{Sn} > \text{Ce} > \text{Yb} > \text{Lu}$ .
49. (c) On moving down in a group atomic radii increases due to successive addition of extra shell hence  $\text{O} < \text{S} < \text{Se}$   
 Further As is in group 15 having one less electron in its p orbital hence have higher atomic radii than group 16 elements.  
 i.e.,  $\text{O} < \text{S} < \text{Se} < \text{As}$
50. (a)
51. (c) Isoelectronic ions have same number of electrons.
52. (a) Continuous increase as no. of shells increases down the group.
53. (d) The size of an anion will be larger than that of the parent atom because the addition of one or more electron(s) would result in increased repulsion among the electrons and a decrease in effective nuclear charge.
54. (b)  $\text{K}^+ \rightarrow \text{K}^{2+} + e^-$ . Since  $e^-$  is to be removed from stable configuration.
55. (c) 56. (c)
57. (a)  $\text{IE}_1$  is always less than  $\text{IE}_2$ .
58. (a)  $\text{Mg} = 1s^2 2s^2 2p^6 3s^2$   
 After removing of 2 electron, the magnesium acquired noble gas configuration hence removing of 3rd electron will require large amount of energy.
59. (d)  $ns^1$  configuration and lesser IE.
60. (b) As I.E. of Mg is more
61. (a) The halogen (group-17) and the chalcogens (group-16) are two groups of elements having highly negative electron gain enthalpies.
62. (b)  $\text{O} < \text{S} < \text{F} < \text{Cl}$   
 Electron gain enthalpy –141, –200, –333, –349  $\text{kJ mol}^{-1}$
63. (a)
64. (d) Noble gases have positive values of electron gain enthalpy because the anion is higher in energy than the isolated atom and electron.
65. (a) Within a group, electron gain enthalpy becomes less negative down a group. However, adding an electron to the 2p-orbital leads to greater repulsion than adding an electron to the larger 3p-orbital. Hence, phosphorus has the least negative electron gain enthalpy.
66. (a)
67. (a) Electronegativity values of given elements are as follows:  
 $\text{Be} - 1.5 \text{ (I)}$                        $\text{Mg} - 1.2 \text{ (IV)}$   
 $\text{O} - 3.5 \text{ (II)}$                        $\text{N} - 3.0 \text{ (III)}$   
 i.e.  $\text{II} > \text{III} > \text{I} > \text{IV}$
68. (b) It is electronic configuration of alkali metal. Hence it will form basic oxide.
69. (d) 70. (c)
71. (b) Silicon has valence of 4 and bromine has valence of 1. Hence formula of compound will be  $\text{SiBr}_4$ .
72. (b) On passing from left to right in a period acidic character of the normal oxides of the elements increases with increase in electronegativity.

### STATEMENT TYPE QUESTIONS

73. (c) Gallium was placed in place of Eka aluminium and germanium was placed in place of Eka silicon.
74. (b) 75. (c)
76. (d) In fourth period filling up of 3d orbital becomes energetically favourable before the 4p orbital is filled.
77. (b) The chemical element with atomic number 17 is chlorine. It belongs to third period in the periodic table and forms anion with unit negative charge ( $\text{Cl}^-$ ).
78. (a) For statement (iii) the s-block elements because of their high reactivity are never found pure in nature. For statement (iv) the compounds of the s-block elements with the exception of lithium and beryllium are predominantly ionic.
79. (c) 80. (d) 81. (d)
82. (c) Noble gases are placed extremely right in periodic table. Sodium is more metallic than magnesium as it is more electropositive and has low ionisation energy.
83. (b) Second ionization enthalpy will be higher than the first ionization enthalpy but lower than the third ionization enthalpy.
84. (d)
85. (b) Oxygen has smaller first ionization enthalpy than nitrogen.
86. (c)



**MATCHING TYPE QUESTIONS**

87. (d) A. 1800 → 31 elements were known  
B. 1865 → 63 elements  
C. At present → 118
88. (b) 89. (d) 90. (b) 91. (a) 92. (b)  
93. (d) 94. (d) 95. (c)
96. (d) Helium (He)  $1s^2$  → Highest ionisation energy due to noble gas in nature.  
Fluorine (F)  $1s^2, 2s^2 2p^3$  → High electronegativity in nature due to small size and  $-1$  oxidation state.  
Rubidium (Rb) → Most electronegative element due to large atomic size.  
Lithium (Li) → Strongest reducing agent due to small size and positive oxidation state (+1)
97. (b) A.  $Li^+ < Al^{2+} < Mg^{2+} < K^+$   
The cation with the greater positive charge will have a smaller radius because of the greater attraction of the electrons to the nucleus. Anion with the greater negative charge will have the larger radius.  
$$\text{Positive charge} \propto \frac{1}{\text{ionic radius}}$$
  
Negative charge  $\propto$  ionic radius  
B. Greater positive charge, increases effective nuclear charge in case of isoelectronic species. While for same group elements effective nuclear charge decreases down the groups.  
C.  $Cl > F > Br > I$   
electron affinity of Cl is highest in halogen family.  
D.  $F > Cl > Br > I$   
electronegativity of fluorine (F) is higher than Cl, Br and I.
98. (b) 99. (b)

**ASSERTION-REASON TYPE QUESTIONS**

100. (d) In a triad, the atomic mass of the middle element is the mean of the atomic masses of the first and third elements.
101. (d) According to Mendeleev, periodic properties of elements is a function of their atomic masses.
102. (a) Both assertion and reason are true and reason is the correct explanation of assertion.
103. (c) Number of elements in each period is twice the number of atomic orbitals available in the energy level that is being filled.
104. (c) He ( $1s^2$ ) should be placed along with s-block elements because of its electronic configuration but it has a completely filled valence shell and as a result it exhibits properties of noble gases, thus it is placed along with noble gases ( $ns^2, np^6$ ).

105. (b) Both the statements are correct but assertion is not correct explanation for reason.
106. (c) Atomic size generally decreases along a period.
107. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.  
It is difficult to remove an electron from a positively charged ion than a neutral atom.
108. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.  
Alkali metals belong to first group and have largest size in a period and hence low I.E.
109. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.  
Depending on the element, the process of adding an electron to the atom can be either endothermic or exothermic.
110. (c) Assertion is true but reason is false.  
Electronegativity refers to the tendency of atom to attract bonding electrons.

**CRITICAL THINKING TYPE QUESTIONS**

111. (b)
112. (a) Iodine with lower atomic weight than that of tellurium (Group VI) was placed in Group VII along with fluorine, chlorine, bromine because of similarities in properties.
113. (d) Oxides of Eka-Aluminium =  $Ga_2O_3$   
Oxides of Eka-Silicon =  $SiO_2$   
Melting point of Eka-Aluminium = Low (302 K)  
Melting point of Eka-Silicon = High (1231 K)
114. (d) Neptunium and plutonium like actinium and protoactinium are also found in pitch.
115. (a) Seventh period includes most of the man-made radioactive elements.
116. (a) Atomic number of the given element is 15 and it belongs to 5th group. Therefore atomic number of the element below the above element  
 $= 15 + 18 = 33$ .
117. (b) These are characteristic properties of d-block elements.
118. (b) 119. (c) 120. (d) 121. (b) 122. (c)
123. (a) By observing principal quantum number (n). Orbital (s, p, d, f) and equating no. of  $e^-$ 's we are able to find the period, block and group of element in periodic table.
124. (b) Periodic table deals with elements and not molecules.
125. (c) Cs is a metal. It is liquid at room temperature. It is lighter than Hg (also a liquid metal).
126. (d) All the given species contains 10  $e^-$  each i.e. isoelectronic.  
For isoelectronic species anion having high negative charge is largest in size and the cation having high positive charge is smallest.
127. (b) The ionic radii of isoelectronic ions decrease with the increase in the magnitude of the nuclear charge.  
So, decreasing order of ionic radii is  $C^{4-} > N^{3-} > O^{2-}$ .

- 128. (b)** Anions will be larger and cations will be smaller than the parent atoms. Among isoelectronic species ( $\text{Na}^+$ ,  $\text{Mg}^{2+}$  and  $\text{Al}^{3+}$ ), the one with the larger positive nuclear charge will have a smaller radius.  
 $\therefore$  Largest =  $\text{Cl}^-$  and smallest =  $\text{Al}^{3+}$
- 129. (b)** In case of halogens covalent radius is considered this bond is formed by overlapping of electron clouds; while noble gases remain monoatomic, in this case only way to obtain radius is through van der Waal radii.
- 130. (c)** Covalent radius is radius of an atom in its bound state i.e., in fluorine it is half of distance between two covalently bonded fluorine atoms; van der Waal radii is one-half of the distance between the nuclei of two identical non-bonded isolated atoms. These atoms are attracted toward each other through weak van der Waal's force hence van der Waal radii are very large.
- 131. (c)** All the given species are isoelectronic. In case of isoelectronic species ionic radii increases with increase in negative charge on anions.
- 132. (c)** I represents Li, II represents K  
 III represents Br, IV represents I  
 V represents He  
 So, amongst these, II represents most reactive metal and V represents least reactive non-metal.
- 133. (b)**      **134. (b)**      **135. (c)**
- 136. (b)** In the isoelectronic species, all isoelectronic anions belong to the same period and cations to the next period.
- 137. (c)** Electron affinity of  $^9\text{F}$  is less than that of  $^{17}\text{Cl}$
- 138. (b)** Fully filled electronic configuration.
- 139. (c)** The increase in the electronegativities across a period is accompanied by an increase in non-metallic properties (or decrease in metallic properties) of elements.
- 140. (b)** On moving along the period, ionization enthalpy increases.  
 In second period, the order of ionization enthalpy should be as follows :  
 $\text{F} > \text{O} > \text{N}$ .  
 But N has half-filled structure, therefore, it is more stable than O. That is why its ionization enthalpy is higher than O. Thus, the correct order of IE is  
 $\text{F} > \text{N} > \text{O}$ .
- 141. (c)** In a period the value of ionisation potential increases from left to right with breaks where the atoms have some what stable configuration. In this case N has half filled stable orbitals. Hence has highest ionisation energy. Thus the correct order is  
 $\text{B} < \text{C} < \text{O} < \text{N}$   
 and not as given in option (c)
- 142. (d)** With the exception of lithium and beryllium compounds of s-block elements are predominantly ionic.
- 143. (d)** As the size increases the basic nature of oxides changes to acidic nature i.e., acidic nature increases.  

$$\text{SO}_2 > \text{P}_2\text{O}_3 > \text{SiO}_2 > \text{Al}_2\text{O}_3$$

Acidic
Weak acidic
Amphoteric

$$\text{SO}_2 \text{ and } \text{P}_2\text{O}_3 \text{ are acidic as their corresponding acids } \text{H}_2\text{SO}_3 \text{ and } \text{H}_3\text{PO}_3 \text{ are strong acids.}$$
- 144. (c)**
- 145. (c)** The anomalous behaviour of first member of a group of element in the s- and p-block element is due to their small size, large charge/radius ratio and high electronegativity.
- 146. (a)** Because Al is amphoteric in nature so it dissolve in both acid and base.

CHAPTER

4

# CHEMICAL BONDING AND MOLECULAR STRUCTURE

## FACT/DEFINITION TYPE QUESTIONS

- The attractive force which holds various constituents (atoms, ions etc.) together in different chemical species is called a
  - chemical bond
  - chemical compound
  - ionic bond
  - covalent bond
- The evolution of various theories of valence and the interpretation of the nature of chemical bonds have closely been related to the developments in the understanding of
  - structure of atom
  - electronic configuration of elements
  - periodic table
  - All of the above
- Who provide explanation of valence based on inertness of noble gases ?
  - Lewis
  - Kössel-Lewis
  - Langmuir
  - Sidgwick & Powell
- In the formation of a molecule which of the following take part in chemical combination?
  - cation
  - anion
  - valence electron
  - inner shell electron
- Which of the following do(es) not represent correct Lewis symbols?
 

$\text{:C:}$	$\text{:}\ddot{\text{O}}\text{:}$	$\text{:}\ddot{\text{Ne}}\text{:}$	$\ddot{\text{Be}}$	$\cdot\ddot{\text{B}}\cdot$
I	II	III	IV	V

  - I, IV & V
  - II, III & IV
  - II only
  - II & III
- The bond formed as a result of the electrostatic attraction between the positive and negative ions is termed as ...
  - Chemical bond
  - Electrovalent bond
  - Co-ordinate bond
  - Covalent bond
- Cation and anion combines in a crystal to form following type of compound
  - ionic
  - metallic
  - covalent
  - dipole-dipole
- Electrovalence of calcium and chlorine respectively is
  - + 2, - 1
  - + 1, - 1
  - + 1, - 2
  - + 2, - 2
- When a metal atom combines with non-metal atom, the non-metal atom will
  - lose electrons and decrease in size
  - lose electrons and increase in size
  - gain electrons and decrease in size
  - gain electrons and increase in size
- Who introduced the term covalent bond ?
  - Lewis
  - Langmuir
  - Nyholm and Gillespie
  - Heitler and London
- Which of the following is/are not the condition(s) for Lewis dot structure?
  - Each bond is formed as a result of sharing of an electron pair between the atoms.
  - From the two combining atoms only one atom contribute electron(s) to the shared pair.
  - The combining atoms attain the outer shell noble gas configurations as a result of the sharing of electrons.
  - (i) and (iii)
  - (ii) and (iii)
  - (ii) only
  - (iii) only
- Which of the following does not represent the correct Lewis dot structure?
 

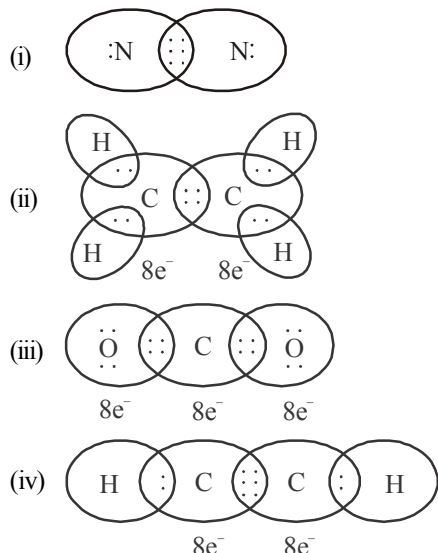
(A)

(B)

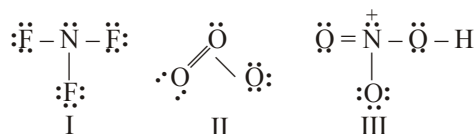
(C)

  - A
  - B
  - C
  - A and C

13. Which of the following statements are correct based on given Lewis dot structure ?

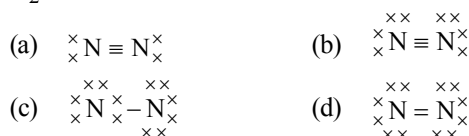


- (a) (i) and (iv) represents formation of triple bond  
 (b) Only (iii) represents formation of double bond  
 (c) Only (ii) represents formation of single bond  
 (d) (ii) and (iii) both represents formation of single bond.
14. Which of the following Lewis representation of the molecules  $\text{NF}_3$ ,  $\text{O}_3$  and  $\text{HNO}_3$  is correct ?



Choose the correct option(s).

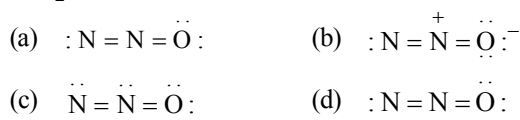
- (a) Only I (b) Only II  
 (c) Only III (d) I, II and III
15. In  $\text{N}_2$  molecule, the number of electrons shared by each nitrogen atom is
- (a) 1 (b) 2  
 (c) 3 (d) 5
16. Which of the following represents the Lewis structure of  $\text{N}_2$  molecule?



17. Which of the following shows the Lewis dot formula for  $\text{CO}_2$  ?



18. Which of the following is the correct electron dot structure of  $\text{N}_2\text{O}$  molecule?



19. What is X, Y and Z in the following expression of formal charge.

Formal charge (F.C) on an atom in a Lewis structure

$$= X - Y - \frac{1}{2}(Z)$$

- (a) X = Total number of non bonding electrons  
 Y = Total number of bonding electrons  
 Z = Total number of valence electrons in the free atom  
 (b) X = Total number of valence electrons in the free atom  
 Y = Total number of bonding electrons  
 Z = Total number of non bonding electrons  
 (c) X = Total number of valence electrons in the free atom  
 Y = Total number of non bonding electrons  
 Z = Total number of bonding electrons  
 (d) X = Total number of electrons in the free atom  
 Y = Total number of non bonding electrons  
 Z = Total number of valence electrons

20. The lowest energy structure is the one with the ..... formal charges on the atoms.

- (a) smallest (b) highest  
 (c) zero (d) negative

21. In  $\text{PO}_4^{3-}$  ion, the formal charge on each oxygen atom and P—O bond order respectively are

- (a) -0.75, 0.6 (b) -0.75, 1.0  
 (c) -0.75, 1.25 (d) -3, 1.25

22. In the cyanide ion, the formal negative charge is on

- (a) C  
 (b) N  
 (c) Both C and N  
 (d) Resonate between C and N

23. What are the exceptions of the octet rule ?

- (a) The incomplete octet of central atom  
 (b) An odd number of electrons on central atom.  
 (c) Expanded octet of the central atom  
 (d) All of these

24. In which of the following molecules octet rule is not followed?

- (a)  $\text{NH}_3$  (b)  $\text{CH}_4$   
 (c)  $\text{CO}_2$  (d)  $\text{NO}$

25. In which of the following compounds octet is complete and incomplete for all atoms :

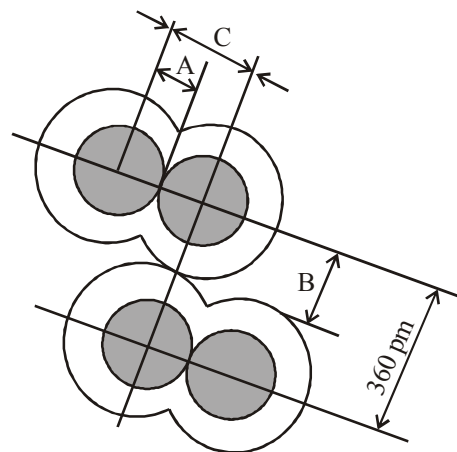
$\text{Al}_2\text{Cl}_6$	$\text{Al}_2(\text{CH}_3)_6$	$\text{AlF}_3$	Dimer of $\text{BeCl}_2$	Dimer of $\text{BeH}_2$
(a) IC	IC	IC	C	C
(b) C	IC	IC	C	IC
(c) C	IC	C	IC	IC
(d) IC	C	IC	IC	IC

(Note : C for complete octet and IC for incomplete octet.)

26. Which of the following molecule(s) obey the octet rule?

- (i)  $[\text{BF}_4]^-$ , (ii)  $[\text{AlCl}_4]^-$ , (iii)  $\text{SO}_2$ , (iv)  $\text{CCl}_4$   
 (a) (i), (ii), (iii), (iv) (b) (ii), (iii), (iv)  
 (c) (i), (iii), (iv) (d) (i), (ii), (iii)

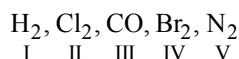
27. Among the following the electron deficient compound is  
 (a)  $\text{BCl}_3$  (b)  $\text{CCl}_4$   
 (c)  $\text{PCl}_5$  (d)  $\text{BeCl}_2$
28. Which of the following is the electron deficient molecule?  
 (a)  $\text{C}_2\text{H}_6$  (b)  $\text{B}_2\text{H}_6$   
 (c)  $\text{SiH}_4$  (d)  $\text{PH}_3$
29. Which of the following compounds does not follow the octet rule for electron distribution?  
 (a)  $\text{PCl}_5$  (b)  $\text{PCl}_3$   
 (c)  $\text{H}_2\text{O}$  (d)  $\text{PH}_3$
30. A pair of compound which have odd electrons in the group  $\text{NO}$ ,  $\text{CO}$ ,  $\text{ClO}_2$ ,  $\text{N}_2\text{O}_5$ ,  $\text{SO}_2$  and  $\text{O}_3$  are  
 (a)  $\text{NO}$  and  $\text{ClO}_2$  (b)  $\text{CO}$  and  $\text{SO}_2$   
 (c)  $\text{ClO}_2$  and  $\text{CO}$  (d)  $\text{SO}_2$  and  $\text{O}_3$
31. Which of the following statements is incorrect ?  
 (a) The formation of ionic compounds depend upon the ease of formation of the positive and negative ions from the respective neutral atoms.  
 (b) Formation of ionic compounds depend upon arrangement of the positive and negative ions in the solid.  
 (c) Formation of positive ion involves addition of electron(s) while that of negative ion involves removal of electron(s).  
 (d) None of these
32. Complete the following statement by choosing the appropriate option.  
 Ionic bonds will be formed more easily between elements with comparatively A and elements with comparatively high negative value of B.  
 (a) A = low electronegativity  
 B = ionization enthalpy  
 (b) A = low ionization enthalpy  
 B = electron gain enthalpy  
 (c) A = high ionization enthalpy  
 B = electron gain enthalpy  
 (d) A = high electronegativity  
 B = ionization enthalpy
33. In ionic solids how crystal structure get stabilized  
 (a) By the energy released in the formation of crystal lattice.  
 (b) By achieving octet of electrons around the ionic species in gaseous state.  
 (c) By electron gain enthalpy and the ionization enthalpy.  
 (d) None of these
34. Energy required to completely separate one mole of a solid ionic compound into gaseous constituent ions is called .....  
 (a) Ionisation enthalpy  
 (b) Electron gain enthalpy  
 (c) Bond dissociation enthalpy  
 (d) Lattice enthalpy
35. The effect of more electronegative atom on the strength of ionic bond  
 (a) increases (b) decreases  
 (c) remains the same (d) decreases slowly
36. Which of the following combination will form an electrovalent bond ?  
 (a) P and Cl (b)  $\text{NH}_3$  and  $\text{BF}_3$   
 (c) H and Ca (d) H and S
37. Among the following which compound will show the highest lattice energy ?  
 (a) KF (b) NaF  
 (c) CsF (d) RbF
38. Which of the following bond will have highest ionic character?  
 (a) H-I (b) H-F  
 (c) H-Cl (d) H-Br
39. Which of the following pairs will form the most stable ionic bond ?  
 (a) Na and Cl (b) Mg and F  
 (c) Li and F (d) Na and F
40. Which of the following methods is used for measuring bond length ?  
 (a) X-ray diffraction  
 (b) Electron-diffraction  
 (c) Spectroscopic techniques  
 (d) All of these
41. .... is measured as the radius of an atom's core which is in contact with the core of an adjacent atom in a bonded situation.  
 (a) van der Waal's radius  
 (b) Bond length  
 (c) Covalent radius  
 (d) Ionic radius
42. Following figure represent a chlorine molecule. Identify A, B and C in the given figure.



- (a) A = Bond length, B = van der Waal's radius  
 C = Covalent radius  
 (b) A = Covalent radius, B = Bond length  
 C = Ionic radius  
 (c) A = Ionic radius, B = van der Waal's radius  
 C = Covalent radius  
 (d) A = Covalent radius, B = van der Waal's radius  
 C = Bond length

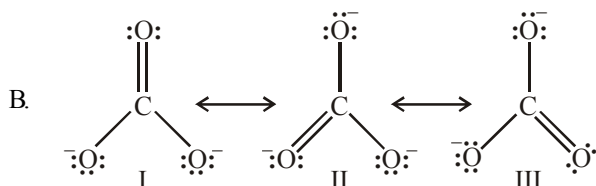
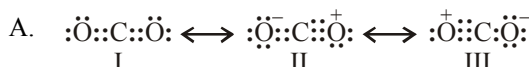


43. Which of the following statement is correct?
- Amount of energy required to break one mole of bonds of a particular type between two atoms in a gaseous state is called bond enthalpy.
  - The unit of bond enthalpy is  $\text{kJ mol}^{-1}$
  - Larger the bond dissociation enthalpy, stronger will be the bond in the molecule
  - All of these
44. Complete the following statements.  
With A in bond order, B increases and C decreases.
- A = increase, B = bond length, C = bond enthalpy
  - A = decrease, B = bond enthalpy, C = bond length
  - A = increase, B = bond enthalpy, C = bond length
  - A = increase, B = bond angle, C = bond enthalpy
45. Which of the following molecules have same bond order ?



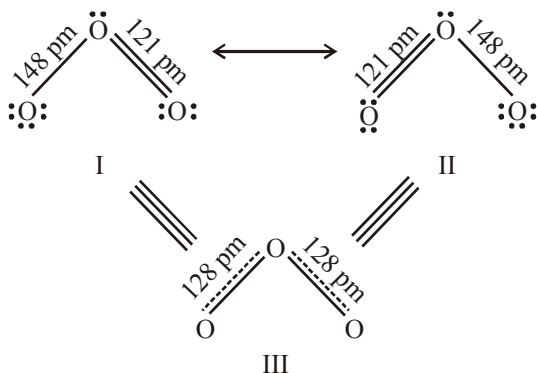
Choose the correct option.

- I, II and IV have same bond order
  - III and V have same bond order
  - Both (a) and (b) are correct
  - None of the above
46. Which one of the following is not correct representation of resonance ?



Choose the correct option.

- Only A
  - Only B
  - Both A and B
  - None of the above
47. Which of the following structure represents structure of  $\text{O}_3$  more accurately?



- I
- II
- III
- I and II

48. Which of the following is/are misconception(s) associated with resonance ?

- The molecule exist for a certain fraction of time in one canonical form and for other fractions of time in other canonical forms.
  - The canonical forms have no real existence.
  - There is no such equilibrium between the canonical forms.
- (i) only
  - (ii) and (iii)
  - (i) and (iii)
  - (iii) only.

49. The number of possible resonance structures for  $\text{CO}_3^{2-}$  is

- 2
- 3
- 6
- 9

50. Which one of the following is not the resonance structure of  $\text{CO}_2$ ?

- $\text{O}=\text{C}=\text{O}$
- $^-\text{O}-\text{C}\equiv\text{O}^+$
- $^+\text{O}\equiv\text{C}-\text{O}^-$
- $\text{O}\equiv\text{C}=\text{O}$

51. All the bond lengths of sulphur – oxygen in sulphate ion, are equal because of:

- symmetry
- resonance
- high electronegativity of oxygen
- None of these

52. Resonance is due to

- delocalization of sigma electrons
- delocalization of pi electrons
- migration of protons
- Both (a) and (b)

53. Which one of the following pairs of molecules will have permanent dipole moments for both members ?

- $\text{NO}_2$  and  $\text{CO}_2$
- $\text{NO}_2$  and  $\text{O}_3$
- $\text{SiF}_4$  and  $\text{CO}_2$
- $\text{SiF}_4$  and  $\text{NO}_2$

54. The molecule which has zero dipole moment is

- $\text{CH}_3\text{Cl}$
- $\text{NF}_3$
- $\text{BF}_3$
- $\text{ClO}_2$

55. Which of the following has dipole moment?

- $\text{CO}_2$
- p*-dichlorobenzene
- $\text{NH}_3$
- $\text{CH}_4$

56. Identify the non polar molecule in the following compounds

- $\text{H}_2$
- $\text{HCl}$
- $\text{HF}$  and  $\text{HBr}$
- $\text{HBr}$

57. A neutral molecule  $\text{XF}_3$  has a zero dipole moment. The element X is most likely

- chlorine
- boron
- nitrogen
- carbon

58. Among the following, the molecule of high dipole moment is

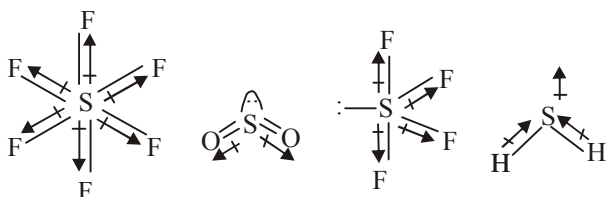
- $\text{CCl}_4$
- $\text{NH}_3$
- $\text{H}_2\text{O}$
- $\text{CHCl}_3$

59. Which one of the following molecules is expected to have zero dipole moment?

- $\text{H}_2\text{O}$
- $\text{CO}_2$
- $\text{SO}_2$
- $\text{CaF}_2$

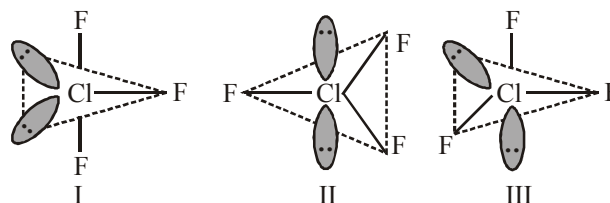


60. The correct order of dipole moments of HF,  $\text{H}_2\text{S}$  and  $\text{H}_2\text{O}$  is  
 (a)  $\text{HF} < \text{H}_2\text{S} < \text{H}_2\text{O}$  (b)  $\text{HF} < \text{H}_2\text{S} > \text{H}_2\text{O}$   
 (c)  $\text{HF} > \text{H}_2\text{S} > \text{H}_2\text{O}$  (d)  $\text{HF} > \text{H}_2\text{O} < \text{H}_2\text{S}$
61. The most polar bond is  
 (a) C–F (b) C–O  
 (c) C–Br (d) C–S
62. Which of the following possess dipole moment  $\text{SF}_6$ (a),  $\text{SO}_2$ (b),  $\text{H}_2\text{S}$ (c),  $\text{SF}_4$ (d) ?  
 (a) b and c (b) a and c  
 (c) b, c and d (d) a and b



63. According to Fajan's rule, covalent bond is favoured by  
 (a) Large cation and small anion  
 (b) Large cation and large anion  
 (c) Small cation and large anion  
 (d) Small cation and small anion
64. Arrange the following in increasing order of covalent character (i) NaCl, (ii) RbCl, (iii)  $\text{MgCl}_2$ , (iv)  $\text{AlCl}_3$  ?  
 (a) (i), (ii), (iii), (iv) (b) (iv), (ii), (i), (iii)  
 (c) (ii), (i), (iii), (iv) (d) (iii), (i), (ii), (iv)
65. The correct sequence of increasing covalent character is represented by  
 (a)  $\text{LiCl} < \text{NaCl} < \text{BeCl}_2$  (b)  $\text{BeCl}_2 < \text{LiCl} < \text{NaCl}$   
 (c)  $\text{NaCl} < \text{LiCl} < \text{BeCl}_2$  (d)  $\text{BeCl}_2 < \text{NaCl} < \text{LiCl}$
66. Which of the following salt shows maximum covalent character?  
 (a)  $\text{AlCl}_3$  (b)  $\text{MgCl}_2$   
 (c)  $\text{CsCl}$  (d)  $\text{LaCl}_3$
67. Polarizability of halide ions increases in the order  
 (a)  $\text{F}^- < \text{I}^- < \text{Br}^- < \text{Cl}^-$  (b)  $\text{Cl}^- < \text{Br}^- < \text{I}^- < \text{F}^-$   
 (c)  $\text{I}^- < \text{Br}^- < \text{Cl}^- < \text{F}^-$  (d)  $\text{F}^- < \text{Cl}^- < \text{Br}^- < \text{I}^-$
68. The covalent bond length is the shortest in which one of the following bonds?  
 (a) C—O (b) C=C  
 (c)  $\text{C}\equiv\text{N}$  (d) O—H
69. Hydrogen chloride molecule contains  
 (a) polar covalent bond (b) double bond  
 (c) co-ordinate bond (d) electrovalent bond
70. Sodium chloride is an ionic compound whereas hydrogen chloride is mainly covalent because  
 (a) sodium is less reactive  
 (b) hydrogen is non-metal  
 (c) hydrogen chloride is a gas  
 (d) electronegativity difference in the case of hydrogen and chlorine is less than 2.1.

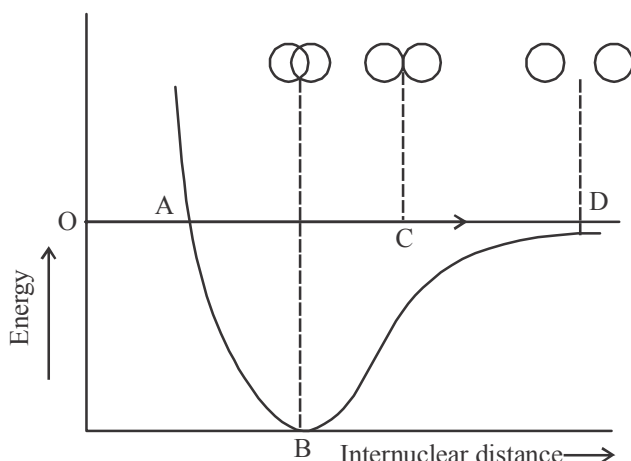
71. According to VSEPR theory the geometry of a covalent molecules depends upon  
 (a) the number of bond pairs of electrons  
 (b) the number of lone pairs of electrons  
 (c) the number of electron pairs present in the outer shell of the central atom  
 (d) All the above
72. The geometry of  $\text{ClO}_3^-$  ion according to Valence Shell Electron Pair Repulsion (VSEPR) theory will be  
 (a) planar triangular (b) pyramidal  
 (c) tetrahedral (d) square planar
73. In  $\text{BrF}_3$  molecule, the lone pairs occupy equatorial positions to minimize  
 (a) lone pair - bond pair repulsion only  
 (b) bond pair - bond pair repulsion only  
 (c) lone pair - lone pair repulsion and lone pair - bond pair repulsion  
 (d) lone pair - lone pair repulsion only
74. Which of the correct increasing order of lone pair of electrons on the central atom?  
 (a)  $\text{IF}_7 < \text{IF}_5 < \text{ClF}_3 < \text{XeF}_2$   
 (b)  $\text{IF}_7 < \text{XeF}_2 < \text{ClF}_2 < \text{IF}_5$   
 (c)  $\text{IF}_7 < \text{ClF}_3 < \text{XeF}_2 < \text{IF}_5$   
 (d)  $\text{IF}_7 < \text{XeF}_2 < \text{IF}_5 < \text{ClF}_3$
75. The number of lone pair and bond pair of electrons on the sulphur atom in sulphur dioxide molecule are respectively  
 (a) 1 and 3 (b) 4 and 1  
 (c) 3 and 1 (d) 1 and 4
76. A molecule has two lone pairs and two bond pairs around the central atom. The molecule shape is expected to be  
 (a) V-shaped (b) triangular  
 (c) linear (d) tetrahedral
77. Using VSEPR theory, predict the species which has square pyramidal shape  
 (a)  $\text{SnCl}_2$  (b)  $\text{CCl}_4$   
 (c)  $\text{SO}_3$  (d)  $\text{BrF}_5$
78. Among the following molecules :  $\text{SO}_2$ ,  $\text{SF}_4$ ,  $\text{ClF}_3$ ,  $\text{BrF}_5$  and  $\text{XeF}_4$ , which of the following shapes does not describe any of the molecules mentioned?  
 (a) Bent (b) Trigonal bipyramidal  
 (c) See-saw (d) T-shape
79. Which of the following structure is most stable ?



Choose the correct option.

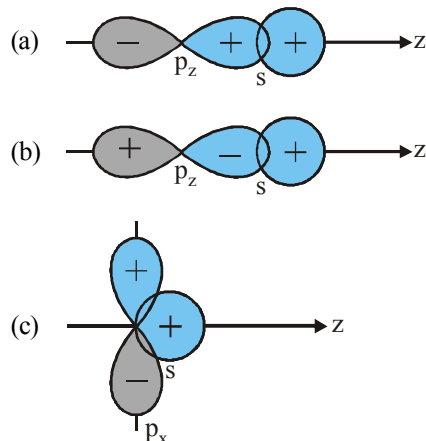
- (a) Only I  
 (b) Only II  
 (c) Only III  
 (d) All three have same stability

80. A  $\sigma$ -bonded molecule  $MX_3$  is T-shaped. The number of non-bonding pairs of electron is  
(a) 0  
(b) 2  
(c) 1  
(d) can be predicted only if atomic number of M is known.
81. Shape of methane molecule is  
(a) tetrahedral (b) pyramidal  
(c) octahedral (d) square planar
82. The shape of stannous chloride molecule is  
(a) see-saw (b) square planar  
(c) trigonal pyramidal (d) bent
83. Look at the following potential energy curve which of the following correctly represents the most stable state of hydrogen molecule.



- (a) A (b) B  
(c) C (d) D
84. Which of the following statements is false ?  
(a)  $H_2$  molecule has one sigma bond  
(b)  $HCl$  molecule has one sigma bond  
(c) Water molecule has two sigma bonds and two lone pairs  
(d) Acetylene molecule has three pi bonds and three sigma bonds
85. The number of sigma ( $\sigma$ ) and pi ( $\pi$ ) bonds present in 1,3,5,7 octatetraene respectively are  
(a) 14 and 3 (b) 17 and 4  
(c) 16 and 5 (d) 15 and 4
86. Allyl cyanide molecule contains  
(a) 9 sigma bonds, 4 pi bonds and no lone pair  
(b) 9 sigma bonds, 3 pi bonds and one lone pair  
(c) 8 sigma bonds, 5 pi bonds and one lone pair  
(d) 8 sigma bonds, 3 pi bonds and two lone pairs
87. The molecule not having  $\pi$ -bond is  
(a)  $Cl_2$  (b)  $O_2$   
(c)  $N_2$  (d)  $CO_2$
88. In hexa-1, 3-diene-5-yne the number of  $C-C$   $\sigma$ ,  $C-C$   $\pi$  and  $C-H$   $\sigma$  bonds, respectively are  
(a) 5, 4 and 6 (b) 6, 3 and 5  
(c) 5, 3 and 6 (d) 6, 4 and 5

89. The angle between the overlapping of one s-orbital and one p-orbital is  
(a)  $180^\circ$  (b)  $120^\circ$   
(c)  $109^\circ 28'$  (d)  $120^\circ 60'$
90. The enolic form of a acetone contains  
(a) 9 sigma bonds, 1 pi bond and 2 lone pairs  
(b) 8 sigma bonds, 2 pi bonds and 2 lone pairs  
(c) 10 sigma bonds, 1 pi bond and 1 lone pair  
(d) 9 sigma bonds, 2 pi bonds and 1 lone pair
91. Linear combination of two hybridized orbitals belonging to two atoms and each having one electron leads to a  
(a) sigma bond  
(b) double bond  
(c) co-ordinate covalent bond  
(d) pi bond.
92. Which of the following statements is not correct ?  
(a) Double bond is shorter than a single bond  
(b) Sigma bond is weaker than a  $\pi$  (pi) bond  
(c) Double bond is stronger than a single bond  
(d) Covalent bond is stronger than hydrogen bond
93. Which of the following represents zero overlap of atomic orbitals.



- (d) All of these
94. As the s-character of hybridised orbital increases, the bond angle  
(a) increase (b) decrease  
(c) becomes zero (d) does not change
95. Which of the following is/are not essential condition(s) for hybridisation?  
(i) The orbitals present in the valence shell of the atom are hybridised.  
(ii) The orbitals undergoing hybridisation should have almost equal energy.  
(iii) Promotion of electron is essential prior to hybridisation  
(iv) Only half filled orbitals participate in hybridisation.  
(a) (i) only (b) (iii) only  
(c) (iv) only (d) (iii) and (iv)

96. The nature of hybridisation in the ammonia molecule is  
 (a)  $sp^2$  (b)  $dp^2$   
 (c)  $sp$  (d)  $sp^3$
97. The shape of sulphate ion is  
 (a) square planar (b) trigonal  
 (c) trigonal planar (d) tetrahedral
98. The strength of bonds formed by s-s and p-p, s-p overlap in the order of  
 (a)  $s-p > s-s > p-p$  (b)  $p-p > s-s > s-p$   
 (c)  $s-s > p-p > s-p$  (d)  $s-s > s-p > p-p$
99. Which of the following will have  $sp^3 d^3$  hybridisation?  
 (a)  $BrF_5$  (b)  $PCl_5$   
 (c)  $XeF_6$  (d)  $SF_6$
100. The shape of  $CO_2$  molecule is  
 (a) linear (b) tetrahedral  
 (c) planar (d) pyramidal
101. The hybridisation state of carbon in fullerene is  
 (a)  $sp$  (b)  $sp^2$   
 (c)  $sp^3$  (d)  $sp^3 d$
102. Which of the following statements is true for an ion having  $sp^3$  hybridisation?  
 (a) all bonds are ionic  
 (b) H-bonds are situated at the corners of a square  
 (c) all bonds are co-ordinate covalent  
 (d) H-atoms are situated at the corners of tetrahedron
103. Which of the following molecule does not have a linear arrangement of atoms?  
 (a)  $H_2S$  (b)  $C_2H_2$   
 (c)  $BeH_2$  (d)  $CO_2$
104. In which one of the following molecules the central atom said to adopt  $sp^2$  hybridization?  
 (a)  $BeF_2$  (b)  $BF_3$   
 (c)  $C_2H_2$  (d)  $NH_3$
105. Considering the state of hybridization of carbon atoms, find out the molecule among the following which is linear?  
 (a)  $CH_3-CH=CH-CH_3$   
 (b)  $CH_3-C \equiv C-CH_3$   
 (c)  $CH_2=CH-CH_2-C \equiv CH$   
 (d)  $CH_3-CH_2-CH_2-CH_3$
106. Equilateral shape has  
 (a)  $sp$  hybridisation (b)  $sp^2$  hybridisation  
 (c)  $sp^3$  hybridisation (d) None of these
107. In an octahedral structure, the pair of  $d$  orbitals involved in  $d^2 sp^3$  hybridization is  
 (a)  $d_{x^2-y^2}, d_{z^2}$  (b)  $d_{xz}, d_{x^2-y^2}$   
 (c)  $d_{z^2}, d_{xz}$  (d)  $d_{xy}, d_{yz}$
108. The trigonal bipyramidal geometry is obtained from the hybridisation  
 (a)  $dsp^3$  or  $sp^3 d$  (b)  $dsp^2$  or  $sp^2 d$   
 (c)  $d^2 sp^3$  or  $sp^3 d^2$  (d) None of these
109. In which of the following species is the underlined carbon having  $sp^3$  - hybridisation?  
 (a)  $CH_3-\underline{C}OOH$  (b)  $CH_3\underline{C}H_2OH$   
 (c)  $CH_3\underline{C}OCH_3$  (d)  $CH_2=\underline{C}H-CH_3$
110. A  $sp^3$ -hybrid orbital contains  
 (a) 25% s-character (b) 75% s-character  
 (c) 50% s-character (d) 25% p-character
111. The types of hybridisation of the five carbon atoms from left to right in the molecule  
 $CH_3-CH=CH-CH=CH-CH_3$  are  
 (a)  $sp^3, sp^2, sp^2, sp^2, sp^3$  (b)  $sp^3, sp, sp^2, sp^2, sp^3$   
 (c)  $sp^3, sp^2, sp, sp^2, sp^3$  (d)  $sp^3, sp^2, sp^2, sp, sp^3$
112. Pick out the incorrect statement from the following  
 (a)  $sp$  hybrid orbitals are equivalent and are at an angle of  $180^\circ$  with each other  
 (b)  $sp^2$  hybrid orbitals are equivalent and bond angle between any two of them is  $120^\circ$   
 (c)  $sp^3 d^2$  hybrid orbitals are equivalent and are oriented towards corners of a regular octahedron  
 (d)  $sp^3 d^3$  hybrid orbitals are not equivalent
113. All carbon atoms are  $sp^2$  hybridised in  
 (a) 1, 3-butadiene (b)  $CH_2=C=CH_2$   
 (c) cyclohexane (d) 2-butene
114. Which one of the following is not correct in respect of hybridization of orbitals?  
 (a) The orbitals present in the valence shell only are hybridized  
 (b) The orbitals undergoing hybridization have almost equal energy  
 (c) Promotion of electron is not essential condition for hybridization  
 (d) Pure atomic orbitals are more effective in forming stable bonds than hybrid orbitals
115. Molecular orbital theory was given by  
 (a) Kossel (b) Mosley  
 (c) Mulliken (d) Werner
116. Atomic orbital is monocentric while a molecular orbital is polycentric. What is the meaning of above statements?  
 (a) Electron density in atomic orbital is given by the electron distribution around a nucleus in an atom. While in molecular orbital it is given by the electron distribution around group of nuclei in a molecule.  
 (b) While an electron in an atomic orbital is influenced by one nucleus, in a molecular orbital it is influenced by two or more nuclei depending upon the number of atoms in the molecule.  
 (c) The electron in an atomic orbital is present in one nucleus while in molecular orbital electrons are present on more than one nuclei depending upon the number of atoms in the molecule.  
 (d) All of these
117. With increasing bond order, stability of bond  
 (a) Remain unaltered (b) Decreases  
 (c) Increases (d) None of these

118. The given increasing order of energies of various molecular orbitals is not true for which of the following molecule?  
 $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < (\pi 2p_x = \pi 2p_y) < \sigma 2p_z < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$   
 (a)  $B_2$  (b)  $C_2$   
 (c)  $N_2$  (d)  $O_2$
119. Which of the following corresponds unstable molecule? Here  $N_b$  is number of bonding electrons and  $N_a$  is number of antibonding electrons.  
 (a)  $N_b > N_a$  (b)  $N_b < N_a$   
 (c)  $N_a = N_b$  (d) Both (b) and (c)
120. If  $N_x$  is the number of bonding orbitals of an atom and  $N_y$  is the number of antibonding orbitals, then the molecule/atom will be stable if  
 (a)  $N_x > N_y$  (b)  $N_x = N_y$   
 (c)  $N_x < N_y$  (d)  $N_x \leq N_y$
121. In the molecular orbital diagram for  $O_2^+$  ion, the highest occupied orbital is  
 (a)  $\sigma$  MO orbital (b)  $\pi$  MO orbital  
 (c)  $\pi^*$  MO orbital (d)  $\sigma^*$  MO orbital
122. The theory capable of explaining paramagnetic behaviour of oxygen is  
 (a) resonance theory  
 (b) V.S.E.P.R. theory  
 (c) molecular orbital theory  
 (d) valence bond energy
123. In an anti-bonding molecular orbital, electron density is minimum  
 (a) around one atom of the molecule  
 (b) between the two nuclei of the molecule  
 (c) at the region away from the nuclei of the molecule  
 (d) at no place
124. When two atomic orbitals combine, they form  
 (a) one molecular orbital (b) two molecular orbital  
 (c) three molecular orbital (d) four molecular orbital
125. Paramagnetism is exhibited by molecules  
 (a) not attracted into a magnetic field  
 (b) containing only paired electrons  
 (c) carrying a positive charge  
 (d) containing unpaired electrons
126. The difference in energy between the molecular orbital formed and the combining atomic orbitals is called  
 (a) bond energy (b) activation energy  
 (c) stabilization energy (d) destabilization energy
127. The bond order in  $N_2^+$  is  
 (a) 1.5 (b) 3.0  
 (c) 2.5 (d) 2.0
128. Which molecule has the highest bond order?  
 (a)  $N_2$  (b)  $Li_2$   
 (c)  $He_2$  (d)  $O_2$
129. Which one of the following molecules is expected to exhibit diamagnetic behaviour?  
 (a)  $C_2$  (b)  $N_2$   
 (c)  $O_2$  (d)  $S_2$
130. The correct statement with regard to  $H_2^+$  and  $H_2^-$  is  
 (a) both  $H_2^+$  and  $H_2^-$  are equally stable  
 (b) both  $H_2^+$  and  $H_2^-$  do not exist  
 (c)  $H_2^-$  is more stable than  $H_2^+$   
 (d)  $H_2^+$  is more stable than  $H_2^-$
131. Mark the incorrect statement in the following  
 (a) the bond order in the species  $O_2$ ,  $O_2^+$  and  $O_2^-$  decreases as  $O_2^+ > O_2 > O_2^-$   
 (b) the bond energy in a diatomic molecule always increases when an electron is lost  
 (c) electrons in antibonding M.O. contribute to repulsion between two atoms.  
 (d) with increase in bond order, bond length decreases and bond strength increases.
132. According to molecular orbital theory which of the following statement about the magnetic character and bond order is correct regarding  $O_2^+$   
 (a) Paramagnetic and Bond order  $< O_2$   
 (b) Paramagnetic and Bond order  $> O_2$   
 (c) Diamagnetic and Bond order  $< O_2$   
 (d) Diamagnetic and Bond order  $> O_2$
133. Bond order is a concept in the molecular orbital theory. It depends on the number of electrons in the bonding and antibonding orbitals. Which of the following statements is true about it? The bond order  
 (a) can have a negative quantity  
 (b) has always an integral value  
 (c) can assume any positive or integral or fractional value including zero  
 (d) is a non-zero quantity
134. Which of the following does not exist on the basis of molecular orbital theory?  
 (a)  $H_2^+$  (b)  $He_2^+$   
 (c)  $He_2$  (d)  $Li_2$
135. The paramagnetic property of the oxygen molecule is due to the presence of unpaired electrons present in  
 (a)  $(\sigma 2p_x)^1$  and  $(\sigma^* 2p_x)^1$   
 (b)  $(\sigma 2p_x)^1$  and  $(\pi 2p_y)^1$   
 (c)  $(\pi^* 2p_y)^1$  and  $(\pi^* 2p_z)^1$   
 (d)  $(\pi^* 2p_x)^1$  and  $(\pi^* 2p_z)^1$
136. In which of the following state of compound the magnitude of H-bonding will be maximum and in which case it will be minimum?  
 (a) Maximum = Solid, Minimum = Liquid  
 (b) Maximum = Liquid, Minimum = Gas  
 (c) Maximum = Solid, Minimum = Gas  
 (d) Maximum = Gas, Minimum = Solid

137. Which of the following are correctly classified ?

**Intermolecular**

**H-bonding**

- (a) HF
- (b) CH<sub>3</sub>OH
- (c) H<sub>2</sub>O
- (d) HF

**Intramolecular**

**H-bonding**

- H<sub>2</sub>O
- HF
- o*-nitrophenol
- p*-nitrophenol

138. Intramolecular hydrogen bond exists in

- (a) *ortho* nitrophenol
- (b) ethyl alcohol
- (c) water
- (d) diethyl ether

139. The boiling point of *p*-nitrophenol is higher than that of *o*-nitrophenol because

- (a) NO<sub>2</sub> group at *p*-position behave in a different way from that at *o*-position.
- (b) intramolecular hydrogen bonding exists in *p*-nitrophenol
- (c) there is intermolecular hydrogen bonding in *p*-nitrophenol
- (d) *p*-nitrophenol has a higher molecular weight than *o*-nitrophenol.

140. Which one of the following is the correct order of interactions ?

- (a) Covalent < hydrogen bonding < vander Waals < dipole-dipole
- (b) vander Waals < hydrogen bonding < dipole < covalent
- (c) vander Waals < dipole-dipole < hydrogen bonding < covalent
- (d) Dipole-dipole < vander Waals < hydrogen bonding < covalent.

141. Strongest hydrogen bond is shown by

- (a) water
- (b) ammonia
- (c) hydrogen fluoride
- (d) hydrogen sulphide

142. The low density of ice compared to water is due to

- (a) induced dipole-induced dipole interactions
- (b) dipole-induced dipole interactions
- (c) hydrogen bonding interactions
- (d) dipole-dipole interactions

143. Methanol and ethanol are miscible in water due to

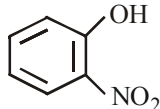
- (a) covalent character
- (b) hydrogen bonding character
- (c) oxygen bonding character
- (d) None of these

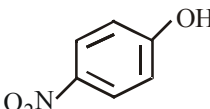
144. The hydrogen bond is shortest in

- (a) S—H---S
- (b) N—H---O
- (c) S—H---O
- (d) F—H---F

145. Hydrogen bonding is maximum in

- (a) C<sub>2</sub>H<sub>5</sub>OH
- (b) CH<sub>3</sub>OCH<sub>3</sub>
- (c) (CH<sub>3</sub>)<sub>2</sub>C=O
- (d) CH<sub>3</sub>CHO

146. The vapour pressure of  is higher than

 due to

- (a) dipole moment
- (b) dipole-dipole interaction
- (c) H-bonding
- (d) lattice structure

147. The reason for exceptionally high boiling point of water is

- (a) its high specific heat
- (b) its high dielectric constant
- (c) low ionization of water molecule
- (d) hydrogen bonding in the molecules of water

148. Acetic acid exists as dimer in benzene due to

- (a) condensation reaction
- (b) hydrogen bonding
- (c) presence of carboxyl group
- (d) presence of hydrogen atom at  $\alpha$ -carbon

149. Hydrogen bonding is formed in compounds containing hydrogen and

- (a) highly electronegative atoms
- (b) highly electropositive atoms
- (c) metal atoms with *d*-orbitals occupied
- (d) metalloids

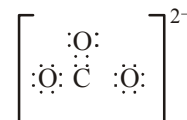
### STATEMENT TYPE QUESTIONS

150. Read the following statements and choose the correct sequence of T and F from the given codes. Here T represents true and F represents false statement.

- (i) The number of dots in Lewis symbol represents the number of valence electrons.
- (ii) Number of valence electrons helps to calculate group valence of element.
- (iii) Group valence is given as 8 minus the number of inner shell electrons.

- (a) T T T
- (b) T F F
- (c) T T F
- (d) F F F

151. Based on the following Lewis dot structure which of the given statement(s) is/are correct?



- (i) There is formation of a double bond and two single bonds.
- (ii) There are two additional electrons than those provided by the neutral atoms.
- (iii) The least electropositive atom occupies the central position in the molecule/ion.

- (a) (i) and (iii)
- (b) (i), (ii) and (iii)
- (c) (iii) only
- (d) (i) and (ii)



**152.** Choose the correct sequence of T and F for following statements. Here T stands for true statement and F stands for false statement.

- Formal charge in the Lewis structure helps in keeping track of the valence electrons in the molecule.
- Formal charge indicates the actual charge separation within the molecule.
- Formal charges help in the selection of the lowest energy structure from a number of possible Lewis structures.

- (a) T T F (b) T F T  
(c) T T T (d) F T T

**153.** Read the following statements and choose the correct option. Here T stands for True and F stands for False statement.

- The smaller the size of the cation and the larger the size of the anion, the greater the covalent character of an ionic bond.
- The smaller the charge on the cation, the greater the covalent character of the ionic bond.
- For cations of the same size and charge, the one, with electronic configuration  $(n-1)d^n ns^0$ , typical of transition metals, is more polarising than the one with a noble gas configuration,  $ns^2 np^6$ , typical of alkali and alkaline earth metal cations.

- (a) T T T (b) T T F  
(c) T F T (d) F T T

**154.** Choose the correct sequence of T and F for following statements. Here T stands for True and F for False statement.

- Sigma bond is formed by head on overlap of bonding orbitals along the internuclear axis.
- Pi bond is formed when atomic orbitals overlap in such a way that their axes remain parallel to each other and perpendicular to the internuclear axis.
- Half-filled  $s$ -orbital of one atom and half filled  $p$ -orbitals of another atom forms  $\pi$  bond on overlapping.
- Overlapping in case of pi-bond takes place to a larger extent as compared to sigma bond.

- (a) T T T T (b) T F T F  
(c) T T F F (d) T T F T

**155.** Give the correct order of initials  $T$  or  $F$  for following statements. Use  $T$  if statement is true and  $F$  if it is false :

- The order of repulsion between different pair of electrons is  $l_p - l_p > l_p - b_p > b_p - b_p$
- In general, as the number of lone pair of electrons on central atom increases, value of bond angle from normal bond angle also increases
- The number of lone pair on O in  $H_2O$  is 2 while on N in  $NH_3$  is 1
- The structures of xenon fluorides and xenon oxyfluorides could not be explained on the basis of VSEPR theory

- (a) TTTF (b) TFTF  
(c) TFFT (d) TFFF

**156.** Which of the following statements is/are not correct for combination of atomic orbitals?

- The combining atomic orbitals must have the same or nearly the same energy.
- Greater the extent of overlap, the greater will be the electron density between the nuclei of a molecular orbital.
- $2p_z$  orbital of one atom can combine with either of  $2p_x$ ,  $2p_y$  or  $2p_z$  orbital of other atom as these orbitals have same energy.

- (a) (i) and (ii) (b) (iii) only  
(c) (i) only (d) (ii) and (iii)

### MATCHING TYPE QUESTIONS

**157.** Match the columns

Column-I	Column-II
(A) $BeH_2$	(p) Odd electron molecules
(B) $SF_6$	(q) Expanded octet
(C) $NO_2$	(r) Incomplete octet of central atom
(a) A – (p), B – (q), C – (r)	
(b) A – (q), B – (r), C – (p)	
(c) A – (r), B – (q), C – (p)	
(d) A – (r), B – (p), C – (q)	

**158.** Match the columns

Column-I	Column-II
(A) HCl	(p) Covalent compound with directional bond
(B) $CO_2$	(q) Ionic compound with non-directional bonds
(C) NaCl	(r) Polar molecule
(D) $CCl_4$	(s) Non-polar molecule
(a) A – (p, q, r), B – (q, r), C – (p, q), D – (r)	
(b) A – (q), B – (r), C – (p), D – (s)	
(c) A – (p, r), B – (p, s), C – (q), D – (p, s)	
(d) A – (q), B – (r), C – (p, q), D – (s)	

**159.** Match Column-I with Column-II and Column-III and choose the correct option from the given codes.

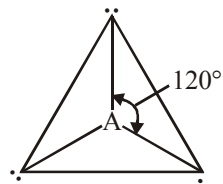
Column-I Molecule	Column-II (No. of lone pairs and bond pairs)	Column-III (Shape of molecule)
(A) $NH_3$	(i) 1, 2	(p) Bent
(B) $SO_2$	(ii) 1, 4	(q) Trigonal pyramidal
(C) $SF_4$	(iii) 2, 3	(r) T-shape
(D) $ClF_3$	(iv) 1, 3	(s) See-Saw
(a) A – (iv, q); B – (ii, p); C – (i, r); D – (iii, s)		
(b) A – (iv, q); B – (i, p); C – (ii, s); D – (iii, r)		
(c) A – (i, p); B – (iii, s); C – (iv, r); D – (ii, q)		
(d) A – (iv, p); B – (i, r); C – (iii, q); D – (ii, s)		



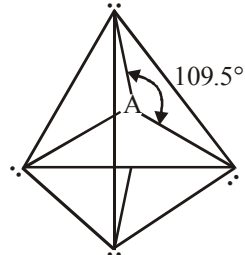
160. Match the columns

**Column-I**

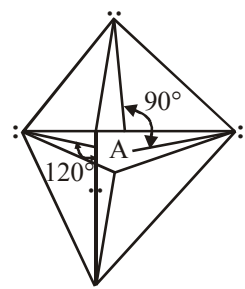
(A) Trigonal planar



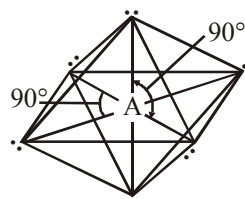
(B) Tetrahedral



(C) Trigonal bipyramidal



(D) Octahedral



**Column-II**

(p)  $\text{PCl}_5$

(q)  $\text{NH}_4^+$

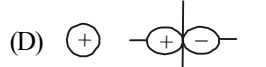
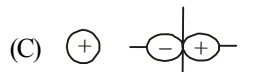
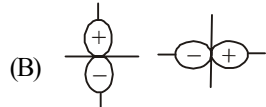
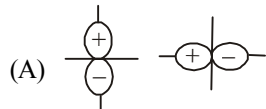
(r)  $\text{SF}_6$

(s)  $\text{BF}_3$

- (a) A – (p), B – (q), C – (r), D – (s)  
 (b) A – (s), B – (r), C – (q), D – (p)  
 (c) A – (s), B – (q), C – (p), D – (r)  
 (d) A – (r), B – (p), C – (q), D – (s)

161. Match the columns

**Column-I**



**Column-II**

(p) negative overlap

(q) zero overlap

(r) positive overlap

(a) A – (p), B – (q), C – (p), D – (r)

(b) A – (p), B – (r), C – (q), D – (p)

(c) A – (q), B – (q), C – (p), D – (r)

(d) A – (r), B – (p), C – (q), D – (p)

162. Match Column-I (molecule) with Column-II (type of hybridisation) and choose the correct option from the codes given below.

**Column-I**

(Molecule)

(A)  $\text{SF}_6$

(B)  $\text{PF}_5$

(C)  $\text{BCl}_3$

(D)  $\text{C}_2\text{H}_6$

(a) A – (r), B – (p), C – (s), D – (q)

(b) A – (r), B – (p), C – (q), D – (s)

(c) A – (p), B – (r), C – (q), D – (s)

(d) A – (p), B – (r), C – (s), D – (q)

**Column-II**

(Type of hybridisation)

(p)  $\text{sp}^3\text{d}$

(q)  $\text{sp}^3$

(r)  $\text{sp}^3\text{d}^2$

(s)  $\text{sp}^2$

163. Match the columns

**Column-I**

(A) Valence bond theory

(B) Octet rule

(C) Molecular orbital

theory

(D) The valence shell electron pair repulsion theory

**Column-II**

(p) Nyholm and Gillespie

(q) F. Hund & R. S Mulliken

(r) Heitler and London

(s) Kössel and Lewis

(a) A – (p), B – (q), C – (r), D – (s)

(b) A – (q), B – (r), C – (s), D – (p)

(c) A – (p), B – (s), C – (q), D – (r)

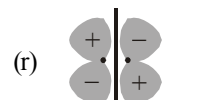
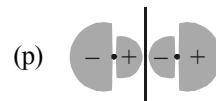
(d) A – (s), B – (r), C – (q), D – (p)

164. Match the columns

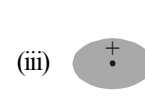
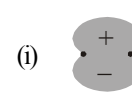
**Column-I**

(A) 1s

**Column-II**



**Column-III**



(a) A – (q, iii), B – (r, i), C – (p, ii)

(b) A – (q, iii), B – (p, ii), C – (r, i)

(c) A – (p, iii), B – (q, ii), C – (r, i)

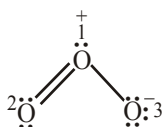
(d) A – (p, ii), B – (q, iii), C – (r, i)

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

**165. Assertion :** The correct Lewis structure of  $O_3$  may be drawn as



**Reason :** The formal charges on atom 1, 2 and 3 are +1, 0 and -1 respectively.

**166. Assertion :** Atoms can combine either by transfer of valence of electrons from one atom to another or by sharing of valence electrons.

**Reason :** Sharing and transfer of valence electrons is done by atoms to have an octet in their valence shell.

**167. Assertion :** The lesser the lattice enthalpy more stable is the ionic compound.

**Reason :** The lattice enthalpy is greater, for ions of highest charge and smaller radii.

**168. Assertion :** Sulphur compounds like  $SF_6$  and  $H_2SO_4$  have 12 valence electrons around S atom.

**Reason :** All sulphur compounds do not follow octet rule.

**169. Assertion :**  $BF_3$  molecule has zero dipole moment.

**Reason :** F is electronegative and B-F bonds are polar in nature.

**170. Assertion :**  $CH_2Cl_2$  is non-polar and  $CCl_4$  is polar molecule.

**Reason :** Molecule with zero dipole moment is non-polar in nature.

**171. Assertion :** Lone pair-lone pair repulsive interactions are greater than lone pair-bond pair and bond pair-bond pair interactions.

**Reason :** The space occupied by lone pair electrons is more as compared to bond pair electrons.

**172. Assertion :** In  $NH_3$ , N is  $sp^3$  hybridised, but angle is found to be  $107^\circ$ .

**Reason :** The decrease in bond angle is due to repulsion between the lone pair.

**173. Assertion :** Shape of  $NH_3$  molecule is tetrahedral.

**Reason :** In  $NH_3$  nitrogen is  $sp^3$  hybridized.

**174. Assertion :** pi bonds are weaker than  $\sigma$  bonds.

**Reason :** pi bonds are formed by the overlapping of p-p orbitals along their axes.

**175. Assertion :** The bond order of helium is always zero.

**Reason :** The number of electrons in bonding molecular orbital and antibonding molecular orbital is equal.

**176. Assertion :** Bonding molecular orbital has greater stability than corresponding antibonding molecular orbital.

**Reason :** The electron density in a bonding molecular orbital is located away from the space between the nuclei while in antibonding molecular orbital it is located between the nuclei of the bonded atoms.

**177. Assertion :** Water is one of the best solvent.

**Reason :** H-bonding is present in water molecules.

### CRITICAL THINKING TYPE QUESTIONS

**178.** What is the correct mode of hybridisation of the central atom in the following compounds?

$NO_2^-$	$SF_4$	$PF_6^-$
(a) $sp$	$sp^2$	$sp^3$
(b) $sp^2$	$sp^3d$	$sp^3d^2$
(c) $sp^2$	$sp^3$	$d^2sp^3$
(d) $sp^3$	$sp^3$	$sp^3d^2$

**179.** Which of the following molecules has trigonal planar geometry?

- (a)  $BF_3$  (b)  $NH_3$   
 (c)  $PCl_3$  (d)  $IF_3$

**180.** Which of the following molecules is planar?

- (a)  $SF_4$  (b)  $XeF_4$   
 (c)  $NF_3$  (d)  $SiF_4$

**181.** Hybridization present in  $ClF_3$  is

- (a)  $sp^2$  (b)  $sp^3$   
 (c)  $dsp^2$  (d)  $sp^3d$

**182.** Which of the following represents the given mode of hybridisation  $sp^2 - sp^2 - sp - sp$  from left to right ?

- (a)  $H_2C=CH-C \equiv N$  (b)  $HC \equiv C-C \equiv CH$

- (c)  $H_2C=C=C=CH_2$  (d)

**183.** Hybridisation states of C in  $CH_3^+$  and  $CH_4$  are

- (a)  $sp^2$  &  $sp^3$  (b)  $sp^3$  &  $sp^2$   
 (c)  $sp^2$  &  $sp^2$  (d)  $sp^3$  &  $sp^3$

**184.** The type of hybridization in xenon atom and the number of lone pairs present on xenon atom in xenon hexafluoride molecule are respectively

- (a)  $sp^3d^3$ , one (b)  $sp^3d^3$ , two  
 (c)  $sp^3d^3$ , two (d)  $sp^3d^2$ , zero

**185.** In which of the following species, all the three types of hybrid carbons are present?

- (a)  $CH_2=C=CH_2$  (b)  $CH_3-CH=CH-CH_2^+$   
 (c)  $CH_3-C \equiv C-CH_2^+$  (d)  $CH_3-CH=CH-CH_2$

**186.** If an organic compound contain 92.3% C and 7.7% H, than number of  $sp^3$ ,  $sp^2$  and  $sp$  hybridized carbon atoms in all possible structures of compound respectively are (molecular mass = 52g/mol)

- (a) 1, 2, 5 (b) 0, 4, 4  
 (c) 0, 8, 4 (d) None of these

187. Arrange the following in increasing order of bond length

- (i)  $N_2$  (ii)  $N_2^+$   
(iii)  $N_2^{2+}$   
(a) (ii), (i) and (iii) (b) (ii), (iii) and (i)  
(c) (iii), (ii) and (i) (d) (i), (ii) and (iii)

188. Which of the following molecule exist ?

- (a)  $He_2$  (b)  $Be_2$   
(c)  $Li_2$  (d) Both (a) and (b)

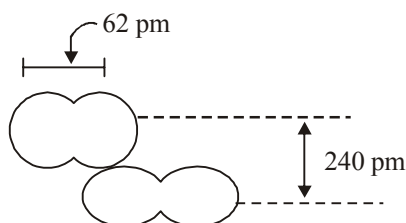
189. Hybridization and structure of  $I^{3-}$  are

- (a)  $sp^2$  and trigonal planar  
(b)  $sp^3d^2$  and linear  
(c)  $sp^3d$  and linear  
(d)  $sp^3$  and T-shape

190. What is the change in hybridization when  $AlCl_3$  changes to  $[Al_2Cl_6]^{-3}$  ?

- (a)  $sp^3d$  to  $sp^3d^2$  (b)  $sp^3$  to  $sp^3d$   
(c)  $sp^2$  to  $sp^3d^2$  (d) None of these

191. From the given figure the van der Waal radius and covalent radius of the hydrogen atom respectively are



- (a) 151, 31 (b) 120, 31  
(c) 31, 100 (d) 30, 120

192. Which of the following substances has the greatest ionic character ?

- (a)  $Cl_2O$  (b)  $NCl_3$   
(c)  $PbCl_2$  (d)  $BaCl_2$

193. Among the following species, identify the pair having same bond order  $CN^-$ ,  $O_2^-$ ,  $NO^+$ ,  $CN^+$

- (a)  $CN^-$  and  $O_2^-$  (b)  $O_2^-$  and  $NO^+$   
(c)  $CN^-$  and  $NO^+$  (d)  $CN^-$  and  $CN^+$

194. Which of the following is not correct with respect to bond length of the species ?

- (a)  $C_2 > C_2^{2-}$  (b)  $B_2^+ > B_2$   
(c)  $Li_2^+ > Li_2$  (d)  $O_2 > O_2^-$

195. The molecule which has the highest bond order is

- (a)  $C_2$  (b)  $N_2$   
(c)  $B_2$  (d)  $O_2$

196. The compound which cannot be formed is

- (a)  $He$  (b)  $He^+$   
(c)  $He_2$  (d)  $He^{+2}$

197. The ground state electronic configuration of valence shell electrons in nitrogen molecule ( $N_2$ ) is written as  $KK \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2, \pi 2p_y^2, \sigma 2p_z^2$ . Bond order in nitrogen molecule is

- (a) 0 (b) 1  
(c) 2 (d) 3

198. Bond order in benzene is

- (a) 1 (b) 2  
(c) 1.5 (d) None of these

199. In  $O_2^-$ ,  $O_2$  and  $O_2^{2-}$  molecular species, the total number of antibonding electrons respectively are

- (a) 7, 6, 8 (b) 1, 0, 2  
(c) 6, 6, 6 (d) 8, 6, 8

200.  $N_2$  and  $O_2$  are converted to monpositive cations  $N_2^+$  and  $O_2^+$  respectively. Which is incorrect ?

- (a) In  $N_2^+$  the N-N bond is weakened  
(b) In  $O_2^+$  the bond order increases  
(c) In  $O_2^+$  the paramagnetism decreases  
(d)  $N_2^+$  becomes diamagnetic

201. Bond order normally gives idea of stability of a molecular species. All the molecules viz.  $H_2$ ,  $Li_2$  and  $B_2$  have the same bond order yet they are not equally stable. Their stability order is

- (a)  $H_2 > B_2 > Li_2$  (b)  $Li_2 > H_2 > B_2$   
(c)  $Li_2 > B_2 > H_2$  (d)  $B_2 > H_2 > Li_2$

202. According to MO theory which of the following lists ranks the nitrogen species in terms of increasing bond order?

- (a)  $N_2^{2-} < N_2^- < N_2$  (b)  $N_2 < N_2^{2-} < N_2^-$   
(c)  $N_2^- < N_2^{2-} < N_2$  (d)  $N_2^- < N_2 < N_2^{2-}$

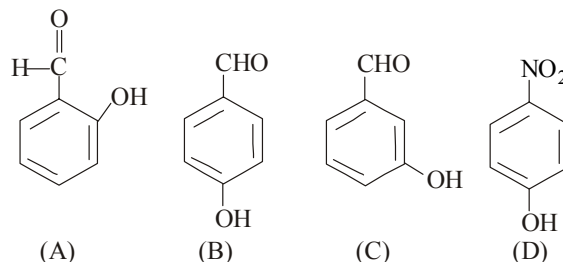
203. Hydrogen bonding would not affect the boiling point of

- (a)  $HI$  (b)  $H_2O$   
(c)  $NH_3$  (d)  $CH_3OH$

204. Which one of the following molecules will form a linear polymeric structure due to hydrogen bonding?

- (a)  $NH_3$  (b)  $H_2O$   
(c)  $HCl$  (d)  $HF$

205. Which among the following can form intermolecular H-bonding ?



- (a) A (b) B and D  
(c) B, C and D (d) A and C

# HINTS AND SOLUTIONS

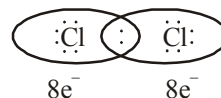
## FACT/DEFINITION TYPE QUESTIONS

- (a) Chemical bond is an attractive force, which holds various constituents (atoms, ions etc.) together in different chemical species.
- (d) The evolution of various theories of valence and the interpretation of the nature of chemical bonds have closely been related to the developments in the understanding of structure of atom, electronic configuration of elements and Periodic Table.
- (b) Kossel and Lewis provide some logical explanation of valence which was based on the inertness of noble gases.
- (c) In the formation of a molecule, only the outer shell electrons take part in chemical combination and they are known as **valence electrons**.
- (d) Valence electrons in O = 6  
 $\therefore$  Correct Lewis symbol =  $\cdot\ddot{\text{O}}\cdot$   
 Similarly, Ne is a noble gas having valence electrons = 8  
 $\therefore$  Correct Lewis symbol for Ne =  $\cdot\ddot{\text{Ne}}\cdot$
- (b) Electrovalent bond is formed as a result of electrostatic attraction between the positive and negative ions.
- (a) The electrostatic force that binds the oppositely charged ions which are formed by transfer of electron(s) from one atom to another is called ionic bond. Cation and anion are oppositely charged particles therefore they form ionic bond in crystal.
- (a) Calcium is assigned a positive electrovalence of two, while chlorine has a negative electrovalence of one.
- (d) When a metal for example Na combines with a non metal e.g.,  $\text{Cl}_2$ . Following reaction occurs  

$$2\text{Na} + \text{Cl}_2 \longrightarrow 2\text{NaCl}$$
 In this process Na loses one electron to form  $\text{Na}^+$  and Cl accepts one electron to form  $\text{Cl}^-$   

$$\text{Na} \longrightarrow \text{Na}^+ + e^-$$

$$\text{Cl} + e^- \longrightarrow \text{Cl}^-$$
 Therefore, in this process Cl gain electrons and hence its size increases.
- (b) **Langmuir** (1919) refined the Lewis postulations by abandoning the idea of the stationary cubical arrangement of the octet, and by introducing the term **covalent bond**.
- (c) Each combining atom contributes at least one electron to the shared pair.
- (a) In formation of  $\text{Cl}_2$  molecule a pair of electrons is shared between the two chlorine atoms. Each chlorine atom contribute one electron to the shared pair.

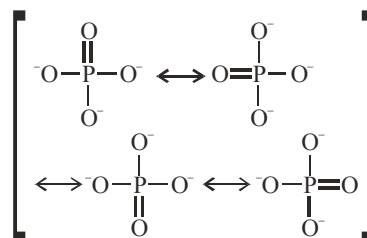


- (a) (i) represents  $\text{N} \equiv \text{N}$   
 (iv) represents  $\text{H} - \text{C} \equiv \text{C} - \text{H}$   
 (ii) and (iii) represents respectively :  

$$\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C} = \text{C} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array} \quad \text{and} \quad \ddot{\text{O}} = \text{C} = \ddot{\text{O}}$$
- (a) All Lewis representation of the molecules  $\text{NH}_3$ ,  $\text{O}_3$  and  $\text{HNO}_3$  given in question are correct.
- (c)  $\text{N}_2$ ;  $\text{N} \equiv \text{N}$   
 3 electrons are shared by each nitrogen atom
- (a) Lewis structure of  $\text{N}_2$  is  $\text{N} \equiv \text{N}$
- (a) Step I : Skeleton  $\text{O} \text{---} \text{C} \text{---} \text{O}$   
 Step II :  $A = 1 \times 4$  for C +  $2 \times 6$  for O = 4 + 12  
 $= 16$  electrons  
 Step III : Total no. of electrons needed to achieve noble gas configuration (N)  
 $N = 1 \times 8 + 2 \times 8 = 24$   
 Step IV : Shared electrons,  $S = N - A = 24 - 16$   
 $= 8$  electrons  
 Step V :  $\text{O} :: \text{C} :: \text{O}$   
 Step VI :  $\cdot\ddot{\text{O}} :: \text{C} :: \ddot{\text{O}}\cdot \Rightarrow \cdot\ddot{\text{O}} = \text{C} = \ddot{\text{O}}\cdot$
- (b) 
$$\text{:N} \equiv \text{N}^+ - \ddot{\text{O}}::\ddot{\text{O}}^-$$
 octet of each atom is complete.
- (c) Formal charge (F.C.) on an atom in a Lewis structure  

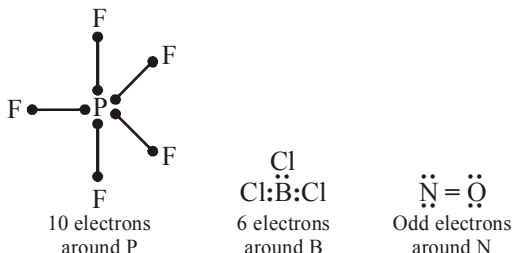
$$= [\text{total number of valence electrons in the free atom}] - [\text{total number of non bonding (lone pair) electrons}] - (1/2) [\text{total number of bonding (shared) electrons}]$$
- (a) The lowest energy structure is the one with the smallest formal charges on the atoms.
- (c) Bond order between P – O  

$$= \frac{\text{no. of bonds in all possible direction}}{\text{total no. of resonating structures}} = \frac{5}{4} = 1.25$$



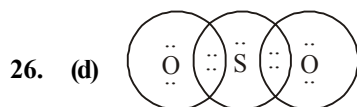
$$\text{Formal charge on oxygen} = -\frac{3}{4} = -0.75$$

22. (b) In  $\text{CN}^-$  ion formal negative charge is on nitrogen atom due to lone pair of electrons.
23. (d) According to octet rule, the central atom must have 8 electrons but in some compounds the number of electrons is more than 8, or less than 8 or an odd number of electrons is left on the central atom e.g.,  $\text{PCl}_5$ ,  $\text{BF}_5$ , NO.



24. (d)

25. (c) (i) (Complete octet)
- (ii) (3c - 2e) bond (incomplete octet)
- (iii)  $\text{AlF}_3 \longrightarrow \text{Al}^{3+} + 3\text{F}^-$   
 (ionic compound)  $2s^2 2p^6$  (octet complete)  $2s^2 2p^6$  (octet complete)
- (iv)  $\text{Cl} - \text{Be} \begin{matrix} \nearrow \text{Cl} \\ \nwarrow \text{Cl} \end{matrix} \text{Be} - \text{C}$  (Incomplete octet)  
 (incomplete octet)
- (v)  $\text{H} - \text{Be} \begin{matrix} \nearrow \text{H} \\ \nwarrow \text{H} \end{matrix} \text{Be} - \text{H}$  (Incomplete octet)  
 (3c - 2e<sup>-</sup>) bond



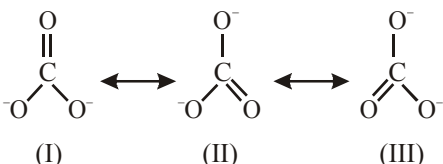
Total no. of valence electron around sulphur in  $\text{SO}_2$  is 10 while in case of other molecules total no. of 8 electrons are present in each.

27. (a) Boron in  $\text{BCl}_3$  has 6 electrons in outermost shell. Hence  $\text{BCl}_3$  is a electron deficient compound.
28. (b) The compounds in which octet of central atom is incomplete are known as electron deficient compounds. Hence  $\text{B}_2\text{H}_6$  is a electron deficient compound.
29. (a)  $\text{PCl}_5$  does not follow octet rule, it has 10 electrons in its valence shell.

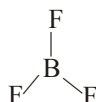
30. (a)
31. (c) Formation of positive ion involves removal of electron(s) from neutral atom and that of the negative ion involves addition of electron(s) to the neutral atom.
32. (b) Ionic bonds will be formed more easily between elements with comparatively low ionization enthalpies and elements with comparatively high negative value of electron gain enthalpy.
33. (a) In ionic solids, the sum of the electron gain enthalpy and the ionization enthalpy may be positive but still the crystal structure gets stabilized due to the energy released in the formation of the crystal lattice.
34. (d) Lattice enthalpy is required to completely separate one mole of a solid ionic compound into gaseous constituent ions.
35. (a) An ionic bond tightly held the two ions of opposite charges together, so it is a dipole. More is the electronegativity of anion higher will be the electron density and higher will be its charge which consequently increases the strength of ionic bond.
36. (c) Higher the difference in electronegativity between the two atoms, more will be electrovalent character of the bond. Among given choices, calcium and hydrogen have maximum difference in their electronegativities.
37. (b) For compounds containing cations of same charge, lattice energy increases as the size of the cation decrease. Thus,  $\text{NaF}$  has highest lattice energy. The size of cations is in the order  $\text{Na}^+ < \text{K}^+ < \text{Rb}^+ < \text{Cs}^+$
38. (b) Ionic character of a bond is directly proportional to the difference of electro negativities of bonded atoms. So,  $\text{H} - \text{F}$  in which electronegativity difference is highest, will have highest ionic character.
39. (b) The stability of the ionic bond depends upon the lattice energy which is expected to be more between  $\text{Mg}$  and  $\text{F}$  due to +2 charge on  $\text{Mg}$  atom.
40. (d) Bond lengths are measured by spectroscopic, X-ray diffraction and electron diffraction techniques.
41. (c) The covalent radius is measured approximately as the radius of an atom's core which is in contact with the core of an adjacent atom in a bonded situation.
42. (d) A = Covalent radius  
 B = van der Waal's radius  
 C = Bond length
43. (d) All of the given statements are correct.
44. (c) Bond order  $\propto$  bond enthalpy  $\propto \frac{1}{\text{bond length}}$
45. (c) In  $\text{CO}$  (three shared election pairs between C and O) the bond order is 3. For  $\text{N}_2$  bond order is 3 and its  $\Delta_g \text{H}^\ominus$  is  $946 \text{ kJ mol}^{-1}$ , being one of the highest for a diatomic molecule, isoelectronic molecularaes and ions have identical bond order for example  $\text{F}_2$  and  $\text{O}_2^{2-}$  have bond ordeer 1,  $\text{N}_2$ ,  $\text{CO}$  and  $\text{NO}^+$  have bond order 3.



46. (c) Both representation of resonating structures in molecules of  $\text{CO}_2$  and  $\text{CO}_3^{2-}$  are correct.
47. (c) I and II structure shown above constitute the canonical structure. III structure represents the structure of  $\text{O}_3$  more accurately. This is also called resonance hybrid.
48. (a) The molecule does not exist for a certain fraction of time in one canonical form and for other fractions of time in other canonical forms.
49. (b) There are three resonance structures of  $\text{CO}_3^{2-}$  ion.

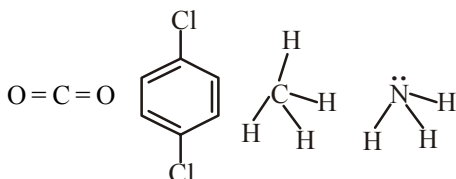


50. (d) Choices (a), (b) and (c) are the resonance structures of  $\text{CO}_2$ .
51. (b)      52. (b)
53. (b) Both  $\text{NO}_2$  and  $\text{O}_3$  have angular shape and hence will have net dipole moment.
54. (c) The dipole moment of symmetrical molecules is zero.



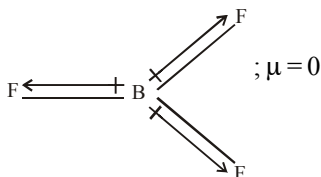
Triangular planar (symmetrical molecule)

55. (c) Dipole moment is a vector quantity, hence the dipole moment of symmetrical molecules is zero. As  $\text{CO}_2$ , *p*-dichlorobenzene and  $\text{CH}_4$  have regular symmetrical shape. Hence  $\mu = 0$



However,  $\text{NH}_3$  has distorted structure due to presence of lone pair of electrons on N atom and thus has definite dipole moment.

56. (a) In  $\text{H}_2$ , both atoms are identical, so the molecule is non polar.
57. (b)  $\text{BF}_3$  has planar and symmetrical structure thus as a result the resultant of two bond moments, being equal and opposite to the third, cancels out and hence molecule possess zero dipole moment.

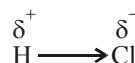


58. (c)  $\text{CCl}_4$  and  $\text{BF}_3$  being symmetrical have zero dipole moment.  $\text{H}_2\text{O}$ ,  $\text{CHCl}_3$  and  $\text{NH}_3$  have dipole moments of 1.84 D, 1.01 D and 1.46 D respectively. Thus among the given molecules  $\text{H}_2\text{O}$  has highest dipole moment.

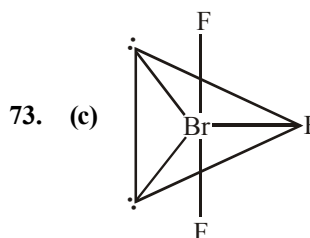
59. (b)  $\text{O}=\text{C}=\text{O}$
60. (a) The correct order of dipole moments of  $\text{HF}$ ,  $\text{H}_2\text{S}$  and  $\text{H}_2\text{O}$  is  $\text{HF} < \text{H}_2\text{S} < \text{H}_2\text{O}$
61. (a)  $\begin{matrix} \delta+ & \delta- \\ \text{C} & - & \text{F} \end{matrix}$   
Because difference between electronegativity of carbon and fluorine is highest.
62. (c) In case of  $\text{SF}_6$  resultant dipole moment is zero while all other possess dipole moment.

63. (c)
64. (c) According to Fajan's rule, smaller size and greater charge on cation favour the formation of partial covalent character in ionic bonds.
65. (c) As difference of electronegativity increases % ionic character increases and covalent character decreases i.e., electronegativity difference decreases covalent character increases.  
Further greater the charge on the cation and smaller the size more will be its polarising power. Hence covalent character increases.
66. (a) According to Fajan's rule, as the charge on the cation increases, and size decreases, its tendency to polarise the anion increases. This brings more and more covalent nature to electrovalent compounds. Hence  $\text{AlCl}_3$  shows maximum covalent character.
67. (d) In case of anions having same charge as the size of anion increases, polarisability of anion also increases.
68. (d) The electronegativity difference is maximum in  $\text{O}-\text{H}$  bond hence  $\text{O}-\text{H}$  bond length is the smallest among the given set.

69. (a) A gaseous  $\text{HCl}$  molecule has hydrogen and chlorine linked by a covalent bond. Here electronegativity of chlorine is greater than that of hydrogen. Due to this the shared pair of electron is more attracted towards chlorine. Thus, chlorine end of molecule has higher electron density and becomes slightly negative and the hydrogen and slightly positive. Hence the covalent bond in  $\text{HCl}$  has a polar character as shown below



70. (b) Hydrogen is non metal and non metal atoms form covalent bond.
71. (d)
72. (b) Hybridisation is  $\text{sp}^3$  and shape pyramidal.





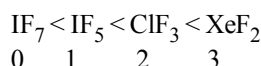
In  $\text{BrF}_3$ , both bond pairs as well as lone pairs of electrons are present. Due to the presence of lone pairs of electrons (lp) in the valence shell, the bond angle is contracted and the molecule takes the T-shape. This is due to greater repulsion between two lone pairs or between a lone pair and a bond pair than between the two bond pairs.

74. (a) The number of lone pairs of electrons on central atom in various given species are

**Species**      **Number of lone pairs on central atom**

$\text{IF}_7$	nil
$\text{IF}_5$	1
$\text{ClF}_3$	2
$\text{XeF}_2$	3

Thus the correct increasing order is



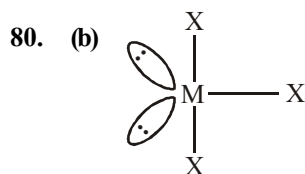
75. (d)  $\text{O}=\ddot{\text{S}}=\text{O}$   
lp = 1  
bp = 4

76. (a) V-shaped  $\text{H}_2\text{O}$  like structure.

77. (d)  $\text{BrF}_5$  has square pyramidal geometry.

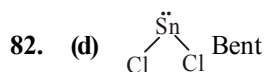
78. (b)  $\text{SO}_2$  — bent  
 $\text{SF}_4$  — see-saw  
 $\text{ClF}_3$  — T-shape  
 $\text{BrF}_5$  — square pyramidal  
 $\text{XeF}_4$  — square planar.

79. (a) I is the most stable geometry because both the lone pairs are present at equatorial position. Due to which repulsion is minimum in molecule as compared to the repulsion in other molecules where lone pair is in axial position.



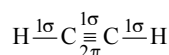
Number of lone pair = 2

81. (a) In methane molecule C is  $sp^3$  hybridised so its shape will be tetrahedral.

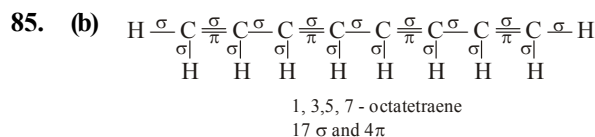


83. (b) The minimum in the energy curve corresponds to the most stable state of  $\text{H}_2$ .

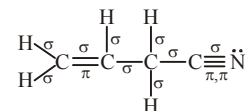
84. (d) Structure of acetylene molecule



Thus acetylene molecule has 3  $\sigma$  bonds and 2  $\pi$  bonds.

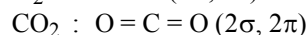
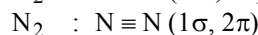
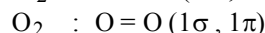


86. (b) Allyl cyanide is :

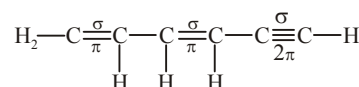


$\therefore$  It contains 9 sigma bonds, 3 pi bonds and 1 lone pair of electrons.

87. (a)  $\text{Cl}_2$  :  $\text{Cl}-\text{Cl}$  (1  $\sigma$ , No  $\pi$ )



88. (a) The given molecule is



The number of C—C ' $\sigma$ ' bonds = 5

The number of C—C ' $\pi$ ' bonds = 4

The number of C—C ' $\sigma$ ' bonds = 6



The overlap between s- and p-orbitals occurs along internuclear axis and hence the angle is  $180^\circ$ .

90. (a)  $\text{CH}_3-\ddot{\text{O}}-\text{H}$   
91. (a) Linear combination of two hybridized orbitals leads to the formation of sigma bond.

92. (b) Sigma bond is stronger than  $\pi$ -bond. The electrons in the  $\pi$  bond are loosely held. The bond is easily broken and is more reactive than  $\sigma$ -bond. Energy released during sigma bond formation is always more than  $\pi$  bond because of greater extent of overlapping

93. (c) Option (c) represents zero overlapping.  
94. (a) Bond angle increases with increase in s-character of hybridised orbital. The table given below shows the hybridised orbitals, their % s-character and bond angles.

Hybridised orbitals	% s-character	Bond angle
$sp^3$	25	$109.5^\circ$
$sp^2$	33	$120^\circ$
$sp$	50	$180^\circ$

95. (d) Promotion of electron is not an essential condition prior to hybridisation. It is not necessary that only half filled orbitals participate in hybridisation. In some cases, even filled orbitals of valence shell take part in hybridisation.

96. (d) The hybridisation in a molecule is given by

$$H = \frac{1}{2} [V + M - C + A] \quad \dots\dots(1)$$

where V = no. of valency  $e^-$  in central atom

M = no. of monovalent atoms around central atom

C = charge on cation, A = charge on anion

For  $\text{NH}_3$ ; V = 5, M = 3, C = 0, A = 0

Putting these values in (1), we get

$$H = \frac{1}{2} [5 + 3 - 0 + 0] = 4$$

For H = 4, the hybridisation in molecule is  $sp^3$ .

97. (d) Hybridisation of  $\text{SO}_4^{2-}$  ion is given by

$$H = \frac{1}{2} [V + M + A - C]$$

Where V = valency of central metal atom

M = no. of monovalent atoms surrounding central metal atom.

A = charge on anion, C = charge on cation

For  $\text{SO}_4^{2-}$ ; V = 6, M = 0, A = 2, C = 0

$$\therefore H = \frac{1}{2} [6 + 0 + 2 - 0] = 4$$

i.e.,  $sp^3$  hybridisation and tetrahedral shape.

98. (d) The strength of a bond depends upon the extent of overlapping. s-s and s-p overlapping results in the formation of  $\sigma$  bond but extent of overlapping along internuclear axis is more in case of s-s overlapping than in s-p. p-p overlapping may result in  $\sigma$  bond if overlapping takes place along internuclear axis or may result in  $\pi$ -bond if sideways overlapping takes place. In any case the extent of overlapping is lesser in p - p than that of the other two, s-s and s-p. Hence the correct order is

$$s - s > s - p > p - p.$$

99. (c) In case of Xenon compounds

Hybridization =  $\frac{1}{2} [\text{No. of valence electrons of Xe} + \text{number of monovalent atoms surrounding Xe} - \text{charge on cation} + \text{charge on anion}]$

In  $\text{XeF}_6$  =  $\frac{1}{2} [8 + 6 - 0 + 0] = 7$  i.e.  $sp^3d^3$  hybridization.

In case of  $\text{SF}_6$ , Sulphur is  $sp^3d^2$  hybridized.

In case of  $\text{BrF}_5$ , Bromine atom has seven valence electrons and 5 are contributed by the fluorine atoms.

$\therefore$  Total number of electron pairs in valence shell of central

$$\text{atom} = \frac{7 + 5}{2} = 6$$

Number of shared pairs = 5

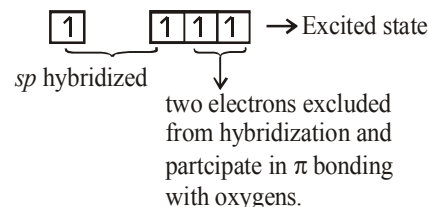
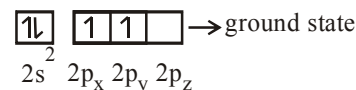
Number of lone pairs = 1

The molecule is **square pyramidal**.

In  $\text{PCl}_5$  P is  $sp^3d$  hybridised. i.e. the correct answer is  $\text{XeF}_6$  or option (c)

100. (a)  $\text{O} = \text{C} = \text{O}$

$$\text{C}(6) = 1s^2 2s^2 2p^2$$

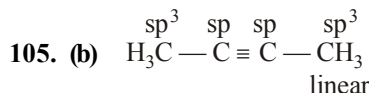


101. (b) In fullerene, carbons are  $sp^2$ -hybridised like graphite. Fullerenes are also the allotropes of carbon other than diamond and graphite but have been produced synthetically, e.g.;  $\text{C}_{60}$ .

102. (d) Ions having  $sp^3$  hybridisation contain hydrogen atoms at the corners of tetrahedron.

103. (a) For linear arrangement of atoms the hybridisation should be  $sp$  (linear shape,  $180^\circ$  angle). Only  $\text{H}_2\text{S}$  has  $sp^3$ -hybridization and hence has angular shape while  $\text{C}_2\text{H}_2$ ,  $\text{BeH}_2$  and  $\text{CO}_2$  all involve  $sp$ -hybridization and hence have linear arrangement of atoms.

104. (b)  $\text{BF}_3$  involves  $sp^2$ -hybridization.



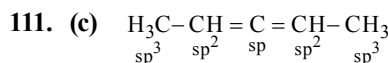
106. (b) Equilateral or triangular planar shape involves  $sp^2$  hybridization.

107. (a) Only those  $d$  orbitals whose lobes are directed along X, Y and Z directions hybridise with  $s$  and  $p$  orbitals. In other three  $d$  orbitals namely  $d_{xy}$ ,  $d_{yz}$  and  $d_{xz}$ , the lobes are at an angle of  $45^\circ$  from both axis, hence the extent of their overlap with  $s$  and  $p$  orbitals is much lesser than  $d_{x^2-y^2}$  and  $d_{z^2}$  orbitals.

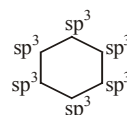
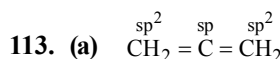
108. (a) According to VSEPR theory, trigonal bipyramidal geometry results from  $sp^3d$  or  $dsp^3$  hybridisation.  $dsp^2$  hybridisation results in square planar geometry, while  $d^2sp^3$  leads to octahedral shape.

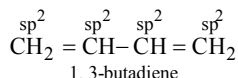
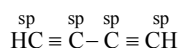
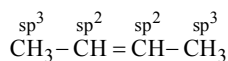
109. (b) In  $\text{CH}_3\text{CH}_2\text{OH}$  underlined C is forming 4  $\sigma$  bonds, hence  $sp^3$  hybridisation. In others it is  $sp^2$  hybridised (due to 3  $\sigma$  bonds).

110. (a) Each  $sp^3$ -hybrid orbital has 25% s-character and 75% p-character.



112. (d)





114. (d) Statement (d) is incorrect.
115. (c) Molecular orbital theory was given by Mulliken.
116. (b) Atomic orbital is monocentric because an electron in it is influenced by one nucleus. While molecular orbital is polycentric as it is influenced by two or more nuclei depending upon the number of atoms in the molecule.
117. (c)
118. (d) For oxygen correct increasing order is  $\sigma 1s < \sigma^* 1s < \sigma 2s < \sigma^* 2s < \sigma 2p_z < (\pi 2p_x = \pi 2p_y) < (\pi^* 2p_x = \pi^* 2p_y) < \sigma^* 2p_z$
119. (d)  $N_b < N_a$  or  $N_a = N_b$   
i.e., a negative or zero bond order corresponds to an unstable molecule.
120. (a) 121. (c)
122. (c) Paramagnetism of  $O_2$  is best explained by molecular orbital theory.
123. (b)
124. (b) One bonding M.O. and one anti-bonding M.O.
125. (d) Molecules having unpaired electrons show paramagnetism.
126. (c)
127. (c)  $N_2^+ = 7 + 7 - 1 = 13$  electrons  
Configuration is  $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2$   
 $= \pi 2p_y^2, \sigma 2p_z^1$   
Bond order =  $\frac{1}{2} (\text{No. of } e^- \text{ in bonding molecular orbital} - \text{No. of } e^- \text{ in antibonding molecular orbital})$   
 $= \frac{1}{2} (9 - 4) = \frac{1}{2} \times 5 = 2.5$
128. (a)
129. (a, b) The molecular orbital structures of  $C_2$  and  $N_2$  are  
 $N_2 = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \sigma 2p_z^2 \pi 2p_x^2 \pi 2p_y^2$   
 $C_2 = \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 \pi 2p_y^2$   
Both  $N_2$  and  $C_2$  have paired electrons, hence they are diamagnetic.

130. (d)  $H_2^+ : (\sigma 1s^1)$   
Bond order =  $\frac{1}{2} (1 - 0) = \frac{1}{2}$   
 $H_2^- : (\sigma 1s^2) (\sigma^* 1s^1)$   
Bond order =  $\frac{1}{2} (2 - 1) = \frac{1}{2}$   
The bond order of  $H_2^+$  and  $H_2^-$  are same but  $H_2^+$  is more stable than  $H_2^-$ . In  $H_2^-$  the antibonding orbital is filled with 1 electron so this causes instability.

131. (b) The removal of an electron from a diatomic molecule may increase the bond order as in the conversion  $O_2 (2) \longrightarrow O_2^+ (2.5)$  or decrease the bond order as in the conversion,  $N_2 (3.0) \longrightarrow N_2^+ (2.5)$ . As a result, the bond energy may increase or decrease. Thus, statement (b) is incorrect.

132. (b)  $O_2 : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2,$

$$\left\{ \begin{array}{l} \pi 2p_x^2 \\ \pi 2p_y^2 \end{array} \right\}, \left\{ \begin{array}{l} \pi^* 2p_x^1 \\ \pi^* 2p_y^1 \end{array} \right\}$$

$$\text{Bond order} = \frac{10 - 6}{2} = 2$$

(two unpaired electrons in antibonding molecular orbital)

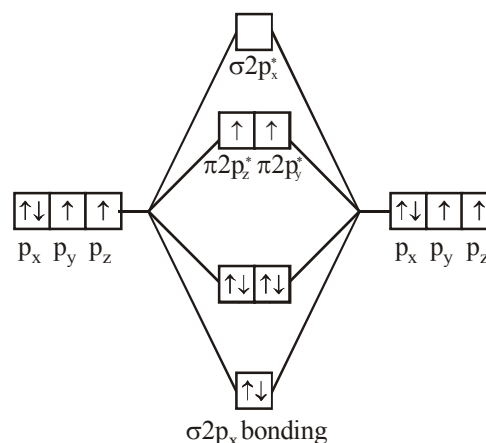
$$O_2^+ : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \left\{ \begin{array}{l} \pi 2p_x^2 \\ \pi 2p_y^2 \end{array} \right\}, \left\{ \begin{array}{l} \pi^* 2p_x^1 \\ \pi^* 2p_y^0 \end{array} \right\}$$

$$\text{Bond order} = \frac{10 - 5}{2} = 2.5$$

(One unpaired electron in antibonding molecular orbital)

Hence  $O_2$  as well as  $O_2^+$  both are paramagnetic, and bond order of  $O_2^+$  is greater than that of  $O_2$ .

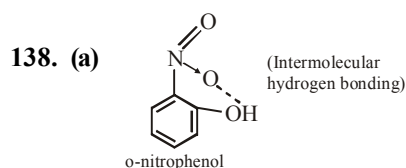
133. (c)
134. (c) Helium molecule does not exist as bond order of  $He_2 = 0$ .
135. (c) The paramagnetic property in oxygen came through unpaired electron which can be explained by molecular orbital theory.



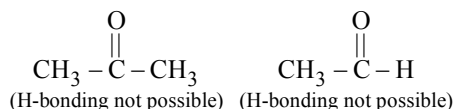
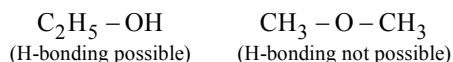
So 2 unpaired of electron present in  $\pi 2p_y^*$  and  $\pi 2p_z^*$

136. (c) H-bonding is maximum in the solid state and minimum in gaseous state.

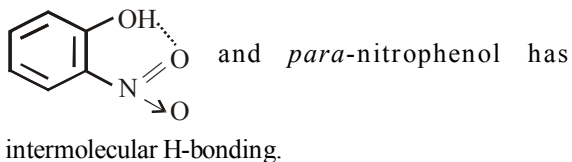
137. (c)  $\text{H}_2\text{O}$  shows intermolecular hydrogen bonding while o-nitrophenol shows intramolecular H-bonding.



139. (c) The b.p. of p-nitrophenol is higher than that of o-nitrophenol because in p-nitrophenol there is intermolecular H-bonding but in o-nitrophenol it is intramolecular H-bonding.
140. (b) The strength of the interactions follows the order vander Waal's < hydrogen – bonding < dipole-dipole < covalent.
141. (c) H–F shows strongest H-bonds due to high electronegativity of F atom.
142. (c) Ice has many hydrogen bonds which give rise to cage like structure of water molecules. This, structure possess larger volume and thus makes the density of ice low.
143. (b) Methanol and ethanol are soluble because of the hydrogen bonding.
144. (d)  $\text{F}—\text{H}—\text{F}$  bond is shortest, because with the increase of electronegativity and decrease in size of the atom to which hydrogen is linked, the strength of the hydrogen bond increases.
145. (a) Hydrogen bonding is possible only in compounds having hydrogen attached with F, O or N.



146. (c) *ortho*-Nitrophenol has intramolecular H-bonding



147. (d) Hydrogen bonding increases the boiling point of compound.
148. (b)
149. (a) Hydrogen bond is formed when hydrogen is attached with the atom which is highly electronegative and having small radius.

### STATEMENT TYPE QUESTIONS

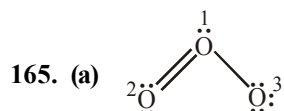
150. (c) The group valence of the elements is generally either equal to the number of dots in Lewis symbols or 8 minus the number of dots or valence electrons.

151. (d) The least electronegative atom occupies the central position in the molecule/ion.
152. (b) Formal charges do not indicate real charge separation within the molecule. Indicating the charges on the atoms in the Lewis structure only helps in keeping track of the valence electrons in the molecule.
153. (c) The greater the charge on the cation, the greater the covalent character of the ionic bond.
154. (d) Statement (c) and (d) are incorrect.
155. (b) (ii) (F) In general as the number of lone pair of electrons on central atom increases, value of bond angle from normal bond angle decreases due to  $\text{lp}—\text{lp} > \text{lp}—\text{bp}$ . (iv) (F) Structures of xenon fluorides and xenon oxyfluoride are explained on the basis of VSEPR theory. In  $\text{SOBr}_2$ , S – O bond has minimum bond length in comparison to S – O bond lengths in  $\text{SOF}_2$  and  $\text{SOCl}_2$ , because in  $\text{SOBr}_2$ , S – O bond has been formed by hybrid orbital containing less s-character.
156. (b) Atomic orbitals having same or nearly same energy will not combine if they do not have the same symmetry.  $2p_z$  orbital of one atom cannot combine with  $2p_x$  or  $2p_y$  orbital of other atom because of their different symmetries.

### MATCHING TYPE QUESTIONS

157. (c)  $\text{BeH}_2$  : Incomplete octet of central atom.  
Be has 2 valence electrons  
 $\text{SF}_6$  : Expanded octet  
There are 12 electrons around the S atom in  $\text{SF}_6$   
 $\text{NO}_2$  : Odd electron molecules.  
In molecules with an odd number of electrons like  $\text{NO}_2$ , the octet rule is not satisfied.
158. (c)
159. (b)  $\text{NH}_3 \rightarrow 1\text{lp}$ ,  $3\text{bp} \rightarrow$  Trigonal pyramidal  
 $\text{SO}_2 \rightarrow 1\text{lp}$ ,  $2\text{bp} \rightarrow$  Bent  
 $\text{SF}_4 \rightarrow 1\text{lp}$ ,  $4\text{bp} \rightarrow$  See-saw  
 $\text{ClF}_3 \rightarrow 2\text{lp}$ ,  $3\text{bp} \rightarrow$  T-shape
160. (c) Trigonal planar =  $\text{BF}_3$   
Tetrahedral =  $\text{NH}_4^+$   
Trigonal bipyramidal =  $\text{PCl}_5$   
Octahedral =  $\text{SF}_6$
161. (c)
162. (a)  $\text{SF}_6 \Rightarrow \text{sp}^3\text{d}^2$   
 $\text{PF}_5 \Rightarrow \text{sp}^3\text{d}$   
 $\text{BCl}_3 \Rightarrow \text{sp}^2$   
 $\text{C}_2\text{H}_6 \Rightarrow \text{sp}^3$
163. (c) Valence bond theory = Heitler and London  
Octet rule = Kössel and Lewis  
Molecular orbital theory = F. Hund and R.S. Mulliken  
VSEPR theory = Nyholm and Gillespie
164. (b)

ASSERTION-REASON TYPE QUESTIONS

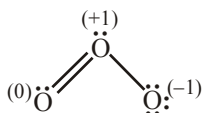


$$\text{Formal charge on } O_1 = 6 - 2 - \frac{1}{2}(6) = +1$$

$$\text{Formal charge on } O_2 = 6 - 4 - \frac{1}{2}(4) = 0$$

$$\text{Formal charge on } O_3 = 6 - 6 - \frac{1}{2} \times 3 = -1$$

Hence, correct representation of  $O_3$  is

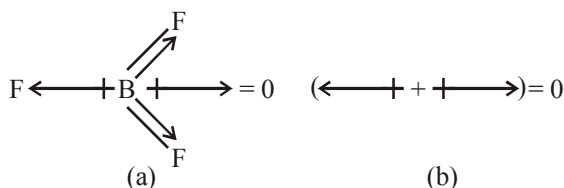


166. (a) Atoms combine either by transfer of valence electrons from one atom to another or by sharing of valence electrons to have an octet in their valence shell.

167. (d) Assertion is false but reason is true.  
The greater the lattice enthalpy, more stable is the ionic compound.

168. (c) Sulphur forms many compounds in which the octet rule is obeyed. For example  $SCl_2$  has an octet of electrons around it.

169. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.  
 $BF_3$  is  $sp^2$  hybridized. Dipole moment is a vector quantity. The three bond moments give a net sum of zero, as the resultant of any two is equal and opposite to the third.



170. (d) Assertion is false but reason is true.  
 $CH_2Cl_2$  is polar while  $CCl_4$  is non-polar because in  $CCl_4$  net dipole moment cancels.

171. (a) While the lone pairs are localised on the central atom, each bonded pair is shared between two atoms. As a result, the lone pair electrons in a molecule occupy more space as compared to the bonding pairs of electrons. This results in greater repulsion between lone pairs of electrons as compared to the lone pair - bond pair and bond pair - bond pair repulsions.

172. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

lone pair – lone pair repulsion > lone pair – bond pair repulsion > bond pair – bond pair repulsion. In the ammonia molecule,  $NH_3$  there are three bond pairs and one lone pair. The three N – H bond pairs are pushed closer because of the lone pair – bond pair repulsion, and HNH bond angle gets reduced from  $109^\circ 28'$  (the tetrahedral angle) to  $107^\circ$ .

173. (d) Assertion is false but reason is true.

$NH_3$  molecule is pyramidal in shape, because out of four electron pairs, three are bonding pairs and one is lone pair.

174. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

$\pi$  bonds are formed by the overlapping of p-p orbitals perpendicular to their axis i.e., sidewise overlap.

175. (a) Both assertion and reason are true and reason is the correct explanation of assertion.

Helium molecule is formed by linking two helium atoms. Both have 1s orbitals. These will combine to form two molecular orbitals  $\sigma(1s)$  and  $\sigma^*(1s)$ . Four available electrons are accommodated as  $\sigma(1s)^2$  and  $\sigma^*(1s)^2$ .

176. (c) The electron density in a bonding molecular orbital is located between the nuclei of the bonded atoms because of which the repulsion between the nuclei is very less while in case of an antibonding molecular orbital, most of the electron density is located away from the space between the nuclei.

Electrons placed in a bonding molecular orbital tend to hold the nuclei together and stabilise a molecule.

177. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

Water is excellent solvent because it has high value of dielectric constant. Due to high value of dielectric constant, the electrostatic force of attraction between the ions decrease and these ions get separated and ultimately get solvated by the solvent molecules.

CRITICAL THINKING TYPE QUESTIONS

178. (b) Hybridisation of the central atom in compound is given by

$$H = \frac{1}{2}[V + M - C + A]$$

where V = No. of valency electrons in central metal atom,

M = No. of monovalent atoms surrounding the central atom,

C = charge on cation and A = charge on anion

- For  $NO_2^-$ ,  $H = \frac{1}{2}[5 + 0 - 0 + 1] = 3$

$sp^2$  hybridisation

- For  $\text{SF}_4$ ,  $H = \frac{1}{2}[6 + 4 - 0 + 0] = 5$

$\text{sp}^3\text{d}$  hybridisation

- For  $\text{PF}_6^-$ ,  $H = \frac{1}{2}[5 + 6 - 0 + 1] = 6$
- $\text{sp}^3\text{d}^2$  hybridisation.

So, option (a) is correct choice.

179. (a)  $\text{BF}_3$  is  $\text{sp}^2$  hybridised. So, it is trigonal planar.  $\text{NH}_3$ ,  $\text{PCl}_3$  has  $\text{sp}^3$  hybridisation hence has trigonal bipyramidal shape,  $\text{IF}_3$ , has  $\text{sp}^3\text{d}$  hybridization and has linear shape.

180. (b)  $\text{XeF}_4$  hybridisation is  $= \frac{1}{2}(V + X - C + A)$

hence  $V = 8$  (no. of valence  $e^-$ )

$X = 4$  (no. of monovalent atom)

$$\frac{1}{2}(8 + 4 + 0 - 0) = 6 \quad \text{sp}^3\text{d}^2$$

$C = 0$  charge on cation

$A = 0$  (charge on anion). The shape is



square

planar shape.

181. (d) Hybridisation present in a molecule can be found out by the following formula.

$$H = \frac{1}{2}(V + M - C + A)$$

Where  $V$  = No. of electrons in valence shell of central atom

$M$  = No. of singly charged atoms

$C$  = charge on cation

$A$  = charge on anion

$$\text{So, Hybridisation (in } \text{ClF}_3) = \frac{1}{2}[7 + 3 - 0 + 0] = 5$$

$\Rightarrow \text{sp}^3\text{d}$  Hybridisation

182. (a)  $\text{CH}_2 = \text{CH} - \text{C} \equiv \text{N}$

3  $\sigma$  bonds ( $\text{sp}^2$  hybridisation); 2  $\sigma$  bonds ( $\text{sp}$  - hybridisation)

$C_1 = 3$   $\sigma$  bonds,  $C_2 = 3$   $\sigma$  bonds,

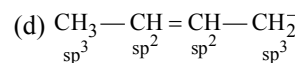
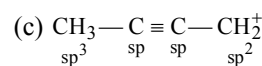
$C_3 = 2$   $\sigma$  bonds

183. (a) Hybridisation of carbon in  $\text{CH}_3^+$  is  $\text{sp}^2$  and in  $\text{CH}_4$  its hybridisation is  $\text{sp}^3$

184. (a)  $\text{XeF}_4$  having one lone pair of electron show distorted pentagonal bipyramidal shape and  $\text{sp}^3\text{d}^2$  hybridisation.

185. (c) (a)  $\text{CH}_2 = \text{C} = \text{CH}_2$

- (b)  $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_2^+$



**Note :** Carbocations and carboanions are  $\text{sp}^2$  and  $\text{sp}^3$  hybridised respectively.

186. (c) Let amount of compound = 100 g

$$\text{No. of moles of C} = \frac{92.3}{12} = 7.69 = 7.7$$

$$\text{No. of moles of H} = \frac{7.7}{1} = 7.7$$

Empirical formula =  $\text{CH}$

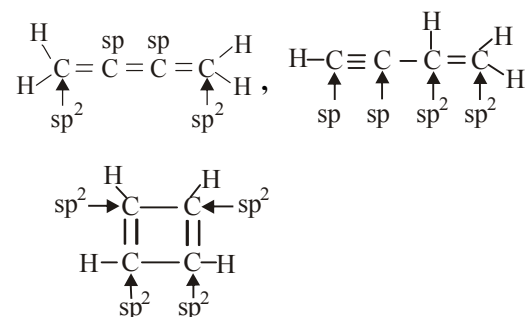
Empirical formula mass =  $12 + 1 = 13$  g/mol

Molecular mass = 52 g/mol

$$n = \frac{52}{13} = 4$$

$$\therefore \text{Molecular formula} = \text{Empirical formula} \times 4 = \text{C}_4\text{H}_4$$

Possible structures



187. (d) As the bond order decreases, bond length increases

Bond order

$$= \frac{\text{No. of bonding } e^-s - \text{No. of antibonding } e^-s}{2}$$

For  $\text{N}_2$ , electronic configuration is

$$\sigma 1s^2 < \sigma^* 1s^2 < \sigma 2s^2 < \sigma^* 2s^2 < (\pi 2p_x^2 = \pi 2p_y^2) < 2p_z^2$$

$$\text{(i) Bond order of } \text{N}_2 = \frac{10 - 4}{2} = 3$$

$$\text{(ii) Bond order of } \text{N}_2^+ = \frac{9 - 4}{2} = 2.5$$

$$\text{(iii) Bond order of } \text{N}_2^{2+} = \frac{8 - 4}{2} = 2$$

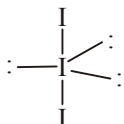
Hence, order of Bond length will be,

$$\text{N}_2 < \text{N}_2^+ < \text{N}_2^{2+}$$

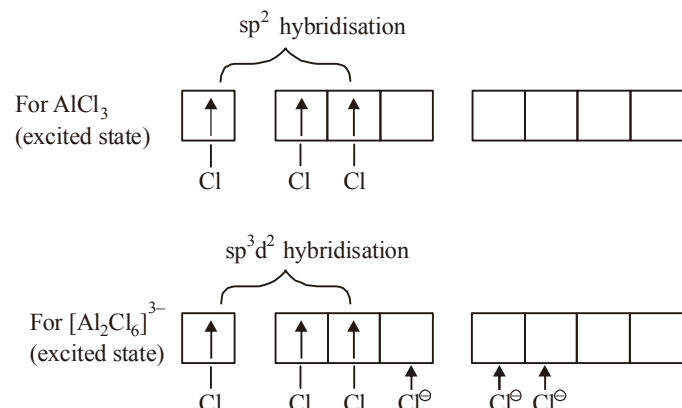
188. (c) According to molecular orbital theory, bond order of  $\text{Li}_2$  is 1, while in all other cases bond order is 0, so they do not exist.  $\text{Li}_2$  molecules are known to exist in the vapour phase.



189. (c)  $I_3^-$  has  $sp^3d$  hybridisation and has linear structure



190. (c)

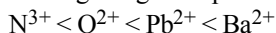


191. (b) Covalent radius is half of the distance between atoms in bonding state, while van der Waal radius is half of the distance between atoms in its non bonding state.

192. (d) According to Fajan's rule :

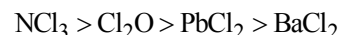
$$\text{Covalent character} \propto \frac{1}{\text{size of cation}} \propto \text{size of anion}$$

Among the given species order of size of cations



order of size of anions  $O^{2-} > Cl^-$ .

Hence the order of covalent character is

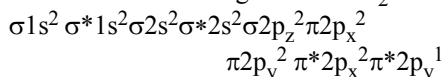


$BaCl_2$  is most ionic in nature.

193. (c) M.O. electronic configuration of  $CN^-$  is  $\sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_x^2 \pi 2p_y^2 \sigma 2p_z^2$

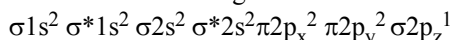
$$\therefore \text{B.O.} = \frac{10-4}{2} = 3$$

M.O. electronic configuration of  $O_2^-$  is



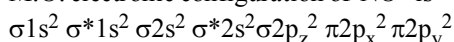
$$\therefore \text{B.O.} = \frac{10-7}{2} = 1.5$$

M.O. electronic configuration of  $CN^+$



$$\therefore \text{B.O.} = \frac{9-4}{2} = 2.5$$

M.O. electronic configuration of  $NO^+$  is



$$\therefore \text{B.O.} = \frac{10-4}{2} = 3$$

$\therefore CN^-$  and  $NO^+$  have bond order equal to 3

194. (d) On calculating bond order of species given in question

$$C_2 = 2 \quad C_2^{2-} = 3$$

$$B_2^+ = 0.5 \quad B_2 = 1$$

$$Li_2^+ = 0.5 \quad Li_2 = 1$$

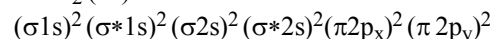
$$N_2^+ = 2.5 \quad N_2 = 3$$

$$O_2 = 2.0 \quad O_2^- = 1.5$$

$$\text{Bond length} \propto \frac{1}{\text{Bond order}}$$

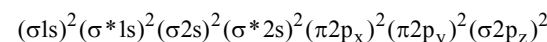
$$\therefore O_2^- > O_2$$

195. (b) For  $C_2$  (12):



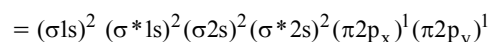
$$\text{B.O.} = \frac{8-4}{2} = 2$$

For  $N_2$  (14):



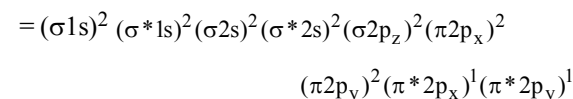
$$\therefore \text{B.O.} = \frac{10-4}{2} = 3$$

For  $B_2$  (10)



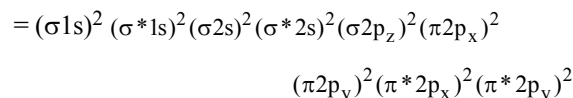
$$\therefore \text{B.O.} = \frac{6-4}{2} = 1$$

For  $O_2$  (16)



$$\therefore \text{B.O.} = \frac{10-6}{2} = 2$$

$F_2$  is (18)



$$\therefore \text{B.O.} = \frac{10-8}{2} = 1$$

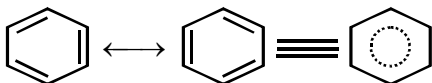
$\therefore N_2$  has the highest bond order = 3.

196. (c)  $\text{B.O.} = \frac{1}{2}[N_b - N_a] = 0$ ; cannot exist

197. (d) In this configuration, there are four completely filled bonding molecular orbitals and one completely filled antibonding molecular orbital. So that  $N_b = 8$  and  $N_a = 2$ .

$$\therefore \text{Bond order} = \frac{1}{2}(N_b - N_a) = \frac{1}{2}(8 - 2) = 3.$$

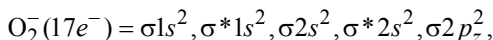
198. (c) Benzene has the following resonance structures—



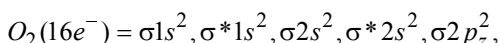
Hence, its bond order is

$$\frac{\text{no of possible resonating structures}}{2} = 1.5.$$

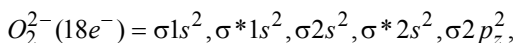
199. (a) Molecular orbital electronic configuration of these species are :



$$\pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^2$$



$$\pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1 = \pi^* 2p_y^1$$



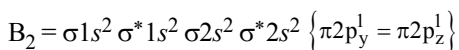
$$\pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^2 = \pi^* 2p_y^2$$

Hence number of antibonding electrons are 7, 6 and 8 respectively.

200. (d)  $\sigma_b^2 \sigma_a^{*2} \sigma_b^2 \sigma_a^{*2} (\pi_b^2 = \pi_a^2) \sigma_b^1 (N_2^+ = 13 \text{ electrons})$   
it contains one unpaired electron hence paramagnetic.

201. (N) None of the given option is correct.

The molecular orbital configuration of the given molecules is

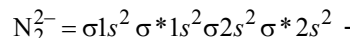


(4 anti-bonding electrons)

Though the bond order of all the species are same (B.O = 1) but stability is different. This is due to difference in the presence of no. of anti-bonding electron.

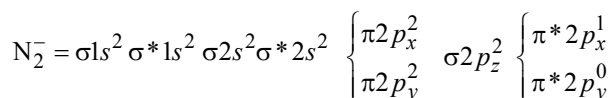
Higher the no. of anti-bonding electron lower is the stability hence the correct order is  $H_2 > Li_2 > B_2$

202. (a) Molecular orbital configuration of

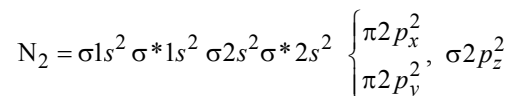


$$\left\{ \begin{array}{l} \pi 2p_x^2 \\ \pi 2p_y^2 \end{array} \right\} \sigma 2p_z^2 \left\{ \begin{array}{l} \pi^* 2p_x^1 \\ \pi^* 2p_y^1 \end{array} \right\}$$

$$\text{Bond order} = \frac{10-6}{2} = 2$$



$$\text{Bond order} = \frac{10-5}{2} = 2.5$$



$$\text{Bond order} = \frac{10-4}{2} = 3$$

$\therefore$  The correct order is  $N_2^{2-} < N_2^- < N_2$

203. (a) Hydrogen bonding is not possible in HI due to low electronegativity of iodine. So, hydrogen bonding would not affect boiling point of HI.

204. (d) HF form linear polymeric structure due to hydrogen bonding.

205. (c) B, C and D form intermolecular hydrogen bonding while A form intramolecular hydrogen bonding due to proximity of oxygen and hydrogen.



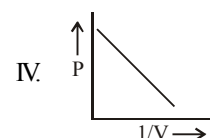
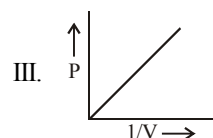
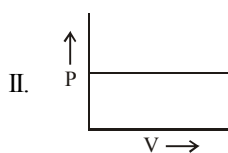
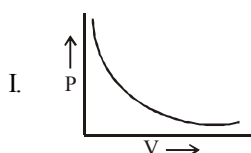
## CHAPTER 5

# STATES OF MATTER

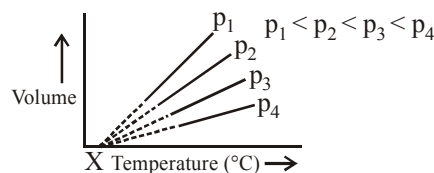
### FACT/DEFINITION TYPE QUESTIONS

- Which of the following is not a type of van der Waal's forces?
  - Dipole - dipole forces
  - Dipole - induced dipole forces
  - Ion - dipole forces
  - London forces
- Who proposed the concept of dispersion force ?
  - Heitler and London
  - van der Waal
  - Gay Lussac
  - Fritz London
- Which of the following option correctly represents the relation between interaction energy and distance between two interacting particles (r) for London forces ?
  - $\frac{1}{\sqrt{r}}$
  - $\frac{1}{r^6}$
  - $\frac{1}{r^{12}}$
  - $\frac{1}{r^3}$
- The interaction energy of London force is inversely proportional to sixth power of the distance between two interacting particles but their magnitude depends upon
  - charge of interacting particles
  - mass of interacting particles
  - polarisability of interacting particles
  - strength of permanent dipoles in the particles.
- London forces are always ...I... and interaction energy is inversely proportional to the ...II... power of the distance between two interacting particles.  
Here, I and II refer to
  - I → repulsive, II → sixth
  - I → attractive, II → fourth
  - I → attractive, II → sixth
  - I → repulsive, II → fourth
- Dipole-dipole forces act between the molecules possessing permanent dipole. Ends of dipoles possess 'partial charges'. The partial charge is
  - more than unit electronic charge
  - equal to unit electronic charge
  - less than unit electronic charge
  - double the unit electronic charge
- Dipole-dipole interaction is stronger than the London forces but is weaker than ion-ion interaction because
  - only partial charges are involved
  - only total charges are involved
  - both (a) and (b)
  - sometimes (a) and sometimes (b)
- Induced dipole moment depend upon the
  - dipole moment present in the permanent dipole.
  - polarisability of the electrically neutral molecules.
 Identify the correct option.
  - I is correct but II is wrong
  - I is wrong and II is correct
  - Both I and II are wrong
  - Both I and II are correct
- Dipole-induced dipole interactions are present in which of the following pairs :
  - $\text{Cl}_2$  and  $\text{CCl}_4$
  - $\text{HCl}$  and He atoms
  - $\text{SiF}_4$  and He atoms
  - $\text{H}_2\text{O}$  and alcohol
- Which of the following exhibits the weakest intermolecular forces ?
  - $\text{NH}_3$
  - $\text{HCl}$
  - He
  - $\text{H}_2\text{O}$
- Strength of the hydrogen bond is determined by interaction between the
  - lone pair of the electronegative atom and the hydrogen atom of other atom.
  - bond pair of the electronegative atom and the hydrogen atom of other atom.
 Identify the correct option.
  - Only I is correct
  - Only II is correct
  - Both I and II are correct
  - Neither I nor II are correct

12. Which of the following statements regarding thermal energy is correct?
- Thermal energy is the measure of average kinetic energy of the particles of the matter and is thus responsible for movement of particles.
  - Intermolecular forces tend to keep the molecules together but thermal energy of the molecules tends to keep them apart.
  - Three states of matter are the result of balance between intermolecular forces and the thermal energy of the molecules.
  - All of the above
13. Which of the following is the correct order of thermal energy in three states of matter ?
- Solid < Liquid < Gas
  - Liquid < Gas < Solid
  - Liquid < Solid < Gas
  - Gas < Solid < Liquid
14. Which of the following are arrangement in the correct order?
- Gas > Liquid > Solid (Thermal energy)
  - Solid > Liquid > Gas (Intermolecular force)
- Select the correct option.
- I only
  - II only
  - Both I and II
  - None of these
15. Which one of the following statements is not correct about the three states of matter i.e., solid, liquid and gaseous ?
- Molecules of a solid possess least energy whereas those of a gas possess highest energy.
  - The density of solid is highest whereas that of gases is lowest
  - Gases like liquids possess definite volumes
  - Molecules of a solid possess vibratory motion
16. Which of the following is true about gaseous state ?
- Thermal energy = Molecular attraction
  - Thermal energy >>> Molecular attraction
  - Thermal energy <<< Molecular attraction
  - Molecular force >>> Those in liquids
17. The first reliable measurement on properties of gases was made by \_\_\_\_\_
- Gay Lussac
  - Jacques charles
  - Robert Boyle
  - Avogadro
18. At constant temperature, for a given mass of an ideal gas
- the ratio of pressure and volume always remains constant.
  - volume always remains constant.
  - pressure always remains constant.
  - the product of pressure and volume always remains constant.
19. Which of following graph(s) represents Boyle's law



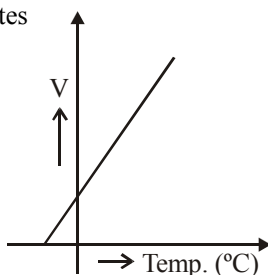
- Only I
  - II and IV
  - I and III
  - Only III
20. Which of the following represents Boyle's law in terms of density ?
- $d \cdot p = k'$
  - $\frac{d}{p} = k'$
  - $\frac{dp}{2} = k'$
  - $d = k' \sqrt{p}$
- (Here d = density, p = pressure, k' = constant)
21. Boyle's law states that the
- pressure of a gas is directly proportional to the temperature at constant volume
  - pressure of a gas is inversely proportional the volume at constant temperature
  - volume is directly proportional to the temperature at constant pressure
  - None of the above
22. 600 c.c. of a gas at a pressure of 750 mm of Hg is compressed to 500 c.c. Taking the temperature to remain constant, the increase in pressure, is
- 150 mm of Hg
  - 250 mm of Hg
  - 350 mm of Hg
  - 450 mm of Hg
23. The lowest hypothetical or imaginary temperature at which gases are supposed to occupy zero volume is called \_\_\_\_\_
- Kelvin temperature
  - absolute zero
  - Charle's temperature
  - constant temperature
24. 500 ml of nitrogen at 27°C is cooled to -5°C at the same pressure. The new volume becomes
- 326.32 ml
  - 446.66 ml
  - 546.32 ml
  - 771.56 ml
25. What is the value of X in °C for given volume vs temperature curve ?



- 0°C
  - 273.15°C
  - 273.15°C
  - 300°C
26. Which of the following expression at constant pressure represents Charle's law?
- $V \propto \frac{1}{T}$
  - $V \propto \frac{1}{T^2}$
  - $V \propto T$
  - $V \propto d$

27. The following graph illustrates

- (a) Dalton's law
- (b) Charle's law
- (c) Boyle's law
- (d) Gay-Lussac's law



28. Air at sea level is dense. This is a practical application of

- (a) Boyle's law
- (b) Charle's law
- (c) Kelvin's law
- (d) Brown's law

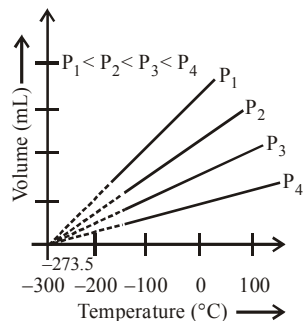
29. Use of hot air balloons in sports and meteorological observations is an application of

- (a) Boyle's law
- (b) Charle's law
- (c) Kelvin's law
- (d) Gay-Lussac's law

30. An ideal gas will have maximum density when

- (a)  $P = 0.5 \text{ atm}$ ,  $T = 600 \text{ K}$
- (b)  $P = 2 \text{ atm}$ ,  $T = 150 \text{ K}$
- (c)  $P = 1 \text{ atm}$ ,  $T = 300 \text{ K}$
- (d)  $P = 1 \text{ atm}$ ,  $T = 500 \text{ K}$

31.



Arrange the pressures  $P_1$ ,  $P_2$ ,  $P_3$  and  $P_4$  in the increasing order which are shown in the graphs.

- (a)  $P_1 < P_2 < P_3 < P_4$
- (b)  $P_4 < P_3 < P_2 < P_1$
- (c)  $P_1 = P_2 = P_3 = P_4$
- (d)  $P_4 = P_3 < P_2 = P_1$

32. On a ship sailing in pacific ocean where temperature is  $23.4^\circ\text{C}$ , a balloon is filled with 2 L air. What will be the volume of the balloon when the ship reaches Indian ocean, where temperature is  $26.1^\circ\text{C}$ ?

- (a) 2.018 L
- (b) 2.8 L
- (c) 3.5 L
- (d) 1.5 L

33. Which of the following represents Gay Lussac's law ?

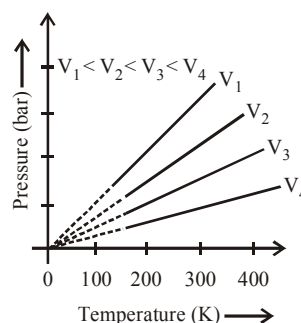
- I.  $\frac{P}{T} = \text{constant}$
- II.  $P_1 T_2 = P_2 T_1$

III.  $P_1 V_1 = P_2 V_2$

Choose the correct option.

- (a) I, II and III
- (b) II and III
- (c) I and III
- (d) I and II

34.



The relationship which is shown in the figure is derived from

- I. Boyle's law.
- II. Avogadro law.
- III. Charles' law.

Which of the following is the correct option ?

- (a) I and II
- (b) II and III
- (c) I and III
- (d) Only I

35. Which of the following represents Avogadro law ?

- (a)  $V = kn$
- (b)  $V = k \frac{m}{M}$
- (c)  $M = kd$
- (d) All of these

36. At STP molar volume of an ideal gas or a combination of ideal gases is \_\_\_\_\_

- (a)  $22.71098 \text{ L mol}^{-1}$
- (b)  $20.71098 \text{ L mol}^{-1}$
- (c)  $22.4139 \text{ L mol}^{-1}$
- (d)  $24.78 \text{ L mol}^{-1}$

37. 4.4 g of a gas at STP occupies a volume of 2.24 L, the gas can be

- (a)  $\text{O}_2$
- (b)  $\text{CO}$
- (c)  $\text{NO}_2$
- (d)  $\text{CO}_2$

38. An ideal gas is one which obeys the gas laws under

- (a) a few selected experimental conditions
- (b) all experimental conditions
- (c) low pressure alone
- (d) high temperature alone

39. For an ideal gas, number of moles per litre in terms of its pressure  $P$ , gas constant  $R$  and temperature  $T$  is

- (a)  $\frac{PT}{R}$
- (b)  $\frac{PRT}{T}$
- (c)  $\frac{P}{RT}$
- (d)  $\frac{RT}{P}$

40. Select one correct statement. In the gas equation,  $PV = nRT$

- (a)  $n$  is the number of molecules of a gas
- (b)  $V$  denotes volume of one mole of the gas
- (c)  $n$  moles of the gas have a volume  $V$
- (d)  $P$  is the pressure of the gas when only one mole of gas is present.

41. Correct gas equation is

- (a)  $\frac{V_1 T_2}{P_1} = \frac{V_2 T_1}{P_2}$
- (b)  $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
- (c)  $\frac{P_1 T_2}{V_1} = \frac{P_2 V_2}{T_2}$
- (d)  $\frac{V_1 V_2}{T_1 T_2} = R P_1 P_2$

42. The correct value of the gas constant 'R' is close to :  
 (a) 0.082 litre-atmosphere K  
 (b) 0.082 litre-atmosphere K<sup>-1</sup> mol<sup>-1</sup>  
 (c) 0.082 litre – atmosphere<sup>-1</sup> K mol<sup>-1</sup>  
 (d) 0.082 litre<sup>-1</sup> atmosphere<sup>-1</sup> K mol
43. If  $P$ ,  $V$ ,  $M$ ,  $T$  and  $R$  are pressure, volume, molar mass, temperature and gas constant respectively, then for an ideal gas, the density is given by  
 (a)  $\frac{RT}{PM}$  (b)  $\frac{P}{RT}$   
 (c)  $\frac{M}{V}$  (d)  $\frac{PM}{RT}$
44. Pure hydrogen sulphide is stored in a tank of 100 litre capacity at 20° C and 2 atm pressure. The mass of the gas will be  
 (a) 34 g (b) 340 g  
 (c) 282.68 g (d) 28.24 g
45. At N.T.P the volume of a gas is found to be 273 ml. What will be the volume of this gas at 600 mm of Hg and 273°C?  
 (a) 391.8ml (b) 380ml  
 (c) 691.6ml (d) 750ml
46. Pressure of a mixture of 4 g of O<sub>2</sub> and 2 g of H<sub>2</sub> confined in a bulb of 1 litre at 0°C is  
 (a) 25.215 atm (b) 31.205 atm  
 (c) 45.215 atm (d) 15.210 atm
47. Gas equation  $PV = nRT$  is obeyed by  
 (a) Only isothermal process  
 (b) Only adiabatic process  
 (c) Both (a) and (b)  
 (d) None of these
48. The total pressure of a mixture of two gases is :  
 (a) the sum of the partial pressures  
 (b) the difference between the partial pressures  
 (c) the product of the partial pressures  
 (d) the ratio of the partial pressures
49. If three unreactive gases having partial pressures  $P_A$ ,  $P_B$  and  $P_C$  and their moles are 1, 2 and 3 respectively then their total pressure will be  
 (a)  $P = P_A + P_B + P_C$  (b)  $P = \frac{P_A + P_B + P_C}{6}$   
 (c)  $P = \frac{\sqrt{P_A + P_B + P_C}}{3}$  (d) None of these
50. Dalton's law of partial pressure will not apply to which of the following mixture of gases  
 (a) H<sub>2</sub> and SO<sub>2</sub> (b) H<sub>2</sub> and Cl<sub>2</sub>  
 (c) H<sub>2</sub> and CO<sub>2</sub> (d) CO<sub>2</sub> and Cl<sub>2</sub>
51. Pressure exerted by saturated water vapour is called  
 (a) Aqueous tension (b) Partial pressure  
 (c) Total pressure (d) Both (a) and (b)
52. The pressure exerted by 6.0g of methane gas in a 0.03 m<sup>3</sup> vessel at 129°C is (Atomic masses : C = 12.01, H = 1.01 and  $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$ )  
 (a) 31684 Pa (b) 215216 Pa  
 (c) 13409 Pa (d) 41648 Pa
53. A gaseous mixture was prepared by taking equal mole of CO and N<sub>2</sub>. If the total pressure of the mixture was found 1 atmosphere, the partial pressure of the nitrogen (N<sub>2</sub>) in the mixture is  
 (a) 0.5 atm (b) 0.8 atm  
 (c) 0.9 atm (d) 1 atm
54. A bubble of air is underwater at temperature 15°C and the pressure 1.5 bar. If the bubble rises to the surface where the temperature is 25°C and the pressure is 1.0 bar, what will happen to the volume of the bubble ?  
 (a) Volume will become greater by a factor of 1.6.  
 (b) Volume will become greater by a factor of 1.1.  
 (c) Volume will become smaller by a factor of 0.70.  
 (d) Volume will become greater by a factor of 2.5.
55. A mixture contains 64 g of dioxygen and 60 g of neon at a total pressure of 10 bar. The partial pressures in bar of dioxygen and neon are respectively (atomic masses O = 16, Ne = 20)  
 (a) 4 and 6 (b) 6 and 4  
 (c) 5 and 5 (d) 8 and 2
56. 500 mL of air at 760 mm pressure were compressed to 200 mL. If the temperature remains constant, what will be the pressure after compression?  
 (a) 1800 mm (b) 1900 mm  
 (c) 2000 mm (d) 1500 mm
57. Value of universal gas constant (R) depends upon  
 (a) Number of moles of gas  
 (b) Volume of gas  
 (c) Temperature of gas  
 (d) None of these
58. Two vessels of volumes 16.4 L and 5 L contain two ideal gases of molecular existence at the respective temperature of 27°C and 227°C and exert 1.5 and 4.1 atmospheres respectively. The ratio of the number of molecules of the former to that of the later is  
 (a) 2 (b) 1  
 (c)  $\frac{1}{2}$  (d)  $\frac{1}{3}$
59. 56 g of nitrogen and 96 g of oxygen are mixed isothermally and at a total pressure of 10 atm. The partial pressures of oxygen and nitrogen (in atm) are respectively  
 (a) 4, 6 (b) 5, 5  
 (c) 2, 8 (d) 6, 4
60. If 10<sup>-4</sup> dm<sup>3</sup> of water is introduced into a 1.0 dm<sup>3</sup> flask at 300 K, how many moles of water are in the vapour phase when equilibrium is established ?  
 (Given : Vapour pressure of H<sub>2</sub>O at 300 K is 3170 Pa;  $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$ )  
 (a)  $5.56 \times 10^{-3} \text{ mol}$  (b)  $1.53 \times 10^{-2} \text{ mol}$   
 (c)  $4.46 \times 10^{-2} \text{ mol}$  (d)  $1.27 \times 10^{-3} \text{ mol}$



61. The total pressure of a mixture of two gases is  
(a) the sum of the partial pressures  
(b) the difference between the partial pressures  
(c) the product of the partial pressures  
(d) the ratio of the partial pressures
62. Ideal gas equation is the combination of  
I. Boyle's law  
II. Charles's law  
III. Avogadro law  
IV. Dalton's law of partial pressure  
Choose the correct option.  
(a) Only I and II (b) I, II and III  
(c) II and III (d) I, III and IV
63. According to the kinetic theory of gases, in an ideal gas, between two successive collisions a gas molecule travels  
(a) in a wavy path  
(b) in a straight line path  
(c) with an accelerated velocity  
(d) in a circular path
64. Gases consist of large number of identical particles (atoms or molecules) that are so small and so far apart on the average that the actual volume of the molecules is negligible in comparison to the empty space between them.  
Above given statement explain which property of gases ?  
(a) Gases occupy all the space available to them.  
(b) Gases has fixed shape.  
(c) Compressibility of gases.  
(d) None of these.
65. If there were loss of kinetic energy, the motion of gas molecules will \_\_\_\_\_ A \_\_\_\_\_ and gas will \_\_\_\_\_ B \_\_\_\_\_.  
(a) A = increase, B = collide  
(b) A = stop, B = settle down  
(c) A = increase, B = exert more pressure on walls of container  
(d) A = decrease, B = get liquified
66. Which of the following assumption of kinetic molecular theory states that gases do not have fixed shape ?  
(a) Particles of a gas move in all possible directions in straight line.  
(b) Particles of a gas are always in constant and random motion.  
(c) Total energy of molecules before and after the collision remains same.  
(d) None of these
67. Which of the following assumption of kinetic theory if hold good than the pressure vs volume graph of experimental data (real gas) and that of theoretically calculated from Boyle's law (ideal gas) should coincide ?  
(i) There is no force of attraction between the molecules of a gas.  
(ii) Volume of the molecules of a gas is negligibly small in comparison to the space occupied by the gas.  
(a) (i) only (b) (ii) only  
(c) Both (i) and (ii) (d) None of these
68. Kinetic theory of gases proves  
(a) only Boyle's law (b) only Charles' law  
(c) only Avogadro's law (d) All of these
69. Which one of the following is the wrong assumption of kinetic theory of gases ?  
(a) Momentum and energy always remain conserved.  
(b) Pressure is the result of elastic collision of molecules with the container's wall.  
(c) Molecules are separated by great distances compared to their sizes.  
(d) All the molecules move in straight line between collision and with same velocity.
70. When is deviation more in the behaviour of a gas from the ideal gas equation  $PV = nRT$  ?  
(a) At high temperature and low pressure  
(b) At low temperature and high pressure  
(c) At high temperature and high pressure  
(d) At low temperature and low pressure
71. In van der Waal's equation of state of the gas law, the constant 'b' is a measure of  
(a) volume occupied by the molecules  
(b) intermolecular attraction  
(c) intermolecular repulsions  
(d) intermolecular collisions per unit volume
72. In van der Waal's equation of state for a non-ideal gas, the term that accounts for intermolecular forces is  
(a)  $(V - b)$  (b)  $RT$   
(c)  $\left(P + \frac{a}{V^2}\right)$  (d)  $(RT)^{-1}$
73. The values of van der Waal's constant 'a' for the gases  $O_2$ ,  $N_2$ ,  $NH_3$  and  $CH_4$  are 1.360, 1.390, 4.170 and 2.253  $L^2 \text{ atm mol}^{-2}$  respectively. The gas which can most easily be liquified is  
(a)  $O_2$  (b)  $N_2$   
(c)  $NH_3$  (d)  $CH_4$
74. A gas described by van der Waal's equation  
(i) behaves similar to an ideal gas in the limit of large molar volume  
(ii) behaves similar to an ideal gas in the limit of large pressure  
(iii) is characterised by van der Waal's coefficients that are dependent on the identity of the gas but are independent of the temperature  
(iv) has the pressure that is lower than the pressure exerted by the same gas behaving ideally  
(a) (i) and (ii) (b) (i) and (iii)  
(c) (i), (ii) and (iii) (d) (ii) and (iv)
75. The units of constant 'a' in van der Waal's equation is  
(a)  $\text{dm}^6 \text{ atm mol}^{-2}$  (b)  $\text{dm}^3 \text{ atm mol}^{-1}$   
(c)  $\text{dm atm mol}^{-1}$  (d)  $\text{atm mol}^{-1}$
76. The van der Waal's constant 'a' for four gases P, Q, R and S are 4.17, 3.59, 6.71 and 3.8  $\text{atm L}^2 \text{ mol}^{-2}$  respectively. Therefore, the ascending order of their liquefaction is  
(a)  $R < P < S < Q$  (b)  $Q < S < R < P$   
(c)  $Q < S < P < R$  (d)  $R < P < Q < S$

77. At low pressure the van der Waal's equation is reduced to

(a)  $Z = \frac{pV_m}{RT} = 1 - \frac{ap}{RT}$  (b)  $Z = \frac{pV_m}{RT} = 1 + \frac{b}{RT}p$

(c)  $pV_m = RT$  (d)  $Z = \frac{pV_m}{RT} = 1 - \frac{a}{RT}$

78. The compressibility factor for a real gas at high pressure is :

(a)  $1 + \frac{RT}{pb}$  (b) 1

(c)  $1 + \frac{pb}{RT}$  (d)  $1 - \frac{pb}{RT}$

79. The gas with the highest critical temperature is

- (a)  $H_2$  (b) He  
(c)  $N_2$  (d)  $CO_2$

80. A gas is said to behave like an ideal gas when the relation  $PV/T = \text{constant}$ . When do you expect a real gas to behave like an ideal gas ?

- (a) When the temperature is low  
(b) When both the temperature and pressure are low  
(c) When both the temperature and pressure are high  
(d) When the temperature is high and pressure is low

81. An ideal gas can't be liquefied because

- (a) its critical temperature is always above  $0^\circ C$   
(b) Its molecules are relatively smaller in size  
(c) it solidifies before becoming a liquid  
(d) forces between its molecules are negligible

82. Gases possess characteristic critical temperature which depends upon the magnitude of intermolecular forces between the particles. Following are the critical temperature of some gases.

Gases	$H_2$	He	$O_2$	$N_2$
Critical temperature in Kelvin	33.2	5.3	154.3	126

From the above data what would be the order of liquefaction of these gases ?

Start writing the order from the gas liquefying first

- (a)  $H_2, He, O_2, N_2$  (b) He,  $O_2, H_2, N_2$   
(c)  $N_2, O_2, He, H_2$  (d)  $O_2, N_2, H_2, He$

83. Above Boyle point, real gases show \_\_\_\_\_ X \_\_\_\_\_ from ideality and Z values are \_\_\_\_\_ Y \_\_\_\_\_ than one.

- (a) X = Negative deviation, Y = Less  
(b) X = Negative deviation, Y = Greater  
(c) X = Positive deviation, Y = Less  
(d) X = Positive deviation, Y = Greater

84. Select the one that when used would be considered as best condition for liquefaction of a gas.

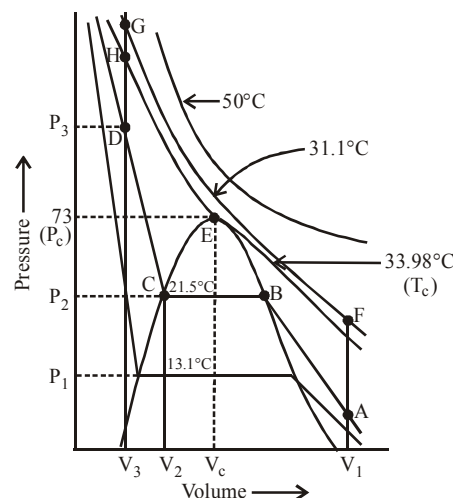
- (a) Increasing the temperature.  
(b) Decreasing the pressure.  
(c) Increasing the pressure and decreasing the temperature.  
(d) Decreasing the pressure and increasing the temperature.

85. Following table represents critical temperature of some gases. Arrange these gases in their increasing order of liquifaction.

Gas	$T_c / K$
$H_2$	33.2
He	5.3
$N_2$	126
$O_2$	154.3

- (a)  $He < N_2 < H_2 < O_2$  (b)  $H_2 < He < N_2 < O_2$   
(c)  $He < H_2 < N_2 < O_2$  (d)  $O_2 < N_2 < H_2 < He$

86. Choose the correct statement based on the following isotherms of carbon dioxide at various temperature.



- (i) We can move from point A to F vertically by increasing the temperature.  
(ii) We can reach the point G by compressing the gas at constant temperature.  
(iii) We can move down from G towards D by increasing the temperature.  
(iv) As soon as we cross the point D on the critical isotherm we get liquid.

- (a) (i) and (ii) (b) (i), (ii) and (iii)  
(c) (i), (ii) and (iv) (d) (i), (ii), (iii) and (iv)

87. At 1 atm pressure boiling temperature is called \_\_\_\_\_ X \_\_\_\_\_. If pressure is 1 bar then the boiling point is called \_\_\_\_\_ Y \_\_\_\_\_ of the liquid.

- (a) X = Standard boiling point, Y = Normal boiling point  
(b) X = Normal boiling point, Y = Standard boiling point  
(c) X = Critical boiling point, Y = Normal boiling point  
(d) X = Critical boiling point, Y = Standard boiling point

88. Which of the following statement is incorrect ?

- (a) Standard boiling point of liquid is slightly lower than the normal boiling point.  
(b) 1 atm pressure is slightly less than 1 bar pressure  
(c) The normal boiling point of water is  $100^\circ C$  and its standard boiling point is  $99.6^\circ C$   
(d) None of the above

89. A liquid can exist only  
 (a) between triple point and critical temperature  
 (b) at any temperature above the melting point  
 (c) between melting point and critical temperature  
 (d) between boiling and melting temperature
90. The kinetic energy of molecules in gaseous state is  
 (a) more than those in the liquid state  
 (b) less than those in the liquid state  
 (c) equal to those in the liquid state  
 (d) less than those in solid state
91. A pin or a needle floats on the surface of water, the reason for this is  
 (a) surface tension (b) less weight  
 (c) upthrust of liquid (d) None of the above
92. The spherical shape of rain-drop is due to  
 (a) density of the liquid (b) surface tension  
 (c) atmospheric pressure (d) gravity
93. Which of the following phenomena is caused by surface tension ?  
 (a) Particles at the bottom of river remain separated but they stick together when taken out.  
 (b) A liquid rise in a thin capillary.  
 (c) Small drops of mercury from spherical bead instead of spreading on the surface.  
 (d) All of the above
94. A drop of oil is placed on the surface of water. Which of the following statement is correct ?  
 (a) It will remain on it as a sphere  
 (b) It will spread as a thin layer  
 (c) It will be partly as spherical droplets and partly as thin film  
 (d) It will float as a distorted drop on the water surface
95. When the temperature increases, the viscosity of  
 (a) gases decreases and viscosity of liquids increases  
 (b) gases increases and viscosity of liquids decreases  
 (c) gases and liquids increases  
 (d) gases and liquids decreases
96. The surface tension of which of the following liquid is maximum?  
 (a)  $C_2H_5OH$  (b)  $CH_3OH$   
 (c)  $H_2O$  (d)  $C_6H_6$
97. In which phenomena water changes into water vapour below its B.P. ?  
 (a) Evaporation (b) Condensation  
 (c) Boiling (d) No such phenomena exist
98. The liquid which has the highest rate of evaporation is  
 (a) petrol (b) nail-polish remover  
 (c) water (d) alcohol

99. The correct order of viscosity of the following liquids will be  
 (a) Water < methyl alcohol < dimethyl ether < glycerol  
 (b) methyl alcohol < glycerol < water < dimethyl ether  
 (c) dimethyl ether < methyl alcohol < water < glycerol  
 (d) glycerol < dimethyl ether < water < methyl alcohol

### STATEMENT TYPE QUESTIONS

100. Which of the following statement(s) is/are true for London force ?  
 (i) These forces are always attractive.  
 (ii) These forces are important for long distance too.  
 (iii) Their magnitude depends on the polarisability of the particle.  
 (a) (i) and (ii) (b) (i) only  
 (c) (iii) only (d) (i) and (iii)
101. Choose the correct sequence of T and F for following statements. Here T stands for true and F stands for false statement.  
 (i) Dipole - dipole forces act between the molecules possessing permanent dipole.  
 (ii) Partial charge possessed by these dipoles is always equal to unit electronic charge.  
 (iii) Dipole - dipole interaction is weaker than London forces and ion - ion interaction.  
 (a) TTF (b) TFF  
 (c) TTT (d) TFT
102. Which of the following statements are correct ?  
 (i) Hydrogen bonding is a special case of dipole - dipole interaction.  
 (ii) Energy of hydrogen bond varies between 10 to 100 kJ mol<sup>-1</sup>.  
 (iii) Hydrogen bonds are powerful force in determining the structure and properties of compounds like proteins, nucleic acids etc.  
 (iv) Strength of the hydrogen bond is determined by the coulombic interaction between the lone-pair electrons of the electronegative atom of one molecule and the hydrogen atom of other molecule.  
 (a) (i) and (ii) (b) (i), (ii) and (iii)  
 (c) (ii), (iii) and (iv) (d) All of these
103. Which of the following statements are correct regarding the characteristic of gases ?  
 (i) Gases are highly compressible.  
 (ii) Gases exert pressure equally in all directions.  
 (iii) Gases have much higher density than the solids and liquids.  
 (iv) Gases mix evenly and completely in all proportion without any mechanical aid.  
 Choose the correct option.  
 (a) (i), (ii) and (iii) (b) (ii), (iii) and (iv)  
 (c) (i), (ii) and (iv) (d) (i), (ii), (iii) and (iv)

104. Read the following statements and choose the correct option. Here T stands for true and F stands for false statement.

- (i) Equation :  $v = \frac{nRT}{p}$  will be applicable to any gas, under those conditions when behaviour of the gas approaches ideal behaviour.  
 (ii) Value of universal gas constant at 0° C and 1 atm pressure is  $8.20578 \times 10^{-2} \text{ L atm K}^{-1} \text{ mol}^{-1}$   
 (iii) Ideal gas equation describes the state of any gas, therefore it is also called equation of state.  
 (iv) Value of R in units of  $\text{Pa m}^3 \text{ K}^{-1} \text{ mol}^{-1}$  is  $8.314 \times 10^{-2}$   
 (a) T T T T (b) T T T F  
 (c) T F T F (d) T F F T

105. Choose the correct sequence of T and F for following statements. Here T stands for true and F stands for false.

- (i) There may be exchange of energy between colliding molecules, their individual energies may change, but the sum of their energies remains constant.  
 (ii) At any particular time, different particles in the gas have different speeds and hence different kinetic energies.  
 (iii) Particles of a gas move in all possible directions in straight lines. During their random motion, they collide with each other and with the walls of the container.  
 (iv) In kinetic theory it is assumed that average kinetic energy of the gas molecules is directly proportional to the absolute temperature.  
 (a) T T T T (b) T T T F  
 (c) T F T T (d) T F F T

106. Which of the following statements are correct ?

- (i) Real gases show deviations from ideal gas law because molecules interact with each other.  
 (ii) Due to interaction of molecules the pressure exerted by the gas is given as :

$$p_{\text{real}} = p_{\text{ideal}} + \frac{an^2}{V^2}$$

- (iii) Value of 'a' is measure of magnitude of intermolecular attractive forces within the gas and depends on temperature and pressure of gas.  
 (iv) At high pressure volume occupied by the molecules also becomes significant because instead of moving in volume  $V$ , these are now restricted to volume  $(V-nb)$   
 (a) (i) and (iv) (b) (i), (ii) and (iii)  
 (c) (i), (iii) and (iv) (d) (i) and (iii)

107. Choose the correct sequence of true and false for following statements. Here T represents true and F represents false statement.

- (i) Greater the viscosity, the more slowly the liquid flows.  
 (ii) Glass is an extremely viscous liquid.  
 (iii) Viscosity of liquid increases as the temperature rise.  
 (a) T F F (b) F T F  
 (c) T F T (d) T T F

### MATCHING TYPE QUESTIONS

108. Match the columns

- | Column-I   | Column-II                       |
|--|---------------------------------|
| (A) Attractive force that operates between the polar molecules having permanent dipole and the molecule lacking permanent dipole | (p) Dipole-dipole force         |
| (B) Interaction in which interaction energy between stationary polar molecules is proportional to $\frac{1}{r^3}$                | (q) London force                |
| (C) Force that are important only at short distances (~ 500 pm)  | (r) Dipole-induced dipole force |
| (a) A – (r), B – (p), C – (q)  |                                 |
| (b) A – (p), B – (r), C – (q)  |                                 |
| (c) A – (r), B – (q), C – (p)  |                                 |
| (d) A – (q), B – (r), C – (p)  |                                 |

109. Match the columns

- | Column-I   | Column-II            |
|--|----------------------|
| (A) Volume of a fixed mass of a gas at constant pressure is directly proportional to its absolute temperature                      | (p) Boyle's Law      |
| (B) At constant volume, pressure of a fixed amount of a gas varies directly with the temperature.                                  | (q) Avogadro's Law   |
| (C) Equal volumes of all gases under the same conditions of temperature and pressure contain equal number of molecules.            | (r) Charle's Law     |
| (D) At constant temperature, the pressure of a fixed amount (i. e., number of moles $n$ ) of gas varies inversely with its volume. | (s) Gay Lussac's Law |
| (a) A – (s), B – (r), C – (q), D – (p)   |                      |
| (b) A – (r), B – (s), C – (q.), D – (p)  |                      |
| (c) A – (r), B – (q), C – (p), D – (s)   |                      |
| (d) A – (q), B – (p), C – (s), D – (r)   |                      |

110. Match the columns

**Column-I**

- (A) Boyle's law  
(B) Charle's law  
(C) Dalton's law  
(D) Avogadro law

**Column-II**

- (p)  $V \propto n$  at constant T and P  
(q)  $p_{\text{total}} = p_1 + p_2 + p_3 + \dots$  at constant T, V  
(r)  $\frac{pV}{T} = \text{Constant}$   
(s)  $V \propto T$  at constant n and p  
(t)  $p \propto \frac{1}{V}$  at constant n and T

- (a) A – (t), B – (s), C – (q), D – (p)  
(b) A – (s), B – (q), C – (p), D – (t)  
(c) A – (r), B – (t), C – (q), D – (p)  
(d) A – (t), B – (q), C – (s), D – (r)

111. Match the graphs between the following variables (Column-I) with their names (Column-II) :

**Column-I  
(Graphs)**

- (A) Pressure vs temperature graph at constant molar volume.  
(B) Pressure vs volume graph at constant temperature  
(C) Volume vs temperature graph at constant pressure

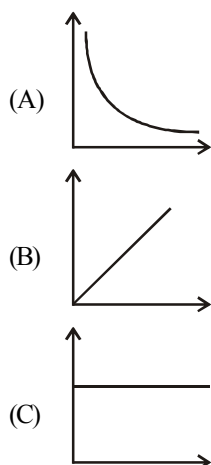
**Column-II  
(Names)**

- (p) Isotherms  
(q) Constant temperature curve  
(r) Isochores  
(s) Isobars

- (a) A – (p), B – (r), C – (s)  
(b) A – (r), B – (p), C – (s)  
(c) A – (r), B – (q), C – (p)  
(d) A – (s), B – (q), C – (r)

112. Match the following graphs of ideal gas (Column-I) with their co-ordinates (Column-II) :

**Column-I  
(Graphical representation)**



**Column-II  
(x and y co-ordinates)**

- (p)  $pV$  vs.  $V$   
(q)  $p$  vs.  $V$   
(r)  $p$  vs.  $\frac{1}{V}$

- (a) A – (r), B – (p), C – (q)  
(b) A – (r), B – (q), C – (p)  
(c) A – (q), B – (r), C – (p)  
(d) A – (p), B – (r), C – (q)

**ASSERTION-REASON TYPE QUESTIONS**

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
(c) Assertion is correct, reason is incorrect  
(d) Assertion is incorrect, reason is correct.

113. **Assertion :** Three states of matter are the result of balance between intermolecular forces and thermal energy of the molecules.

**Reason :** Intermolecular forces tend to keep the molecules together but thermal energy of molecules tends to keep them apart.

114. **Assertion :** Gases expand and occupy all the space available to them

**Reason :** There is no force of attraction between the particles of a gas at ordinary temperature and pressure.

115. **Assertion :** Gases do not liquefy above their critical temperature, even on applying high pressure.

**Reason :** Above critical temperature, the molecular speed is high and intermolecular attractions cannot hold the molecules together because they escape because of high speed.

116. **Assertion :** At critical temperature liquid passes into gaseous state imperceptibly and continuously.

**Reason :** The density of liquid and gaseous phase is equal to critical temperature.

117. **Assertion :** The temperature at which vapour pressure of a liquid is equal to the external pressure is called boiling temperature.

**Reason :** At high altitude atmospheric pressure is high.

118. **Assertion :** Liquids tend to have maximum number of molecules at their surface.

**Reason :** Small liquid drops have spherical shape.

**CRITICAL THINKING TYPE QUESTIONS**

119. Arrange the following in increasing order their intermolecular interaction

- (A) HCl (B)  $\text{SF}_6$  and (C) NaCl  
(a) A, B, C (b) A, C, B  
(c) B, A, C (d) B, C, A



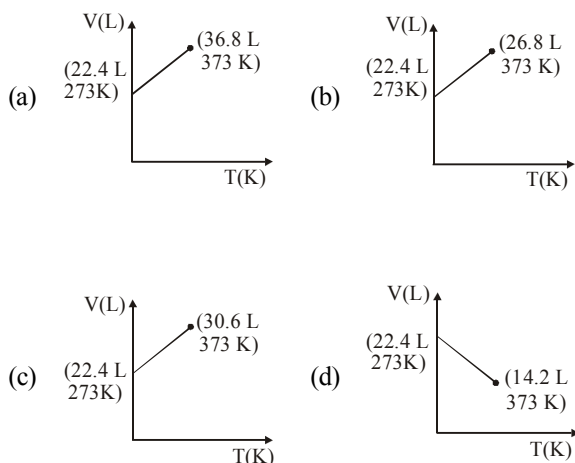
120. When a sample of gas is compressed at constant temperature from 15 atm to 60 atm, its volume changes from 76 cm<sup>3</sup> to 20.5 cm<sup>3</sup>. Which of the following statements are possible explanations of this behaviour?

- (1) The gas behaves non-ideally
  - (2) The gas dimerises
  - (3) The gas is adsorbed into the vessel walls
- (a) 1, 2 and 3                      (b) 1 and 2 only  
(c) 2 and 3 only                      (d) 1 only

121. Three different gases X, Y and Z of molecular masses 2, 16 and 64 were enclosed in a vessel at constant temperature till equilibrium is reached. Which of the following statement is correct?

- (a) Gas Z will be at the top of the vessel
- (b) Gas Y will be at the top of the vessel
- (c) Gas Z will be at the bottom and X will be at the top
- (d) Gases will form homogenous mixture

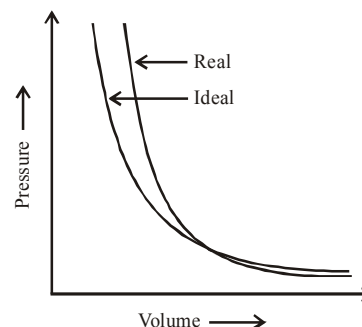
122. Which of the following volume (V) - temperature (T) plots represents the behaviour of one mole of an ideal gas at one atmospheric pressure ?



123. Consider the case of hot air balloon, density of air at 20°C is 1.2 kg/m<sup>3</sup>, if the air was heated to 99°C, density of air becomes 0.94 kg/m<sup>3</sup>. What would be the volume (in m<sup>3</sup>) at 20°C if the volume at 99°C is 2800 m<sup>3</sup> and how much air (in kg) has been escaped at 99°C, if the air in inflated balloon was heated to 99°C (if the inflated volume of balloon was found to be 2800 m<sup>3</sup>) respectively are

- (a) 2243, 728                      (b) 3495.3, 596  
(c) 2687, 593                      (d) 2956, 771

124. From the given figure what can be said about the gases does not deviate much from ideal gases at



- (a) Higher pressure and low volume.
- (b) Low pressure and low volume.
- (c) High pressure and high volume.
- (d) Low pressure and high volume.

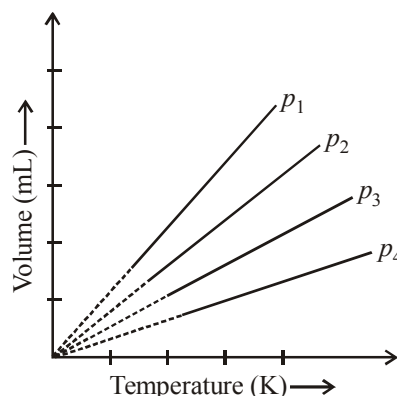
125. 16 g of oxygen and 3 g of hydrogen are mixed and kept at 760 mm of Hg pressure and 0°C. The total volume occupied by the mixture will be nearly

- (a) 22.4 litres                      (b) 33.6 litres  
(c) 448 litres                      (d) 44800 ml

126. The density of neon will be highest at

- (a) S.T.P.                      (b) 0°C, 2 atm  
(c) 273°C, 1 atm.                      (d) 273°C, 2 atm.

127. A plot of volume (V) versus temperature (T) for a gas at constant pressure is a straight line passing through the origin. The plots at different values of pressure are shown in figure. Which of the following order pressure is correct for this gas ?



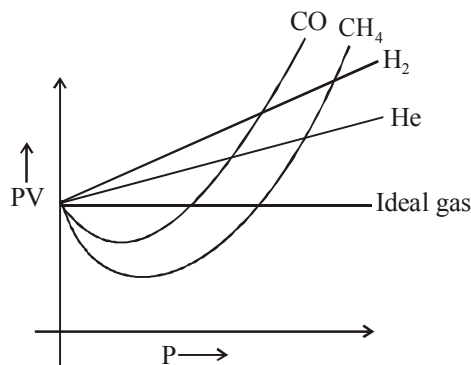
- (a)  $p_1 > p_2 > p_3 > p_4$                       (b)  $p_1 = p_2 = p_3 = p_4$   
(c)  $p_1 < p_2 < p_3 < p_4$                       (d)  $p_1 < p_2 = p_3 < p_4$

128. At constant temperature, for a given mass of an ideal gas

- (a) The ratio of pressure and volume always remains constant.
- (b) Volume always remains constant.
- (c) Pressure always remains constant.
- (d) The product of pressure and volume always remains constant.

- 129.** If 500 ml of gas A at 400 torr and 666.6 ml of B at 600 torr are placed in a 3 litre flask, the pressure of the system will be  
 (a) 200 torr (b) 100 torr  
 (c) 550 torr (d) 366 torr
- 130.** What is the partial pressure (mmHg) of nitrogen if total atmospheric pressure is 760mmHg ?  
 (a) 159 (b) 300  
 (c) 592.8 (d) 230
- 131.** Cyclopropane and oxygen at partial pressures 170 torr and 570 torr respectively are mixed in a gas cylinder. What is the ratio of the number of moles of cyclopropane to the number of moles of oxygen ( $n_{C_3H_6}/n_{O_2}$ )?  
 (a)  $\frac{170 \times 42}{570 \times 32} = 0.39$  (b)  $\frac{170}{42} \left/ \left( \frac{170}{42} + \frac{570}{32} \right) \right. \approx 0.19$   
 (c)  $\frac{170}{740} = 0.23$  (d)  $\frac{170}{570} = 0.30$
- 132.** An evacuated glass vessel weights 50 g when empty, 144.0 g when filled with a liquid of density  $0.47 \text{ g ml}^{-1}$  and 50.5 g when filled with an ideal gas at 760 mm Hg at 300 K. The molar mass of the ideal gas is (Given  $R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$ )  
 (a) 61.575 (b) 130.98  
 (c) 123.75 (d) 47.87
- 133.** The pressure of a 1:4 mixture of dihydrogen and dioxygen enclosed in a vessel is one atmosphere. What would be the partial pressure of dioxygen ?  
 (a)  $0.8 \times 10^5 \text{ atm}$  (b)  $0.008 \text{ Nm}^{-2}$   
 (c)  $8 \times 10^4 \text{ Nm}^{-1}$  (d) 0.25 atm
- 134.** Two vessels containing gases A and B are interconnected as shown in the figure. The stopper is opened, the gases are allowed to mix homogeneously. The partial pressures of A and B in the mixture will be, respectively
- Gas A  
 12 L  
 8 atm

Gas B  
 8 L  
 5 atm
- (a) 8 and 5 atm (b) 9.6 and 4 atm  
 (c) 4.8 and 2 atm (d) 6.4 and 4 atm
- 135.** A neon-dioxygen mixture contains 70.6 g  $O_2$  and 167.5 g neon. If pressure of the mixture of gases in the cylinder is 25 bar. What is the partial pressure of  $O_2$  and Ne in the mixture respectively ?  
 (a) 5.25 bar, 10 bar (b) 19.75 bar, 5.25 bar  
 (c) 19.75 bar, 10 bar (d) 5.75 bar, 19.75 bar
- 136.** 0.5 mole of each  $H_2$ ,  $SO_2$  and  $CH_4$  are kept in a container. A hole was made in the container. After 3 h, the order of partial pressures in the container will be  
 (a)  $P_{SO_2} > P_{CH_4} > P_{H_2}$  (b)  $P_{H_2} > P_{SO_2} > P_{CH_4}$   
 (c)  $P_{H_2} > P_{CH_4} > P_{SO_2}$  (d)  $P_{SO_2} > P_{H_2} > P_{CH_4}$
- 137.** For a person travelling to the peak of the mountain which of the following statement(s) is/are correct ?  
 (i) Oxygen level goes on decreasing.  
 (ii) Gas law can be applied to this situation.  
 (a) Both (i) and (ii)  
 (b) Only (i)  
 (c) Only (ii)  
 (d) Neither (i) nor (ii)
- 138.** Pressure in well inflated tyres of automobiles is almost constant, but on a hot summer day this increases considerably and tyre may burst if pressure is not adjusted properly. During winters, on a cold morning one may find the pressure in the tyres of a vehicle decreased considerably. Which of the following law explain the above observations?  
 (a) Charle's Law (b) Avogadro Law  
 (c) Boyle's Law (d) Gay Lussac's Law
- 139.** What is the ratio of pressure of the 2gm of hydrogen to that of 4 gm of helium at temperature of 298K, 20ml volume? (consider the ideal behaviour)  
 (a) 1 : 2 (b) 2 : 1  
 (c) 1 : 1 (d) 2 : 2
- 140.** In case of CO and  $CH_4$  curve goes to minima then increases with increase in pressure but in case of  $H_2$  and He the curve is linear because:



- (a) Intermolecular interactions for  $H_2$  and He are very low.  
 (b) Molecular size or atomic size for  $H_2$  and He is small.  
 (c) Both (a) and (b)  
 (d) Neither (a) nor (b)

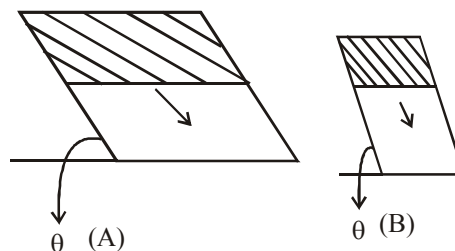
141. Which among the following has lowest surface tension ?

- (a) Hexane (b) Water  
(c)  $\text{CH}_3\text{OH}$  (d)  $\text{CH}_3\text{CH}_2\text{OH}$

142. Water droplets was not able to maintain its spherical shape in the presence of gravity but mercury does, why ?

- (a) Force of attraction between atoms of mercury is very high than that of molecules in case of water.  
(b) Surface tension of mercury is very high.  
(c) Both (a) and (b)  
(d) Neither (a) nor (b)

143. Consider the case of honey flowing over a slope for this situation which of the following statement(s) is/are correct ?

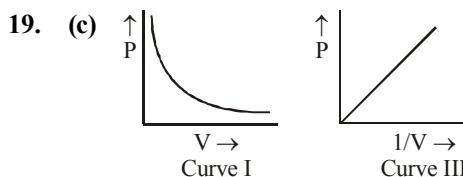


- (i) Velocity with which honey is flowing is slower in A than B ( $\theta$  being same in both cases)  
(ii) Velocity increases with increase in temperature.  
(a) (i) and (ii) (b) Only (i)  
(c) Only (ii) (d) Neither (i) nor (ii)

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (c) Attractive forces between an ion and a dipole are known as ion - dipole forces and these are not van der Waals forces.
2. (d) Fritz London explained the concept of dispersion force.
3. (b) Interaction energy  $\propto \frac{1}{r^6}$
4. (c)
5. (c) London forces are always attractive and interaction energy is inversely proportional to the sixth power of the distance between two interacting particles.
6. (c)
7. (a) Dipole-dipole interaction is stronger than the London forces but is weaker than ion-ion interaction because only partial charges are involved e.g., HCl molecules. The attractive force decreases with the increase of distance between the dipoles.
8. (d) Induced dipole moment depends upon the dipole moment present in the permanent dipole and the polarisability of the electrically neutral molecule. Molecules of large size can be easily polarized. High polarisability increases the strength of attractive interactions.
9. (b) This type of attractive force operates between the polar molecules having permanent dipole and the molecules lacking permanent dipole.  
HCl is polar ( $\mu \neq 0$ ) and He is non polar ( $\mu = 0$ ), thus gives dipole-induced dipole interaction.
10. (c) Noble gases have no intermolecular forces due to inertness.
11. (a) Strength of the hydrogen bond is determined by coulombic interaction between lone pair electrons of the electronegative atom of one molecule and the hydrogen atom of the other molecule.
12. (d) 13. (a)
14. (c) Gaseous state of substance has the maximum thermal energy.
15. (c) Gases do not have definite shape and volume. Their volume is equal to the volume of the container.
16. (b) It is characteristic of gases i.e., Thermal energy  $\gg$  molecular attraction.
17. (c) Robert Boyle made first reliable measurement on properties of gases.
18. (d) According to Boyle's law at constant temperature,  
$$V \propto \frac{1}{P} \text{ or } PV = \text{constant}$$



Both these graphs represent Boyle's law.

20. (b) According to Boyle's Law  
 $pv = k$

$$p \frac{m}{d} = k$$

$$\frac{p}{d} = \frac{k}{m} = k'$$

21. (b) Boyle's law

$$P \propto \frac{1}{V}$$

$$P = \frac{K}{V}$$

$$PV = K$$

22. (a) Given initial volume ( $V_1$ ) = 600 c.c.; Initial pressure ( $P_1$ ) = 750 mm of Hg and final volume ( $V_2$ ) = 500 c.c. according to Boyle's law,  
 $P_1 V_1 = P_2 V_2$

$$\text{or } 750 \times 600 = P_2 \times 500$$

$$\text{or } P_2 = \frac{750 \times 600}{500} = 900 \text{ mm of Hg}$$

Therefore increase of pressure =  $(900 - 750) = 150$  mm of Hg

23. (b) The lowest hypothetical or imaginary temperature at which gases are supposed to occupy zero volume is called **absolute zero**.

24. (b) Given initial volume ( $V_1$ ) = 500 ml; Initial temperature ( $T_1$ ) =  $27^\circ\text{C} = 300 \text{ K}$  and final temperature ( $T_2$ ) =  $-5^\circ\text{C} = 268 \text{ K}$ .

From Charles's law:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \text{ or } \frac{500}{300} = \frac{V_2}{268}$$

Where  $V_2$  = New volume of gas

$$V_2 = \frac{500}{300} \times 268 = 446.66 \text{ ml.}$$

25. (c) At any given pressure, graph of volume vs temperature (in  $^\circ\text{C}$ ) is a straight line and on extending to zero volume each line intercepts the temperature axis at  $-273.15^\circ\text{C}$ .

26. (c) According to Charles's law  $V \propto T$  or  $\frac{V}{T} = k$
27. (b) Charles's law  $V \propto T$  at constant  $P$ .
28. (a)  $d \propto p$ , Boyle's law,  $\left(d = \frac{MP}{RT}\right)$ . At sea level pressure is more, hence density of air is more.
29. (b) Hot air is lighter due to less density (Charles's law)
- $$\left(d = \frac{MP}{RT}\right)$$
30. (b) Higher  $P$ , lower  $T$ , greater the density.  $\left(d = \frac{MP}{RT}\right)$
31. (a) Order of pressure,  $p_1 < p_2 < p_3 < p_4$ .
32. (a)  $V_1 = 2\text{ L}$ ,  $T_2 = (26.1 + 273)\text{ K} = 299.1\text{ K}$ ,  $V_2 = ?$   
 $T_1 = (23.4 + 273)\text{ K} = 296.4\text{ K}$   
 From Charles's law,  $\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow V_2 = \frac{V_1 T_2}{T_1}$   

$$\Rightarrow V_2 = \frac{2\text{ L} \times 299.1\text{ K}}{296.4\text{ K}} = 2\text{ L} \times 1.009$$

$$= 2.018\text{ L}$$
33. (d)  $\frac{P}{T} = \text{constant}$  (Gay Lussac's law)  

$$\Rightarrow \frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow P_1 T_2 = P_2 T_1$$
  
 $PV = \text{constant}$   
 $P_1 V_1 = P_2 V_2$  [Boyle's law]
34. (c) This relationship is derived from Boyle's and Charles' law.
35. (d) All of the given relations are true for Avogadro's law.
36. (a) At STP molar volume of an ideal gas or a combination of ideal gases is  $22.71098\text{ L mol}^{-1}$ .
37. (d)  $44\text{ g}$  at STP occupies volume  $22.4\text{ litre}$  which is molecular mass of  $\text{CO}_2$ . Molecular mass occupies  $22.4\text{ litre}$  at STP.
38. (b) An ideal gas obeys the gas laws under all experimental conditions.
39. (c)  $PV = nRT$   
 $\therefore n/V = P/RT$ .
40. (c) In the equation  $PV = nRT$ ,  $n$  moles of the gas have volume  $V$ .
41. (b)  $\frac{PV}{T} = \text{constant}$  or  $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$   

$$\Rightarrow \frac{P_1 V_1}{P_2 V_2} = \frac{T_1}{T_2}$$
42. (b)  $R = 0.0082\text{ litre atm K}^{-1}\text{ mole}^{-1}$ .
43. (d)  $PV = nRT = \frac{m}{M}RT$   
 or  $PM = \frac{m}{V}RT = dRT \Rightarrow d = \frac{PM}{RT}$
44. (c)  $n = \frac{PV}{RT} = \frac{m}{M}$   

$$m = \frac{MPV}{RT} = \frac{34 \times 2 \times 100}{0.082 \times 293} = 282.68\text{ gm}$$
45. (c)  $V_2 = \frac{P_1 V_1}{T_1} \times \frac{T_2}{P_2} = \frac{760}{600} \times \frac{546}{273} \times 273 = 691.6\text{ ml}$
46. (a) Total moles  

$$= \frac{4}{32} + \frac{2}{2} = 1.125; PV = nRT$$
  

$$\Rightarrow P = 1.125 \times 0.0821 \times 273$$

$$P = 25.215\text{ atm}$$
47. (c)  $PV = nRT$  is for an ideal gas which follows both isothermal and adiabatic processes.
48. (a) By Dalton's law of partial pressures, the total pressure of a mixture of two gases is the sum of the partial pressures of components of the mixture.
49. (a)
50. (b) Because  $\text{H}_2$  &  $\text{Cl}_2$  gases may react with each other to produce  $\text{HCl}$  gas hence Dalton's law is not applicable.
51. (a) Pressure exerted by saturated water vapour is called aqueous tension.
52. (d)  $P = \frac{nRT}{V} = \frac{6}{16.02} \times \frac{8.314 \times 402}{0.03} \approx 41648\text{ Pa}$
53. (a) Given  $n_{\text{CO}} = n_{\text{N}_2}$   
 $P_{\text{CO}} + P_{\text{N}_2} = 1\text{ atm}$   
 Partial pressure of a gas = mole fraction of gas  $\times$  total pressure  

$$\therefore P_{\text{N}_2} = \frac{n_{\text{N}_2}}{n_{\text{CO}} + n_{\text{N}_2}} \times 1 = \frac{n_{\text{N}_2}}{2n_{\text{N}_2}} \times 1 = \frac{1}{2} = 0.5\text{ atm.}$$
54. (a) Given  
 $P_1 = 1.5\text{ bar}$   $T_1 = 273 + 15 = 288\text{ K}$   $V_1 = V$   
 $P_2 = 1.0\text{ bar}$   $T_2 = 273 + 25 = 298\text{ K}$   $V_2 = ?$   

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{1.5 \times V}{288} = \frac{1 \times V_2}{298}$$

$$V_2 = 1.55\text{ V i.e., volume of bubble will be almost 1.6 time to initial volume of bubble.}$$
55. (a) Partial pressure = total pressure  $\times$  mole fraction  
 Moles of oxygen =  $\frac{64}{32} = 2$   
 Moles of neon =  $\frac{60}{20} = 3$   
 Mole fraction of oxygen =  $\frac{2}{2+3} = \frac{2}{5}$   

$$P_{\text{O}_2} = \frac{2}{5} \times 10 = 4\text{ bar}$$



$$\text{Mole fraction of neon} = \frac{3}{2+3} = \frac{3}{5}$$

$$P_{\text{Ne}} = \frac{3}{5} \times 10 = 6 \text{ bar}$$

56. (b)  $P_1 V_1 = P_2 V_2$

$$760 \times 500 = P_2 \times 200.$$

$$P_2 = \frac{760 \times 500}{200} = 1900 \text{ mm Hg}$$

57. (d) Value of gas constant depends only upon units of measurement.

58. (a) Given conditions

$$V_1 = 16.4 \text{ L}, V_2 = 5 \text{ L}$$

$$P_1 = 1.5 \text{ atm}, P_2 = 4.1 \text{ atm}$$

$$T_1 = 273 + 27 = 300 \text{ K},$$

$$T_2 = 273 + 227 = 500 \text{ K}$$

$$\text{Applying gas equation, } \frac{P_1 V_1}{P_2 V_2} = \frac{n_1 T_1}{n_2 T_2}$$

$$\frac{n_1}{n_2} = \frac{P_1 V_1 T_1}{P_2 V_2 T_2}$$

$$\therefore \frac{1.5 \times 16.4 \times 500}{4.1 \times 5 \times 300} = \frac{2}{1}$$

59. (d) On applying Dalton's law,

Partial pressure of a component

= Mole fraction  $\times$  Total pressure

Given, mass of  $\text{N}_2 = 56 \text{ g}$ , mass of  $\text{O}_2 = 96 \text{ g}$

Total pressure = 10 atm

$$^n\text{N}_2 = \frac{56}{28} = 2, \quad ^n\text{O}_2 = \frac{96}{32} = 3$$

$$^x\text{N}_2 = \frac{^n\text{N}_2}{^n\text{N}_2 + ^n\text{O}_2} = \frac{2}{2+3} = 0.4,$$

$$^x\text{O}_2 = \frac{^n\text{O}_2}{^n\text{N}_2 + ^n\text{O}_2} = \frac{3}{2+3} = 0.6$$

$$\therefore P_{\text{N}_2} = 0.4 \times 10 = 4 \text{ atm}, P_{\text{O}_2} = 0.6 \times 10 = 6 \text{ atm}$$

60. (d) From the ideal gas equation :

$$PV = nRT$$

$$\text{or } n = \frac{PV}{RT} = \frac{3170 \times 10^{-3}}{8.314 \times 300} = 1.27 \times 10^{-3}$$

61. (a) By Dalton's law of partial pressures, the total pressure of a mixture of two gases is the sum of the partial pressures.

62. (b) An ideal gas equation is the combination of Boyle's law, Charles' law and Avogadro law.

63. (b) According to kinetic theory the gas molecules are in a state of constant rapid motion in all possible directions colliding in a random manner with one another and with the walls of the container and between two successive collisions molecules travel in a straight line path but show haphazard motion due to collisions.

64. (c) Given statement explain the great compressibility of gases.

65. (b) If there were loss of kinetic energy, the motion of molecule will stop and gases will settle down.

66. (b) Particles of a gas are always in constant and random motion. If the particles were at rest and occupy fixed positions, then a gas would have a fixed shape which is not observed.

67. (b) If assumption (ii) is correct, the pressure vs volume graph of experimental data (real gas) and that of theoretically calculated for Boyle's law (ideal gas) should coincide.

68. (d) Kinetic theory of gases proves all the given gas laws.

69. (d) Molecules move very fast in all directions in a straight line by colliding with each other but with different velocity.

70. (b) At low temperature and high pressure.

71. (a) In van der waals equation 'b' is for volume correction

72. (c)  $\left(P + \frac{a}{V^2}\right)(V - b) = RT$ , Here  $\left(P + \frac{a}{V^2}\right)$  represents the intermolecular forces.

73. (c) 'a' is directly related to forces of attraction. Hence greater the value of 'a', more easily the gas gets liquified.

74. (b)

(i) At very large molar volume

$$P + \frac{a}{V_m^2} \approx P \text{ and } V_m - b = V_m$$

(iii) According to van der Waals equation 'a' and 'b' are independent of temperature.

75. (a)  $P = \frac{n^2 a}{V^2}$ ;  $a = \frac{PV^2}{n^2} = \text{atm dm}^6 \text{ mol}^{-2}$

76. (c) Easily liquefiable gases have greater intermolecular forces which is represented by high value of 'a'. The greater the value of 'a' more will be liquefiability. So, the order is  $Q < S < P < R$ .

77. (a) When pressure is low 'b' can be neglected, thus

$$\left(P + \frac{a}{V^2}\right)V = RT$$

$$PV + \frac{a}{V} = RT$$

$$PV = RT - \frac{a}{V}$$

$$\frac{PV}{RT} = \frac{RT}{RT} - \frac{a}{VRT}$$

$$Z = \frac{PV}{RT} = 1 - \frac{a}{VRT}$$

78. (c)  $\left(P + \frac{a}{V^2}\right)(V - b) = RT$  at high pressure  $\frac{a}{V^2}$  can be neglected  
 $PV - Pb = RT$  and  $PV = RT + Pb$   
 $\frac{PV}{RT} = 1 + \frac{Pb}{RT}$   
 $Z = 1 + \frac{Pb}{RT}$ ;  $Z > 1$  at high pressure
79. (d)  $\text{CO}_2$  has highest critical temperature of 304.2 K
80. (d) At low pressure and high temperature: At low pressure volume correction for 1 mole of a gas is negligible, i.e.  $b = 0$   
 thus the gas equation becomes  
 $\left(P + \frac{a}{V^2}\right)V = RT$   
 or  $Z = \frac{PV_m}{RT} = 1 - \frac{a}{V_m RT}$   
 At higher pressure, the pressure correction for 1 mole of gas is negligible i.e.  $\frac{a}{V^2} = 0$   
 or  $(P + 0)(V - b) = RT$   
 or  $P(V_m - b) = RT$   
 or  $PV_m = RT + Pb$   
 or  $Z = \frac{PV_m}{RT} = 1 + \frac{Pb}{RT}$
81. (d) In the ideal gas, the intermolecular forces of attraction are negligible and hence it cannot be liquefied.
82. (d)
83. (d) Above Boyle point, real gases show positive deviation from ideality and  $Z$  values are greater than one.
84. (c)
85. (c) More will be critical temperature easier is the liquifaction of the gas. Hence correct order will be  $\text{He} < \text{H}_2 < \text{N}_2 < \text{O}_2$
86. (a) For statement (iii), we can move down from G towards D by lowering the temperature.  
 For statement (iv), we get liquid as soon as we cross point H.
87. (b) At 1 atm pressure boiling temperature is called normal boiling point. If pressure is 1 bar than the boiling point is called standard boiling point of the liquid.
88. (b) 1 bar pressure is slightly less than 1 atm pressure.
89. (d) A substance exists as a liquid above its m. pt. and below its b. pt.
90. (a) The kinetic energy of molecules in gaseous state is more than those in the liquid state as the molecules in gaseous state can move freely (with higher speed) as compared in liquid state.

91. (a) 92. (b)
93. (d) All these phenomena are caused by surface tension.
94. (b) 95. (b)
96. (c) Due to intermolecular H-bonding the surface tension of  $\text{H}_2\text{O}$  is more than other liquid. One  $\text{H}_2\text{O}$  molecule is joined with 4 another  $\text{H}_2\text{O}$  molecule through H-bond. Hydrogen bonding is in order  $\text{H}_2\text{O} > \text{C}_2\text{H}_5\text{OH} > \text{CH}_3\text{OH}$ .
97. (a) Boiling point of water is  $100^\circ\text{C}$  whereas evaporation of water into water vapours occurs at room temperature.
98. (a) As intermolecular forces are least in case of petrol. Thus, it has highest rate of evaporation.
99. (c) The correct order of viscosity of the given liquids is dimethyl ether < methyl alcohol < water < glycerol.

### STATEMENT TYPE QUESTIONS

100. (d) These forces are important only at short distances ( $\sim 500$  pm)
101. (b) For statement (ii), partial charge possessed by these dipoles is always less than the unit electronic charge. For statement (iii), dipole - dipole interaction is stronger than London forces but weaker than ion - ion interaction.
102. (d) All of the given statements are correct for hydrogen bond.
103. (c) Gases have much lower density than the solids and liquids.
104. (b) Value of  $R = 8.314 \text{ Pa m}^3 \text{ K}^{-1} \text{ mol}^{-1}$
105. (a) All the given statements are true.
106. (a) For statement (ii),  $p_{\text{real}} = p_{\text{ideal}} - \frac{an^2}{V^2}$   
 For statement (iii), value of 'a' is independent of temperature and pressure.
107. (d) Viscosity of liquid decreases as temperature rise.

### MATCHING TYPE QUESTIONS

108. (a) 109. (b) 110. (a) 111. (b) 112. (c)

### ASSERTION-REASON TYPE QUESTIONS

113. (a)
114. (a) Gases expand and occupy all the space available to them because there is no force of attraction between the particles of a gas at ordinary temperature and pressure.
115. (a) 116. (a)
117. (c) At high altitude atmospheric pressure is low.
118. (d)

**CRITICAL THINKING TYPE QUESTIONS**

**119. (c)** In case of HCl molecules there is dipole-dipole interaction which is stronger than London forces as in case of  $\text{SF}_6$ . Now between HCl and NaCl the ion-ion interaction present in NaCl is far more stronger than dipole-dipole interaction of HCl.

**120. (d)** Given,  $P_1 = 15 \text{ atm}$ ,  $P_2 = 60 \text{ atm}$   
 $V_1 = 76 \text{ cm}^3$ ,  $V_2 = 20.5 \text{ cm}^3$ .  
 If the gas is an ideal gas, then according to Boyle's law, it must follow the equation,

$$P_1 V_1 = P_2 V_2$$

$$P_1 \times V_1 = 15 \times 76 = 1140$$

$$P_2 \times V_2 = 60 \times 20.5 = 1230$$

$$\therefore P_1 V_1 \neq P_2 V_2$$

$\therefore$  The gas behaves non-ideally.

The given information is not sufficient to comment on other statements.

**121. (d)** All the gases occupy the available volume and will form homogeneous mixture.

**122. (c)**  $\frac{V_1}{T_1} = \frac{V_2}{T_2}$  at const. pressure

$$\Rightarrow \frac{22.4}{273} = \frac{V_2}{373}, V_2 = 30.6 \text{ litre}$$

**123. (a)** Since atmospheric pressure remain constant

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow \frac{V_1}{298\text{K}} = \frac{2800\text{m}^3}{372\text{K}}$$

$$V_1 = 2243 \text{ m}^3$$

2800  $\text{m}^3$  volume of inflated balloon.

$$\text{Mass of air in inflated balloon} = 2800 \text{ m}^3 \times 0.94 \text{ kg m}^{-3} \\ = 2632 \text{ kg}$$

Keeping the volume same = 2800  $\text{m}^3$

The mass of air, which occupies it with density (1.2  $\text{kg/m}^3$ ) is  $2800 \times 1.2 = 3360 \text{ kg}$

$$\text{Amount of air which had been escaped} = 3360 - 2632 \\ = 728 \text{ kg}$$

**124. (d)**

**125. (d)**  $n \text{ of } \text{O}_2 = \frac{16}{32} = \frac{1}{2}$

$$n \text{ of } \text{H}_2 = \frac{3}{2}$$

$$\text{Total no. of moles} = \frac{3}{2} + \frac{1}{2} = 2$$

$$V = \frac{nRT}{P} = \frac{2 \times 0.082 \times 273}{1} = 44.8 \text{ lit} = 44800 \text{ ml}$$

**126. (b)**  $d = \frac{PM}{RT}$

It means density of gas is directly proportional to pressure and inversely proportional to temperature. Density of neon will be maximum at highest pressure and lowest temperature.

**127. (c)**

**128. (d)** According to Boyle's law at constant temperature,

$$V \propto \frac{1}{P} \text{ or } PV = \text{constant}$$

**129. (a)** Applying Boyle's law  $P_1 V_1 = P_2 V_2$  for both gases

$$\frac{500}{1000} \times 400 = P \times 3 \Rightarrow P = \frac{200}{3}$$

$$600 \times \frac{666.6}{1000} = P' \times 3 \Rightarrow P' = \frac{400}{3}$$

$$\Rightarrow P_T = P + P' = \frac{200}{3} + \frac{400}{3} = \frac{600}{3} = 200 \text{ tor}$$

**130. (c)** Percentage of nitrogen in atmosphere is 78% .Partial pressure of  $\text{N}_2 = 0.78 \times 760$

**131. (d)** By Ideal gas equation

$$P_1 V = n_1 RT$$

$$n_1 \propto P_1 \text{ and } n_2 \propto P_2$$

$$\frac{n_1}{n_2} = \frac{P_1}{P_2} \Rightarrow \frac{n_1}{n_2} = \frac{170}{570} = 0.30$$

**132. (a)** Given weight of empty glass vessel = 50 g

Weight of vessel filled with liquid = 144 g

$\therefore$  Weight of liquid =  $144 - 50 = 94 \text{ g}$ .

Volume of liquid = Mass/density =  $94/0.47$   
 $= 200 \text{ ml} = 200 \times 10^{-3} \text{ L}$ .

Given, pressure of ideal gas = 760 mm Hg = 1 atm

Temperature = 300 K

$$R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$$

Mass of ideal gas =  $50.5 - 50 = 0.5 \text{ g}$

According to ideal gas equation,

$$PV = nRT = \frac{w}{M} RT$$

$$1 \times 200 \times 10^{-3} = \frac{0.5}{M} \times 0.0821 \times 300$$

$$M = \frac{0.5 \times 0.0821 \times 300}{200 \times 10^{-3}} = 61.575$$

**133. (d)**  $p_1 = 1.5 \text{ atm}$ ,  $T_1 = 15^\circ\text{C} = (15 + 273)\text{K} = 288 \text{ K}$

$p_2 = 1 \text{ atm}$ ,  $T_2 = 25^\circ\text{C} = (25 + 273)\text{K} = 298 \text{ K}$

$$\frac{p_1 V_1}{T_1} = \frac{p_2 V_2}{T_2}$$

$$\frac{p_1 T_2}{T_1 p_2} = \frac{V_2}{V_1} \Rightarrow \frac{V_2}{V_1} = \frac{1.5 \times 298}{288 \times 1} = 1.55$$

$$134. (c) \text{ Moles of A, } (n_A) = \frac{p_A v_A}{RT} = \frac{8 \times 12}{RT} = \frac{96}{RT}$$

$$\text{Moles of B, } (n_B) = \frac{p_B v_B}{RT} = \frac{8 \times 5}{RT} = \frac{40}{RT}$$

$$\text{Total pressure} \times \text{total volume} = (n_A + n_B) \times RT$$

$$p \times (12 + 8) = \frac{1}{RT} (96 + 40) RT$$

$$p = 6.8$$

$$\text{Partial pressure of A} = p \times \text{mole fraction of A}$$

$$= 6.8 \left( \frac{96}{RT} / \frac{96 + 40}{RT} \right)$$

$$= 4.8 \text{ atm}$$

$$\text{Partial pressure of B} = 6.8 - 4.8 = 2 \text{ atm.}$$

$$135. (d) \text{ Number of moles of O}_2 = \frac{70.6 \text{ g}}{32 \text{ g mol}^{-1}} = 2.21 \text{ mol}$$

$$\text{Number of moles of Ne} = \frac{167.5 \text{ g}}{20 \text{ g mol}^{-1}} = 8.375 \text{ mol}$$

$$\text{Mole fraction of O}_2 = \frac{2.21}{2.21 + 8.375} = 0.21$$

$$\text{Mole fraction of Ne} = 1 - 0.21 = 0.79$$

$$\text{Partial pressure of a gas} = \text{Mole fraction} \times \text{total pressure}$$

$$\text{Partial pressure of O}_2 = 0.21 \times 25 = 5.25 \text{ bar}$$

$$\text{Partial pressure of Ne} = 0.79 \times 25 = 19.75 \text{ bar}$$

$$136. (a) \text{ Extent of diffusion } H_2 > CH_4 > SO_2 \text{ because rate of}$$

$$\text{diffusion} \propto \frac{1}{\text{molar mass}}$$

Order of partial pressure after diffusion is

$$p_{SO_2} > p_{CH_4} > p_{H_2}$$

137. (a) As the height increases, atmospheric pressure decreases, so now the volume of the gas increases and gas tends to become less denser, hence the concentration of oxygen decreases.

138. (d) The mathematical relationship between pressure and temperature was given by Gay Lussac's law.

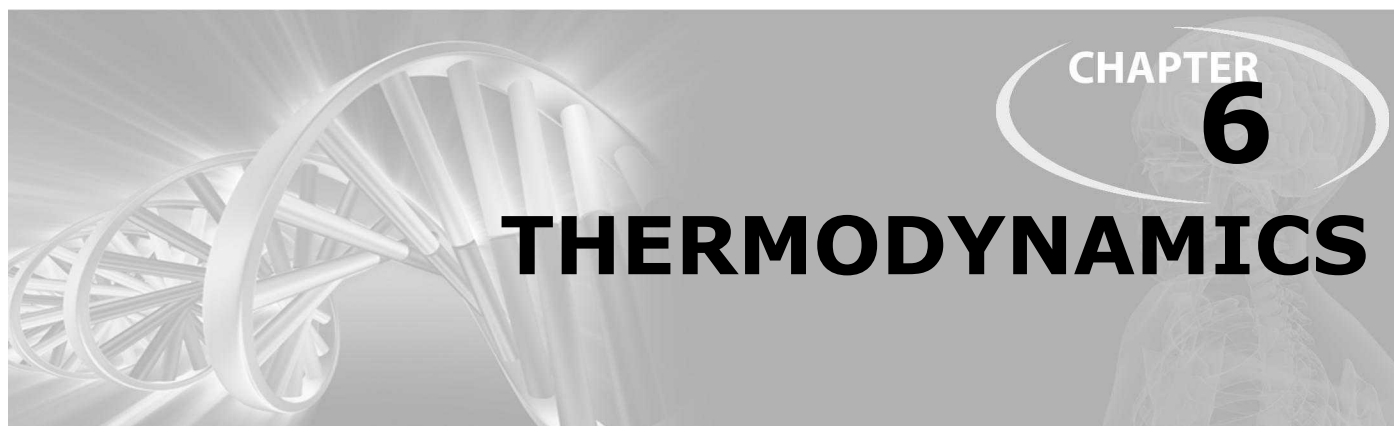
139. (c) Number of moles, temperature and volume are same.

140. (c) Due to small size of these species ( $H_2$  and He) intermolecular interactions (van der Waal forces) are very low, therefore it is difficult to compress these.

141. (a) Since surface tension depends on the attractive forces between the molecules, and hydrogen bonding a special type of dipole-dipole interactions in (b), (c) and (d) which is stronger than London forces of attraction in hexane.

142. (c)

143. (a) Force is required to maintain the flow of layer which is inversely proportional to the area of contact of layer therefore flow in B is greater than that in A as the area of contact is greater in A. Also viscosity of the fluid decreases with increase in temperature therefore liquid flow increases.



### FACT/DEFINITION TYPE QUESTIONS

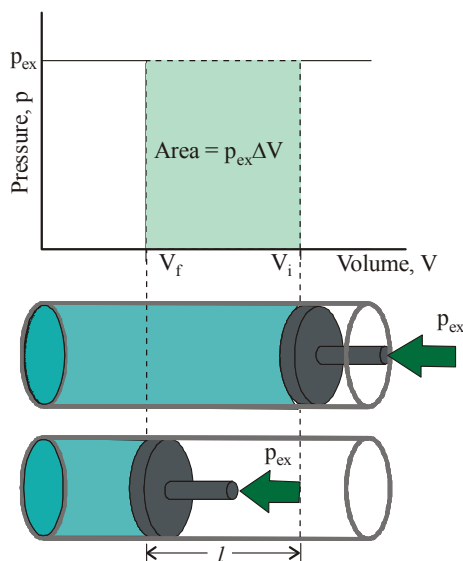
- Thermodynamics is not concerned about \_\_\_\_\_.
  - energy changes involved in a chemical reaction.
  - the extent to which a chemical reaction proceeds.
  - the rate at which a reaction proceeds
  - the feasibility of a chemical reaction.
- Which of the following statements is not true regarding the laws of thermodynamics ?
  - It deal with energy changes of macroscopic systems.
  - It deal with energy changes of microscopic systems.
  - It does not depends on the rate at which these energy transformations are carried out.
  - It depends on initial and final states of a system undergoing the change.
- A..... in thermodynamics refers to that part of universe in which observations are made and remaining universe constitutes the.....
  - surroundings, system
  - system, surroundings
  - system, surroundings
  - system, boundary
- The universe refers to
  - only system
  - only surroundings
  - both system and surroundings
  - None of these
- Which of the following statements is correct?
  - The presence of reacting species in a covered beaker is an example of open system.
  - There is an exchange of energy as well as matter between the system and the surroundings in a closed system.
  - The presence of reactants in a closed vessel made up of copper is an example of a closed system.
  - The presence of reactants in a thermos flask or any other closed insulated vessel is an example of a closed system.
- Which of the following is closed system ?
  - Jet engine
  - Tea placed in a steel kettle
  - Pressure cooker
  - Rocket engine during propulsion
- An isolated system is that system in which
  - There is no exchange of energy with the surroundings
  - There is exchange of mass and energy with the surroundings
  - There is no exchange of mass or energy with the surroundings
  - There is exchange of mass with the surroundings
- The state of a thermodynamic system is described by its measurable or macroscopic (bulk) properties. These are
  - Pressure and volume
  - Pressure, volume, temperature and amount
  - Volume, temperature and amount
  - Pressure and temperature
- Which of the following are *not* state functions ?
 

(I) $q + w$	(II) $q$
(III) $w$	(IV) $H - TS$

  - (I) and (IV)
  - (II), (III) and (IV)
  - (I), (II) and (III)
  - (II) and (III)
- Among the following the state function(s) is (are)
  - Internal energy
  - Irreversible expansion work
  - Reversible expansion work
  - Molar enthalpy
  - (ii) and (iii)
  - (i), (ii) and (iii)
  - (i) and (iv)
  - (i) only
- Enthalpy change ( $\Delta H$ ) of a system depends upon its
  - Initial state
  - Final state
  - Both on initial and final state
  - None of these
- ..... is a quantity which represents the total energy of the system
  - Internal energy
  - Chemical energy
  - Electrical energy
  - Mechanical energy
- Which of the following factors affect the internal energy of the system ?
  - Heat passes into or out of the system.
  - Work is done on or by the system.
  - Matter enters or leaves the system.
  - All of the above



14. The system that would not allow exchange of heat between the system and surroundings through its boundary is considered as  
 (a) isothermal (b) adiabatic  
 (c) isobaric (d) isochoric
15. The enthalpy change of a reaction does not depend on  
 (a) The state of reactants and products  
 (b) Nature of reactants and products  
 (c) Different intermediate reactions  
 (d) Initial and final enthalpy change of a reaction.
16. The  $q$  is ..... when heat is transferred from the surroundings to the system and  $q$  is ..... When heat is transferred from system to the surroundings.  
 (a) positive, negative (b) negative, positive  
 (c) high, low (d) low, high
17. Adiabatic expansions of an ideal gas is accompanied by  
 (a) decrease in  $\Delta E$   
 (b) increase in temperature  
 (c) decrease in  $\Delta S$   
 (d) no change in any one of the above properties
18. Which of the following statements is incorrect?  
 (a)  $q$  is a path dependent function.  
 (b)  $H$  is a state function.  
 (c) Both  $H$  and  $q$  are state functions.  
 (d) Both (a) and (b)
19. Figure below is showing that one mole of an ideal gas is fitted with a frictionless piston. Total volume of the gas is  $V_i$  and pressure of the gas inside is  $p$ . If external pressure is  $p_{ex}$  which is greater than  $p$  is applied, piston is moved inward till the pressure inside becomes equal to  $p_{ex}$ .
20. When 1 mol of a gas is heated at constant volume, temperature is raised from 298 to 308 K. If heat supplied to the gas is 500 J, then which statement is correct?  
 (a)  $q = w = 500 \text{ J}$ ,  $\Delta U = 0$  (b)  $q = \Delta U = 500 \text{ J}$ ,  $w = 0$   
 (c)  $q = -w = 500 \text{ J}$ ,  $\Delta U = 0$  (d)  $\Delta U = 0$ ,  $q = w = -500 \text{ J}$
21. The work done during the expansion of a gas from a volume of  $4 \text{ dm}^3$  to  $6 \text{ dm}^3$  against a constant external pressure of 3 atm is ( $1 \text{ L atm} = 101.32 \text{ J}$ )  
 (a)  $-6 \text{ J}$  (b)  $-608 \text{ J}$   
 (c)  $+304 \text{ J}$  (d)  $-304 \text{ J}$
22. Which of the following statements/relationships is **not** correct in thermodynamic changes?  
 (a)  $\Delta U = 0$  (isothermal reversible expansion of a gas)  
 (b)  $w = -nRT \ln \frac{V_2}{V_1}$  (isothermal reversible expansion of an ideal gas)  
 (c)  $w = nRT \ln \frac{V_2}{V_1}$  (isothermal reversible expansion of an ideal gas)  
 (d) For a system of constant volume heat involved directly changes to internal energy.
23. An ideal gas expands in volume from  $1 \times 10^{-3}$  to  $1 \times 10^{-2} \text{ m}^3$  at 300 K against a constant pressure of  $1 \times 10^5 \text{ Nm}^{-2}$ . The work done is  
 (a) 270 kJ (b)  $-900 \text{ kJ}$   
 (c)  $-900 \text{ J}$  (d) 900 kJ
24. The difference between  $\Delta H$  and  $\Delta U$  is usually significant for systems consisting of  
 (a) only solids (b) only liquids  
 (c) both solids and liquids (d) only gases
25. If a reaction involves only solids and liquids which of the following is true?  
 (a)  $\Delta H < \Delta E$  (b)  $\Delta H = \Delta E$   
 (c)  $\Delta H > \Delta E$  (d)  $\Delta H = \Delta E + RT\Delta n$
26. During isothermal expansion of an ideal gas, its  
 (a) internal energy increases  
 (b) enthalpy decreases  
 (c) enthalpy remains unaffected  
 (d) enthalpy reduces to zero.
27. Assume each reaction is carried out in an open container. For which reaction will  $\Delta H = \Delta E$ ?  
 (a)  $\text{C(s)} + 2\text{H}_2\text{O(g)} \rightarrow 2\text{H}_2\text{(g)} + \text{CO}_2\text{(g)}$   
 (b)  $\text{PCl}_5\text{(g)} \rightarrow \text{PCl}_3\text{(g)} + \text{Cl}_2\text{(g)}$   
 (c)  $2\text{CO(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{CO}_2\text{(g)}$   
 (d)  $\text{H}_2\text{(g)} + \text{Br}_2\text{(g)} \rightarrow 2\text{HBr(g)}$
28. For the reaction  $\text{CO(g)} + \frac{1}{2}\text{O}_2\text{(g)} \rightarrow \text{CO}_2\text{(g)}$   
 Which one of the statement is correct at constant  $T$  and  $P$ ?  
 (a)  $\Delta H = \Delta E$   
 (b)  $\Delta H < \Delta E$   
 (c)  $\Delta H > \Delta E$   
 (d)  $\Delta H$  is independent of physical state of the reactants



What does the shaded area represents in the figure ?

- (a) Work done (b) Pressure change  
 (c) Volume change (d) Temperature change

29. For a reaction in which all reactants and products are liquids, which one of the following equations is most applicable ?  
 (a)  $\Delta H < \Delta E$  (b)  $\Delta H = \Delta S$   
 (c)  $\Delta H = \Delta E$  (d)  $\Delta H = \Delta G$
30. The relationship between enthalpy change and internal energy change is  
 (a)  $\Delta H = \Delta E + P\Delta V$  (b)  $\Delta H = (\Delta E + V\Delta P)$   
 (c)  $\Delta H = \Delta E - P\Delta V$  (d)  $\Delta H = P\Delta V - \Delta E$
31. For the reaction  

$$\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{l})$$
 at constant temperature,  $\Delta H - \Delta E$  is  
 (a)  $-RT$  (b)  $+RT$   
 (c)  $-3RT$  (d)  $+3RT$
32. Consider the reaction :  $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$  carried out at constant temperature and pressure. If  $\Delta H$  and  $\Delta U$  are the enthalpy and internal energy changes for the reaction, which of the following expressions is true ?  
 (a)  $\Delta H > \Delta U$  (b)  $\Delta H < \Delta U$   
 (c)  $\Delta H = \Delta U$  (d)  $\Delta H = 0$
33. Among the following, the intensive properties are  
 (i) molar conductivity (ii) electromotive force  
 (iii) resistance (iv) heat capacity  
 (a) (ii) and (iii) (b) (i), (ii) and (iii)  
 (c) (i) and (iv) (d) (i) only
34. Which is an extensive property of the system ?  
 (a) Volume (b) Viscosity  
 (c) Temperature (d) Refractive index
35. Which of the following is an example of extensive property?  
 (a) Temperature (b) Density  
 (c) Mass (d) Pressure
36. Which of the following factors do not affect heat capacity?  
 (a) Size of system (b) Composition of system  
 (c) Nature of system (d) Temperature of the system
37. The heat required to raise the temperature of body by  $1^\circ\text{C}$  is called  
 (a) specific heat (b) thermal capacity  
 (c) water equivalent (d) None of these.
38. Equal volumes of two monoatomic gases, A and B, at same temperature and pressure are mixed. The ratio of specific heats ( $C_p/C_v$ ) of the mixture will be :  
 (a) 0.83 (b) 1.50  
 (c) 3.3 (d) 1.67
39. The molar heat capacity of water at constant pressure is  $75 \text{ JK}^{-1} \text{ mol}^{-1}$ . When  $1 \text{ kJ}$  of heat is supplied to  $100 \text{ g}$  of water, which is free to expand, the increase in temperature of water is  
 (a)  $6.6 \text{ K}$  (b)  $1.2 \text{ K}$   
 (c)  $2.4 \text{ K}$  (d)  $4.8 \text{ K}$
40. Calorie is equivalent to :  
 (a)  $0.4184 \text{ Joule}$  (b)  $4.184 \text{ Joule}$   
 (c)  $41.84 \text{ Joule}$  (d)  $418.4 \text{ Joule}$
41. Which of the following is not true regarding thermo-chemical equations?  
 (a) The coefficients in a balanced thermo-chemical equation refer to the number of moles of reactants and products involved in the reaction  
 (b) The coefficients in a balanced thermo-chemical equation refer to the number of molecules of reactants and products involved in the reaction  
 (c) The numerical value of  $\Delta_r H$  refers to the number of moles of substances specified by an equation.  
 (d) Standard enthalpy change  $\Delta_r H^\ominus$  will have units as  $\text{kJ mol}^{-1}$ .
42. The enthalpies of elements in their standard states are taken as zero. The enthalpy of formation of a compound  
 (a) is always negative  
 (b) is always positive  
 (c) may be positive or negative  
 (d) is never negative
43. If enthalpies of formation of  $\text{C}_2\text{H}_4(\text{g})$ ,  $\text{CO}_2(\text{g})$  and  $\text{H}_2\text{O}(\text{l})$  at  $25^\circ\text{C}$  and  $1 \text{ atm}$  pressure are  $52$ ,  $-394$  and  $-286 \text{ kJ/mol}$  respectively, the change in enthalpy is equal to  
 (a)  $-141.2 \text{ kJ/mol}$  (b)  $-1412 \text{ kJ/mol}$   
 (c)  $+14.2 \text{ kJ/mol}$  (d)  $+1412 \text{ kJ/mol}$
44. The enthalpy change for a reaction does **not** depend upon  
 (a) use of different reactants for the same product  
 (b) the nature of intermediate reaction steps  
 (c) the differences in initial or final temperatures of involved substances  
 (d) the physical states of reactants and products
45. On the basis of thermochemical equations (i), (ii) and (iii), find out which of the algebraic relationships given in options (a) to (d) is correct.  
 (i)  $\text{C}(\text{graphite}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}); \Delta_r H = x \text{ kJ mol}^{-1}$   
 (ii)  $\text{C}(\text{graphite}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO}(\text{g}); \Delta_r H = y \text{ kJ mol}^{-1}$   
 (iii)  $\text{CO}(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}); \Delta_r H = z \text{ kJ mol}^{-1}$   
 (a)  $z = x + y$  (b)  $x = y - z$   
 (c)  $x = y + z$  (d)  $y = 2z - x$
46. Given that bond energies of  $\text{H}-\text{H}$  and  $\text{Cl}-\text{Cl}$  are  $430 \text{ kJ mol}^{-1}$  and  $240 \text{ kJ mol}^{-1}$  respectively and  $\Delta_f H$  for  $\text{HCl}$  is  $-90 \text{ kJ mol}^{-1}$ , bond enthalpy of  $\text{HCl}$  is  
 (a)  $380 \text{ kJ mol}^{-1}$  (b)  $425 \text{ kJ mol}^{-1}$   
 (c)  $245 \text{ kJ mol}^{-1}$  (d)  $290 \text{ kJ mol}^{-1}$
47. Bond dissociation enthalpy of  $\text{H}_2$ ,  $\text{Cl}_2$  and  $\text{HCl}$  are  $434$ ,  $242$  and  $431 \text{ kJ mol}^{-1}$  respectively. Enthalpy of formation of  $\text{HCl}$  is:  
 (a)  $93 \text{ kJ mol}^{-1}$  (b)  $-245 \text{ kJ mol}^{-1}$   
 (c)  $-93 \text{ kJ mol}^{-1}$  (d)  $245 \text{ kJ mol}^{-1}$

48. From the following bond energies:

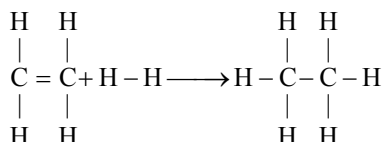
H – H bond energy: 431.37 kJ mol<sup>-1</sup>

C = C bond energy: 606.10 kJ mol<sup>-1</sup>

C – C bond energy: 336.49 kJ mol<sup>-1</sup>

C – H bond energy: 410.50 kJ mol<sup>-1</sup>

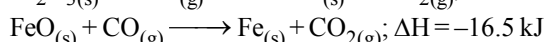
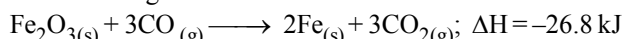
Enthalpy for the reaction,



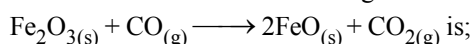
will be:

- (a) -243.6 kJ mol<sup>-1</sup> (b) -120.0 kJ mol<sup>-1</sup>  
(c) 553.0 kJ mol<sup>-1</sup> (d) 1523.6 kJ mol<sup>-1</sup>

49. The following two reactions are known :



The value of  $\Delta H$  for the following reaction



- (a) +6.2 kJ (b) +10.3 kJ  
(c) -43.3 kJ (d) -10.3 kJ

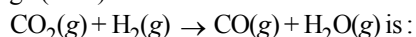
50. Consider the following processes :

	$\Delta H$ (kJ/mol)
$1/2 \text{ A} \rightarrow \text{B}$	+150
$3\text{B} \rightarrow 2\text{C} + \text{D}$	-125
$\text{E} + \text{A} \rightarrow 2\text{D}$	+350

For  $\text{B} + \text{D} \rightarrow \text{E} + 2\text{C}$ ,  $\Delta H$  will be :

- (a) 525 kJ/mol (b) -175 kJ/mol  
(c) -325 kJ/mol (d) 325 kJ/mol

51. The  $\Delta_f H^\circ$  for  $\text{CO}_2(\text{g})$ ,  $\text{CO}(\text{g})$  and  $\text{H}_2\text{O}(\text{g})$  are -393.5, -110.5 and -241.8 kJ/mol respectively, the standard enthalpy change (in kJ) for the reaction



- (a) 524.1 (b) 41.2  
(c) -262.5 (d) -41.2

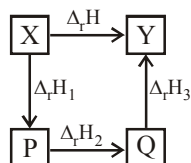
52. If enthalpies of formation of  $\text{C}_2\text{H}_4(\text{g})$ ,  $\text{CO}_2(\text{g})$  and  $\text{H}_2\text{O}(\text{l})$  at 25°C and 1 atm pressure are 52, -394 and -286 kJ/mol respectively, the change in enthalpy is equal to

- (a) -141.2 kJ/mol (b) -1412 kJ/mol  
(c) +14.2 kJ/mol (d) +1412 kJ/mol

53. Hess's law is used to calculate :

- (a) enthalpy of reaction. (b) entropy of reaction  
(c) work done in reaction (d) All of the above

54. Which thermochemical process is shown by the following figure ?



- (a) Standard enthalpy of a reaction  
(b) Born – Haber cycle of lattice enthalpy  
(c) Hess's law of constant heat summation  
(d) Standard enthalpy of a solution

55. The enthalpy change on breaking one mole of bonds completely to obtain atoms in the gas phase is known as

- (a) enthalpy of atomization.  
(b) enthalpy of formation  
(c) enthalpy of sublimation  
(d) enthalpy of vaporization

56. Which of the following statements is true for the given reaction?

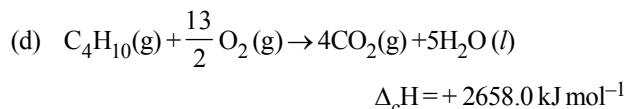
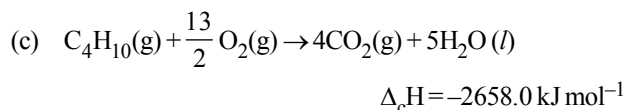
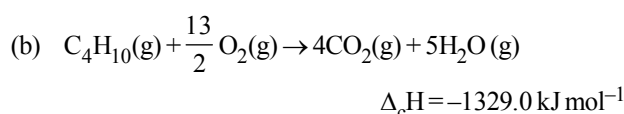
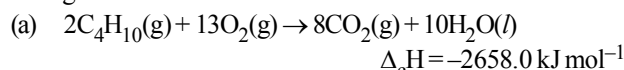


- (a) The enthalpy of atomization is same as the enthalpy of vaporisation  
(b) The enthalpy of atomization is same as the enthalpy of sublimation.  
(c) The enthalpy of atomization is same as the bond enthalpy  
(d) The enthalpy of atomization is same as the enthalpy of solution

57. The heat of combustion of a substance is :

- (a) Always positive  
(b) Always negative  
(c) Numerically equal to the heat of formation  
(d) Unpredictable

58. During complete combustion of one mole of butane, 2658 kJ of heat is released. The thermochemical reaction for above change is



59. Given that heat of neutralisation of strong acid and strong base is -57.1 kJ. The heat produced when 0.25 mole of HCl is neutralised with 0.25 mole of NaOH in aqueous solution is :

- (a) 14.275 kJ (b) 57.1 kJ  
(c) 22.5 kJ (d) 28.6 kJ

60. For most of the ionic compounds,  $\Delta H_{\text{sol}}$  is ..... and the dissociation process is .....

- (a) positive, exothermic (b) negative, exothermic  
(c) positive, endothermic (d) negative, endothermic

61. Pick out the wrong statement
- The standard free energy of formation of all elements is zero
  - A process accompanied by decrease in entropy is spontaneous under certain conditions
  - The entropy of a perfectly crystalline substance at absolute zero is zero
  - A process that leads to increase in free energy will be spontaneous
62. Identify the correct statement for change of Gibbs energy for a system ( $\Delta G_{\text{system}}$ ) at constant temperature and pressure
- If  $\Delta G_{\text{system}} = 0$ , the system has attained equilibrium
  - If  $\Delta G_{\text{system}} = 0$ , the system is still moving in a particular direction
  - If  $\Delta G_{\text{system}} < 0$ , the process is not spontaneous
  - If  $\Delta G_{\text{system}} > 0$ , the process is not spontaneous
63. Identify the correct statement regarding a spontaneous process:
- Lowering of energy in the process is the only criterion for spontaneity.
  - For a spontaneous process in an isolated system, the change in entropy is positive.
  - Endothermic processes are never spontaneous.
  - Exothermic processes are always spontaneous.
64. A chemical reaction will be spontaneous if it is accompanied by a decrease of
- entropy of the system.
  - enthalpy of the system.
  - internal energy of the system.
  - free energy of the system.
65. In which of the following entropy decreases?
- Crystallization of sucrose solution
  - Rusting of iron
  - Melting of ice
  - Vaporization of camphor
66. A spontaneous reaction is impossible if
- both  $\Delta H$  and  $\Delta S$  are negative
  - both  $\Delta H$  and  $\Delta S$  are positive
  - $\Delta H$  is negative and  $\Delta S$  is positive
  - $\Delta H$  is positive and  $\Delta S$  is negative
67. For the gas phase reaction,
- $$\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$$
- which of the following conditions are correct ?
- $\Delta H = 0$  and  $\Delta S < 0$
  - $\Delta H > 0$  and  $\Delta S > 0$
  - $\Delta H < 0$  and  $\Delta S < 0$
  - $\Delta H > 0$  and  $\Delta S < 0$
68. The factor of  $\Delta G$  values is important in metallurgy. The  $\Delta G$  values for the following reactions at  $800^\circ\text{C}$  are given as :
- $$\text{S}_2(\text{s}) + 2\text{O}_2(\text{g}) \longrightarrow 2\text{SO}_2(\text{g}) ; \Delta G = -544 \text{ kJ}$$
- $$2\text{Zn}(\text{s}) + \text{S}_2(\text{s}) \longrightarrow 2\text{ZnS}(\text{s}) ; \Delta G = -293 \text{ kJ}$$
- $$2\text{Zn}(\text{s}) + \text{O}_2(\text{g}) \longrightarrow 2\text{ZnO}(\text{s}) ; \Delta G = -480 \text{ kJ}$$
- Then  $\Delta G$  for the reaction :
- $$2\text{ZnS}(\text{s}) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{ZnO}(\text{s}) + 2\text{SO}_2(\text{g})$$
- will be :
- 357 kJ
  - 731 kJ
  - 773 kJ
  - 229 kJ
69. Identify the correct statement regarding entropy.
- At absolute zero temperature, entropy of a perfectly crystalline substance is taken to be zero.
  - At absolute zero temperature, the entropy of a perfectly crystalline substance is positive.
  - Absolute entropy of a substance cannot be determined.
  - At  $0^\circ\text{C}$ , the entropy of a perfectly crystalline substance is taken to be zero
70. Unit of entropy is
- $\text{JK}^{-1} \text{mol}^{-1}$
  - $\text{J mol}^{-1}$
  - $\text{J}^{-1} \text{K}^{-1} \text{mol}^{-1}$
  - $\text{JK mol}^{-1}$
71. Considering entropy ( $S$ ) as a thermodynamic parameter, the criterion for the spontaneity of any process is
- $\Delta S_{\text{system}} + \Delta S_{\text{surroundings}} > 0$
  - $\Delta S_{\text{system}} - \Delta S_{\text{surroundings}} > 0$
  - $\Delta S_{\text{system}} > 0$  only
  - $\Delta S_{\text{surroundings}} > 0$  only
72. In an exothermic reaction (reversible) which of the following has positive value?
- Enthalpy
  - Entropy
  - Gibb's free energy
  - None of these
73. A reaction cannot take place spontaneously at any temperature when
- both  $\Delta H$  and  $\Delta S$  are positive
  - both  $\Delta H$  and  $\Delta S$  are negative
  - $\Delta H$  is negative and  $\Delta S$  is positive
  - $\Delta H$  is positive and  $\Delta S$  is negative
74. A reaction is spontaneous at low temperature but non-spontaneous at high temperature. Which of the following is true for the reaction?
- $\Delta H > 0, \Delta S > 0$
  - $\Delta H < 0, \Delta S > 0$
  - $\Delta H > 0, \Delta S = 0$
  - $\Delta H < 0, \Delta S < 0$
75. At the sublimation temperature, for the process
- $$\text{CO}_2(\text{s}) \rightleftharpoons \text{CO}_2(\text{g})$$
- $\Delta H, \Delta S$  and  $\Delta G$  are all positive
  - $\Delta H > 0, \Delta S > 0$  and  $\Delta G < 0$
  - $\Delta H < 0, \Delta S > 0$  and  $\Delta G < 0$
  - $\Delta H > 0, \Delta S > 0$  and  $\Delta G = 0$
76. Choose the reaction with negative  $\Delta S$  value.
- $2\text{NaHCO}_3(\text{s}) \rightarrow \text{Na}_2\text{CO}_3(\text{s}) + \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{g})$
  - $\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$
  - $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$
  - $2\text{KClO}_3(\text{s}) \rightarrow 2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g})$

77. A chemical reaction is spontaneous at 298 K but non-spontaneous at 350 K. Which one of the following is true for the reaction?
- |     | $\Delta G$ | $\Delta H$ | $\Delta S$ |
|-----|------------|------------|------------|
| (a) | –          | –          | +          |
| (b) | +          | +          | +          |
| (c) | –          | +          | –          |
| (d) | –          | –          | –          |
78. For a particular reversible reaction at temperature  $T$ ,  $\Delta H$  and  $\Delta S$  were found to be both +ve. If  $T_e$  is the temperature at equilibrium, the reaction would be spontaneous when
- (a)  $T_e > T$  (b)  $T > T_e$   
 (c)  $T_e$  is 5 times  $T$  (d)  $T = T_e$
79. Which of the following pairs of a chemical reaction is certain to result in a spontaneous reaction?
- (a) Exothermic and increasing disorder  
 (b) Exothermic and decreasing disorder  
 (c) Endothermic and increasing disorder  
 (d) Endothermic and decreasing disorder
80. In which of the following reactions, standard entropy change ( $\Delta S^\circ$ ) is positive and standard Gibb's energy change ( $\Delta G^\circ$ ) decreases sharply with increasing temperature?
- (a)  $\text{C graphite} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO}(\text{g})$   
 (b)  $\text{CO}(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$   
 (c)  $\text{Mg}(\text{s}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{MgO}(\text{s})$   
 (d)  $\frac{1}{2} \text{C graphite} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \frac{1}{2} \text{CO}_2(\text{g})$
81. Consider the following reaction occurring in an automobile
- $$2\text{C}_8\text{H}_{18}(\text{g}) + 25\text{O}_2(\text{g}) \longrightarrow 16\text{CO}_2(\text{g}) + 18\text{H}_2\text{O}(\text{g})$$
- the sign of  $\Delta H$ ,  $\Delta S$  and  $\Delta G$  would be
- (a) +, –, + (b) –, +, –  
 (c) –, +, + (d) +, +, –
82. A reaction occurs spontaneously if
- (a)  $T\Delta S < \Delta H$  and both  $\Delta H$  and  $\Delta S$  are +ve  
 (b)  $T\Delta S > \Delta H$  and  $\Delta H$  is +ve and  $\Delta S$  is –ve  
 (c)  $T\Delta S > \Delta H$  and both  $\Delta H$  and  $\Delta S$  are +ve  
 (d)  $T\Delta S = \Delta H$  and both  $\Delta H$  and  $\Delta S$  are +ve
83. The enthalpy of fusion of water is 1.435 kCal/mol. The molar entropy change for the melting of ice at  $0^\circ\text{C}$  is:
- (a) 10.52 cal / (mol K) (b) 21.04 cal / (mol K)  
 (c) 5.260 cal / (mol K) (d) 0.526 cal / (mol K)
- (ii) Variables like P, V and T are called state variables or state functions  
 (iii) Their values depend only on the state of the system and not on how it is reached.
- (a) (i) and (ii) are correct  
 (b) (ii) and (iii) are correct  
 (c) (i), (ii) and (iii) are correct  
 (d) Only (iii) is correct
85. Read the following statements carefully and choose the correct option
- (i) Internal energy, U, of the system is a state function.  
 (ii) –w shows, that work is done on the system.  
 (iii) +w shows, that work is done by the system
- (a) (i) and (ii) are correct (b) (ii) and (iii) are correct  
 (c) (i) and (iii) are correct (d) Only (i) is correct
86. Read the following statements carefully and choose the correct answer
- (i) Expansion of a gas in vacuum ( $p_{\text{ex}} = 0$ ) is called free expansion.  
 (ii) Work is done during free expansion of an ideal gas whether the process is reversible or irreversible  
 (iii) No work is done during free expansion of an ideal gas whether the process is reversible or irreversible  
 (iv) No work is done during free expansion of an ideal gas when the process is reversible
- (a) Only statement (iii) is correct  
 (b) Statements (i) and (iii) are correct  
 (c) Statements (ii) and (iv) are correct  
 (d) Statements (i) and (iv) are correct
87. Which of the following statement(s) is/are correct?
- (i) In case of expansion maximum amount of work can be obtained under isothermal conditions by reversibly carrying out the process rather than through irreversible route.  
 (ii) In case of compression, minimum amount of work can be done on system by carrying out the process irreversibly than reversibly.
- (a) (i) and (ii) (b) Only (i)  
 (c) Only (ii) (d) Neither (i) nor (ii)
88. Read the following statements carefully and choose the correct option
- (i) In case of diatomic molecules the enthalpy of atomization is also the bond dissociation enthalpy.  
 (ii) In case polyatomic molecules, bond dissociation enthalpy is different for different bonds within the same molecule.
- (a) Both (i) and (ii) are correct  
 (b) (i) is correct but (ii) is incorrect  
 (c) (ii) is correct but (i) is incorrect  
 (d) Both (i) and (ii) are incorrect

### STATEMENT TYPE QUESTIONS

84. Read the following statements carefully and choose the correct option
- (i) The state of the system is specified by state functions or state variables.



89. Read the following statements regarding spontaneity of a process and mark the appropriate choice.
- When enthalpy factor is absent than randomness factor decides spontaneity of a process.
  - When randomness factor is absent then enthalpy factor decides spontaneity of a process.
  - When both the factors take place simultaneously, the magnitude of both the factors decide spontaneity of a process.
- Statements (i) and (ii) are correct and (iii) is incorrect.
  - Statement (iii) is correct, (i) and (ii) are incorrect.
  - Statements (i), (ii) and (iii) are correct.
  - Statements (i), (ii) and (iii) are incorrect.
90. Which of the following statement is incorrect ?
- The standard enthalpy of reaction is the enthalpy change for a reaction when all the participating substances are in their standard states.
  - The standard state of a substance at a specified temperature is its pure form at 1 bar.
  - The standard state of solid iron at 298 K is pure iron at 1 bar
  - Standard conditions are denoted by adding the superscript  $\ominus$  to the symbol  $\Delta H$  e.g.,  $-\Delta H^\ominus$

### MATCHING TYPE QUESTIONS

91. Match the columns

Column-I	Column-II
(A) $C_m$	(p) $C_v \Delta T$
(B) $q$	(q) $C/n$
(C) $\Delta U$	(r) $C_p \Delta T$
(D) $\Delta H$	(s) $C \Delta T$
(a) A – (q), B – (s), C – (r), D – (p)	
(b) A – (q), B – (s), C – (p), D – (r)	
(c) A – (s), B – (q), C – (p), D – (r)	
(d) A – (q), B – (p), C – (r), D – (s)	

92. Match the columns

Column-I	Column-II
(A) Free expansion at $\Delta V=0$	(p) $q = -w = nRT \ln \frac{V_f}{V_i}$
(B) Isothermal irreversible change	(q) $\Delta U = w_{ad}$
(C) Isothermal reversible change	(r) $\Delta U = q_v$
(D) For adiabatic change	(s) $q = -w = P_{ex} (V_f - V_i)$
(a) A – (s), B – (p), C – (r), D – (q)	
(b) A – (r), B – (q), C – (p), D – (s)	
(c) A – (r), B – (s), C – (p), D – (q)	
(d) A – (q), B – (r), C – (s), D – (p)	

93. Match the columns

Column-I	Column-II
(A) $p_{ext} = 0$	(p) Free expansion of an ideal gas
(B) $q = p_{ext} (V_f - V_i)$	(q) Adiabatic change
(C) $q = 2.303 nRT \log (V_f / V_i)$	(r) Isothermal reversible change
(D) $\Delta U = W_{ad}$	(s) Isothermal irreversible change
(a) A – (p), B – (s), C – (r), D – (q)	
(b) A – (p), B – (q), C – (r), D – (s)	
(c) A – (p), B – (r), C – (s), D – (q)	
(d) A – (p), B – (r), C – (q), D – (s)	

94. Match the columns

Column-I	Column-II
(A) $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$	(p) $\Delta H = \Delta U - 2RT$
(B) $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$	(q) $\Delta H = \Delta U + 3RT$
(C) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$	(r) $\Delta H = \Delta U$
(D) $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$	(s) $\Delta H = \Delta U + RT$
(a) A – (r), B – (p), C – (q), D – (s)	
(b) A – (r), B – (s), C – (p), D – (q)	
(c) A – (q), B – (p), C – (s), D – (r)	
(d) A – (s), B – (q), C – (p), D – (r)	

95. Match the columns

Column-I	Column-II
(A) $C_4H_{10} + \frac{13}{2} O_2 \rightarrow 4CO_2 + 5H_2O; \Delta H = -w$	(p) Enthalpy of atomisation
(B) $CH_4 \rightarrow C + 4H; \Delta H = x$	(q) Enthalpy of formation
(C) $H_2 + Br_2 \rightarrow 2HBr; \Delta H = y$	(r) Enthalpy of combustion
(D) $Na^-(s) \rightarrow Na(g); \Delta H = z$	(s) Enthalpy of sublimation
(a) A – (s), B – (p), C – (q), D – (r)	
(b) A – (q), B – (r), C – (p), D – (s)	
(c) A – (r), B – (p), C – (q), D – (s)	
(d) A – (p), B – (q), C – (s), D – (r)	

96. Match the columns

Column-I	Column-II
(A) Exothermic	(p) $\Delta H = 0, \Delta E = 0$
(B) Spontaneous	(q) $\Delta G = 0$
(C) Cyclic process	(r) $\Delta H$ is negative
(D) Equilibrium	(s) $\Delta G$ is negative
(a) A – (q), B – (r), C – (p), D – (s)	
(b) A – (s), B – (p), C – (r), D – (q)	
(c) A – (p), B – (q), C – (s), D – (r)	
(d) A – (r), B – (s), C – (p), D – (q)	

97. Match the columns

- | Column-I  | Column-II  |
|---|--|
| (A) $\Delta H = -ve$ ; $\Delta S = -ve$<br>$\Delta G = -ve$ | (p) Reaction will be non-spontaneous at high temperature |
| (B) $\Delta H = -ve$ ; $\Delta S = -ve$<br>$\Delta G = +ve$ | (q) Reaction will be non-spontaneous at low temperature  |
| (C) $\Delta H = +ve$ ; $\Delta S = +ve$<br>$\Delta G = +ve$ | (r) Reaction will be spontaneous at low temperature      |
| (D) $\Delta H = +ve$ ; $\Delta S = +ve$<br>$\Delta G = -ve$ | (s) Reaction will be spontaneous at high temperature     |
- (a) A – (q), B – (r), C – (p), D – (s)  
 (b) A – (r), B – (p), C – (q), D – (s)  
 (c) A – (r), B – (q), C – (s), D – (p)  
 (d) A – (q), B – (s), C – (p), D – (r)

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

98. **Assertion :** T, P and V are state variables or state functions.  
**Reason :** Their values depend on the state of the system and how it is reached.

99. **Assertion :** At constant temperature and pressure whatever heat absorbed by the system is used in doing work.  
**Reason :** Internal energy change is zero.

100. **Assertion :** For an isothermal reversible process  $Q = -W$  i.e. work done by the system equals the heat absorbed by the system.  
**Reason :** Enthalpy change ( $\Delta H$ ) is zero for isothermal process.

101. **Assertion :** Absolute value of internal energy of a substance cannot be determined.  
**Reason :** It is impossible to determine exact values of constituent energies of the substances.

102. **Assertion :** A process is called adiabatic if the system does not exchange heat with the surroundings.  
**Reason :** It does not involve increase or decrease in temperature of the system.

103. **Assertion :** There is exchange in internal energy in a cyclic process.  
**Reason :** Cyclic process is the one in which the system returns to its initial state after a number of reactions.

104. **Assertion :** Internal energy is an extensive property.  
**Reason :** Internal energy depends upon the amount of the system.

105. **Assertion :** The mass and volume of a substance are the extensive properties and are proportional to each other.

**Reason :** The ratio of mass of a sample to its volume is an intensive property.

106. **Assertion :** First law of thermodynamics is applicable to an electric fan or a heater.

**Reason :** In an electric fan, the electrical energy is converted into mechanical work that moves the blades. In a heater, electrical energy is converted into heat energy.

107. **Assertion :** The value of enthalpy of neutralization of weak acid and strong base is numerically less than 57.1 kJ.

**Reason :** All the  $\text{OH}^-$  ions furnished by 1 g equivalent of strong base are not completely neutralized.

108. **Assertion :** When a solid melts, decrease in enthalpy is observed.

**Reason :** Melting of a solid is endothermic.

109. **Assertion :** Many endothermic reactions that are not spontaneous at room temperature become spontaneous at high temperature.

**Reason :** Entropy of the system increases with increase in temperature.

110. **Assertion :** An exothermic process which is non-spontaneous at high temperature may become spontaneous at a low temperature.

**Reason :** There occurs a decrease in entropy factor as the temperature is decreased.

### CRITICAL THINKING TYPE QUESTIONS

111. In an adiabatic process, no transfer of heat takes place between system and surroundings. Choose the correct option for free expansion of an ideal gas under adiabatic condition from the following.

- (a)  $q = 0, \Delta T \neq 0, w = 0$  (b)  $q \neq 0, \Delta T = 0, w = 0$   
 (c)  $q = 0, \Delta T = 0, w = 0$  (d)  $q = 0, \Delta T < 0, w \neq 0$

112. According to the first law of thermodynamics which of the following quantities represents change in a state function ?

- (a)  $q_{\text{rev}}$  (b)  $q_{\text{rev}} - W_{\text{rev}}$   
 (c)  $q_{\text{rev}}/W_{\text{rev}}$  (d)  $q_{\text{rev}} + W_{\text{rev}}$

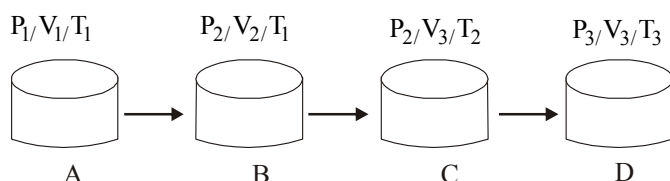
113. If  $\Delta H$  is the change in enthalpy and  $\Delta E$ , the change in internal energy accompanying a gaseous reaction, then

- (a)  $\Delta H$  is always greater than  $\Delta E$   
 (b)  $\Delta H < \Delta E$  only if the number of moles of the products is greater than the number of moles of the reactants  
 (c)  $\Delta H$  is always less than  $\Delta E$   
 (d)  $\Delta H < \Delta E$  only if the number of moles of products is less than the number of moles of the reactants

114. For an isothermal reversible expansion process, the value of  $q$  can be calculated by the expression

- (a)  $q = 2.303nRT \log \frac{V_2}{V_1}$  (b)  $q = -2.303nRT \log \frac{V_2}{V_1}$   
 (c)  $q = -P_{\text{exp}}nRT \log \frac{V_1}{V_2}$  (d) None of these

115. A piston filled with 0.04 mol of an ideal gas expands reversibly from 50.0 mL to 375 mL at a constant temperature of 37.0°C. As it does so, it absorbs 208 J of heat. The values of  $q$  and  $w$  for the process will be:  
( $R = 8.314 \text{ J/mol K}$ ) ( $\ln 7.5 = 2.01$ )
- $q = +208 \text{ J}$ ,  $w = -208 \text{ J}$
  - $q = -208 \text{ J}$ ,  $w = -208 \text{ J}$
  - $q = -208 \text{ J}$ ,  $w = +208 \text{ J}$
  - $q = +208 \text{ J}$ ,  $w = +208 \text{ J}$
116. According to the first law of thermodynamics,  $\Delta U = q + W$ . In special cases the statement can be expressed in different ways. Which of the following is not a correct expression?
- At constant temperature  $q = -W$
  - When no work is done  $\Delta U = q$
  - In gaseous system  $\Delta U = q + P\Delta V$
  - When work is done by the system :  $\Delta U = q + W$
117. The internal energy change when a system goes from state A to B is 40 kJ/mole. If the system goes from A to B by a reversible path and returns to state A by an irreversible path what would be the net change in internal energy?
- $> 40 \text{ kJ}$
  - $< 40 \text{ kJ}$
  - Zero
  - 40 kJ
118. Under isothermal condition for one mole of ideal gas what is the ratio of work done under reversible to irreversible process, initially held at 20 atm undergoes expansion from 1L to 2L, at 298K, under external pressure of 10 atm?
- 1.7
  - 2.0
  - 1.4
  - 1.0
119. Processes A to B, B to C and C to D shown in the figure below respectively are ?



- Isothermal, isobaric and isochoric
  - Isobaric, isothermal and isochoric
  - Isothermal, isothermal and isobaric
  - Isobaric, isobaric and isothermal
120. What is the internal energy (kJ) change occurs when 36g of  $\text{H}_2\text{O}(l)$  converted to  $\text{H}_2\text{O}(g)$ ?  $\Delta H^\circ(\text{vapourisation}) = 40.79 \text{ kJ/mol}$
- 75.38
  - 80.98
  - 70.98
  - 45.89
121. Consider the reaction :
- $$4\text{NO}_2(g) + \text{O}_2(g) \rightarrow 2\text{N}_2\text{O}_5(g),$$
- $$\Delta_r H = -111 \text{ kJ}.$$
- If  $\text{N}_2\text{O}_5(s)$  is formed instead of  $\text{N}_2\text{O}_5(g)$  in the above reaction, the  $\Delta_r H$  value will be :
- (given,  $\Delta H$  of sublimation for  $\text{N}_2\text{O}_5$  is  $-54 \text{ kJ mol}^{-1}$ )
- +54 kJ
  - +219 kJ
  - 219 J
  - 165 kJ

122. An ideal gas is allowed to expand both reversibly and irreversibly in an isolated system. If  $T_i$  is the initial temperature and  $T_f$  is the final temperature, which of the following statements is correct?
- $(T_f)_{\text{rev}} = (T_f)_{\text{irrev}}$
  - $T_f = T_i$  for both reversible and irreversible processes
  - $(T_f)_{\text{irrev}} > (T_f)_{\text{rev}}$
  - $T_f > T_i$  for reversible process but  $T_f = T_i$  for irreversible process

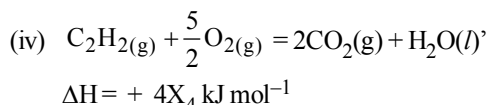
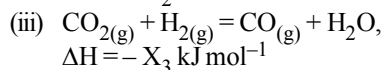
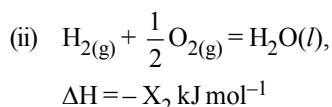
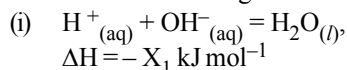
123. Given

Reaction	Energy Change (in kJ)
$\text{Li}(s) \rightarrow \text{Li}(g)$	161
$\text{Li}(g) \rightarrow \text{Li}^+(g)$	520
$\frac{1}{2}\text{F}_2(g) \rightarrow \text{F}(g)$	77
$\text{F}(g) + e^- \rightarrow \text{F}^-(g)$	(Electron gain enthalpy)
$\text{Li}^+(g) + \text{F}^-(g) \rightarrow \text{LiF}(s)$	-1047
$\text{Li}(s) + \frac{1}{2}\text{F}_2(g) \rightarrow \text{LiF}(s)$	-617

Based on data provided, the value of electron gain enthalpy of fluorine would be :

- $-300 \text{ kJ mol}^{-1}$
  - $-350 \text{ kJ mol}^{-1}$
  - $-328 \text{ kJ mol}^{-1}$
  - $-228 \text{ kJ mol}^{-1}$
124. The standard enthalpy of formation ( $\Delta_f H^\circ_{298}$ ) for methane,  $\text{CH}_4$  is  $-74.9 \text{ kJ mol}^{-1}$ . In order to calculate the average energy given out in the formation of a C-H bond from this it is necessary to know which one of the following?
- The dissociation energy of the hydrogen molecule,  $\text{H}_2$ .
  - The first four ionisation energies of carbon.
  - The dissociation energy of  $\text{H}_2$  and enthalpy and sublimation of carbon (graphite).
  - The first four ionisation energies of carbon and electron affinity of hydrogen.
125. For complete combustion of ethanol,
- $$\text{C}_2\text{H}_5\text{OH}(l) + 3\text{O}_2(g) \longrightarrow 2\text{CO}_2(g) + 3\text{H}_2\text{O}(l),$$
- the amount of heat produced as measured in bomb calorimeter, is  $1364.47 \text{ kJ mol}^{-1}$  at 25°C. Assuming ideality the enthalpy of combustion,  $\Delta_c H$ , for the reaction will be: ( $R = 8.314 \text{ kJ mol}^{-1}$ )
- $-1366.95 \text{ kJ mol}^{-1}$
  - $-1361.95 \text{ kJ mol}^{-1}$
  - $-1460.95 \text{ kJ mol}^{-1}$
  - $-1350.50 \text{ kJ mol}^{-1}$
126. Standard enthalpy of vapourisation  $\Delta_{\text{vap}} H^\circ$  for water at 100°C is  $40.66 \text{ kJ mol}^{-1}$ . The internal energy of vaporisation of water at 100°C (in  $\text{kJ mol}^{-1}$ ) is :
- +37.56
  - 43.76
  - +43.76
  - +40.66
- (Assume water vapour to behave like an ideal gas).

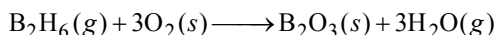
127. Consider the following reactions:



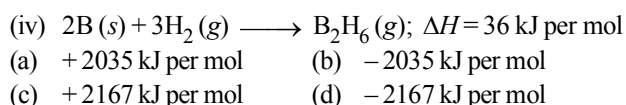
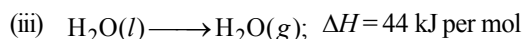
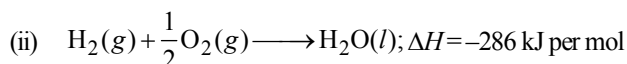
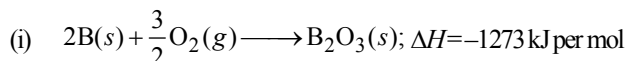
Enthalpy of formation of  $\text{H}_2\text{O}_{(\text{l})}$  is

- (a)  $+X_3 \text{ kJ mol}^{-1}$  (b)  $-X_4 \text{ kJ mol}^{-1}$   
 (c)  $+X_1 \text{ kJ mol}^{-1}$  (d)  $-X_2 \text{ kJ mol}^{-1}$

128. Diborane is a potential rocket fuel which undergoes combustion according to the equation



Calculate the enthalpy change for the combustion of diborane. Given



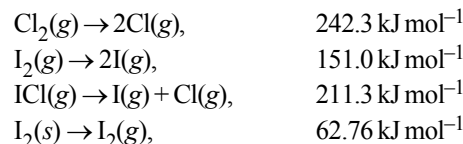
129. How many molecules of ATP, undergo hydrolysis to raise the temperature of 180 kg of water which was originally at room temperature by  $1^\circ\text{C}$ ?  $C_{\text{P,m}} \text{ water} = 75.32 \text{ J/mol K}$ ,  $\Delta H_{\text{P}}$  for ATP hydrolysis = 7 kcal/mol

- (a)  $1.5 \times 10^{25}$  (b)  $2.00 \times 10^{23}$   
 (c)  $3.4 \times 10^{25}$  (d)  $4.0 \times 10^{24}$

130. What is the amount of heat (in Joules) absorbed by 18 g of water initially at room temperature heated to  $100^\circ\text{C}$ ? If 10g of Cu is added to this water, then decrease in temperature (in Kelvin) of water was found to be?  $C_{\text{P,m}}$  for water  $75.32 \text{ J/mol K}$ ;  $C_{\text{P,m}}$  for Cu =  $24.47 \text{ J/mol K}$ .

- (a) 5649, 369 (b) 5544, 324  
 (c) 5278, 342 (d) 3425, 425

131. The enthalpy changes for the following processes are listed below :



Given that the standard states for iodine and chlorine are  $\text{I}_2(\text{s})$  and  $\text{Cl}_2(\text{g})$ , the standard enthalpy of formation for  $\text{ICl}(\text{g})$  is :

- (a)  $+16.8 \text{ kJ mol}^{-1}$  (b)  $+244.8 \text{ kJ mol}^{-1}$   
 (c)  $-14.6 \text{ kJ mol}^{-1}$  (d)  $-16.8 \text{ kJ mol}^{-1}$

132. What is the equilibrium constant if ATP hydrolysis by water produce standard free energy of  $-50 \text{ kJ/mole}$  under normal body conditions ?

- (a)  $2.66 \times 10^8$  (b)  $5.81 \times 10^8$   
 (c)  $1.18 \times 10^7$  (d)  $1.98 \times 10^8$

133. A reaction with  $\Delta H = 0$ , is found to be spontaneous. This is due to

- (a)  $\Delta S$  is negative (b)  $\Delta S$  is positive  
 (c)  $T\Delta S$  is positive (d) Both (b) and (c)

134. In an irreversible process taking place at constant T and P and in which only pressure-volume work is being done, the change in Gibbs free energy (dG) and change in entropy (dS), satisfy the criteria

- (a)  $(dS)_{V,E} > 0, (dG)_{T,P} < 0$   
 (b)  $(dS)_{V,E} = 0, (dG)_{T,P} = 0$   
 (c)  $(dS)_{V,E} = 0, (dG)_{T,P} > 0$   
 (d)  $(dS)_{V,E} < 0, (dG)_{T,P} < 0$

135. In conversion of lime-stone to lime,

$\text{CaCO}_{3(\text{s})} \rightarrow \text{CaO}_{(\text{s})} + \text{CO}_{2(\text{g})}$  the values of  $\Delta H^\circ$  and  $\Delta S^\circ$  are  $+179.1 \text{ kJ mol}^{-1}$  and  $160.2 \text{ J/K}$  respectively at 298 K and 1 bar. Assuming that  $\Delta H^\circ$  and  $\Delta S^\circ$  do not change with temperature, temperature above which conversion of limestone to lime will be spontaneous is

- (a) 1118 K (b) 1008 K  
 (c) 1200 K (d) 845 K.

136. For vaporization of water at 1 atmospheric pressure, the values of  $\Delta H$  and  $\Delta S$  are  $40.63 \text{ kJ mol}^{-1}$  and  $108.8 \text{ JK}^{-1} \text{ mol}^{-1}$ , respectively. The temperature when Gibbs energy change ( $\Delta G$ ) for this transformation will be zero, is:

- (a) 293.4 K (b) 273.4 K  
 (c) 393.4 K (d) 373.4 K.

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (c)
2. (b) The laws of thermodynamics deal with energy changes of macroscopic systems involving a large number of molecules rather than microscopic systems containing a few molecules.
3. (b)
4. (c) The universe = The system + The surroundings
5. (c)
6. (c) Closed system can exchange energy and not matter with surroundings. Pressure cooker provides closed system.
7. (c) Isolated system can not exchange mass or energy.
8. (b) We can describe the state of a gas by quoting its pressure (P), volume (V), temperature (T), amount (n) etc.
9. (d) We know that q (heat) and work (w) are not state functions but (q + w) is a state function. H – TS (i.e. G) is also a state functions. Thus II and III are not state functions so the correct answer is option (d).
10. (c) Internal energy and molar enthalpy are state functions. Work (reversible or irreversible) is a path function.
11. (c)
12. (a) Internal energy is a quantity which represents the total energy of the system. It may be chemical, electrical, and mechanical or any other type of energy you may think of, the sum of all these is the internal energy of the system.
13. (d) 14. (b)
15. (c) In accordance with Hess's law.
16. (a)
17. (a)  $\Delta E = \Delta Q - W$   
For adiabatic expansion,  $\Delta Q = 0$   
 $\Rightarrow \Delta E = -W$   
The negative sign shows decrease in Internal energy, which is equal to the work done on the system by the surroundings.
18. (d) q is a path dependent function, H is a state function because it depends on U, p and V, all of which are state functions.
19. (a) The shaded area shows work done on an ideal gas in a cylinder when it is compressed by a constant external pressure
20. (b) As volume is constant hence work done in this process is zero hence heat supplied is equal to change in internal energy.
21. (b)  $W = -p\Delta V$   
 $= -3(6 - 4) = -6 \text{ litre atmosphere}$   
 $= -6 \times 101.32 = -608 \text{ J}$
22. (c) For isothermal reversible expansion.  
 $w = -nRT \ln \frac{V_2}{V_1}$
23. (c)  $W = -P\Delta V = -10^5(1 \times 10^{-2} - 1 \times 10^{-3}) = -900 \text{ J}$
24. (d) The difference between  $\Delta H$  and  $\Delta U$  is not usually significant for systems consisting of only solids or liquids. Solids and liquids do not suffer any significant volume changes upon heating. The difference, however, becomes significant when gases are involved.
25. (b)  $\Delta H = \Delta E + P\Delta V$ , for solid and liquid,  
 $\Delta V = 0$  or  $\Delta H = \Delta E + \Delta n RT$ , for solids and liquids  $\Delta n = 0$ .
26. (c) During isothermal expansion of an ideal gas,  
 $\Delta T = 0$ . Now  $H = E + PV$   
 $\therefore \Delta H = \Delta E + \Delta(PV)$   
 $\therefore \Delta H = \Delta E + \Delta(nRT)$ ;  
Thus if  $\Delta T = 0$ ,  $\Delta H = \Delta E$   
i.e., remain unaffected
27. (d) We know that  
 $\Delta H = \Delta E + P\Delta V$   
In the reactions,  $H_2 + Br_2 \rightarrow 2HBr$  there is no change in volume or  $\Delta V = 0$   
So,  $\Delta H = \Delta E$  for this reaction
28. (b)  $\Delta n = -\frac{1}{2}$ ;  $\Delta H = \Delta E - \frac{1}{2}RT$ ;  $\Rightarrow \Delta E > \Delta H$
29. (c) As all reactant and product are liquid  $\Delta n_{(g)} = 0$   
 $\Delta H = \Delta E - \Delta nRT$   
 $\Delta H = \Delta E$  ( $\because \Delta n = 0$ )
30. (a)  $\Delta H = \Delta E + P\Delta V$
31. (c)  $\Delta H = \Delta E + \Delta nRT$   
 $\Delta n = 3 - (1 + 5)$   
 $= 3 - 6 = -3$   
 $\Delta H - \Delta E = (-3RT)$
32. (b)  $\Delta H = \Delta U + \Delta nRT$  for  $N_2 + 3H_2 \longrightarrow 2NH_3$   
 $\Delta n_g = 2 - 4 = -2$   
 $\therefore \Delta H = \Delta U - 2RT$  or  $\Delta U = \Delta H + 2RT$   $\therefore \Delta U > \Delta H$
33. (a) Mass independent properties (molar conductivity and electromotive force) are intensive properties. Resistance and heat capacity are mass dependent, hence extensive properties.
34. (a) Volume depends upon mass. Hence it is extensive property.



35. (c) An extensive property is a property whose value depends on the quantity or size of matter present in the system. For example, mass, volume, internal energy, enthalpy, heat capacity, etc. are extensive properties
36. (d) The magnitude of the heat capacity depends on the size, composition and nature of the system.
37. (b) The heat required to raise the temperature of body by  $1^\circ\text{C}$  is called thermal capacity or heat capacity.
38. (d)  $\frac{C_p}{C_v} = \frac{\frac{5}{2}R}{\frac{3}{2}R} = \frac{5}{3} = 1.67$
39. (c) Given  $C_p = 75 \text{ JK}^{-1} \text{ mol}^{-1}$   
 $n = \frac{100}{18} \text{ mole}$ ,  $Q = 1000 \text{ J}$   $\Delta T = ?$   
 $Q = nC_p\Delta T \Rightarrow \Delta T = \frac{1000 \times 18}{100 \times 75} = 2.4 \text{ K}$
40. (b) 1 calorie = 4.184 joule
41. (b) The coefficients in a balanced thermo-chemical equation refer to the number of moles (not to molecules) of reactants and products involved in the reaction.
42. (c)
43. (b) Enthalpy of formation of  $\text{C}_2\text{H}_4$ ,  $\text{CO}_2$  and  $\text{H}_2\text{O}$  are 52, -394 and -286 kJ/mol respectively. (Given)  
 The reaction is  
 $\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$   
 change in enthalpy,  
 $(\Delta H) = \Delta H_{\text{products}} - \Delta H_{\text{reactants}}$   
 $= 2 \times (-394) + 2 \times (-286) - (52 + 0)$   
 $= -1412 \text{ kJ/mol}$
44. (b) 45. (c)
46. (b)  $\frac{1}{2}\text{H}_2 + \frac{1}{2}\text{Cl}_2 \longrightarrow \text{HCl}$   
 $\Delta H_{\text{HCl}} = \sum \text{B.E. of reactant} - \sum \text{B.E. of products}$   
 $-90 = \frac{1}{2} \times 430 + \frac{1}{2} \times 240 - \text{B.E. of HCl}$   
 $\therefore \text{B.E. of HCl} = 215 + 120 + 90$   
 $= 425 \text{ kJ mol}^{-1}$
47. (c) The reaction for formation of HCl can be written as  
 $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$   
 $\text{H}-\text{H} + \text{Cl}-\text{Cl} \rightarrow 2(\text{H}-\text{Cl})$   
 Substituting the given values, we get enthalpy of formation of  
 $2\text{HCl} = -(862 - 676) = -186 \text{ kJ}$   
 $\therefore$  Enthalpy of formation of  
 $\text{HCl} = \frac{-186}{2} \text{ kJ} = -93 \text{ kJ}$
48. (b) Enthalpy of reaction  
 $= \text{B.E.}_{(\text{Reactant})} - \text{B.E.}_{(\text{Product})}$   
 $= [\text{B.E.}_{(\text{C}=\text{C})} + 4 \text{B.E.}_{(\text{C}-\text{H})} + \text{B.E.}_{(\text{H}-\text{H})}] - [\text{B.E.}_{(\text{C}-\text{C})} + 6 \text{B.E.}_{(\text{C}-\text{H})}]$   
 $= [606.1 + (4 \times 410.5) + 431.37] - [336.49 + (6 \times 410.5)]$   
 $= -120.0 \text{ kJ mol}^{-1}$
49. (a)  $\text{Fe}_2\text{O}_{3(s)} + \text{CO}_{(g)} \longrightarrow 2\text{FeO}_{(s)} + \text{CO}_{2(g)}$   
 $\Delta H = -26.8 + 33.0 = +6.2 \text{ kJ}$
50. (b) Given  $\Delta H$   
 $\frac{1}{2}\text{A} \longrightarrow \text{B} \quad +150 \quad \dots(1)$   
 $3\text{B} \longrightarrow 2\text{C} + \text{D} \quad -125 \quad \dots(2)$   
 $\text{E} + \text{A} \longrightarrow 2\text{D} \quad +350 \quad \dots(3)$   
 To calculate  $\Delta H$  operate  
 $2 \times \text{eq. (1)} + \text{eq. (2)} - \text{eq. (3)}$   
 $\Delta H = 300 - 125 - 350 = -175$
51. (b)  $\Delta H = \sum [\Delta H_f^\circ \text{ products}] - \sum [\Delta H_f^\circ \text{ reactants}]$   
 $\Delta H^\circ = [\Delta H_f^\circ (\text{CO})(g) + \Delta H_f^\circ (\text{H}_2\text{O})(g)] - [\Delta H_f^\circ (\text{CO}_2)(g) + \Delta H_f^\circ (\text{H}_2)(g)]$   
 $= [-110.5 + (-241.8)] - [-393.5 + 0] = 41.2$
52. (b)  $\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$   
 Change in enthalpy,  
 $\Delta H = \Delta H_{\text{products}} - \Delta H_{\text{reactants}}$   
 $= 2 \times (-394) + 2 \times (-286) - (52 + 0)$   
 $= -1412 \text{ kJ/mol}$
53. (a) Hess's law is used for calculating enthalpy of reaction.
54. (c)  $\text{X} \xrightarrow{\Delta H} \text{Y}$   
 $\text{X} \xrightarrow{\Delta H_1} \text{P} \xrightarrow{\Delta H_2} \text{Q} \xrightarrow{\Delta H_3} \text{Y}$   
 $\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3$
55. (a) 56. (b)
57. (b) Heat of combustion of a substance is always negative as it is the amount of heat evolved (i.e. decrease in enthalpy) when one mole of the substance is completely burnt in air or oxygen.
58. (c)
59. (a) Conc. of HCl = 0.25 mole  
 Conc. of NaOH = 0.25 mole  
 Heat of neutralization of strong acid by strong base = -57.1 kJ  
 $\text{HCl} + \text{NaOH} \longrightarrow \text{NaCl} + \text{H}_2\text{O} - 57.1 \text{ kJ}$   
 1 mole of HCl neutralise 1 mole of NaOH, heat evolved = 57.1 kJ  
 $\therefore$  0.25 mole of HCl neutralise 0.25 mole of NaOH  
 $\therefore$  Heat evolved =  $57.1 \times 0.25 = 14.275 \text{ kJ}$

60. (c)
61. (d) A process is spontaneous only when there is decrease in the value of free energy, i.e.,  $\Delta G$  is  $-ve$ .
62. (a) If  $\Delta G_{\text{system}} = 0$  the system has attained equilibrium is right choice.  
In it alternative (d) is most confusing as when  $\Delta G > 0$ , the process may be spontaneous when it is coupled with a reaction which has  $\Delta G < 0$  and total  $\Delta G$  is negative, so right answer is (a).
63. (b) Spontaneity of reaction depends on tendency to acquire minimum energy state and maximum randomness. For a spontaneous process in an isolated system the change in entropy is positive.
64. (d)  $\Delta G$  is negative for a spontaneous process.
65. (a) Crystallization of sucrose solution. Entropy is a measure of randomness during the crystallisation of sucrose solution liquid state is changing into solid state hence entropy decreases.
66. (d)  $\Delta G = \Delta H - T \Delta S$ ;  $\Delta G$  is positive for a reaction to be non-spontaneous when  $\Delta H$  is positive and  $\Delta S$  is negative.
67. (b) For the reaction  
 $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$   
The reaction given is an example of decomposition reaction and we know that decomposition reactions are endothermic in nature, i.e.,  $\Delta H > 0$ .  
Further  
 $\Delta n = (1 + 1) - 1 = +1$   
Hence more number of molecules are present in products which shows more randomness i.e.  $\Delta S > 0$  ( $\Delta S$  is positive)
68. (b) For the reaction  
 $2\text{ZnS} \rightarrow 2\text{Zn} + \text{S}_2$ ;  $\Delta G_1^\circ = 293 \text{ kJ}$  .....(1)  
 $2\text{Zn} + \text{O}_2 \rightarrow 2\text{ZnO}$ ;  $\Delta G_2^\circ = -480 \text{ kJ}$  .....(2)  
 $\text{S}_2 + 2\text{O}_2 \rightarrow 2\text{SO}_2$ ;  $\Delta G_3^\circ = -544 \text{ kJ}$  .....(3)  
 $\Delta G^\circ$  for the reaction  
 $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$   
can be obtained by adding eqn. (1), (2) and (3)  
 $\Rightarrow \Delta G^\circ = 293 - 480 - 544 = -731 \text{ kJ}$
69. (a) Third law of Thermodynamics.
70. (a)  $\Delta S = \frac{q}{T}$   
 $q \longrightarrow$  required heat per mole  
 $T \longrightarrow$  constant absolute temperature  
Unit of entropy is  $\text{JK}^{-1} \text{mol}^{-1}$
71. (a) For a spontaneous process,  $\Delta S_{\text{total}}$  is always positive.
72. (d) For an exothermic reaction all three enthalpy, entropy and Gibbs free energy change have negative values.
73. (d) Gibbs-Helmholtz equation is  
 $\Delta G = \Delta H - T \Delta S$
- For a reaction to be non-spontaneous at all temperatures,  $\Delta H$  should be  $+ve$  and  $\Delta S$  should be  $-ve$   
 $\therefore \Delta G = +ve - T \times (-ve)$ ; the value of  $\Delta G$  is always positive for such a reaction and hence it will be non-spontaneous at all temperatures.
74. (d) We know that  $\Delta G = \Delta H - T \Delta S$   
When  $\Delta H < 0$  and  $\Delta S < 0$  then  $\Delta G$  will be negative at low temperatures (positive at high temperature) and the reaction will be spontaneous.
75. (d) Since the process is at equilibrium  $\Delta G = 0$  for  $\Delta G = 0$ , they should be  $\Delta H > 0$ ,  $\Delta S > 0$ .
76. (c)  $\Delta S$  has negative value if number of gaseous moles decreases during a reaction,  $\Delta n_g = -ve$   
For the reaction  
 $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$   
 $\Delta n_g = 2 - 3 = -1$
77. (d)  $\Delta G = \Delta H - T \Delta S$   
For a reaction to be spontaneous,  
 $\Delta H = -ve$ ,  $\Delta S = +ve$   
at all temperatures.  
but at high temperature,  $\Delta G = \frac{\Delta H}{-ve} - \frac{T \Delta S}{+ve}$   
Thus the second term will have high positive value and reaction will be non-spontaneous.
78. (b) At equilibrium  $\Delta G = 0$   
Hence,  $\Delta G = \Delta H - T_e \Delta S = 0$   
 $\therefore \Delta H = T_e \Delta S$  or  $T_e = \frac{\Delta H}{\Delta S}$   
For a spontaneous reaction  
 $\Delta G$  must be negative which is possible only if  
 $\Delta H - T \Delta S < 0$   
 $\therefore \Delta H < T \Delta S$  or  $T > \frac{\Delta H}{\Delta S}$ ;  $T_e < T$
79. (a) Measure of disorder of a system is nothing but Entropy. For a spontaneous reaction,  $\Delta G < 0$ . As per Gibbs Helmholtz equation,  
 $\Delta G = \Delta H - T \Delta S$   
Thus  $\Delta G$  is  $-ve$  only  
When  $\Delta H = -ve$  (exothermic)  
and  $\Delta S = +ve$  (increasing disorder)
80. (a) Since, in the first reaction gaseous products are forming from solid carbon hence entropy will increase i.e.  $\Delta S = +ve$ .  
 $\text{C (gr.)} + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{CO}(\text{g})$ ;  $\Delta S^\circ = +ve$   
Since,  $\Delta G^\circ = \Delta H^\circ - T \Delta S$  hence the value of  $\Delta G$  decrease on increasing temperature.
81. (b) This is combustion reaction, which is always exothermic hence  
 $\Delta H = -ve$   
As the no. of gaseous molecules are increasing hence entropy increases  
now  $\Delta G = \Delta H - T \Delta S$

For a spontaneous reaction

$$\Delta G = -ve$$

Which is possible in this case as  $\Delta H = -ve$  and  $\Delta S = +ve$ .

82. (c) For a spontaneous reaction  $\Delta G(-ve)$ , which is possible if  $\Delta S = +ve$ ,  $\Delta H = +ve$  and  $T\Delta S > \Delta H$  [As  $\Delta G = \Delta H - T\Delta S$ ]

83. (c) 
$$\Delta S = \frac{\Delta H}{T} = \frac{1.435 \times 10^3}{273}$$
  

$$= 5.260 \text{ cal / (mol K)}$$

### STATEMENT TYPE QUESTIONS

84. (c) Variables like P, V and T which describes the state of system are called state variables or state functions because their values depend only on the state of the system and not on how it is reached.
85. (d) The positive sign expresses when work is done on the system. Similarly, negative sign expresses when work is done by the system
86. (b) 87. (a) 88. (a)
89. (c) All the statements regarding spontaneity of a reaction are correct.
90. (c) The standard enthalpy of reaction is the enthalpy change for a reaction when all the participating substances are in their standard states. The standard state of a substance at a specified temperature is its pure form at 1 bar. For example, the standard state of liquid ethanol at 298 K is pure liquid ethanol at 1 bar. Standard state of solid iron at 500 K is pure iron at 1 bar. The standard conditions are denoted by adding the superscript  $\ominus$  to the symbol  $\Delta H$  e.g.,  $-\Delta H^\ominus$ .

### MATCHING TYPE QUESTIONS

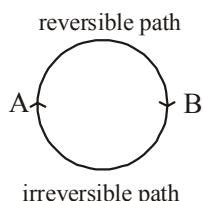
91. (b) 92. (c)
93. (a) A – (p), B – (s), C – (r), D – (q)  
 Expansion of a gas in vacuum ( $p_{\text{ext}} = 0$ ) is called free expansion.  
 For isothermal irreversible change  
 $q = -W = p_{\text{ext}}(V_f - V_i)$   
 for isothermal reversible change  
 $q = -W = nRT \ln(V_f/V_i)$   
 $= 2.303 nRT \log V_f/V_i$   
 For adiabatic change,  $q = 0$ ,  $\Delta U = W_{\text{ad}}$
94. (b) (A)  $\Delta n_g = 2 - 2 = 0$  hence  $\Delta H = \Delta U$   
 (B)  $\Delta n_g = 2 - 1 = 1$  hence  $\Delta H = \Delta U + RT$   
 (C)  $\Delta n_g = 2 - 4 = -2$  hence  $\Delta H = \Delta U - 2RT$   
 (D)  $\Delta n_g = 5 - 2 = 3$  hence  $\Delta H = \Delta U + 3RT$
95. (c) 96. (d) 97. (b)

### ASSERTION-REASON TYPE QUESTIONS

98. (c) Values of state functions depend only on the state of the system and not on how it is reached.
99. (a)  $Q = -W$  if  $\Delta E = 0$
100. (b) In an isothermal process change in internal energy ( $\Delta E$ ) is zero (as it is a function of temperature).  
 $\therefore$  According to first law of thermodynamics  
 $\therefore Q + W = \Delta E$ . Hence  $Q = -W$  (if  $\Delta E = 0$ )  
 If a system undergoes a change in which internal energy of the system remains constant (i.e.  $\Delta E = 0$ ) then  $-W = Q$ . This means that work done by the system equals the heat absorbed by the system.
101. (a) It is fact that absolute values of internal energy of substances cannot be determined. It is also true that it is not possible to determine exact values of constituent energies of a substance.
102. (c) It may involve increase or decrease in temperature of the system. Systems in which such processes occur, are thermally insulated from the surroundings.
103. (a) As internal energy is a state function so its value depends on initial and final states of the system. In case of cyclic system initial and final states are same. So  $\Delta E = 0$ , and similarly  $\Delta H = 0$ .
104. (a) The properties whose magnitude depends upon the quantity of matter present in the system are called extensive properties eg, internal energy.
105. (b) The mass and volume depend upon the quantity of matter so these are extensive properties while ratio of mass to its volume does not depend upon the quantity of matter so this ratio is an extensive property.
106. (a) In case of electric fan electrical energy is converted into mechanical energy and in case of heater, electrical energy is converted into heat energy. Therefore, these follow the first law of thermodynamics.
107. (c) The value of enthalpy of neutralisation of weak acid by strong base is less than 57.1 kJ. This is due to the reason that the part of energy liberated during combination of  $H^+$  and  $OH^+$  ions is utilised in the ionisation of weak acid.
108. (d) When a solid melts, increase in enthalpy is observed.
109. (b) The factor  $T\Delta S$  increases with increase in temperature.
110. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.  
 For a process to be spontaneous  $\Delta G$  must be negative.  
 $\Delta G = \Delta H - T\Delta S$   
 Exothermic process ( $\Delta H$  is negative) is non-spontaneous if  $\Delta S$  is negative and temperature is high because in such condition  $T\Delta S > \Delta H$ .  
 ( $\Delta G = \Delta H - T\Delta S = +ve$ ). When temperature is decreased,  $T\Delta S < \Delta H$  ( $\Delta G = \Delta H - T\Delta S = -ve$ ) and so the reaction becomes spontaneous.

**CRITICAL THINKING TYPE QUESTIONS**

111. (c) Justification : free expansion  $w = 0$   
adiabatic process  $q = 0$   
 $\Delta U = q + w = 0$ , this means that internal energy remains constant. Therefore,  
 $\Delta T = 0$ .
112. (d) Mathematical expression of first law of thermodynamics  
 $\Delta E = q + w$ ,  $\Delta E$  is a state function.
113. (d) As  $\Delta H = \Delta E + \Delta n_g RT$   
if  $n_p < n_r$ ;  $\Delta n_g = n_p - n_r = -ve$ .  
Hence  $\Delta H < \Delta E$ .
114. (a)  $q = -W = 2.303nRT \log \frac{V_2}{V_1}$
115. (a) Process is isothermal reversible expansion, hence  
 $\Delta U = 0$ , therefore  $q = -W$ .  
Since  $q = +208 \text{ J}$ ,  $W = -208 \text{ J}$
116. (d) When work is done by the system,  $\Delta U = q - W$
117. (c) For a cyclic process the net change in the internal energy is zero because the change in internal energy does not depend on the path.



118. (a)  $-W_{\text{irreversible}} = P_{\text{ext}} (V_2 - V_1)$   
 $= 10 \text{ atm} (2\text{L} - 1\text{L})$   
 $= 10 \text{ atm} \cdot \text{L}$
- $-W_{\text{reversible}} = \int_{V_1}^{V_2} P_{\text{ex}} dv$   
 $= 2.303 nRT \log \frac{V_2}{V_1}$   
 $= 1 \times 2.303 \times 0.0821 \text{ atm} \cdot \text{L} / \text{K} \cdot \text{mol} \times \log \frac{2}{1}$   
 $= 16.96 \text{ atm} \cdot \text{L}$
- $\frac{W_{\text{reversible}}}{W_{\text{irreversible}}} = \frac{16.96}{10.00} = 1.69 \approx 1.7$
119. (a)
120. (a)  $\text{H}_2\text{O}(\ell) \rightarrow \text{H}_2\text{O}(\text{g})$   
 $\Delta H_{\text{vap}} = 40.79 \text{ kJ/mol}$   
 $\Delta H = \Delta U + \Delta n_g RT$   
 $\Rightarrow 40.79 \text{ kJ/mol} = \Delta U + (1) (8.314 \text{ JK}^{-1} \text{ mol}^{-1}) (373 \text{ K})$

$$\Rightarrow \Delta U^0 = \left( 40.79 \text{ kJ/mol} - \frac{8.314 \times 373}{1000} \text{ kJ/mol} \right)$$

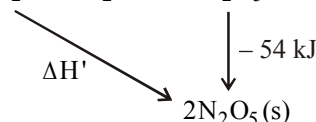
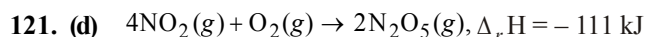
$$= (40.79 - 3.10) \text{ kJ/mol}$$

$$= 37.69 \frac{\text{kJ}}{\text{mol}}$$

Internal energy change for 36 g of water

$$= 37.69 \frac{\text{kJ}}{\text{mol}} \times \frac{36\text{g}}{18\text{g/mol}}$$

$$\Delta U = 75.98 \text{ kJ}$$



$$-111 - 54 = \Delta H'$$

$$\Delta H' = -165 \text{ kJ}$$

122. (c) In a reversible process the work done is greater than in irreversible process. Hence the heat absorbed in reversible process would be greater than in the latter case. So

$$T_f(\text{rev.}) < T_f(\text{irr.})$$

123. (c) Applying Hess's Law

$$\Delta_f H^\circ = \Delta_{\text{sub}} H + \frac{1}{2} \Delta_{\text{diss}} H + \text{I.E.} + \text{E.A.} + \Delta_{\text{lattice}} H$$

$$-617 = 161 + 520 + 77 + \text{E.A.} + (-1047)$$

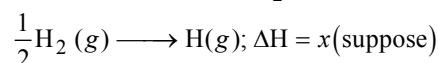
$$\text{E.A.} = -617 + 289 = -328 \text{ kJ mol}^{-1}$$

$\therefore$  electron affinity of fluorine

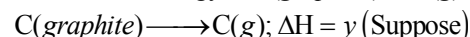
$$= -328 \text{ kJ mol}^{-1}$$

124. (a) To calculate average enthalpy of C - H bond in methane following informations are needed

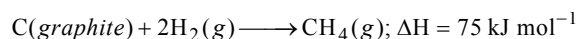
- (i) dissociation energy of  $\text{H}_2$  i.e.



- (ii) Sublimation energy of C(graphite) to C(g)



Given



125. (a)  $\text{C}_2\text{H}_5\text{OH}(\ell) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\ell)$

Bomb calorimeter gives  $\Delta U$  of the reaction

$$\text{Given, } \Delta U = -1364.47 \text{ kJ mol}^{-1}$$

$$\Delta n_g = -1$$

$$\Delta H = \Delta U + \Delta n_g RT = -1364.47 - \frac{1 \times 8.314 \times 298}{1000}$$

$$= -1366.93 \text{ kJ mol}^{-1}$$

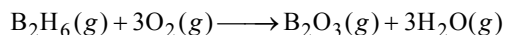
126. (a)  $\text{H}_2\text{O}(\ell) \rightleftharpoons \text{H}_2\text{O}(\text{g}) + \text{Q}$

$$\Delta E = 37558 \text{ J/mol}$$

$$\Delta E = 37.56 \text{ kJ mol}^{-1}$$

127. (d) This reaction shows the formation of  $H_2O$ , and the  $X_2$  represents the enthalpy of formation of  $H_2O$  because as the definition suggests that the enthalpy of formation is the heat evolved or absorbed when one mole of substance is formed from its constituent atoms.

128. (b) For the equation



Eqs. (i) + 3 (ii) + 3 (iii) - (iv)

$$\Delta H = -1273 + 3(-286) + 3(44) - 36$$

$$= -1273 - 858 + 132 - 36$$

$$= -2035 \text{ kJ/mol}$$

129. (a)  $q_p = \Delta H = C_p dT$

$$\Rightarrow q_p = 75.32 \frac{\text{J}}{\text{K mol}} \times (299 - 298) \text{ K}$$

$$\Rightarrow q_p = 75.32 \frac{\text{J}}{\text{K mol}}$$

For 180 kg of water, no. of moles of water

$$= \frac{180 \times 10^3 \text{ g}}{18 \text{ g/mol}} = 10^4 \text{ g moles}$$

$$q_p = 75.32 \frac{\text{J}}{\text{mol}} \times 10^4 \text{ moles}$$

$$= 753.2 \times 10^3 \text{ J} = 753.2 \text{ kJ}$$

$\Delta H$  for ATP = 7 kcal/mol

$$= 7 \times 4.184 \text{ kJ/mol}$$

$$= 29.2 \text{ kJ/mol}$$

$6.022 \times 10^{23}$  molecules of ATP produce = 29.2 kJ

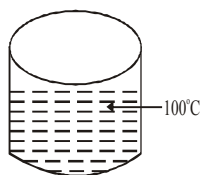
29.2 kJ produced from  $6.022 \times 10^{23}$  molecules

$$753.2 \text{ kJ produced from } 6.022 \times 10^{23} \times \frac{75.8}{29.2}$$

$$= 1.5 \times 10^{25} \text{ molecules}$$

130. (a) 18gm of water at  $100^\circ\text{C}$

10gm of Cu at  $25^\circ\text{C}$  is added.



$$q_p = C_{p,m} dT$$

$$= 75.32 \times \frac{\text{J}}{\text{K mol}} \times \frac{18 \text{ g}}{18 \text{ g/mol}} (373 - 298) \text{ K}$$

$$= 75.32 \frac{\text{J}}{\text{K}} \times 75 \text{ K}$$

$$= 5.649 \times 10^3 \text{ J}$$

If now 10g of copper is added  $C_{p,m} = 24.47 \text{ J/mol K}$

Amount of heat gained by Cu

$$= 24.47 \frac{\text{J}}{\text{K mol}} \times \frac{10 \text{ g}}{63 \text{ g/mol}} (373 - 298) \text{ K}$$

$$= 291.3 \text{ J}$$

Heat lost by water = 291.30 J

$$-291.30 \text{ J} = 75.32 \frac{\text{J}}{\text{K}} \times (T_2 - 373 \text{ K})$$

$$\Rightarrow -3.947 \text{ K} = T_2 - 373 \text{ K}$$

$$\Rightarrow T_2 = 369.05 \text{ K}$$

131. (a)  $I_2(s) + Cl_2(g) \longrightarrow 2ICl(g)$

$$\Delta_r H = [\Delta H(I_2(s) \rightarrow I_2(g)) + \Delta H_{I-I} + \Delta H_{Cl-Cl}] - [\Delta H_{I-Cl}]$$

$$= 151.0 + 242.3 + 62.76 - 2 \times 211.3 = 33.46$$

$$\Delta_f H^\circ(ICl) = \frac{33.46}{2} = 16.73 \text{ kJ/mol}$$

132. (a)  $\Delta G = -RT \ln K_{eq}$  : Normal body temperature =  $37^\circ\text{C}$

$$\Rightarrow -50 \frac{\text{kJ}}{\text{mol}} = 8.314 \frac{\text{J}}{\text{K mol}} \times 310 \ln K_{eq}$$

$$\Rightarrow 19.39 = \ln K_{eq}$$

$$\Rightarrow K_{eq} = 2.6 \times 10^8$$

133. (b)  $\Delta G = \Delta H - T\Delta S$

$\Delta G = -T\Delta S$  (when  $\Delta H = 0$  and  $\Delta S = +ve$ )

$\Delta G = -ve$

134. (a) For spontaneous reaction,  $dS > 0$  and  $dG$  should be negative i.e.  $< 0$ .

135. (a)  $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

For a spontaneous reaction  $\Delta G^\circ < 0$

$$\text{or } \Delta H^\circ - T\Delta S^\circ < 0 \Rightarrow T > \frac{\Delta H^\circ}{\Delta S^\circ}$$

$$\Rightarrow T > \frac{179.3 \times 10^3}{160.2} > 1117.9 \text{ K} \approx 1118 \text{ K}$$

136. (d)  $H_2O(l) \xrightleftharpoons{1 \text{ atm}} H_2O(g)$

$$\Delta H = 40630 \text{ J mol}^{-1}$$

$$\Delta S = 108.8 \text{ JK}^{-1} \text{ mol}^{-1}$$

$$\Delta G = \Delta H - T\Delta S \quad \text{When } \Delta G = 0,$$

$$\Delta H - T\Delta S = 0$$

$$T = \frac{\Delta H}{\Delta S} = \frac{40630 \text{ J mol}^{-1}}{108.8 \text{ J mol}^{-1}} = 373.4 \text{ K}.$$

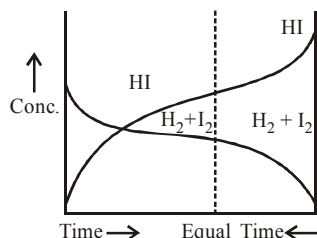




### FACT/DEFINITION TYPE QUESTIONS

- Which of the following is not a general characteristic of equilibria involving physical processes ?
  - Equilibrium is possible only in a closed system at a given temperature.
  - All measurable properties of the system remain constant.
  - All the physical processes stop at equilibrium.
  - The opposing processes occur at the same rate and there is dynamic but stable condition.
- The liquid which has a .....vapour pressure is more volatile and has a .....boiling point.
  - Higher, higher
  - Lower, lower
  - Higher, lower
  - Lower, higher
- Boiling point of the liquid depends on the atmospheric pressure. It depends on the altitude of the place; at high altitude the boiling point.....
  - increases
  - decreases
  - either decreases or increases
  - remains same
- In an experiment three watch glasses containing separately 1mL each of acetone, ethyl alcohol, and water are exposed to atmosphere and the experiment with different volumes of the liquids in a warmer room is repeated, it is observed that in all such cases the liquid eventually disappears and the time taken for complete evaporation in each case was different. The possible reason is/are
  - the nature of the liquids is different
  - the amount of the liquids is different
  - the temperature is different
  - All of the above
- A small amount of acetone is taken in a watch glass and it is kept open in atmosphere. Which statement is correct for the given experiment?
  - The rate of condensation from vapour to liquid state is higher than the rate of evaporation.
  - The rate of condensation from vapour to liquid state is equal to the rate of evaporation.
  - The rate of condensation from vapour to liquid state is much less than the rate of evaporation.
  - The rate of condensation from vapour to liquid state is equal or less than the rate of evaporation.
- When pressure is applied to the equilibrium system
 
$$\text{Ice} \rightleftharpoons \text{Water}$$
 Which of the following phenomenon will happen?
  - More ice will be formed
  - Water will evaporate
  - More water will be formed
  - Equilibrium will not be formed
- A reaction is said to be in equilibrium when
  - the rate of transformation of reactant to products is equal to the rate of transformation of products to the reactants.
  - 50% of the reactants are converted to products.
  - the reaction is near completion and all the reactants are converted to products.
  - the volume of reactants is just equal to the volume of the products.
- Which of the following is not true about a reversible reaction?
  - The reaction does not proceed to completion
  - It cannot be influenced by a catalyst
  - Number of moles of reactants and products is always equal
  - It can be attained only in a closed container
- If the synthesis of ammonia from Haber's process is carried out with exactly the same starting conditions (of partial pressure and temperature) but using  $\text{D}_2$  (deuterium) in place of  $\text{H}_2$ . Then
  - the equilibrium will be disturbed
  - the composition of reaction mixture will remain same at equilibrium.
  - Use of isotope in reaction will not produce ammonia.
  - At equilibrium rate of forward reaction will be greater than the rate of reverse reaction

10. Consider the following graph and mark the correct statement.



- (a) Chemical equilibrium in the reaction,  $H_2 + I_2 \rightleftharpoons 2HI$  can be attained from other directions.  
 (b) Equilibrium can be detained when  $H_2$  and  $I_2$  are mixed in an open vessel.  
 (c) The concentrations of  $H_2$  and  $I_2$  keep decreasing while concentration of  $HI$  keeps increasing with time.  
 (d) We can find out equilibrium concentration of  $H_2$  and  $I_2$  from the given graph.

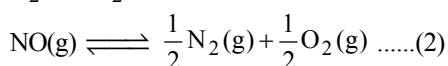
11. What are the product formed when Deuterium is added equilibrium reaction of  $H_2$  and  $I_2$ ?

- (i)  $HD$  (ii)  $DI$   
 (iii)  $D_2$  (iv)  $HI$   
 (a) (i), (ii) and (iv) (b) (i) and (ii)  
 (c) (ii) and (iv) (d) All of these

12. If a system is at equilibrium, the rate of forward to the reverse reaction is :

- (a) less (b) equal  
 (c) high (d) at equilibrium

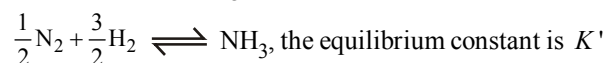
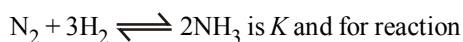
13.  $K_1$  and  $K_2$  are equilibrium constant for reactions (1) and (2)  
 $N_2(g) + O_2(g) \rightleftharpoons 2NO(g) \dots\dots\dots(1)$



Then,

- (a)  $K_1 = \left(\frac{1}{K_2}\right)^2$  (b)  $K_1 = K_2^2$   
 (c)  $K_1 = \frac{1}{K_2}$  (d)  $K_1 = (K_2)^0$

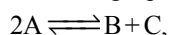
14. The equilibrium constant for the reversible reaction



The  $K$  and  $K'$  will be related as:

- (a)  $K \times K' = 1$  (b)  $K = K'$   
 (c)  $K' = \sqrt{K}$  (d)  $K = \sqrt{K'}$

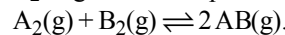
15. In the following equilibrium reaction



the equilibrium concentrations of A, B and C are  $1 \times 10^{-3} M$ ,  $2 \times 10^{-3} M$  and  $3 \times 10^{-3} M$  respectively at 300 K. The value of  $K_c$  for this equilibrium at the same temperature is

- (a)  $\frac{1}{6}$  (b) 6  
 (c)  $\frac{1}{36}$  (d) 36

16. Given the reaction between 2 gases represented by  $A_2$  and  $B_2$  to give the compound  $AB(g)$ .



At equilibrium, the concentration

of  $A_2 = 3.0 \times 10^{-3} M$

of  $B_2 = 4.2 \times 10^{-3} M$

of  $AB = 2.8 \times 10^{-3} M$

If the reaction takes place in a sealed vessel at  $527^\circ C$ , then the value of  $K_C$  will be :

- (a) 2.0 (b) 1.9  
 (c) 0.62 (d) 4.5

17. A reaction is  $A + B \rightleftharpoons C + D$ . Initially we start with equal concentrations of A and B. At equilibrium we find that the moles of C is two times of A. What is the equilibrium constant of the reaction?

- (a)  $\frac{1}{4}$  (b)  $\frac{1}{2}$   
 (c) 4 (d) 2

18. In  $A + B \rightleftharpoons C$ . The unit of equilibrium constant is :

- (a)  $\text{Litre mole}^{-1}$  (b)  $\text{Mole litre}$   
 (c)  $\text{Mole litre}^{-1}$  (d) No unit

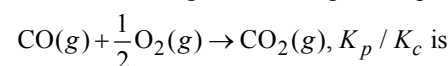
19. For the reaction  $C(s) + CO_2(g) \rightleftharpoons 2CO(g)$ , the partial pressures of  $CO_2$  and  $CO$  are 2.0 and 4.0 atm respectively at equilibrium. The  $K_p$  for the reaction is.

- (a) 0.5 (b) 4.0  
 (c) 8.0 (d) 32.0

20. In which of the following equilibrium  $K_c$  and  $K_p$  are not equal?

- (a)  $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$   
 (b)  $SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$   
 (c)  $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$   
 (d)  $2C(s) + O_2(g) \rightleftharpoons 2CO_2(g)$

21. For the following reaction in gaseous phase



- (a)  $(RT)^{1/2}$  (b)  $(RT)^{-1/2}$   
 (c)  $(RT)$  (d)  $(RT)^{-1}$

22. The  $K_p/K_C$  ratio will be highest in case of

- (a)  $CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$   
 (b)  $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$   
 (c)  $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$   
 (d)  $7H_2(g) + 2NO_2(g) \rightleftharpoons 2NH_3(g) + 4H_2O(g)$

23. For a chemical reaction ;  
 $A(g) + B(l) \rightleftharpoons D(g) + E(g)$   
 Hypothetically at what temperature,  $K_p = K_c$   
 (when,  $R = 0.08 \text{ l-atm/mole-K}$ )  
 (a)  $T = 0 \text{ K}$  (b)  $T = 1 \text{ K}$   
 (c)  $T = 12.5 \text{ K}$  (d)  $T = 273 \text{ K}$
24. Steam reacts with iron at high temperature to give hydrogen gas and  $\text{Fe}_3\text{O}_4(s)$ . The correct expression for the equilibrium constant is  
 (a)  $\frac{P_{\text{H}_2}^2}{P_{\text{H}_2\text{O}}^2}$  (b)  $\frac{(P_{\text{H}_2})^4}{(P_{\text{H}_2\text{O}})^4}$   
 (c)  $\frac{(P_{\text{H}_2})^4[\text{Fe}_3\text{O}_4]}{(P_{\text{H}_2\text{O}})^4[\text{Fe}]}$  (d)  $\frac{[\text{Fe}_3\text{O}_4]}{[\text{Fe}]}$
25. For the reaction  $\text{C}(s) + \text{CO}_2(g) \rightarrow 2\text{CO}(g)$ ,  $K_p = 63 \text{ atm}$  at  $1000 \text{ K}$ . If at equilibrium :  $P_{\text{CO}} = 10 P_{\text{CO}_2}$ , then the total pressure of the gases at equilibrium is  
 (a)  $6.3 \text{ atm}$  (b)  $6.93 \text{ atm}$   
 (c)  $0.63 \text{ atm}$  (d)  $0.693 \text{ atm}$
26. The rate constant for forward and backward reaction of hydrolysis of ester are  $1.1 \times 10^{-2}$  and  $1.5 \times 10^{-3}$  per minute respectively. Equilibrium constant for the reaction  
 $\text{CH}_3\text{COOC}_2\text{H}_5 + \text{H}^+ \rightleftharpoons \text{CH}_3\text{COOH} + \text{C}_2\text{H}_5\text{OH}$  is  
 (a) 4.33 (b) 5.33  
 (c) 6.33 (d) 7.33
27. Value of  $K_p$  in the reaction  
 $\text{MgCO}_3(s) \rightarrow \text{MgO}(s) + \text{CO}_2(g)$  is  
 (a)  $K_p = P_{\text{CO}_2}$   
 (b)  $K_p = P_{\text{CO}_2} \times \frac{P_{\text{CO}_2} \times P_{\text{MgO}}}{P_{\text{MgCO}_3}}$   
 (c)  $K_p = \frac{P_{\text{CO}_2} \times P_{\text{MgO}}}{P_{\text{MgCO}_3}}$   
 (d)  $K_p = \frac{P_{\text{MgCO}_3}}{P_{\text{CO}_2} \times P_{\text{MgO}}}$
28. Which of the following is an example of homogeneous equilibrium?  
 (a)  $2\text{SO}_2(g) + \text{O}_2(g) \rightleftharpoons 2\text{SO}_3(g)$   
 (b)  $\text{C}(s) + \text{H}_2\text{O}(g) \rightleftharpoons \text{CO}(g) + \text{H}_2(g)$   
 (c)  $\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$   
 (d)  $\text{NH}_4\text{HS}(s) \rightleftharpoons \text{NH}_3(g) + \text{H}_2\text{S}(g)$
29. Unit of equilibrium constant for the given reaction is  
 $\text{Ni}(s) + 4\text{CO}(g) \rightleftharpoons \text{Ni}(\text{CO})_4(g)$   
 (a)  $(\text{mol/l})^{-3}$  (b)  $(\text{mol/l})^3$   
 (c)  $(\text{mol/l})^{-4}$  (d)  $(\text{mol/l})^4$
30. The thermal dissociation of calcium carbonate showing heterogeneous equilibrium is  
 $\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$   
 For this reactions which of the following is/are true  
 (i)  $K_c = [\text{CO}_2(g)]$   
 (ii)  $K_p = p_{\text{CO}_2}$   
 (iii)  $[\text{CaCO}_3(s)]$  and  $[\text{CaO}(s)]$  are both constant  
 (iv)  $[\text{CO}_2(g)]$  is constant  
 (a) (i), (ii) and (iv) (b) (i), (ii) and (iii)  
 (c) (ii) and (iv) (d) (i), (iii) and (iv)
31. In a reversible chemical reaction having two reactants in equilibrium, if the concentration of the reactants are doubled then the equilibrium constant will  
 (a) Also be doubled (b) Be halved  
 (c) Become one-fourth (d) Remain the same
32. On doubling  $P$  and  $V$  with constant temperature the equilibrium constant will  
 (a) remain constant (b) become double  
 (c) become one-fourth (d) None of these
33. If for the reaction  
 $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ ,  $\Delta H = -92.38 \text{ KJ/mole}$  than what happens if the temperature is increased?  
 (a) Reaction proceed forward  
 (b) Reaction proceed backward  
 (c) No effect on the formation of product  
 (d) None of these
34. If  $K_c$  is in the range of ..... appreciable concentrations of both reactants and products are present.  
 (a)  $10^{-4}$  to  $10^4$  (b)  $10^{-3}$  to  $10^3$   
 (c)  $10^{-5}$  to  $10^{-3}$  (d)  $10^{-5}$  to  $10^3$
35. The reaction quotient ( $Q$ ) for the reaction  
 $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$   
 is given by  $Q = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}$ . The reaction will proceed from  
 right to left if  
 (a)  $Q = 0$  (b)  $Q = K_c$   
 (c)  $Q < K_c$  (d)  $Q > K_c$   
 where  $K_c$  is the equilibrium constant
36. The reaction quotient  $Q$  is used to  
 (a) predict the extent of a reaction on the basis of its magnitude  
 (b) predict the direction of the reaction  
 (c) calculate equilibrium concentrations  
 (d) calculate equilibrium constant
37. The correct relationship between free energy change in a reaction and the corresponding equilibrium constant,  $K_c$  is  
 (a)  $\Delta G = RT \ln K_c$  (b)  $-\Delta G = RT \ln K_c$   
 (c)  $\Delta G^\circ = RT \ln K_c$  (d)  $-\Delta G^\circ = RT \ln K_c$

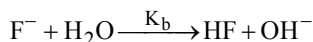
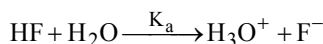
38. Using the equation ( $K = e^{-\Delta G^\ominus/RT}$ ), the reaction spontaneity can be interpreted in terms of the value of  $\Delta G^\ominus$  is/are
- If  $\Delta G^\ominus > 0$ , then  $-\Delta G^\ominus/RT$  is positive, and  $e^{-\Delta G^\ominus/RT} > 1$  making  $K > 1$ , which implies a spontaneous reaction or the reaction which proceeds in the forward direction to such an extent that the products are present predominantly.
  - If  $\Delta G^\ominus > 0$ , then  $-\Delta G^\ominus/RT$  is negative, and  $e^{-\Delta G^\ominus/RT} < 1$  making  $K < 1$ , which implies a non-spontaneous reaction or a reaction which proceeds in the forward direction to such a small degree that only a very minute quantity of product is formed.
  - Both (a) and (b)
  - None of the above
39. Which of the following relation represents correct relation between standard electrode potential and equilibrium constant?
- $\log K = \frac{nFE^\ominus}{2.303 RT}$
  - $K = e^{\frac{nFE^\ominus}{RT}}$
  - $\log K = \frac{-nFE^\ominus}{2.303 RT}$
  - $\log K = 0.4342 \frac{-nFE^\ominus}{RT}$
- Choose the correct statement(s).
- I, II and III are correct
  - II and III are correct
  - I, II and IV are correct
  - I and IV are correct
40. According to Le-chatelier's principle, adding heat to a solid  $\rightleftharpoons$  liquid equilibrium will cause the
- temperature to increase
  - temperature to decrease
  - amount of liquid to decrease
  - amount of solid to decrease
41. Which one of the following information can be obtained on the basis of Le Chatelier principle?
- Dissociation constant of a weak acid
  - Entropy change in a reaction
  - Equilibrium constant of a chemical reaction
  - Shift in equilibrium position on changing value of a constraint
42. For the manufacture of ammonia by the reaction
- $$N_2 + 3H_2 \rightleftharpoons 2NH_3 + 2\text{kcal}$$
- the favourable conditions are
- Low temperature, low pressure and catalyst
  - Low temperature, high pressure and catalyst
  - High temperature, low pressure and catalyst
  - High temperature, high pressure and catalyst
43. Which of the following reaction will be favoured at low pressure ?
- $H_2 + I_2 \rightleftharpoons 2HI$
  - $N_2 + 3H_2 \rightleftharpoons 2NH_3$
  - $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
  - $N_2 + O_2 \rightleftharpoons 2NO$
44. The equilibrium which remains unaffected by pressure change is
- $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
  - $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$
  - $2O_3(g) \rightleftharpoons 3O_2(g)$
  - $2NO_2(g) \rightleftharpoons N_2O_4(g)$
45. Suitable conditions for melting of ice :
- high temperature and high pressure
  - high temperature and low pressure
  - low temperature and low pressure
  - low temperature and high pressure
46. In which of the following reactions, the equilibrium remains unaffected on addition of small amount of argon at constant volume?
- $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
  - $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
  - $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
  - The equilibrium will remain unaffected in all the three cases.
47. Le-Chatelier principle is not applicable to
- $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
  - $Fe(s) + S(s) \rightleftharpoons FeS(s)$
  - $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
  - $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$
48. In an equilibrium reaction if temperature increases
- equilibrium constant increases
  - equilibrium constant decreases
  - any of the above
  - no effect
49. In a two-step exothermic reaction
- $$A_2(g) + B_2(g) \xrightleftharpoons[\text{Step 1}]{\text{Step 2}} 3C(g) \rightleftharpoons D(g)$$
- Steps 1 and 2 are favoured respectively by
- high pressure, high temperature and low pressure, low temperature
  - high pressure, low temperature and low pressure, high temperature
  - low pressure, high temperature and high pressure, high temperature
  - low pressure, low temperature and high pressure, low temperature

50. What happens when an inert gas is added to an equilibrium keeping volume unchanged?  
 (a) More product will form  
 (b) Less product will form  
 (c) More reactant will form  
 (d) Equilibrium will remain unchanged
51. In a vessel  $N_2$ ,  $H_2$  and  $NH_3$  are at equilibrium. Some helium gas is introduced into the vessel so that total pressure increases while temperature and volume remain constant. According to Le Chatelier's principle, the dissociation of  $NH_3$   
 (a) increases (b) decreases  
 (c) remains unchanged (d) equilibrium is disturbed
52. Effect of a catalyst on a equilibrium reaction.  
 (i) A catalyst increases the rate of the chemical reaction by making available a new low energy pathway for the conversion of reactants to products.  
 (ii) It increases the rate of forward and reverse reactions that pass through the same transition state and does not affect equilibrium.  
 (iii) It lowers the activation energy for the forward and reverse reactions by exactly the same amount.  
 Which of the above statement(s) is/are correct ?  
 (a) Only (i) (b) (i) and (ii)  
 (c) (i), (ii) and (iii) (d) (ii) and (iii)
53. Which of the following is/are electrolytes?  
 (i) Sugar solution (ii) Sodium chloride  
 (iii) Acetic acid (iv) Starch solution  
 (a) (i) and (iv) (b) (ii) and (iv)  
 (c) (ii) and (iii) (d) (i) and (iii)
54. The geometry of hydronium ion is  
 (a) tetrahedral (b) linear  
 (c) trigonal pyramidal (d) trigonal planer
55. Which of the following statements are correct regarding Arrhenius theory of acid and base?  
 (a) This theory was applicable to only aqueous solutions  
 (b) This theory was applicable to all solutions  
 (c) This theory could not explain the basicity of substances like ammonia which do not possess a hydroxyl group  
 (d) Both (a) and (c)
56. Would gaseous HCl be considered as an Arrhenius acid ?  
 (a) Yes  
 (b) No  
 (c) Not known  
 (d) Gaseous HCl does not exist
57. A base, as defined by Bronsted theory, is a substance which can  
 (a) lose a pair of electrons  
 (b) donate protons  
 (c) gain a pair of electrons  
 (d) accept protons
58.  $BF_3$  is an acid according to  
 (a) Arrhenius concept (b) Bronsted-Lowry concept  
 (c) Lewis Concept (d) Both (b) and (c)
59. Which of the following can act as both Bronsted acid and Bronsted base?  
 (a)  $Na_2CO_3$  (b)  $OH^-$   
 (c)  $HCO_3^-$  (d)  $NH_3$
60. Conjugate acid of  $NH_2^-$  is :  
 (a)  $NH_4^+$  (b)  $NH_3$   
 (c)  $NH_2$  (d)  $NH$
61. Among boron trifluoride, stannic chloride and stannous chloride, Lewis acid is represented by  
 (a) only stannic chloride  
 (b) boron trifluoride and stannic chloride  
 (c) boron trifluoride and stannous chloride  
 (d) only boron trifluoride
62. Which of the following molecules acts as a Lewis acid ?  
 (a)  $(CH_3)_2O$  (b)  $(CH_3)_3P$   
 (c)  $(CH_3)_3N$  (d)  $(CH_3)_3B$
63. Which one of the following molecular hydrides acts as a Lewis acid?  
 (a)  $NH_3$  (b)  $H_2O$   
 (c)  $B_2H_6$  (d)  $CH_4$
64. Which of these is least likely to act as Lewis base?  
 (a)  $F^-$  (b)  $BF_3$   
 (c)  $PF_3$  (d)  $CO$
65. Which one of the following is the correct statement ?  
 (a)  $HCO_3^-$  is the conjugate base of  $CO_3^{2-}$ .  
 (b)  $NH_2^-$  is the conjugate acid of  $NH_3$ .  
 (c)  $H_2SO_4$  is the conjugate acid of  $HSO_4^-$ .  
 (d)  $NH_3$  is the conjugate base of  $NH_2^-$ .
66. Water is well known amphoprotic solvent. In which chemical reaction water is behaving as a base?  
 (a)  $H_2SO_4 + H_2O \longrightarrow H_3O^+ + HSO_4^-$   
 (b)  $H_2O + H_2O \longrightarrow H_3O^+ + OH^-$   
 (c)  $H_2O + NH_2^- \longrightarrow NH_3 + OH^-$   
 (d)  $H_2O + NH_3 \longrightarrow NH_4^+ + OH^-$
67. An acid/ base dissociation equilibrium is dynamic involving a transfer of proton in forward and reverse directions. Now, with passage of time in which direction equilibrium is favoured ?  
 (a) in the direction of stronger base and stronger acid  
 (b) in the direction of formation of stronger base and weaker acid  
 (c) in the direction of formation of weaker base and weaker acid  
 (d) in the direction of formation of weaker base and stronger acid
68. Three reactions involving  $H_2PO_4^-$  are given below:  
 (i)  $H_3PO_4 + H_2O \rightarrow H_3O^+ + H_2PO_4^-$   
 (ii)  $H_2PO_4^- + H_2O \rightarrow HPO_4^{2-} + H_3O^+$   
 (iii)  $H_2PO_4^- + OH^- \rightarrow H_3PO_4 + O^{2-}$   
 In which of the above does  $H_2PO_4^-$  act as an acid ?  
 (a) (ii) only (b) (i) and (ii)  
 (c) (iii) only (d) (i) only



69. The value of the ionic product of water  
(a) depends on volume of water  
(b) depends on temperature  
(c) changes by adding acid or alkali  
(d) always remains constant
70. A base when dissolved in water yields a solution with a hydroxyl ion concentration of  $0.05 \text{ mol litre}^{-1}$ . The solution is  
(a) basic (b) acidic  
(c) neutral (d) either (b) or (c)
71. pH scale was introduced by :  
(a) Arrhenius (b) Sorensen  
(c) Lewis (d) Lowry
72. pH of solution is defined by expression  
(a)  $\log[H^+]$  (b)  $\log\left[\frac{1}{H^+}\right]$   
(c)  $\frac{1}{\log[H^+]}$  (d)  $\frac{1}{-\log[H^+]}$
73. The pH of a  $10^{-3} \text{ M HCl}$  solution at  $25^\circ\text{C}$  if it is diluted 1000 times, will be –  
(a) 3 (b) zero  
(c) 5.98 (d) 6.02
74. How many litres of water must be added to 1 litre an aqueous solution of HCl with a pH of 1 to create an aqueous solution with pH of 2 ?  
(a) 0.1 L (b) 0.9 L  
(c) 2.0 L (d) 9.0 L
75. What is the approximate pH of a  $1 \times 10^{-3} \text{ M NaOH}$  solution?  
(a) 3 (b) 11  
(c) 7 (d)  $1 \times 10^{-11}$
76. Calculate the pOH of a solution at  $25^\circ\text{C}$  that contains  $1 \times 10^{-10} \text{ M}$  of hydronium ions, i.e.  $\text{H}_3\text{O}^+$ .  
(a) 4.000 (b) 9.0000  
(c) 1.000 (d) 7.000
77. The pH value of a 10 M solution of HCl is  
(a) less than 0 (b) equal to 0  
(c) equal to 1 (d) equal to 2
78. What is the  $\text{H}^+$  ion concentration of a solution prepared by dissolving 4 g of NaOH (Atomic weight of Na = 23 amu) in 1000 ml?  
(a)  $10^{-10} \text{ M}$  (b)  $10^{-4} \text{ M}$   
(c)  $10^{-1} \text{ M}$  (d)  $10^{-13} \text{ M}$
79. Calculate the pOH of a solution at  $25^\circ\text{C}$  that contains  $1 \times 10^{-10} \text{ M}$  of hydronium ions, i.e.  $\text{H}_3\text{O}^+$ .  
(a) 4.000 (b) 9.0000  
(c) 1.000 (d) 7.000
80. The pH of 0.005 molar solution of  $\text{H}_2\text{SO}_4$  is approximately:  
(a) 0.010 (b) 1  
(c) 2 (d) 0.005
81. Which solution has pH equal to 10 ?  
(a)  $10^{-4} \text{ M KOH}$  (b)  $10^{-10} \text{ M KOH}$   
(c)  $10^{-10} \text{ M HCl}$  (d)  $10^{-4} \text{ M HCl}$
82. Which of the following has highest pH ?  
(a)  $\frac{\text{M}}{4} \text{ KOH}$  (b)  $\frac{\text{M}}{4} \text{ NaOH}$   
(c)  $\frac{\text{M}}{4} \text{ NH}_4\text{OH}$  (d)  $\frac{\text{M}}{4} \text{ Ca(OH)}_2$
83. A weak acid, HA, has a  $K_a$  of  $1.00 \times 10^{-5}$ . If 0.100 mole of this acid dissolved in one litre of water, the percentage of acid dissociated at equilibrium is closest to  
(a) 1.00% (b) 99.9%  
(c) 0.100% (d) 99.0%
84. A monobasic weak acid solution has a molarity of 0.005 and pH of 5. What is the percentage ionization in this solution?  
(a) 2.0 (b) 0.2  
(c) 0.5 (d) 0.25
85. Calculate the pH of a solution obtained by diluting 1 mL of 0.10 M weak monoacidic base to 100 mL at constant temperature if  $K_b$  of the base is  $1 \times 10^{-5}$  ?  
(a) 8 (b) 9  
(c) 10 (d) 11
86. The ionisation constant of an acid,  $K_a$ , is the measure of strength of an acid. The  $K_a$  values of acetic acid, hypochlorous acid and formic acid are  $1.74 \times 10^{-5}$ ,  $3.0 \times 10^{-8}$  and  $1.8 \times 10^{-4}$  respectively. Which of the following orders of pH of  $0.1 \text{ mol dm}^{-3}$  solutions of these acids is correct?  
(a) acetic acid > hypochlorous acid > formic acid  
(b) hypochlorous acid > acetic acid > formic acid  
(c) formic acid > hypochlorous acid > acetic acid  
(d) formic acid > acetic acid > hypochlorous acid
87. The first and second dissociation constants of an acid  $\text{H}_2\text{A}$  are  $1.0 \times 10^{-5}$  and  $5.0 \times 10^{-10}$  respectively. The overall dissociation constant of the acid will be  
(a)  $0.2 \times 10^5$  (b)  $5.0 \times 10^{-5}$   
(c)  $5.0 \times 10^{15}$  (d)  $5.0 \times 10^{-15}$
88. Equimolar solutions of HF, HCOOH and HCN at 298 K have the values of  $K_a$  as  $6.8 \times 10^{-4}$  and  $4.8 \times 10^{-9}$  respectively. What is the observed trend of dissociation constants in successive stages ?  
(a)  $\text{HF} > \text{HCN} > \text{HCOOH}$  (b)  $\text{HF} > \text{HCOOH} > \text{HCN}$   
(c)  $\text{HCN} > \text{HF} > \text{HCOOH}$  (d)  $\text{HCOOH} > \text{HCN} > \text{HF}$
89. At  $25^\circ\text{C}$ , the dissociation constant of a base, BOH, is  $1.0 \times 10^{-12}$ . The concentration of hydroxyl ions in 0.01 M aqueous solution of the base would be  
(a)  $1.0 \times 10^{-5} \text{ mol L}^{-1}$  (b)  $1.0 \times 10^{-6} \text{ mol L}^{-1}$   
(c)  $2.0 \times 10^{-6} \text{ mol L}^{-1}$  (d)  $1.0 \times 10^{-7} \text{ mol L}^{-1}$
90. Which of the following  $\text{p}K_a$  value represents the strongest acid ?  
(a)  $10^{-4}$  (b)  $10^{-8}$   
(c)  $10^{-5}$  (d)  $10^{-2}$
91. The dissociation constant of two acids  $\text{HA}_1$  and  $\text{HA}_2$  are  $3.14 \times 10^{-4}$  and  $1.96 \times 10^{-5}$  respectively. The relative strength of the acids will be approximately  
(a) 1 : 4 (b) 4 : 1  
(c) 1 : 16 (d) 16 : 1

92. Given



Which of the following reaction is correct

- (a)  $K_b = K_w$  (b)  $K_b = \frac{1}{K_w}$   
(c)  $K_a \times K_b = K_w$  (d)  $\frac{K_a}{K_b} = K_w$

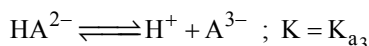
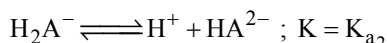
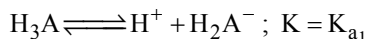
93. At 298K a 0.1 M  $\text{CH}_3\text{COOH}$  solution is 1.34% ionized. The ionization constant  $K_a$  for acetic acid will be

- (a)  $1.82 \times 10^{-5}$  (b)  $18.2 \times 10^{-5}$   
(c)  $0.182 \times 10^{-5}$  (d) None of these

94. For dibasic acid correct order is

- (a)  $K_{a1} < K_{a2}$  (b)  $K_{a1} > K_{a2}$   
(c)  $K_{a1} = K_{a2}$  (d) not certain

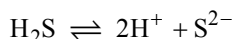
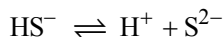
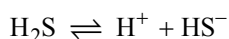
95. For a polybasic acid, the dissociation constants have a different values for each step, e.g.,



What is the observed trend of dissociation constants in successive stages ?

- (a)  $K_{a1} > K_{a2} > K_{a3}$  (b)  $K_{a1} = K_{a2} = K_{a3}$   
(c)  $K_{a1} < K_{a2} < K_{a3}$  (d)  $K_{a1} = K_{a2} + K_{a3}$

96.  $K_{a1}$ ,  $K_{a2}$  and  $K_{a3}$  are the respective ionisation constants for the following reactions.



The correct relationship between  $K_{a1}$ ,  $K_{a2}$  and  $K_{a3}$  is

- (a)  $K_{a3} = K_{a1} \times K_{a2}$  (b)  $K_{a3} = K_{a1} + K_{a2}$   
(c)  $K_{a3} = K_{a1} - K_{a2}$  (d)  $K_{a3} = K_{a1} / K_{a2}$

97. Cationic hydrolysis gives the following solution:

- (a) acidic (b) basic  
(c) neutral (d) amphoteric

98. In qualitative analysis, in III group  $\text{NH}_4\text{Cl}$  is added before  $\text{NH}_4\text{OH}$  because

- (a) to increase the concentration of  $\text{NH}_4^+$  ions  
(b) to increase concentration of  $\text{Cl}^-$  ions  
(c) to reduce the concentration of  $\text{OH}^-$  ions  
(d) to increase concentration of  $\text{OH}^-$  ions

99. The solubility of  $\text{AgI}$  in  $\text{NaI}$  solution is less than that in pure water because :

- (a) the temperature of the solution decreases

- (b) solubility product to  $\text{AgI}$  is less than that of  $\text{NaI}$   
(c) of common ion effect  
(d)  $\text{AgI}$  forms complex with  $\text{NaI}$

100. When sodium acetate is added to an aqueous solution of acetic acid :

- (a) The pH of the solution decreases  
(b) The pH of the solution increases  
(c) The pH of the solution remains unchanged  
(d) An acid salt is produced

101. Which of the following statements about pH and  $\text{H}^+$  ion concentration is incorrect?

- (a) Addition of one drop of concentrated  $\text{HCl}$  in  $\text{NH}_4\text{OH}$  solution decreases pH of the solution.  
(b) A solution of the mixture of one equivalent of each of  $\text{CH}_3\text{COOH}$  and  $\text{NaOH}$  has a pH of 7  
(c) pH of pure neutral water is not zero  
(d) A cold and concentrated  $\text{H}_2\text{SO}_4$  has lower  $\text{H}^+$  ion concentration than a dilute solution of  $\text{H}_2\text{SO}_4$

102.  $\text{H}_2\text{S}$  gas when passed through a solution of cations containing  $\text{HCl}$  precipitates the cations of second group of qualitative analysis but not those belonging to the fourth group. It is because

- (a) presence of  $\text{HCl}$  decreases the sulphide ion concentration.  
(b) solubility product of group II sulphides is more than that of group IV sulphides.  
(c) presence of  $\text{HCl}$  increases the sulphide ion concentration.  
(d) sulphides of group IV cations are unstable in  $\text{HCl}$ .

103. A salt 'X' is dissolved in water of pH = 7. The salt is made resulting solution becomes alkaline in nature. The salt is made

- (a) A strong acid and strong base  
(b) A strong acid and weak base  
(c) A weak acid and weak base  
(d) A weak acid and strong base

104. Aqueous solution of ferric chloride is acidic due to

- (a) ionization (b) polarization  
(c) dissociation (d) hydrolysis

105. The  $\text{pK}_a$  of a weak acid,  $\text{HA}$ , is 4.80. The  $\text{pK}_b$  of a weak base,  $\text{BOH}$ , is 4.78. The pH of an aqueous solution of the corresponding salt,  $\text{BA}$ , will be

- (a) 9.58 (b) 4.79  
(c) 7.01 (d) 9.22

106. The  $\text{pK}_a$  of a weak acid ( $\text{HA}$ ) is 4.5. The  $\text{pOH}$  of an aqueous buffer solution of  $\text{HA}$  in which 50% of the acid is ionized is

- (a) 7.0 (b) 4.5  
(c) 2.5 (d) 9.5

107. A buffer solution is prepared in which the concentration of  $\text{NH}_3$  is 0.30M and the concentration of  $\text{NH}_4^+$  is 0.20 M. If the equilibrium constant,  $K_b$  for  $\text{NH}_3$  equals  $1.8 \times 10^{-5}$ , what is the pH of this solution ? ( $\log 2.7 = 0.433$ ).

- (a) 9.08 (b) 9.43  
(c) 11.72 (d) 8.73

108. What is  $[H^+]$  in mol/L of a solution that is 0.20 M in  $CH_3COONa$  and 0.10 M in  $CH_3COOH$ ?  $K_a$  for  $CH_3COOH = 1.8 \times 10^{-5}$ .
- (a)  $3.5 \times 10^{-4}$  (b)  $1.1 \times 10^{-5}$   
(c)  $1.8 \times 10^{-5}$  (d)  $9.0 \times 10^{-6}$
109. Which of the following pairs constitutes a buffer?
- (a) NaOH and NaCl (b)  $HNO_3$  and  $NH_4NO_3$   
(c) HCl and KCl (d)  $HNO_2$  and  $NaNO_2$
110. Buffer solutions have constant acidity and alkalinity because
- (a) these give unionised acid or base on reaction with added acid or alkali.  
(b) acids and alkalis in these solutions are shielded from attack by other ions.  
(c) they have large excess of  $H^+$  or  $OH^-$  ions  
(d) they have fixed value of pH
111. The buffering action of an acidic buffer is maximum when its pH is equal
- (a) 5 (b) 7  
(c) 1 (d)  $pK_a$
112. When a buffer solution, sodium acetate and acetic acid is diluted with water :
- (a) Acetate ion concentration increases  
(b)  $H^+$  ion concentration increases  
(c)  $OH^-$  ion conc. increases  
(d)  $H^+$  ion concentration remains unaltered
113. The product of ionic concentration in a saturated solution of an electrolyte at a given temperature is constant and is known as
- (a) Ionic product of the electrolyte  
(b) Solubility product  
(c) Ionization constant  
(d) Dissociation constant
114. The  $K_{sp}$  for  $Cr(OH)_3$  is  $1.6 \times 10^{-30}$ . The solubility of this compound in water is :
- (a)  $\sqrt[4]{1.6 \times 10^{-30}}$  (b)  $\sqrt[4]{1.6 \times 10^{-30}} / 27$   
(c)  $1.6 \times 10^{-30/27}$  (d)  $\sqrt[4]{1.6 \times 10^{-30}}$
115. At  $25^\circ C$ , the solubility product of  $Mg(OH)_2$  is  $1.0 \times 10^{-11}$ . At which pH, will  $Mg^{2+}$  ions start precipitating in the form of  $Mg(OH)_2$  from a solution of 0.001 M  $Mg^{2+}$  ions?
- (a) 9 (b) 10  
(c) 11 (d) 8
116. pH of a saturated solution of  $Ba(OH)_2$  is 12. The value of solubility product ( $K_{sp}$ ) of  $Ba(OH)_2$  is :
- (a)  $3.3 \times 10^{-7}$  (b)  $5.0 \times 10^{-7}$   
(c)  $4.0 \times 10^{-6}$  (d)  $5.0 \times 10^{-6}$
117. If  $s$  and  $S$  are respectively solubility and solubility product of a sparingly soluble binary electrolyte then :
- (a)  $s = S$  (b)  $s = S^2$   
(c)  $s = S^{1/2}$  (d)  $s = \frac{1}{2}S$
118. Why only  $As^{+3}$  gets precipitated as  $As_2S_3$  and not  $Zn^{+2}$  as  $ZnS$  when  $H_2S$  is passed through an acidic solution containing  $As^{+3}$  and  $Zn^{+2}$ ?
- (a) Solubility product of  $As_2S_3$  is less than that of  $ZnS$   
(b) Enough  $As^{+3}$  are present in acidic medium  
(c) Zinc salt does not ionise in acidic medium  
(d) Solubility product changes in presence of an acid
119. Solid  $Ba(NO_3)_2$  is gradually dissolved in a  $1.0 \times 10^{-4}$  M  $Na_2CO_3$  solution. At which concentration of  $Ba^{2+}$ , precipitate of  $BaCO_3$  begins to form? ( $K_{sp}$  for  $BaCO_3 = 5.1 \times 10^{-9}$ )
- (a)  $5.1 \times 10^{-5}$  M (b)  $7.1 \times 10^{-8}$  M  
(c)  $4.1 \times 10^{-5}$  M (d)  $8.1 \times 10^{-7}$  M
120. Solubility product of silver bromide is  $5.0 \times 10^{-13}$ . The quantity of potassium bromide (molar mass taken as  $120 \text{ g mol}^{-1}$ ) to be added to 1 litre of 0.05 M solution of silver nitrate to start the precipitation of  $AgBr$  is
- (a)  $1.2 \times 10^{-10}$  g (b)  $1.2 \times 10^{-9}$  g  
(c)  $6.2 \times 10^{-5}$  g (d)  $5.0 \times 10^{-8}$  g
121. At  $25^\circ C$ , the solubility product of  $Mg(OH)_2$  is  $1.0 \times 10^{-11}$ . At which pH, will  $Mg^{2+}$  ions start precipitating in the form of  $Mg(OH)_2$  from a solution of 0.001 M  $Mg^{2+}$  ions?
- (a) 9 (b) 10  
(c) 11 (d) 8

### STATEMENT TYPE QUESTIONS

122. Read the following statements carefully and choose the correct answer
- (i) Water and water vapour remain in equilibrium position at atmospheric pressure (1.013 bar) and at  $100^\circ C$  in a closed vessel.  
(ii) The boiling point of water is  $100^\circ C$  at 1.013 bar pressure  
(iii) Boiling point of the liquid depends on the atmospheric pressure.  
(iv) Boiling point depends on the altitude of the place; at high altitude the boiling point increases.
- (a) (i), (ii) and (iv) are correct  
(b) (i), (iii) and (iv)  
(c) (i), (ii) and (iii) are correct  
(d) only (iii) is correct
123. You must have seen that when a soda water bottle is opened, some of the carbon dioxide gas dissolved in it fizzes out rapidly. There is equilibrium between the molecules in the gaseous state and the molecules dissolved in the liquid under pressure i.e.,
- $$CO_2(\text{gas}) \rightleftharpoons CO_2(\text{in solution})$$
- Which of the following statements is/are correct regarding this?
- (i) The phenomenon arises due to difference in solubility of carbon dioxide at different pressures.  
(ii) This equilibrium is governed by Henry's law.  
(iii) The amount of  $CO_2$  gas dissolved in liquid increases with decrease of temperature.  
(iv) The amount of  $CO_2$  gas dissolved in liquid decreases with increase of temperature.
- (a) (i), (ii) and (iv) are correct  
(b) (i), (iii) and (iv)  
(c) (i), (ii) and (iii) are correct  
(d) only (iii) is correct

- 124.** Identify the CORRECT statements below regarding chemical equilibrium:
- All chemical reactions which are in equilibrium are irreversible.
  - Equilibrium is achieved when the forward reaction rate equals the reverse reaction rate.
  - Equilibrium is achieved when the concentrations of reactants and product remain constant.
  - Equilibrium is dynamic in nature
- (i), (ii) and (iv) are correct
  - (i), (ii), (iii) and (iv) are correct
  - (i), (ii) and (iii) are correct
  - only (ii) is correct
- 125.** Nobel gas is added to a reaction at equilibrium involving gaseous reactant and gaseous product.  
Which of the following statement is true for above reaction?
- Statement 1 :** Reaction will proceed forward, as total pressure has increased due to addition of Nobel gas.  
**Statement 2 :** Reaction will proceed backward, if Nobel gas react with reactant.
- Statement 1 and 2 are both correct.
  - Statement 1 is correct but statement 2 is incorrect.
  - Statement 1 is incorrect but statement 2 is correct.
  - Statement 1 and 2 both are incorrect.
- 126** Read the following statements and choose the correct option.
- The value of equilibrium constant is independent of initial concentrations of the reactants and products.
  - Equilibrium constant is temperature dependent
  - The equilibrium constant for the reverse reaction is equal to the inverse of the equilibrium constant for the forward reaction.
  - The equilibrium constant for the reverse reaction is equal to the equilibrium constant for the forward reaction.
- (i), (ii) and (iv) are correct
  - (i), (iii) and (iv)
  - (i), (ii) and (iii) are correct
  - only (iii) is correct
- 127.** Read the following statements and choose the correct option
- The numerical value of the equilibrium constant for a reaction indicates the extent of the reaction.
  - An equilibrium constant give information about the rate at which the equilibrium is reached.
  - If  $K_c > 10^3$ , products predominate over reactants, i.e., if  $K_c$  is very large, the reaction proceeds nearly to completion.
  - If  $K_c < 10^{-3}$ , reactants predominate over products, i.e., if  $K_c$  is very small, the reaction proceeds rarely.
- (i), (ii) and (iv) are correct
  - (i), (iii) and (iv)
  - (i), (ii) and (iii) are correct
  - only (iii) is correct
- 128.** Which of the following statement(s) is/are correct ?
- $\Delta G$  is negative, then the reaction is spontaneous and proceeds in the forward direction.
  - $\Delta G$  is positive, then reaction is non-spontaneous
  - $\Delta G$  is 0, then reaction is at equilibrium
- (i), (ii) and (iii) are correct
  - (i) and (ii)
  - (ii) and (iii) are correct
  - only (iii) is correct
- 129.** Read the following statements and choose the correct option
- Most of the acids taste sour
  - Acids turns blue litmus paper into red
  - Bases turns red litmus paper blue
  - Bases taste bitter and feel soapy
- (i), (ii) and (iv) are correct
  - (i), (iii) and (iv)
  - (i), (ii) and (iii) are correct
  - All statements are correct
- 130.** Which of the following statements are correct ?
- Strong acids have very weak conjugate bases
  - Weak acids have very strong conjugate bases
  - Strong bases have strong conjugate acids
  - Weak bases have weak conjugate acids
- (i) and (ii)
  - (i) and (iii)
  - (ii) and (iv)
  - (iii) and (iv)
- 131.** Which of the following statement(s) is/are correct ?
- Water has ability to act both as an acid and a base
  - In pure water one  $H_2O$  molecule donate proton and acts an acid and another water molecule accepts a proton and acts as a base.
- Both (i) and (ii)
  - Neither (i) nor (ii)
  - Only (i)
  - Only (ii)
- 132.** Which of the following statements are correct ?
- Ionic product of water ( $K_w$ ) =  $[H^+][OH^-] = 10^{-14}M^2$
  - At 298K  $[H^+] = [OH^-] = 10^{-7}$
  - $K_w$  does not depends upon temperature
  - Molarity of pure water = 55.55M
- (i), (ii) and (iii)
  - (i), (ii) and (iv)
  - (i) and (iv)
  - (ii) and (iii)
- 133.** Read the following statements and choose the correct option
- $K_a$  (ionization constant) is a measure of the strength of the acids
  - Smaller the value of  $K_a$ , the stronger is the acid
  - $K_a$  is a dimensionless quantity
- Statements (i) and (ii) are correct
  - Statements (ii) and (iii) are correct
  - Statements (i), (ii) and (iii) are correct
  - Statements (i) and (iii) are correct
- 134.** Which of the following statement(s) is/are correct ?
- In a tribasic acid 2<sup>nd</sup> and 3<sup>rd</sup> ( $K_{a_2}$ ,  $K_{a_3}$ ) ionization constants are smaller than the first ionisation ( $K_{a_1}$ )
  - It is difficult to remove a positively charged proton from a negative ion due to electrostatic force.
- Both (i) and (ii)
  - Neither (i) nor (ii)
  - Only (i)
  - Only (ii)

135. Which of the following statements are correct ?

- (i) The extent of dissociation of an acid depends on the strength and polarity of the H — A bond (where A is an electronegative element.)  
 (ii) As the strength of H—A bond increases, the energy required to break the bond decreases.  
 (iii) As the electronegativity difference between the atoms H and A increases, acidity increases
- (a) (i) and (ii) (b) (ii) and (iii)  
 (c) (i) and (iii) (d) (i), (ii) and (iii)

### MATCHING TYPE QUESTIONS

136. Match the columns

- | Column-I   | Column-II                                      |
|--|--|
| (A) $\text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_2\text{O}(\text{vap})$ | (p) rate of melting = rate of freezing         |
| (B) $\text{I}_2(\text{solid}) \rightleftharpoons \text{I}_2(\text{vapour})$          | (q) rate of evaporation = rate of condensation |
| (C) $\text{Ice} \rightleftharpoons \text{water}$                                     | (r) rate of sublimation = rate of condensation |
- (a) A — (p), B — (q), C — (r)  
 (b) A — (r), B — (q), C — (p)  
 (c) A — (p), B — (r), C — (q)  
 (d) A — (q), B — (r), C — (p)

137. Match the Column-I with Column-II and mark the appropriate choice.

- | Column-I  | Column-II              |
|---|------------------------|
| (A) Liquid $\rightleftharpoons$ Vapour                | (p) Saturated solution |
| (B) Solid $\rightleftharpoons$ Liquid                 | (q) Boiling point      |
| (C) Solid $\rightleftharpoons$ Vapour                 | (r) Sublimation point  |
| (D) Solute (s) $\rightleftharpoons$ Solute (solution) | (s) Melting point      |
- (a) A — (p) ; B — (r) ; C — (q) ; D — (s)  
 (b) A — (q) ; B — (s) ; C — (r) ; D — (p)  
 (c) A — (s) ; B — (q) ; C — (p) ; D — (r)  
 (d) A — (r) ; B — (s) ; C — (q) ; D — (p)

138. Match the columns.

- | Column-I<br>(Reactions)  | Column-II<br>(Effect of increase in pressure) |
|--|---|
| (A) $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$            | (p) Reaction proceed backward.                |
| (B) $\text{CO}(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightleftharpoons \text{CO}_2(\text{g})$ | (q) No effect on reaction.                    |
| (C) $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$                       | (r) Reaction proceed forward                  |
- (a) A — (q), B — (r), C — (p)  
 (b) A — (r), B — (q), C — (p)  
 (c) A — (p), B — (r), C — (q)  
 (d) A — (q), B — (p), C — (r)

139. Match the columns :

- | Column-I  | Column-II             |
|---|-----------------------|
| (A) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ (t = 300°C)  | (p) $\Delta n > 0$    |
| (B) $\text{PCl}_5(\text{g}) \rightleftharpoons \text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g})$ (t = 50°C)   | (q) $K_p < K_c$       |
| (C) $\text{C}(\text{s}) + \text{H}_2\text{O}(\text{g}) \rightleftharpoons \text{CO}(\text{g}) + \text{H}_2(\text{g})$   | (r) $K_p$ not defined |
| (D) $\text{CH}_3\text{COOH}(\text{l}) + \text{C}_2\text{H}_5\text{OH}(\text{l}) \rightleftharpoons \text{CH}_3\text{COOC}_2\text{H}_5(\text{l}) + \text{H}_2\text{O}(\text{l})$ | (s) $\Delta n = 1$    |
- (a) A — (q), B — (p), C — (s), D — (r)  
 (b) A — (p), B — (q), C — (r), D — (s)  
 (c) A — (r), B — (p), C — (s), D — (q)  
 (d) A — (s), B — (q), C — (p), D — (r)

140. Match the columns :

- | Column-I  | Column-II   |
|---|---|
| (A) For the equilibrium $\text{NH}_4\text{I}(\text{s}) \rightleftharpoons \text{NH}_3(\text{g}) + \text{HI}(\text{g})$ , if pressure is increased at equilibrium                                    | (p) Forward shift                                 |
| (B) For the equilibrium $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ If volume is increased at equilibrium  | (q) No change                                     |
| (C) For the equilibrium $\text{H}_2\text{O}(\text{g}) + \text{CO}(\text{g}) \rightleftharpoons \text{H}_2(\text{g}) + \text{CO}_2(\text{g})$ inert gas is added at constant pressure at equilibrium | (r) Backward shift                                |
| (D) For the equilibrium $\text{PCl}_5 \rightleftharpoons \text{PCl}_3 + \text{Cl}_2$ what happens if more $\text{PCl}_5$ is added   | (s) More $\text{N}_2$ and $\text{H}_2$ is formed. |
- (a) A — (p), B — (q), C — (r), D — (s)  
 (b) A — (r), B — (s), C — (q), D — (p)  
 (c) A — (s), B — (p), C — (q), D — (r)  
 (d) A — (q), B — (s), C — (r), D — (p)

141. Match the columns

- | Column-I        | Column-II                                 |
|-----------------|---|
| (A) $Q_c < K_c$ | (p) Net reaction goes from right to left. |
| (B) $Q_c > K_c$ | (q) Net reaction goes from left to right. |
| (C) $Q_c = K_c$ | (r) No net reaction occurs.               |
- (a) A — (p), B — (q), C — (r)  
 (b) A — (r), B — (q), C — (p)  
 (c) A — (p), B — (r), C — (q)  
 (d) A — (q), B — (p), C — (r)



142. Match the columns

Column-I	Column-II
(A) Hydrochloric acid	(p) Lemon and orange
(B) Acetic acid	(q) Tamarind paste.
(C) Citric and ascorbic acids	(r) Digestive juice
(D) Tartaric acid	(s) Constituent of vinegar
(a) A – (q), B – (r), C – (p), D – (s)	
(b) A – (r), B – (s), C – (p), D – (q)	
(c) A – (s), B – (p), C – (q), D – (r)	
(d) A – (r), B – (p), C – (s), D – (q)	

143. Match the columns

Column-I	Column-II
(A) $\text{HClO}_4$	(p) Strong base
(B) $\text{HNO}_2$	(q) Strong acid
(C) $\text{NH}_2^-$	(r) Weak base
(D) $\text{HSO}_4^-$	(s) Weak acid
(a) A – (s), B – (q), C – (p), D – (r)	
(b) A – (q), B – (s), C – (p), D – (r)	
(c) A – (r), B – (p), C – (q), D – (s)	
(d) A – (s), B – (q), C – (p), D – (r)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

144. **Assertion :**  $K_p$  can be less than, greater than or equal to  $K_c$ .

**Reason :** Relation between  $K_p$  and  $K_c$  depends on the change in number of moles of gaseous reactants and products ( $\Delta n$ ).

145. **Assertion :** If a volume is kept constant and an inert gas such as argon is added which does not take part in the reaction, the equilibrium remains undisturbed.

**Reason :** It is because the addition of an inert gas at constant volume does not change the partial pressure or the molar concentrations of the substance involved in the reaction.

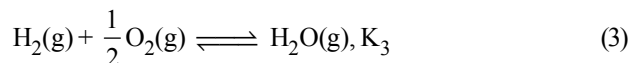
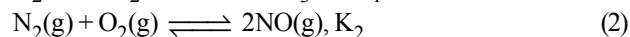
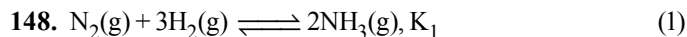
146. **Assertion :** Buffer system of carbonic acid and sodium bicarbonate is used for the precipitation of hydroxides of third group elements.

**Reason :** It maintains the pH to a constant value, about 7.4.

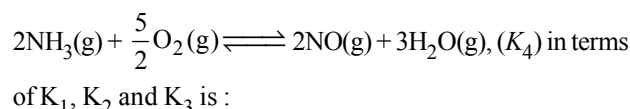
147. **Assertion :** Addition of silver ions to a mixture of aqueous sodium chloride and sodium bromide solution will first precipitate AgBr rather than AgCl.

**Reason :**  $K_{sp}$  of AgCl >  $K_{sp}$  of AgBr.

### CRITICAL THINKING TYPE QUESTIONS



The equation for the equilibrium constant of the reaction



(a)  $\frac{K_1 \cdot K_2}{K_3}$  (b)  $\frac{K_1 \cdot K_3^2}{K_2}$

(c)  $K_1 K_2 K_3$  (d)  $\frac{K_2 \cdot K_3^3}{K_1}$

149. Two equilibria,  $\text{AB} \rightleftharpoons \text{A}^+ + \text{B}^-$  and  $\text{AB} + \text{B}^- \rightleftharpoons \text{AB}_2^-$  are simultaneously maintained in a solution with equilibrium constants,  $K_1$  and  $K_2$  respectively. The ratio of  $[\text{A}^+]$  to  $[\text{AB}_2^-]$  in the solution is

- (a) directly proportional to  $[\text{B}^-]$   
 (b) inversely proportional to  $[\text{B}^-]$   
 (c) directly proportional to the square of  $[\text{B}^-]$   
 (d) inversely proportional to the square of  $[\text{B}^-]$

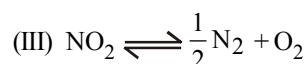
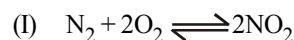
150. Equilibrium constant (K) for the reaction  $\text{Ni}(\text{s}) + 4\text{CO}(\text{g}) \rightleftharpoons \text{Ni}(\text{CO})_4(\text{g})$  can be written in terms of

- (1)  $\text{Ni}(\text{s}) + 2\text{CO}_2(\text{g}) + 2\text{C}(\text{s}) \rightleftharpoons \text{Ni}(\text{CO})_4(\text{g})$ ;  
 equilibrium constant =  $K_1$ .  
 (2)  $\text{CO}_2(\text{g}) + \text{C}(\text{s}) \rightleftharpoons 2\text{CO}(\text{g})$ ;  
 equilibrium constant =  $K_2$ .

What is the relation between  $K, K_1$  and  $K_2$  ?

- (a)  $K = (K_1)/(K_2)^2$  (b)  $K = (K_1 \cdot K_2)$   
 (c)  $K = (K_1)(K_2)^2$  (d)  $K = K_1/K_2$

151.  $K_1, K_2$  and  $K_3$  are the equilibrium constants of the following reactions (I), (II) and (III) respectively:

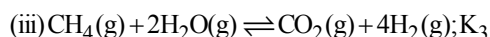
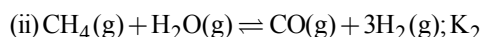
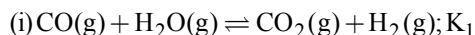


The correct relation from the following is

(a)  $K_1 = \frac{1}{K_2} = \frac{1}{K_3}$  (b)  $K_1 = \frac{1}{K_2} = \frac{1}{(K_3)^2}$

(c)  $K_1 = \sqrt{K_2} = K_3$  (d)  $K_1 = \frac{1}{K_2} = K_3$

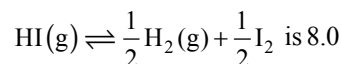
152. For the following three reactions a, b and c, equilibrium constants are given:



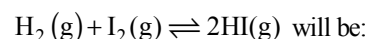
(a)  $K_1\sqrt{K_2} = K_3$  (b)  $K_2K_3 = K_1$

(c)  $K_3 = K_1 K_2$  (d)  $K_3 \cdot K_2^3 = K_1^2$

153. The value of equilibrium constant of the reaction



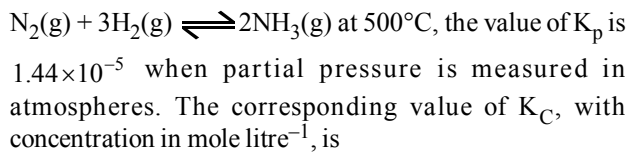
The equilibrium constant of the reaction



(a)  $\frac{1}{16}$  (b)  $\frac{1}{64}$

(c) 16 (d)  $\frac{1}{8}$

154. For the reversible reaction,



(a)  $\frac{1.44 \times 10^{-5}}{(0.082 \times 500)^{-2}}$  (b)  $\frac{1.44 \times 10^{-5}}{(8.314 \times 773)^{-2}}$

(c)  $\frac{1.44 \times 10^{-5}}{(0.082 \times 773)^2}$  (d)  $\frac{1.44 \times 10^{-5}}{(0.082 \times 773)^{-2}}$

155. Two moles of  $\text{PCl}_5$  were heated in a closed vessel of 2L. At equilibrium 40% of  $\text{PCl}_5$  is dissociated into  $\text{PCl}_3$  and  $\text{Cl}_2$ . The value of equilibrium constant is

(a) 0.53 (b) 0.267

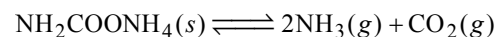
(c) 2.63 (d) 5.3

156.  $\text{PCl}_5$  is dissociating 50% at  $250^\circ\text{C}$  at a total pressure of P atm. If equilibrium constant is  $K_p$ , then which of the following relation is numerically correct?

(a)  $K_p = 3P$  (b)  $P = 3K_p$

(c)  $P = \frac{2K_p}{3}$  (d)  $K_p = \frac{2P}{3}$

157. For the decomposition of the compound, represented as



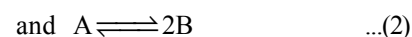
the  $K_p = 2.9 \times 10^{-5} \text{ atm}^3$ .

If the reaction is started with 1 mol of the compound, the total pressure at equilibrium would be:

(a)  $1.94 \times 10^{-2} \text{ atm}$  (b)  $5.82 \times 10^{-2} \text{ atm}$

(c)  $7.66 \times 10^{-2} \text{ atm}$  (d)  $38.8 \times 10^{-2} \text{ atm}$

158. The values of  $K_{p1}$  and  $K_{p2}$  for the reactions

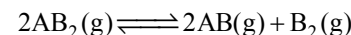


are in the ratio of 9 : 1. If degree of dissociation of X and A be equal, then total pressure at equilibrium (1) and (2) are in the ratio:

(a) 3 : 1 (b) 1 : 9

(c) 36 : 1 (d) 1 : 1

159. The dissociation equilibrium of a gas  $\text{AB}_2$  can be represented as:

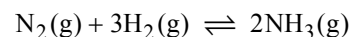


The degree of dissociation is 'x' and is small compared to 1. The expression relating the degree of dissociation (x) with equilibrium constant  $K_p$  and total pressure P is:

(a)  $(2K_p/P)$  (b)  $(2K_p/P)^{1/3}$

(c)  $(2K_p/P)^{1/2}$  (d)  $(K_p/P)$

160. On increasing the pressure, the gas phase reaction proceed forward to re-establish equilibrium, as predicted by applying the Le Chatelier's principle. Consider the reaction.



Which of the following is correct, if the total pressure at which the equilibrium is established, is increased without changing the temperature?

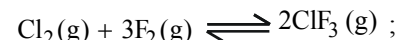
(a) K will remain same

(b) K will decrease

(c) K will increase

(d) K will increase initially and decrease when pressure is very high

161. The exothermic formation of  $\text{ClF}_3$  is represented by the equation:



$\Delta H = -329 \text{ kJ}$

Which of the following will increase the quantity of  $\text{ClF}_3$  in an equilibrium mixture of  $\text{Cl}_2$ ,  $\text{F}_2$  and  $\text{ClF}_3$ ?

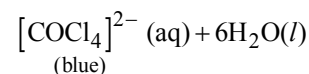
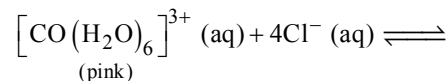
(a) Adding  $\text{F}_2$

(b) Increasing the volume of the container

(c) Removing  $\text{Cl}_2$

(d) Increasing the temperature

162. When hydrochloric acid is added to cobalt nitrate solution at room temperature, the following reaction takes place out the reaction mixture becomes blue. On cooling the mixture it becomes pink. On the basis of this information mark the correct answer.



(a)  $\Delta H > 0$  for the reaction

(b)  $\Delta H < 0$  for the reaction

(c)  $\Delta H = 0$  for the reaction

(d) The sign of  $\Delta H$  cannot be predicted on the basis of this information.

163. In  $\text{HS}^-$ ,  $\text{I}^-$ ,  $\text{RNH}_2$  and  $\text{NH}_3$ , order of proton accepting tendency will be  
 (a)  $\text{I}^- > \text{NH}_3 > \text{RNH}_2 > \text{HS}^-$   
 (b)  $\text{HS}^- > \text{RNH}_2 > \text{NH}_3 > \text{I}^-$   
 (c)  $\text{RNH}_2 > \text{NH}_3 > \text{HS}^- > \text{I}^-$   
 (d)  $\text{NH}_3 > \text{RNH}_2 > \text{HS}^- > \text{I}^-$
164. Which equilibrium can be described as an acid-base reaction using the Lewis acid-base definition but not using the Bronsted-Lowry definition?  
 (a)  $2\text{NH}_3 + \text{H}_2\text{SO}_4 \rightleftharpoons 2\text{NH}_4^+ + \text{SO}_4^{2-}$   
 (b)  $\text{NH}_3 + \text{CH}_3\text{COOH} \rightleftharpoons \text{NH}_4^+ + \text{CH}_3\text{COO}^-$   
 (c)  $\text{H}_2\text{O} + \text{CH}_3\text{COOH} \rightleftharpoons \text{H}_3\text{O}^+ + \text{CH}_3\text{COO}^-$   
 (d)  $[\text{Cu}(\text{H}_2\text{O})_4]^{2+} + 4\text{NH}_3 \rightleftharpoons [\text{Cu}(\text{NH}_3)_4]^{2+} + 4\text{H}_2\text{O}$
165. Equal volumes of three acid solutions of pH 3, 4 and 5 are mixed in a vessel. What will be the  $\text{H}^+$  ion concentration in the mixture?  
 (a)  $1.11 \times 10^{-4} \text{ M}$  (b)  $3.7 \times 10^{-4} \text{ M}$   
 (c)  $3.7 \times 10^{-3} \text{ M}$  (d)  $1.11 \times 10^{-3} \text{ M}$
166. The pH of  $10^{-10} \text{ M}$  NaOH solution is nearest to:  
 (a) 6 (b) -10  
 (c) 4 (d) 7
167. 100 mL of 0.04 N HCl aqueous solution is mixed with 100 mL of 0.02 N NaOH solution. The pH of the resulting solution is:  
 (a) 1.0 (b) 1.7  
 (c) 2.0 (d) 2.3
168. Equal volumes of three acid solutions of pH 3, 4 and 5 are mixed in a vessel. What will be the  $\text{H}^+$  ion concentration in the mixture?  
 (a)  $1.11 \times 10^{-4} \text{ M}$  (b)  $3.7 \times 10^{-4} \text{ M}$   
 (c)  $3.7 \times 10^{-3} \text{ M}$  (d)  $1.11 \times 10^{-3} \text{ M}$
169. At  $100^\circ\text{C}$  the  $K_w$  of water is 55 times its value at  $25^\circ\text{C}$ . What will be the pH of neutral solution? ( $\log 55 = 1.74$ )  
 (a) 6.13 (b) 7.00  
 (c) 7.87 (d) 5.13
170. Ionisation constant of  $\text{CH}_3\text{COOH}$  is  $1.7 \times 10^{-5}$  if concentration of  $\text{H}^+$  ions is  $3.4 \times 10^{-4} \text{ M}$ , then find out initial concentration of  $\text{CH}_3\text{COOH}$  molecules  
 (a)  $3.4 \times 10^{-4} \text{ M}$  (b)  $3.4 \times 10^{-3} \text{ M}$   
 (c)  $6.8 \times 10^{-3} \text{ M}$  (d)  $6.8 \times 10^{-4} \text{ M}$
171. Values of dissociation constant,  $K_a$  are given as follows :  

<b>Acid</b>	<b><math>K_a</math></b>
HCN	$6.2 \times 10^{-10}$
HF	$7.2 \times 10^{-4}$
$\text{HNO}_2$	$4.0 \times 10^{-4}$

 Correct order of increasing base strength of the base  $\text{CN}^-$ ,  $\text{F}^-$  and  $\text{NO}_2^-$  will be :  
 (a)  $\text{F}^- < \text{CN}^- < \text{NO}_2^-$  (b)  $\text{NO}_2^- < \text{CN}^- < \text{F}^-$   
 (c)  $\text{F}^- < \text{NO}_2^- < \text{CN}^-$  (d)  $\text{NO}_2^- < \text{F}^- < \text{CN}^-$
172. The dissociation constants for acetic acid and HCN at  $25^\circ\text{C}$  are  $1.5 \times 10^{-5}$  and  $4.5 \times 10^{-10}$  respectively. The equilibrium constant for the equilibrium  
 $\text{CN}^- + \text{CH}_3\text{COOH} \rightleftharpoons \text{HCN} + \text{CH}_3\text{COO}^-$  would be:  
 (a)  $3.0 \times 10^{-5}$  (b)  $3.0 \times 10^{-4}$   
 (c)  $3.0 \times 10^4$  (d)  $3.0 \times 10^5$
173. If degree of dissociation of pure water at  $100^\circ\text{C}$  is  $1.8 \times 10^{-8}$ , then the dissociation constant of water will be (density of  $\text{H}_2\text{O} = 1 \text{ gm/cc}$ )  
 (a)  $1 \times 10^{-12}$  (b)  $1 \times 10^{-14}$   
 (c)  $1.8 \times 10^{-12}$  (d)  $1.8 \times 10^{-14}$
174. Ionisation of weak acid can be calculated by the formula  
 (a)  $100\sqrt{\frac{K_a}{c}}$  (b)  $\frac{100}{1 + 10^{(pK_a - pH)}}$   
 (c) Both (a) and (b) (d) None of these
175. Equimolar solutions of the following were prepared in water separately. Which one of the solutions will record the highest pH?  
 (a)  $\text{SrCl}_2$  (b)  $\text{BaCl}_2$   
 (c)  $\text{MgCl}_2$  (d)  $\text{CaCl}_2$
176. Solubility product constant ( $K_{sp}$ ) of salts of types  $\text{MX}$ ,  $\text{MX}_2$  and  $\text{M}_3\text{X}$  at temperature T are  $4.0 \times 10^{-8}$ ,  $3.2 \times 10^{-14}$  and  $2.7 \times 10^{-15}$ , respectively. Solubilities ( $\text{mol dm}^{-3}$ ) of the salts at temperature 'T' are in the order –  
 (a)  $\text{MX} > \text{MX}_2 > \text{M}_3\text{X}$  (b)  $\text{M}_3\text{X} > \text{MX}_2 > \text{MX}$   
 (c)  $\text{MX}_2 > \text{M}_3\text{X} > \text{MX}$  (d)  $\text{MX} > \text{M}_3\text{X} > \text{MX}_2$
177. In qualitative analysis, the metals of Group I can be separated from other ions by precipitating them as chloride salts. A solution initially contains  $\text{Ag}^+$  and  $\text{Pb}^{2+}$  at a concentration of 0.10 M. Aqueous HCl is added to this solution until the  $\text{Cl}^-$  concentration is 0.10 M. What will the concentrations of  $\text{Ag}^+$  and  $\text{Pb}^{2+}$  be at equilibrium?  
 ( $K_{sp}$  for  $\text{AgCl} = 1.8 \times 10^{-10}$ ,  $K_{sp}$  for  $\text{PbCl}_2 = 1.7 \times 10^{-5}$ )  
 (a)  $[\text{Ag}^+] = 1.8 \times 10^{-7} \text{ M}$ ;  $[\text{Pb}^{2+}] = 1.7 \times 10^{-6} \text{ M}$   
 (b)  $[\text{Ag}^+] = 1.8 \times 10^{-11} \text{ M}$ ;  $[\text{Pb}^{2+}] = 8.5 \times 10^{-5} \text{ M}$   
 (c)  $[\text{Ag}^+] = 1.8 \times 10^{-9} \text{ M}$ ;  $[\text{Pb}^{2+}] = 1.7 \times 10^{-3} \text{ M}$   
 (d)  $[\text{Ag}^+] = 1.8 \times 10^{-11} \text{ M}$ ;  $[\text{Pb}^{2+}] = 8.5 \times 10^{-4} \text{ M}$
178. The solubility product ( $K_{sp}$ ) of the following compounds are given at  $25^\circ\text{C}$ .  

<b>Compound</b>	<b><math>K_{sp}</math></b>
AgCl	$1.1 \times 10^{-10}$
AgI	$1.0 \times 10^{-16}$
$\text{PbCrO}_4$	$4.0 \times 10^{-14}$
$\text{Ag}_2\text{CO}_3$	$8.0 \times 10^{-12}$

 The most soluble and least soluble compounds are respectively.  
 (a) AgCl and  $\text{PbCrO}_4$  (b) AgI and  $\text{Ag}_2\text{CO}_3$   
 (c) AgCl and  $\text{Ag}_2\text{CO}_3$  (d)  $\text{Ag}_2\text{CO}_3$  and AgI
179. What is the molar solubility of  $\text{Fe}(\text{OH})_3$  if  $K_{sp} = 1.0 \times 10^{-38}$ ?  
 (a)  $3.16 \times 10^{-10}$  (b)  $1.386 \times 10^{-10}$   
 (c)  $1.45 \times 10^{-9}$  (d)  $1.12 \times 10^{-11}$

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (c)      2. (c)      3. (b)
4. (d) The time taken for complete evaporation depends on (i) the nature of the liquid, (ii) the amount of the liquid and (iii) the temperature.
5. (c) When the watch glass is open to the atmosphere, the rate of evaporation remains constant but the molecules are dispersed into large volume of the room. As a consequence the rate of condensation from vapour to liquid state is much less than the rate of evaporation.
6. (c) Ice melts with a reduction in volume. So Increase in pressure shifts equilibrium to water side, result in melting of ice according to Lechatelier's principle.
7. (a) A reaction is said to be in equilibrium when rate of forward reaction is equal to the rate of backward reaction.
8. (c)
9. (b) The reaction mixtures starting either with  $H_2$  or  $D_2$  reach equilibrium with the same composition, except that  $D_2$  and  $ND_3$  are present instead of  $H_2$  and  $NH_3$ .
10. (a) Equilibrium can be attained by either side of the reactions of equilibrium.
11. (d) According to the idea of dynamic equilibrium there is possibility of formation of all product.
12. (b) At equilibrium, the rate of forward and backward reactions is equal.
13. (a) For reaction (1)

$$K_1 = \frac{[NO]^2}{[N_2][O_2]}$$

and for reaction (2)

$$K_2 = \frac{[N_2]^{1/2}[O_2]^{1/2}}{[NO]} \text{ therefore } K_1 = \frac{1}{K_2^2}$$

14. (c)  $N_2 + 3H_2 \rightleftharpoons 2NH_3$   
 $\therefore K = [NH_3]^2 / [N_2][H_2]^3 \quad \dots (i)$   
 $\frac{1}{2}N_2 + \frac{3}{2}H_2 \rightleftharpoons NH_3$   
 $\therefore K' = [NH_3] / [N_2]^{1/2}[H_2]^{3/2} \quad \dots (ii)$

Dividing equation (i) by equation (ii), we get  $K' = \frac{\sqrt{K}}{\sqrt{K}}$

15. (b) Given reaction,  $2A \rightleftharpoons B + C$

$$K_c = \frac{[B][C]}{[A]^2}$$

$$K_c = \frac{2 \times 10^{-3} \times 3 \times 10^{-3}}{(10^{-3})^2} = 6$$

16. (c)  $A_2 + B_2 \rightleftharpoons 2AB \quad K_c = \frac{[AB]^2}{[A_2][B_2]}$

$$K_c = \frac{(2.8 \times 10^{-3})^2}{3 \times 10^{-3} \times 4.2 \times 10^{-3}} = \frac{(2.8)^2}{3 \times 4.2} = 0.62$$

17. (c)  $A + B \rightleftharpoons C + D$   
 At eqb.  $x \quad x \quad 2x \quad 2x$   
 $K_c = \frac{2x \cdot 2x}{x \cdot x} = 4$

18. (a) For  $A + B \rightleftharpoons C$ ,  $\Delta n = 1 - 2 = -1$

$$\text{Unit of } K_c = \left[ \frac{\text{mol}}{\text{litre}} \right]^{\Delta n} = \left[ \frac{\text{mol}}{\text{litre}} \right]^{-1} = \text{Litre mole}^{-1}$$

19. (c)  $K_p = \frac{P^2_{CO}}{P_{CO_2}}; K_p = \frac{4 \times 4}{2} = 8; C(s) = 1;$

The concentration of solids and liquids are taken as unity.

20. (d)  $2C(s) + O_2(g) \rightleftharpoons 2CO_2(g)$

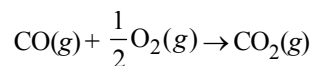
$$\Delta n = 2 - 1 = +1$$

$\therefore K_c$  and  $K_p$  are not equal.

21. (b) For a gaseous phase reaction  $K_p$  and  $K_c$  are related as

$$K_p = K_c (RT)^{\Delta n_g}$$

For the given reaction,



$$\Delta n_g = 1 - (1 + 0.5) = -0.5 \text{ or } -\frac{1}{2}$$

$$\therefore K_p = K_c (RT)^{-\frac{1}{2}}$$

$$\text{or } \frac{K_p}{K_c} = (RT)^{-\frac{1}{2}}$$

22. (c) Using the relation  $K_p = K_c \cdot (RT)^{\Delta n}$ , we get

$$\frac{K_p}{K_c} = (RT)^{\Delta n}$$

Thus  $\frac{K_p}{K_c}$  will be highest for the reaction having highest value of  $\Delta n$ .

The  $\Delta n$  values for various reactions are

$$(a) \Delta n = 1 - \left(1 + \frac{1}{2}\right) = -\frac{1}{2}$$

$$(b) \Delta n = 2 - (1 + 1) = 0$$

$$(c) \Delta n = (1 + 1) - 1 = 1$$

$$(d) \Delta n = (2 + 4) - (7 + 2) = -3$$

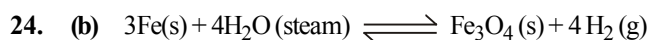
Thus maximum value of  $\Delta n = 1$

$$23. (c) \text{ As } K_p = K_c RT^{\Delta n_g}$$

$$\text{Here } \Delta n_g = 1$$

$$\text{So, } K_p = K_c \text{ when } RT = 1$$

$$\text{Thus } T = 12.5 \text{ K}$$



$$K_p = \frac{(p_{\text{H}_2})^4}{(p_{\text{H}_2\text{O}})^4} \text{ only gaseous products and reactants.}$$



Apply law of mass action,

$$K_p = \frac{(P_{\text{CO}})^2}{P_{\text{CO}_2}} \text{ or } 63 = \frac{(10P_{\text{CO}_2})^2}{P_{\text{CO}_2}}$$

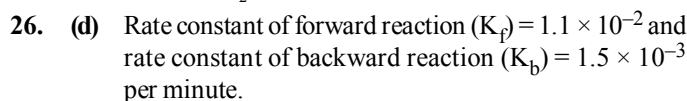
$$(\text{Given } K_p = 65) \text{ and } P_{\text{CO}} = 10P_{\text{CO}_2}$$

$$\text{or } 63 = \frac{100(P_{\text{CO}_2})^2}{P_{\text{CO}_2}} \text{ or } 63 = 100 P_{\text{CO}_2}$$

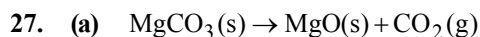
$$P_{\text{CO}_2} = \frac{63}{100} = 0.63 \text{ atm}$$

$$P_{\text{CO}} = 10P_{\text{CO}_2} = 10 \times 0.63 = 6.3 \text{ atm}$$

$$P_{\text{total}} = P_{\text{CO}_2} + P_{\text{CO}} = 0.63 + 6.3 = 6.93 \text{ atm.}$$

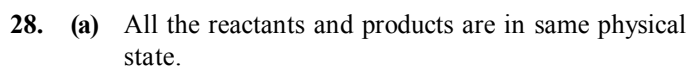


$$\text{Equilibrium constant } (K_c) = \frac{K_f}{K_b} = \frac{1.1 \times 10^{-2}}{1.5 \times 10^{-3}} = 7.33$$

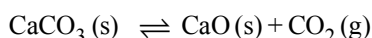


MgO & MgCO<sub>3</sub> are solid and they donot exert any pressure and hence only pressure exerted is by CO<sub>2</sub>.

$$\text{Therefore } K_p = P_{\text{CO}_2}$$



$$29. (a) K = \frac{[\text{Ni(CO)}_4]}{[\text{CO}]^4} = \frac{\text{mol l}^{-1}}{(\text{mol l}^{-1})^4} = (\text{mol l}^{-1})^{-3}$$



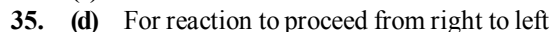
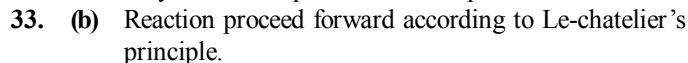
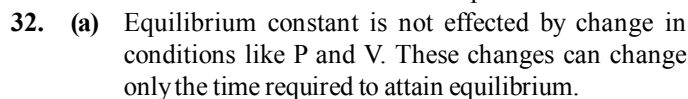
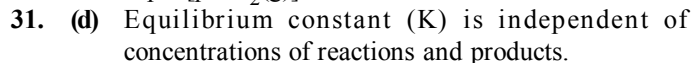
On the basis of the stoichiometric equation, we can write,

$$K_c = [\text{CaO(s)}] [\text{CO}_2\text{(g)}] / [\text{CaCO}_3\text{(s)}]$$

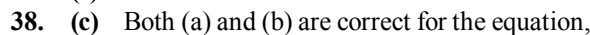
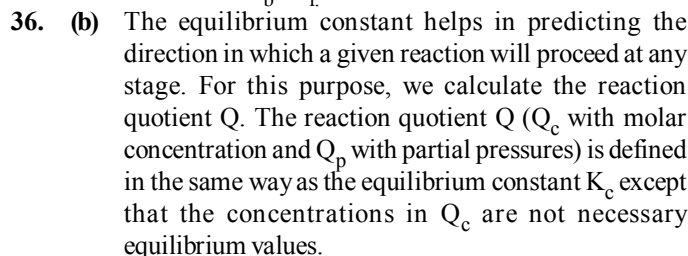
Since [CaCO<sub>3</sub>(s)] and [CaO(s)] are both constant, therefore modified equilibrium constant for the thermal decomposition of calcium carbonate will be

$$K'_c = [\text{CO}_2\text{(g)}]$$

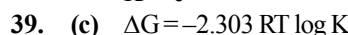
$$K_p = [p \text{ CO}_2\text{(g)}]$$



$Q > K_c$  i.e the reaction will be fast in backward direction i.e  $r_b > r_f$



$$K = e^{-\Delta G^\ominus / RT}$$



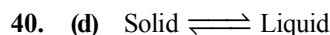
$$-nFE^\ominus = -2.303 RT \log K$$

$$\log K = \frac{nFE^\ominus(I)}{2.303 RT}$$

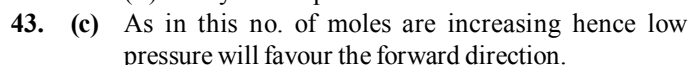
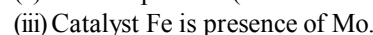
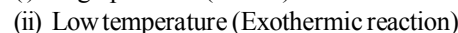
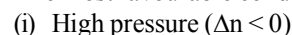
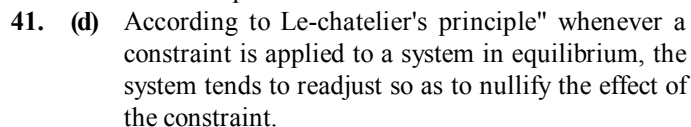
$$= 0.4342 \frac{nFE^\ominus}{RT} \quad \text{..... (i)}$$

$$\ln K = \frac{nFE^\ominus}{RT}$$

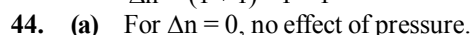
$$K = e^{\frac{-nFE^\ominus}{RT}} \quad \text{..... (ii)}$$



It is an endothermic process. So when temperature is raised, more liquid is formed. Hence adding heat will shift the equilibrium in the forward direction.



$$\Delta n = (1 + 1) - 1 = 1$$





45. (a) Melting of ice involve absorption of heat i.e Endothermic hence high temperature favour the process.  
Further for a given mass volume of water is less than ice thus high pressure favour the process. High pressure and high temperature convert ice into liquid.
46. (d)
47. (b) Le chatelier principle is not applicable to solid-solid equilibrium.
48. (c) Effect of increase of temperature on equilibrium constant depends on the fact that whether the reaction is exothermic, or endothermic. If the reaction is exothermic, it is favoured by low temperature and if the reaction is endothermic, it is favoured by high temperature.
49. (d)  $A_2(g) + B_2(g) \xrightleftharpoons[\text{step-2}]{\text{step-1}} 3C(g) \xrightleftharpoons[\text{step-2}]{\text{step-1}} D(g)$   
since the steps 1 and 2 are exothermic hence low temperature will favour both the reactions. In step - 1 moles are increasing hence low pressure will favour it. In step 2 moles are decreasing, hence high pressure will favour it.
50. (a) On adding inert gas at constant volume the total pressure of the system is increased, but the partial pressure of each reactant and product remains the same. Hence no effect on the state of equilibrium.
51. (c) The backward reaction is not favoured at high pressure.
52. (c) A catalyst increases the rate of the chemical reaction by making available a new low energy pathway for the conversion of reactants to products. It increases the rate of forward and reverse reaction that pass through the same transition state and does not affect equilibrium.  
Catalyst lowers the activation energy for the forward and reverse reactions by exactly the same amount.
53. (c) An aqueous solution of sodium chloride is comprised entirely of sodium ions and chloride ions, while that of acetic acid mainly contains unionized acetic acid molecules and only some acetate ions and hydronium ions. This is because there is almost 100% ionization in case of sodium chloride which is a strong electrolyte as compared to less than 5% ionization of acetic acid which is a weak electrolyte.
54. (c) The hydronium ion has a trigonal pyramidal geometry and is composed of three hydrogen atoms and one oxygen atom. There is a lone pair of electrons on the oxygen giving it this shape. The bond angle between the atoms is  $113^\circ$ .
55. (d)
56. (b) According to Arrhenius, acids are those substances which give proton in aqueous solution, hence gaseous HCl is not an Arrhenius acid.
57. (d) Base accepts protons and acid donates protons.
58. (c) Lewis concept.
59. (c)  $H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$   
 $HCO_3^-$  can donate and accept  $H^+$ .
60. (b) Because  $NH_3$  after losing a proton ( $H^+$ ) gives  $NH_2^-$   
 $NH_3 + H_2O \rightleftharpoons NH_2^- + H_3O^+$   
(Conjugate acid-base pair differ only by a proton)
61. (c) Lewis acid is that compound which have electron deficiency. eg.  $BF_3$ ,  $SnCl_2$ .
62. (d)  $(CH_3)_3 B$  - is an electron deficient, thus behave as a lewis acid.
63. (c) Boron in  $B_2H_6$  is electron deficient
64. (b)  $BF_3$  is Lewis acid ( $e^-$  pair acceptor)
65. (c)  $HSO_4^-$  accepts a proton to form  $H_2SO_4$ .  
Thus  $H_2SO_4$  is the conjugate acid of  $HSO_4^-$
- $$\begin{array}{ccc} HSO_4^- & \xrightarrow{+H^+} & H_2SO_4 \\ \text{base} & & \text{conjugate acid} \\ & & \text{of } HSO_4^- \end{array}$$
66. (a) Bronsted base is a substance which accepts proton. In option (a),  $H_2O$  is accepting proton, i.e., acting as a base.
67. (c)
68. (a) (i)  $H_3PO_4 + H_2O \longrightarrow H_3O^+ + H_2PO_4^-$   
 $\text{acid}_1 \quad \text{base}_2 \quad \text{acid}_2 \quad \text{base}_1$   
(ii)  $H_2PO_4^- + H_2O \longrightarrow HPO_4^{2-} + H_3O^+$   
 $\text{acid}_1 \quad \text{base}_2 \quad \text{base}_1 \quad \text{acid}_2$   
(iii)  $H_2PO_4^- + OH^- \longrightarrow H_3PO_4 + O^{2-}$   
 $\text{base}_1 \quad \text{acid}_2 \quad \text{acid}_1 \quad \text{base}_2$
- Hence only in (ii) reaction  $H_2PO_4^-$  is acting as an acid.
69. (b) The value of ionic product of water changes with the temperature.
70. (a) **Given :** Hydroxyl ion concentration  
 $[OH^-] = 0.05 \text{ mol L}^{-1}$ . We know that  
 $[H^+][OH^-] = 1 \times 10^{-14}$   
or  $[H^+] = \frac{1 \times 10^{-14}}{0.05} = 2 \times 10^{-13} \text{ mol L}^{-1}$   
We also know that  
 $pH = -\log[H^+] = -\log[2 \times 10^{-13}]$   
 $= -\log 2 - \log 10^{-13} = -\log 2 - (-13) \log 10$   
 $= -0.3010 + 13.0000 = 12.6990$ .  
Since the value of  $pH > 7$ , therefore the solution is basic.
71. (b)
72. (b)  $pH = -\log[H^+] = \log\left[\frac{1}{H^+}\right]$
73. (c) On dilution  $[H^+] = 10^{-6} \text{ M} = 10^{-6} \text{ mol}$   
Now dissociation of water cannot be neglected,  
Total  $[H^+] = 10^{-6} + 10^{-7} = 11 \times 10^{-7}$   
 $pH = -\log[H^+]$   
 $= -\log(11 \times 10^{-7}) = 5.98$
74. (d)  $\therefore pH = 1 ; H^+ = 10^{-1} = 0.1 \text{ M}$   
 $pH = 2 ; H^+ = 10^{-2} = 0.01 \text{ M}$   
 $\therefore M_1 = 0.1 \quad V_1 = 1$   
 $M_2 = 0.01 \quad V_2 = ?$

- From  
 $M_1 V_1 = M_2 V_2$   
 $0.1 \times 1 = 0.01 \times V_2$   
 $V_2 = 10$  litres  
 $\therefore$  Volume of water added =  $10 - 1 = 9$  litres
75. (b) Given  $[\text{OH}^-] = 10^{-3}$   
 $\therefore \text{pOH} = 3$   
 $\therefore \text{pH} + \text{pOH} = 14$   
 $\therefore \text{pH} = 14 - 3 = 11$
76. (a) Given  $[\text{H}_3\text{O}^+] = 1 \times 10^{-10}$  M  
 at  $25^\circ$   $[\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$   
 $\therefore [\text{OH}^-] = \frac{10^{-14}}{10^{-10}} = 10^{-4}$   
 Now,  $[\text{OH}^-] = 10^{-\text{pOH}} = 10^{-4} = 10^{-\text{pOH}}$   
 $\therefore \text{pOH} = 4$
77. (a) Molarity (M) = 10M. HCl is a strong acid and it is completely dissociated in aqueous solutions as :  $\text{HCl} (10) \rightleftharpoons \text{H}^+ (10) + \text{Cl}^-$ .  
 So, for every moles of HCl, there is one  $\text{H}^+$ . Therefore  $[\text{H}^+] = [\text{HCl}]$  or  $[\text{H}^+] = 10$ .  
 $\text{pH} = -\log[\text{H}^+] = -\log[10] = -1$ .
78. (d) No. of moles of NaOH =  $\frac{4}{40} = 0.1$   
 [Molecular weight of NaOH = 40]  
 No. of moles of  $\text{OH}^- = 0.1$   
 Concentration of  $\text{OH}^- = \frac{0.1}{1 \text{ litre}} = 0.1 \text{ Mole/L}$   
 As we know that,  $[\text{H}^+][\text{OH}^-] = 10^{-14}$   
 $\therefore [\text{H}^+] = 10^{-13}$  ( $\because [\text{OH}^-] = 10^{-1}$ )
79. (a) Given  $[\text{H}_3\text{O}^+] = 1 \times 10^{-10}$  M  
 at  $25^\circ$   $[\text{H}_3\text{O}^+][\text{OH}^-] = 10^{-14}$   
 $\therefore [\text{OH}^-] = \frac{10^{-14}}{10^{-10}} = 10^{-4}$   
 Now,  $[\text{OH}^-] = 10^{-\text{pOH}} = 10^{-4} = 10^{-\text{pOH}}$   
 $\therefore \text{pOH} = 4$
80. (c)  $\text{H}_2\text{SO}_4 \rightleftharpoons 2\text{H}^+ + \text{SO}_4^{2-}$   
 Given concentration of  $\text{H}_2\text{SO}_4 = 0.005$  M  
 $\therefore [\text{H}^+] = 0.005 \times 2 = 0.01 = 10^{-2}$   
 $\text{pH} = -\log[\text{H}^+] = -\log 10^{-2} = 2$
81. (a)  $\text{pOH} = -\log[\text{OH}^-]$   
 $\text{pH} + \text{pOH} = 14$   
 For  $10^{-4}$  KOH,  $[\text{OH}^-] = 10^{-4}$   
 $\text{pOH} = -\log[\text{OH}^-] = -\log 10^{-4} = 4$   
 $\text{pH} = 14 - \text{pOH} = 10$
82. (d) Among M/4 KOH, M/4 NaOH, M/4  $\text{NH}_4\text{OH}$  and M/4  $\text{Ca}(\text{OH})_2$ ,  $\text{Ca}(\text{OH})_2$  furnishes highest number of  $\text{OH}^-$  ions ( $\because \text{Ca}(\text{OH})_2 \longrightarrow \text{Ca}^{2+} + 2\text{OH}^-$ ).  
 So pH of M/4  $\text{Ca}(\text{OH})_2$  is highest.

83. (a) Given  $K_a = 1.00 \times 10^{-5}$ ,  $C = 0.100$  mol for a weak electrolyte, degree of dissociation  
 $(\alpha) = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{1 \times 10^{-5}}{0.100}} = 10^{-2} = 1\%$
84. (b)  $\text{HA} \longrightarrow \text{H}^+ + \text{A}^-$   
 $K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$ ,  $\therefore [\text{H}^+] = 10^{-\text{pH}}$   
 $\therefore [\text{H}^+] = 10^{-5}$ ; and at equilibrium  $[\text{H}^+] = [\text{A}^-]$   
 $\therefore K_a = \frac{10^{-5} \times 10^{-5}}{0.0015} = 2 \times 10^{-8}$   
 $\alpha = \sqrt{\frac{K_a}{C}} = \sqrt{\frac{2 \times 10^{-8}}{0.005}} = \sqrt{4 \times 10^{-6}} = 2 \times 10^{-3}$   
 Percentage ionization = 0.2
85. (c)  $M_1 V_1 = M_2 V_2$   
 $1 \times 0.10 = M_2 \times 100$   
 $M_2 = 0.001 = 10^{-3}$   
 $\text{BOH} \rightleftharpoons \text{B}^+ + \text{OH}^-$   
 $\begin{matrix} C \\ C(1-\alpha) \end{matrix} \rightleftharpoons \begin{matrix} 0 \\ C\alpha \end{matrix} + \begin{matrix} 0 \\ C\alpha \end{matrix}$   
 $K_b = \frac{C\alpha \times C\alpha}{C(1-\alpha)}$   
 $K_b = C\alpha^2$  ( $\because 1 - \alpha \approx 1$ )  
 $\alpha = \sqrt{K_b / C}$   
 $[\text{OH}^-] = C\alpha = \sqrt{\frac{K_b}{C}} \times C = \sqrt{K_b C}$   
 $= \sqrt{10^{-5} \times 10^{-3}} = 10^{-4}$   
 $\therefore \text{pH} + \text{pOH} = 14$   
 $\therefore \text{pH} = 14 - 4 = 10$
86. (d)
87. (d)  $\text{H}_2\text{A} \rightleftharpoons \text{H}^+ + \text{HA}^-$   
 $\therefore K_1 = 1.0 \times 10^{-5} = \frac{[\text{H}^+][\text{HA}^-]}{[\text{H}_2\text{A}]}$  (Given)  
 $\text{HA}^- \longrightarrow \text{H}^+ + \text{A}^{2-}$   
 $\therefore K_2 = 5.0 \times 10^{-10} = \frac{[\text{H}^+][\text{A}^{2-}]}{[\text{HA}^-]}$  (Given)  
 $K = \frac{[\text{H}^+]^2[\text{A}^{2-}]}{[\text{H}_2\text{A}]} = K_1 \times K_2$   
 $= (1.0 \times 10^{-5}) \times (5 \times 10^{-10}) = 5 \times 10^{-15}$
88. (b) Acidic strength  $\propto \sqrt{K_a}$

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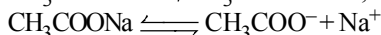
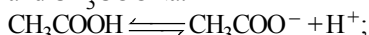
$$\log [H^+] = \log K_a + \log \left[ \frac{\text{Acid}}{\text{Salt}} \right]$$

$$[H^+] = K_a \left[ \frac{\text{Acid}}{\text{Salt}} \right]$$

$$= 1.8 \times 10^{-5} \times \frac{0.1}{0.2} = 9 \times 10^{-6} \text{ M}$$

109. (d)  $\text{HNO}_2$  is a weak acid and  $\text{NaNO}_2$  is salt of that weak acid and strong base (NaOH).

110. (a) Let's take an example of an acidic buffer  $\text{CH}_3\text{COOH}$  and  $\text{CH}_3\text{COONa}$ .



when few drops of HCl are added to this buffer, the  $\text{H}^+$  of HCl immediately combine with  $\text{CH}_3\text{COO}^-$  ions to form undissociated acetic acid molecules. Thus there will be no appreciable change in its pH value. Like wise if few drops of NaOH are added, the  $\text{OH}^-$  ions will combine with  $\text{H}^+$  ions to form unionised water molecule. Thus pH of solution will remain constant.

111. (d) Buffering action is maximum when

$$[\text{Salt}] = [\text{Acid}]$$

$$\text{i.e., } \text{pH} = \text{pK}_a$$

112. (d) pH or  $[H^+]$  of a buffer does not change with dilution.

113. (b) Solubility product is the product of ionic concentration in a saturated solution of an electrolyte at a given temperature.

114. (b)  $\text{Cr}(\text{OH})_3(\text{s}) \rightleftharpoons \text{Cr}^{3+}(\text{aq.}) + 3\text{OH}^-(\text{aq.})$

$$(s) (3s)^3 = K_{sp}$$

$$27s^4 = K_{sp}$$

$$s = \left( \frac{K_{sp}}{27} \right)^{1/4} = \left( \frac{1.6 \times 10^{-30}}{27} \right)^{1/4}$$

115. (b)  $\text{Mg}(\text{OH})_2 \rightleftharpoons \text{Mg}^{++} + 2\text{OH}^-$

$$K_{sp} = [\text{Mg}^{++}][\text{OH}^-]^2$$

$$1.0 \times 10^{-11} = 10^{-3} \times [\text{OH}^-]^2$$

$$[\text{OH}^-] = \sqrt{\frac{10^{-11}}{10^{-3}}} = 10^{-4}$$

$$\therefore \text{pOH} = 4$$

$$\therefore \text{pH} + \text{pOH} = 14$$

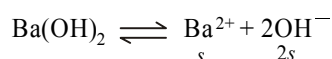
$$\therefore \text{pH} = 10$$

116. (b) Given pH = 12

$$\text{or } [H^+] = 10^{-12}$$

$$\text{Since, } [H^+][\text{OH}^-] = 10^{-14}$$

$$\therefore [\text{OH}^-] = \frac{10^{-14}}{10^{-12}} = 10^{-2}$$



$$[\text{OH}^-] = 10^{-2}$$

$$2s = 10^{-2}$$

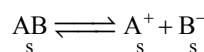
$$s = \frac{10^{-2}}{2}$$

$$K_{sp} = 4s^3$$

$$= 4 \times \left( \frac{10^{-2}}{2} \right)^3$$

$$= 5 \times 10^{-7}$$

117. (c) Let binary electrolyte be AB



Hence, solubility product of AB

$$K_{sp} = [\text{A}^+][\text{B}^-]$$

$$S = [s.] [s] \Rightarrow s = S^{1/2}$$

118. (a)  $K_{sp}$  of  $\text{As}_2\text{S}_3$  is less than  $\text{ZnS}$ . In acid medium ionisation of  $\text{H}_2\text{S}$  is suppressed (common ion effect) and  $K_{sp}$  of  $\text{ZnS}$  does not exceed.

119. (a) Given  $\text{Na}_2\text{CO}_3 = 1.0 \times 10^{-4} \text{ M}$

$$\therefore [\text{CO}_3^{--}] = 1.0 \times 10^{-4} \text{ M}$$

$$\text{i.e. } S = 1.0 \times 10^{-4} \text{ M}$$

At equilibrium

$$[\text{Ba}^{++}][\text{CO}_3^{--}] = K_{sp} \text{ of } \text{BaCO}_3$$

$$[\text{Ba}^{++}] = \frac{K_{sp}}{[\text{CO}_3^{--}]} = \frac{5.1 \times 10^{-9}}{1.0 \times 10^{-4}} = 5.1 \times 10^{-5} \text{ M}$$

120. (b)  $\text{AgBr} \rightleftharpoons \text{Ag}^+ + \text{Br}^-$

$$K_{sp} = [\text{Ag}^+][\text{Br}^-]$$

For precipitation to occur

Ionic product > Solubility product

$$[\text{Br}^-] = \frac{K_{sp}}{[\text{Ag}^+]} = \frac{5 \times 10^{-13}}{0.05} = 10^{-11}$$

i.e., precipitation just starts when  $10^{-11}$  moles of KBr is added to 1 l  $\text{AgNO}_3$  solution

$\therefore$  Number of moles of  $\text{Br}^-$  needed from

$$\text{KBr} = 10^{-11}$$

$$\therefore \text{Mass of KBr} = 10^{-11} \times 120 = 1.2 \times 10^{-9} \text{ g}$$

121. (b)  $\text{Mg}(\text{OH})_2 \rightleftharpoons \text{Mg}^{++} + 2\text{OH}^-$

$$K_{sp} = [\text{Mg}^{++}][\text{OH}^-]^2$$

$$1.0 \times 10^{-11} = 10^{-3} \times [\text{OH}^-]^2$$

$$[\text{OH}^-] = \sqrt{\frac{10^{-11}}{10^{-3}}} = 10^{-4}$$

$$\therefore \text{pOH} = 4$$

$$\therefore \text{pH} + \text{pOH} = 14 \quad \therefore \text{pH} = 10$$

### STATEMENT TYPE QUESTIONS

122. (c) Boiling point depends on the altitude of the place; at high altitude the boiling point decreases.

123. (a)

124. (b) Chemical reactions which are in equilibrium are reversible
125. (c) Since equilibrium constant is related to the partial pressure of reactant and product therefore if nobel gas is added, no change is observed, Statement 1 is incorrect.  
If Nobel gas react with reactant, concentration of reactant will decrease and therefore reaction will proceed backward according to Le- chatelier's principle.
126. (c) Equilibrium constant is temperature dependent having one unique value for a particular reaction represented by a balanced equation at a given temperature.
127. (b) An equilibrium constant does not give any information about the rate at which the equilibrium is reached.
128. (a) 129. (d)
130. (a) As strong acid dissociate completely in water hence resulting base formed would be very weak. On the other hand a weak acid is only partially dissociated in aqueous solution, hence resulting base formed would be strong.
131. (a)  $\text{H}_2\text{O}(l) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq})$   
acid base conjugate acid conjugate base
132. (c)  $K_w$  depends upon temperature as it is an equilibrium constant.
133. (d) Larger the value of  $K_a$ , the stronger is the acid.
134. (a)
135. (c) Bond energy being directly related to bond strength increases with increase in bond strength

### MATCHING TYPE QUESTIONS

136. (d)
137. (b) (A) Liquid  $\rightleftharpoons$  Vapour equilibrium exists at the boiling point.  
(B) Solid  $\rightleftharpoons$  Liquid equilibrium exists at the melting point.  
(C) Solid  $\rightleftharpoons$  Vapour equilibrium exists at the sublimation point.  
(D) Solute  $\rightleftharpoons$  Solute (solution) equilibrium exists in a saturated solution.
138. (a) In case of A no. of moles of product and reactant are same, in case of B no. of moles of reactant are greater so reaction go forward, in case of C the no. of moles of product are greater than no. of moles of reactant.
139. (a) (A)  $K_p = K_c (RT)^{\Delta n}$   
 $\frac{K_p}{K_c} = (RT)^{\Delta n}$  as  $\Delta n = -ve \Rightarrow K_p < K_c$   
(B)  $\Delta n > 0$   
(C)  $\Delta n = 2 - 1 = 1$   
(D) As the reaction is not containing any gaseous component therefore  $K_p$  is not defined for this.
140. (b) (A) As  $\Delta n > 0$  therefore if  $P \uparrow$ , reaction will go in the backward direction.

- (B) As  $\Delta n < 0$  therefore if  $V \uparrow$ ,  $P \downarrow$  reaction will go in the direction in which more number of gaseous moles are formed i.e. backward direction.  
(C) As  $\Delta n = 0$  hence no effect.  
(D) If concentration of reactant is increased reaction will go in the forward direction.

141. (d)

142. (b)

143. (b)  $\text{HClO}_4$  is a strong acid  
 $\text{HNO}_2$  is a weak acid.  
 $\text{NH}_2^-$  is a very good proton acceptor and thus, it is a base.  
 $\text{H}_2\text{SO}_4$  is a strong acid hence its conjugate base ( $\text{HSO}_4^-$ ) will be a weak base.

### ASSERTION-REASON TYPE QUESTIONS

144. (a)  $K_p = K_c (RT)^{\Delta n}$
145. (a) If the volume is kept constant and an inert gas such as argon is added which does not take part in the reaction, the equilibrium remains undisturbed. It is because the addition of an inert gas at constant volume does not change the partial pressure or the molar concentration of the substance involved in the reaction. The reaction quotient changes only if the added gas is reactant or product involved in the reaction.
146. (d) In biological systems buffer system of carbonic acid and sodium bicarbonate is found in our blood. It maintains the pH of blood to a constant value of about 7.4.
147. (a) Ionic product of AgBr is greater than that of AgCl in comparison with there solubility product AgBr will precipitate first rather than that of AgCl.

### CRITICAL THINKING TYPE QUESTIONS

148. (d) To calculate the value of  $K_4$  in the given equation we should apply :  
eqn. (2) + eqn.(3)  $\times 3$  - eqn. (1)  
hence  $K_4 = \frac{K_2 K_3^3}{K_1}$
149. (d) Given,  
 $\text{AB} \xrightleftharpoons{K_1} \text{A}^+ + \text{B}^-$   
 $K_1 = \frac{[\text{A}^+][\text{B}^-]}{[\text{AB}]}$   
 $\text{AB} + \text{B}^- \xrightleftharpoons{K_2} \text{AB}_2^-$   
 $K_2 = \frac{[\text{AB}_2^-]}{[\text{AB}][\text{B}^-]}$   
Dividing  $K_1$  and  $K_2$ , we get  
 $K = \frac{K_1}{K_2} = \frac{[\text{A}^+][\text{B}^-]^2}{[\text{AB}_2^-]}$   
 $\therefore \frac{[\text{A}^+]}{[\text{AB}_2^-]} = \frac{K}{[\text{B}^-]^2}$

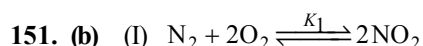


$$150. (a) \quad K_1 = \frac{[\text{Ni}(\text{CO})_4]}{[\text{CO}_2]^2}; \quad K_2 = \frac{[\text{CO}]^2}{[\text{CO}_2]}$$

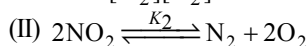
$$K = \frac{[\text{Ni}(\text{CO})_4]}{[\text{CO}]^4}$$

$$K = \frac{[\text{Ni}(\text{CO})_4]}{[\text{CO}_2]^2} \times \left( \frac{[\text{CO}_2]}{[\text{CO}]^2} \right)^2$$

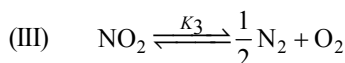
$$K = \frac{K_1}{K_2^2}$$



$$K_1 = \frac{[\text{NO}_2]^2}{[\text{N}_2][\text{O}_2]^2} \quad \dots(i)$$



$$K_2 = \frac{[\text{N}_2][\text{O}_2]^2}{[\text{NO}_2]^2} \quad \dots(ii)$$



$$K_3 = \frac{[\text{N}_2]^{1/2} [\text{O}_2]}{[\text{NO}_2]}$$

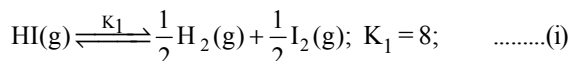
$$\therefore (K_3)^2 = \frac{[\text{N}_2][\text{O}_2]^2}{[\text{NO}_2]^2} \quad \dots(iii)$$

$\therefore$  from equations (i), (ii) and (iii)

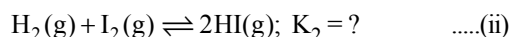
$$K_1 = \frac{1}{K_2} = \frac{1}{(K_3)^2}$$

152. (c) Reaction (c) can be obtained by adding reactions (a) and (b) therefore  $K_3 = K_1 \cdot K_2$ . Hence (c) is the correct answer.

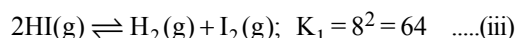
153. (b) **Given:** Equilibrium constant ( $K_1$ ) for the reaction



To find equilibrium constant for the following reaction

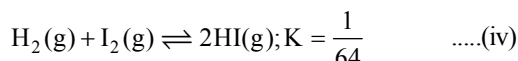


For this multiply (i) by 2, we get



[**Note:** When the equation for an equilibrium is multiplied by a factor, the equilibrium constant must be raised to the power equal to the factor]

Now reverse equation (iii), we get



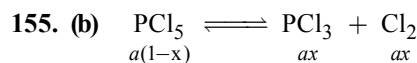
[**Note:** For a reversible reaction, the equilibrium constant of the backward reaction is inverse of the equilibrium constant for the forward reaction.]

Equation (iv) is the same as the required equation (ii),

thus  $K_2$  for equation (ii) is  $\frac{1}{64}$  i.e. option (b) is correct.

$$154. (d) \quad K_c = \frac{K_p}{(\text{RT})^{\Delta n}}$$

$$= \frac{1.44 \times 10^{-5}}{(0.082 \times 773)^{-2}} \quad (\text{R in L. atm. K}^{-1} \text{ mole}^{-1}).$$



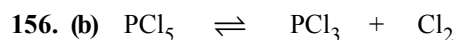
$$a(1-x) \qquad \qquad ax \qquad \qquad ax$$

$$a = 2, x = 0.4, V = 2 \text{ L}$$

$$\therefore [\text{PCl}_5] = \frac{2(1-0.4)}{2} = 0.6 \text{ mol L}^{-1}$$

$$[\text{PCl}_3] = [\text{Cl}_2] = \frac{2 \times 0.4}{2} = 0.4 \text{ mol L}^{-1}$$

$$\therefore K_c = \frac{0.4 \times 0.4}{0.6} = 0.267$$



Moles at equilibrium

$$\frac{1}{2} \qquad \qquad \frac{1}{2} \qquad \frac{1}{2}$$

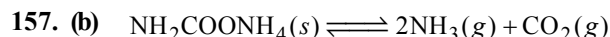
Mole fraction at equilibrium

$$\frac{1}{3} \qquad \qquad \frac{1}{3} \qquad \frac{1}{3}$$

Partial pressure at equilibrium

$$\frac{P}{3} \qquad \qquad \frac{P}{3} \qquad \frac{P}{3}$$

$$K_p = \frac{\frac{P}{3} \times \frac{P}{3}}{\frac{P}{3}} = \frac{P}{3}$$



$$K_p = \frac{(P_{\text{NH}_3})^2 \times (P_{\text{CO}_2})}{P_{\text{NH}_2\text{COONH}_4(\text{s})}} = (P_{\text{NH}_3})^2 \times (P_{\text{CO}_2})$$

As evident by the reaction,  $\text{NH}_3$  and  $\text{CO}_2$  are formed in molar ratio of 2 : 1. Thus if  $P$  is the total pressure of the system at equilibrium, then

$$P_{\text{NH}_3} = \frac{2 \times P}{3} \quad P_{\text{CO}_2} = \frac{1 \times P}{3}$$

$$K_p = \left( \frac{2P}{3} \right)^2 \times \frac{P}{3} = \frac{4P^3}{27}$$

$$\text{Given } K_p = 2.9 \times 10^{-5}$$

$$\therefore 2.9 \times 10^{-5} = \frac{4P^3}{27}$$

$$P^3 = \frac{2.9 \times 10^{-5} \times 27}{4}$$

$$P = \left( \frac{2.9 \times 10^{-5} \times 27}{4} \right)^{1/3} = 5.82 \times 10^{-2} \text{ atm}$$

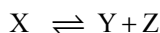
158. (c) Given reaction are



Let the total pressure for reaction (i) and (ii) be  $P_1$  and  $P_2$  respectively, then

$$\frac{K_{P_1}}{K_{P_2}} = \frac{9}{1} \quad (\text{given})$$

After dissociation,



At equilibrium  $(1-\alpha) \quad \alpha \quad \alpha$

[Let 1 mole of X dissociate with  $\alpha$  as degree of dissociation]

$$\text{Total number of moles} = 1 - \alpha + \alpha + \alpha = (1 + \alpha)$$

$$\text{Thus } P_X = \left( \frac{1-\alpha}{1+\alpha} \right) \cdot P_1; P_Y = \left( \frac{\alpha}{1+\alpha} \right) P_1;$$

$$P_Z = \left( \frac{\alpha}{1+\alpha} \right) P_1$$

$$\therefore K_{P_1} = \left( \frac{\alpha}{1+\alpha} \right) \cdot P_1 \times \frac{\alpha}{(1+\alpha)}$$

$$P_1 / \left( \frac{1-\alpha}{1+\alpha} \right) P_1 \quad \dots (i)$$

Similarly for  $A \rightleftharpoons 2B$

At equilibrium  $(1-\alpha) \quad 2\alpha$

We have,

$$K_{P_2} = \left( \frac{2\alpha P_2}{1+\alpha} \right)^2 / \left( \frac{1-\alpha}{1+\alpha} \right) P_2 \quad \dots (ii)$$

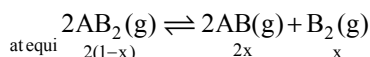
Dividing (i) by (ii), we get

$$\frac{K_{P_1}}{K_{P_2}} = \frac{\alpha^2 \cdot P_1}{4\alpha^2 \cdot P_2} \text{ or } \frac{K_{P_1}}{K_{P_2}} = \frac{1}{4} \cdot \frac{P_1}{P_2}$$

$$\text{or } 9 = \frac{1}{4} \cdot \frac{P_1}{P_2} \quad \left[ \therefore \frac{K_{P_1}}{K_{P_2}} = \frac{9}{1} \right]$$

$$\text{or } \frac{P_1}{P_2} = \frac{36}{1} \text{ or } P_1 : P_2 = 36 : 1$$

159. (b) For the reaction



$$K_c = \frac{[AB]^2 [B_2]}{[AB_2]^2} \text{ or } K_c = \frac{(2x)^2 \times x}{\{2(1-x)\}^2}$$

$$= x^3 [(1-x) \text{ can be neglected in denominator } (1-x) \approx 1]$$

The partial pressure at equilibrium are calculated on the basis of total number of moles at equilibrium.

Total number of moles

$$= 2(1-x) + 2x + x = (2+x)$$

$$\therefore P_{AB_2} = \frac{2(1-x)}{(2+x)} \times P \text{ where } P \text{ is the total pressure.}$$

$$P_{AB} = \frac{2x}{(2+x)} \times P, P_{B_2} = \frac{x}{(2+x)} \times P$$

Since  $x$  is very small so can be neglected in denominator

Thus, we get

$$P_{AB_2} = (1-x) \times P \quad P_{AB} = x \times P$$

$$P_{B_2} = \frac{x}{2} \times P$$

$$\text{Now, } K_p = \frac{(P_{AB})^2 (P_{B_2})}{(P_{AB_2})^2}$$

$$= \frac{(x)^2 \times P^2 \cdot P \times \frac{x}{2}}{(1-x)^2 \times P^2} = \frac{x^3 \cdot P^3}{2 \times 1 \times P^2} \quad [\because 1-x \approx 1]$$

$$= \frac{x^3 \cdot P}{2} \text{ or } x^3 = \frac{2 \cdot K_p}{P} \text{ or } x = \left( \frac{2K_p}{P} \right)^{\frac{1}{3}}$$

160. (a) Justification : According to Le-Chatelier's principle, at constant temperature, the equilibrium composition will change but  $K$  will remain same.

161. (a) The reaction given is an exothermic reaction thus according to Lechatalier's principle lowering of temperature, addition of  $F_2$  and / or  $Cl_2$  favour the forward direction and hence the production of  $ClF_3$ .

162. (a)

163. (c) Strong base has higher tendency to accept the proton. Increasing order of base and hence the order of accepting tendency of proton is



164. (d)  $[Cu(H_2O)_4]^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+} + 4H_2O$  involves lose and gain of electrons.  $H_2O$  is coordinated to Cu by donating electrons (LHS). It is then removed by withdrawing electrons.

165. (b)  $[H_3O]^+$  for a solution having pH = 3 is given by

$$[H_3O]^+ = 1 \times 10^{-3} \text{ moles/litre}$$

$$[\therefore [H_3O]^+ = 10^{-pH}]$$

Similarly for solution having pH = 4,

$$[H_3O]^+ = 1 \times 10^{-4} \text{ moles/ litre and for pH = 5}$$

$$[H_3O^+] = 1 \times 10^{-5} \text{ moles/ litre}$$

Let the volume of each solution in mixture be  $1L$ , then total volume of mixture solution  $L = (1 + 1 + 1)L = 3L$

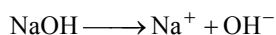
Total  $[H_3O]^+$  ion present in mixture solution  $= (10^{-3} + 10^{-4} + 10^{-5}) \text{ moles}$

Then  $[H_3O]^+$  ion concentration of mixture solution

$$= \frac{10^{-3} + 10^{-4} + 10^{-5}}{3} M = \frac{0.00111}{3} M$$

$$= 0.00037 M = 3.7 \times 10^{-4} M.$$

166. (d) Given concentration of NaOH =  $10^{-10}$  M



$$10^{-10} \text{ M} \quad 10^{-10}$$

$$\therefore [\text{OH}^-] \text{ from NaOH} = 10^{-10}$$

We have to consider dissociation of  $\text{H}_2\text{O}$

$$[\text{OH}^-] \text{ from } \text{H}_2\text{O} = 10^{-7}$$

$$\text{Total } [\text{OH}^-] = 10^{-7} + 10^{-10}$$

$$= 10^{-7} (0.001 + 1) = 10^{-7} \left( \frac{1001}{1000} \right) = 10^{-10} \times 1001$$

$$\therefore \text{pOH} = -\log [\text{OH}^-]$$

$$= -(\log 1001 \times 10^{-10}) = -3.004 + 10 = 6.9996$$

$$\text{pH} = 14 - \text{pOH} = 14 - 6.996 = 7.004$$

$$\therefore \text{pH of } 10^{-10} \text{ M NaOH solution is nearest to 7.}$$

167. (c) Number of meq. of the acid =  $0.04 \times 100 = 4$   
 Number of meq. of the base =  $0.02 \times 100 = 2$   
 $\therefore$  Number of meq. of the acid left on mixing =  $4 - 2 = 2$   
 Total volume of the solution = 200 mL  
 $\therefore$  No. of meq of the acid present in 1000 mL of the solution = 10

or No. of eq. of the acid in 1000 mL of the solution

$$= \frac{10}{1000} = 0.01$$

Since the acid is monobasic and completely ionises in solution

$$0.01 \text{ N HCl} = 0.01 \text{ M HCl}$$

$$\text{Thus } [\text{H}^+] = 0.01$$

$$\therefore \text{pH} = -\log (0.01) = -(-2) = 2$$

168. (b)  $[\text{H}_3\text{O}^+]$  for a solution having pH = 3 is given by

$$[\text{H}_3\text{O}^+] = 1 \times 10^{-3} \text{ moles/litre}$$

$$[\therefore [\text{H}_3\text{O}^+] = 10^{-\text{pH}}]$$

Similarly for solution having pH = 4,

$$[\text{H}_3\text{O}^+] = 1 \times 10^{-4} \text{ moles/litre and for pH=5}$$

$$[\text{H}_3\text{O}^+] = 1 \times 10^{-5} \text{ moles/litre}$$

Let the volume of each solution in mixture be  $\text{L}$ , then total volume of mixture solution  $\text{L} = (1 + 1 + 1) \text{L} = 3\text{L}$

$$\text{Total } [\text{H}_3\text{O}^+] \text{ ion present in mixture solution} = (10^{-3} + 10^{-4} + 10^{-5}) \text{ moles}$$

Then  $[\text{H}_3\text{O}^+]$  ion concentration of mixture solution

$$= \frac{10^{-3} + 10^{-4} + 10^{-5}}{3} \text{ M} = \frac{0.00111}{3} \text{ M}$$

$$= 0.00037 \text{ M} = 3.7 \times 10^{-4} \text{ M.}$$

169. (a)  $K_w$  at  $25^\circ\text{C} = 1 \times 10^{-14}$

At  $25^\circ\text{C}$

$$K_w = [\text{H}^+][\text{OH}^-] = 10^{-14}$$

At  $100^\circ\text{C}$  (given)

$$K_w = [\text{H}^+][\text{OH}^-] = 55 \times 10^{-14}$$

$\therefore$  for a neutral solution

$$[\text{H}^+] = [\text{OH}^-]$$

$$\therefore [\text{H}^+]^2 = 55 \times 10^{-14}$$

$$\text{or } [\text{H}^+] = (55 \times 10^{-14})^{1/2}$$

$$\therefore \text{pH} = -\log [\text{H}^+]$$

On taking log on both side

$$-\log [\text{H}^+] = -\log (55 \times 10^{-14})^{1/2}$$

$$\text{pH} = -\frac{1}{2} \log 55 + 7 \log 10$$

$$\text{pH} = -0.87 + 7$$

$$= 6.13$$

170. (c)  $\text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}^+$

$$K_a = \frac{[\text{CH}_3\text{COO}^-][\text{H}^+]}{[\text{CH}_3\text{COOH}]}$$

Given that,

$$[\text{CH}_3\text{COO}^-] = [\text{H}^+] = 3.4 \times 10^{-4} \text{ M}$$

$$K_a \text{ for } \text{CH}_3\text{COOH} = 1.7 \times 10^{-5}$$

$\text{CH}_3\text{COOH}$  is weak acid, so in it  $[\text{CH}_3\text{COOH}]$  is equal to initial concentration. Hence

$$1.7 \times 10^{-5} = \frac{(3.4 \times 10^{-4})(3.4 \times 10^{-4})}{[\text{CH}_3\text{COOH}]}$$

$$[\text{CH}_3\text{COOH}] = \frac{3.4 \times 10^{-4} \times 3.4 \times 10^{-4}}{1.7 \times 10^{-5}} = 6.8 \times 10^{-3} \text{ M}$$

171. (c) Higher the value of  $K_a$  lower will be the value of  $\text{p}K_a$  i.e. higher will be the acidic nature. Further since  $\text{CN}^-$ ,  $\text{F}^-$  and  $\text{NO}_2^-$  are conjugate base of the acids  $\text{HCN}$ ,  $\text{HF}$  and  $\text{HNO}_2$  respectively hence the correct order of base strength will be  $\text{F}^- < \text{NO}_2^- < \text{CN}^-$   
 ( $\therefore$  stronger the acid weaker will be its conjugate base)

172. (c) Given,  $\text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COO}^- + \text{H}^+$ ;

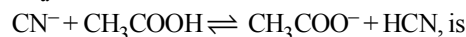
$$K_{a1} = 1.5 \times 10^{-5} \quad \dots(i)$$

$$\text{HCN} \rightleftharpoons \text{H}^+ + \text{CN}^-; K_{a2} = 4.5 \times 10^{-10}$$

$$\text{or } \text{H}^+ + \text{CN}^- \rightleftharpoons \text{HCN};$$

$$K'_{a2} = \frac{1}{K_{a2}} = \frac{1}{4.5 \times 10^{-10}} \quad \dots(ii)$$

$\therefore$  From (i) and (ii), we find that the equilibrium constant ( $K_a$ ) for the reaction,

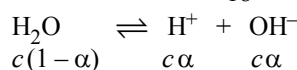


$$K_a = K_{a1} \times K'_{a2}$$

$$= \frac{1.5 \times 10^{-5}}{4.5 \times 10^{-10}} = \frac{1}{3} \times 10^5 = 3.33 \times 10^4$$

173. (d) As, molarity, =  $\frac{\text{wt. of solute per litre of solution}}{\text{Mol. wt. of solute}}$

$$\text{Molarity of } \text{H}_2\text{O} = \frac{1000}{18} \text{ mole/litre}$$



$$\text{Thus, } K_a = \frac{c\alpha^2}{1-\alpha} = c\alpha^2 = 1.8 \times 10^{-14}$$

174. (c) For weak acid dissociation equilibria, degree of dissociation  $\alpha$  is given as :

$$\alpha = \sqrt{\frac{K_a}{c}} \quad \therefore \% \alpha = 100 \sqrt{\frac{K_a}{c}}$$

$$\text{Also, } K_a = \frac{[H^+][A^-]}{[HA]} = \frac{[H^+]c\alpha}{c(1-\alpha)} = \frac{[H^+]\alpha}{(1-\alpha)}$$

$$\log K_a = \log H^+ + \log \frac{\alpha}{1-\alpha}$$

$$\text{or } pK_a = pH + \log \frac{1-\alpha}{\alpha}$$

$$pK_a - pH = \log \frac{1-\alpha}{\alpha}$$

$$\frac{1-\alpha}{\alpha} = 10^{pK_a - pH}$$

$$\text{or, } \frac{1}{\alpha} = 10^{pK_a - pH} + 1$$

$$\therefore \alpha = \frac{1}{[1 + 10^{pK_a - pH}]}$$

175. (b) The highest pH will be recorded by the most basic solution. The basic nature of hydroxides of alkaline earth metals increase as we move from Mg to Ba and thus the solution of  $BaCl_2$  in water will be most basic and so it will have highest pH.

176. (d)  $MX \rightleftharpoons M^+ + X^-$  (Where s is the solubility)

$$\text{Then } K_{sp} = s^2 \quad \text{or} \quad s = \sqrt{K_{sp}}$$

$$\text{Similarly for } MX_2 \rightleftharpoons M^{2+} + 2X^-$$

$$s \qquad 2s$$

$$K_{sp} = s \times (2s)^2 = 4s^3 \quad \text{or} \quad s = \left[ \frac{K_{sp}}{4} \right]^{\frac{1}{3}}$$

$$\text{and for } M_3X \rightleftharpoons 3M^+ + X^{3-}$$

$$3s \qquad s$$

$$K_{sp} = (3s)^3 \times s = 27s^4 \quad \text{or} \quad s = \left[ \frac{K_{sp}}{27} \right]^{\frac{1}{4}}$$

From the given values of  $K_{sp}$  for  $MX$ ,  $MX_2$  and  $M_3X$ , we can find the solubilities of those salts at temperature, T.

$$\text{Solubility of } MX = \sqrt{4 \times 10^{-8}} = 2 \times 10^{-4}$$

$$\text{Solubility of } MX_2 = \left[ \frac{3.2 \times 10^{-14}}{4} \right]^{\frac{1}{3}} \quad \text{or} \quad \left[ \frac{32}{4} \times 10^{-15} \right]^{\frac{1}{3}}$$

$$= [8 \times 10^{-15}]^{\frac{1}{3}} \quad \text{or} \quad 2 \times 10^{-5}$$

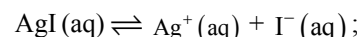
$$\text{Solubility of } M_3X = \left[ \frac{2.7 \times 10^{-15}}{27} \right]^{\frac{1}{4}}$$

$$= [10^{-16}]^{\frac{1}{4}} \quad \text{or} \quad 10^{-4}$$

Thus the solubilities are in the order  $MX > M_3X > MX_2$  i.e the correct answer is (d).

177. (c)  $K_{sp} = [Ag^+][Cl^-]$   
 $1.8 \times 10^{-10} = [Ag^+][0.1]$   
 $[Ag^+] = 1.8 \times 10^{-9} M$   
 $K_{sp} = [Pb^{2+}][Cl^-]^2$   
 $1.7 \times 10^{-5} = [Pb^{2+}][0.1]^2$   
 $[Pb^{2+}] = 1.7 \times 10^{-3} M$

178. (d) The solubility equilibrium for AgI is



$$K_{sp} = [Ag^+][I^-]$$

Let solubility of AgI be S moles per litre,

$$[Ag^+] = S, [I^-] = S$$

$$K_{sp} = [Ag^+][I^-]$$

$$1 \times 10^{-16} = (S) \times (S) = S^2$$

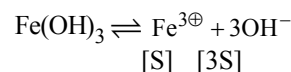
$$S = (1 \times 10^{-16})^{\frac{1}{2}} = 1 \times 10^{-8}$$

On calculating solubility of all given compounds

Compound	Solubility
AgCl	$1 \times 10^{-5}$
AgI	$1 \times 10^{-8}$
PbCrO <sub>4</sub>	$2 \times 10^{-7}$
Ag <sub>2</sub> CO <sub>3</sub>	$1.26 \times 10^{-4}$

$\therefore Ag_2CO_3$  is most soluble and AgI is least soluble.

179. (b)  $K_{sp} = [Fe^{3+}].[3OH^-]$   
 So molar solubility of  $Fe^{3+} = S$  and  $[3OH^-] = 3S$



$$1.0 \times 10^{-38} = [S][3S]^3$$

$$1.0 \times 10^{-38} = S^4 \times 27$$

$$S^4 = \frac{1.0 \times 10^{-38}}{27}$$

$$S^4 = 3.703 \times 10^{-40}$$

$$S = (3.703 \times 10^{-40})^{1/4} = 1.386 \times 10^{-10}$$



### FACT/DEFINITION TYPE QUESTIONS

- Which of the following process takes place in oxidation process?  
 (a) Addition of oxygen (b) Addition of hydrogen  
 (c) Removal of oxygen (d) Addition of chlorine
- Given reaction,  

$$2\text{K}_4[\text{Fe}(\text{CN})_6] (\text{aq}) + \text{H}_2\text{O}_2 (\text{aq}) \rightarrow 2\text{K}_3[\text{Fe}(\text{CN})_6] (\text{aq}) + 2\text{KOH} (\text{aq})$$
 The above given reaction is oxidation reaction due to  
 (a) removal of a hydrogen from  $\text{H}_2\text{O}_2$   
 (b) addition of electropositive potassium to  $\text{H}_2\text{O}_2$   
 (c) removal of electropositive element potassium from potassium ferrocyanide ( $\text{K}_4[\text{Fe}(\text{CN})_6]$ )  
 (d) All of the above are the correct reasons.
- In the reaction given below, identify the species undergoing redox reaction  

$$2\text{Na}(\text{s}) + \text{H}_2(\text{g}) \longrightarrow 2\text{NaH}(\text{s})$$
 (a) Na is reduced and hydrogen is oxidised  
 (b) Na is oxidised and hydrogen is reduced  
 (c) Na undergoes oxidation and hydrogen undergoes reduction  
 (d) Both (b) and (c)
- The loss of electron is termed as  
 (a) oxidation (b) reduction  
 (c) combustion (d) neutralization
- Which of the following is correct code for x and y in the following reaction.  

$$2\text{Na}(\text{s}) + \text{S}(\text{s}) \longrightarrow \text{Na}_2\text{S}(\text{s})$$

$\begin{array}{c} \xrightarrow{x} \\ \text{Na}^+ \text{S}^{2-} \end{array}$ 
 $\xleftarrow{y}$

 (i) x = oxidation reaction, y = reduction reaction  
 (ii) x = gain of two electrons, y = loss of two electrons,  
 (iii) x = reduction reaction, y = oxidation reaction  
 (iv) x = loss of two electrons, y = gain of two electrons  
 (a) (i) and (ii) (b) (i) and (iv)  
 (c) (ii) and (iii) (d) (iii) and (iv)
- Which of the following involves transfer of five electrons?  
 (a)  $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$  (b)  $\text{CrO}_4^{2-} \rightarrow \text{Cr}^{3+}$   
 (c)  $\text{MnO}_4^{2-} \rightarrow \text{MnO}_2$  (d)  $\text{Cr}_2\text{O}_7^{2-} \rightarrow 2\text{Cr}^{3+}$
- Which reaction involves neither oxidation nor reduction?  
 (a)  $\text{CrO}_4^{2-} \longrightarrow \text{Cr}_2\text{O}_7^{2-}$  (b)  $\text{Cr} \longrightarrow \text{CrCl}_3$   
 (c)  $\text{Na} \longrightarrow \text{Na}^+$  (d)  $2\text{S}_2\text{O}_3^{2-} \longrightarrow \text{S}_4\text{O}_6^{2-}$
- In the following reaction  

$$4\text{P} + 3\text{KOH} + 3\text{H}_2\text{O} \longrightarrow 3\text{KH}_2\text{PO}_2 + \text{PH}_3$$
 (a) phosphorus is both oxidised and reduced.  
 (b) only phosphorus is reduced.  
 (c) phosphorus is not oxidised  
 (d) None of these
- Which one of the following reaction involves oxidation-reduction?  
 (a)  $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$   
 (b)  $\text{NaBr} + \text{HCl} \rightarrow \text{NaCl} + \text{HBr}$   
 (c)  $\text{HBr} + \text{AgNO}_3 \rightarrow \text{AgBr} + \text{HNO}_3$   
 (d)  $2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
- In reaction,  $4\text{Na} + \text{O}_2 \longrightarrow 2\text{Na}_2\text{O}$ , sodium behaves as  
 (a) oxidising agent (b) reducing agent  
 (c) Both (a) and (b) (d) None of these
- $\text{Zn}^{2+} (\text{aq.}) + 2\text{e}^- \longrightarrow \text{Zn}(\text{s})$ . This is  
 (a) oxidation (b) reduction  
 (c) redox reaction (d) None of the above
- $\text{Co}(\text{s}) + \text{Cu}^{2+} (\text{aq}) \longrightarrow \text{Co}^{2+} (\text{aq}) + \text{Cu}(\text{s})$   
 The above reaction is  
 (a) oxidation reaction (b) reduction reaction  
 (c) redox reaction (d) None of these
- One mole of  $\text{N}_2\text{H}_4$  loses 10 moles of electrons to form a new compound, y. Assuming that all nitrogen appear in the new compound, what is the oxidation state of nitrogen in y (There is no change in the oxidation state of hydrogen)  
 (a) -1 (b) -3  
 (c) +3 (d) +5



14. When a strip of metallic zinc is placed in an aqueous solution of copper nitrate the blue colour of the solution disappear due to formation of  
(a)  $\text{Cu}^{2+}$  (b)  $\text{Zn}^{2+}$   
(c)  $\text{ZnS}$  (d)  $\text{CuS}$
15. The correct order of electron releasing tendency of the metals Cu, Zn and Ag is in the order:  
(a)  $\text{Cu} > \text{Zn} > \text{Ag}$  (b)  $\text{Zn} > \text{Ag} > \text{Cu}$   
(c)  $\text{Ag} > \text{Zn} > \text{Cu}$  (d)  $\text{Zn} > \text{Cu} > \text{Ag}$
16. What is the oxidation number of elements in the free or in the uncombined state ?  
(a) +1 (b) 0  
(c) +2 (d) -1
17. In which of the following compounds oxygen has highest oxidation state and in which it has lowest oxidation state?  $\text{OF}_2$ ,  $\text{H}_2\text{O}_2$ ,  $\text{KO}_2$ ,  $\text{O}_2\text{F}_2$   
(a) Highest =  $\text{KO}_2$ , lowest =  $\text{H}_2\text{O}_2$   
(b) Highest =  $\text{OF}_2$ , lowest =  $\text{K}_2\text{O}_2$   
(c) Highest =  $\text{OF}_2$ , lowest =  $\text{KO}_2$   
(d) Highest =  $\text{KO}_2$ , lowest =  $\text{H}_2\text{O}_2$
18. 'Oxidation number of H in  $\text{NaH}$ ,  $\text{CaH}_2$  and  $\text{LiH}$ , respectively is  
(a) +1, +1, -1 (b) -1, +1, +1  
(c) +1, +1, +1 (d) -1, -1, -1
19. Which of the following is the correct representative of stock notation for auric chloride?  
(a)  $\text{Au(III)Cl}_3$  (b)  $\text{Au(II)Cl}_2$   
(c)  $\text{Au(I)Cl}_2$  (d) None of these
20. Oxidation number of N in  $\text{HNO}_3$  is  
(a) -3.5 (b) +3.5  
(c) -5 (d) +5
21. In which of the following reactions, there is no change in valency ?  
(a)  $4\text{KClO}_3 \longrightarrow 3\text{KClO}_4 + \text{KCl}$   
(b)  $\text{SO}_2 + 2\text{H}_2\text{S} \longrightarrow 2\text{H}_2\text{O} + 3\text{S}$   
(c)  $\text{BaO}_2 + \text{H}_2\text{SO}_4 \longrightarrow \text{BaSO}_4 + \text{H}_2\text{O}_2$   
(d)  $3\text{BaO} + \text{O}_2 \longrightarrow 2\text{BaO}_2$
22. The oxidation number of chromium in potassium dichromate is  
(a) +6 (b) -5  
(c) -2 (d) +2
23. The oxidation number of sulphur in  $\text{S}_8$ ,  $\text{S}_2\text{F}_2$ ,  $\text{H}_2\text{S}$  respectively, are  
(a) 0, +1 and -2 (b) +2, +1 and -2  
(c) 0, +1 and +2 (d) -2, +1 and -2
24. Oxidation number of cobalt in  $\text{K}[\text{Co}(\text{CO})_4]$  is  
(a) +1 (b) +3  
(c) -1 (d) -3
25. Oxidation number of nitrogen in  $(\text{NH}_4)_2\text{SO}_4$  is  
(a) -1/3 (b) -1  
(c) +1 (d) -3
26. Oxidation number of carbon in  $\text{CH}_2\text{Cl}_2$  is  
(a) -4 (b) +4  
(c) 0 (d) -2
27. In which of the following compounds, iron has lowest oxidation state?  
(a)  $\text{K}_3[\text{Fe}(\text{CN})_6]$   
(b)  $\text{K}_4[\text{Fe}(\text{CN})_6]$   
(c)  $\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$   
(d)  $\text{Fe}(\text{CO})_5$
28. The oxidation state of osmium (Os) in  $\text{OsO}_4$  is  
(a) +7 (b) +6  
(c) +4 (d) +8
29. Which of the following transition metal has zero oxidation state ?  
(a)  $[\text{Fe}(\text{CO})_5]$  (b)  $\text{NH}_2 \cdot \text{NH}_2$   
(c)  $\text{NOClO}_4$  (d)  $\text{CrO}_5$
30. In which of the compounds does 'manganese' exhibit highest oxidation number ?  
(a)  $\text{MnO}_2$  (b)  $\text{Mn}_3\text{O}_4$   
(c)  $\text{K}_2\text{MnO}_4$  (d)  $\text{MnSO}_4$
31. Among the following, identify the species with an atom in +6 oxidation state  
(a)  $\text{MnO}_4^-$  (b)  $\text{Cr}(\text{CN})_6^{3-}$   
(c)  $\text{NiF}_6^{2-}$  (d)  $\text{CrO}_2\text{Cl}_2$
32. In which of the following compounds the oxidation number of carbon is not zero?  
(a)  $\text{HCHO}$  (b)  $\text{CH}_3\text{COOH}$   
(c)  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$  (d)  $\text{CH}_3\text{CHO}$
33. In which of the following compounds, the oxidation number of iodine is fractional ?  
(a)  $\text{IF}_7$  (b)  $\text{I}_3^-$   
(c)  $\text{IF}_5$  (d)  $\text{IF}_3$
34. A metal ion  $\text{M}^{3+}$  loses 3 electrons, its oxidation number will be  
(a) +3 (b) +6  
(c) 0 (d) -3
35. The correct name for  $\text{NO}_2$  using stock notation is  
(a) nitrogen dioxide (b) nitrogen (iv) oxide  
(c) nitrogen per oxide (d) All of these
36. The oxide, which cannot act as a reducing agent, is  
(a)  $\text{NO}_2$  (b)  $\text{SO}_2$   
(c)  $\text{CO}_2$  (d)  $\text{ClO}_2$
37. The oxidation state of Fe in  $\text{Fe}_3\text{O}_4$  is  
(a) +3 (b) 8/3  
(c) +6 (d) +2
38. In oxygen difluoride, the oxidation number of oxygen is  
(a) -2 (b) -1  
(c) +2 (d) +1, -2
39. Oxygen has an oxidation state of +2 in the compound  
(a)  $\text{H}_2\text{O}_2$  (b)  $\text{CO}_2$   
(c)  $\text{H}_2\text{O}$  (d)  $\text{F}_2\text{O}$

40. The number of electrons involved in the reduction of one nitrate ion to hydrazine is  
(a) 8 (b) 5  
(c) 3 (d) 7
41. The average oxidation state of sulphur in  $\text{Na}_2\text{S}_4\text{O}_6$  is  
(a) +2.5 (b) +2  
(c) +3.0 (d) +3.5
42. Which of the following species can function both as oxidizing as well as reducing agent?  
(a)  $\text{Cl}^-$  (b)  $\text{ClO}_4^-$   
(c)  $\text{ClO}^-$  (d)  $\text{MnO}_4^-$
43. The oxidation number of an element in a compound is evaluated on the basis of certain rules. Which of the following rules is not correct in this respect?  
(a) The oxidation number of hydrogen is always +1.  
(b) The algebraic sum of all the oxidation numbers in a compound is zero.  
(c) An element in the free or the uncombined state bears oxidation number zero.  
(d) In all its compounds, the oxidation number of fluorine is -1.
44. Nitric oxide acts as a reducing agent in the reaction  
(a)  $4\text{NH}_3 + 5\text{O}_2 \rightarrow 4\text{NO} + 6\text{H}_2\text{O}$   
(b)  $2\text{NO} + 3\text{I}_2 + 4\text{H}_2\text{O} \rightarrow 2\text{NO}_3^- + 6\text{I}^- + 8\text{H}^+$   
(c)  $2\text{NO} + \text{H}_2\text{SO}_3 \rightarrow \text{N}_2\text{O} + \text{H}_2\text{SO}_4$   
(d)  $2\text{NO} + \text{H}_2\text{S} \rightarrow \text{N}_2\text{O} + \text{S} + \text{H}_2\text{O}$
45. In the compounds  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  the highest oxidation state is of the element  
(a) potassium (b) manganese  
(c) chromium (d) oxygen
46. Atomic number of an element is 22. The highest O.S. exhibited by it in its compounds is  
(a) 1 (b) 2  
(c) 3 (d) 4
47. Why the displacement reactions of chlorine, bromine and iodine using fluorine are not generally carried out in aqueous solution?  
(a) chlorine, bromine and iodine reacts with water and displace oxygen of water  
(b) Fluorine being very reactive attacks water and displaces oxygen of water  
(c) Fluorine does not react with chlorine, bromine and iodine in aqueous media  
(d) None of these
48. Which of the following statement is not true?  
(a) Displacement reaction of chlorine with  $\text{Br}^-$  and  $\text{I}^-$  form the basis of identifying  $\text{Br}^-$  and  $\text{I}^-$  in laboratory using layer test  
(b)  $\text{F}_2$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$  and  $\text{I}_2$  can be recovered by halogen displacement reactions by using their respective halides  
(c)  $\text{F}_2$  can be recovered from  $\text{F}^-$  by oxidising it electrolytically.  
(d) None of these.
49. Which of the following do not show disproportionation reaction?  
 $\text{ClO}_4^-$ ,  $\text{F}_2$ ,  $\text{Cl}_2$ ,  $\text{ClO}_2^-$ ,  $\text{P}_4$ ,  $\text{S}_8$ , and  $\text{ClO}^-$   
(a)  $\text{ClO}_2^-$ ,  $\text{ClO}_4^-$ , and  $\text{ClO}^-$   
(b)  $\text{F}_2$  only  
(c)  $\text{F}_2$  and  $\text{ClO}_4^-$   
(d)  $\text{ClO}_4^-$  only
50. Which one of the following reactions involves disproportionation?  
(a)  $2\text{H}_2\text{SO}_4 + \text{Cu} \rightarrow \text{CuSO}_4 + 2\text{H}_2\text{O} + \text{SO}_2$   
(b)  $\text{As}_2\text{O}_3 + 3\text{H}_2\text{S} \rightarrow \text{As}_2\text{S}_3 + 3\text{H}_2\text{O}$   
(c)  $2\text{KOH} + \text{Cl}_2 \rightarrow \text{KCl} + \text{KOC} + \text{H}_2\text{O}$   
(d)  $\text{Ca}_3\text{P}_2 + 6\text{H}_2\text{O} \rightarrow 3\text{Ca}(\text{OH})_2 + 2\text{PH}_3$
51. The following species will not exhibit disproportionation reaction  
(a)  $\text{ClO}^-$  (b)  $\text{ClO}_2^-$   
(c)  $\text{ClO}_3^-$  (d)  $\text{ClO}_4^-$
52. In the reaction  
 $3\text{Br}_2 + 6\text{CO}_3^{2-} + 3\text{H}_2\text{O} \rightarrow 5\text{Br}^- + \text{BrO}_3^- + 6\text{HCO}_3^-$   
(a) Bromine is oxidised and carbonate is reduced.  
(b) Bromine is reduced and water is oxidised  
(c) Bromine is neither reduced nor oxidised  
(d) Bromine is both reduced and oxidised
53. Which of the following elements does not show disproportionation tendency?  
(a) Cl (b) Br  
(c) F (d) I
54. Phosphorus, sulphur and chlorine undergo disproportion in the ...A... medium.  
Here, A refers to  
(a) acidic (b) alkaline  
(c) neutral (d) Both (a) and (b)
55. The reaction,  $2\text{H}_2\text{O}(l) \xrightarrow{\Delta} 2\text{H}_2(g) + \text{O}_2(g)$  is an example of  
(a) addition reaction (b) decomposition reaction  
(c) displacement reaction (d) None of these
56. How will you balance the total ionic charge of reactant and products if reaction is carried out in acidic solution?  
(a) By using  $\text{H}^+$  ions  
(b) By using  $\text{OH}^-$  ions  
(c) Adding  $\text{H}_2\text{O}$  molecules to the reactant or product  
(d) Multiplying by suitable coefficients.
57. Consider the following reaction occurring in basic medium  
 $2\text{MnO}_4^-(\text{aq}) + \text{Br}^-(\text{aq}) \longrightarrow 2\text{MnO}_2(\text{s}) + \text{BrO}_3^-(\text{aq})$   
How the above reaction can be balanced further?  
(a) By adding 2  $\text{OH}^-$  ions on right side  
(b) By adding one  $\text{H}_2\text{O}$  molecule to left side  
(c) By adding 2  $\text{H}^+$  ions on right side  
(d) Both (a) and (b)

58. For the reaction :  $\text{NH}_3 + \text{OCl}^- \longrightarrow \text{N}_2\text{H}_4 + \text{Cl}^-$  in basic medium, the coefficients of  $\text{NH}_3$ ,  $\text{OCl}^-$  and  $\text{N}_2\text{H}_4$  for the balanced equation are respectively  
 (a) 2, 2, 2 (b) 2, 2, 1  
 (c) 2, 1, 1 (d) 4, 4, 2
59.  $\text{C}_2\text{H}_6(\text{g}) + n\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$   
 In this equation, the ratio of the coefficients of  $\text{CO}_2$  and  $\text{H}_2\text{O}$  is  
 (a) 1 : 1 (b) 2 : 3  
 (c) 3 : 2 (d) 1 : 3
60.  $2\text{MnO}_4^- + 5\text{H}_2\text{O}_2 + 6\text{H}^+ \rightarrow 2\text{Z} + 5\text{O}_2 + 8\text{H}_2\text{O}$ . In this reaction Z is  
 (a)  $\text{Mn}^{+2}$  (b)  $\text{Mn}^{+4}$   
 (c)  $\text{MnO}_2$  (d)  $\text{Mn}$
61. In the redox reaction,  
 $x\text{KMnO}_4 + \text{NH}_3 \longrightarrow y\text{KNO}_3 + \text{MnO}_2 + \text{KOH} + \text{H}_2\text{O}$   
 (a)  $x=4, y=6$  (b)  $x=3, y=8$   
 (c)  $x=8, y=6$  (d)  $x=8, y=3$
62. What is 'A' in the following reaction  
 $2\text{Fe}^{3+}(\text{aq}) + \text{Sn}^{2+}(\text{aq}) \rightarrow 2\text{Fe}^{2+}(\text{aq}) + \text{A}$   
 (a)  $\text{Sn}^{3+}(\text{aq})$  (b)  $\text{Sn}^{4+}(\text{aq})$   
 (c)  $\text{Sn}^{2+}(\text{aq})$  (d)  $\text{Sn}$
63. Given :  
 $\text{X Na}_2\text{HAsO}_3 + \text{Y NaBrO}_3 + \text{Z HCl} \rightarrow \text{NaBr} + \text{H}_3\text{AsO}_4 + \text{NaCl}$   
 The values of X, Y and Z in the above redox reaction are respectively  
 (a) 2, 1, 2 (b) 2, 1, 3  
 (c) 3, 1, 6 (d) 3, 1, 4
64. The values of x and y in the following redox reaction  
 $x\text{Cl}_2 + 6\text{OH}^- \longrightarrow \text{ClO}_3^- + y\text{Cl}^- + 3\text{H}_2\text{O}$  are  
 (a)  $x=5, y=3$  (b)  $x=2, y=4$   
 (c)  $x=3, y=5$  (d)  $x=4, y=2$
65. A negative  $E^\ominus$  means that redox couple is a A than the  $\text{H}^+/\text{H}_2$  couple  
 A positive  $E^\ominus$  means that the redox couple is a B than  $\text{H}^+/\text{H}_2$  couple  
 (a) A = stronger reducing agent  
 B = weaker reducing agent  
 (b) A = stronger oxidising agent  
 B = weaker oxidising agent  
 (c) A = weaker oxidising agent  
 B = stronger oxidising agent  
 (d) Both (a) and (c)
66. Given  $E^\ominus$   
 (i)  $\text{Mg}^{2+}/\text{Mg}(\text{s})$ ,  $E^\ominus = -2.36$   
 (ii)  $\text{Ag}^+/\text{Ag}(\text{s})$ ,  $E^\ominus = 0.80$   
 (iii)  $\text{Al}^{3+}/\text{Al}(\text{s})$ ,  $E^\ominus = -1.66$   
 (iv)  $\text{Cu}^{2+}/\text{Cu}(\text{s})$ ,  $E^\ominus = 0.52$
- Out of the above given elements which is the strongest oxidising agent and which is the weakest oxidising agent ?  
 (a) (iv) is the strong whereas (ii) is the weakest oxidising agent  
 (b) (ii) is the strongest whereas (i) is the weakest oxidising agent  
 (c) (i) is the strongest whereas (ii) is the weakest oxidising agent  
 (d) (ii) is the strongest whereas (iii) is the weakest oxidising agent
67. Stronger is oxidising agent, more is  
 (a) standard reduction potential of that species  
 (b) the tendency to get it self oxidised  
 (c) the tendency to lose electrons by that species  
 (d) standard oxidation potential of that species
68. Standard reduction potentials of the half reactions are given below :  
 $\text{F}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{F}^-(\text{aq})$ ;  $E^\ominus = +2.85\text{ V}$   
 $\text{Cl}_2(\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^-(\text{aq})$ ;  $E^\ominus = +1.36\text{ V}$   
 $\text{Br}_2(\text{l}) + 2\text{e}^- \rightarrow 2\text{Br}^-(\text{aq})$ ;  $E^\ominus = +1.06\text{ V}$   
 $\text{I}_2(\text{s}) + 2\text{e}^- \rightarrow 2\text{I}^-(\text{aq})$ ;  $E^\ominus = +0.53\text{ V}$   
 The strongest oxidising and reducing agents respectively are :  
 (a)  $\text{F}_2$  and  $\text{I}^-$  (b)  $\text{Br}_2$  and  $\text{Cl}^-$   
 (c)  $\text{Cl}_2$  and  $\text{Br}^-$  (d)  $\text{Cl}_2$  and  $\text{I}_2$
69. Standard electrode potentials of redox couples  $\text{A}^{2+}/\text{A}$ ,  $\text{B}^{2+}/\text{B}$ ,  $\text{C}/\text{C}^{2+}$  and  $\text{D}^{2+}/\text{D}$  are 0.3V, -0.5V, -0.75V and 0.9V respectively. Which of these is best oxidising agent and reducing agent respectively –  
 (a)  $\text{D}^{2+}/\text{D}$  and  $\text{B}^{2+}/\text{B}$  (b)  $\text{B}^{2+}/\text{B}$  and  $\text{D}^{2+}/\text{D}$   
 (c)  $\text{D}^{2+}/\text{D}$  and  $\text{C}^{2+}/\text{C}$  (d)  $\text{C}^{2+}/\text{C}$  and  $\text{D}^{2+}/\text{D}$
70. The standard reduction potentials at 298K for the following half reactions are given against each  
 $\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Zn}(\text{s})$ ; -0.762 V  
 $\text{Cr}^{3+}(\text{aq}) + 3\text{e}^- \rightleftharpoons \text{Cr}(\text{s})$ ; -0.740 V  
 $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$ ; 0.00 V  
 $\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{Fe}^{2+}(\text{aq})$ ; 0.770 V  
 Which is the strongest reducing agent?  
 (a)  $\text{Zn}(\text{s})$  (b)  $\text{Cr}(\text{s})$   
 (c)  $\text{H}_2(\text{g})$  (d)  $\text{Fe}^{3+}(\text{aq})$
71. Electrode potential data are given below :  
 $\text{Fe}^{3+}_{(\text{aq})} + \text{e}^- \longrightarrow \text{Fe}^{2+}_{(\text{aq})}$ ;  $E^\ominus = +0.77\text{ V}$   
 $\text{Al}^{3+}_{(\text{aq})} + 3\text{e}^- \longrightarrow \text{Al}_{(\text{s})}$ ;  $E^\ominus = -1.66\text{ V}$   
 $\text{Br}_2(\text{aq}) + 2\text{e}^- \longrightarrow 2\text{Br}^-_{(\text{aq})}$ ;  $E^\ominus = +1.08\text{ V}$   
 Based on the data, the reducing power of  $\text{Fe}^{2+}$ ,  $\text{Al}$  and  $\text{Br}^-$  will increase in the order  
 (a)  $\text{Br}^- < \text{Fe}^{2+} < \text{Al}$  (b)  $\text{Fe}^{2+} < \text{Al} < \text{Br}^-$   
 (c)  $\text{Al} < \text{Br}^- < \text{Fe}^{2+}$  (d)  $\text{Al} < \text{Fe}^{2+} < \text{Br}^-$
72. The standard reduction potentials for  $\text{Cu}^{2+}/\text{Cu}$ ;  $\text{Zn}^{2+}/\text{Zn}$ ;  $\text{Li}^+/\text{Li}$ ;  $\text{Ag}^+/\text{Ag}$  and  $\text{H}^+/\text{H}_2$  are + 0.34 V, - 0.762 V, - 3.05 V, + 0.80 V and 0.00 V respectively. Choose the strongest reducing agent among the following  
 (a)  $\text{Zn}$  (b)  $\text{H}_2$   
 (c)  $\text{Ag}$  (d)  $\text{Li}$

73. Given :

$$E^\circ_{\frac{1}{2}\text{Cl}_2/\text{Cl}^-} = 1.36 \text{ V}, E^\circ_{\text{Cr}^{3+}/\text{Cr}} = -0.74 \text{ V},$$

$$E^\circ_{\text{Cr}_2\text{O}_7^{2-}/\text{Cr}^{3+}} = 1.33 \text{ V}, E^\circ_{\text{MnO}_4^-/\text{Mn}^{2+}} = 1.51 \text{ V}$$

The correct order of reducing power of the species ( $\text{Cr}$ ,  $\text{Cr}^{3+}$ ,  $\text{Mn}^{2+}$  and  $\text{Cl}^-$ ) will be

- $\text{Mn}^{2+} < \text{Cl}^- < \text{Cr}^{3+} < \text{Cr}$
- $\text{Mn}^{2+} < \text{Cr}^{3+} < \text{Cl}^- < \text{Cr}$
- $\text{Cr}^{3+} < \text{Cl}^- < \text{Mn}^{2+} < \text{Cr}$
- $\text{Cr}^{3+} < \text{Cl}^- < \text{Cr} < \text{Mn}^{2+}$

74.  $E^\ominus$  Values of some redox couples are given below. On the basis of these values choose the correct option.

$$E^\ominus \text{ values : } \text{Br}_2/\text{Br}^- = +1.90; \text{Ag}^+/\text{Ag(s)} = +0.80 \\ \text{Cu}^{2+}/\text{Cu(s)} = +0.34; \text{I}_2(\text{s})/\text{I}^- = 0.54$$

- Cu will reduce  $\text{Br}^-$
- Cu will reduce Ag
- Cu will reduce  $\text{I}^-$
- Cu will reduce  $\text{Br}_2$

75. Arrange the following in the order of their decreasing electrode potentials : Mg, K, Ba and Ca

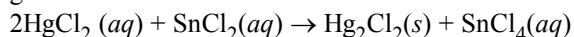
- K, Ca, Ba, Mg
- Ba, Ca, K, Mg
- Ca, Mg, K, Ba
- Mg, Ca, Ba, K

76. The standard electrode potentials of four elements A, B, C and D are  $-3.05$ ,  $-1.66$ ,  $-0.40$  and  $+0.80$ . The highest chemical reactivity will be exhibited by

- A
- B
- C
- D

### STATEMENT TYPE QUESTIONS

77. Which of the following statement(s) is/are correct for the given reaction?



- Mercuric chloride is reduced to  $\text{Hg}_2\text{Cl}_2$
  - Stannous chloride is oxidised to stannic chloride
  - $\text{HgCl}_2$  is oxidised to  $\text{Hg}_2\text{Cl}_2$
  - It is an example of redox reaction
- (i), (ii) and (iv)
  - (i) and (ii)
  - (iii) and (iv)
  - (iii) only

78. Which of the following sequences of T and F is correct for given statements. Here T stands for true and F stands for false statements

- Reducing agents lower the oxidation number of an element in a given substance. These reagents are also called as reductants
  - Reducing agents are acceptor of electrons
  - Loss of electron(s) by any species is called oxidation reaction
  - Oxidation and reduction always occur simultaneously.
- TTTT
  - TFTT
  - TFFT
  - FTTT

79. If aqueous solution of  $\text{H}_2\text{O}_2$  is made acidic. For this which of the following statement(s) is/are correct ?

- This aqueous solution oxidizes  $\text{I}^-$
- This aqueous solution oxidizes  $\text{F}^-$

- Both statements (i) and (ii) are correct.
- Statement (i) is correct and (ii) is incorrect.
- Statement (ii) is correct and (i) is incorrect.
- Both statements (i) and (ii) are incorrect.

80. Which of the following statement(s) is/are correct ?

- All alkali metals and some alkaline earth metals (Ca, Sr and Ba) displace hydrogen from cold water.
  - Magnesium and iron react with steam as well as acids to produce hydrogen gas.
  - Cadmium and tin do not react with steam but displace hydrogen from acids.
- (i) and (ii)
  - (ii) only
  - (i) and (iii)
  - (i), (ii) and (iii)

81. Which of the following statements are correct concerning redox properties?

- A metal M for which  $E^\ominus$  for the half life reaction  $\text{M}^{n+} + n\text{e}^- \rightleftharpoons \text{M}$  is very negative will be a good reducing agent.
  - The oxidizing power of the halogens decreases from chlorine to iodine.
  - The reducing power of hydrogen halides increases from hydrogen chloride to hydrogen iodide
- (i), (ii) and (iii)
  - (i) and (ii)
  - (i) only
  - (ii) and (iii)

82. Which of the following statement(s) is/are correct ?

- A negative value of  $E^\ominus$  means that the redox couple is a weaker reducing agent than the  $\text{H}^+/\text{H}_2$  couple.
- A positive  $E^\ominus$  means that the redox couple is weaker reducing agent than the  $\text{H}^+/\text{H}_2$ .

Which of the following code is incorrect regarding above statements?

- Only (i)
- only (ii)
- Both (i) and (ii)
- Neither (i) nor (ii)

83. Which of the following statement(s) is/are correct ?

- Oxidation state of carbon in  $\text{C}_3\text{H}_4$  is  $-(4/3)$ .
  - Electrons are never shared in fraction.
- (i) and (ii)
  - Only (i)
  - Only (ii)
  - Neither (i) nor (ii)

### MATCHING TYPE QUESTIONS

84. Match the columns

Column-I	Column-II
(A) Addition of electronegative element	(p) Oxidation reaction
(B) Removal of hydrogen	(q) Reduction reaction
(C) Addition of electropositive element	
(D) Removal of oxygen	
(a) (A) – (p), (B) – (q), (C) – (q), (D) – (p)	
(b) (A) – (p), (B) – (p), (C) – (q), (D) – (q)	
(c) (A) – (p), (B) – (q), (C) – (p), (D) – (q)	
(d) (A) – (q), (B) – (q), (C) – (p), (D) – (p)	

85. Match the columns

Column-I	Column-II
(A) $2\text{Mg} + \text{O}_2 \longrightarrow 2\text{MgO}$	(p) Removal of hydrogen
(B) $\text{Mg} + \text{Cl}_2 \longrightarrow \text{MgCl}_2$	(q) Removal of electropositive element
(C) $2\text{H}_2\text{S} + \text{O}_2 \longrightarrow 2\text{S} + 2\text{H}_2\text{O}$	(r) Addition of oxygen
(D) $2\text{KI} + \text{H}_2\text{O} + \text{O}_3 \longrightarrow 2\text{KOH} + \text{I}_2 + \text{O}_2$	(s) Addition of electronegative element, chlorine
(a) A – (s), B – (q), C – (p), D – (r)	
(b) A – (r), B – (s), C – (p), D – (q)	
(c) A – (s), B – (r), C – (q), D – (p)	
(d) A – (r), B – (p), C – (s), D – (q)	

86. Match Column-I (compound) with Column-II (oxidation state of underlined element) and choose the correct option.

Column - I	Column - II
(A) $\underline{\text{Cu}}\text{O}$	(p) 4
(B) $\underline{\text{Mn}}\text{O}_2$	(q) 3
(C) $\text{H}\underline{\text{Au}}\text{Cl}_4$	(r) 2
(D) $\underline{\text{Tl}}_2\text{O}$	(s) 1
(a) A – (r), B – (p), C – (q), D – (s)	
(b) A – (s), B – (r), C – (p), D – (q)	
(c) A – (r), B – (s), C – (p), D – (q)	
(d) A – (s), B – (q), C – (p), D – (r)	

87. Match the columns

Column-I	Column-II
(A) $\text{V}_2\text{O}_5(\text{s}) + 5\text{Ca}(\text{s}) \longrightarrow 2\text{V}(\text{s}) + 5\text{CaO}(\text{s})$	(p) Disproportionation reaction
(B) $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \xrightarrow{\Delta} \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$	(q) Decomposition reaction
(C) $\text{P}_4(\text{s}) + 3\text{OH}^-(\text{aq}) + 3\text{H}_2\text{O}(\text{l}) \longrightarrow \text{PH}_3(\text{g}) + 3\text{H}_2\text{PO}_2^-(\text{aq})$	(r) Combination reaction
(D) $2\text{KClO}_3(\text{s}) \xrightarrow{\Delta} 2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g})$	(s) Displacement reaction
(a) A – (s), B – (q), C – (r), D – (p)	
(b) A – (s), B – (r), C – (p), D – (q)	
(c) A – (r), B – (s), C – (q), D – (p)	
(d) A – (r), B – (s), C – (p), D – (q)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

88. **Assertion :** In the reaction  $2\text{Na}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{NaCl}(\text{s})$  sodium is oxidised.

**Reason :** Sodium acts as an oxidising agent in given reaction.

89. **Assertion :**  $\text{HClO}_4$  is a stronger acid than  $\text{HClO}_3$ .

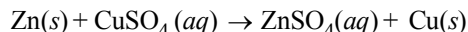
**Reason :** Oxidation state of Cl in  $\text{HClO}_4$  is +VII and in  $\text{HClO}_3$  +V.

90. **Assertion :** The reaction :

$\text{CaCO}_3(\text{s}) \xrightarrow{\Delta} \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$  is an example of decomposition reaction

**Reason :** Above reaction is not a redox reaction.

91. **Assertion :** In a reaction



Zn is a reductant but itself get oxidized.

**Reason :** In a redox reaction, oxidant is reduced by accepting electrons and reductant is oxidized by losing electrons.

### CRITICAL THINKING TYPE QUESTIONS

92. Among  $\text{NH}_3$ ,  $\text{HNO}_3$ ,  $\text{NaN}_3$  and  $\text{Mg}_3\text{N}_2$  the number of molecules having nitrogen in negative oxidation state is

- (a) 1 (b) 2  
(c) 3 (d) 4

93. Fill up the table from the given choice.

Element	Oxidation number
Oxygen	–2 in most compounds (i) in $\text{H}_2\text{O}_2$ and (ii) in $\text{OF}_2$
Halogen	–1 for (iii) in all its compounds
Hydrogen	(iv) in most of its compounds (v) in binary metallic hydrides
Sulphur	(vi) in all sulphides

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
(a)	+1	+1	Cl	+1	–1	+2
(b)	–1	+2	F	+1	–1	–2
(c)	–1	+1	F	+1	+2	+2
(d)	+1	+2	Cl	+1	+1	+6

94. The correct decreasing order of oxidation number of oxygen in compounds  $\text{BaF}_2$ ,  $\text{O}_3$ ,  $\text{KO}_2$  and  $\text{OF}_2$  is

- (a)  $\text{BaO}_2 > \text{KO}_2 > \text{O}_3 > \text{OF}_2$   
 (b)  $\text{OF}_2 > \text{O}_3 > \text{KO}_2 > \text{BaO}_2$   
 (c)  $\text{KO}_2 > \text{OF}_2 > \text{O}_3 > \text{BaO}_2$   
 (d)  $\text{BaO}_2 > \text{O}_3 > \text{OF}_2 > \text{KO}_2$

95. Oxidation numbers of P in  $\text{PO}_4^{3-}$ , of S in  $\text{SO}_4^{2-}$  and that of

Cr in  $\text{Cr}_2\text{O}_7^{2-}$  are respectively

- (a) +3, +6 and +5 (b) +5, +3 and +6  
 (c) –3, +6 and +6 (d) +5, +6 and +6

96. When  $\text{Cl}_2$  gas reacts with hot and concentrated sodium hydroxide solution, the oxidation number of chlorine changes from

- (a) zero to +1 and zero to –5  
 (b) zero to –1 and zero to +5  
 (c) zero to –1 and zero to +3  
 (d) zero to +1 and zero to –3



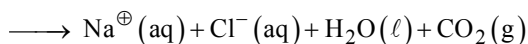
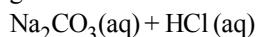
97. Which of the following arrangements represent increasing oxidation number of the central atom?

- (a)  $\text{CrO}_2^-$ ,  $\text{ClO}_3^-$ ,  $\text{CrO}_4^{2-}$ ,  $\text{MnO}_4^-$   
 (b)  $\text{ClO}_3^-$ ,  $\text{CrO}_4^{2-}$ ,  $\text{MnO}_4^-$ ,  $\text{CrO}_2^-$   
 (c)  $\text{CrO}_2^-$ ,  $\text{ClO}_3^-$ ,  $\text{MnO}_4^-$ ,  $\text{CrO}_4^{2-}$   
 (d)  $\text{CrO}_4^{2-}$ ,  $\text{MnO}_4^-$ ,  $\text{CrO}_2^-$ ,  $\text{ClO}_3^-$

98. Which of the following act as reducing agents?

- (i)  $\text{PO}_4^{3-}$  (ii)  $\text{SO}_3$   
 (iii)  $\text{PO}_3^{2-}$  (iv)  $\text{NH}_3$   
 (a) (i), (ii) and (iii) (b) Only (iii)  
 (c) (i), (iii) and (iv) (d) (iii) and (iv)

99. In the reaction shown below, oxidation state of the carbon in reactant and product are (i) and (ii) respectively? Is the given reaction a redox reaction?

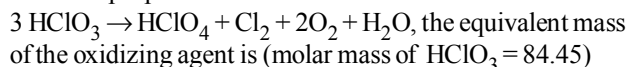


- (a) (i) 6, (ii) 4, yes (b) (i) 6, (ii) 6, No  
 (c) (i) 4, (ii) 4, No (d) (i) 4, (ii) 4, yes

100. What products are expected from the disproportionation reaction of hypochlorous acid?

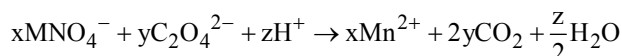
- (a)  $\text{HCl}$  and  $\text{Cl}_2\text{O}$  (b)  $\text{HCl}$  and  $\text{HClO}_3$   
 (c)  $\text{HClO}_3$  and  $\text{Cl}_2\text{O}$  (d)  $\text{HClO}_2$  and  $\text{HClO}_4$

101. In the disproportionation reaction



- (a) 16.89 (b) 32.22  
 (c) 84.45 (d) 28.15

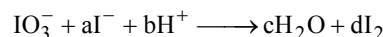
102. Consider the following reaction:



The value's of x, y and z in the reaction are, respectively:

- (a) 5, 2 and 16 (b) 2, 5 and 8  
 (c) 2, 5 and 16 (d) 5, 2 and 8

103. In the balanced chemical reaction



a, b, c and d respectively corresponds to

- (a) 5, 6, 3, 3 (b) 5, 3, 6, 3  
 (c) 3, 5, 3, 6 (d) 5, 6, 5, 5

104. If equal volume of reactants are used, than no. moles of  $\text{KMnO}_4$  (moles per liter) used in acidic medium required to completely oxidises the 0.5 M  $\text{FeSO}_3$ ?

- (a) 0.3 (b) 0.1  
 (c) 0.2 (d) 0.4

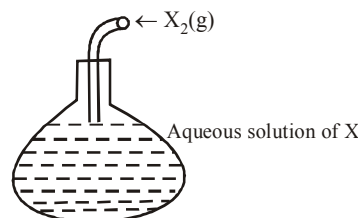
105. Acidic medium used in  $\text{KMnO}_4$  can be made from which of the following acids?

- (a)  $\text{HCl}$  (b)  $\text{H}_2\text{SO}_4$   
 (c)  $\text{HI}$  (d)  $\text{HBr}$

106. If rod of a metal (x) is put in a metal ion solution which is blue in colour, solution turn colorless. The metal rod and solution respectively are?

- (a) Zinc and  $\text{Cu}(\text{II})$  (b) Zinc and  $\text{Ni}(\text{II})$   
 (c) Aluminium and  $\text{Cu}(\text{II})$  (d) Both (a) and (c)

107. What could be the X<sup>-</sup> in the system, Where X signifies halogen; formation of shown below  $\text{X}_2$  takes place, when  $\text{F}_2$  is purge into aqueous solution of X<sup>-</sup>?

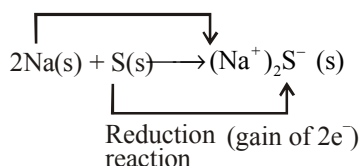


- (a)  $\text{Br}^-$  (b)  $\text{Cl}^-$   
 (c)  $\text{I}^-$  (d) All of these

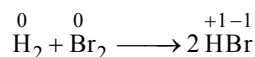
# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

- (a) Addition of oxygen takes place in oxidation.
- (c) Given reaction is oxidation reaction due to removal of electropositive element potassium from potassium ferrocyanide.
- (d)  $2\text{Na(s)} + \text{H}_2\text{(g)} \xrightarrow{\Delta} 2\text{NaH(s)}$   
With the careful application of the concept of electronegativity only S we can find that sodium is oxidised and hydrogen is reduced.
- (a) Losing of electron is called oxidation.
- (b) Oxidation reaction (loss of  $2e^-$ )



- (a) O.N. of Mn in  $\text{MnO}_4^-$  is +7 and in  $\text{Mn}^{2+}$  it is +2. The difference is of 5 electrons.
- (a) Ox. no. of Cr on both side is +6.
- (a)  $4\text{P} + 3\text{KOH} + 3\text{H}_2\text{O} \rightarrow \text{KH}_2\text{PO}_2 + \text{PH}_3$   
O.N. of P = 0, In  $\text{KH}_2\text{PO}_2$  it is +1, In  $\text{PH}_3$  it is -3.  
Hence P is oxidised and reduced.
- (a) In a redox reaction, one molecule is oxidised and other molecule is reduced i.e. oxidation number of reactants are changed.



Here  $\text{H}_2$  is oxidised and  $\text{Br}_2$  is reduced, thus it is oxidation-reduction reaction.

- (b)  $4\text{Na} + \text{O}_2 \longrightarrow 2\overset{+}{\text{Na}}_2\text{O}$   
Loss of electrons (oxidation)

In this reaction, Na converts into ion ( $\text{Na}^+$ ) and Na donates electrons to oxygen atoms, So, Na behaves as reducing agent.

- (b)  $\text{Zn}^{2+} + 2e^- \rightarrow \text{Zn(s)}$   
Here electrons are reducing from  $\text{Zn}^{2+}$  to Zn.
- (c)  $\text{Co(s)} + \text{Cu}^{2+}(\text{aq}) \longrightarrow \text{Co}^{2+}(\text{aq}) + \text{Cu(s)}$   
This reaction is a redox reaction as Co undergoes oxidation whereas  $\text{Cu}^{+2}$  undergoes reduction.
- (c)  $\text{N}_2^{-4}\text{H}_4^{+4} \xrightarrow[\text{N}]{\text{loss of } 10e^-} \text{N}_2^{+6}\text{Y}$   
O.N. of N changes from -2 to +3

- (b) Blue colour of the solution disappear due to formation of  $\text{Zn}^{2+}$ .
- (d) Correct order is  $\text{Zn} > \text{Cu} > \text{Ag}$ .
- (b) For elements, in the free or the uncombined state, each atom bears an oxidation number of zero.
- (c) Oxidation number of oxygen in  $\text{OF}_2 = +2$ .

$$\text{In } \text{KO}_2 = \frac{-1}{2}$$

- (d) Oxidation number of hydrogen when it is bonded to metals in binary compounds is -1
- (a) Auric Chloride =  $\text{Au(III)Cl}_3$
- (d) Let the oxidation no. of N in  $\text{HNO}_3 = x$   
 $\therefore 1 + x + (3 \times -2) = 0$   
 $\therefore x = +5$

- (c)  $\overset{+2}{\text{Ba}}\overset{-1}{\text{O}_2} + \overset{+1}{\text{H}_2}\overset{+6}{\text{S}}\overset{-2}{\text{O}_4} \longrightarrow \overset{+2}{\text{Ba}}\overset{+6}{\text{S}}\overset{-2}{\text{O}_4} + \overset{+1}{\text{H}_2}\overset{-1}{\text{O}_2}$

In this reaction, none of the elements undergoes a change in oxidation number or valency.

- (a) Let  $x$  = oxidation no. of Cr in  $\text{K}_2\text{Cr}_2\text{O}_7$ .  
 $\therefore (2 \times 1) + (2 \times x) + 7(-2) = 0$   
or  $2 + 2x - 14 = 0$  or  $x = +6$ .
- (a) (i) Oxidation state of element in its free state is zero.  
(ii) Sum of oxidation states of all atoms in compound is zero.  
O.N. of S in  $\text{S}_8 = 0$ ; O.N. of S in  $\text{S}_2\text{F}_2 = +1$ ;  
O.N. of S in  $\text{H}_2\text{S} = -2$ ;

- (c)  $\text{K}[\text{Co}(\text{CO})_4]$

Let O.N. of Co be  $x$  then

$$1 \times (+1) + \underset{\text{for K}}{x} + 4 \times \underset{\text{for CO}}{(0)} = 0$$

$\therefore$  O.N. of Co is -1

- (d)  $(\text{NH}_4)_2\text{SO}_4$  is split into ions.  $\text{NH}_4^+$ . Let O.N. of N be  $x$  then,  $1 \times (x) + 4 \times (+1) = 1 \therefore x = -3$

- (c)  $\overset{+1}{\text{H}}-\overset{+1}{\text{C}}\overset{2-}{\overset{+1}{\text{O}}_2}-\overset{-1}{\text{Cl}}\overset{-1}{\text{O}}$  O.N. of C is zero

- (d) O.N. of Fe in (a), (b), (c) and (d) respectively are : +3, +2, +2 and 0.
- (d)  $\text{OsO}_4$   
Let O.N. of Os be  $x$  then  $1 \times (x) + 4(-2) = 0$   
 $\therefore x = 8$

29. (a)  $\text{Fe}(\text{CO})_5$  is metal carbonyl, hence O.N. of Fe is zero.
30. (c) O.N. of Mn in  $\text{K}_2\text{MnO}_4$  is +6
31. (d)  $\text{MnO}_4^-$  (O.S. of Mn +7);  $\text{Cr}(\text{CN})_6^{3-}$  (O.S. of Cr +3),  
 $\text{NiF}_6^{2-}$  (O.S. of Ni +4) and  $\text{CrO}_2\text{Cl}_2$  (O.S. of Cr +6)
32. (d) O.N. of carbon in  $\text{CH}_3\text{CHO}$  is -1; in other cases it is zero.
33. (b) O.N. of iodine in  $\text{I}_3^-$  is -1/3
34. (b)  $\text{M}^{3+}$  on losing 3 electrons will become  $\text{M}^{+6}$  and O.N. = +6.
35. (b) The method of representing oxidation number by a Roman numeral within the paranthesis represents Stock notation.
36. (c) Carbon has the maximum oxidation state of +4, therefore carbon dioxide ( $\text{CO}_2$ ) cannot act as a reducing agent.
37. (b) Let the oxidation no. of Fe in  $\text{Fe}_3\text{O}_4 = x$   
 $\therefore 3x + (-2 \times 4) = 0$  or  $3x = 8$   
 $\therefore x = \frac{8}{3}$
38. (c) Let oxidation state of oxygen in  $\text{OF}_2 = x$   
 $\therefore x + (-1 \times 2) = 0$   
 $\therefore x = +2$
39. (d) In  $\text{H}_2\text{O}_2$ :  $\Rightarrow 2 \times (+1) + 2 \times x = 0 \Rightarrow x = -1$   
 In  $\text{CO}_2$ :  $\Rightarrow 4 + 2x = 0 \Rightarrow x = -2$   
 In  $\text{H}_2\text{O}$ :  $\Rightarrow 2 \times (+1) + x = 0 \Rightarrow x = -2$   
 In  $\text{F}_2\text{O}$ :  $\Rightarrow 2 \times (-1) + x = 0 \Rightarrow x = +2$
40. (d)  $\text{NO}_3^- \xrightarrow{+5} \text{N}_2\text{H}_4 \xrightarrow{-2}$  So, for reduction of 1 mole of  $\text{NO}_3^-$  3 number of electrons required is 7.
41. (a) Let the oxidation state of S be x.  
 $\text{S}_4\text{O}_6^{2-} \Rightarrow 4x - 12 = -2 \Rightarrow 4x = 10 \Rightarrow x = 10/4 = 2.5$
42. (c) 

Species	O.N.
$\text{Cl}^-$	-1
$\text{ClO}_4^-$	+7
$\text{ClO}^-$	+1
$\text{MnO}_4^-$	+7

 In  $\text{ClO}^-$  chlorine is in +1 oxidation state which can be increased or decreased thus it acts as an oxidising or reducing agent.  
 In other given species the underlined elements are either in their minimum or maximum oxidation state.
43. (a)
44. (b) O.N. of N changes from +2 to +5 hence NO is reducing.
45. (b) In  $\text{KMnO}_4$ : Let O.N. of Mn be x  
 $\Rightarrow +1 + x + 4(-2) = 0 \Rightarrow x = +7$   
 In  $\text{K}_2\text{Cr}_2\text{O}_7$ : Let O.N. of Cr be x  
 $\Rightarrow 2(1) + 2x + 7(-2) = 0 \Rightarrow x = +6$
46. (d) The element is Ti (At. no. 22). Electronic configuration is  $1s^2, 2s^2p^6, 3s^2p^6d^2, 4s^2$ . the energy level of 3d and 4s is very close. It can have  $\text{Ti}^{4+}$  O.S.
47. (b) Fluorine is so reactive that it attacks water and displaces the oxygen of water :  

$$\begin{array}{ccccccc} +1 & -2 & & 0 & & +1 & -1 & & 0 \\ 2\text{H}_2\text{O}(\text{l}) + 2\text{F}_2(\text{g}) & \rightarrow & 4\text{HF}(\text{aq}) + \text{O}_2(\text{g}) \end{array}$$
48. (b) As fluorine is the strongest oxidising agent; there is no way to convert  $\text{F}^-$  ions to  $\text{F}_2$  by chemical means. The only way to achieve  $\text{F}_2$  from  $\text{F}^-$  is to oxidise it electrolytically.
49. (c)  $\text{F}_2$  being most electronegative element cannot exhibit any positive oxidation state.  
 In  $\text{ClO}_4^-$  chlorine is present in its highest oxidation state i.e. +7. Therefore it does not show disproportionation reaction.
50. (c) A reaction, in which a substance undergoes simultaneous oxidation and reduction, is called disproportionation reaction. In these reactions, the same substance simultaneously acts as an oxidising agent and as a reducing agent. Here Cl undergoes simultaneous oxidation and reduction.  

$$2\text{KOH} + \text{Cl}_2 \rightarrow \text{KCl} + \text{KOC} + \text{H}_2\text{O}$$

$$\begin{array}{ccccccc} & & & -1 & & +1 & \\ & & & \text{Cl} & & \text{Cl} & \end{array}$$
51. (d) In disproportionation reaction, one element of a compound will simultaneously get reduced and oxidised. In  $\text{ClO}_4^-$ , oxidation number of Cl is +7 and it can not increase it further. So,  $\text{ClO}_4^-$  will not get oxidised and so will not undergo disproportionation reaction.
52. (d)  $3\text{Br}_2 + 6\text{CO}_3^{2-} + 3\text{H}_2\text{O} \rightarrow 5\text{Br}^- + \text{BrO}_3^- + 6\text{HCO}_3^-$   
 O.N. of  $\text{Br}_2$  changes from 0 to -1 and +5 hence it is reduced as well as oxidised.
53. (c)
54. (b) Phosphorus, sulphur and chlorine disproportionate in the alkaline medium.
55. (b)  $2\text{H}_2\text{O} \xrightarrow{\Delta} 2\text{H}_2 + \text{O}_2$   
 There is decomposition of  $\text{H}_2\text{O}$  molecule into  $\text{H}_2$  and  $\text{O}_2$ .
56. (a)  $\text{H}^+$  ions are added to the expression on the appropriate side so that the total ionic charges of reactants and products become equal.
57. (d) Since reaction is occurring in basic medium therefore  $2\text{OH}^-$  are added on right side.  

$$2\text{MnO}_4^- (\text{aq}) + \text{Br}^- (\text{aq}) \longrightarrow 2\text{MnO}_2(\text{s}) + \text{BrO}_3^- (\text{aq}) + 2\text{OH}^- (\text{aq})$$
 Now, hydrogen atoms balanced by adding one  $\text{H}_2\text{O}$  molecule to the left side  

$$2\text{MnO}_4^- (\text{aq}) + \text{Br}^- (\text{aq}) + \text{H}_2\text{O}(\text{l}) \longrightarrow 2\text{MnO}_2(\text{s}) + \text{BrO}_3^- (\text{aq}) + 2\text{OH}^- (\text{aq})$$

58. (c) The balanced equation :  
 $2\text{NH}_3 + \text{OCl}^- \longrightarrow \text{N}_2\text{H}_4 + \text{Cl}^- + \text{H}_2\text{O}$
59. (b) The balanced equation is  
 $2\text{C}_2\text{H}_6 + 7\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$ .  
 Ratio of the coefficients of  $\text{CO}_2$  and  $\text{H}_2\text{O}$  is 4 : 6 or 2 : 3.
60. (a)  $2\text{MnO}_4^- + 5\text{H}_2\text{O}_2 + 6\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 5\text{O}_2 + 8\text{H}_2\text{O}$ .
61. (d)  $8\text{KMnO}_4 + 3\text{NH}_3 \longrightarrow 8\text{MnO}_2 + 3\text{KNO}_3 + 5\text{KOH} + 2\text{H}_2\text{O}$
62. (b) 
$$\begin{array}{c} \text{Reduction} \\ \downarrow \\ 2\text{Fe}^{3+} + \text{Sn}^{2+} \rightarrow 2\text{Fe}^{2+} + \text{Sn}^{4+} \\ \uparrow \\ \text{Oxidation} \end{array}$$
63. (c) On balancing the given reaction, we find  
 $3\text{Na}_2\text{HASO}_3 + \text{NaBrO}_3 + 6\text{HCl} \longrightarrow 6\text{NaCl} + 3\text{H}_3\text{AsO}_4 + \text{NaBr}$
64. (c) 
$$\begin{array}{c} \downarrow \quad \quad \quad \uparrow \quad \quad \quad \downarrow \\ x\text{Cl}_2 + 6\text{OH}^- \longrightarrow x\text{ClO}_3^- + y\text{Cl}^- + 3\text{H}_2\text{O} \\ \text{change in oxidation number} = -1 \end{array}$$
  
 on balancing the eq we get  
 $3\text{Cl}_2 + 6\text{OH}^- \longrightarrow \text{ClO}_3^- + 5\text{Cl}^- + 3\text{H}_2\text{O}$
65. (d) Negative  $E^\ominus \Rightarrow$  Stronger reducing agent or weaker oxidising agent  
 Positive  $E^\ominus \Rightarrow$  Weaker reducing agent or stronger oxidising agent.
66. (b) Strongest oxidising agent =  $\text{Ag}^+/\text{Ag(s)}$   
 Weakest oxidising agent =  $\text{Mg}^{2+}/\text{Mg(s)}$
67. (a) More is  $E_{\text{RP}}^\ominus$ , more is the tendency to get itself reduced or more is oxidising power.
68. (a) Higher the value of reduction potential higher will be the oxidising power whereas the lower the value of reduction potential higher will be the reducing power.
69. (c) The redox couple with maximum reduction potential will be best oxidising agent and with minimum reduction potential will be best reducing agent.
70. (a) Since oxidation potential of Zn is highest hence strongest reducing agent.
71. (a) 

Fe	Al	Br
0.77	-1.66	1.08 $E_{\text{Red}}^\ominus$
-0.77	1.66	-1.08 $E_{\text{Oxi}}^\ominus$

 Hence, reducing power  $\text{Al} > \text{Fe}^{2+} > \text{Br}^-$
72. (d) More the negative reduction potential, more is the tendency to lose electron. The reducing power increases as the standard reduction potential becomes more and more negative.  
 Thus, Li is the strongest reducing agent as the standard reduction potential of  $\text{Li}^+/\text{Li}$  is most negative, -3.05 V.

73. (a) Lower the value of reduction potential higher will be reducing power hence the correct order will be  
 $\text{Mn}^{2+} < \text{Cl}^- < \text{Cr}^{3+} < \text{Cr}$
74. (d)
75. (d) Order of decreasing electrode potentials of Mg, K, Ba and Ca is  
 $\text{Mg} > \text{Ca} > \text{Ba} > \text{K}$   
 It can be explained by their standard reduction potentials.  
 $E_{\text{K}^+|\text{K}}^\ominus = -2.925$   
 $E_{\text{Ba}^{2+}|\text{Ba}}^\ominus = -2.90$   
 $E_{\text{Ca}^{2+}|\text{Ca}}^\ominus = -2.87$   
 $E_{\text{Mg}^{2+}|\text{Mg}}^\ominus = -2.37$   
 Highly negative value of  $E_{\text{red}}^\ominus$  shows the least value of electrode potential.
76. (a) Standard electrode potential i.e. reduction potential of A is minimum (-3.05V) i.e. its oxidation potential is maximum which implies 'A' is most reactive chemically.

### STATEMENT TYPE QUESTIONS

77. (a) For statement (iii),  $\text{HgCl}_2$  is reduced to  $\text{Hg}_2\text{Cl}_2$
78. (b) For statement (ii) reducing agents are donor of electrons.
79. (b)  $\text{H}_2\text{O}_2$  is strong oxidizing than  $\text{I}_2$ , reduction potential of  $\text{H}_2\text{O}_2$  is greater than that of  $\text{I}_2$ .
80. (d) All the given statements are correct.
81. (a) (i)  $\text{M}^{n+} + n\text{e}^- \rightleftharpoons \text{M}$ , for this reaction, high negative value of  $E^\ominus$  indicates lower reduction potential, that means M will be a good reducing agent.
- Stronger reducing agent  $\Rightarrow$  Easy to oxidise  
 $\Downarrow$   
 Lower reduction potential  $\Leftarrow$  higher oxidation potential
- (ii) 

Element	F	Cl	Br	I
Reduction potential ( $E^\ominus$ volt)	+2.87	+1.36	+1.06	+0.54

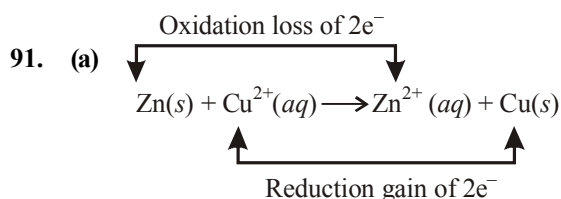
 As reduction potential decreases from fluorine to iodine, oxidising nature also decreases from fluorine to iodine.
- (iii) The size of halide ions increases from  $\text{F}^-$  to  $\text{I}^-$ . The bigger ion can loose electron easily. Hence the reducing nature increases from HF to HI.
82. (a)
83. (a)  $-(4/3)$  is the average oxidation state of C in  $\text{C}_3\text{H}_4$ .

### MATCHING TYPE QUESTIONS

84. (b) Oxidation is addition of electronegative or removal of electropositive element to a substance or removal of hydrogen from a substance.  
Reduction is addition of electropositive or removal of electropositive element or removal of oxygen from a substance.
85. (b)
86. (a)  $\text{CuO} \Rightarrow +2$   
 $\text{MnO}_2 \Rightarrow +4$   
 $\text{HAuCl}_4 \Rightarrow +3$   
 $\text{Tl}_2\text{O} \Rightarrow +1$
87. (b)

### ASSERTION-REASON TYPE QUESTIONS

88. (c) In reaction  $2\text{Na(s)} + \text{Cl}_2\text{(g)} \rightarrow 2\text{NaCl(s)}$  sodium is oxidised by loss of electrons and acts as a reducing agent (donor of electrons).
89. (b) Both Assertion and Reason are true but reason is not the correct explanation of assertion. Greater the number of negative atoms present in the oxy-acid make the acid stronger. In general, the strengths of acids that have general formula  $(\text{HO})_m\text{ZO}_n$  can be related to the value of  $n$ . As the value of  $n$  increases, acidic character also increases. The negative atoms draw electrons away from the Z-atom and make it more positive. The Z-atom, therefore, becomes more effective in withdrawing electron density away from the oxygen atom that bonded to hydrogen. In turn, the electrons of H–O bond are drawn more strongly away from the H-atom. The net effect makes it easier from the proton release and increases the acid a strength.
90. (b) Decomposition of calcium carbonate is not a redox reaction.



### CRITICAL THINKING TYPE QUESTIONS

92. (c) Calculating the oxidation state of nitrogen in given molecules;  
Oxidation state of N in  $\text{NH}_3$  is  
 $x + 3 \times (+1) = 0$  or  $x = -3$   
Oxidation state on N in  $\text{NaNO}_3$  is  
 $1 + x + 3 \times (-2) = 0$  or  $x = +5$

Oxidation state of N in  $\text{NaN}_3$  is

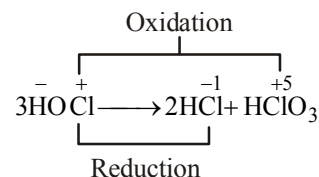
$$+1 + 3x = 0 \text{ or } x = -\frac{1}{3}$$

Oxidation state of N in  $\text{Mg}_3\text{N}_2$  is

$$3 \times 2 + 2x = 0 \text{ or } x = -3$$

Thus 3 molecules (i.e.  $\text{NH}_3$ ,  $\text{NaN}_3$  and  $\text{Mg}_3\text{N}_2$  have nitrogen in negative oxidation state.

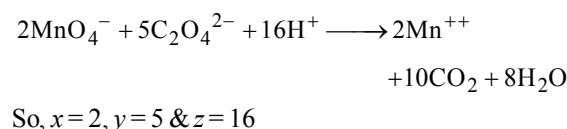
93. (b)
94. (b) Oxidation no. of O are +2, 0,  $-1/2$  and  $-1$  respectively
95. (d)  $\text{PO}_4^{3-} = x + 4(-2) = -3$ ;  $x - 8 = -3$ ;  $x = +5$   
 $\text{SO}_4^{2-} = x + 4(-2) = -2$ ;  $x - 8 = -2$ ;  $x = +6$   
 $\text{Cr}_2\text{O}_7^{2-} = 2x + 7(-2) = -2$ ;  $2x - 14 = -2$ ;  
 $2x = 12$ ;  $x = +6$
96. (b) On reaction with hot and concentrated alkali a mixture of chloride and chlorate is formed  
 $3\text{Cl}_2 + 3\text{NaOH}_{(\text{excess})} \xrightarrow{\text{Hot}}$   
$$\begin{array}{c} -1 \qquad +5 \\ 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O} \end{array}$$
97. (a)
98. (d) In (i) and (ii) both P and S are in highest oxidation state. In (iii) and (iv) ; P has oxidation state of +4 which can be oxidized to +5 state, while in case of  $\text{NH}_3$  nitrogen has oxidation state of  $-3$  which can be oxidised.
99. (c) The redox reaction involve loss or gain of electron(s) i.e. change in oxidation state. Given reaction is not a redox reaction as this reaction involves no change in oxidation state of reactant or product.
100. (b) During disproportionation same compound undergo simultaneous oxidation reduction.



101. (a)  $\text{ClO}_3^- \longrightarrow \text{Cl}_2^0$   
 $x - 6 = -1$      $x = 0$   
 $x = +5$      $x = 0$  ( $x = \text{oxidation number}$ )

$$\text{Equivalent mass} = \frac{\text{Molecular mass}}{\text{Oxidation number}} = \frac{84.45}{5} = 16.89$$

102. (c) On balancing the given equations, we get





- 103. (a)** Given reaction is  
 $\text{IO}_3^- + a\text{I}^- + b\text{H}^+ \longrightarrow c\text{H}_2\text{O} + d\text{I}_2$   
 I<sup>st</sup> half reaction  
 $\text{I}^- \longrightarrow \text{I}_2$  ... (i)  
 $-1 \quad 0$  (oxidation)  
 II<sup>nd</sup> half reaction  
 $\text{IO}_3^- \longrightarrow \text{I}_2$  ... (ii)  
 $+5 \quad 0$  (reduction)  
 On balancing equation (ii) we have  
 $10\text{e}^- + 2\text{IO}_3^- + 12\text{H}^+ \longrightarrow \text{I}_2 + 6\text{H}_2\text{O}$  ... (iii)  
 Now, balance equation (i)  
 $2\text{I}^- \longrightarrow \text{I}_2 + 2\text{e}^-$  .... (iv)  
 Multiply eqn (iv) by 5 and add it to eqn (iii), we get  
 $2\text{IO}_3^- + 10\text{I}^- + 12\text{H}^+ \longrightarrow 6\text{I}_2 + 6\text{H}_2\text{O}$   
 or,  $\text{IO}_3^- + 5\text{I}^- + 6\text{H}^+ \longrightarrow 3\text{I}_2 + 3\text{H}_2\text{O}$   
 Hence  $a = 5$ ,  $b = 6$ ,  $c = 3$ ,  $d = 3$
- 104. (a)** Both Fe(ii) and S(iv) in  $\text{SO}_3^{2-}$  can be oxidised to Fe(iii) and  $(\text{SO}_4)^{2-}$  respectively hence  $(3/5) \times 0.5 = 0.3$  moles / litre.

- $$\left[ \text{MnO}_4^- + 5\text{e}^- + 8\text{H}^+ \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O} \right] \times \frac{3}{5}$$
- $$\text{Fe}^{2+} \longrightarrow \text{Fe}^{3+} + \text{e}^-$$
- $$\text{SO}_3^{2-} \longrightarrow \text{SO}_4^{2-} + 2\text{e}^-$$
- 
- $$\frac{8}{5}\text{MnO}_4^- + \frac{24}{5}\text{H}^+ + \text{Fe}^{2+} + \text{SO}_3^{2-}$$
- $$\longrightarrow 3\text{Mn}^{2+} + 4\text{H}_2\text{O} + \text{Fe}^{3+} + \text{SO}_4^{2-}$$
- 105. (b)** If one uses HCl, HBr or HI, to make acidic medium for  $\text{KMnO}_4$  than all the halide ion can be oxidized as the reduction potential of  $\text{KMnO}_4$  is very high in acidic medium, while in case of  $\text{H}_2\text{SO}_4$ , sulphur is already in its highest oxidation state cannot be further oxidized.
- 106. (d)** Reduction potential of Cu(II) is greater than that of Zn(II) and Al(III) thus can be easily replaced by these ions. Moreover solution of copper is blue in color.
- 107. (d)**  $\text{F}_2$  is strongest oxidizing agent among halogens thus  $\text{X}^-$  can be possibly  $\text{Br}^-$ ,  $\text{Cl}^-$  or  $\text{I}^-$ .




### FACT/DEFINITION TYPE QUESTIONS

- Following are some properties of hydrogen which of the following properties resemble with alkali metals and which with halogens
  - Hydrogen lose one electron to form unipositive ions
  - Hydrogen gain one electron to form uninegative ions
  - Hydrogen forms oxides, halides and sulphides
  - Hydrogen has a very high ionization enthalpy
  - Hydrogen forms a diatomic molecule, combines with elements to form hydrides and covalent compounds.
  - Alkali metals resemble (i), (iii) and (iv)  
Halogens resemble (ii) and (v)
  - Alkali metals resemble (i) and (iii)  
Halogens resemble (ii), (iii) and (v)
  - Alkali metals resemble (i) and (iii)  
Halogens resemble (ii), (iv) and (v)
  - Alkali metals resemble (i) only  
Halogens resemble (iv) and (v)
- Hydrogen molecules differs from chlorine molecule in the following respect
  - Hydrogen molecule is non-polar but chlorine molecule is polar
  - Hydrogen molecule is polar while chlorine molecule is non-polar
  - Hydrogen molecule can form intermolecular hydrogen bonds but chlorine molecule does not
  - Hydrogen molecule cannot participate in coordination bond formation but chlorine molecule can
- Hydrogen can behave as a metal
  - at very high temperature
  - at very low temperature
  - at very high pressure
  - at very low pressure
- The property of hydrogen which distinguishes it from alkali metals is
  - its electropositive character
  - its affinity for non metal
  - its reducing character
  - its non-metallic character
- Hydrogen accepts an electron to form inert gas configuration. In this it resembles
  - halogen
  - alkali metals
  - chalcogens
  - alkaline earth metals
- Which of the following statements is correct ?
  - Hydrogen has same IP as alkali metals
  - Hydrogen has same electronegativity as halogens
  - It has oxidation number of  $-1$  and  $+1$
  - It will not be liberated at anode
- Why does  $H^+$  ion always get associated with other atoms or molecules?
  - Ionisation enthalpy of hydrogen resembles that of alkali metals.
  - Its reactivity is similar to halogens.
  - It resembles both alkali metals and halogens.
  - Loss of an electron from hydrogen atom results in a nucleus of very small size as compared to other atoms or ions. Due to small size it cannot exist free.
- Which one of the following is not an isotope of hydrogen ?
  - Deuterium
  - Tritium
  - Ortho hydrogen
  - None of these
- Number of neutrons in three isotopes of hydrogen, protium, deuterium and tritium respectively is
  - 0, 1, 2
  - 1, 1, 1
  - 2, 1, 0
  - 2, 0, 1
- Which isotope(s) of hydrogen is/are radioactive and emits low energy  $\beta^-$  particles?
  - Protium
  - Tritium
  - Deuterium
  - (i) and (ii)
  - (iii) only
  - (ii) only
  - (ii) and (iii)
- Hydrogen bond energy is equal to :
  - 3-7 cal
  - 30-70 cal
  - 3-10 kcal
  - 30-70 kcal
- Which of the following reaction(s) represents commercial method for production of dihydrogen?
  - $CO(g) + H_2O(g) \xrightarrow[\text{catalyst}]{673K} CO_2(g) + H_2(g)$
  - $2H_2O(l) \xrightarrow[\text{traces of acid/base}]{\text{electrolysis}} 2H_2(g) + O_2(g)$
  - $Zn + 2H^+ \longrightarrow Zn^{2+} + H_2$
  - $CH_4(g) + H_2O(g) \xrightarrow[Ni]{1270K} CO(g) + 3H_2(g)$
  - (i), (ii) and (iii)
  - (iii) only
  - (i), (ii) and (iv)
  - (ii), (iii) and (iv)

13. Which of the following is formed when zinc reacts with sodium hydroxide?  
 (a) Hydrogen gas (b) Sodium zincate  
 (c) Zinc oxide (d) Both (a) and (b)
14. Identify  $x$  and  $y$  in following reaction. What is the mixture of  $x$  and  $y$  called?  

$$\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \xrightarrow[\text{Ni}]{1270\text{K}} x + y$$
  
 (a)  $x = \text{CO}_2$ ,  $y = \text{H}_2\text{O}$ , water gas  
 (b)  $x = \text{CO}$ ,  $y = \text{H}_2\text{O}$ , syn gas  
 (c)  $x = \text{CO}$ ,  $y = \text{H}_2$ , water gas  
 (d)  $x = \text{CO}_2$ ,  $y = \text{H}_2$ , syn gas
15. Why is water gas (mixture of  $\text{CO}$  and  $\text{H}_2$ ) also called 'syn gas'?  
 (a) Because it is synthesised from sewage, saw – dust, scrap wood etc.  
 (b) Because it is synthesised from methane gas  
 (c) Because it is used in the synthesis of methanol and a number of hydrocarbons.  
 (d) None of these
16. Which of the following statements is correct?  
 (a) Production of syngas from coal is called coal gasification.  
 (b)  $\text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \xrightarrow[\text{catalyst}]{673\text{K}} \text{CO}_2(\text{g}) + \text{H}_2(\text{g})$  represents water gas shift reaction.  
 (c)  $\text{CO}_2$  formed in water gas shift reaction is removed by scrubbing with sodium zincate solution.  
 (d) Both (a) and (b)
17. Which one of the following pairs of substances on reaction will not evolve  $\text{H}_2$  gas?  
 (a) Iron and  $\text{H}_2\text{SO}_4$  (aqueous)  
 (b) Iron and steam  
 (c) Copper and  $\text{HCl}$  (aqueous)  
 (d) Sodium and ethyl alcohol
18. Which of the following metal evolves hydrogen on reacting with cold dilute  $\text{HNO}_3$ ?  
 (a) Mg (b) Al  
 (c) Fe (d) Cu
19. Hydrogen is evolved by the action of cold dil.  $\text{HNO}_3$  on  
 (a) Fe (b) Mn  
 (c) Cu (d) Al
20. In Bosch's process which gas is utilised for the production of hydrogen gas?  
 (a) Producer gas (b) Water gas  
 (c) Coal gas (d) None of these
21. Hydrogen is not obtained when zinc reacts with  
 (a) Cold water (b) dil.  $\text{HCl}$   
 (c) dil.  $\text{H}_2\text{SO}_4$  (d) Hot  $\text{NaOH}$  (20%)
22. Which one of the following pairs of substances will not produce hydrogen when reacted together?  
 (a) Copper and conc. nitric acid  
 (b) Ethanol and metallic sodium  
 (c) Magnesium and steam  
 (d) Phenol and metallic sodium
23. Very pure hydrogen (99.9) can be made by which of the following processes?  
 (a) Reaction of methane with steam  
 (b) Mixing natural hydrocarbons of high molecular weight  
 (c) Electrolysis of water  
 (d) Reaction of salts like hydrides with water
24. Which of the following is formed on reaction of carbon monoxide gas with dihydrogen in presence of cobalt as a catalyst?  
 (a) Methanal (b) Methanol  
 (c) Methane (d) Formic acid
25. Which of the following is not a use of dihydrogen?  
 (a) It used in fuel cells for generating electrical energy.  
 (b) Atomic hydrogen and oxy-hydrogen torches are used for cutting and welding purposes.  
 (c) It used in the synthesis of hydroquinone and tartaric acid.  
 (d) Both (b) and (c)
26. Elements of which of the following group do not form hydrides?  
 (a) Alkali metals (b) Halogens  
 (c) Alkaline earth metals (d) Noble gases
27. Which of the following statements is incorrect?  
 (a) Ionic hydrides are stoichiometric compounds of dihydrogen formed with most of  $s$ -block elements  
 (b) Ionic hydrides are crystalline, non-volatile and non-conducting in solid state.  
 (c) Melts of ionic hydrides conduct electricity and liberate dihydrogen gas at cathode.  
 (d) Both (a) and (c)
28. Saline hydrides react explosively with water, such fires can be extinguished by  
 (a) water (b) carbon dioxide  
 (c) sand (d) None of these
29. Choose the correct option for following hydrides.  $\text{B}_2\text{H}_6$ ,  $\text{CH}_4$ ,  $\text{NH}_3$  and  $\text{HF}$   
 (a) Electron deficient hydride =  $\text{B}_2\text{H}_6$  and  $\text{HF}$   
 Electron precise hydride =  $\text{CH}_4$   
 Electron rich hydride =  $\text{NH}_3$   
 (b) Electron deficient hydride =  $\text{B}_2\text{H}_6$   
 Electron precise hydride =  $\text{CH}_4$   
 Electron rich hydride =  $\text{NH}_3$  and  $\text{HF}$   
 (c) Electron deficient hydride =  $\text{CH}_4$   
 Electron precise hydride =  $\text{B}_2\text{H}_6$   
 Electron rich hydride =  $\text{NH}_3$  and  $\text{HF}$   
 (d) Electron deficient hydride =  $\text{CH}_4$  and  $\text{HF}$   
 Electron precise =  $\text{B}_2\text{H}_6$   
 Electron rich hydride =  $\text{NH}_3$ ,
30. Elements of which of the following group(s) of periodic table do not form hydrides.  
 (a) Groups 7, 8, 9 (b) Group 13  
 (c) Groups 15, 16, 17 (d) Group 14
31. Which hydride is an ionic hydride?  
 (a)  $\text{H}_2\text{S}$  (b)  $\text{TiH}_{1.73}$   
 (c)  $\text{NH}_3$  (d)  $\text{NaH}$

- (c)  (d) None of these

52. The process used for the removal of hardness of water is  
 (a) Calgon (b) Baeyer  
 (c) Serpeck (d) Hoope
53. When zeolite (hydrated sodium aluminium silicate) is treated with hard water the sodium ions are exchanged with  
 (a)  $H^+$  ions (b)  $Ca^{2+}$  ions  
 (c)  $SO_4^{2-}$  ions (d)  $OH^-$  ions
54. Calgon used as a water softener is  
 (a)  $Na_2[Na_4(PO_3)_6]$  (b)  $Na_4[Na_2(PO_3)_6]$   
 (c)  $Na_4[Na_4(PO_4)_5]$  (d)  $Na_4[Na_2(PO_4)_6]$
55. Polyphosphates are used as water softening agents because they  
 (a) form soluble complexes with anionic species  
 (b) precipitate anionic species  
 (c) forms soluble complexes with cationic species  
 (d) precipitate cationic species
56. Permanent hardness of water can be removed by adding Calgon ( $NaPO_3$ )<sub>n</sub>. This is an example of  
 (a) Adsorption (b) Exchange of ion  
 (c) Precipitation (d) None
57. Which one the following removes temporary hardness of water ?  
 (a) Slaked lime (b) Plaster of Paris  
 (c) Epsom (d) Hydrolith
58. Permanent hardness of water is due to the presence of  
 (a) bicarbonates of sodium and potassium  
 (b) chlorides and sulphates of sodium and potassium  
 (c) chlorides and sulphates of calcium and magnesium  
 (d) bicarbonates of calcium and magnesium
59. In lab  $H_2O_2$  is prepared by  
 (a) Cold  $H_2SO_4 + BaO_2$  (b)  $HCl + BaO_2$   
 (c) Conc.  $H_2SO_4 + Na_2O_2$  (d)  $H_2 + O_2$
60. HCl is added to following oxides. Which one would give  $H_2O_2$   
 (a)  $MnO_2$  (b)  $PbO_2$   
 (c)  $BaO$  (d) None
61. The oxide that gives  $H_2O_2$  on treatment with dilute  $H_2SO_4$  is—  
 (a)  $PbO_2$  (b)  $BaO_2$   
 (c)  $MnO_2$  (d)  $TiO_2$
62. 30 volume hydrogen peroxide means  
 (a) 30% of  $H_2O_2$  solution  
 (b) 30 cm<sup>3</sup> solution contains 1g of  $H_2O_2$   
 (c) 1 cm<sup>3</sup> of solution liberates 30 cm<sup>3</sup> of  $O_2$  at STP  
 (d) 30 cm<sup>3</sup> of solution contains 1 mole of  $H_2O_2$
63. The volume strength of 1.5 N  $H_2O_2$  solution is :  
 (a) 8.4 (b) 8.0  
 (c) 4.8 (d) 3.0
64. Commercial 10 volume  $H_2O_2$  is a solution with a strength of approximately  
 (a) 15% (b) 3%  
 (c) 1% (d) 10%
65. The structure of  $H_2O_2$  is  
 (a) planar (b) non planar  
 (c) spherical (d) linear
66. The O – O – H bond angle in  $H_2O_2$  is  
 (a) 106° (b) 109°28'  
 (c) 120° (d) 94.8°
67. Which of the following is the true structure of  $H_2O_2$  ?  
 (a)  $H-O-O-H$  (b)  $\begin{array}{c} H \\ | \\ O-O \\ | \\ H \end{array}$   
 (c)  $\begin{array}{c} H & & \\ & \diagdown & \diagup \\ & O=O \end{array}$  (d)  $\begin{array}{c} H & & \\ & \diagdown & \diagup \\ & O \leftarrow O \end{array}$
68. In the hydrogen peroxide molecule :  
 (a) O – H bonds are polar but molecule is non-polar.  
 (b) The four atoms are arranged in a non-linear and non-planar manner.  
 (c) All the four atoms are in same plane.  
 (d) Two hydrogen atoms are connected to one of the oxygen.
69.  $H_2O_2$  is a  
 (a) Weak acid (b) Weak base  
 (c) Neutral (d) None of these
70. When  $H_2O_2$  is oxidised the product is  
 (a)  $OH^-$  (b)  $O_2$   
 (c)  $O^{2-}$  (d)  $HO_2^-$
71. Which of the following is false about  $H_2O_2$   
 (a) Act as both oxidising and reducing agent  
 (b) Two OH bonds lies in the same plane  
 (c) Pale blue liquid  
 (d) Can be oxidised by ozone
72. In which of the following reactions,  $H_2O_2$  acts as a reducing agent  
 (a)  $PbO_2(s) + H_2O_2(aq) \rightarrow PbO(s) + H_2O(l) + O_2(g)$   
 (b)  $Na_2SO_3(aq) + H_2O_2(aq) \rightarrow Na_2SO_4(aq) + H_2O(l)$   
 (c)  $2KI(aq) + H_2O_2(aq) \rightarrow 2KOH(aq) + I_2(s)$   
 (d)  $KNO_2(aq) + H_2O_2(aq) \rightarrow KNO_3(aq) + H_2O(l)$
73.  $H_2O_2 \rightarrow 2H^+ + O_2 + 2e^-$ ;  $E^\circ = -0.68$  V. This equation represents which of the following behaviour of  $H_2O_2$ .  
 (a) Reducing (b) Oxidising  
 (c) Acidic (d) Catalytic
74. The reaction  
 $H_2S + H_2O_2 \longrightarrow S + 2H_2O$  manifests  
 (a) Acidic nature of  $H_2O_2$   
 (b) Alkaline nature of  $H_2O_2$   
 (c) Oxidising action of  $H_2O_2$   
 (d) Reducing action of  $H_2O_2$ .
75. Which of the following statements is incorrect ?  
 (a)  $H_2O_2$  can act as an oxidising agent  
 (b)  $H_2O_2$  can act as a reducing agent  
 (c)  $H_2O_2$  has acidic properties  
 (d)  $H_2O_2$  has basic properties



76. Consider the reactions  
(A)  $\text{H}_2\text{O}_2 + 2\text{HI} \rightarrow \text{I}_2 + 2\text{H}_2\text{O}$   
(B)  $\text{HOCl} + \text{H}_2\text{O}_2 \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^- + \text{O}_2$   
Which of the following statements is correct about  $\text{H}_2\text{O}_2$  with reference to these reactions? Hydrogen peroxide is \_\_\_\_\_.
- an oxidising agent in both (A) and (B)
  - an oxidising agent in (A) and reducing agent in (B)
  - a reducing agent in (A) and oxidising agent in (B)
  - a reducing agent in both (A) and (B)
77. Which of the following equations depict the oxidising nature of  $\text{H}_2\text{O}_2$ ?
- $2\text{MnO}_4^- + 6\text{H}^+ + 5\text{H}_2\text{O}_2 \rightarrow 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 5\text{O}_2$
  - $2\text{Fe}^{3+} + 2\text{H}^+ + \text{H}_2\text{O}_2 \rightarrow 2\text{Fe}^{2+} + 2\text{H}_2\text{O} + \text{O}_2$
  - $2\text{I}^- + 2\text{H}^+ + \text{H}_2\text{O}_2 \rightarrow \text{I}_2 + 2\text{H}_2\text{O}$
  - $\text{KIO}_4 + \text{H}_2\text{O}_2 \rightarrow \text{KIO}_3 + \text{H}_2\text{O} + \text{O}_2$
78. Which one of the following undergoes reduction with hydrogen peroxide in an alkaline medium?
- $\text{Mn}^{2+}$
  - $\text{HOCl}$
  - $\text{PbS}$
  - $\text{I}_2$
79. Which of the following does not represent reducing action of  $\text{H}_2\text{O}_2$ ?
- $\text{PbS(s)} + 4\text{H}_2\text{O}_2(\text{aq}) \rightarrow \text{PbSO}_4(\text{s}) + 4\text{H}_2\text{O(l)}$
  - $\text{HOCl} + \text{H}_2\text{O}_2 \rightarrow \text{H}_3\text{O}^+ + \text{Cl}^- + \text{O}_2$
  - $2\text{MnO}_4^- + 3\text{H}_2\text{O}_2 \rightarrow 2\text{MnO}_2 + 3\text{O}_2 + 2\text{H}_2\text{O} + 2\text{OH}^-$
  - $\text{I}_2 + \text{H}_2\text{O}_2 + 2\text{OH}^- \rightarrow 2\text{I}^- + 2\text{H}_2\text{O} + \text{O}_2$
80. Which of the following is not true for hydrogen peroxide?
- $\text{H}_2\text{O}_2$  decomposes slowly on exposure to light.
  - It is kept away from dust because dust can induce explosive decomposition of the compound.
  - $\text{H}_2\text{O}_2$  is used as bleaching agent for textiles, paper pulp etc.
  - It is used as a moderator in nuclear reactor.
81. The decomposition of  $\text{H}_2\text{O}_2$  is accelerated by –
- glycerine
  - alcohol
  - phosphoric acid
  - Pt powder
82.  $\text{H}_2\text{O}_2$  is always stored in black bottles because
- It is highly unstable
  - Its enthalpy of decomposition is high
  - It undergo auto-oxidation on prolonged standing
  - None of these
83.  $\text{H}_2\text{O}_2$  is
- Poor polar solvent than water
  - Better polar solvent than  $\text{H}_2\text{O}$
  - Both have equal polarity
  - Better polar solvent but its strong auto-oxidising ability limits its use as such
84. Which of the following is wrong about  $\text{H}_2\text{O}_2$ ? It is used
- As aerating agent in production of spong rubber
  - As an antichlor
  - For restoring white colour of blackened lead painting
  - None of these
85. Heavy water is represented as
- $\text{H}_2^{18}\text{O}$
  - $\text{D}_2\text{O}$
  - $\text{D}_2^{18}\text{O}$
  - $\text{H}_2\text{O}$  at  $4^\circ\text{C}$
86. What is formed when calcium carbide reacts with heavy water?
- $\text{C}_2\text{D}_2$
  - $\text{CaD}_2$
  - $\text{Ca}_2\text{D}_2\text{O}$
  - $\text{CD}_2$
87.  $\text{D}_2\text{O}$  is used in
- motor vehicles
  - nuclear reactor
  - medicine
  - insecticide
88. Complete the following reaction.  
 $\text{Al}_4\text{C}_3 + \text{D}_2\text{O} \rightarrow x + y$
- $x = \text{C}_2\text{D}_2$  and  $y = \text{Al(OD)}_3$
  - $x = \text{CD}_4$  and  $y = \text{Al(OD)}_3$
  - $x = \text{CO}_2$  and  $y = \text{Al}_2\text{D}_3$
  - $x = \text{CD}_4$  and  $y = \text{Al}_2\text{D}_3$
89. Which of the following is correct about heavy water ?
- Water at  $4^\circ\text{C}$  having maximum density is known as heavy water
  - It is heavier than water ( $\text{H}_2\text{O}$ )
  - It is formed by the combination of heavier isotope of hydrogen with oxygen
  - None of these
90.  $\text{D}_2\text{O}$  is preferred to  $\text{H}_2\text{O}$ , as a moderator, in nuclear reactors because
- $\text{D}_2\text{O}$  slows down fast neutrons better
  - $\text{D}_2\text{O}$  has high specific heat
  - $\text{D}_2\text{O}$  is cheaper
  - None of these
91. The numbers of protons, electrons and neutrons in a molecule of heavy water are respectively :
- 8, 10, 11
  - 10, 10, 10
  - 10, 11, 10
  - 11, 10, 10
92. Choose the incorrect statement
- Dihydrogen can release more energy than petrol.
  - The only pollutant in combustion of dihydrogen is carbon dioxide.
  - Hydrogen economy is based on the principle of transportation and storage of energy in the form of liquid or gaseous dihydrogen
  - Hydrogen economy has advantage that energy is transmitted in the form of dihydrogen and not as electric power.
93. Which of the following fuel is used for running the automobiles first time in the history of India during October 2005?
- $\text{D}_2\text{O}$
  - $\text{H}_2\text{O}_2$
  - $\text{D}_2$
  - $\text{H}_2$

### STATEMENT TYPE QUESTIONS

94. The storage tanks used for  $\text{H}_2$  are made up of which metal alloy(s)
- $\text{NaNi}_5$
  - $\text{B}_2\text{H}_6$
  - $\text{Ti-TiH}_2$
  - $\text{Mg-MgH}_2$
- (iii) and (iv)
  - (i) and (ii)
  - (i), (iii) and (iv)
  - (ii), (iii) and (iv)

95. Which of the following sequence of T and F is correct for given statements? Here T stands for true and F stands for false statement

- (i) The H-H bond dissociation enthalpy is highest for a single bond between two atoms of any element
- (ii)  $H_2$  is relatively inert at room temperature.
- (iii) Hydrogen combines with almost all the elements due to its incomplete orbital
- (iv) The atomic hydrogen is produced at high temperature in an electric arc or under UV radiations.
- (a) TTTT (b) FTFT
- (c) FTTT (d) FTTF

96. Which of the following statement(s) is/are incorrect?

- (i) Dihydrogen reduces copper (II) oxide to copper
- (ii) Reaction of dihydrogen with sodium gives sodium hydride.
- (iii) Hydroformylation of olefins yields aldehydes which further undergo reduction to give alcohols.
- (iv) Hydrogenation of vegetable oils using iron as catalyst gives edible fats.
- (a) (i), (ii) and (iii) (b) (i) and (iv)
- (c) (iv) only (d) (iii) and (iv)

97. Choose the correct sequence of T and F for following statements. Here T stands for true and F stands for false statement.

- (i) At atmospheric pressure ice crystallises in the hexagonal form, but at very low temperatures it condenses to cubic form.
- (ii) Density of ice is less than that of water. Therefore, an ice cube floats on water.
- (iii) In winter season ice formed on the surface of a lake makes survival of the aquatic life difficult.
- (iv) Hydrogen bonding gives ice a open type structure with wide holes.
- (a) TTFT (b) FTFT
- (c) FTTT (d) TFFT

98. Which of the following statements are correct ?

- (i) Hydrogen peroxide is industrially prepared by the auto-oxidation of 2-alkylanthraquinols
- (ii) One millilitre of 30%  $H_2O_2$  means that solution will give 100 V of oxygen at STP
- (iii) Dihedral angle of  $H_2O_2$  in gas phase is  $90.2^\circ$  and in solid phase dihedral angle is  $111.5^\circ$
- (a) (i), (ii) and (iii) (b) (i) and (iii)
- (c) (ii) and (iii) (d) (i) and (ii)

99. Some statements about heavy water are given below:

- (i) Heavy water is used as a moderator in nuclear reactors.
- (ii) Heavy water is more associated than ordinary water.
- (iii) Heavy water is more effective solvent than ordinary water.

Which of the above statements are correct?

- (a) (i) and (iii) (b) (i) and (ii)
- (c) (i), (ii) and (iii) (d) (ii) and (iii)

### MATCHING TYPE QUESTIONS

100. Match the columns

Column-I	Column-II
(A) Ionic hydrides	(p) $NiH_{0.6-0.7}$
(B) Molecular hydrides	(q) LiH
(C) Metallic hydrides	(r) HF
(a) A - (q), B - (r), C - (p)	
(b) A - (r), B - (q), C - (p)	
(c) A - (q), B - (p), C - (r)	
(d) A - (r), B - (p), C - (q)	

101. Match the columns

Column - I (Chemical property of water)	Column - II (Chemical equation)
(A) Basic nature	(p) $2H_2O(l) + 2Na(s) \longrightarrow 2NaOH(aq) + H_2(g)$
(B) Auto-protolysis	(q) $H_2O(l) + H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$
(C) Oxidising nature	(r) $2F_2(g) + 2H_2O(l) \longrightarrow 4H^+(aq) + 4F^-(aq) + O_2(g)$
(D) Reducing nature	(s) $H_2O(l) + H_2S(aq) \rightleftharpoons H_3O^+(aq) + HS^-(aq)$
(a) A - (s), B - (q), C - (r), D - (p)	
(b) A - (s), B - (q), C - (p), D - (r)	
(c) A - (r), B - (q), C - (s), D - (p)	
(d) A - (p), B - (q), C - (s), D - (r)	

102. Match the columns

Column-I	Column-II
(A) Clark's method	(p) $Mg(HCO_3)_2 + 2Ca(OH)_2 \rightarrow 2CaCO_3 \downarrow + Mg(OH)_2 \downarrow + 2H_2O$
(B) Calgon's method	(q) $2NaZ(s) + M^{2+}(aq) \rightarrow MZ_2(s) + 2Na^+(aq)$
(C) Boiling	(r) $Ca(HCO_3)_2 \rightarrow CaCO_3 \downarrow + H_2O + CO_2 \uparrow$
(D) Ion exchange method	(s) $M^{2+} + Na_4P_6O_{18}^{2-} \rightarrow [Na_2MP_6O_{18}]^{2-} + 2Na^+$
(a) A - (s), B - (q), C - (r), D - (p)	
(b) A - (q), B - (p), C - (r), D - (s)	
(c) A - (p), B - (s), C - (r), D - (q)	
(d) A - (r), B - (q), C - (p), D - (s)	

103. Match the columns

Column-I	Column-II
(A) Coordinated water	(p) $[Cu(H_2O)_4]^{2+} SO_4^{2-} \cdot H_2O$
(B) Interstitial water	(q) $C_{17}H_{35}COONa$
(C) Hydrogen-bonded water	(r) $BaCl_2 \cdot 2H_2O$
	(s) $[Cr(H_2O)_6]^{3+} 3Cl^-$
(a) A - (r), B - (s), C - (q)	
(b) A - (q), B - (r), C - (s)	
(c) A - (r), B - (q), C - (p)	
(d) A - (s), B - (r), C - (p)	

104. Match the columns

**Column-I**

(A) Heavy water

(B) Temporary hard water

(C) Soft water

(D) Permanent hard water

**Column-II**

(p) Bicarbonates of Mg and Ca in water

(q) No foreign ions in water

(r)  $D_2O$ 

(s) Sulphates &amp; chlorides of Mg &amp; Ca in water

(a) A – (r), B – (s), C – (q), D – (p)

(b) A – (q), B – (r), C – (s), D – (s)

(c) A – (q), B – (s), C – (r), D – (p)

(d) A – (r), B – (p), C – (q), D – (s)

105. Match the Column-I with Column-II and mark the appropriate choice.

**Column-I**

(A) Syngas

(B) Calgon

(C) Permutit

(D) Producer gas

**Column-II**(p)  $Na_6P_6O_{18}$ (q)  $NaAlSiO_4$ (r)  $CO + H_2$ (s)  $CO + N_2$ 

(a) (A) – (p), (B) – (q), (C) – (r), (D) – (s)

(b) (A) – (r), (B) – (p), (C) – (q), (D) – (s)

(c) (A) – (r), (B) – (q), (C) – (s), (D) – (p)

(d) (A) – (r), (B) – (q), (C) – (p), (D) – (s)

**ASSERTION-REASON TYPE QUESTIONS**

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion

(c) Assertion is correct, reason is incorrect

(d) Assertion is incorrect, reason is correct.

106. **Assertion :**  $H^+$  does not exist freely and is always associated with other atoms or molecules.

**Reason :** Loss of the electron from hydrogen atom results in nucleus ( $H^+$ ) of  $\sim 1.5 \times 10^{-3}$  pm size. This is extremely small as compared to normal atomic and ionic sizes of 50 to 200 pm.

107. **Assertion :** Hydrogen combines with other elements by losing, gaining or sharing of electrons.

**Reason :** Hydrogen forms electrovalent and covalent bonds with other elements.

108. **Assertion :** Temporary hardness can be removed by boiling.

**Reason :** On boiling the soluble bicarbonates change to carbonates which being insoluble, get precipitated.

109. **Assertion :** Calgon is used for removing permanent hardness of water.

**Reason :** Calgon forms precipitates with  $Ca^{2+}$  and  $Mg^{2+}$ .

110. **Assertion :** Hard water is not suitable for laundry.

**Reason :** Soap containing sodium stearate reacts with hard water to precipitate out as calcium or magnesium stearate.

111. **Assertion :** Decomposition of  $H_2O_2$  is a disproportionation reaction.

**Reason :**  $H_2O_2$  molecule simultaneously undergoes oxidation and reduction.

112. **Assertion :**  $H_2O_2$  is not stored in glass bottles.

**Reason :** Alkali oxides present in glass catalyse the decomposition of  $H_2O_2$

**CRITICAL THINKING TYPE QUESTIONS**

113. Hydrogen will not reduce

(a) heated cupric oxide (d) heated ferric oxide

(c) heated stannic oxide (d) heated aluminium oxide

114. Which of the following terms is not correct for hydrogen ?

(a) Its molecule is diatomic

(b) It exists both as  $H^+$  and  $H^-$  in different chemical compounds

(c) It is the only species which has no neutrons in the nucleus

(d) Heavy water is unstable because hydrogen is substituted by its isotope deuterium

115. The sum of the number of neutrons and protons in all the three isotopes of hydrogen is

(a) 6

(b) 5

(c) 4

(d) 3

116. The hydride ion,  $H^-$ , is a stronger base than the hydroxide ion,  $OH^-$ . Which one of the following reactions will occur if sodium hydride (NaH) is dissolved in water?

(a)  $H^-(aq) + H_2O(l) \rightarrow H_3O^-(aq)$

(b)  $H^-(aq) + H_2O(l) \rightarrow OH^-(aq) + H_2(g)$

(c)  $H^-(aq) + H_2O(l) \rightarrow OH^-(aq) + 2H^+(aq) + 2e^-$

(d)  $H^-(aq) + H_2O(l) \rightarrow$  No reaction

117. The reaction of  $H_2S + H_2O_2 \rightarrow S + 2H_2O$  manifests

(a) Acidic nature of  $H_2O_2$

(b) Alkaline nature of  $H_2O_2$

(c) Oxidising nature of  $H_2O_2$

(d) Reducing action of  $H_2O_2$

118. Which of the following is not true?

(a)  $D_2O$  freezes at lower temperature than  $H_2O$

(b) Reaction between  $H_2$  and  $Cl_2$  is much faster than  $D_2$  and  $Cl_2$

(c) Ordinary water gets electrolysed more rapidly than  $D_2O$

(d) Bond dissociation energy of  $D_2$  is greater than  $H_2$

119. Heavy water reacts respectively with  $CO_2$ ,  $SO_3$ ,  $P_2O_5$  and  $N_2O_5$  to give the compounds :

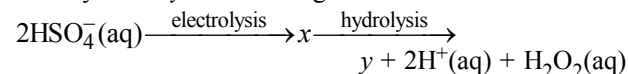
(a)  $D_2CO_3$ ,  $D_2SO_4$ ,  $D_3PO_2$ ,  $DNO_2$

(b)  $D_2CO_3$ ,  $D_2SO_4$ ,  $D_3PO_4$ ,  $DNO_2$

(c)  $D_2CO_3$ ,  $D_2SO_3$ ,  $D_3PO_4$ ,  $DNO_2$

(d)  $D_2CO_3$ ,  $D_2SO_4$ ,  $D_3PO_4$ ,  $DNO_3$

120. Identify  $x$  and  $y$  in following reaction:



(a)  $x = H_2SO_4(aq)$ ,  $y = 2HSO_4^-(aq)$

(b)  $x = HO_3SOOSO_3H(aq)$ ,  $y = 2HSO_4^-(aq)$

(c)  $x = HO_3SOOSO_3H(aq)$ ,  $y = H_2SO_4(aq)$

(d)  $x = H_2SO_4(aq)$ ,  $y = HO_3SOOSO_3H(aq)$

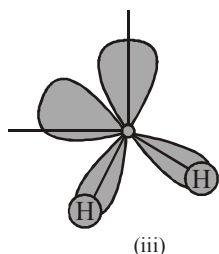
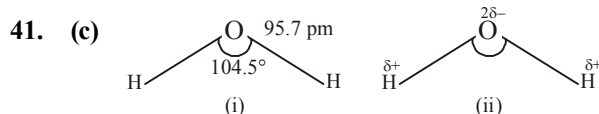
# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (c) (i) and (iii) are properties of hydrogen which shows its resemblance with alkali metals whereas (ii), (iv) and (v) shows resemblance with halogens.
2. (d) Chlorine has lone pair which it can donate to form coordinate bond while hydrogen cannot.
3. (c) Hydrogen behaves as a metal at very high pressure.
4. (d) Hydrogen is a non-metal while all other members of group 1 (alkali metals) are metals.
5. (a)  $\text{H} + \text{e}^- (1s^1) \rightarrow \text{H}^- (1s^2 \text{ or } [\text{He}]^1)$   
 $\text{F} + \text{e}^- ([\text{He}]2s^2 2p^5) \rightarrow \text{F}^- ([\text{He}] 2s^2 2p^6 \text{ or } [\text{Ne}])$
6. (c) In metal hydrides the O.S. of hydrogen -1 otherwise it is +1.
7. (d)
8. (c) (i) Protium, deuterium and tritium are isotopes of hydrogen.  
 (ii) Ortho and para hydrogens are allotropes of hydrogen. In ortho hydrogen, protons are spinning in same direction (parallel spin), while in para hydrogen, protons spin in opposite direction (antiparallel).
9. (a) Number of neutrons in protium, deuterium and tritium respectively is = 0, 1 and 2
10. (c) Tritium is radioactive and emits low energy  $\beta^-$  particles.
11. (c) Hydrogen bond is weak force of attraction existing between molecules. Its energy is equal to 3-10 k cal
12. (c) Except method given in statement (iii) all other are commercial methods for production of dihydrogen.
13. (d)  $\text{Zn} + 2\text{NaOH} \longrightarrow \text{Na}_2\text{ZnO}_2 + \text{H}_2$   
 (Sodium zincate)
14. (c)  $\text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g}) \xrightarrow[\text{Ni}]{1270\text{K}} \text{CO} + 3\text{H}_2$   
 Mixture of CO and  $\text{H}_2$  is called water gas.
15. (c) Mixture of CO and  $\text{H}_2$  is used in synthesis of methanol and a number of hydrocarbons due to this reason it is also called syn gas.
16. (d) Carbon dioxide formed in water gas shift reaction is removed by scrubbing with sodium arsenite solution.
17. (c)  $\text{Fe} + \text{dil. H}_2\text{SO}_4 \rightarrow \text{FeSO}_4 + \text{H}_2 \uparrow$   
 $3\text{Fe} + 4\text{H}_2\text{O} \xrightarrow{\text{Steam}} \text{Fe}_3\text{O}_4 + 4\text{H}_2 \uparrow$   
 $\text{Cu} + \text{dil. HCl} \rightarrow \text{No reaction}$   
 Copper does not evolve  $\text{H}_2$  from acid as it is below hydrogen in electrochemical series.  
 $2\text{Na} + 2\text{C}_2\text{H}_5\text{OH} \rightarrow 2\text{C}_2\text{H}_5\text{ONa} + \text{H}_2 \uparrow$
18. (a)  $\text{Mg} + \text{dil. HNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + \text{H}_2$  (Mg and Mn give  $\text{H}_2$  with dil  $\text{HNO}_3$ )
19. (b)  $\text{Mn} + 2\text{HNO}_3 (\text{dil.}) \rightarrow \text{Mn}(\text{NO}_3)_2 + \text{H}_2$
20. (b)  $\underbrace{\text{CO} + \text{H}_2}_{\text{water gas}} + \text{H}_2\text{O} \xrightarrow{\text{catalyst}} \text{CO}_2 + 2\text{H}_2$
21. (a) Zinc has no action on cold water.
22. (a)  $\text{Cu} + 4\text{HNO}_3(\text{conc.}) \longrightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$   
 $\text{C}_2\text{H}_5\text{OH} + \text{Na} \longrightarrow \text{C}_2\text{H}_5\text{O}^- \text{Na}^+ + 1/2\text{H}_2 \uparrow$   
 $\text{Mg} + 2\text{H}_2\text{O}(\text{steam}) \longrightarrow \text{Mg}(\text{OH})_2 + \text{H}_2 \uparrow$   
 $\text{C}_6\text{H}_5\text{OH} + \text{Na} \longrightarrow \text{C}_6\text{H}_5\text{O}^- \text{Na}^+ + 1/2\text{H}_2 \uparrow$   
 $\text{NaH} + \text{H}_2\text{O} \longrightarrow \text{NaOH} + \text{H}_2 \uparrow$
23. (d) Very pure hydrogen can be prepared by the action of water on sodium hydride.  
 $\text{NaH} + \text{H}_2\text{O} \longrightarrow \text{NaOH} + \text{H}_2$   
 (very pure Hydrogen)
24. (b)  $\text{CO}(\text{g}) + 2\text{H}_2(\text{g}) \xrightarrow[\text{cobalt catalyst}]{} \text{CH}_3\text{OH}(\text{l})$
25. (c) Hydrogen is not used in the synthesis of hydroquinone and tartaric acid.
26. (d) Almost all elements except noble gases, forms hydrides.
27. (c) Melts of ionic hydrides conduct electricity and liberate dihydrogen gas at anode.
28. (c) Fire due to action of water on saline hydrides cannot be extinguished with water or  $\text{CO}_2$ . These hydrides can reduce  $\text{CO}_2$  at high temperature to produce  $\text{O}_2$ .
29. (b) Electron deficient hydride =  $\text{B}_2\text{H}_6$   
 Electron precise =  $\text{CH}_4$   
 Electron rich =  $\text{NH}_3$  and  $\text{HF}$
30. (a)
31. (d) All metal hydrides are ionic in nature.
32. (d)  $\text{Metal hydride} + \text{H}_2\text{O} \rightarrow \text{Metal hydroxide} + \text{H}_2$
33. (d) Due to its covalent nature  $\text{MgH}_2$  is Polymeric in nature.
34. (c) Ionic hydrides give the basic solution when it reacts with water, e.g.,  
 $\text{LiH} + \text{H}_2\text{O} \longrightarrow \text{LiOH} + \text{H}_2$
35. (d) d- and f-block elements form metallic hydride. While p-block elements form covalent hydrides, s-block elements except Be and Mg form ionic hydrides. Hydrides of Be, Mg, Cu, Zn, Ca and Hg are intermediate hydride.
36. (b)
37. (b)  $\text{LiH} + \text{AlCl}_3 \longrightarrow (\text{AlH}_3)_n \xrightarrow[\text{LiH}]{\text{excess}} \text{Li}[\text{AlH}_4]$   
 Lithium aluminium hydride is a most useful organic reducing agent. It reduces functional groups but does not attack double bonds.



38. (a) Polarity of bond depends on difference in electronegativity of the two concerned atoms.  $\text{H}_2\text{O}$  is more polar than  $\text{H}_2\text{S}$  because oxygen (in O–H) is more electronegative than sulphur (in S–H).
39. (b) In gas phase water is a bent molecule with a bond angle of  $104.5^\circ$  and O–H bond length of 95.7 pm.
40. (d) The hybridisation in water is  $\text{sp}^3$  and bond angle  $104.5^\circ$



42. (c) The unusual properties of water in the condensed phase (liquid or solid states) are due to the presence of extensive hydrogen bonding between the water molecules.
43. (c) The high boiling point of water is due to H-bonding.
44. (b) Due to high dielectric constant, water acts as a good solvent therefore it is also called a universal solvent.
45. (b) In the structure of ice each molecule of  $\text{H}_2\text{O}$  is surrounded by three  $\text{H}_2\text{O}$  molecules in hexagonal honey comb manner which results an open cage like structure. As a result there are a number of 'hole' or open spaces. In such a structure lesser number of molecules are packed per ml. When ice melts a large no. of hydrogen bonds are broken. The molecules therefore move into the holes or open spaces and come closer to each other than they were in solid state. This result sharp increase in the density. Therefore ice has lower density than water.
46. (a) We know that due to polar nature, water molecules are held together by intermolecular hydrogen bonds. The structure of ice is open with large number of vacant spaces, therefore the density of ice is less than water.
47. (a) Two ice cubes stick to each other due to H-bonding.
48. (d)
49. (d) Sodium is most electropositive element among those given.  

$$2\text{Na} + 2\text{H}_2\text{O} \xrightarrow{\text{Room temp.}} 2\text{NaOH} + \text{H}_2$$
50. (b) Water has high dielectric constant i.e.,  $78.39 \text{ C}^2/\text{Nm}^2$ , high liquid range and can dissolve maximum number of compounds. That is why it is used as universal solvent.
51. (b) Temporary hardness is due to presence of bicarbonates of calcium and magnesium and permanent hardness is due to the sulphates and chlorides of both of calcium and magnesium.

52. (a) Calgon process is used to remove permanent hardness of water
53. (b)  $\text{Na zeolite} + \text{CaCl}_2 \rightarrow \text{Ca zeolite} + 2\text{NaCl}$
54. (a) The complex salt of metaphosphoric acid sodium hexametaphosphate ( $\text{NaPO}_3$ )<sub>6</sub>, is known as calgon. It is represented as  $\text{Na}_2[\text{Na}_4(\text{PO}_3)_6]$
55. (c) Polyphosphates (sodium hexametaphosphates, sodium tripolyphosphate or STPP) form soluble complexes with  $\text{Ca}^{+2}$ ,  $\text{Mg}^{+2}$  present in hard water.
56. (b)
57. (a) This method is known as Clark's process. In this method temporary hardness is removed by adding lime water or milk of lime.  

$$\text{Ca}(\text{OH})_2 + \text{Ca}(\text{HCO}_3)_2 \longrightarrow 2\text{CaCO}_3 \downarrow + 2\text{H}_2\text{O}$$

ppt.
58. (c) Permanent hardness of water is due to chlorides and sulphates of calcium and magnesium.
59. (a)  $\text{H}_2\text{SO}_4 + \text{BaO}_2 \rightarrow \text{BaSO}_4 + \text{H}_2\text{O}_2$
60. (d)  $\text{MnO}_2$ ,  $\text{PbO}_2$  and  $\text{BaO}$  will not give  $\text{H}_2\text{O}_2$  with  $\text{HCl}$ .  $\text{MnO}_2$  and  $\text{PbO}_2$  will give  $\text{Cl}_2$  and  $\text{BaO}$  will react with  $\text{HCl}$  to give  $\text{BaCl}_2$  and water.
61. (b)
62. (c) 30 vol of  $\text{H}_2\text{O}_2$  means one volume of  $\text{H}_2\text{O}_2$  on decomposition will give 30 volume of oxygen.
63. (a) Normality of  $\text{H}_2\text{O}_2 = \frac{\text{vol. strength}}{5.6}$   
 Volume of normal (1N)  $\text{H}_2\text{O}_2$  solution = 5.6 volumes.  
 $\therefore$  Volume of strength of 1.5 N  $\text{H}_2\text{O}_2$   
 $= 1.5 \times 5.6 = 8.4$  volumes.
64. (b) Strength of 10V  $\text{H}_2\text{O}_2 = \frac{68 \times 10}{22400} \times 100 = 3.035\%$
65. (b) Structure of  $\text{H}_2\text{O}_2$  is nonplanar
66. (d) O–O–H bond angle in  $\text{H}_2\text{O}_2$  is  $94.8^\circ$ .
67. (b) is the true structure of  $\text{H}_2\text{O}_2$ .
68. (b)
69. (a)  $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + [\text{O}]$   
 weak acid
70. (b)  $\text{H}_2\text{O}_2 + [\text{O}] \xrightarrow{\text{Oxidation}} \text{H}_2\text{O} + \text{O}_2 \uparrow$
71. (b) The value of dipole moment of  $\text{H}_2\text{O}_2$  is 2.1 D, which suggest the structure of  $\text{H}_2\text{O}_2$  cannot be planar. An open-book structure is suggested for  $\text{H}_2\text{O}_2$  in which O–H bonds lie in different plane.
72. (a) In the following reaction  $\text{H}_2\text{O}_2$  acts as a reducing agent.  

$$\text{PbO}_2(\text{s}) + \text{H}_2\text{O}_2(\text{aq}) \rightarrow \text{PbO}(\text{s}) + \text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$$
73. (a) As  $\text{H}_2\text{O}_2$  is losing electrons so it is acting as reducing agent.
74. (c)  $\text{H}_2\text{S}$  is oxidised to S by  $\text{H}_2\text{O}_2$ .
75. (d)  $\text{H}_2\text{O}_2$  does not have basic properties.
76. (b) 77. (c)



78. (b,d)  $\text{HOCl(aq)} + \text{H}_2\text{O}_2\text{(aq)} \longrightarrow$   
 $\text{H}_3\text{O}^+\text{(aq)} + \text{Cl}^-\text{(aq)} + \text{O}_2\text{(g)}$   
 $\text{I}_2\text{(s)} + \text{H}_2\text{O}_2\text{(aq)} + 2\text{OH}^-\text{(aq)} \longrightarrow$   
 $2\text{I}^-\text{(aq)} + 2\text{H}_2\text{O(l)} + \text{O}_2\text{(g)}$
79. (a) Option (a) represents oxidising action of  $\text{H}_2\text{O}_2$  in acidic medium.
80. (d)  $\text{H}_2\text{O}_2$  is not used as a moderator in nuclear reactors
81. (d) Decomposition of  $\text{H}_2\text{O}_2$  can be accelerated by finely divided metals such as Ag, Au, Pt, Co, Fe etc.
82. (c)  $\text{H}_2\text{O}_2$  is unstable liquid and decomposes into water and oxygen either on standing or on heating.
83. (d) Although  $\text{H}_2\text{O}_2$  is a better polar solvent than  $\text{H}_2\text{O}$ . However it cannot be used as such because of the strong auto-oxidation ability.
84. (d)  $\text{H}_2\text{O}_2$  show all these properties.
85. (b) The formula of heavy water (deuterium oxide) is  $\text{D}_2\text{O}$ .
86. (a)  $\text{CaC}_2 + 2\text{D}_2\text{O} \rightarrow \text{C}_2\text{D}_2 + \text{Ca(OD)}_2$
87. (b)  $\text{D}_2\text{O}$  is used in nuclear reactors as moderator.
88. (b)  $\text{Al}_4\text{C}_3 + \text{D}_2\text{O} \rightarrow 3\text{CD}_4 + 4\text{Al(OD)}_3$
89. (c) Heavy water is formed by the combination of heavier isotope ( ${}_1\text{H}^2$  or D) with oxygen.  
 $2\text{D}_2 + \text{O}_2 \rightarrow 2\text{D}_2\text{O}$   
Heavy water
90. (d)  $\text{H}_2\text{O}$  absorbs neutrons more than  $\text{D}_2\text{O}$  and this decreases the number of neutrons for the fission process.
91. (b) Heavy water is  $\text{D}_2\text{O}$  hence  
number of electrons =  $2 + 8 = 10$   
number of protons = 10  
Atomic mass of  $\text{D}_2\text{O} = 4 + 16 = 20$   
hence number of neutron  
= Atomic mass – number of protons  
=  $20 - 10 = 10$
92. (b) The only pollutant in combustion of dihydrogen is oxides of dinitrogen (due to the presence of dinitrogen as impurity with dihydrogen).
93. (d) It is for the first time in the history of India that a pilot project using dihydrogen as fuel was launched in October 2005 for running automobiles. Initially 5%  $\text{H}_2$  has been mixed in CNG for use in four wheeler vehicles.

## STATEMENT TYPE QUESTIONS

94. (c) Tanks of metal alloy like  $\text{NaNi}_5$ ,  $\text{Ti-TiH}_2$ ,  $\text{Mg-MgH}_2$  etc are used for storage of dihydrogen in small quantities.
95. (a)
96. (c) Hydrogenation occurs in presence of nickel as a catalyst.
97. (a) In winter seasons ice formed on the surface of a lake provides thermal insulation which ensures the survival of the aquatic life.
98. (d) Dihedral angle of  $\text{H}_2\text{O}_2$  in gas phase is  $111.5^\circ$  and in solid phase it is  $90.2^\circ$
99. (b)

## MATCHING TYPE QUESTIONS

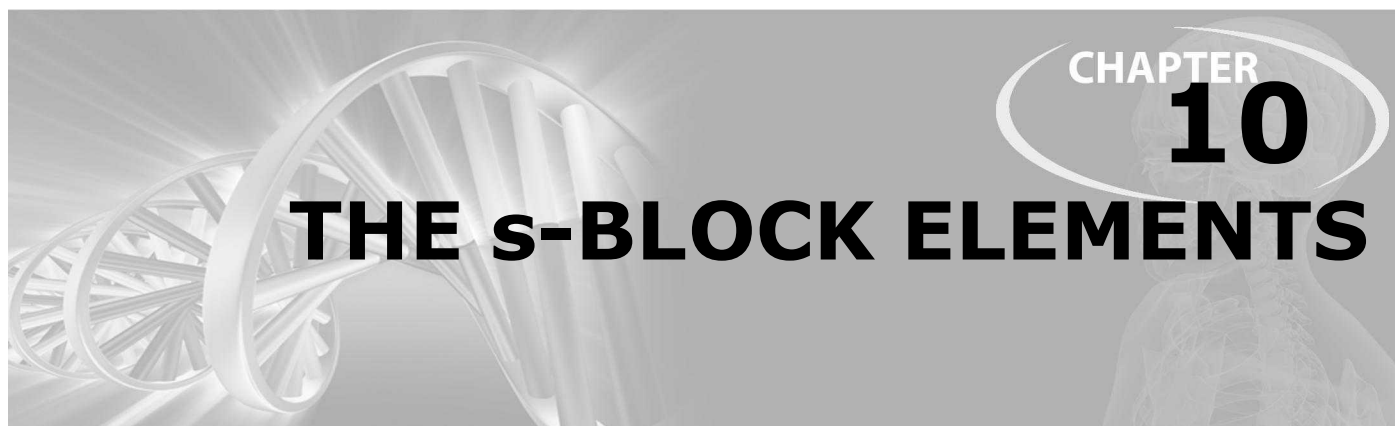
100. (a)      101. (b)      102. (c)
103. (d) Many salts can be crystallised as hydrated salts from an aqueous solutions such an association of water is of different types viz.,  
(i) Coordinated water e.g.,  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} 3\text{Cl}^-$   
(ii) Interstitial water e.g.,  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$   
(iii) Hydrogen-bonded water e.g.,  $[\text{Cu}(\text{H}_2\text{O})_4]^{4+} \text{SO}_4^{2-} \cdot \text{H}_2\text{O}$  in  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
104. (d) Heavy water is  $\text{D}_2\text{O}$  (1 – C); Temporary hard water contains the bi-carbonates of Mg and Ca (2 – A); Soft water contains no foreign ions (3 – B); Permanent hard water contains the sulphates and chlorides of Mg and Ca (4 – D) therefore the answer is D.
105. (b)

## ASSERTION-REASON TYPE QUESTIONS

106. (a) Due to extremely small size of  $\text{H}^+$  as compared to normal atomic and ionic size  $\text{H}^+$  does not exist freely.
107. (a)      108. (a)
109. (c) Both assertion is correct reason is not true.  
Correct reason : Calgon forms soluble complexes with  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  in which properties of these ions are masked.
110. (a)  $2\text{C}_{17}\text{H}_{35}\text{COONa(aq)} + \text{M}^{2+}\text{(aq)} \longrightarrow$   
 $(\text{C}_{17}\text{H}_{35}\text{COO})_2\text{M}\downarrow (\text{M} = \text{Ca or Mg}) + 2\text{Na}^+\text{(aq)}$
111. (a) Both assertion and reason are true and reason is the correct explanation of assertion.
112. (a)

## CRITICAL THINKING TYPE QUESTIONS

113. (d)  $\text{H}_2$  will not reduce heated  $\text{Al}_2\text{O}_3$ . As Al is more electropositive than hydrogen. therefore, its oxide will not be reduced by hydrogen.
114. (d) Heavy water is stable.
115. (a)  ${}_1\text{H}^1 {}_1\text{D}^2 {}_1\text{T}^3$   
no. of neutrons respectively are 0 , 1 , 2  
no. of protons respectively are 1 , 1 , 1  
Hence the sum of protons + neutrons =  $1 + 2 + 3 = 6$
116. (b)  $\text{H}^-\text{(aq)} + \text{H}_2\text{O(l)} \longrightarrow \text{OH}^-\text{(aq)} + \text{H}_2\text{(g)}$   
base 1      acid 1      base 2      acid 2  
In this reaction  $\text{H}^-$  acts as bronsted base as it accepts one proton ( $\text{H}^+$ ) from  $\text{H}_2\text{O}$  and for  $\text{H}_2$ .
117. (c)  $\text{H}_2 \overset{-2}{\text{S}} + \text{H}_2\text{O}_2 \rightarrow \overset{0}{\text{S}} + 2\text{H}_2\text{O}$   
In this reaction  $\text{H}_2\text{O}_2$  shows oxidising nature.
118. (a)  $\text{D}_2\text{O}$  actually has higher freezing point ( $3.8^\circ\text{C}$ ) than water  $\text{H}_2\text{O}$  ( $0^\circ\text{C}$ )
119. (d)
120. (b)  $2\text{HSO}_4^-\text{(aq)} \xrightarrow{\text{electrolysis}} \text{HO}_3\text{SOOSO}_3\text{H(aq)}$   
 $\xrightarrow{\text{Hydrolysis}} 2\text{HSO}_4^-\text{(aq)} + 2\text{H}^+\text{(aq)} + \text{H}_2\text{O}_2\text{(aq)}$



## CHAPTER

# 10

# THE s-BLOCK ELEMENTS

### FACT/DEFINITION TYPE QUESTIONS

- Group 2 elements are called alkaline earth metals why? Choose the correct reason(s).
  - Hydroxides formed by group 2 elements are alkaline in nature.
  - Their metal oxides are found in the earth's crust.
  - Their oxides are alkaline in nature
  - Group 2 elements react with alkalies.
  - (i) and (ii)
  - (ii) and (iv)
  - (i), (ii) and (iii)
  - (ii) and (iii)
- Which of the following alkali metal is highly radioactive?
  - Rubidium
  - Caesium
  - Francium
  - Both (a) and (c)
- Which of the following are found in biological fluids  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{K}^+$ ,  $\text{Sr}^{2+}$ ,  $\text{Li}^+$  and  $\text{Ba}^{2+}$ ?
  - $\text{Mg}^{2+}$ ,  $\text{Ca}^{2+}$ , and  $\text{Sr}^{2+}$
  - $\text{Na}^+$  and  $\text{K}^+$
  - $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$  and  $\text{Ca}^{2+}$
  - $\text{Sr}^+$ ,  $\text{Li}$  and  $\text{Ba}^{2+}$
- Which of the following statements is not correct for alkali metals?
  - Alkali metals are the most electropositive metals.
  - Alkali metals exist in free state in nature.
  - These metals have the largest size in a particular period of the periodic table.
  - Both (b) and (c)
- Which of the following has largest size ?
  - Na
  - $\text{Na}^+$
  - $\text{Na}^-$
  - Can't be predicted
- Ionization potential of Na would be numerically the same as
  - electron affinity of  $\text{Na}^+$
  - electronegativity of  $\text{Na}^+$
  - electron affinity of He
  - ionization potential of Mg
- Which one of the following properties of alkali metals increases in magnitude as the atomic number rises ?
  - Ionic radius
  - Melting point
  - Electronegativity
  - First ionization energy.
- Which of the following has density greater than water?
  - Li
  - Na
  - K
  - Rb
- The elements of group 1 provide a colour to the flame of Bunsen burner due to
  - low ionization potential
  - low melting point
  - softness
  - presence of one electron in the outermost orbit
- The metal that produces red-violet colour in the non-luminous flame is
  - Ba
  - Ag
  - Rb
  - Pb
- The alkali metals have low melting point. Which of the following alkali metal is expected to melt if the room temperature rises to  $30^\circ\text{C}$ ?
  - Na
  - K
  - Rb
  - Cs
- In the case of the alkali metals
  - the cation is less stable than the atom
  - the cation is smaller than the atom
  - the cation and the atom have about the same size
  - the cation is larger than the atom
- Which of the following is not correct ?
  - $2\text{Li}_2\text{O} \xrightarrow{673\text{K}} \text{Li}_2\text{O}_2 + 2\text{Li}$
  - $2\text{K}_2\text{O} \xrightarrow{673\text{K}} \text{K}_2\text{O}_2 + 2\text{K}$
  - $2\text{Na}_2\text{O} \xrightarrow{673\text{K}} \text{Na}_2\text{O}_2 + 2\text{Na}$
  - $2\text{Rb}_2\text{O} \xrightarrow{673\text{K}} \text{Rb}_2\text{O}_2 + 2\text{Rb}$
- The element which on burning in air gives peroxide is
  - lithium
  - sodium
  - rubidium
  - caesium

15. Which one of the alkali metals, forms only, the normal oxide,  $M_2O$  on heating in air ?  
 (a) Rb (b) K  
 (c) Li (d) Na
16. Which of the following is used as a source of oxygen in space capsules, submarines and breathing masks ?  
 (a)  $Li_2O$  (b)  $Na_2O_2$   
 (c)  $KO_2$  (d)  $K_2O_2$
17. The ionic mobility of alkali metal ions in aqueous solution is maximum for  
 (a)  $Li^+$  (b)  $Na^+$   
 (c)  $K^+$  (d)  $Rb^+$
18. For an aqueous solution under an electric field which of the following have lowest mobility ?  
 (a)  $Li^+$  (b)  $Na^+$   
 (c)  $K^+$  (d)  $Rb^+$
19. Which of the following pairs of substances would give same gaseous product on reaction with water?  
 (a) Na and  $Na_2O_2$  (b) Ca and  $CaH_2$   
 (c) Ca and CaO (d) Ba and  $BaO_2$
20. Which is the most basic of the following?  
 (a)  $Na_2O$  (b) BaO  
 (c)  $As_2O_3$  (d)  $Al_2O_3$
21. Which hydride is most stable  
 (a) NaH (b) KH  
 (c) CsH (d) LiH
22. The most stable compound is  
 (a) LiF (b) LiCl  
 (c) LiBr (d) LiI
23. Which of the following represents a correct sequence of reducing power of the following elements?  
 (a)  $Li > Cs > Rb$  (b)  $Rb > Cs > Li$   
 (c)  $Cs > Li > Rb$  (d)  $Li > Rb > Cs$
24. What is the colour of solution of alkali metals in liquid ammonia?  
 (a) Bronze (b) Blue  
 (c) Green (d) Violet
25. The alkali metals dissolve in liquid ammonia giving deep blue solution. The solution is x. In concentrated solution, the blue colour changes to y and becomes z  
 (a)  $x = \text{paramagnetic}$   $y = \text{colourless}$   
 $z = \text{diamagnetic}$   
 (b)  $x = \text{diamagnetic}$   $y = \text{colourless}$   
 $z = \text{paramagnetic}$   
 (c)  $x = \text{paramagnetic}$   $y = \text{bronze}$   
 $z = \text{diamagnetic}$   
 (d)  $x = \text{paramagnetic}$   $y = \text{black}$   
 $z = \text{diamagnetic}$
26. Na metal is stored in  
 (a)  $C_6H_6$  (b) kerosene  
 (c) alcohol (d) toluene
27. Which of the following metal is used along with lithium to make the alloy named 'white metal' ?  
 (a) Nickel (b) Aluminium  
 (c) Silver (d) Lead
28. Which of the following metal is used as a coolant in breeder nuclear reactors?  
 (a) Potassium (b) Sodium  
 (c) Caesium (d) Rubidium
29. Which is most basic in character ?  
 (a) CsOH (b) KOH  
 (c) NaOH (d) LiOH
30. Which compound will show the highest lattice energy ?  
 (a) RbF (b) CsF  
 (c) NaF (d) KF
31. In crystals which one of the following ionic compounds would you expect maximum distance between centres of cations and anions?  
 (a) LiF (b) CsF  
 (c) CsI (d) LiI
32. Among LiI, NaI, KI, the one which is more ionic and more soluble in water is  
 (a) KI (b) NaI  
 (c) LiI (d) None of these
33. The products obtained on heating  $LiNO_2$  will be  
 (a)  $Li_2O + NO_2 + O_2$  (b)  $Li_3N + O_2$   
 (c)  $Li_2O + NO + O_2$  (d)  $LiNO_3 + O_2$
34. On heating anhydrous  $Na_2CO_3$ ,.....is evolved  
 (a)  $CO_2$  (b) water vapour  
 (c) CO (d) no gas
35. Complete the following two reactions.  
 (i)  $4LiNO_3 \rightarrow x + O_2$   
 (ii)  $2NaNO_3 \rightarrow y + O_2$   
 (a)  $x = LiNO_2, y = NaNO_2$   
 (b)  $x = Li_2O + NO_2, y = Na_2O + NO_2$   
 (c)  $x = Li_2O + NO_2, y = NaNO_2$   
 (d)  $x = LiNO_2, y = Na_2O + NO_2$
36. Which of the following does not illustrate the anomalous properties of lithium?  
 (a) The melting point and boiling point of Li are comparatively high  
 (b) Li is much softer than the other group I metals  
 (c) Li forms a nitride  $Li_3N$  unlike group I metals  
 (d) The ion of Li and its compounds are more heavily hydrated than those of the rest of the group

37. Why lithium react less vigorously with water than other alkali metals?
- Lithium has most negative  $E^\ominus$  value
  - Lithium has small size and very high hydration energy.
  - Lithium has least negative  $E^\ominus$  value
  - Both (a) and (b)
38. Identify the correct statement
- Elemental sodium can be prepared and isolated by electrolysis of an aqueous solution of sodium chloride
  - Elemental sodium is a strong oxidising agent
  - Elemental sodium is insoluble in ammonia
  - Elemental sodium is easily oxidised
39. Washing soda has formula
- $\text{Na}_2\text{CO}_3 \cdot 7\text{H}_2\text{O}$
  - $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$
  - $\text{Na}_2\text{CO}_3 \cdot 3\text{H}_2\text{O}$
  - $\text{Na}_2\text{CO}_3$
40. The process associated with sodium carbonate manufacture is known as
- Chamber
  - Haber
  - LeBlanc
  - Castner
41. In Solvay ammonia process, sodium bicarbonate is precipitate due to
- presence of  $\text{NH}_3$
  - reaction with  $\text{CO}_2$
  - reaction with brine solution
  - reaction with  $\text{NaOH}$
42. Sodium carbonate is manufactured by Solvay process. The products which can be recycled are
- $\text{CO}_2$  and  $\text{NH}_3$
  - $\text{CO}_2$  and  $\text{NH}_4\text{Cl}$
  - $\text{NaCl}$  and  $\text{CaO}$
  - $\text{CaCl}_2$  and  $\text{CaO}$
43. How  $\text{NH}_3$  is recovered in Solvay process?
- By reaction of  $\text{NH}_4\text{Cl}$  and  $\text{Ca}(\text{OH})_2$
  - By reaction of  $\text{NH}_4\text{HCO}_3$  and  $\text{NaCl}$
  - By reaction of  $(\text{NH}_4)_2\text{CO}_3$  with  $\text{H}_2\text{O}$
  - By any of the above
44. Why Solvay process cannot be extended to the manufacture of potassium carbonate?
- Ammonium hydrogen carbonate does not react with potassium chloride.
  - Potassium hydrogen carbonate is too soluble to be precipitated by the addition of ammonium hydrogencarbonate to a saturated solution of potassium chloride.
  - Ammonium carbonate is precipitated out instead of potassium hydrogen carbonate on reaction of ammonium hydrogen carbonate with potassium chloride
  - None of the above
45. Which of the following is/are present as impurity in crude sodium chloride, obtained by crystallisation of brine solution?
- Sodium sulphate
  - Calcium chloride
  - Magnesium chloride
  - Potassium chloride
- (i), (ii) and (iv)
  - (ii) and (iii)
  - (iii) and (iv)
  - (i), (ii) and (iii)
46. Which is manufactured by electrolysis of fused  $\text{NaCl}$  ?
- $\text{NaOH}$
  - $\text{Na}$
  - $\text{NaClO}$
  - $\text{NaClO}_3$
47. Baking soda is
- $\text{NaHCO}_3$
  - $\text{K}_2\text{CO}_3$
  - $\text{Na}_2\text{CO}_3$
  - $\text{NaOH}$
48. Baking powder contains :
- $\text{NaHCO}_3$ ,  $\text{Ca}(\text{H}_2\text{PO}_2)_2$  and starch
  - $\text{NaHCO}_3$ ,  $\text{Ca}(\text{H}_2\text{PO}_2)_2$
  - $\text{NaHCO}_3$ , starch
  - $\text{NaHCO}_3$
49. Which of the following is the most abundant ion within cell fluids?
- Sodium ions
  - Potassium ions
  - Calcium ions
  - None of these
50. Which of the following is non-metallic?
- B
  - Be
  - Mg
  - Al
51. Electronic configuration of calcium atom may be written as
- $[\text{Ne}], 4p^2$
  - $[\text{Ar}], 4s^2$
  - $[\text{Ne}], 4s^2$
  - $[\text{Ar}], 4p^2$
52. The outer electronic configuration of alkaline earth metal is
- $ns^2$
  - $ns^1$
  - $np^6$
  - $nd^{10}$
53. Which of the following atoms will have the smallest size ?
- Mg
  - Na
  - Be
  - Li
54. The first ionization energy of magnesium is lower than the first ionization energy of
- Lithium
  - Sodium
  - Calcium
  - Beryllium
55. Which of the following relations is correct with respect to first (I) and second (II) ionization potentials of sodium and magnesium?
- $I_{\text{Mg}} = II_{\text{Na}}$
  - $I_{\text{Mg}} < II_{\text{Na}}$
  - $I_{\text{Na}} > I_{\text{Mg}}$
  - $II_{\text{Na}} > II_{\text{Mg}}$
56. The first ionization energies of alkaline earth metals are higher than those of alkali metals. This is because
- there is no change in the nuclear charge
  - there is decrease in the nuclear charge of alkaline earth metals
  - there is increase in the nuclear charge of alkaline earth metals
  - none of these

57. Which of the following has maximum ionization energy  
 (a)  $\text{Ba} \longrightarrow \text{Ba}^+ + \text{e}^-$  (b)  $\text{Be} \longrightarrow \text{Be}^+ + \text{e}^-$   
 (c)  $\text{Ca} \longrightarrow \text{Ca}^{2+} + 2\text{e}^-$  (d)  $\text{Mg} \longrightarrow \text{Mg}^{2+} + 2\text{e}^-$
58. The most electropositive amongst the alkaline earth metals is  
 (a) beryllium (b) magnesium  
 (c) calcium (d) barium
59. Alkaline earth metals are not found free in nature because of  
 (a) their thermal instability  
 (b) their low melting points  
 (c) their high boiling points  
 (d) their greater chemical reactivity
60. A firework gives out crimson coloured light. It contains a salt of  
 (a) Ca (b) Na  
 (c) Sr (d) Ba
61. Following are colours shown by some alkaline earth metals in flame test. Which of the following are not correctly matched?
- | Metal             | Colour             |
|-------------------|--------------------|
| (i) Calcium       | Apple green        |
| (ii) Strontium    | Crimson            |
| (iii) Barium      | Brick red          |
| (a) (i) and (iii) | (b) (i) only       |
| (c) (ii) only     | (d) (ii) and (iii) |
62. Which one of the following properties of alkali metals increases in magnitude as the atomic number rises?  
 (a) Ionic radius (b) Melting point  
 (c) Electronegativity (d) First ionization energy
63. Out of the following elements which one do you expect to be most reactive, chemically?  
 (a) Mg (b) Ca  
 (c) Sr (d) Ba
64. In the reaction  $\text{Mg} + \text{H}_2\text{O} \xrightarrow{\text{(steam)}} \text{X} + \text{H}_2$ ; X is  
 (a) MgO (b)  $\text{Mg}(\text{OH})_2$   
 (c)  $\text{MgH}_2$  (d) None of these
65. The metals A and B form oxide but B also forms nitride when both burn in air. The A and B are  
 (a) Cs, K (b) Mg, Ca  
 (c) Li, Na (d) K, Mg
66. Which of the following is the best method for preparation of  $\text{BeF}_2$ ?  
 (a) Reaction of Be with  $\text{F}_2$   
 (b) Thermal decomposition of  $(\text{NH}_4)_2\text{BeF}_4$   
 (c) Reaction of Be with HF  
 (d) All of the above are equally effective
67. Arrange the following compounds in order of increasing solubility  
 (i)  $\text{MgF}_2$  (ii)  $\text{CaF}_2$   
 (iii)  $\text{BaF}_2$   
 (a) (i) < (ii) < (iii) (b) (ii) < (i) < (iii)  
 (c) (ii) < (iii) < (i) (d) (iii) < (ii) < (i)
68. Alkaline earth metals are  
 (a) reducing agent (b) amphoteric  
 (c) dehydrating agent (d) oxidizing agent
69. The oxidation state shown by alkaline earth metals is  
 (a) +2 (b) +1, +2  
 (c) -2 (d) -1, -2
70. Which one of the following is the most soluble in water?  
 (a)  $\text{Mg}(\text{OH})_2$  (b)  $\text{Sr}(\text{OH})_2$   
 (c)  $\text{Ca}(\text{OH})_2$  (d)  $\text{Ba}(\text{OH})_2$
71. Which of the following alkaline earth metal hydroxides is amphoteric in character  
 (a)  $\text{Be}(\text{OH})_2$  (b)  $\text{Ca}(\text{OH})_2$   
 (c)  $\text{Sr}(\text{OH})_2$  (d)  $\text{Ba}(\text{OH})_2$
72. Of the metals Be, Mg, Ca and Sr of group 2A. In the periodic table the least ionic chloride would be formed by  
 (a) Be (b) Mg  
 (c) Ca (d) Sr
73. The order of solubility of sulphates of alkaline earth metals in water is  
 (a)  $\text{Be} > \text{Mg} > \text{Ca} > \text{Sr} > \text{Ba}$   
 (b)  $\text{Mg} > \text{Be} > \text{Ba} > \text{Ca} > \text{Sr}$   
 (c)  $\text{Be} > \text{Ca} > \text{Mg} > \text{Ba} > \text{Sr}$   
 (d)  $\text{Mg} > \text{Ca} > \text{Ba} > \text{Be} > \text{Sr}$
74. The solubilities of carbonates decrease down the magnesium group due to a decrease in  
 (a) hydration energies of cations  
 (b) inter-ionic attraction  
 (c) entropy of solution formation  
 (d) lattice energies of solids
75. The correct order of increasing thermal stability of  $\text{K}_2\text{CO}_3$ ,  $\text{MgCO}_3$ ,  $\text{CaCO}_3$  and  $\text{BeCO}_3$  is  
 (a)  $\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{K}_2\text{CO}_3$   
 (b)  $\text{MgCO}_3 < \text{BeCO}_3 < \text{CaCO}_3 < \text{K}_2\text{CO}_3$   
 (c)  $\text{K}_2\text{CO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{BeCO}_3$   
 (d)  $\text{BeCO}_3 < \text{MgCO}_3 < \text{K}_2\text{CO}_3 < \text{CaCO}_3$
76. In which of the following the hydration energy is higher than the lattice energy?  
 (a)  $\text{MgSO}_4$  (b)  $\text{RaSO}_4$   
 (c)  $\text{SrSO}_4$  (d)  $\text{BaSO}_4$
77. Which of the following alkaline earth metal sulphates has hydration enthalpy higher than the lattice enthalpy?  
 (a)  $\text{CaSO}_4$  (b)  $\text{BeSO}_4$   
 (c)  $\text{BaSO}_4$  (d)  $\text{SrSO}_4$



78. Beryllium shows diagonal relationship with aluminium. Which of the following similarity is incorrect ?  
 (a) Be forms beryllates and Al forms aluminates  
 (b)  $\text{Be}(\text{OH})_2$  like  $\text{Al}(\text{OH})_3$  is basic.  
 (c) Be like Al is rendered passive by  $\text{HNO}_3$ .  
 (d)  $\text{Be}_2\text{C}$  like  $\text{Al}_4\text{C}_3$  yields methane on hydrolysis.
79. The substance **not** likely to contain  $\text{CaCO}_3$  is  
 (a) gypsum (b) sea shells  
 (c) dolomite (d) a marble statue
80. Plaster of Paris is  
 (a)  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  (b)  $\text{CaSO}_4 \cdot \text{H}_2\text{O}$   
 (c)  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$  (d)  $\text{CaSO}_4 \cdot 4\text{H}_2\text{O}$
81. Gypsum on heating at  $120 - 130^\circ\text{C}$  gives  
 (a) anhydrous salt (b) hemihydrate  
 (c) monohydrate (d) dihydrate
82. Plaster of Paris on making paste with little water sets to hard mass due to formation of  
 (a)  $\text{CaSO}_4$  (b)  $\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$   
 (c)  $\text{CaSO}_4 \cdot \text{H}_2\text{O}$  (d)  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
83. The chemical which is used for plastering the broken bones is  
 (a)  $(\text{CaSO}_4)_2\text{H}_2\text{O}$  (b)  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$   
 (c)  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  (d)  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
84. Dead burn plaster is  
 (a)  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$  (b)  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$   
 (c)  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$  (d)  $\text{CaSO}_4$
85. The formula for calcium chlorite is  
 (a)  $\text{Ca}(\text{ClO}_4)_2$  (b)  $\text{Ca}(\text{ClO}_3)_2$   
 (c)  $\text{CaClO}_2$  (d)  $\text{Ca}(\text{ClO}_2)_2$
86. Bone ash contains  
 (a)  $\text{CaO}$  (b)  $\text{CaSO}_4$   
 (c)  $\text{Ca}_3(\text{PO}_4)_2$  (d)  $\text{Ca}(\text{H}_2\text{PO}_4)_2$
87. Mortar is a mixture of  
 (a)  $\text{CaCO}_3$ , sand and water  
 (b) slaked lime and water  
 (c) slaked lime, sand and water  
 (d)  $\text{CaCO}_3$  and  $\text{CaO}$
88. Which gas is released when  $\text{CaCO}_3$  reacts with dilute  $\text{HCl}$ ?  
 (a)  $\text{H}_2$  (b)  $\text{CO}_2$   
 (c)  $\text{O}_2$  (d)  $\text{Cl}_2$
89. Setting of cement is an  
 (a) exothermic reaction  
 (b) endothermic reaction  
 (c) neither endothermic nor exothermic  
 (d) example of neutralisation reaction
90. For a good quality cement what should be the ratio of following :  
 I. Silica to alumina  
 II.  $\text{CaO}$  to the total of oxides of  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$  and  $\text{Fe}_2\text{O}_3$   
 (a) I = 2.5 to 4  
     II = Greater than 2  
 (b) I = Nearly 4  
     II = Less than 2  
 (c) I = 2.5  
     II = Closer to 2  
 (d) I = 2.5 to 4  
     II = Closer to 2
91. Calcitonin and parathyroid hormone regulate concentration of which of the following element in plasma?  
 (a) Calcium (b) Magnesium  
 (c) Sodium (d) Potassium
92. Which of the following metal is found in green colouring pigment chlorophyll of plants?  
 (a) Fe (b) Mg  
 (c) Na (d) Al

#### STATEMENT TYPE QUESTIONS

93. Select the correct statements  
 (i)  $\text{Cs}^+$  is more highly hydrated than the other alkali metal ions  
 (ii) Among the alkali metals Li, Na, K and Rb, lithium has the highest melting point  
 (iii) Among the alkali metals only lithium forms a stable nitride by direct combination with nitrogen  
 (a) (i), (ii) and (iii) (b) (i) and (ii)  
 (c) (i) and (iii) (d) (ii) and (iii)
94. Which of the following sequence of T and F is correct for alkali metals ? Here T represents True and F represents False statement.  
 (i) Alkali metal hydrides are ionic solids with high melting point.  
 (ii) All alkali halides are ionic in nature.  
 (iii) Li is the least powerful reducing agent and Na is the most powerful reducing agent.  
 (a) TTT (b) TFT  
 (c) FTF (d) TFF
95. Which of the following statement(s) is/are correct regarding  $\text{Li}_2\text{CO}_3$  and  $\text{Na}_2\text{CO}_3$  ?  
 (i) Sodium salt evolve  $\text{CO}_2$  at higher temperature.  
 (ii) Polarization of  $\text{Na}^+$  is lesser than that of  $\text{Li}^+$ .  
 (a) Both statements (i) and (ii) are correct  
 (b) Both statements (i) and (ii) are incorrect  
 (c) Statement (ii) is correct explanation for statement (i)  
 (d) Statement (i) is correct explanation for statement (ii)

96. Which of the following sequence of T and F is correct for given statements?

- (i) The alkali metal hydroxides are the strongest of all bases.
- (ii) All alkali metal halides have high negative enthalpies of formation.
- (iii) The stability of the carbonates and hydrogen carbonates of alkali metals decrease with increase in electropositive character down the group.
- (iv) Only  $\text{LiHCO}_3$  exist as solid.
- (a) TTFF (b) TTTT
- (c) FTFT (d) TFFT

97. Which of the following statement(s) is/are correct?

- (i) The atomic and ionic radii of alkaline earth metals are smaller than those of the corresponding alkali metals in the same periods.
- (ii) Second ionisation enthalpies of the alkaline earth metals are smaller than those of the corresponding alkali metals.
- (iii) Compounds of alkaline earth metals are more extensively hydrated than those of alkali metals
- (a) (i) and (ii) (b) (ii) and (iii)
- (c) (i) and (iii) (d) (i), (ii) and (iii)

98. Which of the following statements are correct ?

- (i) Copper - beryllium alloys are used in the preparation of high strength springs
- (ii) Metallic beryllium is used for making window X-ray tubes.
- (iii) Magnesium powder is used in incendiary bombs and signals.
- (iv) Barium is used in treatment of cancer.
- (a) (i), (ii) and (iv) (b) (i) and (iii)
- (c) (i), (ii) and (iii) (d) (i), (ii), (iii) and (iv)

99. Which of the following is/are not characteristic property(ies) of alkaline earth metals ?

- (i) All alkaline earth metal oxides are basic in nature and forms sparingly soluble hydroxides with water.
- (ii) The hydrated chlorides, bromides and iodides of Ca, Sr and Ba on heating undergoes hydrolysis while corresponding hydrated halides of Be and Mg on heating undergo dehydration.
- (iii) Nitrates of alkaline earth metals decompose on heating as below



- (a) (i) only (b) (ii) only
- (c) (i) and (iii) (d) (i) and (ii)

100. Which of the following statement(s) is/are correct regarding Al and Be ?

- (i) Both of these react with alkali.
- (ii) There is diagonal relationship among these elements.
- (a) Both (i) and (ii) (b) Only (i)
- (c) Only (ii) (d) Neither (i) nor (ii)

### MATCHING TYPE QUESTIONS

101. Match the columns

**Column-I**  
(Alkali metal)

- (A) Cs
- (B) Rb
- (C) K
- (D) Na
- (E) Li
- (a) A – (q), B – (s), C – (r), D – (p), E – (t)
- (b) A – (s), B – (q), C – (r), D – (p), E – (t)
- (c) A – (t), B – (r), C – (s), D – (p), E – (q)
- (d) A – (q), B – (p), C – (r), D – (p), E – (t)

**Column-II**  
(Colour imparted to an oxidizing flame)

- (p) Yellow
- (q) Blue
- (r) Violet
- (s) Red violet
- (t) Crimson red

102. Match the columns

**Column-I**  
(Metal)

- (A) Caesium
- (B) Lithium
- (C) Sodium
- (a) A – (q), B – (p), C – (r)
- (b) A – (r), B – (q), C – (p)
- (c) A – (p), B – (r), C – (q)
- (d) A – (q), B – (r), C – (p)

**Column-II**  
(Oxide formed on burning)

- (p) Superoxide
- (q) Peroxide
- (r) Monoxide

103. Match the columns. Here Column-I shows the names of the metals used with lithium to make useful alloys and Column-II shows the uses of these alloys

**Column-I**

- (A) Aluminium
- (B) Magnesium
- (C) Lead

**Column-II**

- (p) Armour plates
- (q) Aircraft parts
- (r) Bearings for motor engines.

- (a) A – (q), B – (p), C – (r)
- (b) A – (q), B – (r), C – (p)
- (c) A – (p), B – (q), C – (r)
- (d) A – (p), B – (r), C – (q)

104. Match the columns.

**Column-I**  
(Sodium compound)

- (A) Sodium carbonate
- (B) Sodium chloride
- (C) Sodium hydroxide
- (D) Sodium hydrogen carbonate

**Column-II**  
(Uses)

- (p) In fire extinguisher
- (q) In manufacture of glass, soap, borax and caustic soda.
- (r) In preparation of  $\text{Na}_2\text{O}_2$ ,  $\text{NaOH}$  and  $\text{Na}_2\text{CO}_3$
- (s) In petroleum refining

- (a) A – (q), B – (r), C – (s), D – (p)
- (b) A – (s), B – (q), C – (r), D – (p)
- (c) A – (p), B – (s), C – (r), D – (q)
- (d) A – (s), B – (r), C – (p), D – (q)

105. Match the columns

Column-I	Column-II
(A) Quick lime	(p) $\text{Ca}(\text{OH})_2$
(B) Slaked lime	(q) $\text{CaO}$
(C) Bleaching powder	(r) $\text{Ca}(\text{OCl})_2$
(D) Plaster of Paris	(s) $\text{CaSO}_4 \cdot \text{H}_2\text{O}$
(a) A – (p), B – (q), C – (r), D – (s)	
(b) A – (s), B – (r), C – (q), D – (p)	
(c) A – (q), B – (p), C – (r), D – (s)	
(d) A – (q), B – (p), C – (s), D – (r)	

106. Match the columns

(A) Quick lime	(p) Setting fractured bones
(B) Plaster of Paris	(q) A constituent of chewing gum
(C) Slaked lime	(r) Manufacture of bleaching powder
(D) Limestone	(s) Manufacture of dyestuffs
(a) A – (p), B – (s), C – (q), D – (r)	
(b) A – (s), B – (p), C – (r), D – (q)	
(c) A – (q), B – (r), C – (p), D – (s)	
(d) A – (r), B – (q), C – (s), D – (p)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

107. **Assertion:** Lithium salts are mostly hydrated.

**Reason :** The hydration enthalpy of alkali metal ions decreases with increase in ionic sizes.

108. **Assertion :** Lithium carbonate is not so stable to heat.

**Reason :** Lithium being very small in size polarizes large  $\text{CO}_3^{2-}$  ion leading to the formation of more stable  $\text{Li}_2\text{O}$  and  $\text{CO}_2$

109. **Assertion :** Compounds of beryllium is largely covalent and get hydrolysed easily.

**Reason :** This is due to high value of ionisation potential and small size of Be.

110. **Assertion :** Radium is most abundant s-block element.

**Reason :** s-block elements are non-radioactive in nature.

### CRITICAL THINKING TYPE QUESTIONS

111. The melting point of lithium ( $181^\circ\text{C}$ ) is just double the melting point of sodium ( $98^\circ\text{C}$ ) because  
 (a) down the group, the hydration energy decreases  
 (b) down the group, the ionization energy decreases  
 (c) down the group the cohesive energy decreases  
 (d) None of these
112. Li has the maximum value of ionisation potential among alkali metals i.e. lithium has the minimum tendency to ionise to give  $\text{Li}^+$  ion. Thus, in aq. solution lithium is  
 (a) strongest reducing agent  
 (b) poorest reducing agent  
 (c) strongest oxidising agent  
 (d) poorest oxidising agent
113. Lithium is strongest reducing agent among alkali metals due to which of the following factor?  
 (a) Ionization energy (b) Electron affinity  
 (c) Hydration energy (d) Lattice energy
114. Which of the following statements is incorrect?  
 (a) Alkali metal hydroxide are hygroscopic  
 (b) Dissolution of alkali metal hydroxide is endothermic  
 (c) Aqueous solution of alkali metal hydroxides are strongly basic  
 (d) Alkali metal hydroxides form ionic crystals
115. Which of the following on thermal decomposition yields a basic as well as acidic oxide ?  
 (a)  $\text{NaNO}_3$  (b)  $\text{KClO}_3$   
 (c)  $\text{CaCO}_3$  (d)  $\text{NH}_4\text{NO}_3$
116. Which one of the following on hydrolysis, gives the corresponding metallic hydroxide,  $\text{H}_2\text{O}_2$  and  $\text{O}_2$ ?  
 (a)  $\text{Li}_2\text{O}$  (b)  $\text{Na}_2\text{O}_2$   
 (c)  $\text{NaO}_2$  (d)  $\text{Na}_2\text{O}$
117. Which of the following oxides of potassium is not known ?  
 (a)  $\text{K}_2\text{O}$  (b)  $\text{K}_2\text{O}_4$   
 (c)  $\text{KO}_3$  (d)  $\text{K}_2\text{O}_3$
118. Suppose an element is kept in air chamber, than air content was evaluated after sometime, oxygen and nitrogen content was found to be low comparatively. The given element will be  
 (a) Li (b) Rb  
 (c) Na (d) K
119. Suppose metal react with the oxygen to form oxide, than aqueous solution of this oxide when added to a solution of HI, solution turn yellowish brown in colour. This compound is  
 (a)  $\text{Na}_2\text{O}$  (b)  $\text{Li}_2\text{O}$   
 (c)  $\text{NaOH}$  (d)  $\text{Na}_2\text{O}_2$
120. Which of the following salt of lithium is most soluble in organic solvent ?  
 (a)  $\text{LiF}$  (b)  $\text{LiCl}$   
 (c)  $\text{LiBr}$  (d)  $\text{LiI}$

121. Arrange the following in increasing order of their melting point ?  
(A) LiCl, (B) NaCl, (C) KCl  
(a)  $A < B < C$  (b)  $B < A < C$   
(c)  $C < A < B$  (d)  $A < B \approx C$
122. The raw materials in Solvay Process are  
(a)  $\text{Na}_2\text{CO}_3$ ,  $\text{CaCO}_3$  and  $\text{NH}_3$   
(b)  $\text{Na}_2\text{SO}_4$ ,  $\text{CaCO}_3$  and  $\text{NH}_3$   
(c)  $\text{NaCl}$ ,  $\text{NH}_3$  and  $\text{CaCO}_3$ .  
(d)  $\text{NaOH}$ ,  $\text{CaO}$  and  $\text{NH}_3$ .
123. Compared with the alkaline earth metals, the alkali metals exhibit  
(a) smaller ionic radii (b) highest boiling points  
(c) greater hardness (d) lower ionization energies.
124. Property of the alkaline earth metals that increases with their atomic number is  
(a) solubility of their hydroxides in water  
(b) solubility of their sulphates in water  
(c) ionization energy  
(d) electronegativity
125. Which one of the following does not react with water even under red hot condition?  
(a) Na (b) Be  
(c) Ca (d) K
126. Magnesium burns in  $\text{CO}_2$  to form  
(a)  $\text{MgO} + \text{C}$  (b)  $\text{MgO} + \text{CO}$   
(c)  $\text{MgCO}_3$  (d)  $\text{MgO}$ .
127. Arrange the following in increasing order of their solubility?  
 $\text{MgCO}_3$ (A),  $\text{CaCO}_3$ (B),  $\text{SrCO}_3$ (C),  $\text{Na}_2\text{CO}_3$ (D)  
(a)  $A < B < C < D$  (b)  $A < C < B < D$   
(c)  $C < A < B < D$  (d)  $C < B < A < D$
128. Which of the following will precipitate first when aqueous solution containing sulphate ions are added?  
(a)  $\text{Mg}^{2+}$  (b)  $\text{Ca}^{2+}$   
(c)  $\text{Sr}^{2+}$  (d)  $\text{Ba}^{2+}$
129. If the fluoride salts of group 2 metals are dissolved in water, than which of the following will show high solubility?  
(a)  $\text{BaF}_2$  (b)  $\text{RbF}_2$   
(c)  $\text{CaF}_2$  (d)  $\text{BeF}_2$
130. Aqueous solution of group 2 is precipitated by adding  $\text{Na}_2\text{CO}_3$ , then this precipitate is tested on flame, no light in visible region is observed, this element can be  
(a) Ba (b) Mg  
(c) Ca (d) Sr
131. Which of the following statement is false ?  
(a) Strontium decomposes water readily than beryllium  
(b) Barium carbonate melts at a higher temperature than calcium carbonate  
(c) Barium hydroxide is more soluble in water than magnesium hydroxide  
(d) Beryllium hydroxide is more basic than barium hydroxide.
132. Bleaching powder is obtained by the interaction of chlorine with  
(a) dil. solution of  $\text{Ca}(\text{OH})_2$   
(b) dry  $\text{CaO}$   
(c) conc. solution of  $\text{Ca}(\text{OH})_2$   
(d) dry slaked lime

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (c) Group 2 elements are called alkaline earth metals as their oxides and hydroxides are alkaline in nature and these metal oxides are found in the earth's crust.
2. (c) Francium is highly radioactive.
3. (c) Monovalent sodium and potassium ions and divalent magnesium and calcium ions are found in large proportions in biological fluids.
4. (b) Alkali metals readily lose electron to give monovalent  $M^+$  ion. Hence they are never found in free state in nature.
5. (c) A cation is always much smaller than the corresponding atom, whereas an anion is always larger than the corresponding atom.  
Hence, correct order of the size is  
 $Na^- > Na > Na^+$
6. (a)  $Na \rightarrow Na^+ + e^-$ ; IE of Na = +ve  
 $Na^+ + e^- \rightarrow Na$ ; E.A. of  $Na^+ = -ve$   
Both are equal but opposite in nature
7. (a) Within a group, ionic radius increases with increase in atomic number. The melting points decrease down the group due to weakening of metallic bond. The electronegativity and the 1<sup>st</sup> ionization energy also decreases down the group.
8. (d) Li, Na, K are lighter than water but Rb is heavier than water.
9. (a)
10. (c) Alkali metals have large size. When they are heated in the flame of Bunsen burner, the electrons present in the valence shell move from lower energy level to higher energy level by absorption of heat from the flame. When they come back to the ground state, they emit the extra energy in the form of visible light to provide colour to the flame.
11. (d)
12. (b) Gp 1 metals form cations  $M^+$  by loss of electron from outermost shell. Electronic configuration of Gp 1 metals is  $ns^1$ . When the outer electron is removed to give a positive ion, the size decreases because the outermost shell is completely removed. After removal of an electron, the positive charge of the nucleus is greater on the remaining electrons so that each of the remaining electrons are attracted more strongly towards the nucleus. This further reduces the size.
13. (a) Lithium does not form peroxide.
14. (b) Sodium metal on burning in air gives sodium peroxide.
15. (c) All the alkali metals when heated with oxygen form different types of oxides for example lithium forms lithium oxide ( $Li_2O$ ), sodium forms sodium peroxide ( $Na_2O_2$ ), while K, Rb and Cs form their respective superoxides.  
$$2Li + \frac{1}{2} O_2 \rightarrow Li_2O$$
16. (c) Because  $KO_2$  not only provides  $O_2$  but also removes  $1CO_2$  as follows  
$$4KO_2 + 2CO_2 \rightarrow 2K_2CO_3 + 3O_2$$
$$4KO_2 + 4CO_2 + 2H_2O \rightarrow 4KHCO_3 + 3O_2$$
17. (d) Smaller the size of cation higher is its hydration energy and lesser is its ionic mobility hence the correct order is  $Li^+ < Na^+ < K^+ < Rb^+$
18. (a) In aqueous solution because of high charge density of  $Li^+$  it is heavily hydrated, therefore due to its extensive hydration which increases its size to highest the mobility of  $Li^+$  ion will be lowest.
19. (b) Both Ca and  $CaH_2$  produce  $H_2$  gas with water.  
$$Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2 \uparrow$$
$$CaH_2 + 2H_2O \longrightarrow Ca(OH)_2 + 2H_2 \uparrow$$
20. (a)
21. (d) The basic character and stability of hydrides decrease down the group.
22. (a) For a given metal, order of stability of halides is  $MF > MCl > MBr > MI$
23. (a) A reducing agent is a substance which can loose electron and hence a reducing agent should have low ionisation energy. Now since ionisation energy decreases from Li to Cs, the reducing property should increase from Li to Cs. The only exception to this is lithium. This is because the net process of converting an atom to an ion takes place in 3 steps.  
(i)  $M(s) \rightarrow M(g)$   $\Delta H$  = Sublimation energy  
(ii)  $M(g) \rightarrow M^+(g) + e^-$   $\Delta H$  = Ionisation energy  
(iii)  $M^+(g) + H_2O \rightarrow M^+(aq)$   $\Delta H$  = Hydration energy  
The large amount of energy liberated in hydration of Li (because of its small size) makes the overall  $\Delta H$  negative. This accounts for the higher oxidation potential of lithium i.e., its high reducing power.
24. (b) The alkali metals dissolve in liquid ammonia giving deep blue solution.
25. (c)  $x$  = paramagnetic  $y$  = bronze  
 $z$  = diamagnetic
26. (b) Na reacts violently and may catch fire on exposure to moisture (air + water). So it is always stored in kerosene. Na reacts with alcohol to produce  $H_2$ .



27. (d) Lithium with lead is used to make white metal.
28. (b) Liquid sodium is used as a coolant in fast breeder nuclear reactors.
29. (a) Since the ionization energies of alkali metals decrease down the group, the ionic character and consequently basic property of their hydroxides increases in the same order, i.e. from LiOH to CsOH.
30. (c) With the same anion, smaller the size of the cation, higher is the lattice energy. The correct order of size of cations is –  
 $\text{Na}^+ < \text{K}^+ < \text{Rb}^+ < \text{Cs}^+$   
 Hence, the lattice energy of NaF will be maximum. i.e., NaF.
31. (c) As  $\text{Cs}^+$  ion has larger size than  $\text{Li}^+$  and  $\text{I}^-$  has larger size than  $\text{F}^-$ , therefore maximum distance between centres of cations and anions is in CsI.
32. (a) Larger cation ( $\text{K}^+$ ) develops less polarisation in anion and thus KI has more ionic nature and more soluble in water.
33. (a)  $4\text{LiNO}_3 \rightarrow 2\text{Li}_2\text{O} + 4\text{NO}_2 + \text{O}_2$
34. (d) Anhydrous form of  $\text{Na}_2\text{CO}_3$  does not decompose on heating even to redness. It is a amorphous powder called soda ash.
35. (c)  $4\text{LiNO}_3 \rightarrow 2\text{Li}_2\text{O} + 4\text{NO}_2 + \text{O}_2$   
 $2\text{NaNO}_3 \rightarrow 2\text{NaNO}_2 + \text{O}_2$
36. (b) Li is much softer than the other group I metals. Actually Li is harder than other alkali metals.
37. (b) Lithium although has most negative  $E^\ominus$  value reacts less vigorously with water than other alkali metals due to its small size and very high hydration energy.
38. (d) Elemental sodium is easily oxidised (has low I.P.) and acts as reductant.
39. (b) Washing soda is  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ .
40. (c)
41. (c)  $\text{NH}_4\text{HCO}_3 + \text{NaCl} \xrightarrow[\text{Sod. bicarbonate ppt.}]{\text{Brine}} \text{NaHCO}_3 \downarrow + \text{NH}_4\text{Cl}$
42. (a)  $\text{CO}_2$  and  $\text{NH}_3$  formed are reused (See Solvay process)
43. (a)  $\text{NH}_3$  is recovered when the solution containing  $\text{NH}_4\text{Cl}$  is treated with  $\text{Ca}(\text{OH})_2$   
 $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \rightarrow 2\text{NH}_3 + \text{CaCl}_2 + \text{H}_2\text{O}$
44. (b)
45. (d) Sodium sulphate, calcium chloride and magnesium chloride are present as impurities in crude sodium chloride.
46. (b) Na metal is manufactured by electrolysis of fused NaCl by two methods.  
 (i) Castner's process  
 (ii) Down's process  
 In both the above processes electrolysis of fused sodium chloride produces Na at cathode.  

$$2\text{NaOH} \rightleftharpoons 2\text{Na}^+ + \text{OH}^-$$
  
 at cathode  $2\text{Na}^+ + 2\text{e}^- \longrightarrow 2\text{Na}$   
 at anode  $4\text{OH}^- \longrightarrow 2\text{H}_2\text{O} + \text{O}_2 + 4\text{e}^-$
47. (a)  $\text{NaHCO}_3$  (baking soda) is one of the major constituents of baking powder.
48. (a) Baking powder has starch,  $\text{NaHCO}_3$  and  $\text{Ca}(\text{H}_2\text{PO}_4)_2$ .
49. (b) Potassium ions are the most abundant cations within cell fluids.
50. (a) Metallic character decreases, as we go to the right side in a period and increases when we move downwards in a group.
51. (b)  $\text{Ca} (20) = 1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 = [\text{Ar}], 4s^2$ .
52. (a)
53. (c) Within a period, the size decreases from left to right, i.e.,  $\text{Na} > \text{Mg} > \text{Li} > \text{Be}$ . Atomic size increases down the group.
54. (d)
55. (d) The IInd ionisation potential of Na is higher than Mg because it requires more energy to remove an electron from a saturated shell or stable (fully filled) orbital.  

$${}_{11}\text{Na} \longrightarrow 1s^2, 2s^2 2p^6, 3s^1 \xrightarrow{\text{I}} 1s^2, 2s^2 2p^6, 3s^0 \xrightarrow{\text{II}} 1s^2, 2s^2 2p^5, 3s^0$$
  

$${}_{12}\text{Mg} \longrightarrow 1s^2, 2s^2 2p^6, 3s^2 \xrightarrow{\text{I}} 1s^2, 2s^2 2p^6, 3s^1 \xrightarrow{\text{II}} 1s^2, 2s^2 2p^6, 3s^0$$
  
 Here  $\text{Na-I} < \text{Mg-I}$  and  $\text{Na-II} > \text{Mg-II}$ .
56. (c) As we go from grp I element to grp II element in a period, an extra electron is added in same shell which results in increase in nuclear charge due to which force of attraction by the nucleus increases and hence ionic radii decreases and consequently I.E. increases.
57. (d) 58. (d) 59. (d) 60. (c)
61. (a) Calcium gives brick red colour and barium gives apple green colour in flame test.
62. (a) Within a group, ionic radius increases with increase in atomic number. The melting points decrease down the group due to weakening of metallic bond. The electronegativity and the 1<sup>st</sup> ionization energy also decreases down the group.
63. (d) Barium is most electropositive element among those given. Hence it is most reactive.
64. (a)  $\text{Mg}(\text{OH})_2$  is not formed because of poor solubility of MgO in  $\text{H}_2\text{O}$ .
65. (d) K and Mg, both form oxides  

$$\text{K} + \text{O}_2 \rightarrow \text{KO}_2; 2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$$
  
 Mg form nitride also  $3\text{Mg} + \text{N}_2 \rightarrow \text{Mg}_3\text{N}_2$   
 K does not form nitride.
66. (b) Thermal decomposition of  $(\text{NH}_4)_2\text{BeF}_4$  is the best method for preparation of  $\text{BeF}_2$ .
67. (b)  $\text{BaF}_2 > \text{MgF}_2 > \text{CaF}_2$
68. (a) Alkaline earth metals have a fairly strong tendency to lose their outermost electrons due to which they act as reducing agent.

69. (a)
70. (d) For a compound to be soluble, the hydration energy must exceed lattice energy. For Gp.II hydroxides ( $\text{Mg}(\text{OH})_2$ ,  $\text{Sr}(\text{OH})_2$ ,  $\text{Ca}(\text{OH})_2$ ,  $\text{Ba}(\text{OH})_2$ ), lattice energy decrease more rapidly than the hydration energy & so their solubility increases down the group.  $\text{Ba}(\text{OH})_2 > \text{Sr}(\text{OH})_2 > \text{Ca}(\text{OH})_2 > \text{Mg}(\text{OH})_2$
71. (a)  $\text{Be}(\text{OH})_2$  is amphoteric while  $\text{Ca}(\text{OH})_2$ ,  $\text{Sr}(\text{OH})_2$  and  $\text{Ba}(\text{OH})_2$  are all basic.
72. (a) Because of small atomic size and high I.E. Be forms covalent chloride.
73. (a)
74. (a) As we move down the group, the lattice energies of carbonates remain approximately the same. However the hydration energies of the metal cation decreases from  $\text{Be}^{++}$  to  $\text{Ba}^{++}$ , hence the solubilities of carbonates of the alkaline earth metal decrease down the group mainly due to decreasing hydration energies of the cations from  $\text{Be}^{++}$  to  $\text{Ba}^{++}$ .
75. (a) As the basicity of metal hydroxides increases down the group from Be to Ba, the thermal stability of their carbonates also increases in the same order. Further group 1 compounds are more thermally stable than group 2 because their hydroxide are much basic than group 2 hydroxides therefore, the order of thermal stability is  $\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{K}_2\text{CO}_3$ .
76. (a) In alkaline earth metals ionic size increases down the group. The lattice energy remains constant because sulphate ion is so large, so that small change in cationic sizes do not make any difference. On moving down the group the degree of hydration of metal ions decreases very much leading to decrease in solubility  $\therefore \text{BeSO}_4 > \text{MgSO}_4 > \text{CaSO}_4 > \text{SrSO}_4 > \text{BaSO}_4$
77. (b)  $\text{Be}^{2+}$  is very small, hence its hydration enthalpy is greater than its lattice enthalpy
78. (b) The  $\text{Be}(\text{OH})_2$  and  $\text{Al}(\text{OH})_3$  are amphoteric in nature.
79. (a) Gypsum is  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$
80. (c) Chemically plaster of Paris is  $\text{CaSO}_4 \cdot 1/2\text{H}_2\text{O}$ .
81. (b)  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O} \xrightarrow{120^\circ\text{C}} \text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$   
Plaster of Paris is hemihydrate.
82. (d) Plaster of Paris ( $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ ) on making paste with little water sets to a hard mass due to formation of gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ).  
$$\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O} + \frac{3}{2}\text{H}_2\text{O} \rightarrow \text{CaSO}_4 \cdot 2\text{H}_2\text{O} + \text{Heat}$$
  
Plaster of Paris                      Gypsum
83. (a)  $(\text{CaSO}_4)_2 \cdot \text{H}_2\text{O}$  – Plaster of paris is used for plastering the broken bones.
84. (d)
85. (d)
86. (c)
87. (c)
88. (b)  $\text{CaCO}_3 + 2\text{HCl} \longrightarrow 2\text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$
89. (a) During setting of cement, silicates and aluminates of calcium are hydrated. Hydration is an exothermic process. Therefore setting of cement is exothermic process.
90. (d) For a good quality cement, the ratio of silica ( $\text{SiO}_2$ ) to alumina ( $\text{Al}_2\text{O}_3$ ) should be between 2.5 and 4 and the ratio of lime ( $\text{CaO}$ ) to the total of the oxides of silicon ( $\text{SiO}_2$ ), aluminium ( $\text{Al}_2\text{O}_3$ ) and iron ( $\text{Fe}_2\text{O}_3$ ) should be as close as possible to 2.
91. (a) The calcium concentration in plasma is regulated at about  $100 \text{ mgL}^{-1}$ . It is maintained by two hormones: calcitonin and parathyroid hormone.
92. (b)

## STATEMENT TYPE QUESTIONS

93. (d) Amongst alkali metal Li ions are highly hydrated.
94. (d) Lithium halides are some what covalent in nature. Li is the most powerful reducing agent and Na is the least powerful reducing agent.
95. (c)
96. (a) For statement (iii), stability of the carbonates and hydrogen carbonates of alkali metals increases with increase in electropositive character down the group. Hydrogen carbonate of lithium does not exist as a solid.
97. (d) All the given statements are correct.
98. (c) Radium is used in treatment of cancer.
99. (d) All alkaline earth metal oxides except BeO are basic in nature. BeO is amphoteric in nature. Hydrated halides of Ca, Sr and Ba on heating undergo dehydration while corresponding hydrated halides of Be and Mg on heating suffer hydrolysis.
100. (a)

## MATCHING TYPE QUESTIONS

101. (a)
102. (c)  $\text{Cs} + \text{O}_2 \rightarrow \text{CsO}_2$  (Superoxide)  
 $4\text{Li} + \text{O}_2 \rightarrow 2\text{Li}_2\text{O}$  (Oxide)  
 $2\text{Na} + \text{O}_2 \rightarrow \text{Na}_2\text{O}_2$  (Peroxide)
103. (a) Lithium metal is used to make useful alloys, for example with lead to make 'white metal' bearings for motor engines, with aluminium to make aircraft parts, and with magnesium to make armour plates.
104. (a)
105. (c)
106. (b) Quick lime is used for the manufacture of dyestuffs. Plaster of Paris is used for setting of fractured bones. Slaked lime is used for the manufacture of bleaching powder. Limestone is a constituent of chewing gum.

### ASSERTION-REASON TYPE QUESTIONS

107. (a)  $\text{Li}^+$  has maximum degree of hydration among other alkali metals.
108. (a) Lithium carbonate is unstable to heat; lithium being very small in size polarises a large  $\text{CO}_3^{2-}$  ion leading to the formation of more stable  $\text{Li}_2\text{O}$  and  $\text{CO}_2$ .
109. (a) Because of high value of ionisation enthalpy and small size it forms compound which are highly covalent in nature, hence, it get hydrolysed easily.
110. (d) Both assertion and reason are false.  
Radium is the rarest of all s-block elements comprising only  $10^{-10}$  percent of igneous rocks. Francium (s-block member) is radioactive; its long lived isotope  $^{223}\text{Fr}$  has a half life of only 21 minutes.

### CRITICAL THINKING TYPE QUESTIONS

111. (c) The atom becomes larger on descending the group, so the bonds becomes weaker (metallic bond), the cohesive force/energy decreases and accordingly melting point also decreases.
112. (a) The ionisation potential value of lithium is maximum among alkali metals i.e., its tendency to ionise to give  $\text{Li}^+$  ions should be the minimum i.e. Li should be the poorest reducing agent. But, lithium is the strongest reducing agent in aq. solution. This is due to the largest value of hydration energy of  $\text{Li}^+$  ions.
113. (c) Li due to highest hydration energy among the alkali metals is the strongest reducing agent.
114. (b) During the dissolution of alkali metal hydrides energy is released in large amount, i.e., it is exothermic in nature.
115. (c) Calcium carbonate on thermal decomposition gives  $\text{CaO}$  (Basic oxide) and  $\text{CO}_2$  (Acidic oxide)
- $$\text{CaCO}_3 \xrightarrow{\Delta} \underset{\text{Basic oxide}}{\text{CaO}} + \underset{\text{Acidic oxide}}{\text{CO}_2 \uparrow}$$
116. (c)  $2\text{NaO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2\text{O}_2 + \text{O}$
117. (b)  $\text{O}_4^{2-}$  ion is not possible and  $\text{K}_2\text{O}_4$  is unknown.
118. (a) All the given elements react with oxygen to form oxides but only Li also react with nitrogen to form  $\text{Li}_3\text{N}$ .
119. (d) (a) and (b) forms corresponding hydroxides ( $\text{NaOH}$  and  $\text{LiOH}$ ) in aqueous solution
- $$\text{M}_2\text{O} + \text{H}_2\text{O} \longrightarrow 2\text{M}^+ + 2\text{OH}^- \quad (\text{M} = \text{Na or Li})$$
- Therefore reaction of HI with (a), (b) and (c) is simply a neutralization reaction, while aqueous solution of (d) form  $\text{H}_2\text{O}_2$  which act as oxidizing agent, hence convert Iodide to Iodine ( $\text{I}_2$ ).
- $$\text{Na}_2\text{O}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{Na}^+ + 2\text{OH}^- + \text{H}_2\text{O}_2$$

120. (d)  $\text{LiI}$  is more soluble as the degree of covalent character is high due to larger size of anion i.e., iodide ion by greater polarization of lithium cation.
121. (a)
122. (c)  $\text{NaCl}$  (brine),  $\text{NH}_3$  and  $\text{CO}_2$  are raw materials.  $\text{CaCO}_3$  is source of  $\text{CO}_2$ .
123. (d) Because of larger size and smaller nuclear charge, alkali metals have low ionization potential relative to alkaline earth metals.
124. (a) Lattice energy decreases more rapidly than hydration energy for alkaline earth metal hydroxides. On moving down a group  $\therefore$  solubility of their hydroxides increases.
125. (b)  $2\text{Na} + 2\text{H}_2\text{O} \longrightarrow 2\text{NaOH} + \text{H}_2 \uparrow$   
 $2\text{K} + 2\text{H}_2\text{O} \longrightarrow 2\text{KOH} + \text{H}_2 \uparrow$   
 All alkali metals decompose water with the evolution of hydrogen.  
 $\text{Ca} + 2\text{H}_2\text{O} \longrightarrow \text{Ca(OH)}_2 + \text{H}_2 \uparrow$   
 $\text{Sr} + 2\text{H}_2\text{O} \longrightarrow \text{Sr(OH)}_2 + \text{H}_2 \uparrow$   
 $\text{Be} + 2\text{H}_2\text{O} \longrightarrow \text{No reaction}$   
 Ca, Sr, Ba and Ra decompose cold water readily with evolution of hydrogen. Mg decomposes boiling water but Be is not attacked by water even at high temperatures as its oxidation potential is lower than the other members.
126. (a) Mg burns in  $\text{CO}_2$  to give  $\text{MgO}$  and C.
127. (d) Group 1 carbonates are more soluble than group 2 which are sparingly soluble, and also in case of group 2, down the group the solubility of carbonates decreases.
128. (d) Down the group solubility of sulphate decreases. Thus  $\text{Ba}^{2+}$  ions will precipitate out most easily.
129. (a)  $\text{BeF}_2$  is highly soluble in water due to the high hydration enthalpy of the small  $\text{Be}^{2+}$  ion.
130. (b) Electrons in Mg due to its small size are tightly bound so they cannot be excited by the flame.
131. (d)  $\text{Be(OH)}_2$  is amphoteric, but the hydroxides of other alkaline earth metals are basic. The basic strength increases gradually.
132. (d) When cold calcium hydroxide reacts with chlorine, then bleaching powder is obtained.
- $$3\text{Ca(OH)}_2 + 2\text{Cl}_2 \xrightarrow{\text{slaked lime}} \text{Ca(OC)}_2 \cdot \text{Ca(OH)}_2 \cdot \text{CaCl}_2 \cdot 2\text{H}_2\text{O}$$
- Bleaching powder

# CHAPTER 11

## THE p-BLOCK ELEMENTS (GROUP 13 AND 14)

### FACT/DEFINITION TYPE QUESTIONS

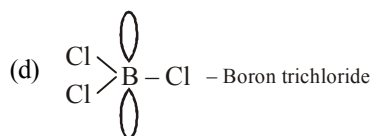
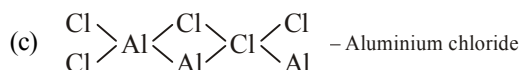
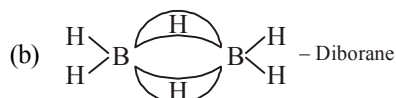
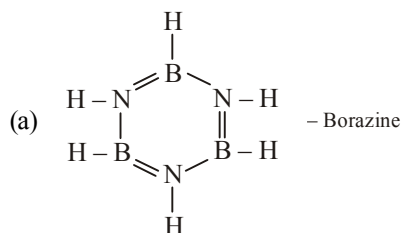
- The non-metal oxides are  $x$  whereas metal oxides are  $y$  in nature.
  - $x$  = acidic or neutral,  $y$  = basic
  - $x$  = acidic,  $y$  = neutral
  - $x$  = basic,  $y$  = acidic
  - $x$  = neutral,  $y$  = basic
- Which of the following is most abundant in the earth crust?
  - Boron
  - Aluminium
  - Gallium
  - Thallium
- Ionisation enthalpy ( $\Delta_i H_1$  kJ mol<sup>-1</sup>) for the elements of Group 13 follows the order.
  - $B > Al > Ga > In > Tl$
  - $B < Al < Ga < In < Tl$
  - $B < Al > Ga < In > Tl$
  - $B > Al < Ga > In < Tl$
- The relationship between first, second and third ionisation enthalpies of each group-13 element is
  - $\Delta_i H_1 > \Delta_i H_2 > \Delta_i H_3$
  - $\Delta_i H_1 < \Delta_i H_2 < \Delta_i H_3$
  - $\Delta_i H_1 = \Delta_i H_2 > \Delta_i H_3$
  - $\Delta_i H_3 > \Delta_i H_1 > \Delta_i H_2$
- Which of the following properties of aluminium makes it useful for food packaging?
  - Good electrical conductivity
  - Good thermal conductivity
  - Low density
  - Non toxicity
- Which of the following is/are true regarding gallium?
  - It has unusually low melting point (303 K).
  - It exist in liquid state during summer.
  - It has a high boiling point (2676 K).
 The correct option is
  - (i) and (ii)
  - (i) and (iii)
  - (i), (ii) and (iii)
  - (ii) and (iii)
- The element which shows least metallic character is
  - Indium
  - Boron
  - Aluminium
  - Gallium
- Which one of the following has the lowest m.p.?
  - B
  - Al
  - Ga
  - Tl
- Which of the following does not form  $M^{3+}$  ion?
  - Boron
  - Aluminium
  - Indium
  - Gallium
- The group 13 element that is liquid during summer and used for measuring high temperature is
  - Boron
  - Aluminium
  - Gallium
  - Indium
- Thallium shows different oxidation states because
  - it is transition element
  - of inert pair effect
  - of its amphoteric character
  - of its higher reactivity
- The exhibition of highest co-ordination number depends on the availability of vacant orbitals in the central atom. Which of the following elements is not likely to act as central atom in  $MF_6^{3-}$ ?
  - B
  - Al
  - Ga
  - In
- Which out of the following compounds does not exist?
  - $BF_3$
  - $TiCl_3$
  - $TiCl_5$
  - Both (b) and (c)
- Aluminium chloride is a/an
  - Bronsted - Lowery acid
  - Arrhenius acid
  - Lewis acid
  - Lewis base
- The strongest Lewis acid is
  - $BF_3$
  - $BCl_3$
  - $BBr_3$
  - $BI_3$
- $AlCl_3$  on hydrolysis gives
  - $Al_2O_3 \cdot H_2O$
  - $Al(OH)_3$
  - $Al_2O_3$
  - $AlCl_3 \cdot 6H_2O$
- Which metal is protected by a layer of its own oxide?
  - Al
  - Ag
  - Au
  - Fe
- Aluminium vessels should not be washed with materials containing washing soda because
  - washing soda is expensive
  - washing soda is easily decomposed
  - washing soda reacts with aluminium to form soluble aluminate
  - washing soda reacts with aluminium to form insoluble aluminium oxide



19. When Al is added to KOH solution  
(a) no action takes place (b) oxygen is evolved  
(c) water is produced (d) hydrogen is evolved
20. Which of the following does not react with aqueous NaOH?  
(a) B (b) Al  
(c) Ga (d) Tl
21. Amphoteric oxide among the following is  
(a)  $B_2O_3$  (b)  $Ga_2O_3$   
(c)  $In_2O_3$  (d)  $Tl_2O_3$
22. Boron forms covalent compound due to  
(a) higher ionization energy  
(b) lower ionization energy  
(c) small size  
(d) Both (a) and (c)
23.  $NH_3$  and  $BF_3$  form an adduct readily because they form  
(a) a coordinate bond (b) a hydrogen bond  
(c) an ionic bond (d) a covalent bond
24. The factor responsible for weak acidic nature of B-F bonds in  $BF_3$  is  
(a) large electronegativity of fluorine  
(b) three centred two electron bonds in  $BF_3$   
(c)  $p\pi - d\pi$  back bonding  
(d)  $p\pi - p\pi$  back bonding
25. In borax bead test which compound is formed?  
(a) Ortho-borate (b) Meta-borate  
(c) Double oxide (d) Tetra-borate
26. The formula of mineral borax is  
(a)  $Na_2B_4O_7$  (b)  $Na_2B_4O_7 \cdot 4H_2O$   
(c)  $Na_2B_4O_7 \cdot 5H_2O$  (d)  $Na_2B_4O_7 \cdot 10H_2O$
27. Which of the following hydroxide is acidic?  
(a)  $Al(OH)_3$  (b)  $Ca(OH)_2$   
(c)  $Tl(OH)_3$  (d)  $B(OH)_3$
28. Orthoboric acid  
(a) donate proton to form  $H_2BO_3^-$   
(b) accept proton of form  $H_4BO_3^+$   
(c) donate  $OH^-$  to form  $H_2BO_2^+$   
(d) accept  $OH^-$  to form  $[B(OH)_4]^-$
29.  $H_3BO_3$  on heating up to 373 K yields:  
(a) boric anhydride (b) orthoboric acid  
(c) metaboric acid (d) tetraboric acid
30. Boric acid is polymeric due to  
(a) its acidic nature  
(b) the presence of hydrogen bonds  
(c) its monobasic nature  
(d) its geometry
31.  $B(OH)_3$  is  
(a) monobasic acid (b) dibasic acid  
(c) tribasic acid (d) triacidic base
32. Orthoboric acid when heated to red hot gives  
(a) metaboric acid (b) pyroboric acid  
(c) boron and water (d) boric anhydride
33. Which is false in case of boric acid  $H_3BO_3$ ?  
(a) It acts as a tribasic acid.  
(b) It has a planar structure.  
(c) It acts as a monobasic acid.  
(d) It is soluble in hot water.
34.  $BCl_3$  does not exist as dimer but  $BH_3$  exists as dimer ( $B_2H_6$ ) because  
(a) chlorine is more electronegative than hydrogen  
(b) there is  $p\pi - p\pi$  back bonding in  $BCl_3$  but  $BH_3$  does not contain such multiple bonding  
(c) large sized chlorine atoms do not fit in between the small boron atoms where as small sized hydrogen atoms get fitted in between boron atoms  
(d) None of the above
35. In reaction  $BF_3 + 3LiBH_4 \rightarrow 3LiF + X$ ; X is  
(a)  $B_4H_{10}$  (b)  $B_2H_6$   
(c)  $BH_3$  (d)  $B_3H_8$
36. Inorganic benzene is  
(a)  $B_3H_3N_3$  (b)  $BH_3NH_3$   
(c)  $B_3H_6N_3$  (d)  $H_3B_3N_6$
37. The structure of diborane ( $B_2H_6$ ) contains  
(a) four 2c-2e bonds and four 3c-2e bonds  
(b) two 2c-2e bonds and two 3c-3e bonds  
(c) two 2c-2e bonds and four 3c-2e bonds  
(d) four 2c-2e bonds and two 3c-2e bonds
38. In diborane  
(a) 4-bridged hydrogens and two terminal hydrogens are present  
(b) 2-bridged hydrogens and four terminal hydrogens are present  
(c) 3-bridged and three terminal hydrogens are present  
(d) None of these
39. Diborane upon hydrolysis gives  
(a) boric anhydride (b) metaboric acid  
(c) orthoboric acid (d) boron oxide
40. Borazole is known as  
(a) organic benzene (b) organic xylene  
(c) inorganic benzene (d) inorganic xylene
41. The compounds of boron and hydrogen are collectively called  
(a) diboranes (b) borazoles  
(c) boracits (d) boranes
42. The bonds present in borazole or inorganic benzene are  
(a)  $9\sigma, 6\pi$  (b)  $12\sigma, 3\pi$   
(c)  $6\sigma, 9\pi$  (d)  $15\sigma$  only
43. The two type of bonds present in  $B_2H_6$  are covalent and  
(a) ionic (b) co-ordinate  
(c) hydrogen bridge bond (d) None of these
44. Reaction of diborane with ammonia gives initially  
(a)  $B_2H_6 \cdot NH_3$  (b) Borazole  
(c)  $B_2H_6 \cdot 3NH_3$  (d)  $[BH_2(NH_3)_2]^+[BH_4]^-$



45. Which of the following compounds is not matched correctly with its structure?



46. The electronic configuration of four different elements is given below. Identify the group 14 element among these

- (a)  $[\text{He}] 2s^1$  (b)  $[\text{Ne}] 3s^2$   
(c)  $[\text{Ne}] 3s^2 3p^2$  (d)  $[\text{Ne}] 3s^2 3p^5$

47. Which of the following is most electronegative?

- (a) Pb (b) Si  
(c) C (d) Sn

48. Which of the following isotope of carbon is radioactive?

- (a)  $^{12}\text{C}$  (b)  $^{13}\text{C}$   
(c)  $^{14}\text{C}$  (d) All of these

49. Carbon and silicon belong to group 14. The maximum coordination number of carbon in commonly occurring compounds is 4, whereas that of silicon is 6. This is due to

- (a) large size of silicon  
(b) more electropositive nature of silicon  
(c) availability of *d*-orbitals in silicon  
(d) Both (a) and (b)

50. The inert pair effect is most prominent in

- (a) C (b) Pb  
(c) Ge (d) Si

51. The most stable +2 oxidation state is exhibited by

- (a) Fe (b) Sn  
(c) Pb (d) Si

52. Which of the following lead oxides is present in 'Sindhur'?

- (a)  $\text{PbO}$  (b)  $\text{PbO}_2$   
(c)  $\text{Pb}_2\text{O}_3$  (d)  $\text{Pb}_3\text{O}_4$

53. Mark the oxide which is amphoteric in character

- (a)  $\text{CO}_2$  (b)  $\text{SiO}_2$   
(c)  $\text{SnO}_2$  (d)  $\text{CaO}$

54. Red lead is

- (a)  $\text{Pb}_3\text{O}_4$  (b)  $\text{Pb}_2\text{O}_3$   
(c)  $\text{Pb}_2\text{O}$  (d)  $\text{PbO}$

55. The oxide of lead used in lead accumulators is

- (a)  $\text{PbO}$  (b)  $\text{Pb}_2\text{O}_3$   
(c)  $\text{Pb}_3\text{O}_4$  (d)  $\text{PbO}_2$

56. Which of the following is/are not correctly matched ?

- (i)  $\text{GeO}_2$  - Acidic (ii)  $\text{PbO}_2$  - Amphoteric  
(iii)  $\text{CO}$  - Neutral (iv)  $\text{SiO}_2$  - Amphoteric  
(a) (i) and (iv) (b) (iv) only  
(c) (ii) only (d) (iii) only

57. Least thermally stable is

- (a)  $\text{CCl}_4$  (b)  $\text{SiCl}_4$   
(c)  $\text{GeCl}_4$  (d)  $\text{GeBr}_4$

58. Unlike the other elements of its group carbon and silicon does not form  $\text{MX}_2$  type molecules because

- (a) energetically this is not possible  
(b) carbon undergoes catenation  
(c) it is non-metallic  
(d) carbon does not contain *d*-orbital

59. Which of the following halides is the most stable?

- (a)  $\text{CF}_4$  (b)  $\text{Cl}_4$   
(c)  $\text{CBr}_4$  (d)  $\text{CCl}_4$

60. The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence

- (a)  $\text{PbX}_2 \ll \text{SnX}_2 \ll \text{GeX}_2 \ll \text{SiX}_2$   
(b)  $\text{GeX}_2 \ll \text{SiX}_2 \ll \text{SnX}_2 \ll \text{PbX}_2$   
(c)  $\text{SiX}_2 \ll \text{GeX}_2 \ll \text{PbX}_2 \ll \text{SnX}_2$   
(d)  $\text{SiX}_2 \ll \text{GeX}_2 \ll \text{SnX}_2 \ll \text{PbX}_2$

61. Which of the following is not correct?

- (a)  $\text{Ge}(\text{OH})_2$  is amphoteric  
(b)  $\text{GeCl}_2$  is more stable than  $\text{GeCl}_4$   
(c)  $\text{GeO}_2$  is weakly acidic  
(d)  $\text{GeCl}_4$  in  $\text{HCl}$  forms  $[\text{GeCl}_2]^{2-}$  ion

62. The main reason that  $\text{SiCl}_4$  is easily hydrolysed as compared to  $\text{CCl}_4$  is that

- (a) Si-Si bond is weaker  
(b)  $\text{SiCl}_4$  can form hydrogen bonds  
(c)  $\text{SiCl}_4$  is covalent  
(d) Si can extend its coordination number beyond four

63. Which halide is least stable and has doubtful existence

- (a)  $\text{Cl}_4$  (b)  $\text{GeI}_4$   
(c)  $\text{SnI}_4$  (d)  $\text{PbI}_4$

64.  $\text{PbF}_4$ ,  $\text{PbCl}_4$  exist but  $\text{PbBr}_4$  and  $\text{PbI}_4$  do not exist because of

- (a) large size of  $\text{Br}^-$  and  $\text{I}^-$   
(b) strong oxidising character of  $\text{Pb}^{4+}$   
(c) strong reducing character of  $\text{Pb}^{4+}$   
(d) low electronegativity of  $\text{Br}^-$  and  $\text{I}^-$

65. Catenation i.e., linking of similar atoms depends on size and electronic configuration of atoms. The tendency of catenation in Group 14 elements follows the order :  
 (a)  $C > Si > Ge > Sn$  (b)  $C \gg Si > Ge \approx Sn$   
 (c)  $Si > C > Sn > Ge$  (d)  $Ge > Sn > Si > C$
66. The catenation tendency of C, Si and Ge is in the order  $Ge < Si < C$ . The bond energies (in  $\text{kJ mol}^{-1}$ ) of C-C, Si-Si and Ge-Ge bonds, respectively are  
 (a) 167, 180, 348 (b) 180, 167, 348  
 (c) 348, 167, 180 (d) 348, 180, 167
67. Lead pipes are readily corroded by  
 (a)  $\text{H}_2\text{SO}_4$  (b)  $\text{HCl}$   
 (c)  $\text{CH}_3\text{COOH}$  (d) pure water
68. Lead pipes are not suitable for drinking water because  
 (a) lead forms basic lead carbonate  
 (b) lead reacts with water containing air to form  $\text{Pb}(\text{OH})_2$   
 (c) a layer of lead dioxide is deposited over pipes  
 (d) lead reacts with air to form litharge
69. The reducing power of divalent species decreases in the order  
 (a)  $Ge > Sn > Pb$  (b)  $Sn > Ge > Pb$   
 (c)  $Pb > Sn > Ge$  (d) None of these
70. The element that does not show catenation among the following p-block elements is  
 (a) carbon (b) silicon  
 (c) germanium (d) lead
71. How many six membered and five membered rings are present in fullerene?  
 (a) Six membered = 20, five membered = 10  
 (b) Six membered = 20, five membered = 12  
 (c) Six membered = 25, five membered = 10  
 (d) Six membered = 12, five membered = 25
72. Which of the following is the pure form of carbon ?  
 (a) Diamond  
 (b) Fullerene  
 (c) Graphite  
 (d) All three forms are equally pure
73. Which one of the following is not an allotrope of carbon ?  
 (a) Carborundum (b) Diamond  
 (c) Soot (d) Graphite
74. Which of the following types of forces bind together the carbon atoms in diamond ?  
 (a) Ionic (b) Covalent  
 (c) Dipolar (d) van der Waal's
75. Carborundum is  
 (a)  $\text{SiC}$  (b)  $\text{CaC}_2$   
 (c)  $\text{Mg}_2\text{C}_3$  (d) None of these
76. Buckminster fullerene is  
 (a) pure graphite (b) C-60  
 (c) diamond (d) C-90
77. The hybridisation state of carbon in fullerene is  
 (a)  $sp$  (b)  $sp^2$   
 (c)  $sp^3$  (d)  $sp^3d$
78. The number of carbon atoms in Buckminsterfullerene is  
 (a) 50 (b) 350  
 (c) 60 (d) 70
79. Graphite is a soft solid lubricant extremely difficult to melt. The reason for this anomalous behaviour is that graphite  
 (a) is an allotropic form of diamond  
 (b) has molecules of variable molecular masses like polymers  
 (c) has carbon atoms arranged in large plates of rings of strongly bound carbon atoms with weak inter plate bonds  
 (d) is a non-crystalline substance
80. In graphite, electrons are  
 (a) localised on every third C-atom  
 (b) present in anti-bonding orbital  
 (c) localised on each C-atom  
 (d) spread out between the structure
81. The elements commonly used for making transistors are  
 (a) C and Si (b) Ga and In  
 (c) P and As (d) Si and Ge
82. The element which is exclusively applied as semi-conductor  
 (a) Au (b) Ge  
 (c) Pt (d) Si
83. Glass is a  
 (a) liquid  
 (b) solid  
 (c) supercooled liquid  
 (d) transparent organic polymer
84. Glass reacts with  $\text{HF}$  to produce  
 (a)  $\text{SiF}_4$  (b)  $\text{H}_2\text{SiF}_6$   
 (c)  $\text{H}_2\text{SiO}_3$  (d)  $\text{Na}_3\text{AlF}_6$
85. Producer gas is the mixture of  
 (a)  $\text{CO} + \text{N}_2$  (b)  $\text{CO} + \text{H}_2$   
 (c)  $\text{CO} + \text{water vapours}$  (d)  $\text{N}_2 + \text{CH}_4$
86. Coal gas is a mixture of  
 (a)  $\text{H}_2\text{O}$  and  $\text{CO}$  (b)  $\text{H}_2, \text{CO}, \text{N}_2$  and  $\text{CH}_4$   
 (c)  $\text{H}_2$  and  $\text{CO}$  (d)  $\text{CH}_4$  and  $\text{CO}$
87. Crystalline form of silica is called  
 (a) crystalline silicon (b) quartz  
 (c) rock (d) talc
88. Dry ice is  
 (a) solid  $\text{SO}_2$  (b) solid  $\text{NH}_3$   
 (c) solid  $\text{O}_2$  (d) solid  $\text{CO}_2$
89. In silica ( $\text{SiO}_2$ ), each silicon atom is bonded to  
 (a) two oxygen atoms  
 (b) four oxygen atoms  
 (c) one silicon and two oxygen atoms  
 (d) one silicon and three oxygen atoms

90.  $R_3SiCl$  on hydrolysis forms  
 (a)  $R_3SiOH$  (b)  $R_3Si-O-SiR_3$   
 (c)  $R_2Si=O$  (d) None of these
91. Which of the following statements is false?  
 (a) Water gas is a mixture of hydrogen and carbon monoxide  
 (b) Producer gas is a mixture of CO and nitrogen  
 (c) Water gas is a mixture of water vapour and hydrogen  
 (d) Natural gas consists of methane, ethane and gaseous hydrocarbons.
92. Which gas is essential constituent of almost all fuel gases?  
 (a)  $CO_2$  (b)  $N_2$   
 (c) CO (d)  $H_2O$
93.  $CO_2$  is used for extinguishing fire because  
 (a) it has a relatively high critical temperature  
 (b) in solid state, it is called dry ice  
 (c) it is neither combustible nor a supporter of combustion  
 (d) it is a colourless gas
94. The correct statement with respect to CO is  
 (a) it combines with  $H_2O$  to give carbonic acid  
 (b) it reacts with haemoglobin in RBC  
 (c) it is powerful oxidising agent  
 (d) it is used to prepare aerated drinks
95. Producer gas, a fuel and also a source of nitrogen is obtained by  
 (a) passing a mixture of steam and air over incandescent coke.  
 (b) spraying oil into hot retorts.  
 (c) restricted supply of air through a bed of incandescent coke.  
 (d) passing steam over incandescent coke.
96. Which of the following shows bond in silicone :  
 (a)  $Si-Si-Si-Si$  (b)  $-Si-O-Si-O-Si$   
 (c)  $Si-C-Si-C-Si$  (d)  $Si-C-Si-O-Si$
97. Which of the following is formed on dehydration of formic acid with concentrated  $H_2SO_4$  ?  
 (a) CO (b)  $CO_2$   
 (c)  $CH_4$  (d)  $H_2$
98. \_\_\_\_\_ helps to maintain pH of blood between 7.26 to 7.42  
 (a)  $CO_2$  (b)  $H_2CO_3$   
 (c)  $CO_3^{2-}$  (d)  $H_2CO_3/HCO_3^-$
99. Which of the following is not the crystalline form of silica?  
 (a) Quartz  
 (b) Cristobalite  
 (c) Tridymite  
 (d) All are crystalline form of silica.
100. Which of the following is used in surgical and cosmetic plants?  
 (a) Silicones (b) Silicates  
 (c) Silica (d) None of these

101. Which of the following is not a man-made silicate ?  
 (a) Glass (b) Cement  
 (c) Zeolites (d) All are man-made silicates
102. Which type of zeolite is used to convert alcohols directly into gasoline ?  
 (a) ZSM - 3 (b) ZSM - 5  
 (c) ZSM - 2 (d) All of these

### STATEMENT TYPE QUESTIONS

103. Which of the following statement(s) is/are not correct ?  
 (i) Valence shell electronic configuration of p-block elements is  $ns^2 np^{1-6}$   
 (ii) Non metals and metalloids exist only in the p-block of the periodic table.  
 (iii) In boron, carbon and nitrogen families the group oxidation state is the most stable state for the lighter elements in the group.  
 (iv) For heavier elements in each group oxidation state two unit less than the group oxidation state becomes more stable due to inert pair effect  
 (a) (ii) only  
 (b) (ii), (iii) and (iv)  
 (c) (iii) and (iv)  
 (d) All given statements are correct
104. Which of the following sequence of T and F is correct for given statements. Here T represents 'True' and F represents 'False' statement.  
 (i) Aluminium forms  $[AlF_6]^{3-}$  ion while boron forms only  $[BF_4]^-$  ion due to presence of d-orbitals in aluminium.  
 (ii) The first member of a group differs from the heavier members in its ability to form  $p\pi-p\pi$  multiple bonds to itself and to other second row elements. While heavier member forms  $d\pi-p\pi$  bonds.  
 (iii) d-orbitals contribute more to the overall stability of molecules than  $p\pi-p\pi$  bonding of second row elements.  
 (a) TTT (b) FTF  
 (c) TTF (d) FTT
105. Which of the following statement(s) is/are incorrect ?  
 (i) Trichlorides on hydrolysis in water form tetrahedral  $[M(OH)_4]^-$  species.  
 (ii) Hybridisation state of metal in tetrahedral species is  $sp^3$ .  
 (iii) Aluminium chloride in acidified aqueous solution forms  $[Al(OH)_4]^-$  ion.  
 (a) (i) and (ii) (b) (ii) only  
 (c) (iii) only (d) (i) and (iii)
106. Which of the following statement(s) regarding  $BCl_3$  and  $AlCl_3$  is/are correct ?  
 (i)  $BCl_3$  possess lower melting point than  $AlCl_3$ .  
 (ii)  $BCl_3$  is more covalent in character than  $AlCl_3$ .  
 (a) Statement (i) is correct explanation for statement (ii).  
 (b) Statement (i) and (ii) both are incorrect  
 (c) Statement (i) and (ii) both are correct  
 (d) Statement (ii) is correct explanation for statement (i)

107. Which of the following statement(s) is/are incorrect ?

- (i) Higher boranes are not flammable.
- (ii) Boranes are hydrolysed by water to give orthoboric acid.
- (iii) Boranes undergoes cleavage reactions with Lewis bases to give borane adducts.
- (a) (i) only                      (b) (ii) and (iii)
- (c) (iii) only                    (d) (i) and (ii)

108. Select the correct statements for diborane :

- (i) Boron is approximately  $sp^3$  hybridized
- (ii) B-H-B angle is  $180^\circ$
- (iii) There are two terminal B-H bonds for each boron atom
- (iv) There are only 12 bonding electrons
- (a) (i), (ii) and (iv)              (b) (i), (ii) and (iii)
- (c) (ii), (iii) and (iv)            (d) (i), (iii) and (iv)

109. Which of the following sequence of T and F is correct for given statements. Here T stands for the true and F stands for false statement.

- (i) The tendency to show +2 oxidation state increase in the sequence  $Ge < Sn < Pb$ .
- (ii) Tin in +2 state is a reducing agent.
- (iii) Lead compounds in +2 state are strong oxidising agents.
- (iv) In tetravalent state molecules of group 13 elements act as electrons donor species.
- (a) TTTT                              (b) TTFF
- (c) TTFT                              (d) TFFT

110. Which of the following statement(s) is / are incorrect for  $CO_2$ ?

- (i) In laboratory  $CO_2$  is prepared by the action of dilute HCl on calcium carbonate
- (ii) Carbon dioxide is a poisonous gas
- (iii) Increase in carbon dioxide content in atmosphere lead to increase in green house effect.
- (iv)  $CO_2$  as dry ice is used as a refrigerant for ice cream and frozen food.
- (a) (i) and (ii)                      (b) Only (ii)
- (c) (i), (ii) and (iii)              (d) (ii) and (iii)

111. Which of the following sequence of T and F is correct for given statements. Here T stands for true and F stands for false statement.

- (i) Quartz is extensively used as a piezoelectric material.
- (ii) Kieselghur is an amorphous form of silica which is used in filtration plants.
- (iii) Silica does not react with halogens, dihydrogen and most of the acids and metals even at elevated temperature.
- (a) TTT                                  (b) TFF
- (b) TFT                                  (d) FFT

### MATCHING TYPE QUESTIONS

112. Match the columns

Column-I	Column-II
(A) Borax-bead	(p) Alum
(B) Inorganic benzene	(q) Diborane
(C) Antiseptic	(r) Metaborate
(D) Bridged hydrogens	(s) Borazole
(a) A - (p), B - (r), C - (q), D - (s)	
(b) A - (r), B - (s), C - (p), D - (q)	
(c) A - (s), B - (r), C - (p), D - (q)	
(d) A - (q), B - (r), C - (s), D - (p)	

113. Identify (i) to (v) in reactions (1) and (2) on the basis of your identification choose the correct code for matching Column-I with Column-II.

1.  $Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} (i) \xrightarrow{\Delta} (ii) + (iii)$
2.  $Na_2B_4O_7 \cdot 7H_2O \longrightarrow (iv) + (v)$

Column-I	Column-II
(A) (i)	(p) $H_3BO_3$
(B) (ii)	(q) $B_2O_3$
(C) (iii)	(r) $NaBO_2$
(D) (iv)	(s) NaOH
(E) (v)	(t) $Na_2B_4O_7$
(a) A - (t), B - (s), C - (p), D - (q), E - (r)	
(b) A - (r), B - (q), C - (s), D - (p), E - (t)	
(c) A - (t), B - (r), C - (q), D - (p), E - (s)	
(d) A - (t), B - (r), C - (s), D - (q), E - (p)	

114. Match Column-I (Compound of boron) with Column-II (Use) and choose the correct option.

Column-I	Column-II
(A) Metal borides	(p) Flux for soldering metals
(B) Boron fibres	(q) Bullet-proof vest
(C) Borax	(r) As a mild antiseptic
(D) Boric acid	(s) As control rods in nuclear industry
(a) A - (q), B - (s), C - (r), D - (p)	
(b) A - (q), B - (s), C - (p), D - (r)	
(c) A - (s), B - (q), C - (r), D - (p)	
(d) A - (s), B - (q), C - (p), D - (r)	

115. Match the columns

Column-I	Column-II
(A) Carbon	(p) Metal
(B) Silicon	(q) Non-metal
(C) Germanium	(r) Metalloid
(D) Tin	
(E) Lead	
(a) A - (q), B - (q), C - (r), D - (p), E - (p)	
(b) A - (q), B - (r), C - (r), D - (p), E - (p)	
(c) A - (q), B - (r), C - (r), D - (p), E - (q)	
(d) A - (q), B - (q), C - (q), D - (r), E - (p)	

116. Match columns

Column-I	Column-II
(A) Graphite fibres	(p) Abrasive for sharpening hard tools
(B) Carbon black	(q) Formation of light weight composites.
(C) Charcoal	(r) Used in water filters to remove organic contaminants
(D) Diamond	(s) As filler in automobile tyres
(a) A – (s), B – (q), C – (r), D – (p)	
(b) A – (q), B – (s), C – (r), D – (p)	
(c) A – (q), B – (r), C – (s), D – (p)	
(d) A – (p), B – (r), C – (s), D – (q)	

117. Match the columns

Column-I	Column-II
(A) Borazole	(p) $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$
(B) Plaster of Paris	(q) $\text{C}_{60}$
(C) Boric acid	(r) $\text{SiO}_2$
(D) Quartz	(s) $\text{B}_3\text{N}_3\text{H}_6$
(E) Buckminsterfullerene	(t) $\text{H}_3\text{BO}_3$
(a) A – (r); B – (p); C – (q); D – (t); E – (s)	
(b) A – (p); B – (t); C – (r); D – (s); E – (q)	
(c) A – (t); B – (q); C – (p); D – (r); E – (s)	
(d) A – (s); B – (p); C – (t); D – (r); E – (q)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

118. **Assertion :** Atomic radius of gallium is higher than that of aluminium

**Reason :** The presence of additional *d*-electron offer poor screening effect for the outer electrons from increased nuclear charge.

119. **Assertion :** Boron is metalloid.

**Reason :** Boron shows metallic nature.

120. **Assertion :** The use of aluminium and its compounds for domestic purposes is now reduced considerably.

**Reason :** The highly toxic nature of aluminium is the responsible factor.

121. **Assertion :**  $\text{Pb}^{4+}$  compounds are stronger oxidizing agents than  $\text{Sn}^{4+}$  compounds.

**Reason :** The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to 'inert pair effect'.

122. **Assertion :**  $\text{PbI}_4$  of lead does not exist.

**Reason :** Pb–I bond initially formed during the reaction does not release enough energy to unpair  $6s^2$  electrons.

123. **Assertion :** Graphite is thermodynamically most stable allotrope of carbon.

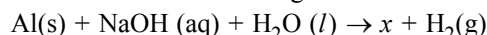
**Reason :**  $\Delta_f H^\ominus$  of graphite is taken as zero.

### CRITICAL THINKING TYPE QUESTIONS

124. The liquefied metal which expands on solidification is :

- (a) Ga (b) Al  
(c) Zn (d) In

125. What is *x* in the following reaction?



- (a)  $\text{Na}_2[\text{Al}(\text{OH})_4]^-$  (b)  $\text{Na}^+[\text{Al}(\text{OH})_4]^-$   
 (c)  $\text{Na}_2[\text{Al}(\text{OH})_6]^-$  (d)  $\text{Na}^+[\text{Al}(\text{OH})_6]^-$

126. Which among the following oxides react with alkali?

$\text{B}_2\text{O}_3$ ,  $\text{Al}_2\text{O}_3$  and  $\text{Ti}_2\text{O}$

- (a)  $\text{B}_2\text{O}_3$  and  $\text{Al}_2\text{O}_3$  (b)  $\text{Al}_2\text{O}_3$  and  $\text{Ti}_2\text{O}$   
 (c) Only  $\text{B}_2\text{O}_3$  (d)  $\text{B}_2\text{O}_3$  and  $\text{Ti}_2\text{O}$

127. White fumes appeared around the bottle of anhydrous aluminium chloride is due to \_\_\_\_\_

- (a)  $\text{Cl}_2$  gas  
 (b) moist HCl  
 (c) condensation of aluminium chloride vapours  
 (d) None of these

128. What is the oxidation state and hybridisation of boron in compound formed when  $\text{BCl}_3$  undergoes reaction with the water?

- (a) 3,  $\text{sp}^2\text{d}$  (b) 3,  $\text{sp}^3$   
 (c) 4,  $\text{sp}^3$  (d) 3,  $\text{sp}^2\text{d}$

129. Which is not correct?

- (a) Al acts as a reducing agent  
 (b) Al does not react with steam even at higher temperature  
 (c) Al forms a number of alloys with other metals  
 (d) Al is ionic in all its compounds

130. Which one of the following is the correct statement?

- (a) Boric acid is a protonic acid  
 (b) Beryllium exhibits coordination number of six  
 (c) Chlorides of both beryllium and aluminium have bridged structures in solid phase  
 (d)  $\text{B}_2\text{H}_6 \cdot 2\text{NH}_3$  is known as 'inorganic benzene'

131.  $\text{BF}_3$  is used as a catalyst in several industrial processes due to its

- (a) strong reducing nature  
 (b) weak reducing action  
 (c) strong Lewis acid nature  
 (d) weak Lewis acid character

132. What is the colour obtained when borax is heated in a Bunsen burner flame with  $\text{CoO}$ ?

- (a) Blue (b) Black  
 (c) Green (d) Violet

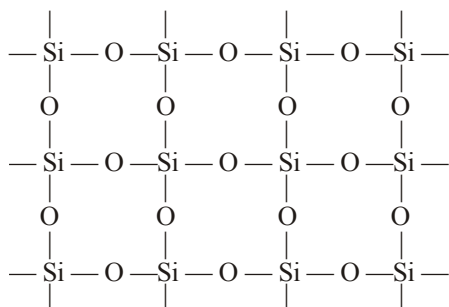


133. Which of the following statements about  $\text{H}_3\text{BO}_3$  is not correct?
- It is a strong tribasic acid
  - It is prepared by acidifying an aqueous solution of borax
  - It has a layer structure in which planar  $\text{BO}_3$  units are joined by hydrogen bonds
  - It does not act as proton donor but acts as a Lewis acid by accepting a lone pair of electrons
134. The hybridisation of boron atom in orthoboric acid is
- sp
  - $\text{sp}^2$
  - $\text{sp}^3$
  - $\text{sp}^3\text{d}$
135. Which is not the use of orthoboric acid?
- As an antiseptic and eye wash.
  - In glass industry.
  - In glazes for pottery.
  - In borax - bead test.
136. Which of the following reaction shows production of diborane on industrial scale ?
- $4\text{BF}_3 + 3\text{LiAlH}_4 \longrightarrow 2\text{B}_2\text{H}_6 + 3\text{LiF} + 3\text{AlF}_3$
  - $2\text{NaBH}_4 + \text{I}_2 \longrightarrow \text{B}_2\text{H}_6 + 2\text{NaI} + \text{H}_2$
  - $2\text{BF}_3 + 6\text{NaH} \xrightarrow{450\text{K}} \text{B}_2\text{H}_6 + 6\text{NaF}$
  - Both (b) and (c)
137. Identify the statement that is not correct as far as structure of diborane is concerned
- There are two bridging hydrogen atoms and four terminal hydrogen atoms in diborane
  - Each boron atom forms four bonds in diborane
  - The hydrogen atoms are not in the same plane in diborane
  - All, B-H bonds in diborane are similar
138. Which of the following structure is similar to graphite?
- B
  - $\text{B}_4\text{C}$
  - $\text{B}_2\text{H}_6$
  - BN
139. A compound X, of boron reacts with  $\text{NH}_3$  on heating to give another compound Y which is called inorganic benzene. The compound X can be prepared by treating  $\text{BF}_3$  with lithium aluminium hydride. The compounds X and Y are represented by the formulas.
- $\text{B}_2\text{H}_6, \text{B}_3\text{N}_3\text{H}_6$
  - $\text{B}_2\text{O}_3, \text{B}_3\text{N}_3\text{H}_6$
  - $\text{BF}_3, \text{B}_3\text{N}_3\text{H}_6$
  - $\text{B}_3\text{N}_3\text{H}_6, \text{B}_2\text{H}_6$
140. The product/s formed when diborane is hydrolysed is/are
- $\text{B}_2\text{O}_3$  and  $\text{H}_3\text{BO}_3$
  - $\text{B}_2\text{O}_3$  only
  - $\text{H}_3\text{BO}_3$  and  $\text{H}_2$
  - $\text{H}_3\text{BO}_3$  only
141. Which of the following species exists (A)  $[\text{SiF}_6]^{2-}$ , (B)  $[\text{GeCl}_6]^{2-}$  and (C)  $[\text{CCl}_6]^{2-}$ ?
- (A) and (B)
  - (B) and (C)
  - Only (C)
  - (A) and (C)
142. Ge(II) compounds are powerful reducing agents whereas Pb(IV) compounds are strong oxidants. It is because
- Pb is more electropositive than Ge
  - ionization potential of lead is less than that of Ge
  - ionic radii of  $\text{Pb}^{2+}$  and  $\text{Pb}^{4+}$  are larger than those of  $\text{Ge}^{2+}$  and  $\text{Ge}^{4+}$
  - of more pronounced inert pair effect in lead than in Ge
143. Which of the following statements is not correct ?
- Fullerene is formed by condensation of vapourised  $\text{C}^n$  small molecules consists of mainly  $\text{C}_{60}$ .
  - In fullerene a six membered ring can only fuse with five membered ring and a five membered ring can only fuse with six membered rings.
  - All carbon atoms are  $\text{sp}^2$  hybridised in fullerene
  - All the above are correct.
144. The element that does not form a monoxide is
- lead
  - tin
  - germanium
  - silicon
145. A group 14 element is oxidised to form corresponding oxide which is gaseous in nature, when dissolved in water pH of the water decreases further addition of group 2 hydroxides leads to precipitation. This oxide can be
- $\text{GeO}_2$
  - CO
  - $\text{CO}_2$
  - $\text{SnO}_2$
146. Which among the following can act as reducing agent (A)  $\text{SnCl}_2$ , (B) CO and (C)  $\text{PbCl}_2$ ?
- (A) and (B)
  - (B) and (C)
  - (C) and (A)
  - Only (B)
147. Lead is not affected by dil. HCl in cold because
- Pb is less electronegative than H
  - $\text{PbO}$  film is formed which resists chemical attack by acid
  - $\text{PbCl}_2$  protective coating gets formed on Pb surface
  - $\text{PbO}_2$  film is always present on Pb surface, which resist chemical attack
148. The percentage of s-character of the hybrid orbitals of carbon in graphite and diamond are respectively
- 33, 25
  - 50, 50
  - 67, 25
  - 33, 67
149. What is the hybridisations of carbon atoms present in diamond, graphite and fullerene respectively?
- $\text{sp}^3, \text{sp}^2$  and  $\text{sp}^2$
  - $\text{sp}^2, \text{sp}^3$  and  $\text{sp}^2$
  - $\text{sp}^2, \text{sp}^2$  and  $\text{sp}^3$
  - $\text{sp}^3, \text{sp}^3$  and  $\text{sp}^2$
150. Which one of the following allotropic forms of carbon is isomorphous with crystalline silicon?
- Graphite
  - Coal
  - Coke
  - Diamond
151. Which one of the following statements about the zeolites is false ?
- They are used as cation exchangers
  - They have open structure which enables them to take up small molecules
  - Zeolites are aluminosilicates having three dimensional network
  - None of the above
152. Which of the following attacks glass
- HCl
  - HF
  - HI
  - HBr



45. (c)  $\begin{array}{c} \text{Cl} > \text{Al} < \text{Cl} > \text{Cl} < \text{Cl} \\ \text{Cl} < \text{Al} > \text{Al} < \text{Al} \end{array}$   $\text{AlCl}_3$  (dimer)
46. (c) Valence shell electronic configuration of group 14 elements is  $ns^2p^2$ .
47. (c) Electronegativity decreases down the group.
48. (c)  $^{14}\text{C}$  is a radioactive isotope with half life of 5770 years and used for radiocarbon dating.
49. (c) Due to non-availability of vacant  $d$ -orbitals, it cannot exceed its coordination number more than four. Thus carbon never forms complexes e.g.,  $[\text{CCl}_6]^{2-}$  does not exist but  $[\text{SiCl}_6]^{2-}$  exists.
50. (b) The inert pair effect is most prominent in the heavier members of the group. Inert pair effect increases as we move the group down the group.
51. (c) Inert pair effect increases down the group. Hence for  $\text{Pb}^{2+}$ , O.S. is most stable.
52. (d)  $\text{Pb}_3\text{O}_4$  is also known as Sindhur.
53. (c)  $\text{CO}_2$ ,  $\text{SiO}_2$  are acidic,  $\text{CaO}$  is basic and  $\text{SnO}_2$  is amphoteric.
54. (a) Red lead is  $\text{Pb}_3\text{O}_4$ . It is a mixed oxide of Pb (II) and Pb (IV). It acts as a powerful oxidising agent.
55. (d)  $\text{PbO}_2$  is a strong oxidising agent and is produced in situ in lead storage batteries. The anode is oxidized to  $\text{PbO}_2$  and cathode is reduced to spongy Pb.
56. (b)  $\text{SiO}_2$  is acidic oxide.
57. (d) The thermal stability of tetrahalides decreases in order  $\text{CX}_4 > \text{SiX}_4 > \text{GeX}_4 > \text{SnX}_4$  and in terms of same metal with different halides is in order of  $\text{MF}_4 > \text{MCl}_4 > \text{MBr}_4 > \text{MI}_4$ .
58. (a) The stability of dihalides ( $\text{MX}_2$ ) increases down the group. Except C and Si, the other members form dihalides.
59. (a) Since bond energy of  $\text{C-F} > \text{C-Cl} > \text{C-Br} > \text{C-I}$  Hence  $\text{CF}_4$  is most stable.
60. (d) Reluctance of valence shell electrons to participate in bonding is called inert pair effect. The stability of lower oxidation state (+2 for group 14 element) increases on going down the group. So the correct order is  $\text{SiX}_2 < \text{GeX}_2 < \text{SnX}_2 < \text{PbX}_2$
61. (b)  $\text{Ge}^{4+}$  is more stable than  $\text{Ge}^{2+}$ . Hence  $\text{GeCl}_4$  is more stable than  $\text{GeCl}_2$
62. (d) Carbon halides are not hydrolysed due to absence of  $d$ -orbitals. On the other hand  $\text{SiCl}_4$  is easily hydrolysed due to the availability of  $d$ -orbitals in Si.  
 $\text{SiX}_4 + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 4\text{HX}$
63. (d) In nature  $\text{Pb}^{4+}$  is strong oxidant and  $\text{I}^-$  is strong reductant. Hence  $\text{PbI}_4$  cannot exist.
64. (b) F and Cl are more oxidising in nature and can achieve Pb in (IV) O.S. but  $\text{Br}_2$  and  $\text{I}_2$  can not achieve Pb in (IV) O.S. secondly  $\text{Pb}^{4+}$  is strong in oxidising nature and in its presence,  $\text{Br}^-$  and  $\text{I}^-$  can not exist.
65. (b)
66. (d) The more the bond energy, the more is the catenation.
67. (c) Lead pipes are readily corroded by water containing organic acids.
68. (b)  $2\text{Pb} + 2\text{H}_2\text{O} + \text{O}_2 \rightarrow 2\text{Pb}(\text{OH})_2$
69. (a) The stability of +2 O.S. follows the order  $\text{Pb}^{2+} > \text{Sn}^{2+} > \text{Ge}^{2+}$   
Hence reducing power  $\text{Ge} > \text{Sn} > \text{Pb}$
70. (d) The order of tendency of catenation for elements of C family is  $\text{C} \gg \text{Si} > \text{Ge} \approx \text{Sn} > \text{Pb}$
71. (b) Fullerene contains twenty six membered rings and twelve five membered rings.
72. (b) Fullerenes are the only pure form of carbon because they have smooth structure without having dangling bonds.
73. (a) Carborundum is chemically  $\text{SiC}$ . It is not an allotrope of carbon.
74. (b) In diamond each carbon atom is  $\text{sp}^3$  hybridized and thus forms covalent bonds with four other carbon atoms lying at the corners of a regular tetrahedron.
75. (a)
76. (b) Buckminster fullerene is  $\text{C}_{60}$ . The molecule has shape of soccer ball.
77. (b) In fullerene each carbon atom is bonded to three other carbon atoms and is  $\text{sp}^2$  hybridised.
78. (c) Buckminster fullerene has the formula  $\text{C}_{60}$  and is made from interlocking hexagonal and pentagonal rings of C-atoms.
79. (c)
80. (d) In graphite, each carbon is  $\text{sp}^2$ -hybridized and the single occupied unhybridized p-orbitals of C-atoms overlap side wise to give  $\pi$ -electron cloud which is delocalized and thus the electrons are spread out between the structure.
81. (d) Si and Ge are semiconductors and are used in making transistors.
82. (b) Both Ge and Si are extensively used as semiconductors. Semiconductors are solids where there is only a small difference in energy, called band gap, between the filled valency band of electrons and a conduction band since the band gap of Ge is less than Si, it is a better element to be used as semiconductor.
83. (c) Glass is a super cooled liquid.
84. (b)  $6\text{HF} + \text{SiO}_2 \rightarrow \text{H}_2\text{SiF}_6 + 2\text{H}_2\text{O}$

85. (a) Producer gas is a fuel gas and is mixture of CO and N<sub>2</sub>.  
 86. (b) Coal gas is a mixture of H<sub>2</sub> + CO + N<sub>2</sub> + CH<sub>4</sub>  
 87. (b) Quartz is crystalline form of silica.  
 88. (d)  
 89. (b) In silica (SiO<sub>2</sub>); each Si atom is surrounded by four oxygen atom.



Structure of SiO<sub>2</sub>

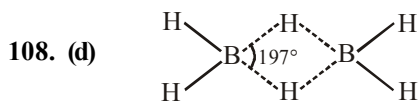
Only Si – O bonds exist and no Si = O.

90. (b)  $R_3SiCl + HOH \rightarrow R_3SiOH + HCl$   
 $R_3SiOH + HOSiR_3 \rightarrow R_3Si-O-SiR_3 + H_2O$   
 91. (a) Water gas is CO + H<sub>2</sub>  
 92. (c) CO is essential constituent of almost all fuel gases.  
 93. (c) CO<sub>2</sub> is incombustible and non supporter of combustion.  
 94. (b) CO react with haemoglobin, forms carboxy haemoglobin and stopes the supply of O<sub>2</sub>  
 95. (c) Producer gas is mixture of CO + N<sub>2</sub>. It is prepared by incomplete combustion of coal in limited supply of air.  
 96. (b) Silicone has Si – O – Si – O – Si linkage.  
 97. (a)  $HCOOH \xrightarrow[\text{conc. } H_2SO_4]{373K} H_2O + CO$   
 98. (d) H<sub>2</sub>CO<sub>3</sub>/HCO<sub>3</sub><sup>-</sup> buffer system help to maintain pH of blood between 7.26 to 7.42.  
 99. (d) Quartz, Cristobalite and Tridymite are crystalline form of silica.  
 100. (a) Being biocompatible silicones are used in surgical and cosmetic plants.  
 101. (c) Zeolite is not a man-made silicate.  
 102. (b) ZSM – 5 type of zeolite is used to convert alcohols directly into gasoline.

### STATEMENT TYPE QUESTIONS

103. (d) All the given statements are correct.  
 104. (c) *d*-orbitals are of higher energy than the *p*-orbitals, they contribute less to the overall stability of molecules than *pπ-pπ* bonding of the second row elements.  
 105. (c) Aluminium chloride in acidified aqueous solution forms octahedral [Al(H<sub>2</sub>O)<sub>6</sub>]<sup>3+</sup> ion.

106. (d) BCl<sub>3</sub> is a covalent compound hence lower melting point.  
 107. (a) Higher boranes are also spontaneously flammable in air.



B is *sp*<sup>3</sup> hybridized

Only 12 bonding electrons available

BHB angle is 97° not 180°.

109. (b) Lead compounds in +4 state are strong oxidising agents. In tetravalent state the number of electrons around the central atom in a molecule is eight. Being electron precise molecules, they are normally not expected to act as electron acceptor or electron donor species.  
 110. (b) Carbon dioxide is not a poisonous gas.  
 111. (a) All the given statements are true.

### MATCHING TYPE QUESTIONS

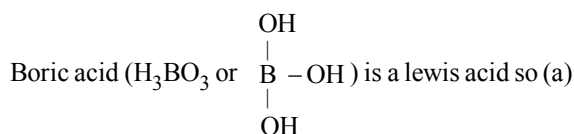
112. (b)  
 113. (c)  $Na_2B_4O_7 \cdot 10H_2O \xrightarrow{\Delta} Na_2B_4O_7 \xrightarrow{\Delta} (i) \quad 2NaBO_2 + B_2O_3 \quad (ii) \quad (iii)$   
 $Na_2B_4O_7 + 7H_2O \longrightarrow 4H_3BO_3 + 2NaOH \quad (iv) \quad (v)$   
 114. (d)  
 115. (a) Carbon and silicon are non-metals. Germanium is a metalloid. Tin and lead are metals.  
 116. (b) 117. (d)

### ASSERTION-REASON TYPE QUESTIONS

118. (c) Atomic radius of gallium is less than that of aluminium.  
 119. (c) Boron is metalloid. Thus assertion is correct. Metalloids possess, metallic as well as non-metallic nature. Hence, reason is false.  
 120. (a) The use of aluminium and its compounds for domestic purposes is now reduced considerably because of their toxic nature.  
 121. (c) Assertion is true because lower oxidation state becomes more & more stable for heavier elements in *p*-block due to inert pair effect. Hence Reason is false.  
 122. (a) PbI<sub>4</sub> does not exist because Pb–I bond initially formed during the reaction does not release enough energy to unpair 6*s*<sup>2</sup> electrons and excite one of them to higher orbital to have four unpaired electrons around lead atom.  
 123. (a)

# CRITICAL THINKING TYPE QUESTIONS

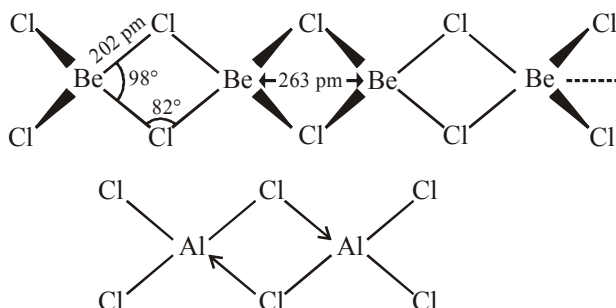
124. (a) Gallium (Ga) is soft, silvery metal. Its melting point is 30°C. This metal expands by 3.1% when it solidifies and hence, it should not be stored in glass or metal containers.
125. (b)  $2\text{Al(s)} + 2\text{NaOH(aq)} + 6\text{H}_2\text{O(l)} \rightarrow 2\text{Na}^+[\text{Al(OH)}_4]^- \text{(aq)} + 3\text{H}_2 \text{(g)}$
126. (a)  $\text{B}_2\text{O}_3$  is acidic and  $\text{Al}_2\text{O}_3$  is amphoteric.
127. (b) Anhydrous aluminium chloride gets partially hydrolysed with atmospheric moisture to liberate HCl gas. Moist HCl appears white in colour.
128. (b)  $\text{BCl}_3$  forms  $[\text{B(OH)}_4]^-$  in which B is  $\text{sp}^3$  hybridized and have +3 oxidation state.
129. (d) Al in its compounds forms covalent bonds.
130. (c) The correct formula of inorganic benzene is  $\text{B}_3\text{N}_3\text{H}_6$  so (d) is incorrect statement



is incorrect statement.

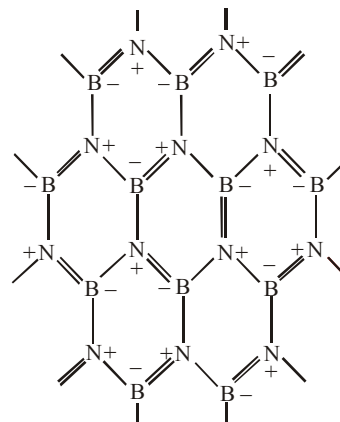
The coordination number exhibited by beryllium is 4 and not 6 so statement (b) is incorrect.

Both  $\text{BeCl}_2$  and  $\text{AlCl}_3$  exhibit bridged structures in solid state so (c) is correct statement.



131. (d)
132. (a) When borax is heated in a Bunsen burner flame with CoO on a loop of platinum wire a blue coloured  $\text{Co(BO}_2)_2$  bead is formed.
133. (a)  $\text{H}_3\text{BO}_3$  is a weak monobasic acid.
134. (b) The hybridizations of B in  $\text{H}_3\text{BO}_3$  is  $\text{sp}^2$
135. (d) Borax on heating gives  $\text{B}_2\text{O}_3$  and  $\text{NaBO}_2$  which is glassy mass and used for borax-bead test.
136. (c) Diborane is produced on industrial scale by the reaction of  $\text{BF}_3$  with sodium hydride.
137. (d)

138. (d) Boron nitride (BN) is known as inorganic graphite. The most stable form is hexagonal one. It has layered structure similar to graphite.



139. (a)
140. (c) When diborane is hydrolysed one can get both orthoboric acid and  $\text{H}_2$ .  
 $\text{B}_2\text{H}_6 + 6\text{H}_2\text{O} \rightarrow 2\text{H}_3\text{BO}_3 + 6\text{H}_2$
141. (a) Carbon does not contain d-orbital hence it cannot expand its octet.
142. (d) Ge(II) tends to acquire Ge(IV) state by loss of electrons. Hence it is reducing in nature. Pb(IV) tends to acquire Pb(II) O.S. by gain of electrons. Hence it is oxidising in nature. This is due to inert pair effect.
143. (b) In fullerene a six membered ring can fuse with five as well as with six membered ring while a five membered ring can only fuse with a six membered ring.
144. (d) Silicon does not form mono oxide.
145. (c)  $\text{CO}_2$  forms carbonic acid  $\text{H}_2\text{CO}_3$ , when dissolved in water, CO is neutral, whereas other two  $\text{GeO}_2$  and  $\text{SnO}_2$  are solids.
146. (a) Lead in +2 oxidation is stable while Sn and C are both stable in +4 oxidation.
147. (c) Pb with dil HCl forms protective coating of  $\text{PbCl}_2$
148. (a) Graphite  $\text{sp}^3$ ,  $\therefore$  % s character = 33%  
 Diamond  $\text{sp}^3$ ,  $\therefore$  % s character = 25%
149. (a)
150. (d) Diamond and crystalline silicon are isomorphous.
151. (d)
152. (b) Glass being a mixture of sodium and calcium silicates reacts with hydrofluoric acid forming sodium and calcium fluorosilicates respectively.  
 $\text{Na}_2\text{SiO}_3 + 6\text{HF} \rightarrow \text{Na}_2\text{SiF}_6 + 3\text{H}_2\text{O}$   
 $\text{CaSiO}_3 + 6\text{HF} \rightarrow \text{CaSiF}_6 + 3\text{H}_2\text{O}$   
 The etching of glass is based on these reactions.



# CHAPTER 12

## ORGANIC CHEMISTRY—SOME BASIC PRINCIPLES & TECHNIQUES

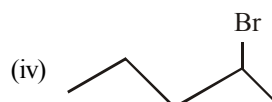
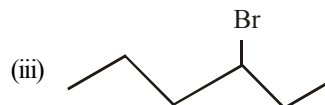
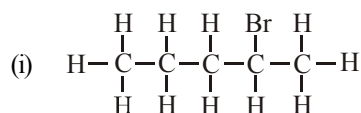
### FACT/DEFINITION TYPE QUESTIONS

- Which of the following scientist proposed that a 'vital force' was responsible for the formation of organic compounds ?  
(a) Berzilius (b) Wohler  
(c) Berthelot (d) Kolbe
- First organic compound to be synthesised was  
(a) methane (b) cane sugar  
(c) acetic acid (d) urea
- Which of the following organic compound was synthesised by F. Wohler from an inorganic compound?  
(a) Methane (b) Urea  
(c) Acetic acid (d) Chloroform
- The discovery that shook the belief in the vital force theory was  
(a) Stereoisomerism  
(b) Synthesis of indigo  
(c) Wohler's synthesis of urea from ammonium cyanate  
(d) Fermentation of sugars
- In laboratory, first organic compound was synthesised by  
(a) Kekule (b) Hennel  
(c) Wohler (d) Liebig
- Who is known as the "Father of Chemistry"?  
(a) Faraday (b) Priestley  
(c) Rutherford (d) Lavoisier
- The hybridisation of carbon atom in C—C single bond of  $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$  is  
(a)  $sp^3-sp$  (b)  $sp^2-sp$   
(c)  $sp^2-sp^2$  (d)  $sp^3-sp^3$
- In the hydrocarbon  

$$\begin{array}{ccccccc} \text{CH}_3 & - & \text{CH} & = & \text{CH} & - & \text{CH}_2 & - & \text{C} & \equiv & \text{CH} \\ 6 & & 5 & & 4 & & 3 & & 2 & & 1 \end{array}$$

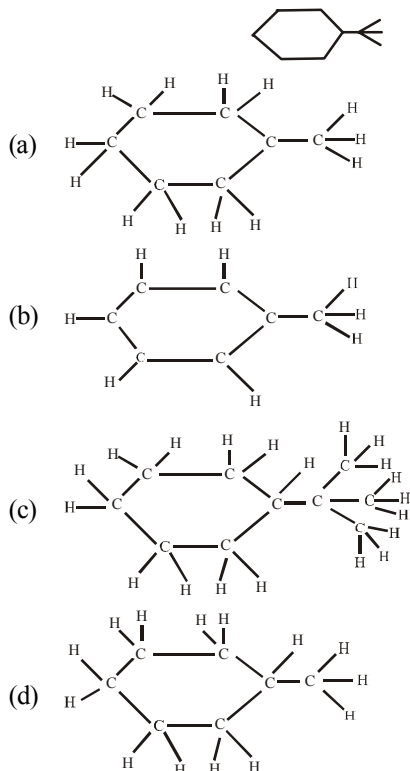
The state of hybridization of carbons 1, 3 and 5 are in the following sequence

- $sp^2, sp, sp^3$  (b)  $sp, sp^3, sp^2$   
(c)  $sp, sp^2, sp^3$  (d)  $sp^3, sp^2, sp$
- The percentage of s-character of the hybrid orbitals in ethane, ethene and ethyne are respectively.  
(a) 50, 75, 100 (b) 10, 20, 40  
(c) 25, 33, 50 (d) 25, 50, 75
- Select the molecule which has only one  $\pi$ -bond  
(a)  $\text{CH}\equiv\text{CH}$  (b)  $\text{CH}_2=\text{CHCHO}$   
(c)  $\text{CH}_3\text{CH}=\text{CH}_2$  (d)  $\text{CH}_3\text{CH}=\text{CHCOOH}$
- 2-Pentene contains  
(a) 15  $\sigma$ - and one  $\pi$ -bond (b) 14  $\sigma$ - and one  $\pi$ -bond  
(c) 15  $\sigma$ - and two  $\pi$ -bonds (d) 14  $\sigma$ - and two  $\pi$ -bonds
- Which of the following does not represent the 2-bromo pentane ?

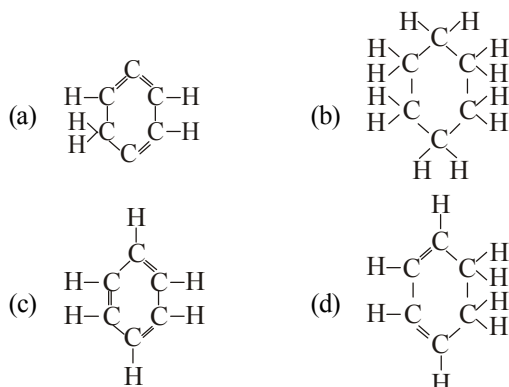


- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHBrCH}_3$   
(a) (ii), (iii) and (v) (b) Only (ii)  
(c) (ii) and (iii) (d) (iii) and (v)

13. Which of the following correctly represents the expanded form of following organic compound ?



14. Structural formula of benzene is



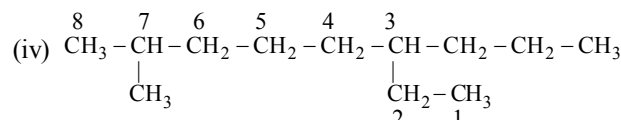
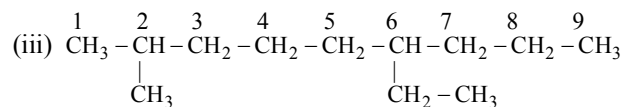
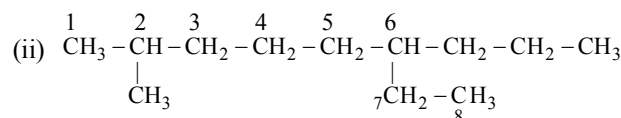
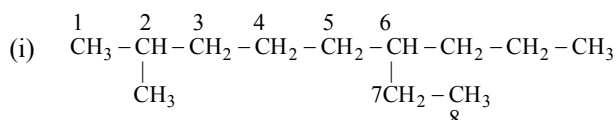
15. The successive members in a homologues series differ from each other by \_\_\_\_\_

- (a)  $-\text{CH}_2\text{CH}_2-$  unit (b)  $-\text{CH}_2$  unit  
(c)  $-\text{OCH}_3$  unit (d)  $-\text{CH}_3$  unit

16. Which of the following have incorrect molecular formula?

- A. Icosane  $-\text{C}_{10}\text{H}_{22}$   
B. Triacontane  $-\text{C}_{30}\text{H}_{62}$   
C. Nonane  $-\text{C}_9\text{H}_{20}$   
D. Heptane  $-\text{C}_7\text{H}_{14}$   
(a) (A) and (D) (b) Only (D)  
(c) (B) and (D) (d) Only (B)

17. Which of the following are incorrect methods of selecting parent chain ?



- (a) (i) and (ii) (b) (iv) only  
(c) (i), (ii) and (iv) (d) (ii) only

18. The correct decreasing order of priority of functional groups is

- (a)  $-\text{SO}_3\text{H}$ ,  $-\text{OH}$ ,  $-\text{COCl}$ ,  $>\text{C}=\text{C}<$   
(b)  $-\text{COOH}$ ,  $-\text{SO}_3\text{H}$ ,  $-\text{COOR}$ ,  $-\text{OH}$   
(c)  $-\text{C}\equiv\text{C}$ ,  $-\text{NH}_2$ ,  $-\text{OH}$ ,  $>\text{C}=\text{O}$   
(d)  $-\text{CN}$ ,  $-\text{CONH}_2$ ,  $>\text{C}=\text{O}$ ,  $-\text{OH}$

19. Which of the following is incorrectly matched –

- (a) vinegar  $\rightarrow$  carboxylic acid  
(b)  $\text{C}_2\text{H}_6 \rightarrow$  alkane  
(c) ethanol  $\rightarrow$  alcohol  
(d) methanol  $\rightarrow$  ketone

20. The functional group present in organic acid is –

- (a)  $-\text{OH}$  (b)  $-\text{CHO}$   
(c)  $-\text{COOH}$  (d)  $>\text{C}=\text{O}$

21. Which of these contains the carbonyl group?

- (a) ketones (b) aldehydes  
(c) esters (d) all of these

22. Butanone is a four-carbon compound with the functional group –

- (a) carboxylic acid (b) aldehyde.  
(c) ketone (d) alcohol.

23. The functional group present in  $\text{CH}_3\text{COOC}_2\text{H}_5$  is –

- (a) ketonic (b) aldehydic  
(c) ester (d) carboxylic

24. Which of the following compounds contains  $1^\circ$ ,  $2^\circ$ ,  $3^\circ$  as well as  $4^\circ$  carbon atoms ?

- (a) Neopentane (b) 2-methyl pentane  
(c) 2,3-dimethyl butane (d) 2,2,3-trimethyl pentane

25. The number of secondary hydrogens in 2, 2-dimethylbutane is

- (a) 8 (b) 6  
(c) 4 (d) 2

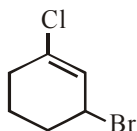
26. The compound which has one isopropyl group is

- (a) 2, 2, 3, 3 - Tetramethylpentane  
(b) 2, 2 - Dimethylpentane  
(c) 2, 2, 3- Trimethylpentane  
(d) 2- Methylpentane

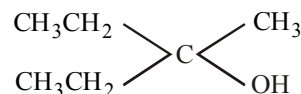
27. Which of the following statements is false for isopentane ?

- (a) It has three  $\text{CH}_3$  groups  
(b) It has one  $\text{CH}_2$  group  
(c) It has one  $\text{CH}$  group  
(d) It has a carbon which is not bonded to hydrogen

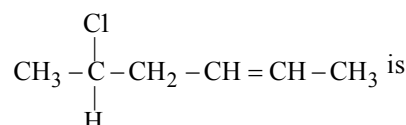
28. The number of primary, secondary and tertiary carbons in 3,4-dimethylheptane are respectively  
 (a) 4, 3 and 2 (b) 2, 3 and 4  
 (c) 4, 2 and 3 (d) 3, 4 and 2
29. The number of primary, secondary, tertiary and quaternary carbons in neopentane are respectively  
 (a) 4, 3, 2 and 1 (b) 5, 0, 0 and 1  
 (c) 4, 0, 0 and 1 (d) 4, 0, 1 and 1
30. What is the IUPAC name of t-butyl alcohol.  
 (a) Butanol-2 (b) 2-Methyl-propan-2-ol  
 (c) Butanol-1 (d) Propanol-2
31. The IUPAC name of  $\text{CH}_3\text{COCH}(\text{CH}_3)_2$  is -  
 (a) isopropyl methyl ketone  
 (b) 2-methyl-3-butanone  
 (c) 4-methylisopropyl ketone  
 (d) 3-methyl-2-butanone
32.  $\text{CH}_3\text{CH}_2-\underset{\text{CH}_3}{\text{CH}}-\underset{\text{CHO}}{\text{CH}}-\text{CH}_2\text{CH}_3$  has the IUPAC name -  
 (a) 2-sec butylbutanal  
 (b) 2,3-diethylbutanal  
 (c) 2-ethyl-3-methylpentanal  
 (d) 3-methyl-2-ethylpentanal
33. Which of the following statements is false for isopentane-  
 (a) It has three  $\text{CH}_3$  groups  
 (b) It has one  $\text{CH}_2$  group  
 (c) It has one  $\text{CH}$  group  
 (d) It has a carbon which is not bonded to hydrogen
34. The IUPAC name of the compound  $\text{CH}_3\text{OCH}_2\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_3$  is  
 (a) 3-ethoxy-1-methoxypropane  
 (b) 1-ethoxy-3-methoxypropane  
 (c) 2,5-dioxyhexane  
 (d) ethoxypropane oxymethane
35. Which of the following compounds has wrong IUPAC name?  
 (a)  $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{COO}-\text{CH}_2\text{CH}_3 \rightarrow$  ethyl butanoate  
 (b)  $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CHO} \rightarrow$  3-methyl-butanal  
 (c)  $\text{CH}_3-\underset{\text{OH}}{\text{CH}}-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_3 \rightarrow$  2-methyl-3-butanol  
 (d)  $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_2-\text{CH}_3 \rightarrow$  2-methyl-3-pentanone
36. The IUPAC name of the compound shown below is



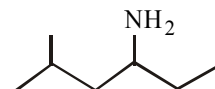
- (a) 3-bromo-1-chlorocyclohexene  
 (b) 1-bromo-3-chlorocyclohexene  
 (c) 2-bromo-6-chlorocyclohex-1-ene  
 (d) 6-bromo-2-chlorocyclohexene
37. Name of the following compound is



- (a) 2-ethylbutan-2-ol  
 (b) 1-ethyl-1-methylpropan-1-ol  
 (c) 3-methyl pentan-3-ol  
 (d) diethylethanol
38. The IUPAC name for



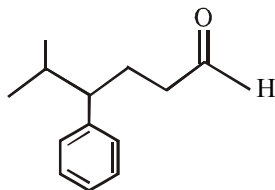
- (a) 5-chlorohex-2-ene  
 (b) 2-chlorohex-5-ene  
 (c) 1-chloro-1-methylpent-3-ene  
 (d) 5-chloro-5-methylpent-2-ene
39. IUPAC name of following compound is :
- 
- (a) 2-cyclohexylbutane (b) 2-phenylbutane  
 (c) 3-cyclohexylbutane (d) 3-phenylbutane
40. What is the IUPAC name of the following compound ?



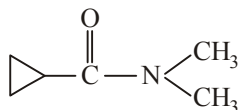
- (a) 2-methyl-4-hexanamine  
 (b) 5-methyl-3-hexanamine  
 (c) 2-methyl-4-amino hexane  
 (d) 5-methyl-3-amino hexane
41. Which one of the following is ethyl-4-(dimethyl amino) butanoate ?

- (a)
- (b)
- (c)
- (d)

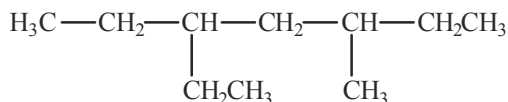
42. Identify the correct IUPAC name of the compound given below



- (a) 4-benzyl-5-methylhexanal  
(b) 2-methyl-3-phenylhexanal  
(c) 5-isopropyl-5-phenylbutanal  
(d) 5-methyl-4-phenylhexanal
43. IUPAC name of  $(\text{CH}_3)_3\text{CCl}$  is  
(a) 1-butyl chloride  
(b) 3-chlorobutane  
(c) 2-chloro-2-methylpropane  
(d) 2-butyl chloride
44. IUPAC name of the following compound



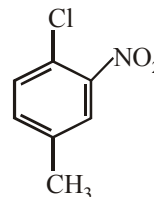
- (a) N,N-dimethylcyclopropane carboxamide  
(b) N-methylcyclopropanamide  
(c) cyclopropionamide  
(d) None of these
45. Which of the following is a 3-methylbutyl group?  
(a)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2-$   
(b)  $(\text{CH}_3\text{CH}_2)_2\text{CH}-$   
(c)  $(\text{CH}_3)_3\text{CCH}_2-$   
(d)  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2-$
46. The IUPAC name of the following compound



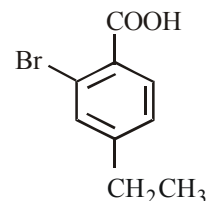
is

- (a) 3-ethyl-5-methylheptane  
(b) 5-ethyl-3-methylheptane  
(c) 3,5-diethylhexane  
(d) 1,1-diethyl-3-methylpentane
47. The IUPAC name of the following compound is  
 $(\text{CH}_3)_2\text{CH}-\text{CH}_2\text{CH}=\text{CH}-\text{CH}=\underset{\text{C}_2\text{H}_5}{\text{CH}}-\text{CHCH}_3$
- (a) 1,1,7,7-tetramethyl-2,5-octadiene  
(b) 2,8-dimethyl-3,6-decadiene  
(c) 1,5-di-isopropyl-1,4-hexadiene  
(d) 2,8-dimethyl-4,6-decadiene
48. The IUPAC name of the compound  $\text{CH}_3-\text{CH}(\text{CH}_3)-\text{CO}-\text{CH}_3$ , is  
(a) 3-methyl 2-butanone  
(b) 2-methyl 3-butanone  
(c) isopropyl methyl ketone  
(d) methyl isopropyl ketone

49. The IUPAC name of neopentane is  
(a) 2,2-dimethylpropane (b) 2-methylpropane  
(c) 2,2-dimethylbutane (d) 2-methylbutane
50. The IUPAC name for

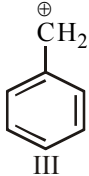
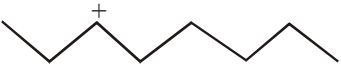
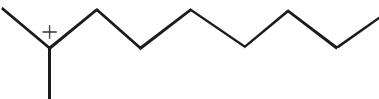
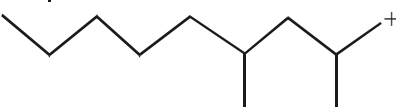
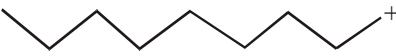
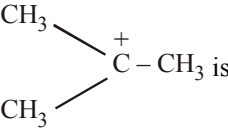


- (a) 1-Chloro-2-nitro-4-methylbenzene  
(b) 1-Chloro-4-methyl-2-nitrobenzene  
(c) 2-Chloro-1-nitro-5-methylbenzene  
(d) *m*-Nitro-*p*-chlorotoluene
51. What is the IUPAC name of the following compound?



- (a) 6-bromo-4-ethylbenzene carboxylic acid  
(b) 2-bromo-4-ethylbenzene carboxylic acid  
(c) Ortho-bromo-paraethyl benzoic acid  
(d) 4-bromo-3-ethyl benzoic acid
52. Total number of structural isomers possible for  $\text{C}_3\text{H}_6$  are :  
(a) 2 (b) 1  
(c) 4 (d) 3
53. An aromatic compound of formula  $\text{C}_7\text{H}_7\text{Cl}$  has in all ..... isomers :  
(a) 5 (d) 2  
(c) 4 (d) 3
54.  $\text{CH}_3\text{CH}_2\text{OH}$  and  $\text{CH}_3\text{OCH}_3$  are the examples of  
(a) chain isomerism (b) functional isomerism  
(c) position isomerism (d) metamerism
55. Which organic structure among the following is not an isomer of the compound  $\text{CH}_3-\text{CO}-\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$ ?  
(a)  $\text{CH}_3\text{CH}_2\text{OCH}=\text{CHCH}_2\text{CH}_3$   
(b)  $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_2\text{CHO}$   
(c)  $(\text{CH}_3)_2\text{CH}-\text{CO}-\text{CH}_2\text{CH}_3$   
(d)  $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_2\text{CH}_3$
56. The least number of carbon atoms in alkane showing isomerism is  
(a) 3 (b) 1  
(c) 2 (d) 4
57. The number of possible alkynes with molecular formula  $\text{C}_5\text{H}_8$  is  
(a) 2 (b) 3  
(c) 4 (d) 5
58. The total number of isomers for  $\text{C}_4\text{H}_8$  is  
(a) 5 (b) 6  
(c) 7 (d) 8

59. Which of the following compounds is isomeric with 2, 2, 4, 4-tetramethylhexane?
- 3-ethyl-2, 2-dimethylpentane
  - 4-isopropylheptane
  - 4-ethyl-3-methyl-4-n-propyloctane
  - 4, 4-diethyl-3-methylheptane
60. Which are isomers?
- ethyl alcohol and dimethyl ether
  - acetone and acetaldehyde
  - propionic acid and propanone
  - methyl alcohol and dimethyl ether
61. Methoxyethane and propanol are the examples of isomerism of the type
- structural
  - position
  - functional
  - tautomerism
62. Isomers of propionic acid are
- $\text{HCOOC}_2\text{H}_5$  and  $\text{CH}_3\text{COOCH}_3$
  - $\text{HCOOC}_2\text{H}_5$  and  $\text{C}_3\text{H}_7\text{COOH}$
  - $\text{CH}_3\text{COOCH}_3$  and  $\text{C}_3\text{H}_7\text{OH}$
  - $\text{C}_3\text{H}_7\text{OH}$  and  $\text{CH}_3\text{COCH}_3$
63.  $\text{C}_6\text{H}_5\text{C}\equiv\text{N}$  and  $\text{C}_6\text{H}_5\text{N}\equiv\text{C}$  are which type of isomers?
- Position
  - Functional
  - Tautomerism
  - Linkage
64. A functional isomer of 1-butyne is
- 2-butyne
  - 1-butene
  - 2-butene
  - 1, 3-butadiene
65. In which of the following, functional group isomerism is not possible?
- Alcohols
  - Aldehydes
  - Alkyl halides
  - Cyanides
66. The compounds  $\text{CH}_3\text{CH}=\text{CHCH}_3$  and  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$
- are tautomers
  - are position isomers
  - contain same number of  $\text{sp}^3\text{-sp}^3$ ,  $\text{sp}^3\text{-sp}^2$  and  $\text{sp}^2\text{-sp}^2$  carbon-carbon bonds
  - exist together in dynamic equilibrium
67. Heterolytic fission of a covalent bond in organic molecules gives
- free radicals
  - cations and anions
  - only cations
  - only anions
68. Which of the following statements is not correct?
- Carbocation possesses sextet of electrons.
  - The order of carbocation stability is :  

$$\text{CH}_3^+ > (\text{CH}_3)_2\text{CH}^+ > (\text{CH}_3)_3\text{C}^+$$
  - Carbocations have trigonal planar shape
  - Carbocations are formed by heterolytic cleavage
69. Heterolytic fission of C – Br bond results in the formation of
- free radical
  - carbanion
  - carbocation
  - Both (b) and (c)
70. Which of the following carbocations is least stable?
- tert*-Alkyl
  - sec*-Alkyl
  - pri*-Alkyl
  - Methyl
71. Which of the following ions is most stable?
- $\text{CH}_3 - \overset{+}{\text{C}}(\text{CH}_3) - \text{CH}_3$
  - $\text{CH}_3\text{CH}_2\text{CH}_2^+$
  - $\text{CH}_3\text{CH}^+\text{CH}_2\text{CH}_3$
  - None of these
72. The order of stability of the following carbocations is :
- $\text{CH}_2 = \text{CH} - \overset{+}{\text{C}}\text{H}_2$  (I)
  - $\text{CH}_3 - \text{CH}_2 - \overset{+}{\text{C}}\text{H}_2$  (II)
  -  (III)
- $\text{III} > \text{II} > \text{I}$
  - $\text{II} > \text{III} > \text{I}$
  - $\text{I} > \text{II} > \text{III}$
  - $\text{III} > \text{I} > \text{II}$
73. Select the most stable carbocation amongst the following
- 
  - 
  - 
  - 
74. What is the correct order of decreasing stability of the following cations.
- $\text{CH}_3 - \overset{+}{\text{C}}\text{H} - \text{CH}_3$  (I)
  - $\text{CH}_3 - \overset{+}{\text{C}}\text{H} - \text{OCH}_3$  (II)
  - $\text{CH}_3 - \overset{+}{\text{C}}\text{H} - \text{CH}_2 - \text{OCH}_3$  (III)
- $\text{II} > \text{I} > \text{III}$
  - $\text{II} > \text{III} > \text{I}$
  - $\text{III} > \text{I} > \text{II}$
  - $\text{I} > \text{II} > \text{III}$
75. The most stable carbonium ion among the following is
- $\text{C}_6\text{H}_5\text{CH}^+\text{C}_6\text{H}_5$
  - $\text{C}_6\text{H}_5\text{CH}_2^+$
  - $\text{CH}_3\text{CH}_2^+$
  - $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2^+$
76. The organic reaction which proceeds through heterolytic bond cleavage are called \_\_\_\_\_
- ionic
  - polar
  - nonpolar
  - Both (a) and (b)
77. Among the following, the true property about
-  is
  - it is non-planar
  - its  $\text{C}^+$  is  $\text{sp}^2$ -hybridized
  - an electrophile can attack on its  $\text{C}^+$
  - it does not undergo hydrolysis



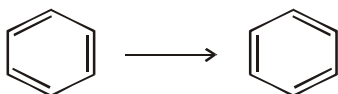
78. The shape of methyl carbanion is similar to that of—  
 (a)  $\text{BF}_3$  (b)  $\text{NH}_3$   
 (c) methyl free radical (d) methyl carbocation
79. Arrange the carbanions,  
 $(\text{CH}_3)_3\bar{\text{C}}, \bar{\text{C}}\text{Cl}_3, (\text{CH}_3)_2\bar{\text{C}}\text{H}, \text{C}_6\text{H}_5\bar{\text{C}}\text{H}_2$   
 in order of their decreasing stability:  
 (a)  $(\text{CH}_3)_2\bar{\text{C}}\text{H} > \bar{\text{C}}\text{Cl}_3 > \text{C}_6\text{H}_5\bar{\text{C}}\text{H}_2 > (\text{CH}_3)_3\bar{\text{C}}$   
 (b)  $\bar{\text{C}}\text{Cl}_3 > \text{C}_6\text{H}_5\bar{\text{C}}\text{H}_2 > (\text{CH}_3)_2\bar{\text{C}}\text{H} > (\text{CH}_3)_3\bar{\text{C}}$   
 (c)  $(\text{CH}_3)_3\bar{\text{C}} > (\text{CH}_3)_2\bar{\text{C}}\text{H} > \text{C}_6\text{H}_5\bar{\text{C}}\text{H}_2 > \bar{\text{C}}\text{Cl}_3$   
 (d)  $\text{C}_6\text{H}_5\bar{\text{C}}\text{H}_2 > \bar{\text{C}}\text{Cl}_3 > (\text{CH}_3)_3\bar{\text{C}} > (\text{CH}_3)_2\bar{\text{C}}\text{H}$
80. The homolytic fission of a covalent bond liberates  
 (a) Carbonium ions (b) Carbanions  
 (c) Free radicals (d) Carbenes
81. Homolytic fission of C–C bond in ethane gives an intermediate in which carbon is  
 (a)  $sp^3$ -hybridised (b)  $sp^2$ -hybridised  
 (c)  $sp$ -hybridised (d)  $sp^2d$ -hybridised
82. Geometry of methyl free-radical is  
 (a) pyramidal (b) planar  
 (c) tetrahedral (d) linear
83. In which of the following homolytic bond fission takes place?  
 (a) Alkaline hydrolysis of ethyl chloride  
 (b) Addition of HBr to double bond  
 (c) Photochlorination of methane  
 (d) Nitration of benzene
84. On exciting,  $\text{Cl}_2$  molecules by UV light, we get  
 (a)  $\text{Cl}^\bullet$  (b)  $\text{Cl}^+$   
 (c)  $\text{Cl}^-$  (d) all of these
85. The increasing order of stability of the following free radicals is  
 (a)  $(\text{C}_6\text{H}_5)_2\dot{\text{C}}\text{H} < (\text{C}_6\text{H}_5)_3\dot{\text{C}} < (\text{CH}_3)_3\dot{\text{C}} < (\text{CH}_3)_2\dot{\text{C}}\text{H}$   
 (b)  $(\text{CH}_3)_2\dot{\text{C}}\text{H} < (\text{CH}_3)_3\dot{\text{C}} < (\text{C}_6\text{H}_5)_2\dot{\text{C}}\text{H} < (\text{C}_6\text{H}_5)_3\dot{\text{C}}$   
 (c)  $(\text{CH}_3)_2\dot{\text{C}}\text{H} < (\text{CH}_3)_3\dot{\text{C}} < (\text{C}_6\text{H}_5)_2\dot{\text{C}}\text{H} < (\text{C}_6\text{H}_5)_3\dot{\text{C}}$   
 (d)  $(\text{C}_6\text{H}_5)_3\dot{\text{C}} < (\text{C}_6\text{H}_5)_2\dot{\text{C}}\text{H} < (\text{CH}_3)_3\dot{\text{C}} < (\text{CH}_3)_2\dot{\text{C}}\text{H}$
86. Which of the following orders regarding relative stability of free radicals is correct?  
 (a)  $3^\circ < 2^\circ < 1^\circ$  (b)  $3^\circ > 2^\circ > 1^\circ$   
 (c)  $1^\circ < 2^\circ > 3^\circ$  (d)  $3^\circ > 2^\circ < 1^\circ$
87. The most stable free radical among the following is  
 (a)  $\text{C}_6\text{H}_5\text{CH}_2\dot{\text{C}}\text{H}_2$  (b)  $\text{C}_6\text{H}_5\dot{\text{C}}\text{HCH}_3$   
 (c)  $\text{CH}_3\dot{\text{C}}\text{H}_2$  (d)  $\text{CH}_3\dot{\text{C}}\text{HCH}_3$
88. For the reaction of phenol with  $\text{CHCl}_3$  in presence of KOH, the electrophile is  
 (a)  $^+\text{CHCl}_2$  (b)  $:\text{CCl}_2$   
 (c)  $\dot{\text{C}}\text{HCl}_2$  (d)  $\text{CCl}_4$
89. The least stable free radical is  
 (a)  $\text{CH}_3\dot{\text{C}}\text{H}_2$  (b)  $\text{CH}_3\text{CH}_2\dot{\text{C}}\text{H}_2$   
 (c)  $(\text{CH}_3)_2\dot{\text{C}}\text{H}$  (d)  $\dot{\text{C}}\text{H}_3$
90. Which of the following is strongest nucleophile  
 (a)  $\text{Br}^-$  (b)  $:\text{OH}^-$   
 (c)  $:\text{CN}^-$  (d)  $\text{C}_2\text{H}_5\bar{\text{O}}:$
91. Which of the following represents a set of nucleophiles?  
 (a)  $\text{BF}_3, \text{H}_2\text{O}, \text{NH}_2^-$  (b)  $\text{AlCl}_3, \text{BF}_3, \text{NH}_3$   
 (c)  $\text{CN}^-, \text{RCH}_2^-, \text{ROH}$  (d) All of these
92. Which of the following species does not acts as a nucleophile?  
 (a) ROH (b) ROR  
 (c)  $\text{PCl}_3$  (d)  $\text{BF}_3$
93. Which of the following is an electrophile?  
 (a) Lewis acid  
 (b) Lewis base  
 (c) Negatively charged species  
 (d) None of the above
94. Which of the following pairs represent electrophiles?  
 (a)  $\text{AlCl}_3, \text{H}_2\text{O}$  (b)  $\text{SO}_3, \text{NO}_2^+$   
 (c)  $\text{BF}_3, \text{H}_2\text{O}$  (d)  $\text{NH}_3, \text{SO}_3$
95. Which out of A, B, C and D is/are not correctly categorised.
- |    | Nucleophile                                     | Electrophile                     |
|----|---|----------------------------------|
| A. | $\text{HS}^-$                                   | $\text{Cl}^+$                    |
| B. | $\text{BF}_3$                                   | $(\text{CH}_3)_3\text{N}^+$      |
| C. | $\text{H}_2\text{N}^-$                          | $^-\text{C}=\text{O}$            |
| D. | $\text{R}_3\text{C}-\text{X}$<br>(X = H alogen) | $\text{C}_2\text{H}_5\text{O}^-$ |
- (a) B, C and D (b) C and D  
 (c) C only (d) B and D
96. Arrangement of  $(\text{CH}_3)_3\text{C}-$ ,  $(\text{CH}_3)_2\text{CH}-$ ,  $\text{CH}_3\text{CH}_2-$  when attached to benzyl or an unsaturated group in increasing order of inductive effect is  
 (a)  $(\text{CH}_3)_3\text{C}- < (\text{CH}_3)_2\text{CH}- < \text{CH}_3\text{CH}_2-$   
 (b)  $\text{CH}_3\text{CH}_2- < (\text{CH}_3)_2\text{CH}- < (\text{CH}_3)_3\text{C}-$   
 (c)  $(\text{CH}_3)_2\text{CH}- < (\text{CH}_3)_3\text{C}- < \text{CH}_3\text{CH}_2-$   
 (d)  $(\text{CH}_3)_3\text{C}- < \text{CH}_3\text{CH}_2- < (\text{CH}_3)_2\text{CH}-$
97. Polarization of electrons in acrolein may be written as  
 (a)  $\delta^- \text{CH}_2 = \text{CH} - \text{CH} = \text{O} \delta^+$  (b)  $\delta^- \text{CH}_2 = \text{CH} - \text{CH} = \text{O} \delta^+$   
 (c)  $\delta^- \text{CH}_2 = \text{CH} - \text{CH} = \text{O} \delta^-$  (d)  $\delta^+ \text{CH}_2 = \text{CH} - \text{CH} = \text{O} \delta^-$
98. Point out the incorrect statement about resonance?  
 (a) Resonance structures should have equal energy  
 (b) In resonating structures, the constituent atoms must be in the same position  
 (c) In resonating structures, there should not be same number of electron pairs  
 (d) Resonating structures should differ only in the location of electrons around the constituent atoms
99.  $^-\text{CH}_2 - \text{C} = \text{CH}_3$  and  $\text{CH}_2 = \text{C} - \text{CH}_3$  are  
 $\begin{array}{c} \text{O} \\ || \\ \text{O}^- \end{array}$   $\begin{array}{c} \text{O} \\ | \\ \text{O}^- \end{array}$   
 (a) resonating structures (b) tautomers  
 (c) geometrical isomers (d) optical isomers

100. In which of the following, resonance will be possible?

- (a)  $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CHO}$
- (b)  $\text{CH}_2 = \text{CH} - \text{CH} = \text{O}$
- (c)  $\text{CH}_3\text{COCH}_3$
- (d)  $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH} = \text{CH}_2$

101. Which of the following statements regarding the resonance energy of benzene is *correct*?

- (a) Resonance energy is the energy required to break the C-H bond in benzene
- (b) Resonance energy is the energy required to break the C-C bond in benzene
- (c) Resonance energy is a measure of stability of benzene
- (d) Resonance energy is the energy required to convert



102. Which of the following is not correctly matched ?

**Group showing + R effect**      **Group showing – R effect**

- |                          |                |
|--------------------------|----------------|
| (a) $-\text{NHCOR}$      | $-\text{COOH}$ |
| (b) $>\text{C}=\text{O}$ | $-\text{OH}$   |
| (c) $-\text{OR}$         | $-\text{CHO}$  |
| (d) $-\text{OCOR}$       | $-\text{NO}_2$ |

103. The polarity is produced in the molecule by the interaction of two  $\pi$  – bonds or between a  $\pi$  – bond and lone pair of electrons present on an adjacent atom.

The above statement is true for which of the following ?

- (a) Inductive effect
- (b) Electromeric effect
- (c) Resonance effect
- (d) Hyperconjugation

104. Electromeric effect is a

- (a) permanent effect
- (b) temporary effect
- (c) resonance effect
- (d) inductive effect

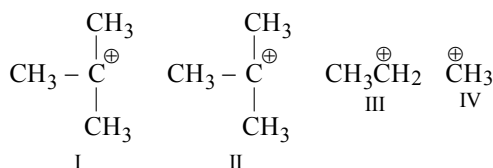
105. The kind of delocalization involving sigma bond orbitals is called

- (a) inductive effect
- (b) hyperconjugation effect
- (c) electromeric effect
- (d) mesomeric effect

106. Hyperconjugation involves overlap of the following orbitals

- (a)  $\sigma-\sigma$
- (b)  $\sigma-\pi$
- (c) p- p
- (d)  $\pi-\pi$

107. Choose the correct order of stability of carbocation using concept of hyperconjugation.



- (a)  $\text{I} < \text{II} < \text{III} < \text{IV}$
- (b)  $\text{IV} < \text{III} < \text{II} < \text{I}$
- (c)  $\text{III} < \text{IV} < \text{II} < \text{I}$
- (d) None of these

108. Hyperconjugation is most useful for stabilizing which of the following carbocations ?

- (a) neo-Pentyl
- (b) tert-Butyl
- (c) iso-Propyl
- (d) Ethyl

109. Which of the following is an example of elimination reaction?

- (a) Chlorination of methane
- (b) Dehydration of ethanol
- (c) Nitration of benzene
- (d) Hydroxylation of ethylene

110.  $\text{CH}_3 - \text{Br} + \text{NH}_3 \rightarrow \text{CH}_3 - \text{NH}_2 + \text{HBr}$

The above reaction is classified as

- (a) substitution
- (b) addition
- (c) elimination
- (d) rearrangement

111. Which of the following method is not used for determining purity of a compound ?

- (a) Chromatographic techniques
- (b) Spectroscopic techniques
- (c) Melting point
- (d) All of the above parameters are used for determining the purity of a compound.

112. Which of the following is not the criteria of purity of a substance?

- (a) solubility
- (b) melting point
- (c) boiling point
- (d) density

113. In crystallisation process impurities which impart colour to the solution are removed by which of the following ?

- (a) Repeated crystallisation
- (b) Activated charcoal
- (c) Bleaching agent
- (d) Both (a) and (b)

114. Aniline is purified by

- (a) steam distillation
- (b) simple distillation
- (c) vacuum distillation
- (d) extraction with a solvent

115. Which is purified by steam distillation

- (a) Aniline
- (b) Benzoic acid
- (c) Petroleum
- (d) Naphthalene

116. The best method for the separation of naphthalene and benzoic acid from their mixture is:

- (a) distillation
- (b) sublimation
- (c) chromatography
- (d) crystallisation

117. In steam distillation the vapour pressure of volatile organic compound is

- (a) equal to atmospheric pressure
- (b) double the atmospheric pressure
- (c) less than atmospheric pressure
- (d) more than atmospheric pressure

118. Fractional distillation is used when

- (a) there is a large difference in the boiling point of liquids
- (b) there is a small difference in the boiling points of liquids
- (c) boiling points of liquids are same
- (d) liquids form a constant boiling mixture

119. Purification of petroleum is carried out by

- (a) fractional distillation
- (b) steam distillation
- (c) vacuum distillation
- (d) simple distillation

120. A liquid decomposes at its boiling point. It can be purified by

- (a) steam distillation
- (b) fractional distillation
- (c) vacuum distillation
- (d) sublimation

121. Distillation under reduced pressure is employed for  
 (a)  $C_6H_6$   
 (b) petrol  
 (c)  $CH_2OHCHOHCH_2OH$   
 (d) organic compounds used in medicine
122. Impure glycerine is purified by  
 (a) steam distillation (b) simple distillation  
 (c) vacuum distillation (d) None of these
123. Glycerol can be separated from spent lye in soap industry by which of the following method ?  
 (a) Steam distillation  
 (b) Fractional distillation  
 (c) Distillation under reduced pressure  
 (d) Differential extraction
124. The latest technique for the purification of organic compounds is  
 (a) chromatography (b) fractional distillation  
 (c) crystallization (d) vacuum distillation
125. Which of the following is used as an adsorbent in adsorption chromatography ?  
 (a) Silica gel (b) Alumina  
 (c) Zeolite (d) Both (a) and (b)
126. Which of the following acts as the stationary phase in paper chromatography ?  
 (a) Water (b) Alumina  
 (c) Silica gel (d) None of these
127. The most satisfactory method to separate mixture of sugars is  
 (a) fractional crystallisation (b) sublimation  
 (c) chromatography (d) benedict reagent
128. Chromatography is a valuable method for the separation, isolation, purification and identification of the constituents of a mixture and it is based on general principle of  
 (a) phase rule (b) phase distribution  
 (c) interphase separation (d) phase operation
129. In paper chromatography  
 (a) moving phase is liquid and stationary phase is solid  
 (b) moving phase is liquid and stationary phase is liquid  
 (c) moving phase is solid and stationary phase is solid  
 (d) moving phase is solid and stationary phase is liquid
130. Which of the following is used for detection of carbon and hydrogen ?  
 (a)  $Ca(OH)_2$  (b)  $CuO$   
 (c)  $CaCl_2$  (d)  $KOH$
131. In sodium fusion test of organic compounds, the nitrogen of the organic compound is converted into  
 (a) sodamide (b) sodium cyanide  
 (c) sodium nitrite (d) sodium nitrate
132. Which of the following compounds does not show Lassaigne's test for nitrogen ?  
 (a) Urea (b) Hydrazine  
 (c) Phenylhydrazine (d) Azobenzene
133. The compound formed in the positive test for nitrogen with the Lassaigne solution of an organic compound is  
 (a)  $Fe_4[Fe(CN)_6]_3$  (b)  $Na_3[Fe(CN)_6]$   
 (c)  $Fe(CN)_3$  (d)  $Na_4[Fe(CN)_5NOS]$
134. In quantitative analysis of carbon and hydrogen, the mass of water produced is determined by passing the mixture through a weighed U – tube containing X and carbon dioxide is absorbed in concentrated solution of Y  
 (a)  $X = CaCl_2$ ,  $Y = NaOH$   
 (b)  $X = Ca(OH)_2$ ,  $Y = CuSO_4$   
 (c)  $X = CuSO_4$ ,  $Y = Ca(OH)_2$   
 (d)  $X = CaCl_2$ ,  $Y = KOH$
135. Kjeldahl method is not applicable to which of the following ?  
 (a) Nitro compounds (b) Azo compounds  
 (c) Pyridine (d) All of these.
136. Nitrogen in an organic compound can be estimated by  
 (a) Kjeldahl's method only (b) Duma's method only  
 (c) Both (a) and (b) (d) Neither (a) nor (b)
137. Duma's method involves the determination of nitrogen content in the organic compound in form of  
 (a)  $NH_3$  (b)  $N_2$   
 (c)  $NaCN$  (d)  $(NH_4)_2SO_4$
138. In Kjeldahl's method nitrogen present is estimated as  
 (a)  $N_2$  (b)  $NH_3$   
 (c)  $NO_2$  (d) None of these
139. In kjeldahl's method of estimation of nitrogen,  $K_2SO_4$  acts as  
 (a) oxidising agent (b) catalytic agent  
 (c) hydrolysing agent (d) boiling point elevator
140. 0.5g of an organic compound containing nitrogen on Kjeldahlising required 29 mL of N/5  $H_2SO_4$  for complete neutralization of ammonia. The percentage of nitrogen in the compound is  
 (a) 34.3 (b) 16.2  
 (c) 21.6 (d) 14.8
141. The percentage of sulphur in an organic compound whose 0.32 g produces 0.233 g of  $BaSO_4$  [At. wt. Ba = 137, S = 32] is  
 (a) 1.0 (b) 10.0  
 (c) 23.5 (d) 32.1
142. An organic compound contains C = 40%, H = 13.33% and N = 46.67%. Its empirical formula would be  
 (a) CHN (b)  $C_2H_2N$   
 (c)  $CH_4N$  (d)  $C_3H_7N$
143. 2.79 g of an organic compound when heated in Carius tube with conc.  $HNO_3$  and  $H_3PO_4$  formed converted into  $MgNH_4.PO_4$  ppt. The ppt. on heating gave 1.332 g of  $Mg_2P_2O_7$ . The percentage of P in the compound is  
 (a) 23.33% (b) 13.33%  
 (c) 33.33% (d) 26.66%
144. A compound contains 38.8% C, 16% H and 45.2% N. The formula of compound would be :  
 (a)  $CH_3NH_2$  (b)  $CH_3CN$   
 (c)  $C_2H_5CN$  (d)  $CH_2(NH_2)_2$

145. In estimation of percentage of oxygen. The mixture of gaseous products containing oxygen is passed over red hot coke. All oxygen is converted to A. This mixture is passed through B when A is converted to C.

What is A, B and C in above statement.

- (a) A = CO<sub>2</sub>, B = KOH, C = pure O<sub>2</sub>  
 (b) A = CO, B = I<sub>2</sub>O<sub>5</sub>, C = CO<sub>2</sub>  
 (c) A = CO, B = I<sub>2</sub>, C = CO<sub>2</sub>  
 (d) A = CO<sub>2</sub>, B = Ca(OH)<sub>2</sub>, C = CaCO<sub>3</sub>

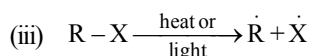
### STATEMENT TYPE QUESTIONS

146. Which of the following statement(s) is/are correct ?

- (i) A carbon atom having an *sp* hybrid orbital is less electronegative than carbon atoms possessing *sp*<sup>2</sup> or *sp*<sup>3</sup> hybridised orbitals.  
 (ii)  $\pi$ -bonds provide the most reactive centres in the molecules containing multiple bonds  
 (iii) The number of  $\sigma$  and  $\pi$  bonds in compound CH<sub>2</sub>=C=CHCH<sub>3</sub> are 7 and 2 respectively.  
 (a) (i) and (iii) (b) (ii) and (iii)  
 (c) (ii) only (d) (i) only

147. Which of the following sequence of T and F is correct. Here T stands for true statement and F stands for false statement

- (i) In heterolytic cleavage the bond breaks in such a fashion that the shared pair of electrons remain with one of the fragment.  
 (ii) In homolytic cleavage, one of the electrons of the shared pair in a covalent bond goes with each of the bonded atoms.



This equation represents heterolytic cleavage

- (a) TTF (b) FFT  
 (c) FFF (d) TTT

148. Which of the following is/are correct for inductive effect ?

- (i) In inductive effect polarisation of sigma bond is caused by the adjacent  $\sigma$  bond.  
 (ii) Halogens, -NO<sub>2</sub>, -CN, and -CH<sub>3</sub> are electron withdrawing groups.  
 (iii) -CH<sub>2</sub>CH<sub>3</sub> and -OC<sub>6</sub>H<sub>5</sub> are electron donating groups.  
 (a) (i) only (b) (ii) only  
 (c) (i) and (iii) (d) (i), (ii) and (iii)

149. Which of the following sequence of T and F is correct for given statements. Here T stands for correct and F stands for false statement

- (i) The more the number of contributing structures, the more is the resonance energy.  
 (ii) The resonance structures have different positions of nuclei but same number of unpaired electrons  
 (iii) The energy of actual structure of the molecule (the resonance hybrid) is lower than that of any of the canonical structures.

- (a) TTT (b) TFT  
 (c) FFF (d) TFF

150. Which of the following statements are correct for fractional distillation ?

- (i) Fractional distillation method is used if the two liquids have sufficiently large difference in their boiling points.  
 (ii) A fractionating column provides many surfaces for heat exchange between the ascending vapours and the descending condensed liquid.  
 (iii) Each successive condensation and vaporisation unit in the fractionating column is called a theoretical plate.  
 (iv) Fractional distillation method is used to separate different fractions of crude oil in petroleum industry.

- (a) (i), (ii) and (iv) (b) (ii), (iii) and (iv)  
 (c) (i), (ii) and (iii) (d) (i), (ii), (iii) and (iv)

151. Which of the following sequence of T and F is correct for given statements. Here 'T' stands for True and 'F' stands for False statement.

- (i) The relative adsorption of each component of mixture is expressed in terms of its retardation factor ( $R_F$ )  
 (ii) Retardation factor is given as :

$$R_F = \frac{\text{Distance moved by the solvent from base line}}{\text{Distance moved by the substance from baseline}}$$

- (iii) In TLC the spots of colourless compounds can be detected by ultraviolet light.  
 (iv) Spots of amino acids may be detected by iodine.  
 (a) TTTF (b) TFFF  
 (c) TTTT (d) TFTF

152. In Kjeldahl's method for the estimation of N<sub>2</sub>, potassium sulphate and copper sulphate are used. On the basis of their functions which of the following statement(s) is/are correct?

- (i) Potassium sulphate raises the bpt. and ensures complete reaction.  
 (ii) Copper sulphate acts as catalyst.  
 (iii) Potassium sulphate acts as catalyst and copper sulphate raises the bpt.

- (a) Only (iii) is correct (b) (i) and (ii) are correct  
 (c) Only (ii) is correct (d) None is correct

153. In the estimation of carbon and hydrogen by combustion method which of the following is/are correct ?

- (i) A spiral of copper is introduced at the right extreme of combustion tube if the organic compound contains nitrogen.  
 (ii) A spiral of silver is introduced if the organic compound contains halogens.  
 (iii) The copper oxide in the combustion tube is replaced by lead chromate if the organic compound contains sulphur.

- (a) (i) and (ii) are correct (b) (i) and (iii) are correct  
 (c) (ii) and (iii) are correct (d) All are correct

# MATCHING TYPE QUESTIONS

154. Match the columns

## Column-I

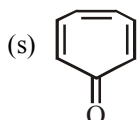
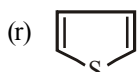
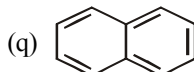
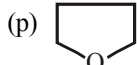
(A) Non – benzenoid compound

(B) Alicyclic compound

(C) Benzenoid compound

(D) Heterocyclic aromatic compound

## Column-II



(a) A – (r), B – (p), C – (s), D – (q)

(b) A – (s), B – (p), C – (q), D – (r)

(c) A – (p), B – (r), C – (s), D – (q)

(d) A – (r), B – (p), C – (q), D – (s)

155. Match Column-I (organic compound) with Column-II (common name of the compound) and choose the correct option.

## Column-I

(Organic compound)

(A)  $C_6H_5OCH_3$

(B)  $H_3CCH_2CH_2OH$

(C)  $(H_3C)_4C$

(D)  $C_6H_5COCH_3$

(a) A – (r), B – (s), C – (p), D – (q)

(b) A – (r), B – (p), C – (s), D – (q)

(c) A – (q), B – (s), C – (p), D – (r)

(d) A – (q), B – (s), C – (r), D – (p)

## Column-II

(Common name of compound)

(p) Neopentane

(q) Anisole

(r) Acetophenone

(s) n – propyl alcohol.

156. Match the columns

## Column-I

(A) Aldehyde

(B) Ketone

(C) Alcohol

(D) Halogen

(a) A – (s), B – (r), C – (q), D – (p)

(b) A – (s), B – (q), C – (p), D – (r)

(c) A – (p), B – (q), C – (r), D – (s)

(d) A – (r), B – (s), C – (q), D – (p)

## Column-II

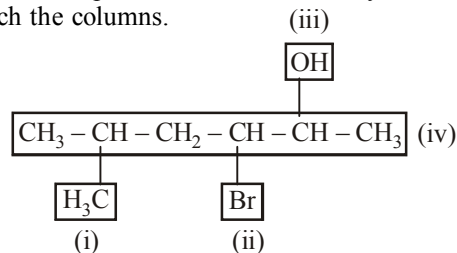
(p) Chloro

(q) ol

(r) one

(s) al

157. Identify (i), (ii), (iii) and (iv) in the structure of given organic compound. On the basis of your identification match the columns.



## Column-I

A (i)

B (ii)

C (iii)

D (iv)

## Column-II

(p) Functional group

(q) Branch chain

(r) Parent chain

(s) Homologues unit

(a) A – (q), B – (p), C – (s), D – (r)

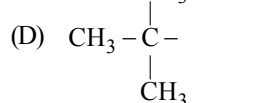
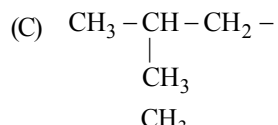
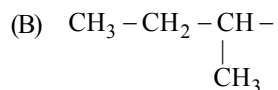
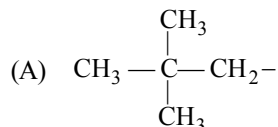
(b) A – (p), B – (s), C – (q), D – (r)

(c) A – (q), B – (p), C – (p), D – (r)

(d) A – (q), B – (p), C – (q), D – (r)

158. Match the columns.

## Column-I



## Column-II

(p) Isobutyl

(q) sec – Butyl

(r) Neopentyl

(s) tert – Butyl

(a) A – (r), B – (q), C – (p), D – (s)

(b) A – (s), B – (p), C – (r), D – (q)

(c) A – (s), B – (p), C – (q), D – (r)

(d) A – (s), B – (q), C – (p), D – (r)

159. Column-II give formula for compounds given in Column-I, match them correctly.

## Column-I

(A) Propane

(B) ethyl alcohol

(C) carboxylic acid

(D) ethyl ethanoate

(a) A – (q), B – (p), C – (r), D – (s)

(b) A – (p), B – (q), C – (s), D – (r)

(c) A – (q), B – (s), C – (p), D – (r)

(d) A – (q), B – (p), C – (s), D – (r)

## Column-II

(p)  $C_2H_5OH$

(q)  $C_3H_8$

(r)  $CH_3COOH$

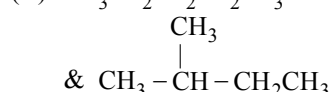
(s)  $CH_3COOC_2H_5$

160. Match the columns

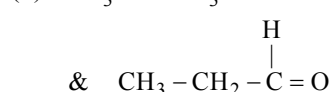
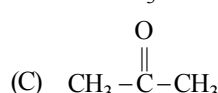
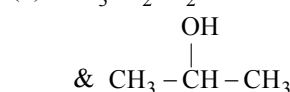
## Column-I

(Organic compounds)

(A)  $CH_3CH_2CH_2CH_2CH_3$



(B)  $CH_3CH_2CH_2OH$



## Column-II

(Type of isomerism)

(p) Functional group isomerism

(q) Chain isomerism

(r) Metamerism

(D)  $CH_3OC_3H_7$  &  $C_2H_5OC_2H_5$  (s) Position isomerism

(a) A – (s), B – (q), C – (r), D – (p)

(b) A – (s), B – (q), C – (p), D – (r)

(c) A – (q), B – (s), C – (r), D – (p)

(d) A – (q), B – (s), C – (p), D – (r)



161. Match the columns

Column-I	Column-II
(A) $\text{CH}_3\text{COOH}$ & $\text{HCOOCH}_3$	(p) Functional isomers
(B) 1 butene & 2-butene	(q) Metamers
(C) diethyl ether & methyl propyl ether	(r) Position isomers
(D) dimethyl ether and ethanol	(s) Chain isomers and ethanol
(a) A – (p), B – (r), C – (q), D – (s)	
(b) A – (q), B – (r), C – (s), D – (p)	
(c) A – (q), B – (s), C – (p), D – (r)	
(d) A – (q), B – (p), C – (s), D – (r)	

162. Match the columns

Column-I	Column-II
(A) Free radical	(p) Trigonal planar
(B) Carbocation	(q) Pyramidal
(C) Carbanion	(r) Linear
(a) A – (p), B – (q), C – (r)	
(b) A – (p), B – (p), C – (q)	
(c) A – (r), B – (p), C – (q)	
(d) A – (p), B – (p), C – (r)	

163. Match the columns

Column - I	Column - II
(A) Separation of sublimable compounds from non sublimable	(p) Steam distillation
(B) Method based on the difference in the solubilities of the compound and the impurities in a suitable solvent	(q) Sublimation
(C) Separation of liquids having sufficient difference in their boiling points.	(r) Distillation
(D) Separation of substances which are steam volatile and are immiscible with water.	(s) Crystallisation
(a) A – (q), B – (s), C – (r), D – (p)	
(b) A – (q), B – (r), C – (p), D – (s)	
(c) A – (s), B – (q), C – (r), D – (p)	
(d) A – (q), B – (s), C – (p), D – (r)	

164. Match the columns

Column - I (Elements)	Column - II (Colour of precipitate formed in Lassaigne's test)
(A) Nitrogen	(p) Yellow
(B) Sulphur	(q) Prussian blue
(C) Chlorine	(r) Violet
(D) Phosphorus	(s) White
(a) A – (q), B – (r), C – (p), D – (s)	
(b) A – (r), B – (q), C – (p), D – (s)	
(c) A – (q), B – (r), C – (s), D – (p)	
(d) A – (r), B – (q), C – (s), D – (p)	

165. Match the columns

Column - I	Column - II
(A) Duma's method	(p) $\frac{80 \times m_1 \times 100}{188 \times m}$
(B) Kjeldahl's method	(q) $\frac{31 \times m_1 \times 100}{1877 \times m} \%$
(C) Carius method for bromine	(r) $\frac{1.4 \times M \times 2 \left( v - \frac{v_1}{2} \right)}{m} \%$
(D) Percentage of phosphorus	(s) $\frac{28 \times V \times 100}{22400 \times m} \%$
(a) A – (s), B – (r), C – (p), D – (q)	
(b) A – (r), B – (s), C – (q), D – (p)	
(c) A – (s), B – (p), C – (q), D – (r)	
(d) A – (p), B – (r), C – (q), D – (s)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

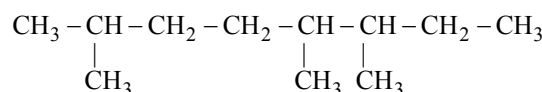
**166. Assertion :** A primary suffix indicates the type of linkage in the carbon atom.

**Reason :** CN is a Primary suffix

**167. Assertion :** The general formula for a dihydric alcohol is  $\text{C}_n\text{H}_{2n}(\text{OH})_2$

**Reason :** Ethylene glycol is a dihydric alcohol.

**168. Assertion :** IUPAC name of the following organic compound is 3, 4, 7 – trimethyloctane



**Reason :** The numbering is done in such a way that the branched carbon atoms get the lowest possible numbers.

**169. Assertion :** Chain isomerism is observed in compounds containing four or more than four carbon atoms

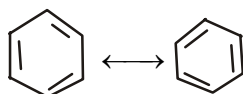
**Reason :** Only alkanes show chain isomerism

**170. Assertion :** But-1-ene and 2-methylprop-1-ene are position isomers.

**Reason :** Position isomers have same molecular formula but differ in position of functional group or  $\text{C}=\text{C}$ .

- 171. Assertion :** Benzene exhibit two different bond lengths, due to C – C single and C = C double bonds.

**Reason :** Actual structure of benzene is a hybrid of following two structures.



- 172. Assertion :** Aniline is better nucleophile than anilium ion.

**Reason :** Anilium ion have +ve charge.

- 173. Assertion :** Different number of electron pairs are present in resonance structures.

**Reason :** Resonance structures differ in the location of electrons around the constituent atoms.

- 174. Assertion :** Energy of resonance hybrid is equal to the average of energies of all canonical forms.

**Reason :** Resonance hybrid cannot be presented by a single structure.

- 175. Assertion :** Simple distillation can help in separating a mixture of propan-1-ol (boiling point 97°C) and propanone (boiling point 56°C).

**Reason :** Liquids with a difference of more than 20°C in their boiling points can be separated by simple distillation.

- 176. Assertion :** Components of a mixture of red and blue inks can be separated by distributing the components between stationary and mobile phases in paper chromatography.

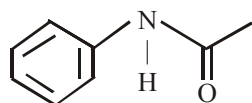
**Reason :** The coloured components of inks migrate at different rates because paper selectively retains different components according to the difference in their partition between the two phases.

- 177. Assertion :** Sulphur present in an organic compound can be estimated quantitatively by Carius method.

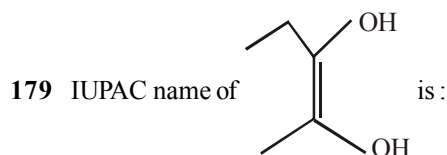
**Reason :** Sulphur is separated easily from other atoms in the molecule and gets precipitated as light yellow solid.

### CRITICAL THINKING TYPE QUESTIONS

- 178.** The IUPAC name of the following compounds is

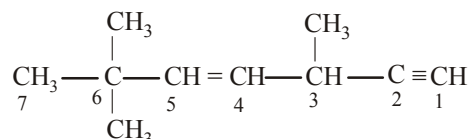


- (a) N-phenyl ethanamide  
(b) N-phenyl ethanone  
(c) N-phenyl methanamide  
(d) None of these



- (a) But-2-ene-2,3-diol  
(b) Pent-2-ene-2,3-diol  
(c) 2-methylbut-2-ene-2,3-diol  
(d) Hex-2-ene-2,3-diol

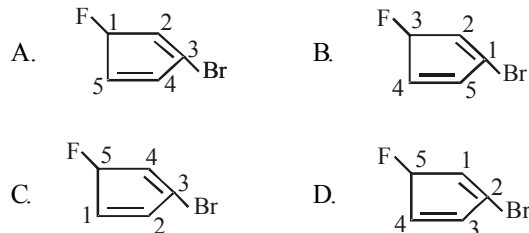
- 180.** The state of hybridization of C<sub>2</sub>, C<sub>3</sub>, C<sub>5</sub> and C<sub>6</sub> of the hydrocarbon,



is in the following sequence

- (a)  $sp^3$ ,  $sp^2$ ,  $sp^2$  and  $sp$  (b)  $sp$ ,  $sp^2$ ,  $sp^2$  and  $sp^3$   
(c)  $sp$ ,  $sp^2$ ,  $sp^3$  and  $sp^2$  (d)  $sp$ ,  $sp^3$ ,  $sp^2$  and  $sp^3$

- 181.** Which of the following numberings is correct ?



- (a) A (b) B (c) C (d) D

- 182.** The ratio of  $\pi$ - to  $\sigma$ - bonds in benzene is

- (a) 1 : 4 (b) 1 : 2  
(c) 3 : 1 (d) 1 : 6

- 183.** In which of the compounds given below there is more than one kind of hybridization ( $sp$ ,  $sp^2$ ,  $sp^3$ ) for carbon ?

- (i)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$  (ii)  $\text{CH}_3\text{CH}=\text{CHCH}_3$   
(iii)  $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$  (iv)  $\text{H}-\text{C}\equiv\text{C}-\text{H}$   
(a) (ii) (b) (iii) and (iv)  
(c) (i) and (iv) (d) (ii) and (iii)

- 184.** Which of the following represents the given mode of hybridisation  $sp^2-sp^2-sp-sp$  from left to right?

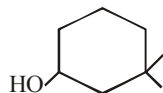
- (a)  $\text{H}_2\text{C}=\text{CH}-\text{C}\equiv\text{N}$  (b)  $\text{CH}\equiv\text{C}-\text{C}\equiv\text{CH}$

- (c)  $\text{H}_2\text{C}=\text{C}=\text{C}=\text{CH}_2$  (d)

185. The compound in which  $\overset{\text{X}}{\text{C}}$  uses its  $\text{sp}^3$  - hybrid orbitals for bond formation is

- (a)  $\text{HCOOH}$  (b)  $(\text{H}_2\text{N})_2\overset{\text{X}}{\text{CO}}$   
 (c)  $(\text{CH}_3)_3\overset{\text{X}}{\text{COH}}$  (d)  $\text{CH}_3\overset{\text{X}}{\text{CHO}}$

186. The IUPAC name of the compound is



- (a) 3,3-dimethyl - 1 - cyclohexanol  
 (b) 1, 1-dimethyl-3-hydroxy cyclohexane  
 (c) 3,3-dimethyl-1-hydroxy cyclohexane  
 (d) 1, 1-dimethyl-3-cyclohexanol

187. The IUPAC name of compound is:

- (a) 1, 2, 3 - tricarboxy - 2, 1 - propane  
 (b) 3 - carboxy - 3 hydroxy - 1, 5 - pentanedioic acid  
 (c) 3 - hydroxy - 3 - carboxy - 1, 5 - pentanedioic acid  
 (d) 2 - hydroxy propane - 1, 2, 3 - tricarboxylic acid.

188. The number of possible open chain (acyclic) isomeric compounds for molecular formula  $\text{C}_5\text{H}_{10}$  would be

- (a) 8 (b) 7  
 (c) 6 (d) 5

189. Which of the following compounds will show metamerism?

- (a)  $\text{CH}_3\text{CO-C}_2\text{H}_5$  (b)  $\text{C}_2\text{H}_5\text{-S-C}_2\text{H}_5$   
 (c)  $\text{CH}_3\text{-O-CH}_3$  (d)  $\text{CH}_3\text{-O-C}_2\text{H}_5$

190. The compound  $\text{C}_4\text{H}_{10}\text{O}$  can show

- (a) metamerism (b) functional isomerism  
 (c) position isomerism (d) All of these

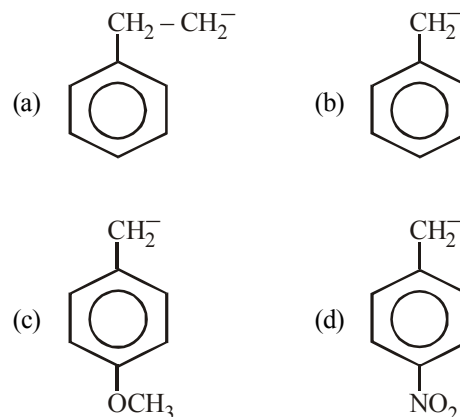
191. Which pair of isomerism is not possible together?

- (a) Ring-chain and functional  
 (b) Geometrical and optical  
 (c) Metamerism and functional  
 (d) Metamerism and chain

192. Which of the following represents the correct order of stability of the given carbocations ?

- (a)  $\text{F}_3\text{C}^+ > \text{F}_3\text{C}-\overset{+}{\underset{|}{\text{C}}}> \text{CH}_3^+$  (b)  $\text{H}_3\text{C}^+ > \text{F}_3\text{C}-\overset{+}{\underset{|}{\text{C}}}> \text{F}_3\text{C}^+$   
 (c)  $\text{F}_3\text{C}-\overset{+}{\underset{|}{\text{C}}}> \text{F}_3\text{C}^+ > \text{H}_3\text{C}^+$  (d)  $\text{F}_3\text{C}-\overset{+}{\underset{|}{\text{C}}}> \text{H}_3\text{C}^+ > \text{F}_3\text{C}^+$

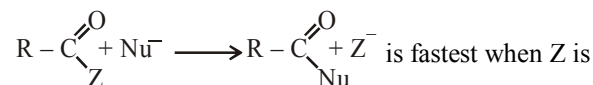
193. The most stable carbanion among the following is



194. Which one of the following is a free-radical substitution reaction?

- (a)  $\text{CH}_3\text{CHO} + \text{HCN} \longrightarrow \text{CH}_3\text{CH(OH)CN}$   
 (b)   
 (c)   
 (d)

195. Rate of the reaction



- (a)  $\text{OC}_2\text{H}_5$  (b)  $\text{NH}_2$   
 (c)  $\text{Cl}$  (d)  $\text{OCOCH}_3$

196. For (i)  $\text{I}^-$ , (ii)  $\text{Cl}^-$ , (iii)  $\text{Br}^-$ , the increasing order of nucleophilicity would be

- (a)  $\text{Cl}^- < \text{Br}^- < \text{I}^-$  (b)  $\text{I}^- < \text{Cl}^- < \text{Br}^-$   
 (c)  $\text{Br}^- < \text{Cl}^- < \text{I}^-$  (d)  $\text{I}^- < \text{Br}^- < \text{Cl}^-$

197. Which of the following is least reactive in a nucleophilic substitution reaction.
- $(\text{CH}_3)_3\text{C}-\text{Cl}$
  - $\text{CH}_2=\text{CHCl}$
  - $\text{CH}_3\text{CH}_2\text{Cl}$
  - $\text{CH}_2=\text{CHCH}_2\text{Cl}$
198. Which of the following does not represent formation of reactive intermediate correctly ?
- $\text{CH}_3-\text{CN} \rightarrow \overset{+}{\text{C}}\text{H}_3 + \text{CN}^-$
  - $\text{CH}_3-\text{Cu} \rightarrow \overset{-}{\text{C}}\text{H}_3 + \overset{+}{\text{C}}\text{u}$
  - $\text{CH}_3-\text{Br} \rightarrow \overset{+}{\text{C}}\text{H}_3 + \text{Br}^-$
  - $\text{CH}_3-\text{Cl} \rightarrow \overset{+}{\text{C}}\text{H}_3 + \text{Cl}^-$
- (ii) only
  - (ii) and (iii)
  - (ii) and (iv)
  - (iii) and (iv)
199. In Lassaigne's test, the organic compound is fused with a piece of sodium metal in order to
- increase the ionisation of the compound
  - decrease the melting point of the compound
  - increase the reactivity of the compound
  - convert the covalent compound into a mixture of ionic compounds
200. The most suitable method for separation of a 1 : 1 mixture of ortho and para nitrophenols is
- Sublimation
  - Chromatography
  - Crystallization
  - Steam distillation
201. The Lassaigne's extract is boiled with dil.  $\text{HNO}_3$  before testing for halogens because
- silver halides are soluble in  $\text{HNO}_3$
  - $\text{Na}_2\text{S}$  and  $\text{NaCN}$  are decomposed by  $\text{HNO}_3$
  - $\text{Ag}_2\text{S}$  is soluble in  $\text{HNO}_3$
  - $\text{AgCN}$  is soluble in  $\text{HNO}_3$
202. The molecular mass of an organic compound which contains only one nitrogen atom can be
- 152
  - 146
  - 76
  - 73
203. 0.25 g of an organic compound on Kjeldahl's analysis gave enough ammonia to just neutralize  $10\text{cm}^3$  of  $0.5\text{M H}_2\text{SO}_4$ . The percentage of nitrogen in the compound is
- 28
  - 56
  - 14
  - 112
204. During hearing of a court case, the judge suspected that some changes in the documents had been carried out. He asked the forensic department to check the ink used at two different places. According to you which technique can give the best results?
- Column chromatography
  - Solvent extraction
  - Distillation
  - Thin layer chromatography

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

- (a) Berzilius, a Swedish chemist proposed the concept of 'vital force'.
- (d) Urea was first discovered in human urine by H.M. Rouelle in 1773. It was synthesised in 1828 by Friedrich Wohler and was the first organic compound to be synthesised from inorganic starting materials. It was found when Wohler attempted to synthesize ammonium cyanate, to continue a study of cyanates which he had been carrying out for several years. On treating silver cyanate with ammonium chloride solution he obtained a white crystalline material which proved identical to urea obtained from urine.
- (b) F. Wohler synthesised urea from an inorganic compound ammonium cyanate  

$$\text{NH}_4\text{CNO} \xrightarrow{\text{Heat}} \text{NH}_2\text{CONH}_2$$

Ammonium cyanate                      Urea
- (c) According to vital force theory, organic compounds could only be produced by living matter by a vital force. It was in 1828, Friedrich Wohler heated  $\text{NH}_4\text{CNO}$  (derived from inorganic substance) and obtained urea (an organic compound).
- (c) Wohler synthesized urea from ammonium cyanate in 1828. Kekule proposed catenation and structure of benzene. Liebig is a history maker in sports science (energy metabolism).
- (d) Antoine-Laurent de Lavoisier (August 26, 1743 – May 8, 1794) is known as the "father of modern chemistry." He was a French nobleman prominent in the histories of chemistry, finance, biology, and economics. He stated the first version of the Law of conservation of mass, co-discovered, recognized and named oxygen (1778) as well as hydrogen, disproved the phlogiston theory, introduced the *Metric system*, invented the first periodic table including 33 elements, and helped to reform chemical nomenclature.
- (c) Hybridisation on the particular carbon can be established by number of  $\sigma$  and  $\pi$  bonds attached to it.

$\sigma$ Bond	$\pi$ Bond	Hybridisation
4	—	$sp^3$
3	1	$sp^2$
2	2	$sp$

$$\overset{1}{\text{CH}_2} = \overset{2}{\text{CH}} - \overset{3}{\text{CH}} = \overset{4}{\text{CH}_2}$$

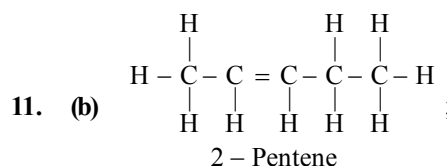
$3\sigma$	$3\sigma$	$3\sigma$	$3\sigma$
$1\pi$	$1\pi$	$1\pi$	$1\pi$

$\therefore sp^2 \quad sp^2 \quad sp^2 \quad sp^2$

$\therefore$  Both carbon atoms forming C—C single bond ( $\text{C}_2$  and  $\text{C}_3$ ) are  $sp^2$  hybridised

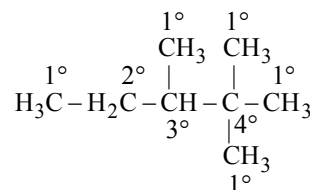
- (b) C-1 is  $sp$  hybridized ( $\text{C} \equiv \text{C}$ )  
C-3 is  $sp^3$  hybridized ( $\text{C}-\text{C}$ )  
C-5 is  $sp^2$  hybridized ( $\text{C}=\text{C}$ )  
Thus the correct sequence is  $sp, sp^3, sp^2$ .

- (c) 10. (c)



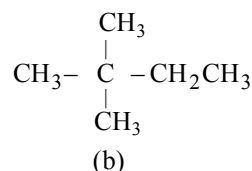
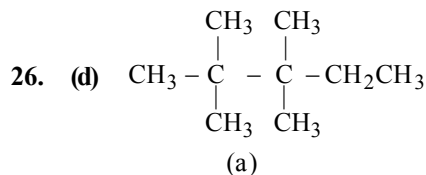
No. of  $\sigma$  bonds = 14, No. of  $\pi$  bonds = 1

- (c) (ii) and (iii) do not represent 2-bromopentane
- (c) Correct expanded form of given structure is shown in option (c).
- (c)
- (b) The successive members of a homologous series differ by a  $-\text{CH}_2$  unit.
- (a) Correct molecular formula of icosane is  $\text{C}_{20}\text{H}_{42}$   
Correct molecular formula of heptane is  $\text{C}_7\text{H}_{16}$
- (c) (iii) is the only correct method of selecting parent chain.
- (b) Correct order of decreasing priority is  $-\text{COOH}, -\text{SO}_3\text{H}, -\text{COOR}, -\text{OH}$ .
- (d) 20. (c) 21. (d) 22. (c) 23. (c)
- (d) 2, 2, 3-trimethyl pentane



- (d) 25. (d)
- $$\begin{array}{ccccccc} & & 1^\circ & & & & \\ & & \text{CH}_3 & & & & \\ 1^\circ & \text{CH}_3 & - & 4^\circ & \text{C} & - & 2^\circ & \text{CH}_2 & - & 1^\circ & \text{CH}_3 \\ & & & & | & & & & & & \\ & & & & \text{CH}_3 & & & & & & \\ & & & & 1^\circ & & & & & & \end{array}$$

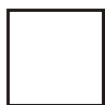
Thus number of secondary hydrogens is two.



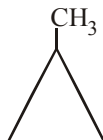




57. (b)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}\equiv\text{CH}$ ,  $(\text{CH}_3)_2\text{CHC}\equiv\text{CH}$ ,  $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CCH}_3$   
 I II III  
 58. (b)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$   $\text{CH}_3\text{CH}=\text{CHCH}_3$   $(\text{CH}_3)_2\text{C}=\text{CH}_2$   
 1-butene (i) 2-butene (ii), (iii) 2-methylpropene  
 (cis, - trans) (iv)



cyclobutane (v)



methylcyclopropane (vi)

59. (b) 2, 2, 4, 4 - Tetramethylhexane has 10 carbon atoms, only 4-isopropylheptane has also 10 carbon atoms so these two are isomers.

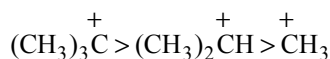
60. (a) 61. (c) 62. (a) 63. (b) 64. (d)

65. (c)

66. (b) The two isomers differ in the position of the double bond so they are called position isomers.

67. (b)

68. (b) The order of stability of carbocations is :

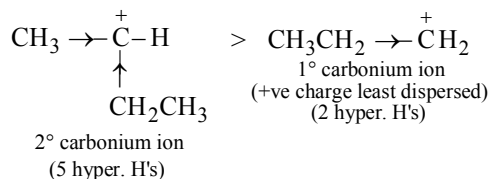
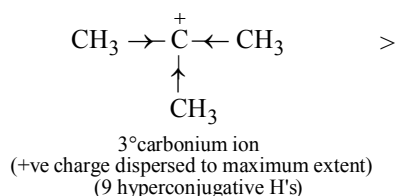


69. (c)

70. (d) Greater the number of alkyl groups attached to a positively charged C atom, greater is the hyperconjugation (no bond resonance) and stable is the cation.

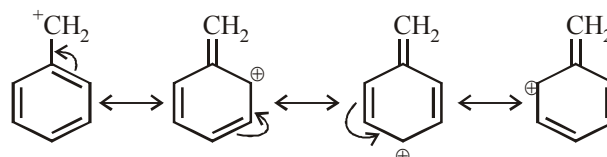
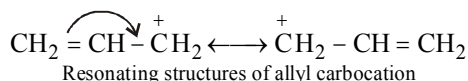
Thus order of decreasing stability of carbocation is, tert-Alkyl > Sec-Alkyl > Pri-Alkyl > Methyl.

71. (a) Carbonium ions are electron deficient species. More the number of alkyl groups attached to it, more will be stability due to + I effect.



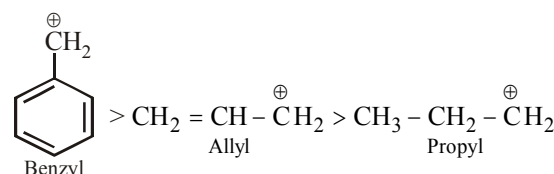
Alternatively, above order of stability order can be explained in terms of hyperconjugation.

72. (d) Higher stability of allyl and aryl substituted methyl carbocation is due to dispersal of positive charge due to resonance



Resonating structures of benzyl carbocation

whereas in alkyl carbocations dispersal of positive charge on different hydrogen atoms is due to hyper conjugation hence the correct order of stability will be



73. (b) Structure (b) is a 3° carbocation, while (a) is 2° and (c) and (d) are 1° carbocations; thus (b) is the most stable.

74. (a)

75. (a) Higher the possibility of delocalisation, greater is its stability; in  $\text{C}_6\text{H}_5\text{CH}^+\text{C}_6\text{H}_5$ , +ve charge can delocalise over two benzene rings.

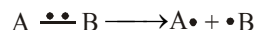
76. (d) The organic reaction which proceed through heterolytic bond cleavage are called ionic or heteropolar or just polar reactions.

77. (b) In carbocations, carbon bearing positive charge is always  $\text{sp}^2$ -hybridised

78. (b) Methyl carbanion is  $\text{sp}^3$  hybridised, with three bond pairs and one lone pair same is the case with  $\text{NH}_3$ .

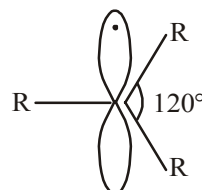
79. (b)  $\begin{array}{c} \text{Cl} \\ | \\ \text{C}^- \\ | \\ \text{Cl} \end{array} > \text{C}_6\text{H}_5\text{CH}_2^- > (\text{CH}_3)_2\text{CH}^- > (\text{CH}_3)_3\text{C}^-$   
 -ve charge highly dispersed due to -I effect      -M effect delocalises -ve charge      +I effect of  $\text{CH}_3$  group intensifies the -ve charge

80. (c) In homolytic fission each of the atoms acquires one of the bonding electrons producing free radicals (species having one unpaired electron).

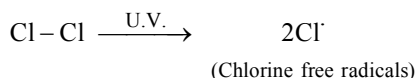


81. (b) Homolytic fission of the C - C bond gives free radicals in which carbon is  $\text{sp}^2$ - hybridised.

82. (b) The carbon atom of alkyl free radicals which is bonded to only three atoms or groups of atoms is  $\text{sp}^2$ -hybridized. Thus free radicals have a planar structure with odd electrons situated in the unused  $p$ -orbital at right angles to the plane of hybrid orbitals.



83. (c)  
84. (a) On exposure to UV light,  $\text{Cl}_2$  molecule undergoes homolytic fission, to form chlorine free radicals.

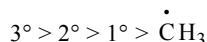


85. (b) The order of stability of free radicals  
 $(\text{C}_6\text{H}_5)_3\dot{\text{C}} > (\text{C}_6\text{H}_5)_2\dot{\text{C}}\text{H} > (\text{CH}_3)_3\dot{\text{C}} > (\text{CH}_3)_2\dot{\text{C}}\text{H}$   
 The stabilisation of first two is due to resonance and last two is due to inductive effect.  
 86. (d) Free radicals are stabilized by hyperconjugation, thus  $3^\circ$  free radicals having maximum number of hyperconjugative structures are the most stable, and primary free radical the least.

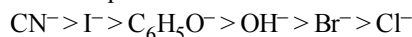
87. (b)  $\text{C}_6\text{H}_5\dot{\text{C}}\text{HCH}_3$  is a  $2^\circ$  benzylic free radical, hence stabilized most due to resonance.

88. (b) Dichlorocarbene,  $:\text{CCl}_2$  (a carbene) is the electrophile formed as an intermediate in Reimer-Tiemann reaction.

89. (d) Order of stability of free radicals is



90. (c) The strength of nucleophile depends upon the nature of alkyl group R on which nucleophile has to attack and also on the nature of solvent. The order of strength of nucleophiles follows the order :



91. (c) 92. (d)

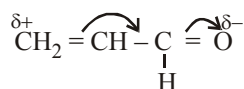
93. (a) Electrophile is positively charged or electron deficient species. Lewis acids are electron acceptors that is electron deficient species.

94. (b) Electrophiles are electron deficient or positively charged species.

95. (d)  $\text{BF}_3$  and  $\text{R}_3\text{C}-\text{X}$  are electrophile while  $(\text{CH}_3)_3\text{N}$  and  $\text{C}_2\text{H}_5\text{O}^-$  are nucleophile

96. (b)  $-\text{CH}_3$  group has +I effect, as number of  $-\text{CH}_3$  group increases, the inductive effect increases.

97. (d) Due to -I effect of the  $-\text{CHO}$  group, oxygen acquires  $\delta^-$  charge and the terminal carbon acquires  $\delta^+$  charge.



98. (c) All resonating structures should have same number of electron pairs.

99. (a) The two structures involve only movement of electrons and not of atoms or groups, hence these are resonating structures.

100. (b) Only structure (b) has a conjugated system, which is necessary for resonance.

101. (c)

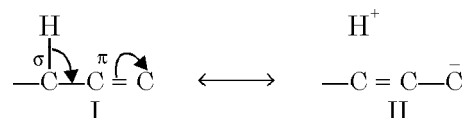
102. (b)  $-\text{OH}$  shows + R effect while  $>\text{C}=\text{O}$  shows - R effect.

103. (c) Resonance effect is the polarity produced in the molecule by the interactions of two  $\pi$  - bonds or between a  $\pi$  - bond and a lone pair of electrons present on an adjacent atom.

104. (b) Electromeric effect is purely a temporary effect and is brought into play only at the requirement of attacking reagent, it vanishes out as soon as the attacking reagent is removed from reaction mixture.

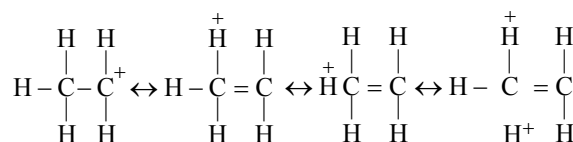
105. (b)

106. (b) Alkyl groups with at least one hydrogen atom on the  $\alpha$ -carbon atom, attached to an unsaturated carbon atom, are able to release electrons in the following way.

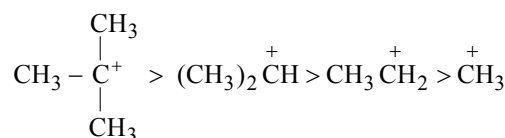


Note that the delocalisation involves  $\sigma$  and  $\pi$  bond orbitals (or  $p$  orbitals in case of free radicals) ; thus it is also known as  $\sigma - \pi$  **conjugation**. This type of *electron release due to the presence of the system  $\text{H}-\text{C}-\text{C}=\text{C}$*  is known as **hyperconjugation**

107. (b) The stability of carbocation on the basis of hyperconjugation can be explained as hyperconjugation stabilises the carbocation because electron density from the adjacent  $\pi$ -bond helps in dispersing the positive charge.

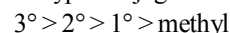


In general greater the number of alkyl groups attached to a positively charged carbon atom, the greater is the hyperconjugation interaction and stabilisation of the cation. Thus, we have the following relative stability of carbocation.



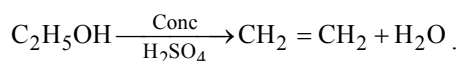
Hence, stability of carbocation is directly proportional to number of alkyl group directly attached to carbocations.

108. (b) Stability order of different alkyl carbocations on the basis of hyperconjugation is :



In t-butyl cation, the C-atom bearing the positive charge is attached to three methyl groups therefore it possess nine  $\alpha$ -hydrogens. It will give maximum nine hyperconjugative structures leading to maximum stability.

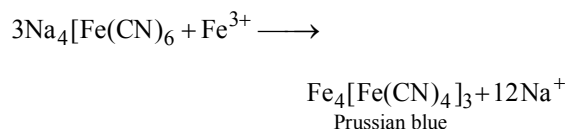
109. (b) In elimination reactions one or two molecules are lost from the substrate to form a multiple bond. Dehydration of ethanol is an example of elimination reaction.



110. (a) 111. (d) 112. (a)  
 113. (b) Coloured impurities are removed by adsorbing over activated charcoal.  
 114. (a) This method is applied for the purification of substances which (i) are insoluble in water, (ii) are volatile in steam, (iii) are associated with non steam volatile impurities, (iv) have high molecular weights and (v) possess a fairly high vapour pressure at about the boiling point of water e.g. Aniline.  
 115. (a) Aniline is purified by steam distillation. A mixture of water and aniline boils at 371 K and 760 mm pressure which is less than boiling point of water.  
 116. (b) Among the given compounds naphthelene is volatile but benzoic acid is non-volatile (it forms a dimer). So, the best method for their separation is sublimation, which is applicable to compounds which can be converted directly into the vapour phase from its solid state on heating and back to the solid state on cooling. Hence it is the most appropriate method.  
 117. (d)  
 118. (b) If there is a small difference (10 or less) in the boiling points of liquids fractional distillation is used e.g. acetone b.p. 333 K and methanol b.p. 338 K.  
 119. (a) Fractional distillation is used for the distillation of petroleum. This method is used for separating a mixture of two or more miscible, volatile liquids having close (less than 40 degrees) boiling points. (For example, a mixture of acetone, b.p., 56°C and methanol, b.p. 65°C)  
 120. (c) If any liquid decomposes at its boiling point, it can be purified by vacuum distillation.  
 121. (c) Glycerol decomposes at its boiling point, hence it should be purified by distillation under reduced pressure.  
 122. (c) Vacuum distillation means distillation under reduced pressure.  
 123. (c)  
 124. (a) The latest technique for the purification of organic compounds is chromatography. These are of various types like column, paper and gas-chromatography.  
 125. (d) Both silica gel and alumina are used as adsorbents in adsorption chromatography.  
 126. (a) Chromatography paper contains water trapped in it, which acts as the stationary phase.  
 127. (c) The mixture of sugars is a homogenous one. Homogeneous mixtures of a solvent and one or more solutes (dissolved substances) are often separated by chromatography. Chromatography works to separate a mixture because the components of a mixture distribute themselves differently when they are in

contact with a “two phase system”. One phase is stationary and the other is moving or mobile. The stationary phase may be a solid packed in a tube or a piece of paper. The mobile phase may be liquid or gaseous.

128. (b) 129. (b)  
 130. (b) Carbon and hydrogen are detected by heating the compound with copper (II) oxide. Carbon present in the compound is oxidised to  $\text{CO}_2$  and hydrogen to  $\text{H}_2\text{O}$ .  
 131. (b)  
 132. (b) Hydrazine ( $\text{NH}_2\text{NH}_2$ ) does not contain carbon and hence on fusion with Na metal, it cannot form NaCN; consequently hydrazine does not show Lassaigne's test for nitrogen.  
 133. (a) Prussian blue  $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$  is formed in lassaigne test for nitrogen.



134. (d)  
 135. (d) Kjeldahl method is not applicable to any of the given compounds. As nitrogen of these compounds does not change to ammonium sulphate on heating with conc.  $\text{H}_2\text{SO}_4$ .  
 136. (c) 137. (b)  
 138. (b) In Kjeldahl's method nitrogen is converted into  $(\text{NH}_4)_2\text{SO}_4$ , then to  $\text{NH}_3$   
 139. (d) To increase the bpt of  $\text{H}_2\text{SO}_4$ ,  $\text{K}_2\text{SO}_4$  is added

$$140. (b) \text{N}\% = \frac{1.4 \times \text{N} \times \text{V}}{\text{wt. of organic compound}}$$

$$= \frac{1.4 \times 29 \times 1/5}{0.5} = 16.24\%$$

$$141. (b) \% \text{ of S} = \frac{32}{233} \times \frac{0.233}{0.32} \times 100 = 10\%$$

142. (c) As in above question,

$$\text{C} = \frac{40}{12} = 3.33; \text{H} = \frac{13.33}{1} = 13.33; \text{N} = \frac{46.67}{14} = 3.34$$

Relative No. of atoms,

$$\text{C} = \frac{3.33}{3.33} = 1; \text{H} = \frac{13.33}{3.33} = 4; \text{N} = \frac{3.34}{3.33} = 1$$

∴ Empirical formula =  $\text{CH}_4\text{N}$

$$143. (b) \text{Percentage of P} = \frac{62}{222} \times \frac{\text{wt. of Mg}_2\text{P}_2\text{O}_7}{\text{wt. of compound}} \times 100$$

$$= \frac{62}{222} \times \frac{1.332}{2.79} \times 100 = 13.33\%$$

144. (a)
- |   | % of element | Relative no. of atoms    | Simpleratio |
|---|--------------|--------------------------|-------------|
| C | 38.8         | $\frac{38.8}{12} = 3.2$  | 1           |
| H | 16.0         | $\frac{16}{1} = 16.0$    | 5           |
| N | 45.28        | $\frac{45.28}{14} = 3.2$ | 1           |
145. (b) Compound  $\xrightarrow{\text{heat}}$  O<sub>2</sub> + Other gaseous products
- $$2\text{C} + \text{O}_2 \xrightarrow[1373\text{K}]{\text{(A)}} 2\text{CO}$$
- $$\text{I}_2\text{O}_5 + 5\text{CO} \rightarrow \text{I}_2 + 5\text{CO}_2$$
- (B)      (A)                      (C)

### STATEMENT TYPE QUESTIONS

146. (c) A carbon having an *sp* hybrid orbital with 50% *s*-character is more electronegative than carbon atoms having *sp*<sup>2</sup> and *sp*<sup>3</sup> hybrid orbitals with 33% and 25% *s*-character respectively.
- In CH<sub>2</sub> = C = CHCH<sub>3</sub>
- Number of σ bonds :
- σ<sub>C-C</sub> = 3, σ<sub>C-H</sub> = 6, total = 6 + 3 = 9
- Number of π bonds = 2
147. (a)  $\text{R}-\text{X} \xrightarrow[\text{light}]{\text{heat or}} \text{R}\cdot + \text{X}\cdot$
- Above equation is an example of homolytic cleavage
148. (c) – CH<sub>3</sub> is an electron donating group.
149. (b) The resonance structures have same positions of nuclei and same number of unpaired electrons.
150. (b) Fractional distillation method is used if the difference in boiling points of two liquids is not much.
151. (d) For statement (ii),

$$R_F = \frac{\text{Distance moved by the substance from base line}}{\text{Distance moved by the solvent from base line}}$$

For statement (iv), amino acids spots may be detected by spraying the TLC plate with ninhydrin solution.

152. (b) K<sub>2</sub>SO<sub>4</sub> raises bpt. and CuSO<sub>4</sub> acts as catalyst.
153. (d) When organic compound contains nitrogen, upon combustion it will produce oxides of nitrogen soluble in KOH solution. The copper will convert them into N<sub>2</sub>
- $$2\text{NO} + 2\text{Cu} \longrightarrow 2\text{CuO} + \text{N}_2$$
- $$2\text{NO}_2 + 4\text{Cu} \longrightarrow 4\text{CuO} + \text{N}_2 \text{ etc.}$$
- Halogens will be removed as AgX. In case of sulphur SO<sub>2</sub> formed will be removed as PbSO<sub>4</sub>.

### MATCHING TYPE QUESTIONS

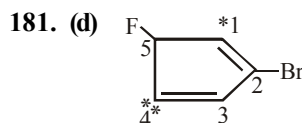
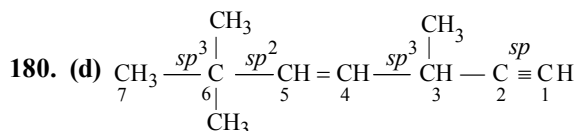
154. (b)      155. (c)      156. (a)      157. (c)      158. (a)
159. (a)      160. (d)      161. (a)      162. (b)      163. (d)
164. (c)      165. (a)

### ASSERTION-REASON TYPE QUESTIONS

166. (c) – CN is a secondary suffix.
167. (b)
168. (d) The correct name of the given compound is 2, 5, 6 -trimethyloctane
169. (c)      170. (d)
171. (c) Benzene has a uniform C – C bond distance of 139 pm, a value intermediate between the C – C single. (154 pm) and C = C double (134 pm) bonds.
172. (a) It is fact that aniline is better nucleophile than anilium ion. Anilium ion contain +ve charge, which reduces the tendency to donate lone pair of electron
- C<sub>6</sub>H<sub>5</sub>NH<sub>3</sub><sup>+</sup>  
Anilium ion
173. (d) Resonance structures contain the same number of unpaired electrons. However, they differ in the way of distribution of electrons.
174. (d)      175. (a)      176. (a)      177. (c)

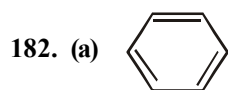
### CRITICAL THINKING TYPE QUESTIONS

178. (a) It is derivative of ethanamide having N-phenyl group.
179. (b) The compound contains longest chain of 5C - atoms and e of ene is retained as the suffix name starts with constant



The numbering of C-atom starts from <sup>\*</sup>C or <sup>\*\*</sup>C. But numbering from <sup>\*</sup>C give minimum locant (2) to Br which is correct.

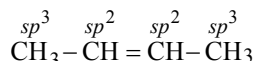




No. of  $\sigma$  bonds = 12 ; No. of  $\pi$  bonds = 3

$\therefore$  Ratio of  $\pi : \sigma$  bonds = 3 : 12 = 1 : 4

183. (a) In compounds (i), (iii) and (iv), all carbon atoms are  $sp^3$ ,  $sp^2$  and  $sp$  hybridised, respectively. However, compound (ii) has  $sp^2$  and  $sp^3$  hybridised carbon atoms;

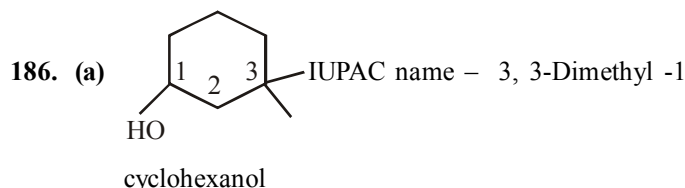


184. (a)

185. (c) See the number of  $\sigma$  bonds formed by  $\overset{x}{\text{C}}$  in each case.

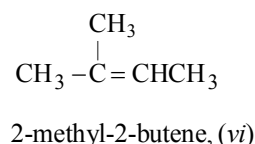
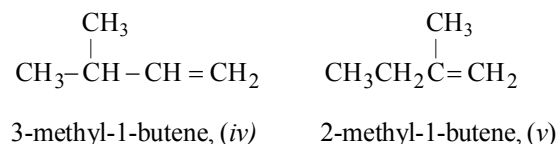
In  $\text{H}\overset{x}{\text{C}}\text{OOH}$ ,  $(\text{H}_2\text{N})_2\overset{x}{\text{C}}\text{O}$  and  $\text{CH}_3\overset{x}{\text{C}}\text{HO}$ ,  $\overset{x}{\text{C}}$  forms 3 $\sigma$  bonds and 1  $\pi$  bond, hybridisation is  $sp^2$ . In

$(\text{CH}_3)_3\overset{x}{\text{C}}\text{OH}$ ,  $\overset{x}{\text{C}}$  forms 4 $\sigma$  bonds, hence hybridisation is  $sp^3$



187. (d) The compound contains longest chain of 3 C - atoms and three -COOH groups and one -OH group attached to it (latest convention).
188. (c)  $\text{C}_5\text{H}_{10}$  has 1° degree of unsaturation since the isomers are acyclic, all of these are alkenes. For writing the isomers, first introduce the double bond at different possible positions, and then consider the possibility of branching in the alkyl group.

$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}=\text{CH}_2$      $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$   
1-pentene (i)    2-pentene, (cis, - trans) (ii), (iii)



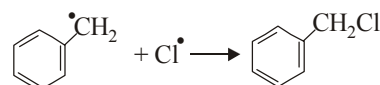
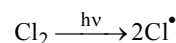
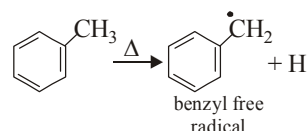
189. (b)    190. (d)

191. (c) Metamerism shown among compounds of the same functional group.

192. (b) – I group destabilises carbocation and since inductive effect decreases with increasing length of carbon chain. Therefore (b) is the correct option.

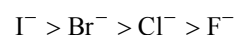
193. (d)  $-\text{NO}_2$  group, being strong electron-withdrawing, disperses the –ve charge, hence stabilizes the concerned carbanion.

194. (b) In the presence of UV rays or energy, by boiling chlorine, free radical is generated which attack the methyl carbon atom of the toluene.

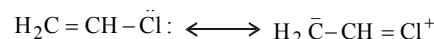


195. (c)  $\text{Cl}^-$  is the best leaving group among the given option.

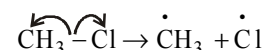
196. (a) Nucleophilicity increases down the periodic table.



197. (b)  $\text{H}_2\text{C}=\text{CHCl}$  is capable of showing resonance which develops a partial double bond character on C–Cl bond, thereby making it less reactive toward nucleophilic substitution.



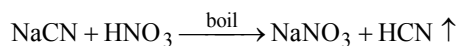
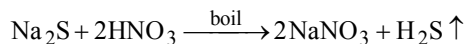
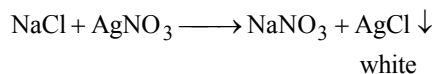
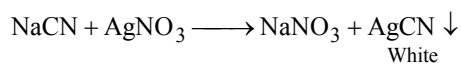
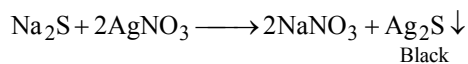
198. (d)  $\text{CH}_3-\text{Br} \rightarrow {}^+\text{CH}_3 + \text{Br}^-$



199. (d) To convert covalent compounds into ionic compounds such as  $\text{NaCN}$ ,  $\text{Na}_2\text{S}$ ,  $\text{NaX}$ , etc.

200. (d) The boiling point of o-nitrophenol is less than para-nitrophenol due to presence of intramolecular hydrogen bonding. Since p-nitrophenol is less volatile than o-nitrophenol due to presence of inter molecular hydrogen bonding hence they can be separated by steam distillation.

201. (b)  $\text{Na}_2\text{S}$  and  $\text{NaCN}$ , formed during fusion with metallic sodium, must be removed before adding  $\text{AgNO}_3$ , otherwise black ppt. due to  $\text{Na}_2\text{S}$  or white precipitate due to  $\text{AgCN}$  will be formed and thus white precipitate of  $\text{AgCl}$  will not be identified easily.



- 202. (d)** The compounds with odd number of N-atoms have odd masses and with even number of N-atoms have even masses. This is “nitrogen rule”.

- 203. (b)** Percentage of N in a compound

$$= \frac{1.4 \times \text{Normality of acid} \times \text{Volume of acid used}}{\text{Mass of the substance taken}}$$

Given, 0.5 M  $\text{H}_2\text{SO}_4$  is used.

Normality = Molarity  $\times$  n

$$\text{where } n = \frac{\text{Mol.mass}}{\text{Eq.mass}} = \frac{98}{49} = 2$$

$$\therefore \text{Normality} = 0.5 \times 2 = 1 \text{ N } \text{H}_2\text{SO}_4$$

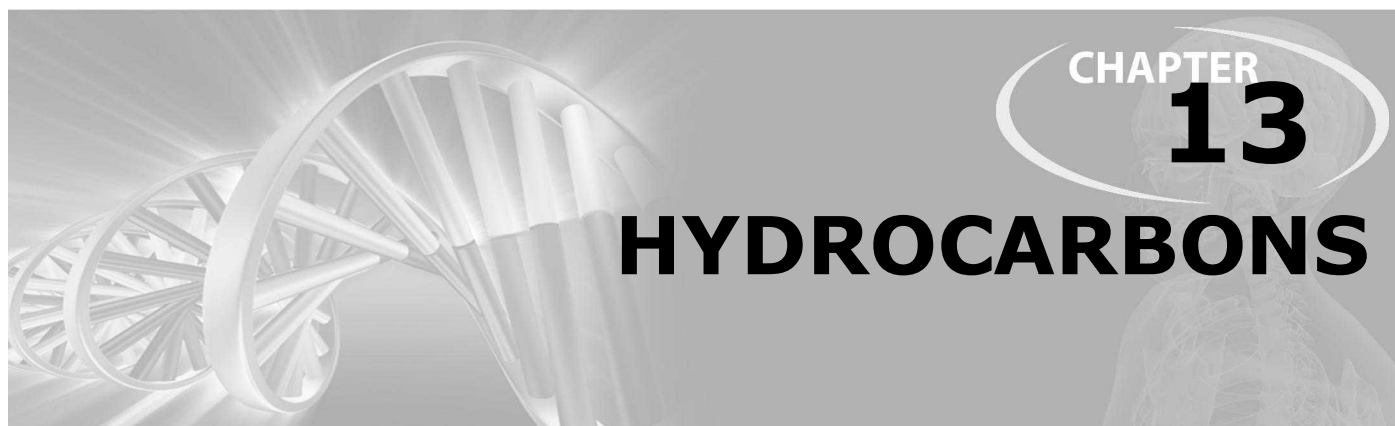
Volume of acid used to neutralise

$$\text{NH}_3 = 10 \text{ cm}^3$$

Mass of organic compound taken = 0.25 g

$$\therefore \% \text{N} = \frac{1.4 \times 1 \times 10}{0.25} = 56.$$

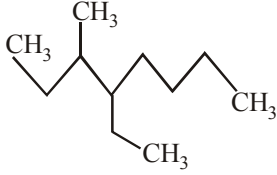
- 204. (d)**



# CHAPTER 13

## HYDROCARBONS

### FACT/DEFINITION TYPE QUESTIONS

- Which of the following fuel cause the least pollution ?  
(a) Petrol (b) CNG  
(c) Kerosene (d) LPG
- LPG mainly contains :  
(a) ethyne (b) butane  
(c) methane (d) ethane
- Natural gas is a mixture of :  
(a)  $\text{CH}_4 + \text{C}_2\text{H}_6 + \text{C}_3\text{H}_8$  (b)  $\text{CO} + \text{H}_2 + \text{CH}_4$   
(c)  $\text{CO} + \text{H}_2$  (d)  $\text{H}_2\text{O} + \text{CO}_2$
- Which of the following gas is find in coal mines and marshy places?  
(a) Methane (b) Ethane  
(c) Benzene (d) Propane
- Which of the following represents the correct general formula of alkanes ?  
(a)  $\text{C}_n\text{H}_{2n}$  (b)  $\text{C}_n\text{H}_{2n+2}$   
(c)  $\text{C}_n\text{H}_{2n-2}$  (d)  $\text{C}_n\text{H}_n$
- Two adjacent members of a homologous series have  
(a) a difference of  $\text{CH}_2$  in their structure  
(b) a different of 14 amu in molecular mass  
(c) same general method of preparation  
(d) All the above
- Methane, ethane and propane are said to form a homologous series because all are  
(a) hydrocarbons  
(b) saturated compounds  
(c) aliphatic compounds  
(d) differ from each other by a  $\text{CH}_2$  group
- Which of the following does not belong to the same homologous series?  
(a)  $\text{CH}_4$  (b)  $\text{C}_2\text{H}_6$   
(c)  $\text{C}_3\text{H}_8$  (d)  $\text{C}_4\text{H}_8$
- In which of the following compounds only primary carbon atoms are present?  
(a)  $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_3$  (b)  $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_3$   
(c)  $\text{CH}_3-\underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}}-\text{CH}_3$  (d)  $\text{CH}_3-\text{CH}_3$
- The IUPAC name of the following compound  
$$\text{H}_3\text{C}-\text{CH}_2-\underset{\text{CH}_2\text{CH}_3}{\text{CH}}-\text{CH}_2-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2\text{CH}_3$$
  
is  
(a) 3-ethyl-5-methylheptane  
(b) 5-ethyl-3-methylheptane  
(c) 3,5-diethylhexane  
(d) 1,1-diethyl-3-methylpentane
- The number of chain isomers possible for the hydrocarbon  $\text{C}_5\text{H}_{12}$  is  
(a) 1 (b) 2  
(c) 3 (d) 4
- The number of primary, secondary and tertiary carbons in 3,4-dimethylheptane are respectively  
(a) 4, 3 and 2 (b) 2, 3 and 4  
(c) 4, 2 and 3 (d) 3, 4 and 2
- Name of the given compound -  
  
(a) 2,3-diethyl heptane (b) 5-ethyl-6-methyl octane  
(c) 4-ethyl-3-methyl octane (d) 3-methyl-4-ethyl octane
- Which of the following statements is false for isopentane—  
(a) It has three  $\text{CH}_3$  groups  
(b) It has one  $\text{CH}_2$  group  
(c) It has one  $\text{CH}$  group  
(d) It has a carbon which is not bonded to hydrogen
- Molecular formula of which of the following alkane can exist in more than one structure ?  
(a)  $\text{CH}_4$  (b)  $\text{C}_2\text{H}_6$   
(c)  $\text{C}_3\text{H}_8$  (d)  $\text{C}_4\text{H}_{10}$
- How many isomers are possible for the  $\text{C}_5\text{H}_{12}$  ?  
(a) 2 (b) 3  
(c) 4 (d) 5
- The number of  $4^\circ$  carbon atoms in 2,2,4,4-tetramethyl pentane is –  
(a) 1 (b) 2  
(c) 3 (d) 4

18. Which one of the following cannot be prepared by Wurtz reaction ?  
 (a)  $\text{CH}_4$  (b)  $\text{C}_2\text{H}_6$   
 (c)  $\text{C}_3\text{H}_8$  (d)  $\text{C}_4\text{H}_{10}$
19. The reaction,  
 $\text{CH}_3 - \text{Br} + 2\text{Na} + \text{Br} - \text{CH}_3 \rightarrow$  the product, is called  
 (a) Wurtz reaction (b) Perkin's reaction  
 (c) Aldol condensation (d) Levit reaction
20. Pure methane can be produced by  
 (a) Wurtz reaction  
 (b) Kolbe's electrolytic method  
 (c) Soda-lime decarboxylation  
 (d) Reduction with  $\text{H}_2$
21. Sodium salts of carboxylic acids on heating with soda lime give alkanes containing \_\_\_\_\_ than the carboxylic acid.  
 (a) one carbon more (b) one carbon less  
 (c) two carbon less (d) Either (a) or (b)
22. Which one of the following has the least boiling point?  
 (a) 2,2-dimethylpropane (b) n-butane  
 (c) 2-methylpropane (d) n-pentane
23. Which one of the following has highest boiling point?  
 (a) n-Octane (b) 2,2 dimethyl pentane  
 (c) Iso-octan (d) All have equal values
24. Which of the following reactions of methane is incomplete combustion ?  
 (a)  $2\text{CH}_4 + \text{O}_2 \xrightarrow{\text{Cu}/523\text{K}/100\text{atm}} 2\text{CH}_3\text{OH}$   
 (b)  $\text{CH}_4 + \text{O}_2 \xrightarrow{\text{Mo}_2\text{O}_3} \text{HCHO} + \text{H}_2\text{O}$   
 (c)  $\text{CH}_4 + \text{O}_2 \rightarrow \text{C(s)} + 2\text{H}_2\text{O(l)}$   
 (d)  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2\text{(g)} + 2\text{H}_2\text{O(l)}$
25. In the free radical chlorination of methane, the chain initiating step involves the formation of  
 (a) chlorine free radical  
 (b) hydrogen chloride  
 (c) methyl radical  
 (d) chloromethyl radical.
26. Which one of the following gives only one monochloro derivative?  
 (a) n-hexane (b) 2-methylpentane  
 (c) 2,3-dimethylpentane (d) neo-pentane
27. Photochemical halogenation of alkane is an example of  
 (a) electrophilic substitution  
 (b) electrophilic addition  
 (c) nucleophilic substitution  
 (d) free radical substitution
28. 2-Methylbutane on reacting with bromine in the presence of sunlight gives mainly  
 (a) 1-bromo-3-methylbutane  
 (b) 2-bromo-3-methylbutane  
 (c) 2-bromo-2-methylbutane  
 (d) 1-bromo-2-methylbutane
29. Complete combustion of  $\text{CH}_4$  gives :  
 (a)  $\text{CO}_2 + \text{H}_2\text{O}$  (b)  $\text{CO}_2 + \text{H}_2$   
 (c)  $\text{COCl}_2$  (d)  $\text{CO} + \text{CO}_2 + \text{H}_2\text{O}$
30. Aromatisation of n-hexane gives :  
 (a) cyclohexane (b) benzene  
 (c) cycloheptane (d) toluene
31. Liquid hydrocarbons can be converted to a mixture of gaseous hydrocarbons by :  
 (a) oxidation  
 (b) cracking  
 (c) distillation under reduced pressure  
 (d) hydrolysis
32. n-Hexane isomerises in presence of anhydrous aluminium chloride and hydrogen chloride gas to give  
 (a) 2-Methyl pentane (b) 3-Methyl pentane  
 (c) Both (a) and (b) (d) Neither (a) nor (b)
33. Which of the following represents the correct reaction ?  
 (a)  $\text{CH}_4 + 2\text{H}_2\text{O} \xrightarrow{\text{Ni}} \text{CO}_2 + 4\text{H}_2$   
 (b)  $\text{CH}_4 + \text{H}_2\text{O} \xrightarrow{\text{Ni}} \text{CO} + 3\text{H}_2$   
 (c)  $\text{CH}_4 + \text{H}_2\text{O} \xrightarrow{\text{Ni}} \text{CH}_3\text{OH} + \text{H}_2$   
 (d)  $\text{CH}_4 + \text{H}_2\text{O} \xrightarrow{\text{Ni}} \text{HCHO} + 2\text{H}_2$
34. How many conformations are possible for ethane ?  
 (a) 2 (b) 3  
 (c) infinite (d) one
35. Spatial arrangements of atoms which can be converted into one another by rotation around a C-C single bond are called  
 (a) Stereoisomers (b) Tautomers  
 (c) Optical isomers (d) Conformers
36. General formula of alkenes and alkyl radicals are respectively:  
 (a)  $\text{C}_n\text{H}_{2n}$  and  $\text{C}_n\text{H}_{2n+1}$  (b)  $\text{C}_n\text{H}_{2n}$  and  $\text{C}_n\text{H}_{2n+2}$   
 (c)  $\text{C}_n\text{H}_{2n-1}$  and  $\text{C}_n\text{H}_{2n}$  (d)  $\text{C}_n\text{H}_{2n+1}$  and  $\text{C}_n\text{H}_{2n+2}$
37. The restricted rotation about carbon-carbon double bond in 2-butene is due to  
 (a) overlap of one s- and one  $\text{sp}^2$ -hybridized orbitals  
 (b) overlap of two  $\text{sp}^2$ -hybridized orbitals  
 (c) overlap of one p- and one  $\text{sp}^2$ -hybridized orbitals  
 (d) sideways overlap of two p-orbitals
38. Bond angle in alkenes is equal to  
 (a)  $120^\circ$  (b)  $109^\circ 28'$   
 (c)  $180^\circ$  (d)  $60^\circ$
39. The molecular formula of a compound in which double bond is present between C & C :  
 (a)  $\text{C}_n\text{H}_{2n+2}$  (b)  $\text{C}_n\text{H}_n$   
 (c)  $\text{C}_n\text{H}_{2n}$  (d)  $\text{C}_n\text{H}_{2n-2}$
40. IUPAC name of the following compound is  

$$\begin{array}{c} \text{H}_3\text{C} - \text{CH} - \text{CH}_2 - \text{CH} = \text{CH} - \text{CH}_3 \\ | \\ \text{Cl} \end{array}$$
  
 (a) 5-chloroheptene (b) 4-chloropent-1-ene  
 (c) 5-chloropent-3-ene (d) 5-chlorohex-2-ene

41. IUPAC name of the following compound will be
- $$\begin{array}{c} \text{CH}_3 - \text{CH} = \text{C} - \text{CH}_2 - \text{CH}_3 \\ | \\ \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \end{array}$$
- (a) 3-Ethyl-2-hexene (b) 3-Propyl-2-hexene  
(c) 3-Propyl-3-hexene (d) 4-Ethyl-4-hexene
42. Which of the following represents the correct IUPAC name of the compound
- $$\text{CH}_2 = \text{CH} - \text{CH}_2\text{Cl}$$
- (a) Allyl chloride (b) 1-chloro-3-propene  
(c) 3-chloro-1-propene (d) Vinyl chloride
43. The name of  $\text{ClCH}_2 - \text{C} = \text{C} - \text{CH}_2\text{Cl}$  according to
- $$\begin{array}{c} \text{Br} \quad \text{Br} \\ | \quad | \\ \text{C} = \text{C} \end{array}$$
- IUPAC nomenclature system is
- (a) 2,3-dibromo-1,4-dichlorobutene-2  
(b) 1,4-dichloro-2,3-dibromobutene-2  
(c) Dichlorodibromobutene  
(d) Dichlorodibromobutane
44. The IUPAC name of
- $$\begin{array}{c} \text{CH}_3 - \text{CH} - \text{CH} = \text{C} - \text{CHO} \\ | \quad | \\ \text{OH} \quad \text{CH}_3 \end{array}$$
- (a) 4-Hydroxy-1-methylpentanal  
(b) 4-Hydroxy-2-methylpent-2-en-1-al  
(c) 2-Hydroxy-4-methylpent-3-en-5-al  
(d) 2-Hydroxy-3-methylpent-2-en-5-al
45. The alkene that exhibits geometrical isomerism is
- (a) 2-methyl propene (b) 2-butene  
(c) 2-methyl-2-butene (d) propene
46. Which one of the following exhibits geometrical isomerism?
- (a) 1,2-dibromopropene (b) 2,3-dimethylbut-2-ene  
(c) 2,3-dibromobut-2-ene (d) Both (a) and (c)
47. The compounds  $\text{CH}_3\text{CH}=\text{CHCH}_3$  and  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$
- (a) are tautomers  
(b) are position isomers  
(c) contain same number of  $\text{sp}^3 - \text{sp}^3$ ,  $\text{sp}^3 - \text{sp}^2$  and  $\text{sp}^2 - \text{sp}^2$  carbon-carbon bonds  
(d) exist together in dynamic equilibrium
48. The total number of isomers for  $\text{C}_4\text{H}_8$  is
- (a) 5 (b) 6  
(c) 7 (d) 8
49. Consider the following statements : A hydrocarbon of molecular formula  $\text{C}_5\text{H}_{10}$  is a
- I. monosubstituted alkene  
II. disubstituted alkene  
III. trisubstituted alkene
- Which of the following statement(s) is(are) correct?
- (a) I, II and III (b) I and II  
(c) II and III (d) I and III
50. Geometrical isomerism is not shown by
- (a)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3\text{CH}_2\text{C} = \text{CCH}_2\text{CH}_3 \\ | \\ \text{CH}_3 \end{array}$   
(b)  $\begin{array}{c} \text{C}_2\text{H}_5 - \text{C} = \text{C} - \text{CH}_2\text{I} \\ | \quad | \\ \text{H} \quad \text{H} \end{array}$   
(c)  $\text{CH}_2 = \text{C}(\text{Cl})\text{CH}_3$   
(d)  $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH} = \text{CH}_2$
51. Hex-2-ene and 2-methylpent-2-ene exhibit
- (a) chain isomerism (b) position isomerism  
(c) geometrical isomerism (d) optical isomerism
52. Ethyl bromide gives ethylene when reacted with –
- (a) ethyl alcohol (b) dilute  $\text{H}_2\text{SO}_4$   
(c) aqueous KOH (d) alcoholic KOH
53. By which reaction ethene is obtained from ethyne –
- (a) oxidation (b) polymerisation  
(c) hydrogenation (d) dehydrogenation
54. The major product formed when 2-bromobutane is treated with alcoholic KOH is
- (a) 2-Butanol (b) 1-Butene  
(c) 1-Butanol (d) Trans-2-butene
55. Ethyl alcohol is heated with conc.  $\text{H}_2\text{SO}_4$ . The product formed is :
- (a)  $\begin{array}{c} \text{H}_3\text{C} - \text{C} - \text{OC}_2\text{H}_5 \\ || \\ \text{O} \end{array}$  (b)  $\text{C}_2\text{H}_6$   
(c)  $\text{C}_2\text{H}_4$  (d)  $\text{C}_2\text{H}_2$
56. Alcoholic solution of KOH is used for
- (a) Dehydrogenation (b) Dehalogenation  
(c) Dehydration (d) Dehydrohalogenation
57. Paraffins are soluble in
- (a) Distilled water (b) Benzene  
(c) Methanol (d) Sea water
58. When hydrochloric acid gas is treated with propene in presence of benzoyl peroxide, it gives
- (a) 2-Chloropropane (b) Allyl chloride  
(c) No reaction (d) n-Propyl chloride.
59. "The addition of unsymmetrical reagents to unsymmetrical alkenes occurs in such a way that the negative part of the addendum goes to that carbon atom of the double bond which carries lesser number of hydrogen atoms" is called by :
- (a) Saytzeff rule (b) Markownikoff's rule  
(c) Kharasch effect (d) Anti-Saytzeff rule
60. When one mole of an alkene on ozonolysis produces 2 moles of propanone, the alkene is
- (a) 3-methyl-1-butene  
(b) 2,3-dimethyl-1-butene  
(c) 2,3-dimethyl-2-pentene  
(d) 2,3-dimethyl-2-butene



61. Which alkene on ozonolysis gives  $\text{CH}_3\text{CH}_2\text{CHO}$  and  $\text{CH}_3\text{C}(=\text{O})\text{CH}_3$
- (a)  $\text{CH}_3\text{CH}_2\text{CH}=\text{C}(\text{CH}_3)_2$   
 (b)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_3$   
 (c)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$   
 (d)  $\text{CH}_3-\text{C}(\text{CH}_3)=\text{CHCH}_3$
62. Reaction of HBr with propene in the presence of peroxide gives  
 (a) isopropyl bromide (b) 3-bromopropane  
 (c) allyl bromide (d) n-propyl bromide
63.  $\text{H}_3\text{C}-\underset{\text{CH}_3}{\text{CH}}-\text{CH}=\text{CH}_2 + \text{HBr} \rightarrow \text{A}$   
 A(predominantly) is :  
 (a)  $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\text{CH}_2\text{Br}$   
 (b)  $\text{CH}_3-\underset{\text{CH}_3}{\overset{\text{Br}}{\text{C}}}-\text{CH}_2-\text{CH}_3$   
 (c)  $\text{CH}_3-\underset{\text{Br}}{\text{CH}}-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_3$   
 (d)  $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\underset{\text{Br}}{\text{CH}}-\text{CH}_3$
64. Butene-1 may be converted to butane by reaction with  
 (a)  $\text{Sn}-\text{HCl}$  (b)  $\text{Zn}-\text{Hg}$   
 (c)  $\text{Pd}/\text{H}_2$  (d)  $\text{Zn}-\text{HCl}$
65. Alkenes usually show which type of reaction –  
 (a) addition (b) substitution  
 (c) elimination (d) superposition
66. A reagent used to test unsaturation in alkene is –  
 (a) ammonical  $\text{Cu}_2\text{Cl}_2$  (b) ammonical  $\text{AgNO}_3$   
 (c) solution of  $\text{Br}_2$  in  $\text{CCl}_4$  (d) conc.  $\text{H}_2\text{SO}_4$
67. In the given reaction  

$$\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3 \xrightarrow{\text{X}} \text{CH}_3\text{CH}_2\text{COOH} + \text{CH}_3\text{COOH}$$
  
 The X is  
 (a)  $\text{C}_2\text{H}_5\text{ONa}$  (b) Conc.  $\text{HCl} + \text{Anhy. ZnCl}_2$   
 (c) Anhyd.  $\text{AlCl}_3$  (d)  $\text{KMnO}_4/\text{OH}^-$
68. Polythene is a resin obtained by polymerisation of  
 (a) Butadiene (b) Ethylene  
 (c) Methane (d) Ethyne
69. Ethyl hydrogen sulphate is obtained by reaction of  $\text{H}_2\text{SO}_4$  on  
 (a) Ethylene (b) Ethane  
 (c) Ethyl chloride (d) Ethanol
70. The negative part of an addendum adds on to the carbon atom joined to the least number of hydrogen atoms. This statement is called  
 (a) Thiele's theory (b) Peroxide effect  
 (c) Markownikoff's rule (d) Baeyer's strain theory
71. Which of the following compounds does not follow Markownikoff's law?  
 (a)  $\text{CH}_3\text{CH}=\text{CH}_2$  (b)  $\text{CH}_2\text{CHCl}$   
 (c)  $\text{CH}_3\text{CH}=\text{CHCH}_3$  (d) None of these
72. In the following sequence of reactions, the alkene affords the compound 'B'  

$$\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3 \xrightarrow{\text{O}_3} \text{A} \xrightarrow[\text{Zn}]{\text{H}_2\text{O}} \text{B}$$
  
 The compound B is  
 (a)  $\text{CH}_3\text{CH}_2\text{CHO}$  (b)  $\text{CH}_3\text{COCH}_3$   
 (c)  $\text{CH}_3\text{CH}_2\text{COCH}_3$  (d)  $\text{CH}_3\text{CHO}$
73. One mole of a symmetrical alkene on ozonolysis gives two moles of an aldehyde having a molecular mass of 44 u. The alkene is  
 (a) propene (b) 1-butene  
 (c) 2-butene (d) ethene
74. The alkene that will give the same product with HBr in the absence as well as in the presence of peroxide is  
 (a) 2-butene (b) 1-butene  
 (c) propene (d) 1-hexene
75. Ethylene reacts with alkaline  $\text{KMnO}_4$  to form  
 (a) Oxalic acid (b)  $\text{HCHO}$   
 (c) Ethyl alcohol (d) Glycol
76. The reaction of HI with  $\text{CH}_3-\text{CH}=\text{CH}_2$  at  $400^\circ\text{C}$  yields :  
 (a)  $\text{CH}_2\text{I}-\text{CH}=\text{CH}_2$  (b)  $\text{CH}_3-\text{CHI}-\text{CH}_3$   
 (c)  $\text{CH}_3-\text{CH}_2-\text{CH}_2\text{I}$  (d)  $\text{CH}_2\text{I}-\text{CH}_2-\text{CH}_2\text{I}$
77. Ethene when treated with  $\text{Br}_2$  in the presence of  $\text{CCl}_4$  which compound is formed  
 (a) 1, 2-dibromoethane (b) 1-bromo-2-chloroethane  
 (c) Both (a) and (b) (d) 1, 1, 1-tribromoethane
78. In a reaction  

$$\text{CH}_2=\text{CH}_2 \xrightarrow[\text{acid}]{\text{Hypochlorous}} \text{M} \xrightarrow{\text{R}} \begin{array}{c} \text{CH}_2-\text{OH} \\ | \\ \text{CH}_2-\text{OH} \end{array}$$
  
 Where M = molecule; R = reagent; M and R are  
 (a)  $\text{CH}_3\text{CH}_2\text{Cl}$  and  $\text{NaOH}$   
 (b)  $\text{CH}_3\text{Cl}-\text{CH}_2\text{OH}$  and aq.  $\text{NaHCO}_3$   
 (c)  $\text{CH}_3\text{CH}_2\text{OH}$  and  $\text{HCl}$   
 (d)  $\text{CH}_2=\text{CH}_2$  and heat
79. The test for unsaturation is confirmed by the decolourisation of which of the following  
 (a) Iodine water (b)  $\text{CuSO}_4$  solution  
 (c) Bromine water (d) All of these

80. Isopropyl alcohol is obtained by reacting which of the following alkenes with conc.  $\text{H}_2\text{SO}_4$  and  $\text{H}_2\text{O}$   
 (a) Ethylene (b) Propylene  
 (c) 2-methyl propene (d) Isoprene
81. Which one of the following is the strongest bond?  
 (a)  $>\text{C}=\text{C}<$  (b)  $-\text{C}\equiv\text{C}-$   
 (c)  $\begin{array}{c} | \\ -\text{C}-\text{C}= \\ | \end{array}$  (d)  $\begin{array}{c} | \quad | \\ -\text{C}-\text{C}- \\ | \quad | \end{array}$
82. An alkyne has general formula :  
 (a)  $\text{C}_n\text{H}_{2n}$  (b)  $\text{C}_n\text{H}_{2n+1}$   
 (c)  $\text{C}_n\text{H}_{2n+2}$  (d)  $\text{C}_n\text{H}_{2n-2}$
83. The IUPAC name of the compound  $\text{CH}_3\text{CH}=\text{CHC}\equiv\text{CH}$  is  
 (a) Pent-1-yn-3-ene (b) Pent-4-yn-2-ene  
 (c) Pent-3-en-1-yne (d) Pent-2-en-4-yne
84. Number of alkynes for formula  $\text{C}_5\text{H}_8$  is –  
 (a) 2 (b) 3  
 (c) 4 (d) 5
85. The IUPAC name of the compound having the formula  $\text{CH}\equiv\text{C}-\text{CH}=\text{CH}_2$  is :  
 (a) 1-butyne-3-ene (b) but-1-yne-3-ene  
 (c) 1-butene-3-yne (d) 3-butene-1-yne
86. The homologue of ethyne is  
 (a)  $\text{C}_2\text{H}_4$  (b)  $\text{C}_2\text{H}_6$   
 (c)  $\text{C}_3\text{H}_8$  (d)  $\text{C}_3\text{H}_6$
87. The C - H bond length is minimum in the bond formed by  
 (a)  $sp-s$  overlapping (as in alkynes)  
 (b)  $sp^2-s$  overlapping (as in alkenes)  
 (c)  $sp^3-s$  overlapping (as in alkanes)  
 (d) None of these
88. Triple bond of ethyne is made of  
 (a) Three  $\sigma$  – bonds  
 (b) Three  $\pi$  – bonds  
 (c) Two  $\sigma$  and one  $\pi$  – bond  
 (d) Two  $\pi$  and one  $\sigma$  – bond
89. Maximum carbon-carbon bond distance is found in –  
 (a) ethyne (b) ethene  
 (c) ethane (d) benzene
90. The acetylene molecule contains :  
 (a) 5 sigma bonds (b) 4 sigma and 1 pi bonds  
 (c) 3 sigma and 2 pi bonds (d) 2 sigma and 3 pi bonds
91. Butyne-2 contains :  
 (a)  $sp$  hybridised carbon atoms only  
 (b)  $sp^3$  hybridised carbon atoms only  
 (c) both  $sp$  and  $sp^2$  hybridised carbon atoms  
 (d) both  $sp$  and  $sp^3$  hybridised carbon atoms
92. The correct order towards bond length is  
 (a)  $\text{C}-\text{C} < \text{C}=\text{C} < \text{C}\equiv\text{C}$  (b)  $\text{C}\equiv\text{C} < \text{C}=\text{C} < \text{C}-\text{C}$   
 (c)  $\text{C}=\text{C} < \text{C}\equiv\text{C} < \text{C}-\text{C}$  (d)  $\text{C}=\text{C} < \text{C}-\text{C} < \text{C}\equiv\text{C}$
93. Which C-atom is the most electronegative in this structure?  

$$\begin{array}{c} \text{III} \quad \text{II} \quad \text{I} \\ \text{CH}_3 - \text{CH}_2 - \text{C} \equiv \text{CH} \end{array}$$
  
 (a) I  
 (b) II  
 (c) III  
 (d) all are equal electronegative
94.  $\text{R}-\text{CH}_2-\text{CCl}_2-\text{R} \xrightarrow{\text{Reagent}} \text{R}-\text{C}\equiv\text{C}-\text{R}$   
 The reagent is  
 (a) Na (b) HCl in  $\text{H}_2\text{O}$   
 (c) KOH in  $\text{C}_2\text{H}_5\text{OH}$  (d) Zn in alcohol.
95. Calcium carbide when treated with water gives :  
 (a) ethylene (b) methane  
 (c) acetylene (d) ethane
96. Which one of the following has the minimum boiling point ?  
 (a) 1-Butene (b) 1-Butyne  
 (c) *n*- Butane (d) Isobutane
97. Ammonical silver nitrate forms a white precipitate easily with  
 (a)  $\text{CH}_3\text{C}\equiv\text{CH}$  (b)  $\text{CH}_3\text{C}\equiv\text{CCH}_3$   
 (c)  $\text{CH}_3\text{CH}=\text{CH}_2$  (d)  $\text{CH}_2=\text{CH}_2$
98. When acetylene is passed through dil.  $\text{H}_2\text{SO}_4$  in presence of  $\text{HgSO}_4$ , the compound formed is  
 (a) ether (b) acetaldehyde  
 (c) acetic acid (d) ketone
99. Which of the following will be the final product when  $\text{C}_2\text{H}_2$  reacts with HCl  

$$\begin{array}{cc} \text{CH} & \text{CH}_3 \\ \text{(a) } \parallel & \text{(b) } | \\ \text{CHCl} & \text{CHCl}_2 \end{array}$$
  

$$\begin{array}{cc} \text{CHCl} & \\ \text{(c) } \parallel & \text{(d) None of these} \\ \text{CHCl} & \end{array}$$
100. The hydrocarbon which can react with sodium in liquid ammonia is  
 (a)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}\equiv\text{CCH}_2\text{CH}_2\text{CH}_3$   
 (b)  $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CH}$   
 (c)  $\text{CH}_3\text{CH}=\text{CHCH}_3$   
 (d)  $\text{CH}_3\text{CH}_2\text{C}\equiv\text{CCH}_2\text{CH}_3$
101. Which of these will not react with acetylene?  
 (a) NaOH (b) Ammonical  $\text{AgNO}_3$   
 (c) Na (d) HCl.
102. When acetylene is passed over heated iron tube, the product obtained is –  
 (a)  $\text{C}_2\text{H}_2$  (b)  $\text{C}_4\text{H}_4$   
 (c)  $\text{C}_6\text{H}_6$  (d)  $\text{C}_8\text{H}_8$
103. But-2-yne on chlorination gives  
 (a) 1-chlorobutane  
 (b) 1,2-dichlorobutane  
 (c) 1,1,2,2-tetrachlorobutane  
 (d) 2,2,3,3-tetrachlorobutane

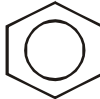
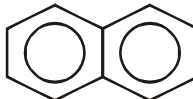
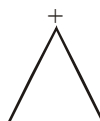
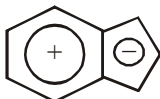
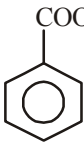
104. When propyne reacts with aqueous  $H_2SO_4$  in the presence of  $HgSO_4$ , the major product is  
 (a) Propanal  
 (b) Propyl hydrogen sulphate  
 (c) Acetone  
 (d) Propanol
105. Propyne on polymerisation gives  
 (a) Mesitylene (b) Benzene  
 (c) Ethyl benzene (d) Propyl benzene
106. What happens when a mixture of acetylene and hydrogen is passed over heated Lindlar's catalyst ?  
 (a) Ethane and water are formed  
 (b) Ethylene is formed  
 (c) Acetylene and ethane are formed  
 (d) None of these
107. Which of the following reaction is shown by alkynes ?  
 (a) Addition (b) Substitution  
 (c) Polymerization (d) All of these
108. Which of the following reactions will yield 2, 2-dibromopropane ?  
 (a)  $HC \equiv CH + 2HBr \rightarrow$   
 (b)  $CH_3C \equiv CH + 2HBr \rightarrow$   
 (c)  $CH_3CH = CH_2 + HBr \rightarrow$   
 (d)  $CH_3CH = CHBr + HBr \rightarrow$
109. In the given reactions  

$$CH_3C \equiv CH \xrightarrow{A} CH_3CBr_2CHBr_2$$

$$CH_3C \equiv CH \xrightarrow{B} CH_3CBr_2CH_3$$


$$CH_3C \equiv CH \xrightarrow[333\text{ K}]{Hg^{2+}/H^+} C$$

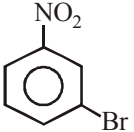
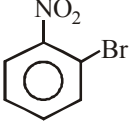
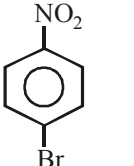
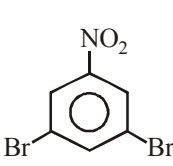
$$HC \equiv CH \xrightarrow[333\text{ K}]{Hg^{2+}/H^+} D$$
 A, B, C and D are respectively  
 (a)  $HBr, Br_2, CH_3COCH_3, CH_3CHO$   
 (b)  $Br_2, HBr, CH_3COCH_3, CH_3CHO$   
 (c)  $HBr, HBr, CH_3COCH_3, CH_3CHO$   
 (d)  $Br_2, HBr, CH_3CH_2CHO, CH_3CHO$
110. Which of the following polymer can be used as electrodes in batteries ?  
 (a) Polypropene (b) Polyacetylene  
 (c) Polyethene (d) Polyisoprene
111. Which of the following catalyst is used for the following conversion ?  

$$3CH \equiv CH \xrightarrow{873\text{ K}} \text{C}_6\text{H}_6$$
  
 (a) Platinized Asbestos (b) Red hot iron tube  
 (c) Platinized Nickel (d) Iron-molybdenum
112. Which one of the following is a non-benzenoid aromatic compound?  
 (a) Aniline (b) Benzoic acid  
 (c) Naphthalene (d) Tropolone
113. Benzene was discovered by  
 (a) Ramsay (b) Dalton  
 (c) Faraday (d) Priestley
114. The ring structure of benzene was proposed by  
 (a) Faraday (b) Davy  
 (c) Kekule (d) Wohler
115. Six carbon atoms of benzene are of  
 (a) one type (b) two types  
 (c) three types (d) six types
116. Select the true statement about benzene amongst the following  
 (a) Because of unsaturation benzene easily undergoes addition  
 (b) There are two types of C – C bonds in benzene molecule  
 (c) There is cyclic delocalisation of pi-electrons in benzene  
 (d) Monosubstitution of benzene gives three isomeric products.
117. The benzene molecule contains  
 (a) 6  $sp^2$  hybrid carbons (b) 3  $sp^2$  hybrid carbons  
 (c) 6  $sp^3$  hybrid carbons (d) 3  $sp^3$  hybrid carbons
118. Aromatic compounds burn with sooty flame because  
 (a) they have a ring structure of carbon atoms  
 (b) they have a relatively high percentage of hydrogen  
 (c) they have a relatively high percentage of carbon  
 (d) they resist reaction with oxygen of air
119. Carbon atom in benzene molecule is inclined at an angle of  
 (a)  $120^\circ$  (b)  $180^\circ$   
 (c)  $109^\circ 28'$  (d)  $60^\circ$
120. The conditions for aromaticity is :  
 (a) molecule must have cyclic clouds of delocalised  $\pi$  electrons  
 (b) molecule must contain  $(4n + 2) \pi$  electrons  
 (c) Both (a) and (b)  
 (d) None of the above
121. The chemical system that is non-aromatic is  
 (a)  (b)   
 (c)  (d) 
122. Benzene can be directly obtained from  
 (a) Acetylene (b) Phenol  
 (c) Chlorobenzene (d) All the above
123.   $\xrightarrow{NaOH + CaO}$  A  
 The product A is  
 (a) Benzene (b) Benzaldehyde  
 (c) Toluene (d) Benzoic acid

124. In a reaction of  $C_6H_5Y$ , the major product ( $> 60\%$ ) is m-isomer, so the group Y is

- (a)  $-COOH$  (b)  $-NH_2$   
(c)  $-OH$  (d)  $-Cl$

125.   $\xrightarrow[H_2SO_4]{HNO_3}$  A  $\xrightarrow[FeBr_2]{Br_2}$  B. The compound B is

- (a)  (b)   
(c)  (d) 

126. Chlorobenzene is *o*, *p*-directing in electrophilic substitution reaction. The directing influence is explained by

- (a)  $+M$  of Ph (b)  $+I$  of Cl  
(c)  $+M$  of Cl (d)  $+I$  of Ph

127. Catalytic hydrogenation of benzene gives

- (a) xylene (b) cyclohexane  
(c) benzoic acid (d) toluene

128. The strongest ortho - para and strongest meta - directing groups respectively are

- (a)  $-NO_2$  and  $-NH_2$  (b)  $-CONH_2$  and  $-NH_2$   
(c)  $-NH_2$  and  $-CONH_2$  (d)  $-NH_2$  and  $-NO_2$

129. For the formation of toluene by Friedel Craft reaction, reactants used in presence of anhydrous  $AlCl_3$  are

- (a)  $C_2H_2$  and  $CCl_4$  (b)  $CH_4$  and  $CaCN_2$   
(c)  $C_6H_6$  and  $CH_3Cl$  (d)  $C_2H_5OH$  and Zn

130. Benzene can be obtained in the reaction

- (a) Ethene + 1, 3-butadiene  
(b) Trimerisation of ethyne  
(c) Reduction of  $PhCHO$   
(d) All of these

131. Nitration of benzene by nitric acid and sulphuric acid is

- (a) Electrophilic substitution  
(b) Electrophilic addition  
(c) Nucleophilic substitution  
(d) Free radical substitution

132.  $C_6H_6 + CH_3Cl \xrightarrow[AlCl_3]{BHC, anhydrous} C_6H_5CH_3 + HCl$

is an example of

- (a) Friedel - Craft's reaction  
(b) Kolbe's synthesis  
(c) Wurtz reaction  
(d) Grignard reaction

133. Benzene reacts with  $CH_3COCl + AlCl_3$  to give

- (a) chlorobenzene (b) toluene  
(c) benzyl chloride (d) acetophenone

134. Benzene on reaction with ozone forms \_\_\_\_\_.

- (a) 2 molecules of aldehyde and 1 molecule of ketone  
(b) 2 molecules of ketone and 1 molecule of aldehyde  
(c) triozonide  
(d) hexaozonide

135.  $AlCl_3$  acts as \_\_\_\_\_ in Friedel-Crafts reaction

- (a) nucleophile (b) electrophile  
(c) free radical (d) intermediate

### STATEMENT TYPE QUESTIONS

136. The electrophilic substitutions reactions of benzene takes place via

- (i) generation of electrophile  
(ii) generation of nucleophile  
(iii) formation of carbocation intermediate  
(iv) removal of proton from the carbocation intermediate  
(a) (i), (iii) and (iv) (b) (ii), (iii) and (iv)  
(c) (i) and (iv) (d) (ii) and (iv)

137. During the nitration of benzene. In the process of generation of nitronium ion sulphuric acid behaves as a/an \_\_\_\_\_ and nitric acid behave as a/an \_\_\_\_\_.

- (a) base, acid (b) acid, base  
(c) strong acid, weak acid (d) weak acid, strong acid

138. Benzene is highly unsaturated but it does not undergo addition reaction because

- (a)  $\pi$ -electrons of benzene are delocalised.  
(b) cyclic structures do not show addition reaction  
(c) benzene is a non-reactive compound  
(d) All of the above

139. Which of the following statements are correct ?

- (i) LNG is obtained by liquefaction of natural gas.  
(ii) Petrol is obtained by fractional distillation of petroleum.  
(iii) Coal gas is obtained by destructive distillation of coal.  
(iv) CNG is found in upper strata during drilling of oil wells.  
(a) (i), (ii) and (iv) (b) (i), (ii) and (iii)  
(c) (i) and (iii) (d) (ii) and (iv)

140. Which of the following statements are correct ?

- (i) Saturated hydrocarbons contain only carbon-carbon single bonds.  
(ii) Saturated hydrocarbons contain both carbon-carbon and carbon-hydrogen single bond.  
(iii) Unsaturated hydrocarbons contain carbon-carbon double bonds.  
(iv) Unsaturated hydrocarbons contain carbon-carbon double and triple bonds both.  
(a) (i) and (iii) (b) (ii) and (iv)  
(c) (i) and (ii) (d) (i) and (iv)

141. Which of the following statements are correct regarding structure of methane ?

- (i) Methane has tetrahedral structure.  
(ii) The bond angle between all  $H-C-H$  bonds is  $109.5^\circ$ .  
(iii) The carbon atom is  $sp^2$  hybridized.  
(iv)  $C-C$  and  $C-H$  bond lengths are 154 pm and 112 pm respectively.  
(a) (i), (ii) and (iii) (b) (i), (iii) and (iv)  
(c) (i), (ii) and (iv) (d) (i), (ii), (iii) and (iv)

- 142.** In the preparation of alkanes from hydrogenation of alkenes and alkynes. Finely divided catalysts are used which of the following statement(s) is/are correct regarding these catalysts
- Platinum and palladium catalyse the reaction at room temperature.
  - Nickel catalyse the reaction at relatively higher temperature and pressure.
  - Platinum and palladium catalyse the reaction at higher temperature.
- (i) and (iii)
  - (i) and (ii)
  - (ii) and (iii)
  - (i) only
- 143.** Which of the following statements are correct ?
- The rate of reactivity of alkanes with halogens is  $F_2 > Cl_2 > Br_2 > I_2$ .
  - Rate of replacement of hydrogens of alkanes is  $3^\circ > 2^\circ > 1^\circ$
  - Fluorination of alkanes is a very slow process.
  - Iodination of alkanes is too violent to be controlled.
- (i), (ii) and (iii)
  - (i) and (ii)
  - (ii) and (iii)
  - (i) and (iv)
- 144.** Which of the following statements are correct ?
- Decomposition reaction of higher alkanes into smaller fragments by the application of heat is called pyrolysis.
  - Pyrolysis and cracking are different processes.
  - Dodecane on pyrolysis gives a mixture of heptane and pentene.
  - Pyrolysis follow free radical mechanism.
- (i), (ii) and (iii)
  - (i), (ii) and (iv)
  - (i), (iii) and (iv)
  - (ii) and (iv)
- 145.** Which of the following statement(s) is/are correct ?
- Alkanes can have infinite number of conformations by rotation around a C – C single bonds.
  - Rotation around C – C single bond is completely free.
  - Rotation is hindered by a small energy barrier of  $1-20 \text{ kJ mol}^{-1}$  due to torsional strain.
- (i) and (ii)
  - (i) and (iii)
  - (ii) and (iii)
  - Only (iii)
- 146.** Which of the following statements are correct ?
- Stability of conformation is affected due to torsional strain.
  - Magnitude of torsional strain depends upon the angle of rotation about C – C bond.
  - Eclipsed form has least torsional strain.
  - Staggered form has maximum torsional strain.
- (i) and (iii)
  - (i) and (ii)
  - (iii) and (iv)
  - (i) and (iv)
- 147.** Which of the following statements are correct ?
- The general formula of alkenes is  $C_nH_{2n}$ .
  - Alkenes are also known as paraffins.
  - Bond length of C–C double bond in alkene is shorter than C–C single bond in alkane.
  - Carbon–Carbon double bond in alkene consists of two sigma bonds.
  - Alkenes are easily attacked by electrophilic reagent.
- (i) and (iv)
  - (i), (iii) and (v)
  - (i) and (iii)
  - (i), (ii), (iv) and (v)
- 148.** Which of the following statements are correct ?
- Cis form of alkene is polar whereas trans form is non-polar
  - Cis form of alkene is non-polar whereas trans form is polar.
  - In case of solid alkenes the trans isomer has higher melting point than the cis isomer.
  - Cis and trans both form have same properties.
- (i) and (iii)
  - (ii) and (iii)
  - (i), (iii) and (iv)
  - (i) and (iv)
- 149.** Which of the following statements are correct ?
- Alkynes on reduction with palladised charcoal form cis alkenes.
  - Alkynes on reduction with palladised charcoal form trans alkenes.
  - Alkynes on reduction with sodium in liquid ammonia form trans alkenes.
  - Propyne on reduction with palladised charcoal form a mixture of cis and trans propene.
- (i) and (iv)
  - (i) and (iii)
  - (ii) and (iv)
  - (i), (iii) and (iv)
- 150.** Which of the following statements are correct ?
- Polynuclear hydrocarbons contain two or more benzene rings fused together.
  - Polynuclear hydrocarbons have carcinogenic property.
  - Polynuclear hydrocarbons are formed on incomplete combustion of organic materials like tobacco, coal and petroleum.
  - They are also produced in human body due to various biochemical reactions.
- (i), (ii) and (iv)
  - (i), (iii) and (iv)
  - (ii), (iii) and (iv)
  - (i), (ii) and (iii)

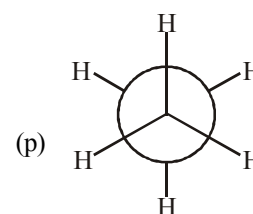
### MATCHING TYPE QUESTIONS

**151.** Match the columns

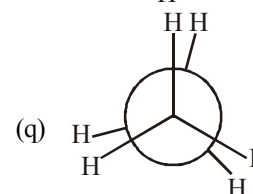
**Column-I**

**Column-II**

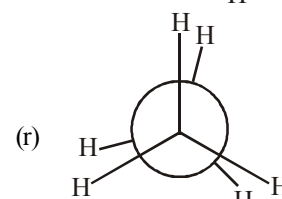
(A) Eclipsed



(B) Staggered



(C) Skew



- A – (r), B – (p), C – (q)
- A – (r), B – (q), C – (p)
- A – (p), B – (q), C – (r)
- A – (q), B – (p), C – (r)



152. Match the columns

Column-I	Column-II
(A) $\text{CH}_2=\text{CH}_2 \rightarrow \text{CH}_3-\text{CH}_3$	(p) $\text{H}_2, \text{Zn}, \text{H}^+$
(B) $\text{CH}_3\text{Cl} \rightarrow \text{CH}_4$	(q) $\text{NaOH}, \text{CaO}$
(C) $\text{CH}_3\text{Br} \rightarrow \text{CH}_3\text{CH}_3$	(r) $\text{H}_2, \text{Pt/Pd}$
(D) $\text{CH}_3\text{COONa} \rightarrow \text{CH}_4$	(s) $\text{Na}, \text{dry ether}$
(a) A - (r), B - (p), C - (s), D - (q)	
(b) A - (p), B - (s), C - (r), D - (q)	
(c) A - (s), B - (q), C - (p), D - (r)	
(d) A - (q), B - (p), C - (s), D - (r)	


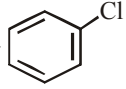

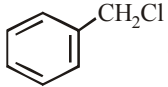
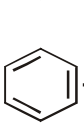
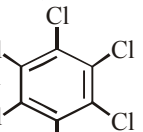
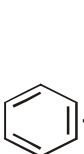
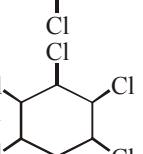
153. Match the columns

Column-I	Column-II
(A) $\text{CH}_4 + \text{O}_2 \xrightarrow{\text{Cu}/523\text{K}/100\text{ atm}}$	(p) $\text{HCHO}$
(B) $\text{CH}_4 + \text{O}_2 \xrightarrow[\Delta]{\text{Mo}_2\text{O}_3}$	(q) $(\text{CH}_3)_3\text{COH}$
(C) $\text{C}_2\text{H}_6 + \text{O}_2 \xrightarrow[\Delta]{(\text{CH}_3\text{COO})_2\text{Mn}}$	(r) $\text{CH}_3\text{OH}$
(D) $(\text{CH}_3)_3\text{CH} \xrightarrow[\text{oxidation}]{\text{KMnO}_4}$	(s) $\text{CH}_3\text{COOH}$
(a) A - (s), B - (p), C - (r), D - (s)	
(b) A - (q), B - (p), C - (s), D - (r)	
(c) A - (r), B - (p), C - (s), D - (q)	
(d) A - (p), B - (q), C - (r), D - (s)	

154. Match the columns

Column-I	Column-II
(A) $\text{CH} \equiv \text{CH} + \text{H}_2 \longrightarrow \text{CH}_2 = \text{CH}_2$	(p) $\text{Zn}$
(B) $\text{CH}_3\text{CH}_2\text{Br} \longrightarrow \text{CH}_2 = \text{CH}_2$	(q) $\text{Conc. H}_2\text{SO}_4$
(C) $\text{CH}_2\text{BrCH}_2\text{Br} \longrightarrow \text{CH}_2 = \text{CH}_2$	(r) $\text{Pd/C}$
(D) $\text{CH}_3\text{CH}_2\text{OH} \longrightarrow \text{CH}_2 = \text{CH}_2$	(s) $\text{Alc. KOH}$
(a) A - (r), B - (s), C - (p), D - (q)	
(b) A - (s), B - (r), C - (q), D - (p)	
(c) A - (q), B - (p), C - (s), D - (r)	
(d) A - (r), B - (s), C - (q), D - (p)	

155. Match the columns

Column-I	Column-II
(A)  $\longrightarrow$ 	(p) $\text{Cl}_2, \text{uv}, 500\text{ K}$
(B)  $\longrightarrow$ 	(q) $\text{anhy. AlCl}_3$
(C)  $\longrightarrow$ 	(r) $\text{CH}_2\text{Cl}_2, \text{anhy. AlCl}_3$
(D)  $\longrightarrow$ 	(s) $\text{Cl}_2, \text{anhy. AlCl}_3$

(a) A - (s), B - (r), C - (q), D - (p)

(b) A - (q), B - (r), C - (s), D - (p)

(c) A - (r), B - (p), C - (q), D - (s)

(d) A - (q), B - (p), C - (s), D - (r)

156. Match the following reactants in Column I with the corresponding reaction products in Column II and choose the correct option from the codes given below.

Column - I	Column - II
(A) Benzene + $\text{Cl}_2 \xrightarrow{\text{AlCl}_3}$	(p) Benzoic acid
(B) Benzene + $\text{CH}_3\text{Cl} \xrightarrow{\text{AlCl}_3}$	(q) Methyl phenyl ketone
(C) Benzene + $\text{CH}_3\text{COCl} \xrightarrow{\text{AlCl}_3}$	(r) Toluene
(D) Toluene $\xrightarrow{\text{KMnO}_4/\text{NaOH}}$	(s) Chlorobenzene
(a) A - (s), B - (r), C - (q), D - (p)	
(b) A - (s), B - (r), C - (p), D - (q)	
(c) A - (r), B - (s), C - (p), D - (q)	
(d) A - (r), B - (s), C - (q), D - (p)	

157. Match the columns

Column - I	Column - II
(A) Alkyl + Acid halide in presence of dry ether	(p) Sulphonation
(B) Arene + Acid halide in presence of $\text{AlCl}_3$	(q) Wurtz reaction
(C) Arene + Fuming sulphuric in presence of $\text{AlCl}_3$	(r) Catalytic hydrogenation
(D) Arene + Hydrogen in presence of Ni	(s) Friedel-Crafts reaction
(a) A - (p), B - (r), C - (q); D - (s)	
(b) A - (s), B - (q), C - (r); D - (p)	
(c) A - (r), B - (p), C - (s); D - (q)	
(d) A - (q), B - (s), C - (p); D - (r)	

158. Match the columns

Column - I	Column - II
(A) Aromatic	(p) Planar
(B) Antiaromatic	(q) Non-planar
(C) Huckel rule	(r) $4n\pi$ localised electrons
(D) Cyclo-octatetraene	(s) $(4n+2)\pi$ delocalised electrons
(a) A - (p, s), B - (p, r), C - (s), D - (q, r)	
(b) A - (p, r), B - (p, s), C - (s), D - (q, r)	
(c) A - (p, s), B - (s), C - (p, r), D - (q, r)	
(d) A - (q, r), B - (p, r), C - (s), D - (p, s)	

159. Match the columns

Column - I (Reactants)	Column - II (No. of chlorinated products)
(A) Benzene $\xrightarrow{\text{Cl}_2, \text{light}}$	p. Three compounds
(B) Toluene $\xrightarrow{\text{Cl}_2, \text{light}}$	q. Four compounds
(C) Methane $\xrightarrow{\text{Cl}_2, \text{light}}$	r. Single monochloro derivative
(D) Benzene $\xrightarrow{\text{Cl}_2, \text{AlCl}_3}$	s. Six isomeric compounds
(a) A – (r), B – (p, r), C – (q, r), D – (s)	
(b) A – (s), B – (p, r), C – (q, r), D – (r)	
(c) A – (p, r), B – (s), C – (q, r), D – (r)	
(d) A – (s), B – (p, r), C – (r), D – (q, r)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

160. **Statement-1 :** 1-Butene on reaction with HBr in the presence of a peroxide produces 1-bromobutane.

**Statement-2 :** It involves the free radical mechanism.

161. **Statement-1 :**  $\text{CH}_4$  does not react with  $\text{Cl}_2$  in dark.

**Statement-2 :** Chlorination of  $\text{CH}_4$  takes place in sunlight.

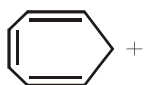
162. **Statement-1 :** Iodination of alkanes is reversible.

**Statement-2 :** Iodination is carried out in presence of iodic acid.

163. **Statement-1 :** All the hydrogen atoms in  $\text{CH}_2 = \text{C} = \text{CH}_2$  lie in one plane.

**Statement-2 :** Carbon atoms are  $sp^2$  and  $sp$  hybridized.

164. **Statement-1 :** Tropylium cation is aromatic in nature



**Statement-2 :** The only property that determines its aromatic behaviour is its planar structure.

### CRITICAL THINKING TYPE QUESTIONS

165. In cyclopropane, cyclobutane and cyclohexane, the common group is

- (a)  $\begin{array}{c} | \\ -\text{C}- \\ | \end{array}$  (b)  $\begin{array}{c} | \\ -\text{CH} \\ | \end{array}$   
 (c)  $-\text{CH}_3$  (d)  $\begin{array}{c} | \\ \text{CH}_2 \\ | \end{array}$

166. The number of primary, secondary, tertiary and quaternary carbons in neopentane are respectively

- (a) 4, 3, 2 and 1 (b) 5, 0, 0 and 1  
 (c) 4, 0, 0 and 1 (d) 4, 0, 1 and 1

167. The IUPAC name of  $\text{CH}_3 - \text{CH}_2 - \text{C} \begin{array}{c} \text{H} \quad \text{C}_4\text{H}_9 \\ | \quad | \\ \text{CH}_3\text{CH}_3 \end{array} - \text{C} - \text{CH}_3$  : –

- (a) 3, 4, 4-Trimethyl octane  
 (b) 3, 4, 4-Trimethyl heptane  
 (c) 2-Ethyl, 3,3-dimethyl heptane  
 (d) 2-Butyl, 2 methyl, 3-ethyl butane

168. Which one of the following has the lowest boiling point?

- (a) 2-methylbutane (b) 2-methyl propane  
 (c) 2, 2-dimethyl propane (d) n-pentane

169. Arrange the following in decreasing order of their boiling points.

- (A) n-butane (B) 2-methylbutane  
 (C) n-pentane (D) 2, 2-dimethylpropane  
 (a)  $A > B > C > D$  (b)  $B > C > D > A$   
 (c)  $D > C > B > A$  (d)  $C > B > D > A$

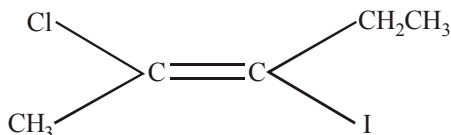
170. When neo-pentyl bromide is subjected to Wurtz reaction, the product formed is

- (a) 2,2,4,4-tetramethylhexane  
 (b) 2,2,4,4-tetramethylpentane  
 (c) 2,2,5,5-tetramethylhexane  
 (d) 2,2,3,3-tetramethylhexane

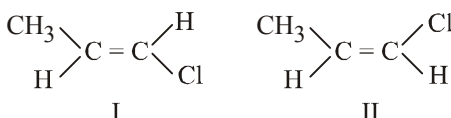
171. Which one of the following reactions is expected to readily give a hydrocarbon product in good yields ?

- (a)  $\text{RCOOK} \xrightarrow[\text{oxidation}]{\text{Electrolytic}}$   
 (b)  $\text{RCOO}^- \text{Ag}^+ \xrightarrow{\text{Br}_2}$   
 (c)  $\text{CH}_3\text{CH}_3 \xrightarrow[\text{h}\nu]{\text{Cl}_2}$   
 (d)  $(\text{CH}_3)_3\text{CCl} \xrightarrow{\text{C}_2\text{H}_5\text{OH}}$

172. A hydrocarbon A on chlorination gives B which on heating with alcoholic potassium hydroxide changes into another hydrocarbon C. The latter decolourises Baeyer's reagent and on ozonolysis forms formaldehyde only. A is  
 (a) Ethane (b) Butane  
 (c) Methane (d) Ethene
173. Which of the following compounds can yield only one monochlorinated product upon free radical chlorination?  
 (a) Propane (b) 2, 2-Dimethylpropane  
 (c) 2-Methylpropane (d) n-Butane
174. In the eclipsed conformation of ethane, the dihedral angle between the hydrogen atoms of adjacent methyl groups is  
 (a)  $60^\circ$  (b)  $120^\circ$   
 (c)  $0^\circ$  (d)  $180^\circ$
175. The nodal plane in the  $\pi$ -bond of ethene is located in  
 (a) the molecular plane  
 (b) a plane parallel to the molecular plane  
 (c) a plane perpendicular to the molecular plane which bisects the carbon - carbon  $\sigma$ -bond at right angle  
 (d) a plane perpendicular to the molecular plane which contains the carbon - carbon  $\sigma$ -bond.
176. The IUPAC name of the compound having the formula  $(\text{CH}_3)_3\text{CCH}=\text{CH}_2$  is –  
 (a) 3, 3, 3-trimethyl-1-propane  
 (b) 1, 1, 1-trimethyl-1-butene  
 (c) 3, 3-dimethyl-1-butene  
 (d) 1, 1-dimethyl-1, 3-butene
177. The IUPAC name of the following compound is

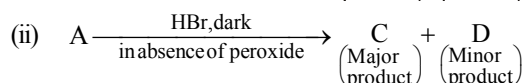
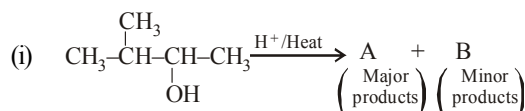


- (a) trans-2-chloro-3-iodo-2-pentene  
 (b) cis-3-iodo-4-chloro-3-pentene  
 (c) trans-3-iodo-4-chloro-3-pentene  
 (d) cis-2-chloro-3-iodo-2-pentene
178. The number of possible open chain (acyclic) isomeric compounds for molecular formula  $\text{C}_5\text{H}_{10}$  would be  
 (a) 8 (b) 7  
 (c) 6 (d) 5
179. Correct order of stability is :  
 (a) cis -2- butene > 1-butene > trans -2-butene  
 (b) trans-2-butene > cis-2-butene > 1-butene  
 (c) 1-butene > cis-2-butene > trans-2- butene  
 (d) cis-2-butene > trans-2-butene > 1-butene
180. Which of the following is correct set of physical properties of the geometrical isomers –



Dipole moment	B.P.	M.P.	Stability
(a) $\text{I} > \text{II}$	$\text{I} > \text{II}$	$\text{II} > \text{I}$	$\text{I} > \text{II}$
(b) $\text{II} > \text{I}$	$\text{II} > \text{I}$	$\text{II} > \text{I}$	$\text{II} > \text{I}$
(c) $\text{I} > \text{II}$	$\text{I} > \text{II}$	$\text{I} > \text{II}$	$\text{I} > \text{II}$
(d) $\text{II} > \text{I}$	$\text{II} > \text{I}$	$\text{II} > \text{I}$	$\text{I} > \text{II}$

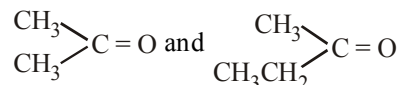
181. But-2-ene exhibits cis-trans-isomerism due to  
 (a) rotation around  $\text{C}_3 - \text{C}_4$  sigma bond  
 (b) restricted rotation around  $\text{C} = \text{C}$  bond  
 (c) rotation around  $\text{C}_1 - \text{C}_2$  bond  
 (d) rotation around  $\text{C}_2 - \text{C}_3$  double bond
182. In the following reactions,



the major products (A) and (C) are respectively :

- (a)  $\text{CH}_2 = \overset{\text{CH}_3}{\text{C}} - \text{CH}_2 - \text{CH}_3$  and  $\text{CH}_2 - \overset{\text{CH}_3}{\underset{\text{Br}}{\text{C}}} - \text{CH}_2 - \text{CH}_3$
- (b)  $\text{CH}_3 - \overset{\text{CH}_3}{\text{C}} = \text{CH} - \text{CH}_3$  and  $\text{CH}_3 - \overset{\text{CH}_3}{\underset{\text{Br}}{\text{C}}} - \text{CH}_2 - \text{CH}_3$
- (c)  $\text{CH}_3 - \overset{\text{CH}_3}{\text{C}} = \text{CH} - \text{CH}_3$  and  $\text{CH}_3 - \overset{\text{CH}_3}{\text{CH}} - \underset{\text{Br}}{\text{CH}} - \text{CH}_3$
- (d)  $\text{CH}_2 = \overset{\text{CH}_3}{\text{C}} - \text{CH}_2 - \text{CH}_3$  and  $\text{CH}_3 - \overset{\text{CH}_3}{\underset{\text{Br}}{\text{C}}} - \text{CH}_2 - \text{CH}_3$

183. When 3, 3-dimethyl 2-butanol is heated with  $\text{H}_2\text{SO}_4$ , the major product obtained is  
 (a) 2,3-dimethyl 2-butene  
 (b) 3, 3-dimethyl 1- butene  
 (c) 2, 3-dimethyl 1- butene  
 (d) cis & trans isomers of 2, 3-dimethyl 2-butene
184. An alkene having molecular formula  $\text{C}_7\text{H}_{14}$  was subjected to ozonolysis in the presence of zinc dust. An equimolar amount of the following two compounds was obtained



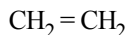
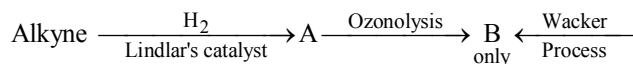
The IUPAC name of the alkene is

- (a) 3, 4-dimethyl-3-pentene (b) 3, 4-dimethyl-2-pentene  
 (c) 2, 3-dimethyl-3-pentene (d) 2, 3-dimethyl-2-pentene
185. Reaction of hydrogen bromide with propene in the absence of peroxide is a/an  
 (a) free radical addition  
 (b) nucleophilic addition  
 (c) electrophilic substitution  
 (d) electrophilic addition

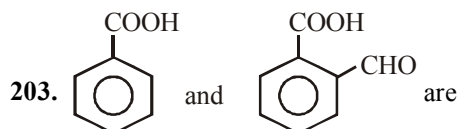
- 186.** Which of the following types of reaction occur when a reactant has got a double bond ?  
 (i) Addition  
 (ii) Photolysis  
 (iii) Nucleophilic substitution  
 (iv) Polymerization  
 (a) (i) and (iv) (b) (i), (ii) and (iii)  
 (c) (iii) and (iv) (d) (ii) and (iii)
- 187.** The disappearance of the characteristic purple colour of  $\text{KMnO}_4$  in its reaction with an alkene is the test for unsaturation. It is known as  
 (a) Markownikoff test (b) Baeyer test  
 (c) Wurtz test (d) Grignard test
- 188.**  $\text{CH}_2 = \text{CHCl}$  reacts with  $\text{HCl}$  to form  
 (a)  $\text{CH}_2\text{Cl} - \text{CH}_2\text{Cl}$  (b)  $\text{CH}_3 - \text{CHCl}_2$   
 (c)  $\text{CH}_2 = \text{CHClHCl}$  (d) None of these
- 189.** The only alcohol that can be prepared by the indirect hydration of alkene is  
 (a) Ethyl alcohol (b) Propyl alcohol  
 (c) Isobutyl alcohol (d) Methyl alcohol
- 190.** Which reactions are most common in alkenes  
 (a) Electrophilic substitution reactions  
 (b) Nucleophilic substitution reactions  
 (c) Electrophilic addition reactions  
 (d) Nucleophilic addition reactions
- 191.** In the presence of peroxide, hydrogen chloride and hydrogen iodide do not give anti-Markownikov's addition to alkenes because  
 (a) Both are highly ionic  
 (b) One is oxidising and the other is reducing  
 (c) One of the steps is endothermic in both the cases  
 (d) All the steps are exothermic in both the cases
- 192.** Which of the following statements is incorrect regarding dehydrohalogenation of alkenes ?  
 (a) During the reaction hydrogen atom is eliminated from the  $\beta$ -carbon atom.  
 (b) Rate of reaction for same alkyl group; Iodine > Bromine > Chlorine  
 (c) Rate of reaction;  $(\text{CH}_3)_3\text{C} - > (\text{CH}_3)_2\text{CH} - > \text{CH}_3\text{CH}_2 -$   
 (d) Only nature of halogen atom determine rate of the reaction.
- 193.** How many structural isomers are possible for the alkyne  $\text{C}_6\text{H}_{10}$  ?  
 (a) 7 (b) 6  
 (c) 8 (d) 5
- 194.** Which of the following will have least hindered rotation around carbon - carbon bond ?  
 (a) Ethane (b) Ethylene  
 (c) Acetylene (d) Hexachloroethane
- 195.** Acetylenic hydrogens are acidic because  
 (a) Sigma electron density of C - H bond in acetylene is nearer to carbon, which has 50% s-character  
 (b) Acetylene has only open hydrogen in each carbon  
 (c) Acetylene contains least number of hydrogens among the possible hydrocarbons having two carbons  
 (d) Acetylene belongs to the class of alkynes with molecular formula  $\text{C}_n\text{H}_{2n-2}$ .
- 196.** Propyne can be prepared by dehydrohalogenation of  
 (a) 1-chloropropane  
 (b) 1,2-dichloropropane  
 (c) 1,2-dichloroethane  
 (d) 1,1,2,2-tetrachloroethane
- 197.** Which is the most suitable reagent among the following to distinguish compound (3) from rest of the compounds ?  
 1.  $\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3$   
 2.  $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$   
 3.  $\text{CH}_3 - \text{CH}_2\text{C} \equiv \text{CH}$   
 4.  $\text{CH}_3 - \text{CH} = \text{CH}_2$   
 (a) Bromine in carbon tetrachloride  
 (b) Bromine in acetic acid  
 (c) Alk  $\text{KMnO}_4$   
 (d) Ammonical silver nitrate.
- 198.** Predict the product C obtained in the following reaction of butyne-1.  

$$\text{CH}_3\text{CH}_2 - \text{C} \equiv \text{CH} + \text{HCl} \longrightarrow \text{B} \xrightarrow{\text{HI}} \text{C}$$
  
 (a) 
$$\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \overset{\text{I}}{\underset{\text{Cl}}{\text{C}}} - \text{H}$$
  
 (b) 
$$\text{CH}_3 - \text{CH}_2 - \overset{\text{I}}{\text{CH}} - \text{CH}_2\text{Cl}$$
  
 (c) 
$$\text{CH}_3\text{CH}_2 - \overset{\text{I}}{\underset{\text{Cl}}{\text{C}}} - \text{CH}_3$$
  
 (d) 
$$\text{CH}_3 - \overset{\text{I}}{\underset{\text{Cl}}{\text{CH}}} - \text{CH}_2\text{CH}_2\text{I}$$
- 199.** The correct increasing order of acidity of the following alkynes  
 (1)  $\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3$   
 (2)  $\text{CH}_3 - \text{C} \equiv \text{CH}$   
 (3)  $\text{CH} \equiv \text{CH}$   
 (a)  $1 < 2 < 3$  (b)  $2 < 3 < 1$   
 (c)  $3 < 2 < 1$  (d)  $1 < 3 < 2$

200. Identify the alkyne in the following sequence of reactions.



- (a)  $\text{H}_3\text{C} - \text{C} \equiv \text{C} - \text{CH}_3$   
 (b)  $\text{H}_3\text{C} - \text{CH}_2 - \text{C} \equiv \text{CH}$   
 (c)  $\text{H}_2\text{C} = \text{CH} - \text{C} \equiv \text{CH}$   
 (d)  $\text{HC} \equiv \text{C} - \text{CH}_2 - \text{C} \equiv \text{CH}$
201. Which of the following represent the correct order of acidic strength ?
- (i)  $\text{HC} \equiv \text{CH} > \text{H}_2\text{C} = \text{CH}_2 > \text{CH}_3 - \text{CH}_3$   
 (ii)  $\text{HC} \equiv \text{CH} > \text{CH}_3 - \text{CH}_3 > \text{H}_2\text{C} = \text{CH}_2$   
 (iii)  $\text{CH}_3\text{C} \equiv \text{CH} > \text{HC} \equiv \text{CH} > \text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3$   
 (iv)  $\text{HC} \equiv \text{CH} > \text{CH}_3 - \text{C} \equiv \text{CH} > \text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3$
- (a) (i) and (iii) (b) (ii) and (iv)  
 (c) (i) and (iv) (d) (i) and (iv)
202. Which one of these is not compatible with arenes?
- (a) Greater stability  
 (b) **Delocalisation** of  $\pi$ -electrons  
 (c) Electrophilic additions  
 (d) Resonance




- (a) Position isomer (b) Chain isomer  
 (c) Functional isomer (d) Stereoisomer
204. The carbon-carbon bond length in benzene is
- (a) Same as in  $\text{C}_2\text{H}_4$   
 (b) In between  $\text{C}_2\text{H}_6$  and  $\text{C}_2\text{H}_2$   
 (c) In between  $\text{C}_2\text{H}_4$  and  $\text{C}_2\text{H}_2$   
 (d) In between  $\text{C}_2\text{H}_6$  and  $\text{C}_2\text{H}_4$
205. Point out the wrong statement in relation to the structure of benzene

- (a) It forms only one monosubstitution product  
 (b) The C - C bond distance in benzene is uniformly  $1.397\text{\AA}$   
 (c) It is a resonance hybrid of a number of canonical forms  
 (d) It has three delocalised  $\pi$ -molecular orbitals

206. The ratio of  $\sigma$  to  $\pi$  bonds in benzene is :

- (a) 2 (b) 3  
 (c) 4 (d) 8

207. The radical,  is aromatic because it has :

- (a) 7 p-orbitals and 6 unpaired electrons  
 (b) 7 p-orbitals and 7 unpaired electrons  
 (c) 6 p-orbitals and 7 unpaired electrons  
 (d) 6 p-orbitals and 6 unpaired electrons

208. (i) Chlorobenzene and (ii) benzene hexachloride are obtained from benzene by the reaction of chlorine, in the presence of

- (a) (i) Direct sunlight and (ii) anhydrous  $\text{AlCl}_3$   
 (b) (i) Sodium hydroxide and (ii) sulphuric acid  
 (c) (i) Ultraviolet light and (ii) anhydrous  $\text{FeCl}_3$   
 (d) (i) Anhydrous  $\text{AlCl}_3$  and (ii) direct sunlight

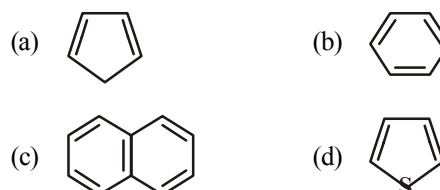
209. A group which deactivates the benzene ring towards electrophilic substitution but which directs the incoming group principally to the o- and p-positions is

- (a)  $-\text{NH}_2$  (b)  $-\text{Cl}$   
 (c)  $-\text{NO}_2$  (d)  $-\text{C}_2\text{H}_5$

210. Benzene can be obtained by heating either benzoic acid with X or phenol with Y. X and Y are respectively.

- (a) Zinc dust and soda lime  
 (b) Soda lime and zinc dust  
 (c) Zinc dust and sodium hydroxide  
 (d) Soda lime and copper

211. Which of the following chemical system is non aromatic?





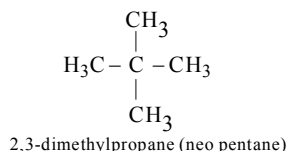
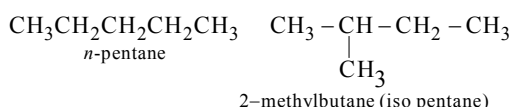
# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

- (d) LPG is used as a domestic fuel with the least pollution.
- (b) LPG mainly contains butane.
- (a) Natural gas is a mixture of  $\text{CH}_4$ ,  $\text{C}_2\text{H}_6$  and  $\text{C}_3\text{H}_8$ .
- (a) 5. (b) 6. (d) 7. (d) 8. (d)

- (d)  $\text{CH}_3 - \text{CH}_3$   
Both carbon atoms in ethane are primary.

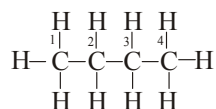
- (a)
- (c) Pentane ( $\text{C}_5\text{H}_{12}$ ) exists as three chain isomers



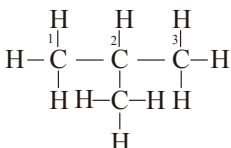
- (a)  $\text{H}_3\text{C} - \overset{1^\circ}{\underset{\text{H}}{\text{C}}} - \overset{2^\circ}{\underset{\text{H}}{\text{C}}} - \overset{2^\circ}{\underset{\text{H}}{\text{C}}} - \overset{3^\circ}{\underset{\text{CH}_3}{\text{C}}} - \overset{3^\circ}{\underset{\text{CH}_3}{\text{C}}} - \overset{2^\circ}{\underset{\text{H}}{\text{C}}} - \overset{1^\circ}{\text{CH}_3}$   
3, 4-dimethylheptane

There are four  $1^\circ$  C-atoms, three  $2^\circ$  C-atoms and two  $3^\circ$  C-atoms

- (c)
- (d)  $\text{CH}_4$ ,  $\text{C}_2\text{H}_6$  and  $\text{C}_3\text{H}_8$  can have only one structure but  $\text{C}_4\text{H}_{10}$  can have more than one structure. Possible structures of  $\text{C}_4\text{H}_{10}$  are following

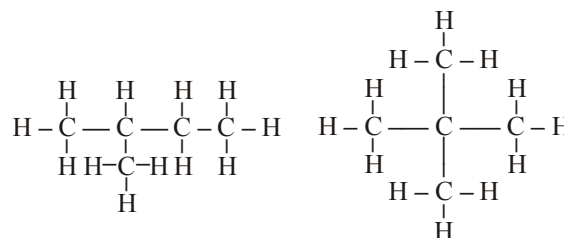
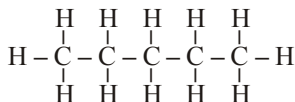


Butane (*n*-butane), (b.p. 273 K)

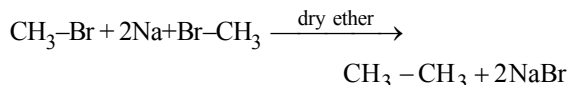
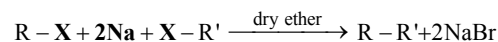


2-Methylpropane (isobutane)  
(b.p. 261 K)

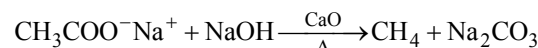
- (b) Possible isomers of  $\text{C}_5\text{H}_{12}$  are



- (b)
- (a)  $\text{CH}_4$  has only one carbon atom, hence it can't be prepared by Wurtz reaction, which involves two molecules of alkyl halide.
- (a) When alkyl halide is treated with sodium metal in presence of ether, alkane is obtained, this reaction is called as Wurtz reaction.



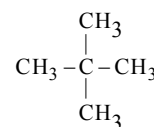
- (c) Other three methods can be used for the preparation of alkane having at least two carbon atoms.
- (b) Sodium salts of carboxylic acids on heating with soda lime (mixture of sodium hydroxide and calcium oxide) give alkanes containing one carbon atom less than the carboxylic acid. This process of elimination of carbon dioxide from a carboxylic acid is known as decarboxylation



Sodium ethanoate

Methane

- (a) Higher is the branching lesser will be the boiling point further increase in molecular weight increases boiling point in alkane. Hence 2, 2-dimethyl propane will have least boiling point.

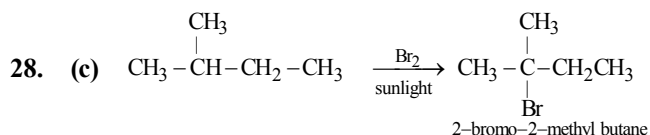


- (a) *n*-octane has highest boiling point due to unbranched chain and maximum carbon atoms. It has max. Van der Waal forces.
- (c)



- (d) Neo-pentane,  $\text{H}_3\text{C} - \text{C}(\text{CH}_3)_3$ , has only  $1^\circ$  hydrogen and hence gives only one monochloro derivative.

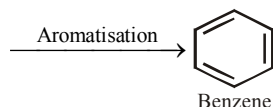
27. (d)



Ease of replacement of H-atom  $3^\circ > 2^\circ > 1^\circ$ .

29. (a) Complete combustion of all organic compounds leads to formation of  $\text{CO}_2 + \text{H}_2\text{O}$ .

30. (b)  $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$



Aromatisation is a process in which aromatic compounds are formed from open chain compounds.

31. (b) During cracking higher hydrocarbons (liquid) are converted to lower gaseous hydrocarbons.

32. (c) n-Alkanes on heating with anhydrous aluminium chloride and hydrogen chloride gas isomerise to branched chain alkanes.

33. (b) Methane reacts with steam at 1273 K in the presence of nickel catalyst to form carbon monoxide and dihydrogen. This method is used for industrial preparation of dihydrogen gas.

34. (c) A conformation is defined as the relative arrangement of atoms or groups around a central atom, obtained by the free rotation of one part of the molecule with respect to rest of the molecule. For a complete rotation of  $360^\circ$ , one part may rotate through any degree say  $0.1^\circ$ ,  $0.5^\circ$ ,  $1^\circ$  etc. giving rise to infinite number of relative arrangements of group (atom) around a central atom, keeping other part fixed.

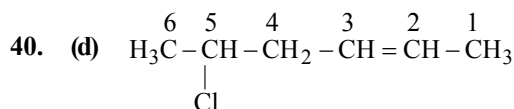
35. (d) Spatial arrangements of atoms which can be converted around a C – C single bond are called conformations or conformers or rotamers.

36. (a)

37. (d)

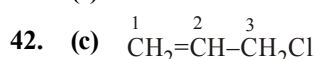
38. (a) As predicted by the VSEPR model of electron pair repulsion, the molecular geometry of alkenes includes bond angles about each carbon in a double bond of about  $120^\circ$ .

39. (c) Double bond in between carbon-carbon is present in alkenes whose general formula is  $\text{C}_n\text{H}_{2n}$ .

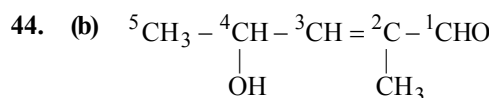


IUPAC name : 5-chlorohex-2-ene

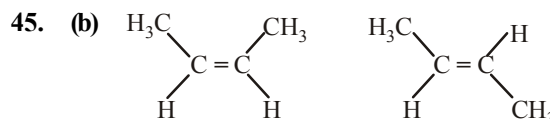
41. (a)



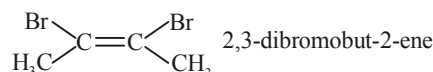
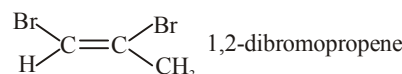
43. (a) Since **b** (from bromo) comes earlier in alphabetical order than **c** (from chloro), the correct name should be 2,3-dibromo-1,4-dichlorobutene-2 and not 1,4-dichloro-2,3-dibromobutene-2.



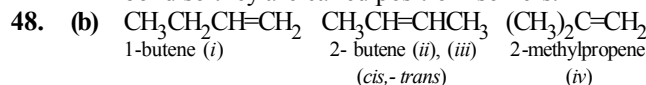
4-Hydroxy-2-methylpent-2-en-1-al



46. (d) Alkenes having double bonds with two different groups on each end of the double bond show geometrical isomerism.  $\text{A}_2\text{B}_2\text{C}_2$ ,  $\text{A}_2\text{B}_2\text{CD}$ ,  $\text{A}_2\text{BCDE}$ .



47. (b) The two isomers differ in the position of the double bond so they are called position isomers.



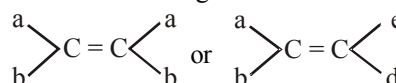
cyclobutane (v)



methylcyclopropane (vi)

49. (a) As sketched in the above question,  $\text{C}_5\text{H}_{10}$  may be monosubstituted (i) and (iv), disubstituted as in (ii), (iii) and (v) and trisubstituted as in (vi)

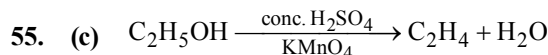
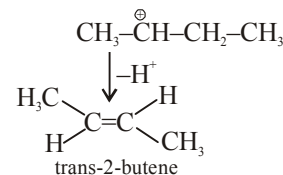
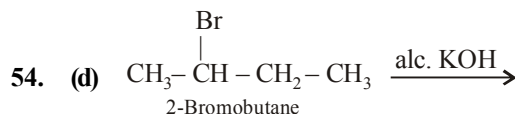
50. (c) The condition for geometrical isomerism is



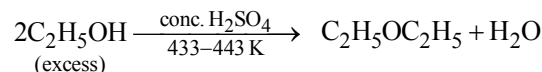
51. (a)



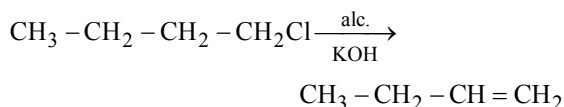
53. (c)



Note : If ethyl alcohol is taken in excess and the reaction is carried out at a temperature of 433-443 K diethyl ether is formed.

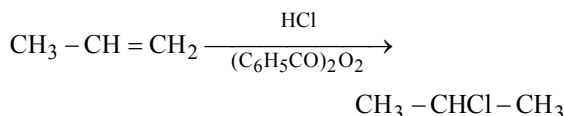


56. (d) Alcoholic KOH is used for dehydrohalogenation e.g.

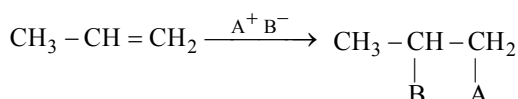


57. (b) Paraffins or alkanes are non-polar compounds. Hence soluble in benzene.

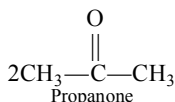
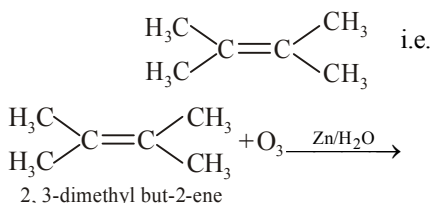
58. (a) Peroxide effect is observed only in case of HBr. Therefore, addition of HCl to propene even in the presence of benzyoyl peroxide occurs according to Markovnikov's rule :



59. (b) Markonikov's way of addition :

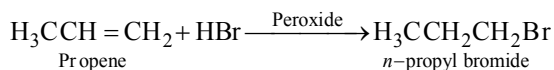


60. (d) Since given alkene on ozonolysis gives 2 moles of propanone hence alkene should have a double bond between two equivalent C atoms i.e. the formula should be



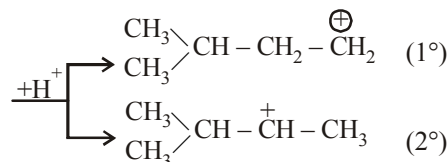
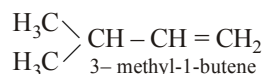
61. (a) 
$$\text{CH}_3 - \text{CH}_2 - \overset{\text{H}}{\underset{\text{O}}{\text{C}}} = \overset{\text{CH}_3}{\text{C}} \xrightarrow{\text{O}_3} \text{CH}_3 - \text{CH}_2 - \overset{\text{H}}{\underset{\text{O}}{\text{C}}} - \overset{\text{O}}{\underset{\text{O}}{\text{C}}} - \text{CH}_3$$
- $$\text{CH}_3 - \overset{\text{O}}{\parallel} \text{C} - \text{CH}_3 + \text{CH}_3 - \text{CH}_2 - \text{CHO} \xleftarrow{(-\text{H}_2\text{O})}$$

62. (d) In presence of peroxide, HBr adds on alkenes in anti-markovnikov's way, thus

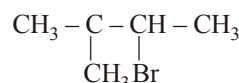


Kharasch observed that the addition of HBr to unsymmetrical alkene in the presence of organic peroxides follows an opposite course to that suggested by Markownikoff. This is termed anti-Markownikoff or peroxide effect.

63. (b) We know that in case of an unsymmetrical alkene there is the possibility of forming two products. In such cases the formation of major product is decided on the basis of *Markownikoff's rule* which is rationalized in terms of *stability of the intermediate* carbocation. Also remember that 3° carbocation is more stable than 2° carbocation and 2° carbocation is more stable than 1° carbocation.



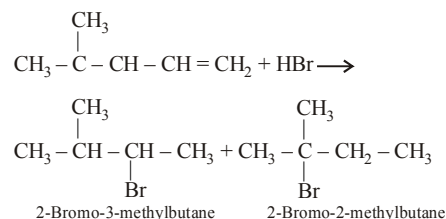
of the two possibilities 2° carbocation is more stable so the product of the reaction expected was predominantly one formed by 2° carbocation i.e.



i.e. 2-Bromo-3-Methylbutane

However some electrophilic addition reaction form products that are clearly not the result of the addition of electrophile to the  $sp^2$  carbon bonded to the most hydrogens and the addition of a nucleophile to the other  $sp^2$  carbon.

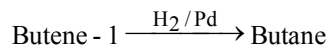
In the above cases the addition of HBr to 3-methyl-1-butene the two products formed are shown below.



In this case the major product formed is 2-Bromo-2-methylbutane i.e. option (b) is correct answer.

(Note: The unexpected product results from a rearrangement of carbocation intermediate. Please note that all carbocation do not rearrange.

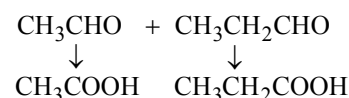
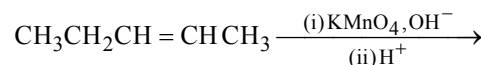
64. (c) Alkenes combine with hydrogen under pressure and in presence of a catalyst (Ni, Pt or Pd) and form alkanes.



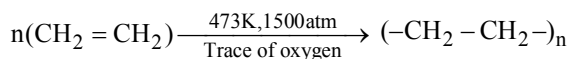
65. (a) Alkenes are unsaturated hydrocarbon having double bond so generally gives addition reaction.

66. (c)

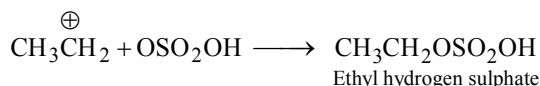
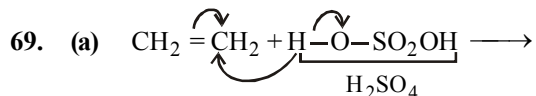
67. (d) A doubly bonded carbon atom having an alkyl group is oxidised to aldehyde which is further oxidised to carboxylic acid.



68. (b) Polythene is manufactured by heating ethylene to 473K under a pressure of 1500 atmosphere and in the presence of a trace of oxygen.

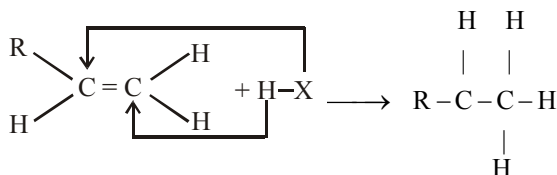


The polythene manufactured in this way is called low density of polythene.



Addition of sulphuric acid takes place according to Markownikoff's rule. Alkanes do not absorb cold conc.  $\text{H}_2\text{SO}_4$ .

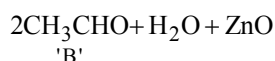
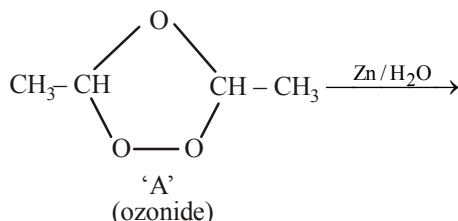
70. (c) According to Markownikoff's rule, "in case of addition of an unsymmetrical reagent ( $\text{H}-\text{X}$ ), the positive part get attached to the C which is least substituted or which bears larger number of hydrogen atoms."



Markownikoff's rule is based on the stability of carbocations ( $3^\circ > 2^\circ > 1^\circ > \text{methyl}$ ).

71. (c) As per Markownikoff's law, the positive part (e.g. H of  $\text{HX}$ ) or the less negative part of the reagent adds to that carbon atom of alkene which has more number of hydrogen atoms (the rich gets richer). So (c) is the correct option as the two carbons containing the double bond have one H atom each i.e. symmetric.

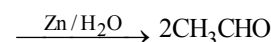
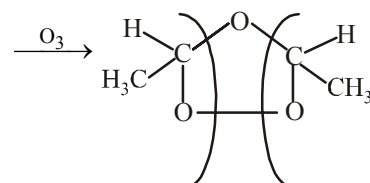
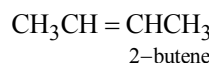
72. (d) Completing the sequence of given reactions,



Thus 'B' is  $\text{CH}_3\text{CHO}$

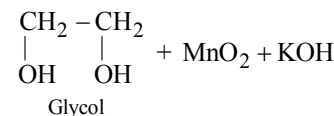
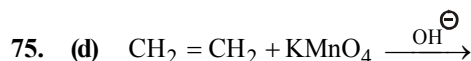
Hence (d) is correct answer.

73. (c) The given molecular formula suggests that the aldehyde formed will be acetaldehyde hence the alkene will be

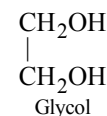
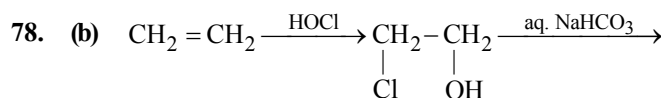
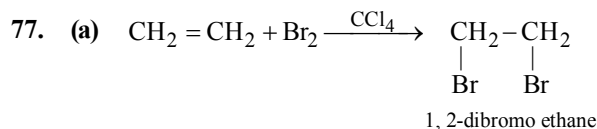
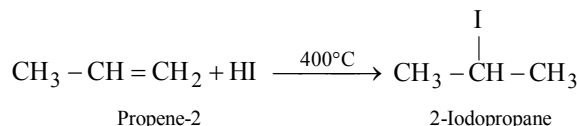


74. (a) The addition of  $\text{HBr}$  takes place according to anti-Markownikoff's rule in presence of peroxide for unsymmetrical alkenes.

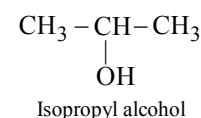
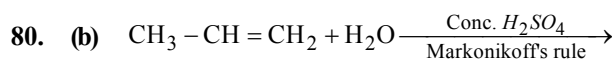
The addition of  $\text{HBr}$  to symmetrical alkenes is not affected by the presence or absence of peroxide.



76. (b) When unsymmetrical unsaturated hydrocarbon reacts with unsymmetrical reagent, then negative part of reagents attacks that carbon which has less H-atom. [Markownikoff's rule]



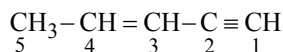
79. (c) By adding bromine water to a solution, if the colour of bromine water decolourise then the compound is unsaturated. This is a confirmatory test for unsaturation.



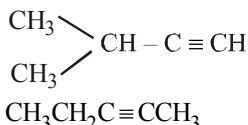
81. (b) Greater the  $s$ -character of C, higher is its electronegativity, shorter and stronger will be the bond formed by it. Thus  $-C \equiv C-$  is the strongest bond.

82. (b) General formula for alkynes is  $C_nH_{2n-2}$

83. (c) When both double and triple bonds are present, then triple bond is considered as the principal group.



84. (b) Three alkynes are possible for the formula  $C_5H_8$ .  
 $CH_3CH_2CH_2C \equiv CH$



85. (c) If both the double and triple bonds are present, the compound is regarded as derivative of alkyne. Further if double and triple bonds are at equidistance from either side, the preference is given to double bond.

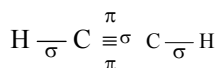
86. (d)  $C_2H_2$  and  $C_3H_4$  are homologue because they differ by  $-CH_2$  group. Both have triple bond in their molecule.

87. (a)

88. (d) In  $CH \equiv CH$  triple bond consists of one  $\sigma$  and two  $\pi$  bonds.

89. (c) In  $C_2H_6$ , C-C bond length is  $1.54 \text{ \AA}$ .

90. (c) Acetylene molecule can be represented as,



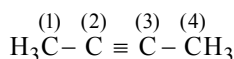
So, it contains 3  $\sigma$  and 2  $\pi$  bonds.

91. (d) We know that carbon having

(i) 4  $\sigma$  bonds correspond to  $sp^3$

(ii) 3  $\sigma$  and 1  $\pi$  bond correspond to  $sp^2$

(iii) 2  $\sigma$  and 2  $\pi$  bonds correspond to  $sp$



No. of bonds :  $4\sigma$   $2\sigma$   $2\sigma$   $4\sigma$

$-$   $2\pi$   $2\pi$   $-$

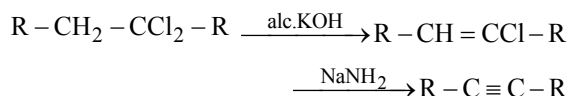
Hybridisation :  $sp^3$   $sp$   $sp$   $sp^3$

Thus, butyne-2 has  $sp$  and  $sp^3$  hybridised carbon atoms.

92. (b)  $C \equiv C < C = C < C - C$   
 $1.20 \text{ \AA} \quad 1.34 \text{ \AA} \quad 1.54 \text{ \AA}$

93. (a) As the number of bonds between carbon atoms increases, electronegativity of that carbon also increases due to increasing active power of electrons. Also  $sp$  hybrid is more electronegative than  $sp^2$  which is more electronegative than  $sp^3$  ( $\because$   $s$  character decreases) Hence, option (a) is correct.

94. (c) On heating ethylene chloride (1, 1 dichloro ethane) with alcoholic potash followed by sodamide alkyne is obtained



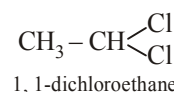
95. (c)  $\text{CaC}_2 + 2\text{H}_2\text{O} \longrightarrow \text{HC} \equiv \text{CH} + \text{Ca}(\text{OH})_2$   
 Calcium carbide Acetylene

96. (d) Among isomeric alkanes, the straight chain isomer has higher boiling point than the branched chain isomer. The greater the branching of the chain, the lower is the boiling point. Further due to the presence of  $\pi$  electrons, these molecules are slightly polar and hence have higher boiling points than the corresponding alkanes.

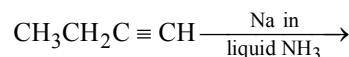
97. (a) Terminal alkynes give a white precipitate easily on reaction with ammonical silver nitrate solution.

98. (b)  $CH \equiv CH + \text{H}_2\text{O} \xrightarrow[\text{HgSO}_4, 60^\circ\text{C}]{\text{dil H}_2\text{SO}_4} [\text{CH}_2 = \text{CHOH}] \longrightarrow \text{CH}_3\text{CHO}$   
 unstable

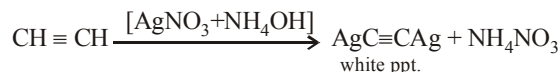
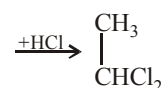
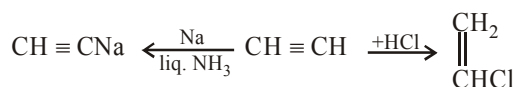
99. (b)  $CH \equiv CH + \text{HCl} \rightarrow \text{CH}_2 = \text{CH} - \text{Cl} \xrightarrow{\text{HCl}}$



100. (b) Alkynes having terminal  $-C \equiv H$  react with Na in liquid ammonia to yield  $\text{H}_2$  gas.  $CH_3CH_2C \equiv CH$  can react with Na in liquid  $\text{NH}_3$  so the correct answer is (b).

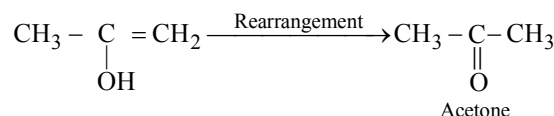


101. (a) Acetylene reacts with the other three as:

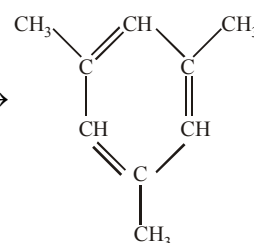


102. (c) 103. (d)

104. (c)  $CH_3 - C \equiv CH + \text{H}_2\text{O} \xrightarrow[1\% \text{ HgSO}_4]{40\% \text{ H}_2\text{SO}_4}$

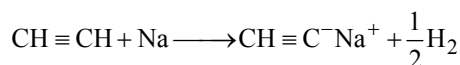
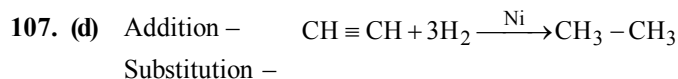
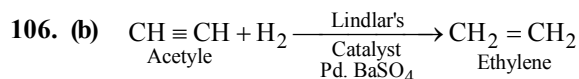


105. (a)  $3\text{CH}_3 - \text{C} \equiv \text{CH} \longrightarrow$

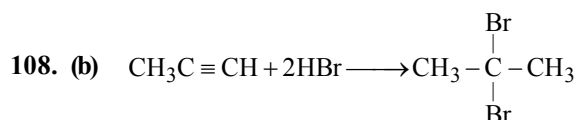
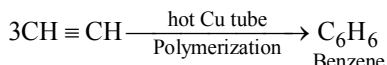


Mesitylene or 1, 3, 5-trimethyl benzene





Polymerization –



109. (b)

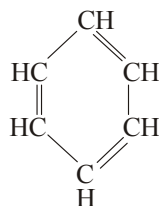
110. (b) Thin film of polyacetylene can be used as electrodes in batteries. These films are good conductors, lighter and cheaper than the metal conductors.

111. (b)

112. (d) Amongst all tropolone is a non-benzenoid aromatic compound.

113. (c)

114. (c) Kekule in 1865 suggested a ring structure of benzene in which the ring was composed of six carbon atoms, each of which carries one atom of hydrogen. To satisfy the fourth valency of the carbon atom, he suggested three alternate double bonds.



115. (a)

116. (c) Benzene does not show addition reactions like other unsaturated hydrocarbons. However it shows substitution reactions. Due to resonance all the C–C bonds have the same nature, which is possible because of the cyclic delocalisation of  $\pi$ -electrons in benzene. Monosubstitution will give only a single product.

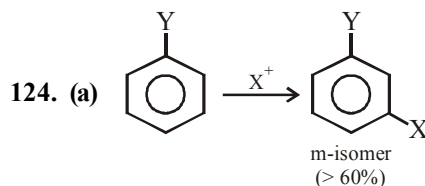
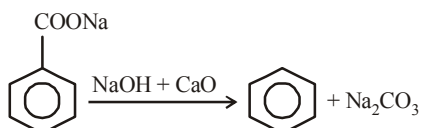
117. (a) In the benzene molecule all the six carbons are  $sp^2$  hybridised as each C has one double bond.

118. (c) They have a relatively high percentage of carbon.

119. (a) 120. (c) 121. (c)

122. (d) Benzene can be obtained by all the compounds given.

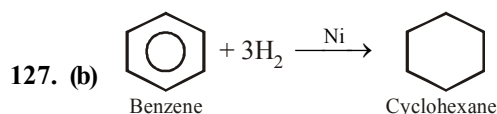
123. (a) This is an example of decarboxylation reaction.



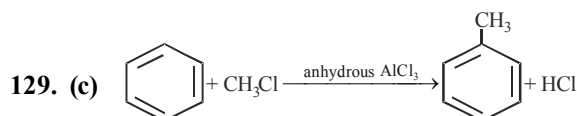
Y = –COOH because it is a meta directing group while –NH<sub>2</sub>, –OH and –Cl are *o* and *p* directing groups.

125. (a) –NO<sub>2</sub> is a meta-directing group. As it is also a deactivating group so no chance of introduction of second –Br atom.

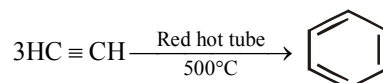
126. (c) Cl exhibits –I effect and +M effect.



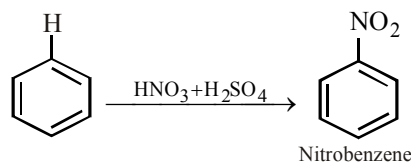
128. (d)



130. (b) Benzene can be obtained by polymerisation of acetylene.

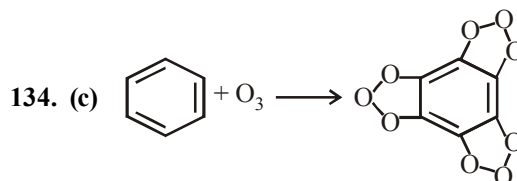


131. (a) In electrophilic substitution reaction an electrophile (in this case NO<sub>2</sub><sup>+</sup>) replaces another atom (in this case H) from the substrate (benzene).



132. (a) This is an example of Friedel-Craft alkylation.

133. (d)



Benzene triozonide

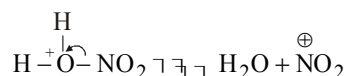
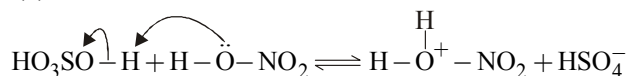
135. (b) Friedel-Craft reaction occurs in presence of an attacking reagent which is an electrophile (AlCl<sub>3</sub>).

### STATEMENT TYPE QUESTIONS

136. (a) According to experimental evidences, electrophilic substitution reactions are supposed to proceed via the following three steps:

- (1) Generation of the electrophile
- (2) Formation of carbocation intermediate
- (3) Removal of proton from the carbocation intermediate

137. (b)



Protonated  
nitric acid

Nitronium ion

In the process of generation of nitronium ion, sulphuric acid serves as an acid and nitric acid as a base.

138. (a)  $\pi$ -electrons of benzene rings are delocalised throughout the molecule. This makes the molecule very stable. The stability resists breaking of double bonds for addition.

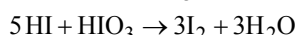
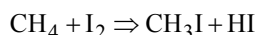
139. (b) Natural gas is found in upper strata during drilling of oil wells. The gas after compression is known as Compressed Natural Gas (CNG).

140. (b)

141. (c) In methane carbon atom is  $\text{sp}^3$  hybridized.

142. (b) Dihydrogen gas adds to alkenes and alkynes in the presence of finely divided catalysts like platinum, palladium or nickel to form alkanes. These metals adsorb dihydrogen gas on their surfaces and activate the hydrogen-hydrogen bond. Platinum and palladium catalyse the reaction at room temperature but relatively higher temperature and pressure are required with nickel catalyst.

143. (b) For statement (iii), Fluorination is too violent to be controlled. For statement (iv), Iodination is very slow and an irreversible reaction. It can be carried out in the presence of oxidizing agents like  $\text{HIO}_3$  or  $\text{HNO}_3$

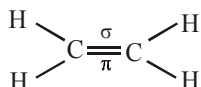


144. (c) Pyrolysis and cracking are same process.

145. (b) Rotation around a C-C single bond is not completely free. It is hindered by a small energy barrier of 1-20 kJ  $\text{mol}^{-1}$  due to weak repulsive interaction between the adjacent bonds. Such a type of repulsive interaction is called **torsional strain**.

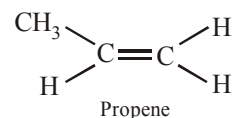
146. (b) Eclipsed form has maximum torsional strain while staggered form has the least.

147. (b) For statement (ii), Alkenes are also known as olefins. For statement (iv), Carbon-Carbon double bond in alkene consists of one sigma and one pi bond.



148. (a) For statement (i), cis form of alkenes have significant dipole moment whereas dipole moment of trans form is almost zero. For statement (iv), due to different arrangements of atoms or groups in space cis and trans isomers differ in their properties like melting point, boiling point, dipole moment, solubility etc.

149. (b) For statement (ii), alkynes on reduction with Pd/C form cis-alkenes. For statement (iv), Propyne on reduction with Pd/C form propene. Propene does not show geometrical isomerism. Only those compounds show geometrical isomerism which have two different atoms or groups attached to each carbon atom.

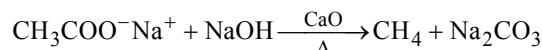
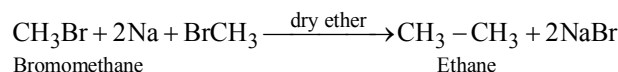
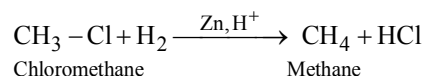
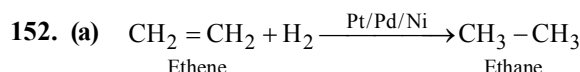


150. (d) Polynuclear hydrocarbons are not produced in human body by any biochemical reaction as when they enter into human body they undergo various biochemical reactions which finally damage DNA and cause cancer.

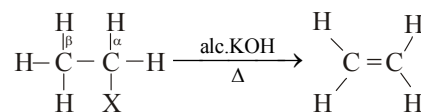
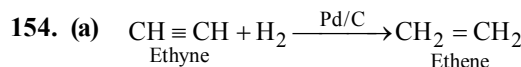
### MATCHING TYPE QUESTIONS

151. (a) Among the infinite number of conformations in the staggered conformation hydrogen atoms are as far as apart as possible. While in eclipse conformation hydrogen atoms are perfectly eclipsed.

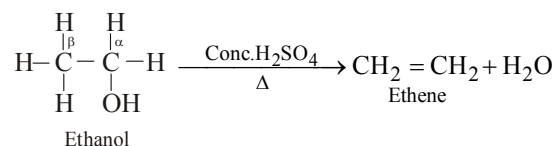
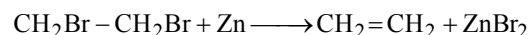
In skew conformation, hydrogen atoms are closer than in staggered but away than in eclipsed conformation.

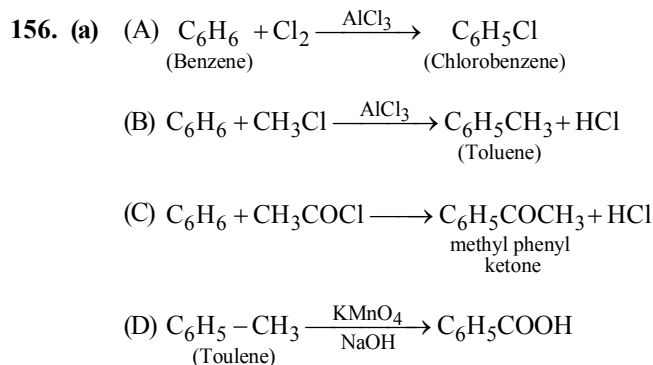
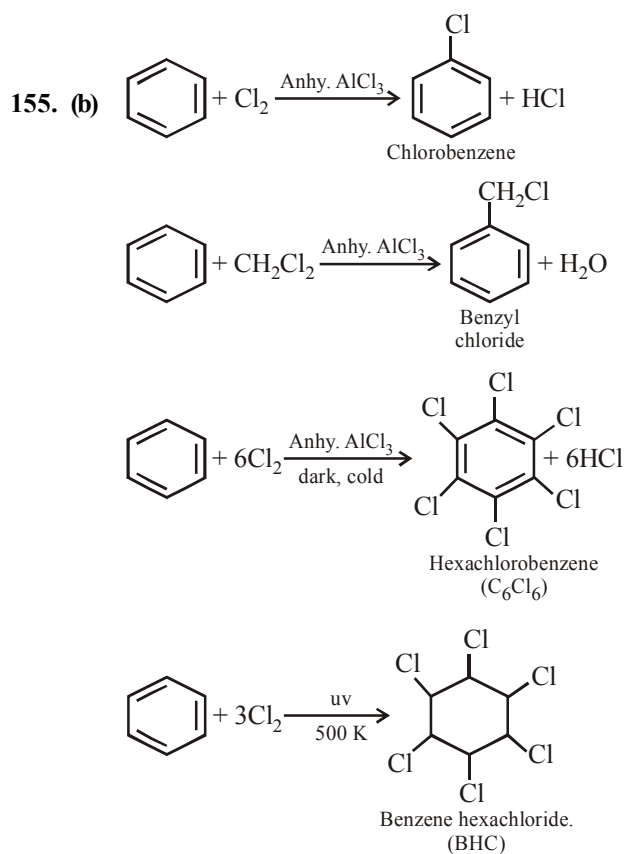


153. (c)



(X = Cl, Br, I)

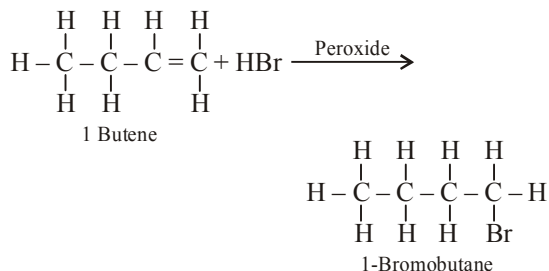




157. (d) 158. (a) 159. (b)

### ASSERTION-REASON TYPE QUESTIONS

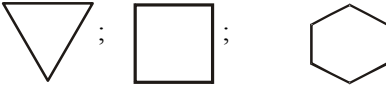
160. (a) This reaction is followed by anti Markownikoff rule



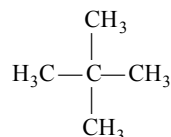
In this reaction anti Markownikoff's addition is explained on the basis of the fact that in the presence of peroxides, addition takes place via free radical mechanism rather than the ionic mechanism.

161. (b) The assertion that chlorination of CH<sub>4</sub> does not take place in dark is correct because it is a free radical reaction and free radicals are obtained in presence of sun light.
162. (b) Iodination is reversible since formed HI is a strong reducing agent and reduces the alkyl iodide back to alkane.  $\text{CH}_4 + \text{I}_2 \rightleftharpoons \text{CH}_3\text{I} + \text{HI}$   
Iodination can be done only in presence of strong oxidising agents like iodic acid which destroys the hydriodic acid.
163. (d) The two hydrogen atoms on first carbon and the two H-atoms on the third carbon atom lie in perpendicular planes. The central carbon atom is *sp*-hybridized while terminal carbon atoms are *sp*<sup>2</sup>-hybridized
164. (c)  $(4n + 2)\pi$  electrons and planar structure are the essential conditions for aromaticity.

### CRITICAL THINKING TYPE QUESTIONS

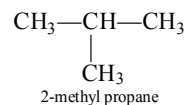
165. (d)  ;  
In all these we find  $\text{CH}_2$  group i.e. correct answer is (d).

166. (c) The structure of neopentane is

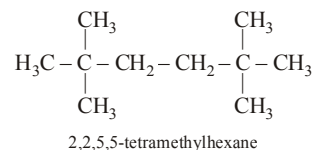
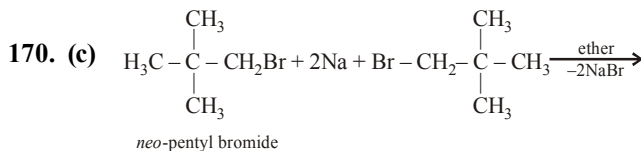


It has 1 quaternary and 4 primary carbons.

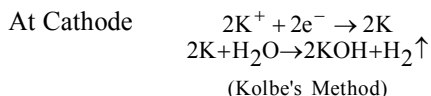
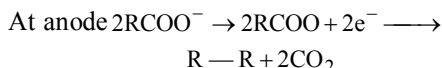
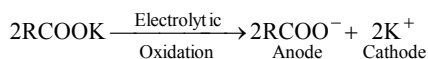
167. (a)
168. (b) For the compounds with same molecular mass, boiling point decreases with increase in branching. The boiling point also increases steadily with increase in molecular mass. Hence 2-methyl propane will have lowest boiling point



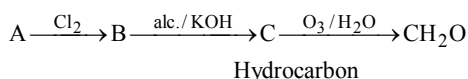
169. (d)



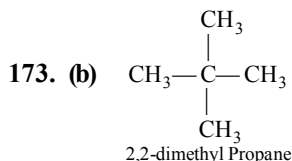
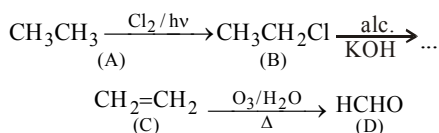
171. (a) Electrolysis of a concentrated aqueous solution of either sodium or potassium salts of saturated monocarboxylic acids yields higher alkane at anode.



172. (a) Given

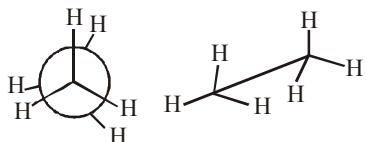


Since hydrocarbon C give only  $\text{CH}_2\text{O}$ , on ozonolysis, C should be  $\text{CH}_2 = \text{CH}_2$ , hence going backward A should be ethane. Thus the reactions are



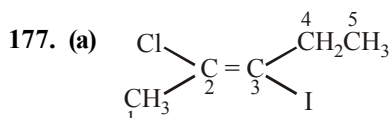
All hydrogen atoms are equivalent in 2,2-dimethylpropane. So it forms only one monochlorinated product.

174. (c) In the eclipsed conformation of ethane, the dihedral angle between hydrogen atoms of adjacent methyl groups is  $0^\circ$ .



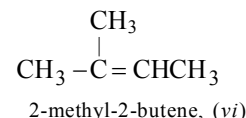
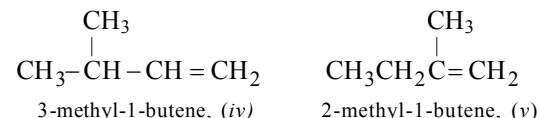
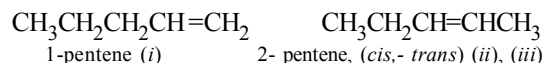
175. (a) The  $\pi$  bond is formed by the sideways overlapping of two  $p$ -orbitals of the two carbon atoms. The molecular plane does not have any  $\pi$  electron density as the  $p$ -orbitals are perpendicular to the plane containing the ethene molecule. The nodal plane in the  $\pi$ -bond of ethene is located in the molecular plane.

176. (c)



Correct IUPAC name of above compound is trans-2-chloro-3-iodo-2-pentene

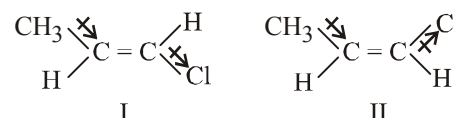
178. (c)  $\text{C}_5\text{H}_{10}$  has  $1^\circ$  degree of unsaturation since the isomers are acyclic, all of these are alkenes. For writing the isomers, first introduce the double bond at different possible positions, and then consider the possibility of branching in the alkyl group.



179. (b) Stability of an alkene depends upon the heat of hydrogenation of an alkene. The heat of hydration is the standard enthalpy change in hydrogenation of an alkene. The lower the heat of hydrogenation of an alkene higher will be stability.

Order of stability	Heat of hydrogenation (kJ/mol)
trans-2-butene	-115.5
cis-2-butene	-119.6 and
1-butene	-126.8 respectively.

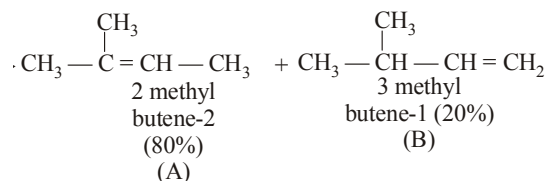
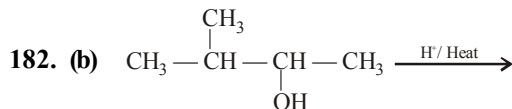
180. (c) In compounds



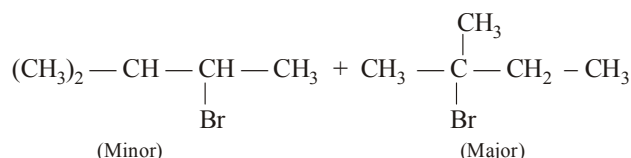
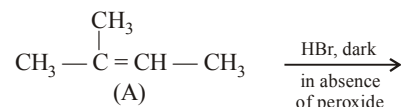
first has more dipole moment than second.

Therefore its boiling point will be higher. Melting point depends on symmetry therefore I has higher melting point than II. Steric crowding in I is more than II therefore I is more stable than II.

181. (b)

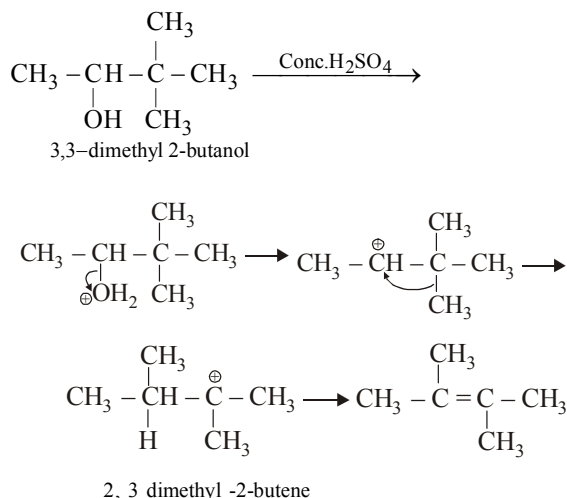


In this case dehydration is governed by Saytzeff's rule according to which hydrogen is preferentially eliminated from the carbon atom with fewer number of hydrogen atoms i.e., poor becomes poorer. Thus, 2-methyl butene-2 is the major product.

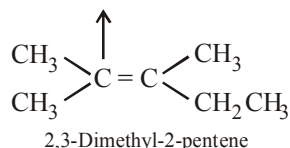


This reaction is governed by Markownikoff's rule according to which when an unsymmetrical reagent e.g. HBr adds to an unsymmetrical alkene, then the negative part of the reagent is added to that carbon atom of the double bond which bears the least number of hydrogen atom. Thus, in above case. 2-methyl 2-bromo butane will be the major product.

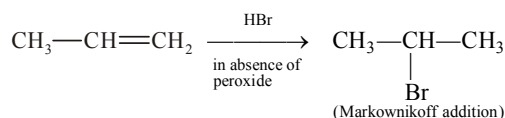
183. (a) When 3, 3 dimethyl 2-butanol is heated with  $\text{H}_2\text{SO}_4$  the major product obtained is 2, 3 dimethyl 2-butene.



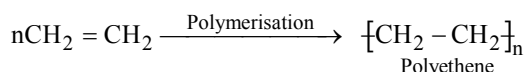
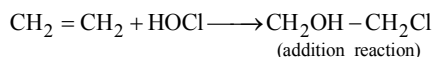
184. (d)  $\text{CH}_3 \text{C}(\text{CH}_3)_2 = \text{O} + \text{O} = \text{C}(\text{CH}_3)_2 \text{C}_2\text{H}_5$



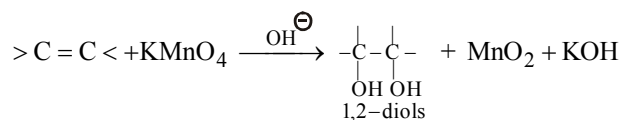
185. (d) Addition of hydrogen halide to alkene is an example of electrophilic addition involving carbocations as intermediates.



186. (a) Addition reaction occurs on a double bond. The compound containing double bonds are also undergo polymerisation. So, the correct option are both (a) and (d) e.g.



187. (b) Alkenes react with cold alkaline  $\text{KMnO}_4$  solution to form glycols. During this reaction  $\text{KMnO}_4$  (violet) gets converted to  $\text{MnO}_2$  (brown ppt.) and therefore the colour of  $\text{KMnO}_4$  is disappeared.

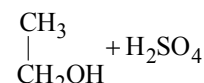


This test is known as Baeyer test.

188. (b)  $\text{CH}_2 = \text{CH}_2 - \text{Cl} + \text{HCl} \longrightarrow \text{CH}_3\text{CHCl}_2$

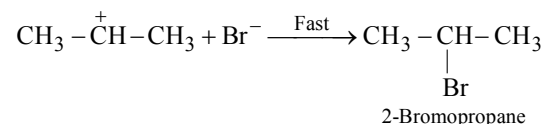
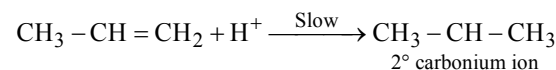
Addition of HCl takes place according to Markownikoff's rule. (H goes to C which is least substituted)

189. (a)  $\text{CH}_2 = \text{CH}_2 + \text{H}_2\text{SO}_4 \rightarrow \begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_2\text{H}_2\text{SO}_4 \end{array} \xrightarrow{\text{H}_2\text{O}}$



Except ethyl alcohol, no other primary alcohol can be prepared by this method as the addition of  $\text{H}_2\text{SO}_4$  follows Markownikoff's rule. Generally secondary and tertiary alcohols are obtained.

190. (c) Electrophilic addition reactions are shown by alkenes or alkynes, in these reactions attacking species is electrophile



191. (c)

192. (d) Nature of halogen atom and the alkyl group both determine rate of reaction.

193. (a) (i)  $\text{HC} \equiv \text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$   
Hex-1-yne

- (ii)  $\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$   
Hex-2-yne

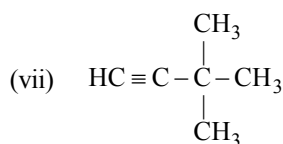
- (iii)  $\text{CH}_3 - \text{CH}_2 - \text{C} \equiv \text{C} - \text{CH}_2 - \text{CH}_3$   
Hex-3-yne

- (iv)  $\text{HC} \equiv \text{C} - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_2 - \text{CH}_3$   
3-Methylpent-1-yne

- (v)  $\text{HC} \equiv \text{C} - \text{CH}_2 - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_3$   
4-Methylpent-1-yne

- (vi)  $\text{CH}_3 - \text{C} \equiv \text{C} - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_3$   
4-Methylpent-2-yne





3,3- Dimethylbut-1-yne

194. (a) Ethylene has restricted rotation, acetylene has no rotation, hexachloroethane has more rotation than ethylene but less than ethane because of greater size of the substituent (chlorine) in hexachloroethane than in ethane (substituent is hydrogen).

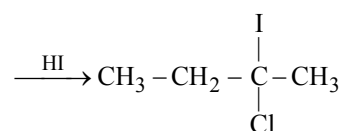
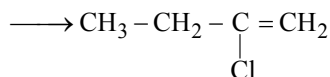
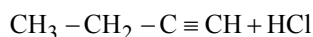
195. (a) The acidity of acetylene or 1-alkyne can be explained on the basis of molecular orbital concept according to which formation of C—H bond in acetylene involves  $sp$ -hybridised carbon atom. Now since  $s$  electrons are closer to the nucleus than  $p$  electrons, the electrons present in a bond having more  $s$  character will be correspondingly more closer to the nucleus.

Thus owing to high  $s$  character of the C—H bond in alkynes ( $s = 50\%$ ), the electrons constituting this bond are more strongly held by the carbon nucleus i.e., the acetylenic carbon atom or the  $sp$  orbital acts as more electronegative species than the  $sp^2$  and  $sp^3$  with the result the hydrogen present on such a carbon atom ( $\equiv\text{C—H}$ ) can be easily removed as a proton.

196. (b)

197. (d)  $\text{Br}_2$  in  $\text{CCl}_4$  (a),  $\text{Br}_2$  in  $\text{CH}_3\text{COOH}$  (b) and alk.  $\text{KMnO}_4$  (c) will react with all unsaturated compounds, i.e., 1, 3 and 4 while ammonical  $\text{AgNO}_3$  (d) reacts only with terminal alkynes, i.e., 3 and hence 3 can be distinguished from 1, 2 and 4 by ammonical  $\text{AgNO}_3$  (d).

198. (c) This reaction occurs according to Markownikoff's rule which states that when an unsymmetrical alkene undergo hydrohalogenation, the negative part goes to that C-atom which contain lesser no. of H-atom.



199. (a) Only terminal alkynes show acidic nature. Ethyne is more acidic than propyne. But-2-yne is not acidic as it does not contain any hydrogen attached to  $sp$  hybridised carbon.

200. (a)

201. (c) Due to the maximum percentage of  $s$  character (50%), the  $sp$  hybridised orbitals of carbon atoms in ethyne molecules have highest electronegativity; hence, these attract the shared electron pair of the C-H bond of ethyne to a greater extent than that of the  $sp^2$  hybridised orbitals of carbon in ethene and the  $sp^3$  hybridised orbital of carbon in ethane. Thus in ethyne, hydrogen atoms can be liberated as protons more easily as compared to ethene and ethane.

202. (c) In arenes,  $\pi$  electrons are delocalised, hence arenes do not undergo addition reactions easily. Aromatic compounds (Arenes) are highly stable and show resonance. eg. Benzene is the simplest example.

203. (c) Compounds having same molecular formula but different functional groups in their molecules are called functional isomers.

204. (d) In benzene due to delocalisation of  $\pi$  - electrons, all the C—C bond lengths are equal as each C—C bond has some double bond character and thus the bond length is between single and double bond, i.e., between  $\text{C}_2\text{H}_6$  and  $\text{C}_2\text{H}_4$ .

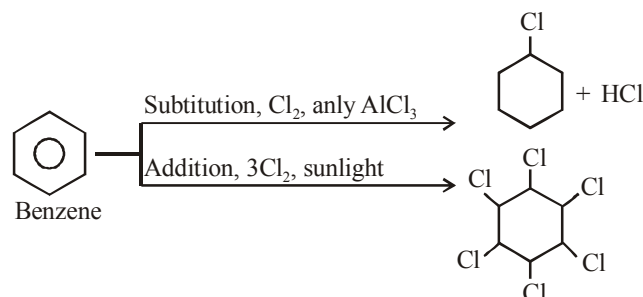
205. (a)

206. (c) Benzene has 12  $\sigma$  and 3  $\pi$  bonds.

$$\therefore \text{Ratio of } \sigma \text{ bonds to } \pi \text{ bonds} = 12/3 = 4$$

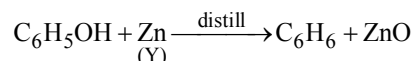
207. (d) Presence of 6  $p$  orbitals, each containing one unpaired electron, in a six membered cyclic structure is in accordance with Huckel rule of aromaticity.

208. (a)



209. (b)  $-\text{Cl}$  group is  $o$ -,  $p$ -directing due to  $+R$  effect; however it is deactivating due to strong  $-I$  effect of  $\text{Cl}$  (difference from other  $o$ -,  $p$ -directing groups which are activating). The net result is that chlorobenzene undergoes  $o$ -,  $p$ -substitution, but with difficulty

210. (b)  $\text{C}_6\text{H}_5\text{COOH} + \text{NaOH} \rightarrow \text{C}_6\text{H}_5\text{COONa} + \text{H}_2\text{O}$  (X)



211. (a) Huckel rule is not obeyed. It has only four electrons. Further it does not have continuous conjugation.

# ENVIRONMENTAL CHEMISTRY

## FACT/DEFINITION TYPE QUESTIONS

- The type of pollution caused by spraying of DDT is
  - air and soil
  - air and water
  - air
  - air, water and soil
- What is DDT among the following ?
  - Greenhouse gas
  - A fertilizer
  - Biodegradable pollutant
  - Non-biodegradable pollutant
- The uppermost region of the atmosphere is called
  - Ionosphere
  - Stratosphere
  - Troposphere
  - Exosphere
- Which of the following is the coldest region of atmosphere ?
  - Thermosphere
  - Mesosphere
  - Troposphere
  - Stratosphere
- The region which is greatly affected by air pollution is
  - Thermosphere
  - Stratosphere
  - Troposphere
  - Mesosphere
- The region containing water vapour is
  - thermosphere
  - stratosphere
  - troposphere
  - mesosphere
- High concentration of which of the following in atmosphere leads to stiffness of flower buds which eventually fall off from plants?
  - $\text{NO}_2$
  - $\text{SO}_2$
  - CFC
  - Smog
- The irritant red haze in the traffic and congested places is due to presence of which of the following ?
  - Oxides of sulphur
  - Oxides of nitrogen
  - Carbon dioxide
  - Mists, smoke and dust
  - Smog
  - (i), (iv) and (v)
  - (iii) only
  - (ii) only
  - (ii) and (v)
- The quantity of  $\text{CO}_2$  in atmosphere is
  - 3.34%
  - 0.034%
  - 6.5%
  - 0.34%
- The substance which is not regarded as a pollutant?
  - $\text{NO}_2$
  - $\text{CO}_2$
  - $\text{O}_3$
  - Hydrocarbons
- Which of the following is/are the hazardous pollutant(s) present in automobile exhaust gases?
  - $\text{N}_2$
  - $\text{CH}_4$
  - (ii) and (iii)
  - (ii) and (iv)
  - CO
  - Oxides of nitrogen
  - (i) and (ii)
  - (i) and (iii)
- The gas emitted by supersonic jet planes that slowly depletes the concentration of ozone layer is
  - CO
  - $\text{SO}_2$
  - NO
  - $\text{O}_2$
- Carbon monoxide (CO) is harmful to man because
  - it forms carbolic acid
  - it generates excess  $\text{CO}_2$
  - it is carcinogenic
  - it competes with  $\text{O}_2$  for haemoglobin
- Increase in global temperature increases the incidence of which of the following infectious disease(s)
  - Sleeping sickness
  - Malaria
  - (ii) only
  - (iii) and (iv)
  - Yellow fever
  - Dengue
  - (i) and (ii)
  - (i), (ii), (iii) and (iv)
- The green house effect is caused by
  - $\text{CO}_2$
  - NO
  - $\text{NO}_2$
  - CO
- Which is related to 'Green House Effect'?
  - Farming of Green plants
  - Farming of Vegetables in Houses
  - Global Warming
  - Biodegradable pollutant

17. Green house gases
  - (a) allow shorter wavelength to enter earth's atmosphere while doesn't allow longer wavelength to leave the earth's atmosphere.
  - (b) allow longer wavelength to enter earth atmosphere while doesn't allow shorter wavelength to leave the surface
  - (c) don't have wavelength specific character.
  - (d) show wavelength specific behaviour near the earth while far from earth these have wavelength independent behaviour.
18. Today the concentration of green house gases is very high because of
  - (a) use of refrigerator
  - (b) increased combustion of oils and coal
  - (c) deforestation
  - (d) All of the above
19. The greenhouse effect is because of the
  - (a) presence of gases, which in general are strong infrared absorbers, in the atmosphere
  - (b) presence of  $\text{CO}_2$  only in the atmosphere
  - (c) pressure of  $\text{O}_3$  and  $\text{CH}_4$  in the atmosphere
  - (d)  $\text{N}_2\text{O}$  and chlorofluorohydrocarbons in the atmosphere
20. The greenhouse gas is
  - (a)  $\text{CO}_2$
  - (b)  $\text{SO}_2$
  - (c)  $\text{N}_2$
  - (d)  $\text{H}_2\text{S}$
21. Which of the following gases is not a green house gas?
  - (a)  $\text{CO}$
  - (b)  $\text{O}_3$
  - (c)  $\text{CH}_4$
  - (d)  $\text{H}_2\text{O}$  vapour
22. Which of the following strategy is not a correct approach to reduce global warming ?
  - (a) Reducing the green house gas emission by limiting the use of fossil fuels
  - (b) Increase the vegetation cover particularly the forest for photosynthetic utilization of  $\text{CO}_2$
  - (c) Minimizing the use of nitrogen fertilizers in agriculture for reducing  $\text{N}_2\text{O}$  emission
  - (d) Increasing the use of air conditioners, refrigeration unit and production of plastic foams and propellants in aerosol spray cans
23. The substance having the largest concentration in acid rain
  - (a)  $\text{H}_2\text{CO}_3$
  - (b)  $\text{HNO}_3$
  - (c)  $\text{HCl}$
  - (d)  $\text{H}_2\text{SO}_4$
24. When rain is accompanied by a thunderstorm, the collected rain water will have a pH value
  - (a) slightly lower than that of rain water without thunderstorm
  - (b) slightly higher than that when the thunderstorm is not there
  - (c) uninfluenced by occurrence of thunderstorm
  - (d) which depends upon the amount of dust in air
25. Acid rain is due to
  - (a)  $\text{CH}_3$
  - (b)  $\text{N}_2\text{O}_5$
  - (c)  $\text{SO}_2$  and  $\text{NO}_2$
  - (d)  $\text{C}_2\text{H}_5\text{OH}$
26. The pH of normal rain water is
  - (a) 6.5
  - (b) 7.5
  - (c) 5.6
  - (d) 3.5
27. Which of the following statements is incorrect ?
  - (a) Smoke particulates consist of solid or mixture of solid and liquid particles formed during combustion of organic matter.
  - (b) Herbicides and insecticides that miss their target and travel through air form mists.
  - (c) Organic solvents, metals and metallic oxides form fume particles
  - (d) None of these
28. Which of the following green house gas is released in paddy field ?
  - I. CFCs
  - II.  $\text{CH}_4$
  - III.  $\text{SO}_2$
  - (a) Only I
  - (b) Only II
  - (c) Only III
  - (d) I and II
29. Photochemical smog is due to the presence of
  - (a) oxides of sulphur
  - (b) oxides of nitrogen
  - (c) oxides of carbon
  - (d) lead
30. The secondary precursors of photochemical smog are
  - (a)  $\text{SO}_2$  and  $\text{NO}_2$
  - (b)  $\text{SO}_2$  and hydrocarbons
  - (c)  $\text{NO}_2$  and hydrocarbons
  - (d)  $\text{O}_3$  and PAN
31. The main element of smog is
  - (a)  $\text{O}_3$  and PAN
  - (b)  $\text{O}_3$
  - (c) PAN
  - (d) PPN and PBN
32. Classical smog occurs in places of
  - (a) excess  $\text{SO}_2$
  - (b) low temperature
  - (c) high temperature
  - (d) excess  $\text{NH}_3$
33. The smog is essentially caused by the presence of
  - (a) Oxides of sulphur and nitrogen
  - (b)  $\text{O}_2$  and  $\text{N}_2$
  - (c)  $\text{O}_2$  and  $\text{O}_3$
  - (d)  $\text{O}_3$  and  $\text{N}_2$
34. Air pollution causing photochemical oxidants production include
  - (a) Carbon monoxide, sulphur dioxide
  - (b) Nitrous oxide, nitric acid fumes, nitric oxide
  - (c) Ozone, peroxyacetyl nitrate, aldehydes
  - (d) Oxygen, chlorine, fuming nitric acid
35. Photochemical smog formed in congested metropolitan cities mainly consists of
  - (a) ozone, peroxyacetyl nitrate and  $\text{NO}_x$
  - (b) smoke, peroxyacetyl nitrate and  $\text{SO}_2$
  - (c) hydrocarbons,  $\text{SO}_2$  and  $\text{CO}_2$
  - (d) hydrocarbons, ozone and  $\text{SO}_x$

36. In almost all Indian metropolitan cities like Delhi, the major atmospheric pollutant(s) is/are  
(a) suspended particulate matter (SPM)  
(b) oxides of sulphur  
(c) carbon dioxide and carbon monoxide  
(d) oxides of nitrogen
37. The non-viable particulate among the following is  
(a) Dust (b) Bacteria  
(c) Moulds (d) Fungi
38. Photochemical smog occurs in warm, dry and sunny climate. One of the following is not amongst the components of photochemical smog, identify it.  
(a)  $\text{NO}_2$   
(b)  $\text{O}_3$   
(c)  $\text{SO}_2$   
(d) Unsaturated hydrocarbon
39. The pollutants which came directly in the air from sources are called primary pollutants. Primary pollutants are sometimes converted into secondary pollutants. Which of the following belongs to secondary air pollutants?  
(a) CO (b) Hydrocarbon  
(c) Peroxyacetyl nitrate (d) NO
40. The main element of smog is  
(a)  $\text{O}_3$  and PAN (b)  $\text{O}_3$   
(c) PAN (d) Both (a) and (b)
41. Which of the following statements is not true about classical smog?  
(a) Its main components are produced by the action of sunlight on emissions of automobiles and factories.  
(b) Produced in cold and humid climate.  
(c) It contains compounds of reducing nature.  
(d) It contains smoke fog and sulphur dioxide
42. Which of the following statements about photochemical smog is wrong?  
(a) It has high concentration of oxidising agents  
(b) It has low concentration of oxidising agent  
(c) It can be controlled by controlling the release of  $\text{NO}_2$ , hydrocarbons ozone, etc.  
(d) Plantation of some plants like pinus helps in controlling photochemical smog.
43. Select the process that does not add particulate materials to air.  
(a) Use of air conditioner  
(b) Burning of fossil fuels  
(c) Paper industry  
(d) Incomplete combustion of coal
44. The biggest particulate matter is  
(a)  $\text{HNO}_3$  droplets (b) Soot  
(c)  $\text{H}_2\text{SO}_4$  droplets (d) Fly ash
45. The viable particulate among the following is  
(a) Fumes (b) Algae  
(c) Smoke (d) Mist
46. The aromatic compounds present as particulates are  
(a) Polycyclic aromatic hydrocarbons  
(b) Benzene  
(c) Toluene  
(d) Nitrobenzene
47. Which of the following can control the photochemical smog ?  
(A) Use of catalytic converters in automobiles.  
(B) Plantation of trees like pinus, pyrus vitis etc.  
(C) Using less sulphur containing fossil fuels.  
(a) A and C (b) B  
(c) A and B (d) A, B and C
48. The gas responsible for ozone depletion :  
(a) NO and freons (b)  $\text{SO}_2$   
(c)  $\text{CO}_2$  (d) CO
49. Identify the incorrect statement from the following :  
(a) Ozone absorbs the intense ultraviolet radiation of the sun.  
(b) Depletion of ozone layer is because of its chemical reactions with chlorofluoro alkanes.  
(c) Ozone absorbs infrared radiation.  
(d) Oxides of nitrogen in the atmosphere can cause the depletion of ozone layer.
50. Identify the wrong statement in the following:  
(a) Chlorofluorocarbons are responsible for ozone layer depletion.  
(b) Greenhouse effect is responsible for global warming.  
(c) Acid rain is mostly because of oxides of nitrogen and sulphur.  
(d) Ozone layer does not permit infrared radiation from the sun to reach the earth.
51. Which of the following chemical, harmful to ozone, is released by chlorofluoro carbon?  
(a) Sulphur dioxide (b) Fluorine  
(c) Chlorine (d) Nitrogen dioxide
52. In Antarctica ozone depletion is due to the formation of following compound  
(a) acrolein (b) peroxyacetyl nitrate  
(c)  $\text{SO}_2$  and  $\text{SO}_3$  (d) chlorine nitrate
53. Depletion of ozone layer causes  
(a) breast cancer (b) blood cancer  
(c) lung cancer (d) skin cancer
54. Select the one that has an adverse effect on ozone layer.  
(a) Carbon dioxide (b) Chlorofluorocarbons  
(c) Soil (d) Dust particles
55. Ozone hole refers to  
(a) Increase in concentration of ozone  
(b) Hole in ozone layer  
(c) Reduction in thickness of ozone layer in troposphere  
(d) Reduction in thickness of ozone layer in stratosphere

56. Which of the following statements is wrong?  
(a) Ozone is not responsible for green house effect.  
(b) Ozone can oxidise sulphur dioxide present in the atmosphere to sulphur trioxide.  
(c) Ozone hole is thinning of ozone layer present in stratosphere.  
(d) Ozone is produced in upper stratosphere by the action of UV rays on oxygen.
57. Which of the following statements is correct?  
(a) Ozone hole is a hole formed in stratosphere from which ozone oozes out.  
(b) Ozone hole is a hole formed in the troposphere from which ozone oozes out.  
(c) Ozone hole is thinning of ozone layer of stratosphere at some places.  
(d) Ozone hole means vanishing of ozone layer around the earth completely.
58. Ozone is an important constituent of stratosphere because it  
(a) Destroys bacteria which are harmful to human life  
(b) Prevents the formation of smog over large cities  
(c) Removes poisonous gases of the atmosphere by reacting with them  
(d) Absorbs ultraviolet radiation which is harmful to human life
59. The gas(es) not responsible for ozone depletion :  
(a) NO and freons (b) SO<sub>2</sub>  
(c) CO<sub>2</sub> (d) Both (b) and (c)
60. What is the concentration of dissolved oxygen in cold water ?  
(a) 5 ppm (b) 10 ppm  
(c) 200, 000 ppm (d) 100 ppm
61. Water pollution is caused by  
(a) pesticides (b) SO<sub>2</sub>  
(c) O<sub>2</sub> (d) CO<sub>2</sub>
62. Minamata disease of Japan is due to pollution of  
(a) Aresenic (b) Lead  
(c) Cynide (d) Mercury
63. The high amount of E. coli in water is the indicator of  
(a) hardness of water  
(b) industrial pollution  
(c) sewage pollution  
(d) presence of chlorine in water
64. A lake with an inflow of domestic sewage rich in organic waste may result in  
(a) drying of the lake very soon due to algal bloom  
(b) an increase production of fish due to lot of nutrients  
(c) death of fish due to lack of oxygen  
(d) increased population of aquatic food web organisms
65. Which of the following does not occur when the sewage is discharged into water ?  
(a) Increase in O<sub>2</sub>  
(b) Cyanophycean blooms occur  
(c) Depletion of O<sub>2</sub> layers  
(d) Eutrophication
66. Which of the following metal is a water pollutant and causes sterility in human being  
(a) As (b) Mn  
(c) Mg (d) Hg
67. Sewage mostly constitutes  
(a) Non-biodegradable pollutants  
(b) Biodegradable pollutants  
(c) Effluents  
(d) Air pollutants
68. Sewage containing organic waste should not be disposed in water bodies because it causes major water pollution. Fishes in such a polluted water die because of  
(a) large number of mosquitoes  
(b) increase in the amount of dissolved oxygen  
(c) decrease in the amount of dissolved oxygen in water  
(d) clogging of gills by mud
69. Sewage water is purified by  
(a) aquatic plants (b) microorganisms  
(c) light (d) fishes
70. Water is often treated with chlorine to  
(a) remove hardness  
(b) increase oxygen content  
(c) kill germs  
(d) remove suspended particles
71. Which causes death of fish in water bodies polluted by sewage?  
(a) Foul smell (b) Pathogens  
(c) Herbicides (d) Decrease in D.O.
72. B.O.D. test or biochemical oxygen demand test is made for measuring  
(a) air pollution (b) water pollution  
(c) noise pollution (d) soil pollution
73. Brewery and sugar factory waste alters the quality of a water body by increasing  
(a) temperature (b) turbidity  
(c) pH (d) COD and BOD
74. Which one of the following statement is **not** true ?  
(a) pH of drinking water should be between 5.5 – 9.5.  
(b) Concentration of DO below 6 ppm is good for the growth of fish.  
(c) Clean water would have a BOD value of less than 5 ppm.  
(d) Oxides of sulphur, nitrogen and carbon are the most widespread air pollutant.



75. Limit of BOD prescribed by Central pollution Control Board for the discharge of industrial and municipal waste waters into natural surface waters, is  
 (a) < 100 ppm (b) < 30 ppm  
 (c) < 3.0 ppm (d) < 10 ppm
76. Biochemical Oxygen Demand, (BOD) is a measure of organic material present in water. BOD value less than 5 ppm indicates a water sample to be \_\_\_\_\_.  
 (a) rich in dissolved oxygen  
 (b) poor in dissolved oxygen  
 (c) highly polluted  
 (d) not suitable for aquatic life
77. Phosphate fertilizers when added to water leads to  
 (a) Increased growth of decomposers  
 (b) Reduced algal growth  
 (c) Increased algal growth  
 (d) Nutrient enrichment (eutrophication)
78. BOD of pond is connected with  
 (a) Microbes & organic matter  
 (b) Organic matter  
 (c) Microbes  
 (d) None of these
79. The maximum prescribed concentration of cadmium in drinking water in ppm is  
 (a) 0.05 (b) 3  
 (c) 2 (d) 0.005
80. Excess nitrate in drinking water can cause  
 (a) methemoglobinemia (b) kidney damage  
 (c) liver damage (d) laxative effect
81. Eutrophication causes reduction in  
 (a) dissolved oxygen (b) nutrients  
 (c) dissolved salts (d) All of the above
82. Water pollution is caused by  
 (a) pesticides (b) fly ash  
 (c) auto exhausts (d) aeroplanes
83. Which causes death of fishes in water bodies polluted by sewage?  
 (a) Foul smell (b) Pathogens  
 (c) Clogging of gills by silt (d) Decrease in D.O.
84. Chief source of soil and water pollution is  
 (a) mining (b) agro industry  
 (c) thermal power plant (d) All of the above
85. What is DDT among the following ?  
 (a) Greenhouse gas  
 (b) A fertilizer  
 (c) Biodegradable pollutant  
 (d) Non-biodegradable pollutant
86. The quantity of DDT in food chain  
 (a) decreases (b) remains same  
 (c) increases (d) changes
87. The effect of polluted water on soil is, that  
 (a) it decreases fertility  
 (b) it contaminates ground water  
 (c) it renders soil acidic or basic  
 (d) all of the above
88. Soil is polluted by  
 I. pesticides  
 II. synthetic fertilizers  
 III. green manure  
 Choose the correct option.  
 (a) I and III (b) I and II  
 (c) II and III (d) I, II and III
89. Which of the following trophic level has least concentration of toxins deposition ?  
 (a) Aquatic plant (b) Small fish  
 (c) Human being (d) Largest fish
90. Green chemistry means such reactions which :  
 (a) produce colour during reactions  
 (b) reduce the use and production of hazardous chemicals  
 (c) are related to the depletion of ozone layer  
 (d) study the reactions in plants
91. Which of the following practices will not come under green chemistry?  
 (a) If possible, making use of soap made of vegetable oils instead of using synthetic detergents.  
 (b) Using  $\text{H}_2\text{O}_2$  for bleaching purpose instead of using chlorine based bleaching agents.  
 (c) Using bicycle for travelling small distances instead of using petrol/ diesel based vehicles.  
 (d) Using plastic cans for neatly storing substances.
92. "Reducing potentially hazardous waste through smarter production".  
 This represents a great step forward for  
 (a) green revolution (b) green chemistry  
 (c) industrial revolution (d) green biotechnology
93. Use of which of the following solvent in dry cleaning will result in less harm to ground water ?  
 (a)  $\text{Cl}_2\text{C}=\text{CCl}_2$  (b) Liquid  $\text{CO}_2$   
 (c)  $\text{H}_2\text{O}_2$  (d) None of these
94. Synthesis of ethanal commercially from which of the following reagent is the part of green chemistry ?  
 (a)  $\text{CH}_3\text{CH}_2\text{OH}$  (b)  $\text{CH}_2=\text{CH}_2$   
 (c)  $\text{HC}\equiv\text{CH}$  (d) All of these

### STATEMENT TYPE QUESTIONS

95. Which of the following sequence of T and F is correct for given statements. Here T stands for True statement and F stands for False statement.
- Troposphere is the lowest region of atmosphere in which the human beings along with other organisms live.
  - Troposphere extends up to the height of 10 km from sea level.
  - Stratosphere lies above troposphere, between 10 and 20 km above sea level.
  - Troposphere contains much little water vapour, dinitrogen, dioxygen and ozone
  - Stratosphere contains ozone, and cloud formation also takes place in this region.
- (a) TTTTT (b) TFTFF  
(c) TFFFF (d) TFTFT
96. Which of the following statement(s) is / are correct ?
- Sulphuric acid, nitric acid as well as ammonium salts are components of acid rain.
  - Formation of acid rain can be reduced by using less sulphur content fossil fuels for power plants and industries.
  - Catalytic converters must be used in cars to reduce the harmful effect of exhaust.
  - Main component of catalytic converter is ceramic honey comb coated with metals like – Au, Ag, Pt etc.
- (a) (i), (ii) and (iii) (b) (ii) and (iii)  
(c) (ii), (iii) and (iv) (d) (i), (ii), (iii) and (iv)
97. Which of the following statement(s) is/are correct ?
- Classical smog is a mixture of smoke, fog and sulphur dioxide.
  - Classical smog is also called oxidising smog
  - Hydrocarbons,  $\text{NO}_2$  and PAN are components of photochemical smog.
- (a) (i) and (iii) (b) (i) and (ii)  
(c) (iii) only (d) (i), (ii) and (iii)
98. Which of the following statements are not correct?
- $\text{F}^-$  ion concentration above 2ppm causes brown mottling in teeth.
  - Excessive  $\text{F}^-$  (over 10 ppm) causes harmful effect to bones and teeth.
  - Excessive lead in drinking water causes disease methemoglobinemia
  - Deficiency of sulphate in drinking water causes laxative effect.
- (a) (ii) and (iv) (b) (ii) and (iii)  
(c) (ii), (iii) and (iv) (d) (iii) and (iv)
99. Which of the following statement(s) is/are true about waste recycling ?
- Clothes can be made from recycled plastic waste.
  - Fuel that has high octane rating and contains no lead can be obtained from plastic waste.

- Technology has now been developed to produce electricity from the garbage.
- (a) (ii) only (b) (ii) and (iii)  
(c) (iii) only (d) All of these

### MATCHING TYPE QUESTIONS

100. Match the columns

Column - I	Column - II
(A) Concentration of dissolved oxygen in cold water	(p) 6 ppm
(B) Concentration of dissolved oxygen below which growth of fish gets inhibited	(q) 17 ppm
(C) BOD value of clean water	(r) 5 ppm
(D) BOD value of polluted water.	(s) 10 ppm
(a) A – (s), B – (s), C – (q), D – (p)	
(b) A – (p), B – (q), C – (r), D – (s)	
(c) A – (s), B – (p), C – (r), D – (q)	
(d) A – (p), B – (s), C – (q), D – (r)	

101. Match the columns

Column I	Column II
(A) Acid rain	(p) $\text{CHCl}_2 - \text{CHF}_2$
(B) Photochemical smog	(q) CO
(C) Combination with haemoglobin	(r) $\text{CO}_2$
(D) Depletion of ozone layer	(s) $\text{SO}_2$
	(t) Unsaturated hydrocarbons
(a) A – (r, s), B – (t, s), C – (q), D – (p)	
(b) A – (r), B – (s), C – (q), D – (p)	
(c) A – (t, s), B – (s), C – (q), D – (r)	
(d) A – (r), B – (t), C – (q), D – (p)	

102. Match the columns

Column-I	Column-II
(A) Oxides of sulphur	(p) Global warming
(B) Nitrogen dioxide	(q) Damage to kidney
(C) Carbon dioxide	(r) 'Blue baby' syndrome
(D) Nitrate in drinking water	(s) Respiratory diseases
(E) Lead	(t) Red haze in traffic and congested areas
(a) A – (t), B – (p), C – (r), D – (s), E – (q)	
(b) A – (s), B – (t), C – (p), D – (r), E – (q)	
(c) A – (s), B – (q), C – (p), D – (t), E – (r)	
(d) A – (q), B – (s), C – (t), D – (r), E – (p)	

103. Match the columns

Column-I	Column-II
(A) Nitrous oxide from car exhausts	(p) Secondary pollutant
(B) Chlorofluorocarbon (CFCs)	(q) Combustion of fossil fuels, wood, etc
(C) Methane	(r) Denitrification
(D) Ozone (O <sub>3</sub> )	(s) Refrigerators, aerosol, sprays
(E) Carbon dioxide	(t) Cattle, rice fields, toilets.
(a) A – (r), B – (s), C – (t), D – (p), E – (q)	
(b) A – (t), B – (p), C – (r), D – (s), E – (q)	
(c) A – (s), B – (t), C – (p), D – (q), E – (r)	
(d) A – (p), B – (r), C – (s), D – (t), E – (q)	

104. Match the columns

Column-I	Column-II
(A) Releasing gases to the atmosphere after burning waste material containing sulphur	(p) Water pollution
(B) Using carbamates as pesticides	(q) Photochemical smog, damage to plant life, corrosion to building material, induce breathing problems, water pollution
(C) Using synthetic detergents for washing clothes	(r) Damaging ozone layer
(D) Releasing gases produced by automobiles and factories in the atmosphere.	(s) May cause nerve diseases in human
(E) Using chlorofluoro-carbon compounds for cleaning computer parts	(t) Classical smog, acid rain, water pollution, induce breathing problems, damage to buildings, corrosion of metals.

- (a) A – (t), B – (s), C – (p), D – (q), E – (r)  
 (b) A – (s), B – (t), C – (q), D – (p), E – (r)  
 (c) A – (q), B – (t), C – (r), D – (p), E – (s)  
 (d) A – (r), B – (s), C – (p), D – (q), E – (t)

105. Match the columns

Column I	Column II
(A) Phosphate fertilisers in water	(p) BOD level of water increases
(B) Methane in air	(q) Acid rain
(C) Synthetic detergents in water	(r) Global warming
(D) Nitrogen oxides in air	(s) Eutrophication

- (a) A – (p,s), B – (r), C – (p), D – (q)  
 (b) A – (p), B – (s), C – (r), D – (q)  
 (c) A – (s), B – (r), C – (q), D – (p)  
 (d) A – (p), B – (q), C – (s), D – (r)

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

106. **Assertion :** Uncatalysed oxidation of sulphur dioxide is a slow process.

**Reason :** Particulate matter in polluted air catalyses the oxidation of sulphur dioxide.

107. **Assertion :** Dinitrogen and dioxygen do not react with each other at a normal temperature.

**Reason :** At high altitudes dinitrogen combines with dioxygen to form oxides of nitrogen

108. **Assertion :** CO<sub>2</sub> causes green house effect.

**Reason :** Other gases do not show such effect.

109. **Assertion :** Green house effect was observed in houses used to grow plants and these are made of green glass.

**Reason :** Green house name has been given because glass houses are made of green glass.

110. **Assertion :** The pH of acid rain is less than 5.6.

**Reason :** Carbon dioxide present in the atmosphere dissolves in rain water and forms carbonic acid.

111. **Assertion :** Photochemical smog is oxidising in nature.

**Reason :** Photochemical smog contains NO<sub>2</sub> and O<sub>3</sub>, which are formed during the sequence of reactions.

112. **Assertion :** Suspended particulate matter (SPM) is an important pollutant released by diesel vehicles.

**Reason :** Catalytic converters greatly reduce pollution caused by automobiles.

113. **Assertion :** Carbon dioxide is one of the important greenhouse gases.

**Reason :** It is largely produced by respiratory function of animals and plants.

114. **Assertion :** Ozone is destroyed by solar radiation in upper stratosphere.

**Reason :** Thinning of the ozone layer allows excessive UV radiations to reach the surface of earth.

115. **Assertion :** Excessive use of chlorinated synthetic pesticides causes soil and water pollution.

**Reason :** Such pesticides are non-biodegradables.

- 116. Assertion :** If BOD level of water in a reservoir is less than 5 ppm it is highly polluted.  
**Reason :** High biological oxygen demand means low activity of bacteria in water.
- 117. Assertion :** Eutrophication shows increase in productivity in water.  
**Reason :** With increasing eutrophication, the diversity of the phytoplankton increases.
- 118. Assertion :** The  $F^-$  ions make the enamel on teeth much harder.  
**Reason :**  $F^-$  ions converts hydroxyapatite  $[3(Ca(PO_4)_2 \cdot Ca(OH)_2)]$  into fluorapatite  $[3(Ca_3(PO_4)_2 \cdot CaF_2)]$ .
- 126.** Which pollutant is harmful for 'Taj Mahal'?  
 (a) Hydrogen (b)  $O_2$   
 (c)  $SO_2$  (d) Chlorine
- 127.** The beauty of Taj Mahal is endangered due to  
 (a) degradation of marble due to high temperature  
 (b) discharge of industrial waste in Yamuna river  
 (c) air pollutants released from oil refinery  
 (d) riparian erosion
- 128.** Acid rain is caused by or recent reports of acid rain in some industrial cities are due to the effect of atmospheric pollution by  
 (a) excessive release of  $CO_2$  by burning of fuels like wood and charcoal, cutting of forests and increased animal population  
 (b) excessive release of  $NO_2$  and  $SO_2$  in atmosphere by burning of fossil fuel  
 (c) excessive release of  $NH_3$  by industrial plants and coal gas  
 (d) excessive release of CO in atmosphere by incomplete combustion of coke, charcoal and other carbonaceous fuel in paucity of oxygen.

### CRITICAL THINKING TYPE QUESTIONS

- 119.** In which of the following regions hydrogen and helium are found ?  
 (a) Stratosphere (b) Mesosphere  
 (c) Exosphere (d) Troposphere
- 120.** Which one of the following pairs is mismatched ?  
 (a) Fossil fuel burning - release of  $CO_2$   
 (b) Nuclear power - radioactive wastes  
 (c) Solar energy - Greenhouse effect  
 (d) Biomass burning - release of  $CO_2$
- 121.** Which of the following acts as a sink for CO?  
 (a) Plants  
 (b) Haemoglobin  
 (c) Microorganisms present in the soil  
 (d) Oceans
- 122.** How many time oxyhaemoglobin is less stable than carboxyhaemoglobin?  
 (a) 50 (b) 200  
 (c) 500 (d) 300
- 123.** Dinitrogen and dioxygen are main constituents of air but these do not react with each other to form oxides of nitrogen because \_\_\_\_\_.  
 (a) the reaction is endothermic and requires very high temperature.  
 (b) the reaction can be initiated only in presence of a catalyst.  
 (c) oxides of nitrogen are unstable.  
 (d)  $N_2$  and  $O_2$  are unreactive
- 124.**  $SO_2$  is one of the air pollutants.  $SO_2$   
 (a) is a lung irritant  
 (b) dissolves in water to form acid rain  
 (c) both (a) and (b)  
 (d) none of the above
- 125.** The greatest affinity for haemoglobin is shown by which of the following :  
 (a) NO (b) CO  
 (c)  $O_2$  (d)  $CO_2$
- 129.** Which of the following is the major cause of global warming?  
 (a) re-radiation of U.V. rays by  $CO_2$  and  $H_2O$   
 (b) re-radiation of I.R. rays by  $CO_2$  and  $H_2O$   
 (c) re-radiation of I.R. rays by  $O_2$  and  $N_2$   
 (d) re-radiation of U.V. rays by  $O_2$  and  $N_2$
- 130.** Formation of London smog takes place in  
 (a) winter during day time  
 (b) summer during day time  
 (c) summer during morning time  
 (d) winter during morning time
- 131.** The false statement among the followings :  
 (a) The average residence time of NO is one month  
 (b) Limestone acts as a sink for  $SO_x$   
 (c)  $SO_x$  can be removed from flue gases by passing through a solution of citrate ions  
 (d) Ammonia acts as a sink for  $NO_x$
- 132.** Which of the following statements about polar stratosphere clouds (PSCs) is not correct?  
 (a) PSCs do not react with chlorine nitrate and HCl  
 (b) Type I clouds are formed at about  $-77^\circ C$  and contain solid  $HNO_3 \cdot 3H_2O$   
 (c) Type II clouds are formed at about  $-85^\circ C$  and contain some ice  
 (d) A tight whirlpool of wind called Polar Vortex is formed which surrounds Antarctica
- 133.** Which of the following is/are formed when ozone reacts with the unburnt hydrocarbons in polluted air ?  
 (i) Formaldehyde (ii) Acrolein  
 (iii) Peroxyacetyl nitrate (iv) Formic acid  
 (a) (i) and (iv) (b) (ii) only  
 (c) (iii) only (d) (i), (ii) and (iii)

- 134.** Thermal pollution affects mainly  
 (a) vegetation (b) aquatic creature  
 (c) rocks (d) air
- 135.** A dental disease characterised by mottling of teeth is due to presence of a certain chemical element in drinking water. Which is that element?  
 (a) Boron (b) Chlorine  
 (c) Fluorine (d) Mercury
- 136.** Frequent occurrence of water blooms in a lake indicates  
 (a) nutrient deficiency  
 (b) oxygen deficiency  
 (c) excessive nutrient availability  
 (d) absence of herbivores in the lake
- 137.** Which one of the following statements is correct ?  
 (a) Extensive use of chemical fertilizers may lead to eutrophication of nearby water bodies  
 (b) Both Azotobacter and Rhizobium fix atmospheric nitrogen in root nodules of plants  
 (c) Cyanobacteria such as Anabaena and Nostoc are important mobilizers of phosphates and potassium for plant nutrition in soil  
 (d) At present it is not possible to grow maize without chemical fertilizers
- 138.** Lichens do not like to grow in cities  
 (a) because of absence of the right type of algae and fungi  
 (b) because of lack of moisture  
 (c) because of  $\text{SO}_2$  pollution  
 (d) because natural habitat is missing
- 139.** BOD of pond is connected with  
 (a) microbes & organic matter  
 (b) organic matter  
 (c) microbes  
 (d) None of these
- 140.** Which is known as 'Third poison of environment' and also creates 'Blue baby syndrome'  
 (a) Nitrate present in water  
 (b) Phosphate and detergents found in water  
 (c) Cyanide  
 (d) Pesticides
- 141.** Negative soil pollution is  
 (a) reduction in soil productivity due to erosion and over use  
 (b) reduction in soil productivity due to addition of pesticides and industrial wastes  
 (c) converting fertile land into barren land by dumping ash, sludge and garbage  
 (d) None of the above



# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (d) DDT causes air, water and soil pollution.
2. (d) DDT is a non-biodegradable pollutant.
3. (d) The uppermost region of atmosphere is exosphere.
4. (b) The coldest region is mesosphere (temp.  $-27^{\circ}\text{C}$  to  $-92^{\circ}\text{C}$ )
5. (c) Air pollution greatly affect the troposphere.
6. (c) Troposphere contains water vapour.
7. (b) High concentration of  $\text{SO}_2$  leads to stiffness of flower buds.
8. (c) The irritant red haze in the traffic and congested places is due to presence of oxides of nitrogen.
9. (c)
10. (b)  $\text{CO}_2$  is generally not regarded as pollutant.
11. (c) CO and oxides of Nitrogen are poisonous gases present in automobile exhaust gases.
12. (b) Nitric oxide (NO) which may be produced at the ground level due to human activity or natural sources or is produced in large amounts in the exhaust gases by the engine of supersonic transport planes and introduced directly into the stratosphere.  

$$\text{NO} + \text{O}_3 \longrightarrow \text{NO}_2 + \text{O}_2$$
13. (d) CO is highly toxic and impairs respiration. CO combine with haemoglobin of blood and reduces its  $\text{O}_2$  carry capacity.
14. (d)
15. (a)  $\text{CO}_2$  causes green house effect.
16. (c)
17. (a) Radiation coming from sun or outerspace have high energy or short wavelength, which are allowed to enter by green house gases. However, radiation emitted by earth is in infrared region, having long wavelength, are reflected back by the envelope of green house gases.
18. (d)
19. (a) Green house gases such as  $\text{CO}_2$ , ozone, methane, the chlorofluorocarbon compounds and water vapour form a thick cover around the earth which prevents the IR rays emitted by the earth to escape. It gradually leads to increase in temperature of atmosphere.
20. (a)  $\text{CO}_2$  is a green house gas.
21. (a) 22. (d)
23. (d) Acid rain contains  $\text{H}_2\text{SO}_4 > \text{HNO}_3 > \text{HCl}$ .
24. (a) Normal rain water has pH 5.6. Thunderstorm results in the formation of NO and  $\text{HNO}_3$  which lowers the pH.
25. (c) Acid rain is rain or any other form of precipitation that is unusually acidic. It has harmful effects on plants, aquatic animals, and infrastructure. Acid rain is mostly

- caused by human emissions of sulfur and nitrogen compounds which react in the atmosphere to produce acids. In recent years, many governments have introduced laws to reduce these emissions.
26. (c) pH of normal rain water is 5.6 as  $\text{CO}_2$  present in atmosphere combines with moisture to form  $\text{H}_2\text{CO}_3$ .
  27. (d)
  28. (b) Large amounts of  $\text{CH}_4$  are released in paddy fields, coal mines and by fossil fuels.
  29. (b) The oxidised hydrocarbons and ozone in presence of humidity cause photochemical smog.  

$$\text{Hydrocarbons} + \text{O}_2, \text{NO}_2, \text{NO}, \text{O}, \text{O}_3 \rightarrow \text{Peroxides}$$
  30. (d) 31. (a) 32. (b)
  33. (a) Smog is caused by oxides of sulphur and nitrogen.
  34. (c) 35. (a) 36. (a) 37. (a) 38. (c)
  39. (c) 40. (a) 41. (a) 42. (b) 43. (a)
  44. (d) 45. (b)
  46. (a) PAH (Poly Aromatic Hydrocarbon)
  47. (c) Usually catalytic converters are used in the automobiles, which prevent the release of nitrogen oxide and hydrocarbons to the atmosphere. Certain plants e.g., Pinus, Juniperus, Quercus, Pyrus and Vitis can metabolise nitrogen oxide and therefore, their plantation could help in this matter.
  48. (a) NO and freons are responsible for ozone depletion.
  49. (c) The ozone layer, existing between 20 to 35 km above the earth's surface, shield the earth from the harmful U. V. radiations from the sun.  
 Depletion of ozone is caused by oxides of nitrogen  

$$\text{N}_2\text{O} + h\nu \longrightarrow \text{NO} + \text{N}$$

reactive nitric oxide

$$\text{NO} + \text{O}_3 \longrightarrow \text{NO}_2 + \text{O}_2$$

$$\text{O}_3 + h\nu \longrightarrow \text{O}_2 + \text{O}$$

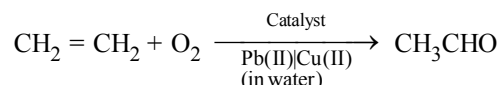
$$\text{NO}_2 + \text{O} \longrightarrow \text{NO} + \text{O}_2$$

$$2\text{O}_3 + h\nu \longrightarrow 3\text{O}_2 \text{ (Net reaction)}$$
 The presence of oxides of nitrogen increase the decomposition of  $\text{O}_3$ .
  50. (d) Ozone layer acts as a shield and does not allow ultraviolet radiation from sun to reach earth. It does not prevent infra-red radiation from sun to reach earth, thus option (d) is wrong statement and so it is the correct answer.
  51. (c) 
$$\text{CF}_2\text{Cl}_2 \xrightarrow{h\nu} \text{CF}_2\text{Cl} + \dot{\text{C}}\text{F}_2$$

$$\dot{\text{C}}\text{F}_2 + \text{O}_3 \longrightarrow \text{Cl}\dot{\text{O}} + \text{O}_2$$

52. (a) In antarctica ozone depletion is due to formation of acrolein.  
 53. (d) Depletion of ozone layer causes skin cancer.  
 54. (b) They create holes in ozone layer.  
 55. (d) Ozone hole is reduction in ozone layer in stratosphere.  
 56. (a) 57. (c)  
 58. (d) Ozone absorbs U.V. radiations harmful to human life.  
 59. (d)  
 60. (b) In cold water, dissolved oxygen can reach a concentration upto 10 ppm, whereas oxygen in air is about 200, 000 ppm.  
 61. (a) Pesticides cause water pollution.  
 62. (d) Minamata is caused by Hg poisoning.  
 63. (c) 64. (c) 65. (a) 66. (b)  
 67. (b) Domestic sewage constitute biodegradable pollutants.  
 68. (c)  
 69. (b) Sewage water is purified by micro-organisms.  
 70. (c) Water is often treated with  $\text{Cl}_2$  to kill germs.  
 71. (d) Decrease in D.O causes death of fish.  
 72. (b) Strength of sewage or degree of water pollution is measured in terms of BOD (Biochemical oxygen demand) value.  
 73. (d)  
 74. (b) The ideal value of D.O for growth of fishes is  $8 \text{ mg}/\ell$ .  $7 \text{ mg}/\ell$  is desirable range, below this value fishes get susceptible to disease. A value of  $2 \text{ mg}/\ell$  or below is lethal for fishes.  
 75. (b) Water pollution is mainly caused by industrial wastes, sewage, insecticide, herbicides, etc.  
 76. (a)  
 77. (d) Addition of phosphate fertilizers to water leads to nutrient enrichment (eutrophication).  
 78. (a) BOD of pond is connected with microbes and organic matter.  
 79. (d)  
 80. (a) Excessive concentration of nitrate in drinking water is harmful and can cause methemoglobinemia (blue baby syndrome).  
 81. (a) Eutrophication causes reduction in D.O  
 82. (a) Pesticides cause water pollution.  
 83. (d) Decrease in D.O causes death of fish  
 84. (d)  
 85. (d) DDT is a non-biodegradable pollutant.  
 86. (c) 87. (d)  
 88. (b) Pesticides and synthetic fertilizers pollute the soil.  
 89. (a) Lower trophic level has lower toxins deposition than higher trophic level.  
 90. (b) Green chemistry may be defined as the programme of developing new chemical products and chemical processes or making improvements in the already existing compounds and processes so as to make less harmful to human health and environment. This means the same as to reduce the use and production of hazardous chemicals.

91. (d)  
 92. (b) This represents a great step forward for green chemistry.  
 93. (b) Replacement of earlier used tetra-chloroethene as solvent for dry cleaning by liquid  $\text{CO}_2$  results in less harm to ground water.  
 94. (b) Ethanal is commercially prepared by one step oxidation of ethene in the presence of ionic catalyst in aqueous medium with an yield of 90%.



### STATEMENT TYPE QUESTIONS

95. (c) For statement (iii), Stratosphere lies above troposphere between 10 and 50 km above sea level cloud formation takes place in troposphere.  
 For statement (iv), Troposphere is a turbulent, dusty zone containing air, much water vapour and clouds.  
 For statement (v), Stratosphere contains dinitrogen, dioxygen, ozone and little water vapour.  
 96. (d)  
 97. (a) Classical smog is also called reducing smog.  
 98. (d) For statement (iii), Methemoglobinemia (blue baby syndrome) is caused due to excess of nitrate in drinking water.  
 For statement (iv), Excessive sulphate ( $> 500 \text{ ppm}$ ) in drinking water causes laxative effect, otherwise at moderate levels it is harmless.  
 99. (d) All the given statements are true for about waste recycling.

### MATCHING TYPE QUESTIONS

100. (c) 101. (a) 102. (b)  
 103. (a) 104. (a) 105. (a)

### ASSERTION-REASON TYPE QUESTIONS

106. (a) The presence of particulate matter in polluted air catalyses the oxidation of  $\text{SO}_2$  to  $\text{SO}_3$   
 107. (b) At high altitudes when lightening strikes dinitrogen and dioxygen combine to form oxides of nitrogen.  
 108. (c) Other gases like CFCs, ozone, water vapour and nitrous oxide also show green house effect.  
 109. (c) 110. (b) 111. (a)  
 112. (b) SPM (Suspended Particulate Matter) is defined as particles floating in the air with a diameter below  $10 \mu\text{m}$ . Studies have shown that high SPM concentrations in the air can have a detrimental impact on respiratory organs. SPM is generated from natural sources (e.g., volcanoes or dust storms) and human activities (vehicles, incinerators and industrial plants).

SPM	Other aerosols
Less than 10 $\mu\text{m}$	Less than 100 $\mu\text{m}$
Tend to float longer in air due to small size	Tend to settle fairly quickly due to comparative heaviness

Catalytic converters is a device designed to reduce the amount of emissions from automobiles. The current (so-called three-way) systems use a heated metal catalyst to reduce the emissions of carbon monoxide (CO), hydrocarbons, and nitric oxide (NO), all of which contribute to the formation of photochemical smog. In an automobile's exhaust system, a catalytic converter provides an environment for a chemical reaction where unburned hydrocarbons completely combust.

113. (b) 114. (d) 115. (a) 116. (c)
117. (b) Eutrophication is a natural process which literally means well nourished or enriched. It is a natural state in many lakes and ponds which have a rich supply of nutrients. Eutrophication become excessive, however when abnormally high amount of nutrient from sewage, fertilizers, animal wastage and detergent, enter streams and lakes causes excessive growth or blooms of microorganisms. With increasing eutrophication, the diversity of the phytoplankton community of a lake increases and the lake finally becomes dominated by blue - green algae.
118. (a) The  $\text{F}^-$  ions make the enamel on teeth much harder by converting hydroxyapatite,  $[\text{3}(\text{Ca}_3(\text{PO}_4))_2 \cdot \text{Ca}(\text{OH})_2]$ . the enamel on the surface of the teeth, into much harder fluorapatite,  $[\text{3}(\text{Ca}_3(\text{PO}_4)_2 \cdot \text{CaF}_2)]$ .

### CRITICAL THINKING TYPE QUESTIONS

119. (c)  $\text{H}_2$ , He and ionic oxygen are present in exosphere.
120. (c) Solar energy is not responsible for green house effect instead it is a source of energy for the plants and animals.
121. (c) CO is converted into  $\text{CO}_2$  by microorganism present in soil.

122. (d) Carboxyhaemoglobin is 300 times more stable than oxyhaemoglobin.
123. (a) 124. (c)
125. (a) Haemoglobin has great affinity for NO.
126. (c)
127. (c) The beauty of Taj Mahal is endangered due to air pollutants like  $\text{SO}_2$  released from oil refinery.
128. (b) When  $\text{SO}_2$  pollution in air is much higher. Sometimes,  $\text{SO}_2$  mixes in the air with small particles of metals near the factories and gets oxidised into sulphur trioxide  $\text{SO}_3$ . These gases are harmful and they react with water to form sulphuric acid ( $\text{H}_2\text{SO}_4$ ) or sulphurous acid ( $\text{H}_2\text{SO}_3$ ) and come down to earth with rain water, it is called acid rain or acid precipitation.
129. (b)
130. (d) London smog is formed in morning during winter.
131. (a) The average residence time of NO is 4 days.
132. (a) PSCs react with chlorine nitrate and HCl to give HOCl and  $\text{Cl}_2$ .
133. (d)  $3\text{CH}_4 + 2\text{O}_3 \rightarrow 3\text{CH}_2=\text{O} + 3\text{H}_2\text{O}$   
Formaldehyde  

$$\begin{array}{c} \text{CH}_2=\text{CHCH}=\text{OCH}_3\text{COONO}_2 \\ \parallel \\ \text{O} \end{array}$$
  
 Acrolein Peroxyacetyl nitrate (PAN)
134. (b) Thermal pollution is caused by power plants. Power plant requires a larger quantity of water for cooling. The water after cooling is left in the water body. The temperature of left water is generally very high and affects aquatic life.
135. (c) The excess of fluorine in water causes fluorosis. The symptoms of fluorosis are mottling of teeth (yellowish streaks) and abnormal bones liable to fracture etc. It is an example of endemic disease.
136. (b) 137. (a)
138. (c) Because they are very sensitive to sulphur dioxide and in cities the amount of  $\text{SO}_2$  is high so lichen do not grow in cities.
139. (a) BOD of pond is connected with microbes and organic matter.
140. (b) 141. (a)



### FACT/DEFINITION TYPE QUESTIONS

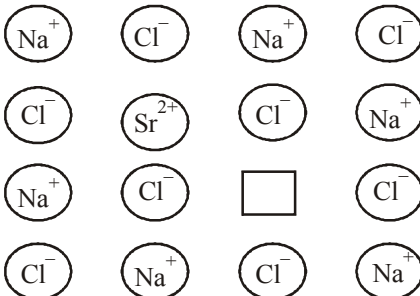
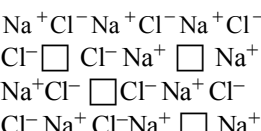
- Which of the following is not a characteristic property of solids?
  - Intermolecular distances are short.
  - Intermolecular forces are weak.
  - Constituent particles have fixed positions.
  - Solids oscillate about their mean positions.
- Most crystals show good cleavage because their atoms, ions or molecules are
  - weakly bonded together
  - strongly bonded together
  - spherically symmetrical
  - arranged in planes
- "Crystalline solids are anisotropic in nature. What is the meaning of anisotropic in the given statement?
  - A regular pattern of arrangement of particles which repeats itself periodically over the entire crystal.
  - Different values of some of physical properties are shown when measured along different directions in the same crystals.
  - An irregular arrangement of particles over the entire crystal.
  - Same values of some of physical properties are shown when measured along different directions in the same crystals.
- A crystalline solid
  - changes abruptly from solid to liquid when heated
  - has no definite melting point
  - undergoes deformation of its geometry easily
  - has an irregular 3-dimensional arrangements
- Which of the following is not a characteristic of a crystalline solid ?
  - Definite and characteristic heat of fusion.
  - Isotropic nature.
  - A regular periodically repeated pattern of arrangement of constituent particles in the entire crystal.
  - A true solid
- Which of the following is not a crystalline solid?
  - KCl
  - CsCl
  - Glass
  - Rhombic S
- Which of the following statements about amorphous solids is incorrect ?
  - They melt over a range of temperature
  - They are anisotropic
  - There is no orderly arrangement of particles
  - They are rigid and incompressible
- Which of the following is not a crystalline solid?
  - KCl
  - CsCl
  - Glass
  - Rhombic S
- Which of the following is an amorphous solid ?
  - Graphite (C)
  - Quartz glass ( $\text{SiO}_2$ )
  - Chrome alum
  - Silicon carbide ( $\text{SiC}$ )
- Which of the following statement is not true about amorphous solids ?
  - On heating they may become crystalline at certain temperature.
  - They may become crystalline on keeping for long time.
  - Amorphous solids can be moulded by heating.
  - They are anisotropic in nature.
- The sharp melting point of crystalline solids is due to \_\_\_\_\_.
  - a regular arrangement of constituent particles observed over a short distance in the crystal lattice.
  - a regular arrangement of constituent particles observed over a long distance in the crystal lattice.
  - same arrangement of constituent particles in different directions.
  - different arrangement of constituent particles in different directions.
- Why some glass objects from ancient civilisations are found to become milky in appearance?
  - Glass is a crystalline solid, milky appearance is due to its crystalline nature.
  - Glass is amorphous but on heating it become crystalline at some temperature.
  - Because of reaction of glass with impurities present in the atmosphere.
  - None of these.
- Which of the following amorphous solid is used as photovoltaic material for conversion of sunlight into electricity?
  - Quartz glass
  - Quartz
  - Silicon
  - Both (a) and (b)



14. Solid  $\text{CH}_4$  is  
(a) ionic solid (b) covalent solid  
(c) molecular solid (d) does not exist
15. An example of a covalent crystalline solid is:  
(a) Si (b) Al  
(c) NaF (d) Ar
16. Among solids, the highest melting point is exhibited by  
(a) Covalent solids (b) Ionic solids  
(c) Pseudo solids (d) Molecular solids
17. Which of the following exists as covalent crystals in the solid state?  
(a) Iodine (b) Silicon  
(c) Sulphur (d) Phosphorus
18. The major binding force of diamond, silicon and quartz is  
(a) electrostatic force (b) electrical attraction  
(c) covalent bond force (d) non-covalent bond force
19. In graphite electrons are :  
(a) localised on each carbon atom  
(b) spread out between the sheets  
(c) localised on every third carbon atom  
(d) present in antibonding orbital.
20. Which one of the following forms a molecular solid when solidified?  
(a) Silicon carbide (b) Calcium fluoride  
(c) Rock salt (d) Methane
21. Which of the following is a network solid?  
(a)  $\text{SO}_2$  (solid) (b)  $\text{I}_2$   
(c) Diamond (d)  $\text{H}_2\text{O}$  (Ice)
22. Which of the following solids is not an electrical conductor?  
(a) Mg (s) (b) TiO (s)  
(c)  $\text{I}_2$  (s) (d)  $\text{H}_2\text{O}$  (s)
23. Iodine molecules are held in the crystals lattice by \_\_\_\_\_.  
(a) london forces  
(b) dipole-dipole interactions  
(c) covalent bonds  
(d) coulombic forces
24. Which of the following is not the characteristic of ionic solids?  
(a) Very low value of electrical conductivity in the molten state.  
(b) Brittle nature.  
(c) Very strong forces of interactions.  
(d) Anisotropic nature.
25. Graphite is a good conductor of electricity due to the presence of \_\_\_\_\_.  
(a) lone pair of electrons (b) free valence electrons  
(c) cations (d) anions
26. Graphite cannot be classified as \_\_\_\_\_.  
(a) conducting solid (b) network solid  
(c) covalent solid (d) ionic solid
27. Which of the following cannot be regarded as molecular solid?  
(i) SiC (Silicon carbide) (ii) AlN  
(iii) Diamond (iv)  $\text{I}_2$   
(a) (i), (ii) and (iii) (b) (ii) and (iii)  
(c) (iv) (d) (ii) and (iv)
28. Crystals can be classified into basic crystal units, equal to  
(a) 7 (b) 4  
(c) 14 (d) 2
29. How many three dimensional crystal lattice are possible?  
(a) 20 (b) 7  
(c) 14 (d) 10
30. Which of the following represents monoclinic crystal system?  
(a)  $a \neq b \neq c, \alpha \neq \beta \neq \gamma \neq 90^\circ$   
(b)  $a = b = c, \alpha = \beta = \gamma \neq 90^\circ$   
(c)  $a \neq b \neq c, \alpha = \gamma = 90^\circ \beta \neq 90^\circ$   
(d)  $a = b = c, \alpha = \beta = \gamma = 90^\circ$
31. In face-centred cubic lattice, a unit cell is shared equally by how many unit cells  
(a) 2 (b) 4  
(c) 6 (d) 8
32. For orthorhombic system axial ratios are  $a \neq b \neq c$  and the axial angles are  
(a)  $\alpha = \beta = \gamma \neq 90^\circ$  (b)  $\alpha = \beta = \gamma = 90^\circ$   
(c)  $\alpha = \beta = \gamma = 90^\circ, \beta = 90^\circ$  (d)  $\alpha \neq \beta \neq \gamma = 90^\circ$
33. The unit cell dimensions of a cubic lattice (edges a, b, c and the angles between them,  $\alpha$ ,  $\beta$  and  $\gamma$ ) are  
(a)  $a = b = c, \alpha = \beta = \gamma = 90^\circ$   
(b)  $a = b \neq c, \alpha = \beta = \gamma = 90^\circ$   
(c)  $a = b = c, \alpha = \gamma = 90^\circ, \beta \neq 90^\circ$   
(d)  $a \neq b \neq c, \alpha = \beta = 90^\circ, \gamma \neq 90^\circ$
34. Tetragonal crystal system has the following unit cell dimensions  
(a)  $a = b = c, \alpha = \beta = \gamma = 90^\circ$   
(b)  $a = b \neq c, \alpha = \beta = \gamma = 90^\circ$   
(c)  $a \neq b \neq c, \alpha = \beta = \gamma = 90^\circ$   
(d)  $a = b \neq c, \alpha = \beta = 90^\circ \gamma = 120^\circ$
35. The number of atoms contained in a fcc unit cell of a monoatomic substance is  
(a) 1 (b) 2  
(c) 4 (d) 6
36. In face-centred cubic lattice, a unit cell is shared equally by how many unit cells  
(a) 2 (b) 4  
(c) 6 (d) 8
37. The number of atoms per unit cell of bcc structure is  
(a) 1 (b) 2  
(c) 4 (d) 6
38. When molten zinc is converted into solid state, it acquires hcp structure. The number of nearest neighbours of Zn will be  
(a) 6 (b) 12  
(c) 8 (d) 4
39. Hexagonal close packed arrangement of ions is described as  
(a) ABCABA (b) ABCABC  
(c) ABABA (d) ABBAB

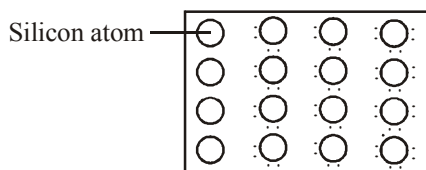


40. In which of the following crystals alternate tetrahedral voids are occupied?  
 (a) NaCl (b) ZnS  
 (c) CaF<sub>2</sub> (d) Na<sub>2</sub>O
41. Which of the following metal(s) show(s) hexagonal close packed structure (hcp) and which show face centred cubic (fcc) structure?  
 hcp fcc  
 (a) Ag, Zn Mg, Cu  
 (b) Mg, Zn Ag, Cu  
 (c) Cu, Fe Al, Sn  
 (d) Na, Li Zn, Cu
42. The number of octahedral voids present in a lattice is A. The number of closed packed particles, the number of tetrahedral voids generated is B the number of closed packed particles  
 (a) A- equal, B- half (b) A- twice, B- equal  
 (c) A- twice, B- half (d) A- equal, B- twice
43. In the hexagonal close packed structure of a metallic lattice, the number of nearest neighbours of a metallic atom is  
 (a) twelve (b) four  
 (c) eight (d) six
44. The Ca<sup>2+</sup> and F<sup>-</sup> are located in CaF<sub>2</sub> crystal, respectively at face centred cubic lattice points and in  
 (a) tetrahedral voids (b) half of tetrahedral voids  
 (c) octahedral voids (d) half of octahedral voids
45. If Germanium crystallises in the same way as diamond, then which of the following statement is not correct?  
 (a) Every atom in the structure is tetrahedrally bonded to 4 atoms.  
 (b) Unit cell consists of 8 Ge atoms and co-ordination number is 4.  
 (c) All the octahedral voids are occupied.  
 (d) All the octahedral voids and 50% tetrahedral voids remain unoccupied.
46. The arrangement ABC ABC ..... is referred to as  
 (a) Octahedral close packing  
 (b) Hexagonal close packing  
 (c) Tetrahedral close packing  
 (d) Cubic close packing
47. The total number of tetrahedral voids in the face centred unit cell is \_\_\_\_\_.  
 (a) 6 (b) 8  
 (c) 10 (d) 12
48. What is the coordination number in a square close packed structure in two dimensions ?  
 (a) 2 (b) 3  
 (c) 4 (d) 6
49. In the cubic close packing, the unit cell has \_\_\_\_\_.  
 (a) 4 tetrahedral voids each of which is shared by four adjacent unit cells.  
 (b) 4 tetrahedral voids within the unit cell.  
 (c) 8 tetrahedral voids each of the which is shared by four adjacent unit cells.  
 (d) 8 tetrahedral voids within the unit cells.
50. In which of the following arrangements octahedral voids are formed ?  
 (i) hcp (ii) bcc  
 (iii) simple cubic (iv) fcc  
 (a) (i), (ii) (b) (i), (iv)  
 (c) (iii) (d) (ii), (iv)
51. Which of the following is the correct increasing order of packing efficiency for hcp, bcc and simple cubic lattice?  
 (a) hcp < bcc < simple cubic  
 (b) bcc < hcp < simple cubic  
 (c) simple cubic < bcc < hcp  
 (d) simple cubic < hcp < bcc
52. Total volume of atoms present in bcc unit cell is.  
 (a)  $\frac{16}{3}\pi r^3$  (b)  $\frac{4}{3}\pi r^3$   
 (c)  $\frac{8}{3}\pi r^3$  (d)  $\frac{12}{3}\pi r^3$
53. Total volume of atoms present in a face-centred cubic unit cell of a metal is (r is atomic radius)  
 (a)  $\frac{12}{3}\pi r^3$  (b)  $\frac{16}{3}\pi r^3$   
 (c)  $\frac{20}{3}\pi r^3$  (d)  $\frac{24}{3}\pi r^3$
54. The interionic distance for cesium chloride crystal will be  
 (a) a (b)  $\frac{a}{2}$   
 (c)  $\frac{\sqrt{3}a}{2}$  (d)  $\frac{2a}{\sqrt{3}}$
55. The fraction of total volume occupied by the atoms present in a simple cube is  
 (a)  $\frac{\pi}{3\sqrt{2}}$  (b)  $\frac{\pi}{4\sqrt{2}}$   
 (c)  $\frac{\pi}{4}$  (d)  $\frac{\pi}{6}$
56. Percentages of free space in cubic close packed structure and in body centered packed structure are respectively  
 (a) 30% and 26% (b) 26% and 32%  
 (c) 32% and 48% (d) 48% and 26%
57. The empty space in the body centred cubic lattice is  
 (a) 68% (b) 52.4%  
 (c) 47.6% (d) 32%  
 (e) 74%
58. Which one of the following statements about packing in solids is **incorrect** ?  
 (a) Coordination number in bcc mode of packing is 8.  
 (b) Coordination number in hcp mode of packing is 12.  
 (c) Void space in hcp mode of packing is 32%.  
 (d) Void space in ccp mode of packing is 26%.
59. A metallic crystal crystallizes into a lattice containing a sequence of layers AB AB AB.....Any packing of spheres leaves out voids in the lattice. What percentage of volume of this lattice is empty space?  
 (a) 74% (b) 26%  
 (c) 50% (d) none of these.

60. In NaCl, the centre-to-centre nearest-neighbour distance of ions is  
 (a)  $\frac{1}{4}a$  (b)  $\frac{\sqrt{3}}{2}a$   
 (c)  $\frac{1}{2}a\sqrt{2}$  (d)  $\frac{1}{2}a$
61. The edge lengths of the unit cells in terms of the radius of spheres constituting *fcc*, *bcc* and simple cubic unit cell are respectively \_\_\_\_\_.  
 (a)  $2\sqrt{2}r, \frac{4r}{\sqrt{3}}, 2r$  (b)  $\frac{4r}{\sqrt{3}}, 2\sqrt{2}r, 2r$   
 (c)  $2r, 2\sqrt{2}r, \frac{4r}{\sqrt{3}}$  (d)  $2r, \frac{4r}{\sqrt{3}}, 2\sqrt{2}r$
62. CsBr crystallises in a body centered cubic lattice. The unit cell length is 436.6 pm. Given that the atomic mass of Cs = 133 and that of Br = 80 amu and Avogadro number being  $6.02 \times 10^{23} \text{ mol}^{-1}$ , the density of CsBr is  
 (a)  $0.425 \text{ g/cm}^3$  (b)  $8.5 \text{ g/cm}^3$   
 (c)  $4.25 \text{ g/cm}^3$  (d)  $82.5 \text{ g/cm}^3$
63. An element occurring in the bcc structure has  $12.08 \times 10^{23}$  unit cells. The total number of atoms of the element in these cells will be  
 (a)  $24.16 \times 10^{23}$  (b)  $36.18 \times 10^{23}$   
 (c)  $6.04 \times 10^{23}$  (d)  $12.08 \times 10^{23}$
64. Potassium has a bcc structure with nearest neighbour distance 4.52 Å. Its atomic weight is 39. Its density (in  $\text{kg m}^{-3}$ ) will be  
 (a) 454 (b) 804  
 (c) 852 (d) 910
65. The cubic unit cell of a metal (molar mass =  $63.55 \text{ g mol}^{-1}$ ) has an edge length of 362 pm. Its density is  $8.92 \text{ g cm}^{-3}$ . The type of unit cell is  
 (a) primitive (b) face centered  
 (c) body centered (d) end centered
66. AB<sub>2</sub> crystallizes in a body centred cubic lattice with edge length 'a' equal to 387 pm. The distance between two oppositely charged ions in the lattice is :  
 (a) 335 pm (b) 250 pm  
 (c) 200 pm (d) 300 pm
67. Iron crystallizes in a b.c.c. system with a lattice parameter of 2.861 Å. Calculate the density of iron in the b.c.c. system (Atomic weight of Fe = 56,  $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ )  
 (a)  $7.92 \text{ g ml}^{-1}$  (b)  $8.96 \text{ g ml}^{-1}$   
 (c)  $2.78 \text{ g ml}^{-1}$  (d)  $6.72 \text{ g ml}^{-1}$
68. An element (atomic mass = 100 g/mol) having bcc structure has unit cell edge 400 pm. Then, density of the element is  
 (a)  $10.376 \text{ g/cm}^3$  (b)  $5.188 \text{ g/cm}^3$   
 (c)  $7.289 \text{ g/cm}^3$  (d)  $2.144 \text{ g/cm}^3$
69. A metal crystallizes in 2 cubic phases fcc and bcc whose unit cell lengths are 3.5 Å and 3.0 Å respectively. The ratio of their densities is  
 (a) 0.72 (b) 2.04  
 (c) 1.46 (d) 3.12
70. Which of the following statements is not correct ?  
 (a) Vacancy defect results in decrease in density of substance.  
 (b) Vacancy defect can develop when a substance is heated.  
 (c) Interstitial defect increases the density of the substance.  
 (d) Ionic solids show interstitial defects only.
71. Which defect is shown in the given figure?  
  
 (a) Frenkel defect (b) Impurity defect  
 (c) Schottky defect (d) Vacancy defect
72. Each of the following solids show, the Frenkel defect except  
 (a) ZnS (b) AgBr  
 (c) AgI (d) KCl
73. Schottky defect defines imperfection in the lattice structure of  
 (a) solid (b) gas  
 (c) liquid (d) plasma
74. When electrons are trapped into the crystal in anion vacancy, the defect is known as :  
 (a) Schottky defect (b) Frenkel defect  
 (c) Stoichiometric defect (d) F-centre
75. Schottky defect in crystals is observed when  
 (a) an ion leaves its normal site and occupies an interstitial site  
 (b) unequal number of cations and anions are missing from the lattice  
 (c) density of the crystal increases  
 (d) equal number of cations and anions are missing from the lattice
76. The appearance of colour in solid alkali metal halides is generally due to  
 (a) Schottky defect (b) Frenkel defect  
 (c) Interstitial positions (d) F-centre
77. Crystal defect indicated in the diagram below is  
  
 (a) Interstitial defect  
 (b) Schottky defect  
 (c) Frenkel defect  
 (d) Frenkel and Schottky defects

78. Schottky defect generally appears in :  
(a) NaCl (b) KCl  
(c) CsCl (d) all of these
79. Which defect causes decrease in the density of crystal  
(a) Frenkel (b) Schottky  
(c) Interstitial (d) F – centre
80. Which statement does not make sense?  
(a) Frenkel defect is not found in alkali metal halides  
(b) Schottky defect is very common in alkali metal halides  
(c) Schottky defect lowers the density of the crystal  
(d) Frenkel defect lowers the density of the crystal.
81. Frenkel and Schottky defects are :  
(a) nucleus defects (b) non-crystal defects  
(c) crystal defects (d) nuclear defects
82. Equal number of atoms or ion missing from normal lattice point creating a vacancy due to  
(a) Frenkel defect (b) Mass defect  
(c) Schottky defect (d) Interstitial defect
83. In stoichiometric defects, the types of compound exhibit Frenkel defects have/has  
(a) Low co-ordination nos.  
(b) High co-ordination  
(c) Small difference in the size of cations and anions  
(d) None of these
84. The crystal with metal deficiency defect is  
(a) NaCl (b) FeO  
(c) KCl (d) ZnO
85. Which of the following has Frenkel defects?  
(a) Sodium chloride (b) Graphite  
(c) Silver bromide (d) Diamond
86. Which of the following crystals does not exhibit Frenkel defect?  
(a) AgBr (b) AgCl  
(c) KBr (d) ZnS
87. Due to Frenkel defect, the density of ionic solids  
(a) decreases (b) increases  
(c) neither (a) nor (b) (d) does not change
88. In a solid lattice the cation has left a lattice site and is located at an interstitial position, the lattice defect is :  
(a) Interstitial defect (b) Valency defect  
(c) Frenkel defect (d) Schottky defect
89. Doping of AgCl crystals with  $\text{CdCl}_2$  results in  
(a) Frenkel defect  
(b) Schottky defect  
(c) Substitutional cation vacancy  
(d) Formation of F - centres
90. Cations are present in the interstitial sites in \_\_\_\_\_.  
(a) Frenkel defect (b) Schottky defect  
(c) Vacancy defect (d) Metal deficiency defect
91. What is the energy gap between valence band and conduction band in crystal of insulators ?  
(a) Both the bands are overlapped with each other  
(b) Very small  
(c) Infinite  
(d) Very large
92. Which of the following is non stoichiometric defect?  
(i) Metal excess defect (ii) Impurity defect  
(iii) F-centre (iv) Metal deficiency defect  
(a) (i) and (iv) (b) (i), (iii) and (iv)  
(c) (iii) and (ii) (d) All of these
93. Which kind of defects are introduced by doping ?  
(a) Dislocation defect (b) Schottky defect  
(c) Frenkel defects (d) Electronic defects
94. Silicon doped with electron – rich impurity forms \_\_\_\_\_.  
(a) p-type semiconductor  
(b) n-type semiconductor  
(c) intrinsic semiconductor  
(d) insulator
95. Which of the following defects is also known as dislocation defect ?  
(a) Frenkel defect  
(b) Schottky defect  
(c) Non – stoichiometric defect  
(d) Simple interstitial defect
96. Doping of silicon (Si) with boron (B) leads to :  
(a) n-type semiconductor (b) p-type semiconductor  
(c) metal (d) insulator
97. On doping Ge metal with a little of In or Ga, one gets  
(a) p-type semi conductor (b) n-type semi conductor  
(c) insulator (d) rectifier
98. With which one of the following elements silicon should be doped so as to give p-type of semiconductor ?  
(a) Germanium (b) Arsenic  
(c) Selenium (d) Boron
99. To get a n- type semiconductor, the impurity to be added to silicon should have which of the following number of valence electrons  
(a) 1 (b) 2  
(c) 3 (d) 5
100. If we mix a pentavalent impurity in a crystal lattice of germanium, what type of semiconductor formation will occur?  
(a) p-type (b) n-type  
(c) both (a) and (b) (d) None of the two.
101. The addition of arsenic to germanium makes the latter a  
(a) metallic conductor (b) intrinsic semiconductor  
(c) mixed conductor (d) extrinsic semiconductor
102. Pure silicon doped with phosphorus is a  
(a) metallic conductor (b) insulator  
(c) n-type semiconductor (d) p-type semiconductor
103. Which of the following metal oxides is anti-ferromagnetic in nature?  
(a)  $\text{MnO}_2$  (b)  $\text{TiO}_2$   
(c)  $\text{VO}_2$  (d)  $\text{CrO}_2$
104. Which of the following compound is like metallic copper in its conductivity and appearance?  
(a)  $\text{VO}_3$  (b)  $\text{TiO}_3$   
(c)  $\text{ReO}_3$  (d)  $\text{CrO}_2$
105. Magnetic moment of electron is due to which of the following reason?  
(a) Due to its orbital motion around the nucleus.  
(b) Due to its spin around its own axis.  
(c) Due to negative charge on electron.  
(d) Both (a) and (b).

106. What is the value of Bohr magneton  $\mu_B$  in  $A m^2$ ?  
 (a)  $9.27 \times 10^{-24} A m^2$  (b)  $9.27 \times 10^{-20} A m^2$   
 (c)  $9.00 \times 10^{-30} A m^2$  (d)  $9.27 \times 10^{-25} A m^2$
107. Which of the following type of substances can be permanently magnetised?  
 (a) Diamagnetic (b) Ferromagnetic  
 (c) Ferrimagnetic (d) Antiferromagnetic
108. Which of the following structure represents ferrimagnetism?  
 (a)  $\uparrow \downarrow \uparrow \downarrow \uparrow \downarrow$  (b)  $\uparrow \uparrow \uparrow \uparrow \uparrow$   
 (c)  $\downarrow \downarrow \downarrow \downarrow \downarrow$  (d)  $\uparrow \uparrow \downarrow \uparrow \uparrow \downarrow$
109. Which of the following statement is not correct?  
 (a) Paramagnetic substances lose their magnetism in the absence of magnetic field.  
 (b) Diamagnetic substances are weakly magnetised in magnetic field in opposite direction.  
 (c) Ferromagnetic substances becomes paramagnetic on heating.  
 (d) In antiferromagnetism domains are oppositely oriented and cancel out each other's magnetic moment.
110. An element containing an odd number of electrons is:  
 (a) Paramagnetic (b) Diamagnetic  
 (c) Antiferromagnetic (d) None of these
111. Which of the following oxides behaves as conductor or insulator depending upon temperature?  
 (a) TiO (b)  $SiO_2$   
 (c)  $TiO_3$  (d)  $MgO$
112. Which of the following oxides shows electrical properties like metals?  
 (a)  $SiO_2$  (b)  $MgO$   
 (c)  $SO_2(s)$  (d)  $CrO_2$
113. Which of the following statements is not true?  
 (a) Paramagnetic substances are weakly attracted by magnetic field.  
 (b) Ferromagnetic substances cannot be magnetised permanently  
 (c) The domains in antiferromagnetic substances are oppositely oriented with respect to each other.  
 (d) Pairing of electrons cancels their magnetic moment in the diamagnetic substances.
114. A ferromagnetic substance becomes a permanent magnet when it is placed in a magnetic field because \_\_\_\_\_.  
 (a) all the domains get oriented in the direction of magnetic field.  
 (b) all the domains get oriented in the direction opposite to the direction of magnetic field.  
 (c) domains get oriented randomly.  
 (d) domains are not affected by magnetic field.
115. A perfect crystal of silicon interchange is doped with some elements as given in the options. Which of these options show n-type semiconductors?



- (i)
- (ii)
- (iii)
- (iv)
- (a) (i) and (iii) (b) (i)  
 (c) (ii) and (iv) (d) (iii)

### STATEMENT TYPE QUESTIONS

116. Which of the following statement(s) is/are correct?  
 (i) Crystalline solids have definite characteristic geometrical shape.  
 (ii) Crystalline solids have long range order.  
 (iii) Sodium chloride and quartz glass are examples of crystalline solids.  
 (iv) Crystalline solids are isotropic in nature.  
 (a) (i), (ii) and (iii) (b) (i), (ii) and (iv)  
 (c) (i) and (ii) (d) (i) only
117. Which of the following sequence of T and F is correct for given statements. Here T stands for true statement and F stands for false statement?  
 (i) Ionic solids are electrical insulators in the solid state but conduct electricity in molten state.  
 (ii) Graphite is a covalent solid.  
 (iii) Covalent solids are conductor of electricity.  
 (iv) Non polar molecular solids are held by weak dispersion forces or London forces while polar molecular solids are held by stronger dipole - dipole interactions.  
 (a) TTTF (b) FTTF  
 (c) TFFT (d) TTFT

# THE SOLID STATE

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118. Which of the following statements(s) is/are incorrect?
- Only  $1/8^{\text{th}}$  portion of an atom located at corner of a cubic unit cell is its neighbouring unit cell.
  - Total number of atoms per unit cell for a face centered cubic unit cell is 3.
  - Atom located at the body center is shared between two adjacent unit cells.
- (a) (iii) only (b) (ii) only  
(c) (i) and (ii) (d) (ii) and (iii)
119. Which of the following is/are not true about the voids formed in 3 dimensional hexagonal close packed structure?
- A tetrahedral void is formed when a sphere of the second layer is present above triangular void in the first layer.
  - All the triangular voids are not covered by the spheres of the second layer.
  - Tetrahedral voids are formed when the triangular voids in the second layer lie above the triangular voids in the first layer and the triangular shapes of these voids do not overlap.
  - Octahedral voids are formed when the triangular voids in the second layer exactly overlap with similar voids in the first layer.
- (a) (i) and (iv) (b) (iii) and (iv)  
(c) (ii) and (iii) (d) (iv) only
120. Which of the following sequence of T and F is true for given statements. Here T stands for true statement and F stands for false statement?
- Frenkel defect results in increase in density of the solid.
  - ZnS, AgCl, AgBr and AgI shows Frenkel defect.
  - Schottky defect results in decrease in density of the solid.
  - AgBr shows Schottky defect only.
  - For NaCl there is one Schottky defect per  $10^{16}$  ions.
- (a) TTTFT (b) TTTF  
(c) FTTFT (d) FTTF
121. Which of the following statements is /are correct?
- LiCl crystals are pink due to metal excess defect due to presence of extra  $\text{Li}^+$  ion at interstitial sites.
  - Zinc oxide on heating turns yellow because its anionic sites are occupied by unpaired electrons.
  - In FeO crystals some  $\text{Fe}^{2+}$  are missing and the loss of positive charge is made up by the presence of required number of  $\text{Fe}^{3+}$  ions.
- (a) (i) and (ii) (b) (i), (ii) and (iii)  
(c) (ii) and (iii) (d) (iii) only
122. Which of the following sequence of T and F is correct? Here 'T' stands for true and 'F' stands for false statement.
- Solids have conductivities in the order of  $10^{-20}$  to  $10^7 \text{ ohm}^{-1} \text{ m}^{-1}$ .
  - In semiconductors the gap between filled valence band and conduction band is small.
  - Electrical conductivity of insulators increases with rise in temperature.
  - Insulators have conductivities ranging between  $10^{-6}$  to  $10^4 \text{ ohm}^{-1} \text{ m}^{-1}$ .
- (a) TTFF (b) TTFT  
(c) FTFF (d) FTTF

123. White crystal of zinc oxide is heated
- Metal excess defect is created.
  - Crystal become *p*-type semiconductor
  - Crystal become yellow in color.
  - Free electron are created.
- (a) All statement(s) are correct. (b) (i), (ii) and (iv)  
(c) (i), (ii) and (iii) (d) (ii) and (iv)
124. Consider the Oxygen and chromium dioxide, both are placed in magnetic field:
- Oxygen is attracted strongly in a magnetic field.
  - Magnetic field persist in chromium dioxide while in Oxygen not.
- (a) Both Statements are correct.  
(b) Statement (i) is correct only.  
(c) Statement (ii) is correct only.  
(d) Both Statements are incorrect.

## MATCHING TYPE QUESTIONS

125. Match the columns

Column-I (Type of solid)	Column-II (Example of solid)
(A) Molecular solid	(p) Ag
(B) Ionic solid	(q) SiC
(C) Metallic solid	(r) $\text{CCl}_4$
(D) Covalent solid	(s) MgO
(a) A – (s), B – (r), C – (p), D – (q)	
(b) A – (q), B – (s), C – (p), D – (r)	
(c) A – (r), B – (q), C – (p), D – (s)	
(d) A – (r), B – (s), C – (p), D – (q)	

126. Match the columns

Column-I (Type of unit cell)	Column-II (Characteristic feature)
(A) Primitive cubic unit cell	(p) Each of the three perpendicular edges compulsorily have the different edge length i.e.; $a \neq b \neq c$ .
(B) Body centered cubic unit cell	(q) Number of atoms per unit cell is one
(C) Face centered cubic unit cell	(r) Each of the three perpendicular edges compulsorily have the same edge length i.e.; $a = b = c$ .
(D) End centered orthorhombic unit cell	(s) In addition to the contribution from the corner atoms the number of atoms present in a unit cell is one.
	(t) In addition to the contribution from the corner atoms the number of atoms present in a unit cell is three.
(a) A – (q), B – (s), C – (r, t), D – (p)	
(b) A – (q, r), B – (r, s), C – (r, t), D – (p, s)	
(c) A – (r, s), B – (q, r), C – (r), D – (p)	
(d) A – (t), B – (r, s), C – (p, s), D – (q)	



127. Match the columns

Column-I (Crystal system)	Column-II (Compounds)
(A) Rhombohedral	(p) $\text{KNO}_3$
(B) Orthorhombic	(q) Zinc blende
(C) Cubic	(r) CdS
(D) Hexagonal	(s) Calcite
(a) A – (p), B – (q), C – (s), D – (r)	
(b) A – (r), B – (p), C – (q), D – (s)	
(c) A – (s), B – (p), C – (q), D – (r)	
(d) A – (q), B – (r), C – (s), D – (p)	

128. Match the columns

Column-I	Column-II
(A) Square close packing in two dimensions	(p) Triangular voids
(B) Hexagonal close packing in two dimensions	(q) Pattern of spheres is repeated every fourth layer
(C) Hexagonal close packing in three dimensions	(q) Coordination number 4
(D) Cubic close packing in three dimensions	(s) Pattern of sphere is repeated alternate layers
(a) A – (r), B – (p), C – (s), D – (q)	
(b) A – (p), B – (s), C – (q), D – (r)	
(c) A – (s), B – (p), C – (q), D – (s)	
(d) A – (r), B – (p), C – (s), D – (q)	

129. Match Column-I (Type of close packed structure) with Column-II (Coordination number) and choose the correct option.

Column-I	Column-II
(A) One dimensional close packed arrangement.	(p) 12
(B) Square close packing in two dimensions.	(q) 6
(C) Two dimensional hexagonal close packing.	(r) 2
(D) Cubic close packed arrangement.	(s) 4
(a) A – (r), B – (s), C – (q), D – (p)	
(b) A – (r), B – (s), C – (p), D – (q)	
(c) A – (s), B – (r), C – (q), D – (p)	
(d) A – (s), B – (q), C – (p), D – (r)	

130. Match the columns

Column-I	Column-II
(A) Impurity defect	(p) NaCl with anionic sites F-centres
(B) Metal excess defect	(q) FeO with $\text{Fe}^{3+}$
(C) Metal deficiency defect	(r) NaCl with $\text{Sr}^{2+}$ and some cationic sites vacant
(a) A – (r), B – (p), C – (q)	
(b) A – (p), B – (q), C – (r)	
(c) A – (r), B – (q), C – (p)	
(d) A – (q), B – (p), C – (r)	

131. Match the columns

Column-I	Column-II
(A) Mg in solid state	(p) <i>p</i> -Type semiconductor
(B) $\text{MgCl}_2$ in molten state	(q) <i>n</i> -Type semiconductor
(C) Silicon with phosphorus	(r) Electrolytic conductors
(D) Germanium with boron	(s) Electronic conductors
(a) A – (q), B – (p), C – (r), D – (s)	
(b) A – (p), B – (q), C – (s), D – (r)	
(c) A – (s), B – (r), C – (q), D – (p)	
(d) A – (r), B – (s), C – (p), D – (q)	

132. Match the columns

Column-I (Molecule/ion)	Column-II (Magnetic property)
(A) $\text{C}_6\text{H}_6$	(p) Antiferromagnetic
(B) $\text{CrO}_2$	(q) Ferrimagnetic
(C) $\text{MnO}$	(r) Ferromagnetic
(D) $\text{Fe}_3\text{O}_4$	(s) Paramagnetic
(E) $\text{Fe}^{3+}$	(t) Diamagnetic
(a) A – (t), B – (r), C – (q), D – (p), E – (s)	
(b) A – (r), B – (t), C – (p), D – (s), E – (q)	
(c) A – (t), B – (r), C – (p), D – (q), E – (s)	
(d) A – (t), B – (r), C – (p), D – (s), E – (q)	

133. Match the columns

Column-I (Compound)	Column-II (Magnetic Property)
(A) NaCl	(p) Ferrimagnetic
(B) MnO	(q) Paramagnetic
(C) $\text{CrCl}_3$	(r) Ferromagnetic
(D) $\text{CrO}_2$	(s) Diamagnetic
(E) $\text{MgFe}_2\text{O}_4$	(t) Antiferromagnetic
(a) A – (p), B – (r), C – (q), D – (t), E – (s)	
(b) A – (t), B – (q), C – (r), D – (p), E – (s)	
(c) A – (r), B – (t), C – (q), D – (p), E – (s)	
(d) A – (s), B – (t), C – (q), D – (r), E – (p)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

134. **Assertion :** Crystalline solids have long range order.

**Reason :** Amorphous solids have short range order.

135. **Assertion:** Glass panes fixed to windows or panes of old buildings are found to be slightly thicker at the bottom.

**Reason:** Amorphous solids have a tendency to flow.

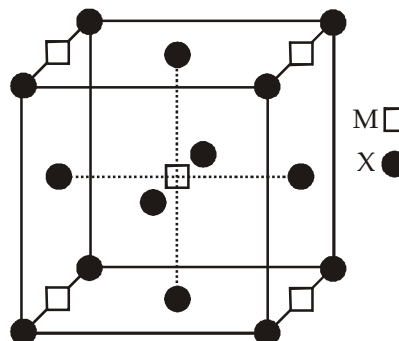
136. **Assertion :** In crystal lattice, the size of the tetrahedral hole is larger than an octahedral hole.

**Reason :** The cations occupy less space than anions in crystal packing.

- 137. Assertion :** In close packing of spheres, a tetrahedral void is surrounded by four spheres whereas an octahedral void is surrounded by six spheres.  
**Reason :** A tetrahedral void has a tetrahedral shape whereas an octahedral void has an octahedral shape.
- 138. Assertion :** The packing efficiency is maximum for the *fcc* structure.  
**Reason :** The coordination number is 12 in *fcc* structures.
- 139. Assertion :** In any ionic solid (MX) with Schottky defects, the number of positive and negative ions are same.  
**Reason :** Equal number of cation and anion vacancies are present.
- 140. Assertion :** Electrical conductivity of semiconductors increases with increasing temperature.  
**Reason :** With increase in temperature, large number of electrons from the valence band can jump to the conduction band.
- 141. Assertion :** On heating ferromagnetic or ferrimagnetic substances, they become paramagnetic.  
**Reason :** The electrons change their spin on heating.

## CRITICAL THINKING TYPE QUESTIONS

- 142.** Which of the following type of solid has high melting point and do not conduct electricity but its aqueous solution and melt conduct electricity ?  
 (a) Covalent (b) Ionic  
 (c) Molecular (d) Metallic
- 143.** A group 1 hydride crystal when heated in presence of its constituent metal vapour shows pink color. This metal can be  
 (a) Na (b) K  
 (c) Rb (d) Li
- 144.** A solid with high electrical and thermal conductivity is  
 (a) Si (b) Li  
 (c) NaCl (d) Ice
- 145.** Which of the following is true about the value of refractive index of quartz glass ?  
 (a) Same in all directions  
 (b) Different in different directions  
 (c) Cannot be measured  
 (d) Always zero
- 146.** Which of the following features are not shown by quartz glass ?  
 (i) This is a crystalline solid.  
 (ii) Refractive index is same in all the directions.  
 (iii) This has definite heat of fusion.  
 (iv) This is also called super cooled liquid.  
 (a) (i) and (iii) (b) (iii) and (iv)  
 (c) (i), (ii) and (iv) (d) (iii) only
- 147.** The number of carbon atoms per unit cell of diamond unit cell is :  
 (a) 8 (b) 6  
 (c) 1 (d) 4
- 148.** Na and Mg crystallize in *bcc* and *fcc* type crystals respectively, then the number of atoms of Na and Mg present in the unit cell of their respective crystal is  
 (a) 4 and 2 (b) 9 and 14  
 (c) 14 and 9 (d) 2 and 4
- 149.** In a cubic lattice A atom occupy all the corners. If B atom occupy one of the opposite face, and atom C occupy the remaining faces. The simplest formulae of the compound is  
 (a)  $ABC_3$  (b)  $ABC_2$   
 (c)  $ABC$  (d)  $AB_2C$
- 150.** A solid has a structure in which 'W' atoms are located at the corners of a cubic lattice 'O' atoms at the centre of edges and Na atoms at the centre of the cube. The formula for the compound is  
 (a)  $Na_2WO_3$  (b)  $Na_2WO_2$   
 (c)  $NaWO_2$  (d)  $NaWO_3$
- 151.** Potassium crystallizes with a  
 (a) body-centred cubic lattice  
 (b) face-centred cubic lattice  
 (c) simple cubic lattice  
 (d) orthorhombic lattice
- 152.** In a compound, atoms of element Y form *ccp* lattice and those of element X occupy  $2/3^{rd}$  of tetrahedral voids. The formula of the compound will be  
 (a)  $X_4Y_3$  (b)  $X_2Y_3$  (c)  $X_2Y$   
 (d)  $X_3Y_4$
- 153.** A compound  $M_pX_q$  has cubic close packing (ccp) arrangement of X. Its unit cell structure is shown below. The empirical formula of the compound is



- (a) MX (b)  $MX_2$   
 (c)  $M_2X$  (d)  $M_5X_{14}$
- 154.** A substance  $A_xB_y$  crystallizes in a face centred cubic (fcc) lattice in which atoms 'A' occupy each corner of the cube and atoms 'B' occupy the centres of each face of the cube. Identify the correct composition of the substance  $A_xB_y$   
 (a)  $AB_3$   
 (b)  $A_4B_3$   
 (c)  $A_3B$   
 (d) Composition can't be specified
- 155.** In which of the following structures coordination number for cations and anions in the packed structure will be same ?  
 (a)  $Cl^-$  ion form *fcc* lattice and  $Na^+$  ions occupy all octahedral voids of the unit cell.  
 (b)  $Ca^{2+}$  ions form *fcc* lattice and  $F^-$  ions occupy all the eight tetrahedral voids of the unit cell.  
 (c)  $O^{2-}$  ions form *fcc* lattice and  $Na^+$  ions occupy all the eight tetrahedral voids of the unit cell.  
 (d)  $S^{2-}$  ions form *fcc* lattice and  $Zn^{2+}$  ions go into alternate tetrahedral voids of the unit cell.

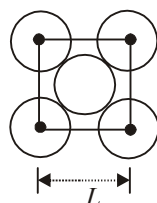
156. If 'a' stands for the edge length of the cubic systems : simple cubic, body centred cubic and face centred cubic, then the ratio of radii of the spheres in these systems will be respectively,

(a)  $\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$  (b)  $\frac{1}{2}a : \sqrt{3}a : \frac{1}{\sqrt{2}}a$   
 (c)  $\frac{1}{2}a : \frac{\sqrt{3}}{2}a : \frac{\sqrt{3}}{2}a$  (d)  $1a : \sqrt{3}a : \sqrt{2}a$

157. Packing efficiency by arrangement of atoms in two dimensional hexagonal close packing is

- (a) 60.43 (b) 65.78  
 (c) 59.78 (d) 68.76

158. The packing efficiency of the two-dimensional square unit cell shown below is :



- (a) 39.27% (b) 68.02%  
 (c) 74.05% (d) 78.54%

159. Edge length of unit cell is  $3.608 \times 10^{-8}$  cm, which crystallizes in fcc and is determined to have a density of  $8.92 \text{ g/cm}^3$ . The mass of four atoms is

- (a)  $4.18 \times 10^{-22}$  (b)  $1.67 \times 10^{-21}$   
 (c)  $2.09 \times 10^{-22}$  (d)  $8.37 \times 10^{-22}$

160. The edge length of unit cell of a metal having molecular weight 75 g/mol is  $5 \text{ \AA}$  which crystallizes in cubic lattice. If the density is  $2 \text{ g/cc}$  then find the radius of metal atom. ( $N_A = 6 \times 10^{23}$ ). Give the answer in pm.

- (a) 217 pm (b) 210 pm  
 (c) 220 pm (d) 205 pm

161. The number of atoms in 100 g of an fcc crystal with density,  $d = 10 \text{ g/cm}^3$  and cell edge equal to 100 pm, is equal to

- (a)  $1 \times 10^{25}$  (b)  $2 \times 10^{25}$   
 (c)  $3 \times 10^{25}$  (d)  $4 \times 10^{25}$

162. A metallic element exists as cubic lattice. Each edge of the unit cell is  $2.88 \text{ \AA}$ . The density of the metal is  $7.20 \text{ g cm}^{-3}$ . How many unit cell will be present in 100 g of the metal?

- (a)  $6.85 \times 10^2$  (b)  $5.82 \times 10^{23}$   
 (c)  $4.37 \times 10^5$  (d)  $2.12 \times 10^6$

163. A metal has a fcc lattice. The edge length of the unit cell is 404 pm. The density of the metal is  $2.72 \text{ g cm}^{-3}$ . The molar mass of the metal is :

( $N_A$  Avogadro's constant =  $6.02 \times 10^{23} \text{ mol}^{-1}$ )

- (a)  $30 \text{ g mol}^{-1}$  (b)  $27 \text{ g mol}^{-1}$   
 (c)  $20 \text{ g mol}^{-1}$  (d)  $40 \text{ g mol}^{-1}$

164. Al (at. wt 27) crystallizes in the cubic system with a cell edge of  $4.05 \text{ \AA}$ . Its density is  $2.7 \text{ g per cm}^3$ . Determine the unit cell type calculate the radius of the Al atom

- (a) fcc,  $2.432 \text{ \AA}$  (b) bcc,  $2.432 \text{ \AA}$   
 (c) bcc,  $1.432 \text{ \AA}$  (d) fcc,  $1.432 \text{ \AA}$

165. A compound is formed by elements A and B. The crystalline cubic structure has the A atoms at the corners of the cube and B atoms at the body centre. The simplest formula of the compound is

- (a) AB (b)  $A_6B$   
 (c)  $AB_6$  (d)  $A_8B_4$

166. What type of semiconductors respectively are formed when the group 14 are doped with the group 13 and group 15?

- (a) p,n (b) n,p  
 (c) p,p (d) n,n

167. Which of the following is ferroelectric compound?

- (a)  $\text{BaTiO}_3$  (b)  $\text{K}_4[\text{Fe}(\text{CN})_6]$   
 (c)  $\text{Pb}_2\text{O}_3$  (d) None of these

168. Substance which is weakly repelled by a magnetic field is

- (a)  $\text{O}_2$  (b)  $\text{H}_2\text{O}$   
 (c)  $\text{CrO}_2$  (d)  $\text{Fe}_3\text{O}_4$   
 (e)  $\text{ZnFe}_2\text{O}_4$

169. Which one of the following statements is correct?

- (a) NaCl is a paramagnetic salt  
 (b)  $\text{CuSO}_4$  is a diamagnetic salt  
 (c) MnO is an example of ferromagnetic substance  
 (d) Ferrimagnetic substance like  $\text{ZnFe}_2\text{O}_4$  becomes paramagnetic on heating

170. Which of the following is true about the charge acquired by p-type semiconductors ?

- (a) positive  
 (b) neutral  
 (c) negative  
 (d) depends on concentration of p impurity

171. Which of the following represents correct order of conductivity in solids ?

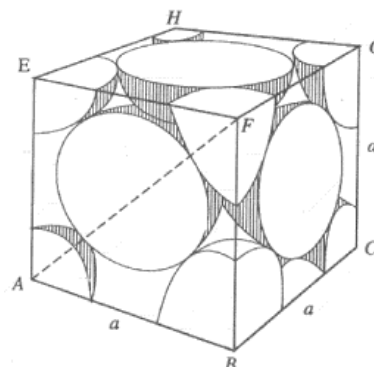
- (a)  $K_{\text{metals}} > K_{\text{insulators}} < K_{\text{semiconductors}}$   
 (b)  $K_{\text{metals}} < K_{\text{insulators}} < K_{\text{semiconductors}}$   
 (c)  $K_{\text{metals}} ; K_{\text{insulators}} > K_{\text{semiconductors}} = \text{zero}$   
 (d)  $K_{\text{metals}} < K_{\text{semiconductors}} > K_{\text{insulators}} \neq \text{zero}$

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (b) Intermolecular forces are strong in solids.
2. (d) Crystals show good cleavage because their constituent particles are arranged in planes.
3. (b) Crystalline solids are anisotropic in nature that is some of their physical properties like electrical resistance or refractive index show different values when measured along different directions in the same crystals.
4. (a) In crystalline solid there is perfect arrangement of the constituent particles only at 0 K. As the temperature increases the chance that a lattice site may be unoccupied by an ion increases. As the number of defects increases with temperature solid changes into liquid.
5. (b)
6. (c) Glass is amorphous solid.
7. (b) Amorphous solids are isotropic, because these substances show same properties in all directions.
8. (c) Glass is amorphous solid.
9. (b)      10. (d)      11. (b)
12. (b) On heating, amorphous solids become crystalline at some temperature. The milky appearance of glass is because of some crystallisation.
13. (c) Amorphous silicon is used as best photovoltaic material available for conversion of sunlight into electricity.
14. (c) Solid  $\text{CH}_4$  is a molecular solid. In this, the constituent molecules are held together by van der Waal's forces.
15. (a) Si is an example of covalent crystalline solid among the given choices. Si atoms are covalently linked in tetrahedral manner.
16. (a) Covalent as in case of diamond.
17. (b) Among the given crystals, only silicon exists as a covalent solid. It has diamond like structure.
18. (c) Covalent bond force
19. (b) In graphite, the electrons are spread out between the sheets.
20. (d)      21. (c)      22. (c)      23. (a)      24. (a)
25. (b)      26. (d)      27. (a)      28. (a)
29. (c) There are only 14 possible three dimensional lattice. These are called Bravais lattices.
30. (b)

31. (c)



An isolated fcc cell is shown here. Each face of the cell is common to two adjacent cells. Therefore, each face centre atom contributes only half of its volume and mass to one cell. Arranging six cells each sharing the remaining half of the face centred atoms, constitutes fcc cubic lattice. e.g., Cu and Al.

32. (b) For orthorhombic system  $\alpha = \beta = \gamma = 90^\circ$

33. (a) It is based on the definition of the cubic lattice.

34. (b) For tetragonal  $a = b \neq c$ ,  $\alpha = \beta = \gamma = 90^\circ$

35. (c) The no. of atoms in a unit cell may be calculated by the formula

$$Z = \frac{n_c}{8} + \frac{n_b}{1} + \frac{n_f}{2} + \frac{n_e}{4}$$

Where  $n_c$  = no. of atom at the corner

$n_b$  = no. of atoms at body centre

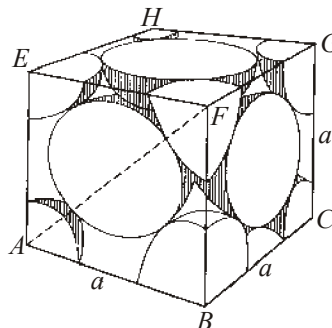
$n_f$  = no. of atoms at face centre

$n_e$  = no. of atoms at edge centre.

An fcc crystal contains

$$= \frac{8}{8} + \frac{6}{2} = 4 \text{ atoms in a unit cell.}$$

36. (c)



An isolated fcc cell is shown here. Each face of the cell is common to two adjacent cells. Therefore, each face centre atom contributes only half of its volume and mass to one cell. Arranging six cells each sharing the remaining half of the face centred atoms, constitutes fcc cubic lattice. e.g., Cu and Al.

37. (b) In bcc structure,  
no. of atoms at corner =  $(1/8) \times 8 = 1$   
no. of atoms at body centre = 1  
 $\therefore$  Total no. of atoms per unit cell =  $1 + 1 = 2$ .
38. (b) *hcp* is a closed packed arrangement in which the unit cell is hexagonal and coordination number is 12.
39. (c) ABAB..... is hexagonal close packing.
40. (b) In ZnS structure, sulphide ions occupy all *fcc* lattice points while  $\text{Zn}^{2+}$  ions are present in alternate tetrahedral voids.
41. (b) Metals such as copper and silver crystallise in *fcc* structure while metals Mg and Zn crystallise in *hcp* structure.
42. (d)
43. (a) Co-ordination number in *hcp* and *ccp* arrangement is 12.
44. (a) 45. (c)
46. (d) It represents *ccp* arrangement.
47. (b) 48. (c) 49. (d) 50. (b)
51. (c) *hcp* and *ccp* structures have maximum packing efficiency = 74%.  
For bcc = 68%  
For simple cubic = 52.4%
52. Total volume of atoms present in bcc unit cell is.  
(a)  $\frac{16}{3}\pi r^3$  (b)  $\frac{4}{3}\pi r^3$   
(c)  $\frac{8}{3}\pi r^3$  (d)  $\frac{12}{3}\pi r^3$
52. (c) For bcc structure total number of atoms = 2.  
 $\therefore$  Total volume =  $2 \times \frac{4}{3}\pi r^3$   
 $= \frac{8}{3}\pi r^3$
53. (b) The face centered cubic unit cell contains 4 atom  
 $\therefore$  Total volume of atoms =  $4 \times \frac{4}{3}\pi r^3 = \frac{16}{3}\pi r^3$
54. (c) As CsCl is body-centred,  $d = \sqrt{3}a/2$ .
55. (d) Number of atoms per unit cell = 1  
Atoms touch each other along edges. Hence  $r = \frac{a}{2}$   
( $r$  = radius of atom and  $a$  = edge length)  
Therefore % fraction =  $\frac{\frac{4}{3}\pi r^3}{(2r)^3} = \frac{\pi}{6}$
56. (b) Packing fraction is defined as the ratio of the volume of the unit cell that is occupied by the spheres to the total volume of the unit cell.  
P.F. for *ccp* and *bcc* are 0.74 and 0.68 respectively.  
So, the free space in *ccp* and *bcc* are 26% & 32% respectively.
57. (d) Packing fraction of bcc = 68%  
Empty space =  $100 - 68 = 32\%$
58. (c) The *hcp* arrangement of atoms occupies 74% of the available space and thus has 26% vacant space.
59. (b) In ABAB packing spheres occupy 74%. 26% is empty.
60. (d) In NaCl the  $\text{Cl}^-$  and  $\text{Na}^+$  touch along edge of cube the distance between ions is  $\frac{a}{2}$
61. (a)
62. (b) For body centred cubic lattice  $Z = 2$   
Atomic mass of unit cell =  $133 + 80 = 213$  a.m.u  
Volume of cell =  $(436.6 \times 10^{-10})^3 \text{ cm}^3$   
Density,  $\rho = \frac{ZM}{a^3 N_A} = \frac{2 \times 213}{(436.6 \times 10^{-10})^3 \times 6.02 \times 10^{23}} = 8.50 \text{ g/cm}^3$
63. (a) There are two atoms in a *bcc* unit cell.  
So, number of atoms in  $12.08 \times 10^{23}$  unit cells =  $2 \times 12.08 \times 10^{23} = 24.16 \times 10^{23}$  atoms.
64. (d) For *bcc*,  $d = \frac{\sqrt{3}}{2}a$  or  $a = \frac{2d}{\sqrt{3}} = \frac{2 \times 4.52}{1.732} = 5.219 \text{ \AA}$   
 $= 522 \text{ pm}$   
 $\rho = \frac{Z \times M}{a^3 \times N_A \times 10^{-30}} = \frac{2 \times 39}{(522)^3 \times (6.023 \times 10^{23}) \times 10^{-30}} = 0.91 \text{ g/cm}^3 = 910 \text{ kg m}^{-3}$
65. (b)  $\rho = \frac{ZM}{N_A V}$   
 $Z = \frac{\rho N_A V}{M} = \frac{8.92 \times 6.02 \times 10^{23} \times (362)^3 \times 10^{-30}}{63.55} = 4$   
 $\therefore$  It has *fcc* unit cell
66. (a) For *bcc* lattice body diagonal =  $a\sqrt{3}$ .  
The distance between the two oppositely charged ions =  $\frac{a}{2}\sqrt{3}$   
 $= \frac{387 \times 1.732}{2} = 335 \text{ pm}$
67. (a) For b.c.c.,  $Z = 2$ , Now,  $d = \frac{ZM}{NV}$  and  $V = a^3$   
 $\therefore d = \frac{2 \times 56}{(6.02 \times 10^{23}) \times (2.861 \times 10^{-8})^3} = 7.92 \text{ g ml}^{-1}$



68. (b) 
$$\rho = \frac{Z \times M}{N_A \times a^3} = \frac{2 \times 100}{6.023 \times 10^{23} \times (400 \times 10^{-10})^3}$$
  

$$= 5.188 \text{ g/cm}^3$$

69. (c) 
$$\frac{d_1}{d_2} = \frac{(a_2)^3}{(a_1)^3} \times \frac{z_1}{z_2} = \left(\frac{3}{3.5}\right)^3 \times \frac{4}{2} = 1.46$$

70. (d) Ionic solids must always maintain electrical neutrality. Ionic solids show vacancy or interstitial defects as Frenkel and Schottky defect.

71. (b)

72. (d) In KCl, co-ordination number of cation and anion is 6 and 6 respectively. KCl is highly ionic so Schottky defect is common.

**Note :** Schottky defect is common in compounds having high coordination number while Frenkel defect is common in compounds with low coordination number.

73. (a) Schottky defects are found in solid.

74. (d) When electrons are trapped in anion vacancies, these are called F-centre.



F- centre in crystal

75. (d) If in an ionic crystal of the type  $A^+ B^-$ , equal number of cations and anions are missing from their lattice sites so that the electrical neutrality is maintained. The defect is called Schottky defect.

76. (d) The appearance of colour in solid alkali metal halide is due to presence of F-centre found as defect in the crystal structure.

77. (b) When equal number of cations ( $Na^+$ ) and anions ( $Cl^-$ ) are missing from their regular lattice positions, we have Schottky defect.

78. (d) Schottky defect occurs in ionic crystals of type  $A^+ B^-$ , when equal number of cations and anions are missing from their lattice sites so that the electrical neutrality is maintained. This defect generally appears in highly ionic compounds which have high coordination number. NaCl, KCl and CsCl all have high coordination numbers i.e., 6, 6 and 8 respectively. So, Schottky defect appear in all of the given compounds.

79. (b) More is the Schottky defect in crystal more is the decrease in density.

80. (d) Frenkel defect does not lower the density of the crystal since the ions do not leave the crystal lattice.

81. (c) Frenkel and Schottky defects are crystal defects. It arises due to dislodgement of cation or anion from their places in the crystal lattice.

82. (c) The vacancy created due to missing of equal no. of atoms or ions from normal lattice point is called Schottky defect. In this type of defect electrical neutrality of ionic crystal is maintained.

83. (a) In stoichiometric Frenkel defects occurs in those compound which have

(i) Low C.N.

(ii) Large difference in size of cations and anions

84. (b) Transition metals exhibit this defect due to metal deficiency, the compound obtained are non stoichiometric e.g. It is difficult to prepare ferrous oxide with the ideal composition of FeO what we actually obtain is  $Fe_{0.95}O$  or  $Fe_xO$  with  $x = 0.93$  to  $0.96$

85. (c) AgBr exhibit Frenkel defect.

86. (c) KBr does not exhibit Frenkel defect.

87. (d) No change in density

88. (c) Frenkel defect is due to dislocation of ion from its usual lattice site to interstitial position.

89. (c) 90. (a)

91. (d) When insulators (non metal atoms) interact to form a solid, their atomic orbitals mix to form two bunch of orbitals, separated by a large band gap. Electrons cannot therefore be promoted to an empty level, where they could move freely.

92. (b) 93. (d) 94. (b) 95. (a) 96. (b)

97. (a)  $p$ -type of semiconductors are produced

(i) due to metal deficiency defects

(ii) by adding impurity containing less electrons (i.e., atoms of group 13)

Ge belongs to Group 14 and In to Group 13. Hence on doping,  $p$ -type semiconductor is obtained.

98. (d) The semiconductors formed by the introduction of impurity atoms containing one electron less than the parent atoms of insulators are termed as  $p$ -type semiconductors. Therefore silicon containing 14 electrons is to be doped with boron containing 13 electrons to give a  $p$ -type semi-conductor.

99. (d) For  $n$ -type, impurity added to silicon should have more than 4 valence electrons.

100. (b)  $n$ -type, since electron is set free.

101. (d) Extrinsic semiconductor

102. (c) Pure silicon doped with phosphorus is a  $n$ -type semiconductor, as  $n$ -type extrinsic semiconductor (Si) is made by doping the semiconductor with pentavalent element.

103. (a)  $MnO_2$

104. (c) Rhenium oxide  $ReO_3$  is like metallic copper in conductivity.

105. (d) 106. (a) 107. (b)

108. (d) Ferrimagnetism is observed when the magnetic moments of the domains in the substance are aligned in parallel and antiparallel directions in unequal numbers.

- 141. (a)** All magnetically ordered solids (ferromagnetic, ferrimagnetic and antiferromagnetic solids) transform to the paramagnetic state at high temperature due to the randomisation of spins.

## CRITICAL THINKING TYPE QUESTIONS

- 124. (c)**  $\text{CrO}_2$  is a ferromagnetic whereas  $\text{O}_2$  is paramagnetic.

Hence, formula =  $\text{NaWO}_3$

THE SOLID STATE

253

151. (a) Potassium crystallises in *bcc* lattice.

152. (a) From the given data, we have

Number of Y atoms in a unit cell = 4

Number of X atoms in a unit cell =  $8 \times \frac{2}{3} = \frac{16}{3}$

From the above we get the formula of the compound

as  $X_{16/3}Y_4$  or  $X_4Y_3$

153. (b) No. of M atoms =  $\frac{1}{4} \times 4 + 1 = 1 + 1 = 2$

No. of X atoms =  $\frac{1}{2} \times 6 + \frac{1}{8} \times 8 = 3 + 1 = 4$

So, formula =  $M_2X_4 = MX_2$

154. (a) Number of A atoms =  $\frac{1}{8} \times 8 = 1$

Number of B atoms =  $\frac{1}{2} \times 6 = 3$

$\therefore$  Formula  $AB_3$

155. (a)

156. (a) Following generalization can be easily derived for various types of lattice arrangements in cubic cells between the edge length ( $a$ ) of the cell and  $r$  the radius of the sphere.

For simple cubic :  $a = 2r$  or  $r = \frac{a}{2}$

For body centred cubic :

$a = \frac{4}{\sqrt{3}}r$  or  $r = \frac{\sqrt{3}}{4}a$

For face centred cubic :

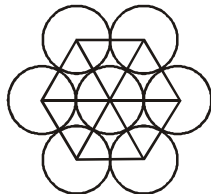
$a = 2\sqrt{2}r$  or  $r = \frac{1}{2\sqrt{2}}a$

Thus the ratio of radii of spheres for these will be simple : *bcc* : *fcc*

$= \frac{a}{2} : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$

i.e. option (a) is correct answer.

157. (a)



Let radius of the sphere =  $r$

Area occupied by sphere in hexagonal close packing

$$\pi r^2 + 6 \times \left( \frac{1}{6} \times \pi r^2 \right) = 2\pi r^2$$

$$\text{Area of hexagonal} = 6 \times \left[ \frac{\sqrt{3}}{4} \times (2r)^2 \right]$$

$$= 6 \times \frac{\sqrt{3}}{4} \times 4r^2$$

$$= 6\sqrt{3} \times r^2$$

$$\% \text{ occupied by} = \frac{2\pi r^2}{6 \times \sqrt{3} \times r^2} \times 100$$

$$= \frac{2 \times 3.14}{6 \times \sqrt{3}} \times 100 = 60.43\%$$

158. (d) Packing efficiency

$$= \frac{\text{Area occupied by circles within the square}}{\text{Area of square}}$$

$$= \frac{2\pi r^2}{L^2} \times 100 = \frac{2\pi r^2}{2(\sqrt{2}r)^2} \times 100 = \frac{\pi}{4} \times 100 = 78.54\%$$

159. (a) In fcc structure one unit cell consist 4 atoms, hence

density  $\times a^3 =$  The mass of four atoms

$$= 8.92 \times (3.608 \times 10^{-8})^3$$

$$= 4.18 \times 10^{-22}$$

160. (a)  $\rho = \frac{ZM}{N_A V}$

$$Z = \frac{\rho N_A V}{M} = \frac{2 \times 6 \times 10^{23} \times (5 \times 10^{-8})^3}{75}$$

$Z = 2$ , which represents *bcc* structure

$$\therefore r = \frac{\sqrt{3}}{4}a = \frac{\sqrt{3}}{4} \times 5 = 2.165 \text{ \AA} = 216.5 \text{ pm}$$

$$\approx 217 \text{ pm}$$

161. (d)  $M = \frac{\rho \times a^3 \times N_A \times 10^{-30}}{Z}$

$$= \frac{10 \times (100)^3 \times 6.02 \times 10^{23} \times 10^{-30}}{4} = 15.05$$

$$\therefore \text{Number of atoms in } 100 \text{ g} = \frac{6.02 \times 10^{23}}{15.05} \times 100$$

$$= 4 \times 10^{25}$$

162. (b) The volume of the unit cell

$$= (2.88 \text{ \AA})^3 = 23.9 \times 10^{-24} \text{ cm}^3$$

The volume of 100 g of the metal

$$= \frac{m}{\rho} = \frac{100}{7.20} = 13.9 \text{ cm}^3$$

Number of unit cells in this volume

$$= \frac{13.9 \text{ cm}^3}{23.9 \times 10^{-24} \text{ cm}^3} = 5.82 \times 10^{23}$$

**163. (b)** Density is given by

$$d = \frac{Z \times M}{N_A a^3}; \text{ where } Z = \text{number of formula units present}$$

in unit cell, which is 4 for *fcc*

*a* = edge length of unit cell. *M* = Molecular mass

$$2.72 = \frac{4 \times M}{6.02 \times 10^{23} \times (404 \times 10^{-10})^3} (\because 1 \text{ pm} = 10^{-10} \text{ cm})$$

$$M = \frac{2.72 \times 6.02 \times (404)^3}{4 \times 10^7} = 26.99 = 27 \text{ gm mole}^{-1}$$

**164. (d)**  $\rho = \frac{Z \times M}{N_0 \times a^3},$

$$2.7 = \frac{Z \times 27}{6.02 \times 10^{23} \times (4.05)^3 \times 10^{-24}} \quad \therefore Z = 4$$

Hence it is face centred cubic unit lattice.

$$\text{Again } 4r = a\sqrt{2} = 5.727 \text{ \AA}$$

$$\therefore r = 1.432 \text{ \AA}$$

**165. (a)** Given: Atoms are present in the corners of cube = A and atom present at body centre = B. We know that a cubic unit cell has 8 corners. Therefore contribution of

each atom at the corner =  $\frac{1}{8}$ . Since number of atoms per unit cell is 8, therefore total contribution =

$$8 \times \frac{1}{8} = 1. \text{ We also know that atoms in the body centre,}$$

therefore number of atoms per unit cell = 1. Thus formula of the compound is AB.

**166. (a)** In first case conduction is due to hole, while in second case it is due electron.

**167. (a)**  $\text{BaTiO}_3$

**168. (b)** Substances which are weakly repelled by external magnetic field are called diamagnetic substances, *e.g.*,  $\text{H}_2\text{O}$ .

**169. (d)** Ferrimagnetic substance become para-magnetic on heating. This is due to randomisation of spins on heating.

**170. (b)**      **171. (a)**



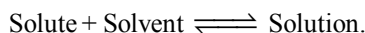
### FACT/DEFINITION TYPE QUESTIONS

- “The importance of many pure substance in life depends on their composition.”  
Which of the following statement justify the above fact?  
(a) 1 ppm of fluoride ions in water prevents tooth decay.  
(b) 1.5 ppm of fluoride ions causes tooth decay.  
(c) Concentration above 1.5 ppm can be poisonous.  
(d) All of the above.
- Which of the following fluoride is used as rat poison?  
(a)  $\text{CaF}_2$  (b)  $\text{KF}$   
(c)  $\text{NaF}$  (d)  $\text{MgF}_2$
- Most of the processes in our body occur in  
(a) solid solution (b) liquid solution  
(c) gaseous solution (d) colloidal solution
- The term homogenous mixtures signifies that  
(a) its composition is uniform throughout the mixture.  
(b) its properties are uniform throughout the mixture.  
(c) both composition and properties are uniform throughout the mixture.  
(d) neither composition nor properties are uniform throughout the mixture.
- Which of the following mixture is(are) called solution?  
(i) water + ammonia (ii) water + acetone  
(iii) acetone + alcohol (iv) hexane + water  
(a) (i), (ii) and (iii) (b) (i), (iii) and (iv)  
(c) (i) and (iv) (d) (ii) and (iii)
- Which of the following is a quantitative description of the solution?  
(a) Dilute (b) Concentrated  
(c) Saturated (d) Molar
- When a solute is present in trace quantities the following expression is used  
(a) Gram per million (b) Milligram percent  
(c) Microgram percent (d) Parts per million
- Molarity of liquid  $\text{HCl}$  will be, if density of solution is  $1.17 \text{ gm/cc}$   
(a) 36.5 (b) 32.05  
(c) 18.25 (d) 42.10
- 1 M, 2.5 litre  $\text{NaOH}$  solution is mixed with another 0.5 M, 3 litre  $\text{NaOH}$  solution. Then find out the molarity of resultant solution  
(a) 0.80 M (b) 1.0 M  
(c) 0.73 M (d) 0.50 M
- An  $X$  molal solution of a compound in benzene has mole fraction of solute equal to 0.2. The value of  $X$  is  
(a) 14 (b) 3.2  
(c) 1.4 (d) 2
- The molarity of the solution containing 7.1 g of  $\text{Na}_2\text{SO}_4$  in 100 ml of aqueous solution is  
(a) 2 M (b) 0.5 M  
(c) 1 M (d) 0.05 M
- The vapour pressure of pure benzene at  $25^\circ\text{C}$  is 640 mm Hg and that of solution of solute A is 630 mm Hg. The molality of solution is  
(a) 0.2m (b) 0.4m  
(c) 0.5m (d) 0.1m
- 4.0 g of  $\text{NaOH}$  is dissolved in 100 ml solution. The normality of the solution is  
(a) 0.1 N (b) 0.5 N  
(c) 4.0 N (d) 1.0 N
- The molarity of pure water is  
(a) 50 M (b) 18 M  
(c) 55.6 M (d) 100 M
- An aqueous solution of glucose is 10% in strength. The volume in which 1 g mole of it is dissolved, will be  
(a) 9 litre (b) 1.8 litre  
(c) 8 litre (d) 0.9 litre
- 10 g of  $\text{NaCl}$  is dissolved in  $10^6 \text{ g}$  of the solution. Its concentration is  
(a) 100 ppm (b) 0.1 ppm  
(c) 1 ppm (d) 10 ppm
- On adding a solute to a solvent having vapour pressure 0.80 atm, vapour pressure reduces to 0.60 atm. Mole fraction of solute is  
(a) 0.25 (b) 0.75  
(c) 0.50 (d) 0.33



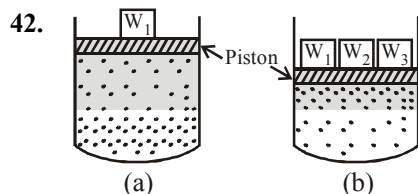
18. 2.5 litres of NaCl solution contain 5 moles of the solute. What is the molarity?  
(a) 5 molar (b) 2 molar  
(c) 2.5 molar (d) 12.5 molar
19. The mole fraction of the solute in one molal aqueous solution is  
(a) 0.009 (b) 0.018  
(c) 0.027 (d) 0.036
20. 5 ml of N HCl, 20 ml of N/2 H<sub>2</sub>SO<sub>4</sub> and 30 ml of N/3 HNO<sub>3</sub> are mixed together and volume made to one litre. The normality of the resulting solution is  
(a)  $\frac{N}{5}$  (b)  $\frac{N}{10}$   
(c)  $\frac{N}{20}$  (d)  $\frac{N}{40}$
21. 25ml of a solution of barium hydroxide on titration with a 0.1 molar solution of hydrochloric acid gave a titre value of 35 ml. The molarity of barium hydroxide solution was  
(a) 0.07 (b) 0.14  
(c) 0.28 (d) 0.35
22. Mole fraction of the solute in a 1.00 molal aqueous solution is  
(a) 0.1770 (b) 0.0177  
(c) 0.0344 (d) 1.7700
23. What is the normality of a 1 M solution of H<sub>3</sub>PO<sub>4</sub>?  
(a) 0.5 N (b) 1.0 N  
(c) 2.0 N (d) 3.0 N
24. The volume of 4 N HCl and 10 N HCl required to make 1 litre of 6 N HCl are  
(a) 0.75 litre of 10 N HCl and 0.25 litre of 4 N HCl  
(b) 0.50 litre of 4 N HCl and 0.50 litre of 10 N HCl  
(c) 0.67 litre of 4 N HCl and 0.33 litre of 10 N HCl  
(d) 0.80 litre of 4 N HCl and 0.20 litre of 10 N HCl
25. Molarity of H<sub>2</sub>SO<sub>4</sub> is 18 M. Its density is 1.8 g/ml. Hence molality is  
(a) 36 (b) 200  
(c) 500 (d) 18
26. 200 ml of water is added to 500 ml of 0.2 M solution. What is the molarity of this diluted solution?  
(a) 0.5010 M (b) 0.2897 M  
(c) 0.7093 M (d) 0.1428 M
27. How many grams of concentrated nitric acid solution should be used to prepare 250 mL of 2.0M HNO<sub>3</sub>? The concentrated acid is 70% HNO<sub>3</sub>  
(a) 90.0 g conc. HNO<sub>3</sub> (b) 70.0 g conc. HNO<sub>3</sub>  
(c) 54.0 g conc. HNO<sub>3</sub> (d) 45.0 g conc. HNO<sub>3</sub>
28. For preparing 0.1 N solution of a compound from its impure sample of which the percentage purity is known, the weight of the substance required will be  
(a) Less than the theoretical weight  
(b) More than the theoretical weight  
(c) Same as the theoretical weight  
(d) None of these
29. If  $\frac{N}{10}$  50 ml H<sub>2</sub>SO<sub>4</sub>,  $\frac{N}{3}$  30 ml HNO<sub>3</sub>,  $\frac{N}{2}$  10 ml HCl is mixed and solution is made to 1L. Then normality of resultant solution is  
(a)  $\frac{N}{20}$  (b)  $\frac{N}{40}$   
(c)  $\frac{N}{50}$  (d) N
30. A solution made by dissolving 40 g NaOH in 1000 g of water is  
(a) 1 molar (b) 1 normal  
(c) 1 molal (d) None of these
31. Which of the following concentration terms is/are independent of temperature?  
(a) Molality only  
(b) Molality and mole fraction  
(c) Molarity and mole fraction  
(d) Molality and normality
32. A solution is prepared by dissolving 10 g NaOH in 1250 mL of a solvent of density 0.8 mL/g. The molality of the solution in mol kg<sup>-1</sup> is  
(a) 0.25 (b) 0.2  
(c) 0.008 (d) 0.0064
33. Which of the following units is useful in relating concentration of solution with its vapour pressure?  
(a) mole fraction (b) parts per million  
(c) mass percentage (d) molality
34. For mixture containing "four" components which of the following is correct in term of mole fraction?  
(a)  $x_1 + x_2 + x_3 + x_4 \neq 1$   
(b)  $\frac{n_3}{n_1 + n_2 + n_3} = x_3$   
(c)  $x_1 = \frac{n_1}{n_1 + n_2 + n_3 + n_4} = \frac{n_1}{\Sigma n}$   
(d)  $n_1 + n_2 + n_3 + n_4 = 1$
35. Which of the following concentration unit is independent of temperature?  
(a) Normality (b) Molarity  
(c) Formality (d) Molality
36. Which of the following factor do not affect solubility of solid solute in liquid?  
(a) Temperature (b) Pressure  
(c) Nature of solute (d) All of these
37. When a solid solute is added to the solvent, some solute dissolves and its concentration increases in solution. This process is known as \_\_\_\_\_. Some solute particles in solution collide with the solid solute particles and get separated out of solution. This process is known as \_\_\_\_\_.  
(a) Crystallization, dissolution.  
(b) Dissolution, saturation.  
(c) Saturation, crystallization.  
(d) Dissolution, crystallization.

38. At the state of dynamic equilibrium, for solute + solvent  $\rightleftharpoons$  solution.
- Rate of dissolution = Rate of unsaturation.
  - Rate of dissolution = Rate of unsaturation.
  - Rate of dissolution = Rate of saturation
  - Rate of crystallization = Rate of saturation.
39. Which of the following statements is incorrect?
- A solution in which no more solute can be dissolved at the same temperature and pressure is called a saturated solution.
  - An unsaturated solution is one in which more solute can be dissolved at the same temperature.
  - The solution which is in dynamic equilibrium with undissolved solute is the saturated solution.
  - The minimum amount of solute dissolved in a given amount of solvent is its solubility.
40. On dissolving sugar in water at room temperature solution feels cool to touch. Under which of the following cases dissolution of sugar will be most rapid ?
- Sugar crystals in cold water.
  - Sugar crystals in hot water.
  - Powdered sugar in cold water.
  - Powdered sugar in hot water.
41. The solubility of a solid in a liquid is significantly affected by temperature changes.



The system being in a dynamic equilibrium must follow Le-chatelier's principle. Considering the Le-chatelier's principle which of the following is correct?

- $\Delta H_{\text{sol}} > 0$ ; solubility  $\uparrow$ ; temperature  $\downarrow$
- $\Delta H_{\text{sol}} < 0$ ; solubility  $\downarrow$ ; temperature  $\uparrow$
- $\Delta H_{\text{sol}} > 0$ ; solubility  $\downarrow$ ; temperature  $\uparrow$
- $\Delta H_{\text{sol}} < 0$ ; solubility  $\uparrow$ ; temperature  $\uparrow$

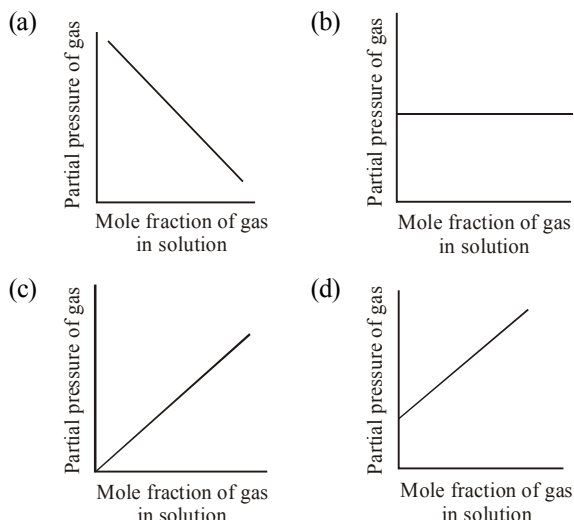


On the basis of the figure given above which of the following is not true?

- In figure (a) assuming the state of dynamic equilibrium rate of gaseous particles entering and leaving the solution phase is same.
- In figure (b) on compressing the gas number of gaseous particles per unit volume over the solution increases.
- Rate at which gaseous particles are striking the solution to enter it, decreases.
- Rate at which gaseous particles are striking the solution to enter it, increases.

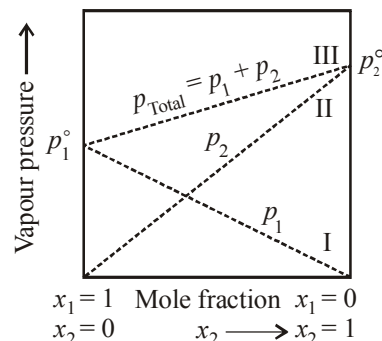
43. The statement "If 0.003 moles of a gas are dissolved in 900 g of water under a pressure of 1 atmosphere, 0.006 moles will be dissolved under a pressure of 2 atmospheres", illustrates
- Dalton's law of partial pressure
  - Graham's law
  - Raoult's law
  - Henry's law
44. According to Henry's law, the amount of gas that will dissolve in blood plasma or any other liquid is determined by which of these factor?
- Solubility of the gas in the liquid.
  - The total pressure of the gas mixture .
  - pH of the liquid.
  - The osmotic pressure of the gas mixture.
45. Henry's law constant of oxygen is  $1.4 \times 10^{-3} \text{ mol. lit}^{-1} \cdot \text{atm}^{-1}$  at 298 K. How much of oxygen is dissolved in 100 ml at 298 K when the partial pressure of oxygen is 0.5 atm?
- 1.4 g
  - 3.2 g
  - 22.4 mg
  - 2.24 mg
46. At equilibrium the rate of dissolution of a solid solute in a volatile liquid solvent is \_\_\_\_.
- less than the rate of crystallisation.
  - greater than the rate of crystallisation.
  - equal to the rate of crystallisation.
  - zero
47. A beaker contains a solution of substance 'A'. Precipitation of substance 'A' takes place when small amount of 'A' is added to the solution. The solution is \_\_\_\_.
- saturated
  - supersaturated
  - unsaturated
  - concentrated
48. Maximum amount of a solid solute that can be dissolved in a specified amount of a given liquid solvent does **not** depend upon \_\_\_\_.
- Temperature
  - Nature of solute
  - Pressure
  - Nature of solvent
49. Low concentration of oxygen in the blood and tissues of people living at high altitude is due to \_\_\_\_.
- low temperature
  - low atmospheric pressure
  - high atmospheric pressure
  - both low temperature and high atmospheric pressure
50. Value of Henry's constant  $K_H$  \_\_\_\_.
- increases with increase in temperature.
  - decreases with increase in temperature.
  - remains constant.
  - first increases then decreases.
51. The value of Henry's constant  $K_H$  is \_\_\_\_.
- greater for gases with higher solubility.
  - greater for gases with lower solubility.
  - constant for all gases.
  - not related to the solubility of gases.

52. Which of the following factor(s) affect the solubility of a gaseous solute in the fixed volume of liquid solvent ?  
 (i) Nature of solute (ii) Temperature (iii) Pressure  
 (a) (i) and (iii) at constant T  
 (b) (i) and (ii) at constant P  
 (c) (ii) and (iii) only  
 (d) (iii) only
53. Which of the following graph is a correct representation of Henry's law?



54. Which is an application of Henry's law?  
 (a) Spray paint (b) Bottled water  
 (c) Filling up a tire (d) Soft drinks (soda)
55. Scuba divers may experience a condition called \_\_\_\_\_. To avoid this, the tanks used by scuba divers are filled with air diluted with \_\_\_\_\_.  
 (a) Migrains, Hydrogen (b) Cramps, Nitrogen  
 (c) Nausea, Oxygen (d) Bends, Helium
56. People living at high altitudes often reported with a problem of feeling weak and inability to think clearly. The reason for this is.  
 (a) at high altitudes the partial pressure of oxygen is less than at the ground level.  
 (b) at high altitudes the partial pressure of oxygen is more than at the ground level.  
 (c) at high altitudes the partial pressure of oxygen is equal to at the ground level.  
 (d) None of these.
57. \_\_\_\_\_ a contemporary of Henry concluded independently that solubility of a gas in a liquid solution is a function of \_\_\_\_\_ of the gas.  
 (a) Mosley, temperature  
 (b) Dalton, temperature  
 (c) Dalton, partial pressure  
 (d) Mosley, partial pressure
58. Raoult's law becomes a special case of Henry's law when  
 (a)  $K_H = p_1^\circ$  (b)  $K_H > p_1^\circ$   
 (c)  $K_H < p_1^\circ$  (d)  $K_H \geq p_1^\circ$

59. Iodine and sulphur dissolve in  
 (a) water (b) benzene  
 (c) carbon disulphide (d) ethanol
60. The liquids at a given temperature vapourise and under equilibrium conditions the pressure exerted by the vapours of the liquid over the liquid phase is called  
 (a) osmotic pressure (b) atmospheric pressure  
 (c) hydrostatic pressure (d) vapour pressure
61. The vapour pressure of the solution at a given temperature is found to be ..... than the vapour pressure of the pure solvent at the same temperature.  
 (a) higher (b) lower  
 (c) equal (d) can't calculate
62. The decrease in the vapour pressure of solvent depends on the  
 (a) quantity of non-volatile solute present in the solution  
 (b) nature of non-volatile solute present in the solution  
 (c) molar mass of non-volatile solute present in the solution  
 (d) physical state of non-volatile solute present in the solution
63. A plot of  $p_1$  or  $p_2$  vs the mole fractions  $x_1$  and  $x_2$  is given as.



In this figure, lines I and II pass through the point for which.

- (a)  $x_1 \neq 1; x_2 = 1$  (b)  $x_1 = x_2 = 1$   
 (c)  $x_1 = 1; x_2 \neq 1$  (d)  $x_1 = x_2 = 1$
64. The vapour pressure of two liquids 'P' and 'Q' are 80 and 60 torr, respectively. The total vapour pressure of solution obtained by mixing 3 mole of P and 2 mole of Q would be  
 (a) 72 torr (b) 140 torr  
 (c) 68 torr (d) 20 torr
65. 18 g of glucose ( $C_6H_{12}O_6$ ) is added to 178.2 g of water. The vapour pressure of water for this aqueous solution is  
 (a) 76.00 torr (b) 752.40 torr  
 (c) 759.00 torr (d) 7.60 torr
66.  $P_A$  and  $P_B$  are the vapour pressure of pure liquid components, A and B, respectively of an ideal binary solution. If  $X_A$  represents the mole fraction of component A, the total pressure of the solution will be.  
 (a)  $P_A + X_A(P_B - P_A)$  (b)  $P_A + X_A(P_A - P_B)$   
 (c)  $P_B + X_A(P_B - P_A)$  (d)  $P_B + X_A(P_A - P_B)$

67. A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm Hg at 300 K. The vapour pressure of propyl alcohol is 200 mm Hg. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm Hg) at the same temperature will be  
(a) 360 (b) 350  
(c) 300 (d) 700
68. Two liquids  $X$  and  $Y$  form an ideal solution. At 300 K, vapour pressure of the solution containing 1 mol of  $X$  and 3 mol of  $Y$  is 550 mm Hg. At the same temperature, if 1 mol of  $Y$  is further added to this solution, vapour pressure of the solution increases by 10 mm Hg. Vapour pressure (in mm Hg) of  $X$  and  $Y$  in their pure states will be, respectively  
(a) 300 and 400 (b) 400 and 600  
(c) 500 and 600 (d) 200 and 300
69. The vapour pressure of two liquids  $X$  and  $Y$  are 80 and 60 torr respectively. The total vapour pressure of the ideal solution obtained by mixing 3 moles of  $X$  and 2 moles of  $Y$  would be  
(a) 68 Torr (b) 140 Torr  
(c) 48 Torr (d) 72 Torr
70. The vapour pressure of pure benzene and toluene at a particular temperature are 100 mm and 50 mm respectively. Then the mole fraction of benzene in vapour phase in contact with equimolar solution of benzene and toluene is  
(a) 0.67 (b) 0.75  
(c) 0.33 (d) 0.50
71. A solution containing components  $A$  and  $B$  follows Raoult's law when  
(a)  $A-B$  attraction force is greater than  $A-A$  and  $B-B$   
(b)  $A-B$  attraction force is less than  $A-A$  and  $B-B$   
(c)  $A-B$  attraction force remains same as  $A-A$  and  $B-B$   
(d) volume of solution is different from sum of volume of solute and solvent
72. Relation between partial pressure and mole fraction is stated by  
(a) Graham's law (b) Raoult's law  
(c) Le-Chatelier (d) Avogadro law
73. Which one of the following is not correct for an ideal solution?  
(a) It must obey Raoult's law  
(b)  $\Delta H = 0$   
(c)  $\Delta H = \Delta V \neq 0$   
(d) All are correct
74. An ideal solution is formed when its components  
(a) have no volume change on mixing  
(b) have no enthalpy change on mixing  
(c) Both (a) and (b) are correct  
(d) Neither (a) nor (b) is correct
75. All form ideal solution except  
(a)  $C_6H_6$  and  $C_6H_5CH_3$  (b)  $C_2H_6$  and  $C_2H_5I$   
(c)  $C_6H_5Cl$  and  $C_6H_5Br$  (d)  $C_2H_5I$  and  $C_2H_5OH$
76. Which one of the following is non-ideal solution  
(a) Benzene + toluene  
(b)  $n$ -hexane +  $n$ -heptane  
(c) Ethyl bromide + ethyl iodide  
(d)  $CCl_4 + CHCl_3$
77. Mixtures of ethanol and acetone show positive deviation. The reason is  
(a) In pure ethanol, molecules are hydrogen bonded.  
(b) In pure acetone, molecules are hydrogen bonded  
(c) In both molecules are hydrogen bonded  
(d) None of these
78. A mixture of components  $A$  and  $B$  will show  $-ve$  deviation when  
(a)  $\Delta V_{mix} > 0$   
(b)  $\Delta H_{mix} < 0$   
(c)  $A-B$  interaction is weaker than  $A-A$  and  $B-B$  interactions  
(d)  $A-B$  interaction is stronger than  $A-A$  and  $B-B$  interactions.
79. Which of the following liquid pairs shows a positive deviation from Raoult's law?  
(a) Water - Nitric acid  
(b) Benzene - Methanol  
(c) Water - Hydrochloric acid  
(d) Acetone - Chloroform
80. A solution of acetone in ethanol  
(a) shows a positive deviation from Raoult's law  
(b) behaves like a non ideal solution  
(c) obeys Raoult's law  
(d) shows a negative deviation from Raoult's law
81. Negative deviation from Raoult's law is observed in which one of the following binary liquid mixtures?  
(a) Ethanol and acetone  
(b) Benzene and toluene  
(c) Acetone and chloroform  
(d) Chloroethane and bromoethane
82. Which one of the following binary liquid systems shows positive deviation from Raoult's law?  
(a) Benzene-toluene  
(b) Carbon disulphide-acetone  
(c) Phenol-aniline  
(d) Chloroform-acetone
83. A binary liquid solution is prepared by mixing  $n$ -heptane and ethanol. Which one of the following statements is correct regarding the behaviour of the solution?  
(a) The solution is non-ideal, showing negative deviation from Raoult's Law.  
(b) The solution is non-ideal, showing positive deviation from Raoult's Law.  
(c)  $n$ -heptane shows positive deviation while ethanol shows negative deviation from Raoult's Law.  
(d) The solution formed is an ideal solution.
84. Which one is not equal to zero for an ideal solution:  
(a)  $\Delta S_{mix}$   
(b)  $\Delta V_{mix}$   
(c)  $\Delta P = P_{observed} - P_{Raoult}$   
(d)  $\Delta H_{mix}$



85. A mixture of two completely miscible non-ideal liquids which distill as such without change in its composition at a constant temperature as though it were a pure liquid. This mixture is known as  
(a) binary liquid mixture (b) azeotropic mixture  
(c) eutectic mixture (d) ideal mixture
86. The azeotropic mixture of water (b.p.  $100^{\circ}\text{C}$ ) and HCl (b.p.  $85^{\circ}\text{C}$ ) boils at  $108.5^{\circ}\text{C}$ . When this mixture is distilled it is possible to obtain  
(a) pure HCl  
(b) pure water  
(c) pure water as well as pure HCl  
(d) neither HCl nor  $\text{H}_2\text{O}$  in their pure states
87. The system that forms maximum boiling azeotrope is  
(a) carbondisulphide – acetone  
(b) benzene – toluene  
(c) acetone – chloroform  
(d) *n*-hexane – *n*-heptane
88. Which one of the following binary mixtures forms an azeotrope with minimum boiling point type?  
(a) acetone-ethanol (b)  $\text{H}_2\text{O}$ - $\text{HNO}_3$   
(c) benzene-toluene (d) *n*-hexane-*n*-heptane
89. On the basis of information given below mark the correct option.  
*Information:* On adding acetone to methanol some of the hydrogen bonds between methanol molecules break.  
(a) At specific composition methanol-acetone mixture will form boiling azeotrope and will show positive deviation from Raoult's law.  
(b) At specific composition methanol-acetone mixture forms boiling azeotrope and will show positive deviation from Raoult's law.  
(c) At specific composition methanol-acetone mixture will form minimum boiling azeotrope and will show negative deviation from Raoult's law.  
(d) At specific composition methanol-acetone mixture will form boiling azeotrope and will show negative deviation from Raoult's law.
90. According to Raoult's law, relative lowering of vapour pressure for a solution is equal to  
(a) moles of solute (b) moles of solvent  
(c) mole fraction of solute (d) mole fraction of solvent
91. The relative lowering of the vapour pressure is equal to the ratio between the number of  
(a) solute molecules to the solvent molecules  
(b) solute molecules to the total molecules in the solution  
(c) solvent molecules to the total molecules in the solution  
(d) solvent molecules to the total number of ions of the solute.
92. Vapour pressure of benzene at  $30^{\circ}\text{C}$  is 121.8 mm Hg. When 15 g of a non volatile solute is dissolved in 250 g of benzene its vapour pressure decreased to 120.2 mm Hg. The molecular weight of the solute (Mo. wt. of solvent = 78)  
(a) 356.2 (b) 456.8  
(c) 530.1 (d) 656.7
93. The value of  $P^{\circ}$  for benzene is 640 mm of Hg. The vapour pressure of solution containing 2.5gm substance in 39gm. benzene is 600mm of Hg the molecular mass of X is  
(a) 65.25 (b) 130  
(c) 40 (d) 75
94. The vapour pressure at a given temperature of an ideal solution containing 0.2 mol of a non-volatile solute and 0.8 mol of solvent is 60 mm of Hg. The vapour pressure of the pure solvent at the same temperature is  
(a) 150 mm of Hg (b) 60 mm of Hg  
(c) 75 mm of Hg (d) 120 mm of Hg
95. 12 g of a nonvolatile solute dissolved in 108 g of water produces the relative lowering of vapour pressure of 0.1. The molecular mass of the solute is  
(a) 80 (b) 60  
(c) 20 (d) 40
96. The amount of solute (molar mass  $60 \text{ g. mol}^{-1}$ ) that must be added to 180 g of water so that the vapour pressure of water is lowered by 10% is  
(a) 30 g (b) 60 g  
(c) 120 g (d) 12 g
97. The vapour pressure of water at  $20^{\circ}\text{C}$  is 17.5 mm Hg. If 18 g of glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ ) is added to 178.2 g of water at  $20^{\circ}\text{C}$ , the vapour pressure of the resulting solution will be  
(a) 17.325 mm Hg (b) 15.750 mm Hg  
(c) 16.500 mm Hg (d) 17.500 mm Hg
98. Which one of the following is a colligative property ?  
(a) Boiling point (b) Vapour pressure  
(c) Osmotic pressure (d) Freezing point
99. Which one of the following aqueous solutions will exhibit highest boiling point ?  
(a) 0.015 M urea (b) 0.01 M  $\text{KNO}_3$   
(c) 0.01 M  $\text{Na}_2\text{SO}_4$  (d) 0.015 M glucose
100. The rise in the boiling point of a solution containing 1.8 g of glucose in 100 g of solvent is  $0.1^{\circ}\text{C}$ . The molal elevation constant of the liquid is  
(a) 0.01 K/m (b) 0.1 K/m  
(c) 1 K/m (d) 10 K/m
101. For an electrolyte, elevation of B.P. is directly proportional to  
(a) molarity (b) molality  
(c) mole fraction (d) All of these
102. Which of the following aqueous solution has minimum freezing point ?  
(a) 0.01 m NaCl (b) 0.005 m  $\text{C}_2\text{H}_5\text{OH}$   
(c) 0.005 m  $\text{MgI}_2$  (d) 0.005 m  $\text{MgSO}_4$ .
103. 1.00 g of a non-electrolyte solute (molar mass  $250 \text{ g mol}^{-1}$ ) was dissolved in 51.2 g of benzene. If the freezing point depression constant,  $K_f$  of benzene is  $5.12 \text{ K kg mol}^{-1}$ , the freezing point of benzene will be lowered by  
(a) 0.3 K (b) 0.5 K  
(c) 0.4 K (d) 0.2
104. In a 0.2 molal aqueous solution of a weak acid HX the degree of ionization is 0.3. Taking  $k_f$  for water as 1.85, the freezing point of the solution will be nearest to  
(a)  $-0.360^{\circ}\text{C}$  (b)  $-0.260^{\circ}\text{C}$   
(c)  $+0.481^{\circ}\text{C}$  (d)  $-0.481^{\circ}\text{C}$



- 105.** The molecular weight of benzoic acid in benzene as determined by depression in freezing point method corresponds to  
 (a) ionization of benzoic acid.  
 (b) dimerization of benzoic acid.  
 (c) trimerization of benzoic acid.  
 (d) solvation of benzoic acid.
- 106.** A 0.5 molal solution of ethylene glycol in water is used as coolant in a car. If the freezing point constant of water be  $1.86^{\circ}\text{C}$  per mole, the mixture shall freeze at  
 (a)  $0.93^{\circ}\text{C}$  (b)  $-0.93^{\circ}\text{C}$   
 (c)  $1.86^{\circ}\text{C}$  (d)  $-1.86^{\circ}\text{C}$
- 107.** A solution of urea (mol. mass  $56\text{ g mol}^{-1}$ ) boils at  $100.18^{\circ}\text{C}$  at the atmospheric pressure. If  $K_f$  and  $K_b$  for water are  $1.86$  and  $0.512\text{ K kg mol}^{-1}$  respectively, the above solution will freeze at  
 (a)  $0.654^{\circ}\text{C}$  (b)  $-0.654^{\circ}\text{C}$   
 (c)  $6.54^{\circ}\text{C}$  (d)  $-6.54^{\circ}\text{C}$
- 108.** The freezing point of 1% solution of lead nitrate in water will be  
 (a)  $2^{\circ}\text{C}$  (b)  $1^{\circ}\text{C}$   
 (c)  $0^{\circ}\text{C}$  (d) below  $0^{\circ}\text{C}$
- 109.** A solution of sucrose (molar mass =  $342\text{ g mol}^{-1}$ ) has been prepared by dissolving  $68.5\text{ g}$  of sucrose in  $1000\text{ g}$  of water. The freezing point of the solution obtained will be ( $K_f$  for water =  $1.86\text{ K kg mol}^{-1}$ ).  
 (a)  $-0.372^{\circ}\text{C}$  (b)  $-0.520^{\circ}\text{C}$   
 (d)  $+0.372^{\circ}\text{C}$  (c)  $-0.570^{\circ}\text{C}$
- 110.** A solution containing  $1.8\text{ g}$  of a compound (empirical formula  $\text{CH}_2\text{O}$ ) in  $40\text{ g}$  of water is observed to freeze at  $-0.465^{\circ}\text{C}$ . The molecular formula of the compound is ( $K_f$  of water =  $1.86\text{ K kg mol}^{-1}$ )  
 (a)  $\text{C}_2\text{H}_4\text{O}_2$  (b)  $\text{C}_3\text{H}_6\text{O}_3$   
 (c)  $\text{C}_4\text{H}_8\text{O}_4$  (d)  $\text{C}_6\text{H}_{12}\text{O}_6$
- 111.** Blood cells retain their normal shape in solution which are  
 (a) hypotonic to blood (b) isotonic to blood  
 (c) hypertonic to blood (d) equinormal to blood.
- 112.** Isotonic solutions have same  
 (a) molar concentration (b) molality  
 (c) normality (d) None of these
- 113.** As a result of osmosis, the volume of more concentrated solution  
 (a) gradually decreases (b) gradually increases  
 (c) is not affected (d) suddenly increases
- 114.** Which of the following pairs of solution are isotonic at the same temperature ?  
 (a)  $0.1\text{ M Ca}(\text{NO}_3)_2$  and  $0.1\text{ M Na}_2\text{SO}_4$   
 (b)  $0.1\text{ M NaCl}$  and  $0.1\text{ M Na}_2\text{SO}_4$   
 (c)  $0.1\text{ M urea}$  and  $0.1\text{ M MgCl}_2$   
 (d)  $0.2\text{ M urea}$  and  $0.1\text{ M NaCl}$
- 115.** Osmotic pressure of  $0.4\%$  urea solution is  $1.64\text{ atm}$  and that of  $3.42\%$  cane sugar is  $2.46\text{ atm}$ . When the above two solutions are mixed, the osmotic pressure of the resulting solution is :  
 (a)  $0.82\text{ atm}$  (b)  $2.46\text{ atm}$   
 (c)  $1.64\text{ atm}$  (d)  $4.10\text{ atm}$
- 116.** Osmotic pressure of a solution at a given temperature  
 (a) increases with concentration  
 (b) decreases with concentration  
 (c) remains same  
 (d) initially increases and then decreases
- 117.** At  $25^{\circ}\text{C}$ , at  $5\%$  aqueous solution of glucose (molecular weight =  $180\text{ g mol}^{-1}$ ) is isotonic with a  $2\%$  aqueous solution containing an unknown solute. What is the molecular weight of the unknown solute?  
 (a) 60 (b) 80  
 (c) 72 (d) 63
- 118.** Which one of the following statements is false?  
 (a) Raoult's law states that the vapour pressure of a component over a binary solution of volatile liquids is directly proportional to its mole fraction  
 (b) Two sucrose solutions of the same molality prepared in different solvents will have the same depression of freezing point  
 (c) The correct order of osmotic pressures of  $0.01\text{ M}$  solution of each compound is  $\text{BaCl}_2 > \text{KCl} > \text{CH}_3\text{COOH} > \text{glucose}$   
 (d) In the equation osmotic pressure  $\pi = MRT$ ,  $M$  is the molarity of the solution
- 119.** Which of the following statements is false?  
 (a) Units of atmospheric pressure and osmotic pressure are the same.  
 (b) In reverse osmosis, solvent molecules move through a semipermeable membrane from a region of lower concentration of solute to a region of higher concentration.  
 (c) The value of molal depression constant depends on nature of solvent.  
 (d) Relative lowering of vapour pressure, is a dimensionless quantity.
- 120.** During osmosis, flow of water through a semipermeable membrane is  
 (a) from both sides of semipermeable membrane with equal flow rates  
 (b) from both sides of semipermeable membrane with unequal flow rates  
 (c) from solution having lower concentration only  
 (d) from solution having higher concentration only
- 121.** If  $0.1\text{ M}$  solution of glucose and  $0.1\text{ M}$  solution of urea are placed on two sides of the semipermeable membrane to equal heights, then it will be correct to say that  
 (a) there will be no net movement across the membrane  
 (b) glucose will flow towards urea solution  
 (c) urea will flow towards glucose solution  
 (d) water will flow from urea solution to glucose
- 122.** The van't Hoff factor  $i$  for a compound which undergoes dissociation in one solvent and association in other solvent is respectively  
 (a) less than one and greater than one.  
 (b) less than one and less than one.  
 (c) greater than one and less than one.  
 (d) greater than one and greater than one.

123. If the various terms in the given below expressions have usual meanings, the van't Hoff factor ( $i$ ) cannot be calculated by which one of the following expressions
- $\pi V = \sqrt{inRT}$
  - $\Delta T_f = iK_f \cdot m$
  - $\Delta T_b = iK_b \cdot m$
  - $\frac{P_{\text{solvent}}^\circ - P_{\text{solution}}}{P_{\text{solvent}}^\circ} = i \left( \frac{n}{N+n} \right)$
124. Van't Hoff factor is given by the expression \_\_\_\_\_.
- $i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$
  - $i = \frac{\text{Abnormal molar mass}}{\text{Normal molar mass}}$
  - $i = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$
  - Both (a) and (c)
125. We have three aqueous solutions of NaCl labelled as 'A', 'B' and 'C' with concentrations 0.1M, 0.01M and 0.001M, respectively. The value of van't Hoff factor for these solutions will be in the order \_\_\_\_\_.
- $i_A < i_B < i_C$
  - $i_A > i_B > i_C$
  - $i_A = i_B = i_C$
  - $i_A < i_B > i_C$
126. If  $\alpha$  is the degree of dissociation of  $\text{Na}_2\text{SO}_4$ , the Vant Hoff's factor ( $i$ ) used for calculating the molecular mass is
- $1 + \alpha$
  - $1 - \alpha$
  - $1 + 2\alpha$
  - $1 - 2\alpha$
127. The freezing point of equimolal aqueous solutions will be highest for
- $\text{C}_6\text{H}_5\text{NH}_3^+\text{Cl}^-$  (aniline hydrochloride)
  - $\text{Ca}(\text{NO}_3)_2$
  - $\text{La}(\text{NO}_3)_3$
  - $\text{C}_6\text{H}_{12}\text{O}_6$  (glucose)
128. The correct relationship between the boiling points of very dilute solutions of  $\text{AlCl}_3$  ( $t_1$ ) and  $\text{CaCl}_2$  ( $t_2$ ), having the same molar concentration is
- $t_1 = t_2$
  - $t_1 > t_2$
  - $t_2 > t_1$
  - $t_2 \geq t_1$
129. At  $25^\circ\text{C}$ , the highest osmotic pressure is exhibited by 0.1 M solution of
- $\text{CaCl}_2$
  - KCl
  - glucose
  - urea
130. Which one of the following salts will have the same value of van't Hoff factor ( $i$ ) as that of  $\text{K}_4[\text{Fe}(\text{CN})_6]$ .
- $\text{Al}_2(\text{SO}_4)_3$
  - NaCl
  - $\text{Al}(\text{NO}_3)_3$
  - $\text{Na}_2\text{SO}_4$
131. Which of the following 0.10 m aqueous solutions will have the lowest freezing point ?
- $\text{Al}_2(\text{SO}_4)_3$
  - $\text{C}_6\text{H}_{12}\text{O}_6$
  - KCl
  - $\text{C}_{12}\text{H}_{22}\text{O}_{11}$
132. The elevation in boiling point of a solution of 13.44 g of  $\text{CuCl}_2$  in 1 kg of water using the following information will be (Molecular weight of  $\text{CuCl}_2 = 134.4$  g and  $K_b = 0.52$  K kg mol $^{-1}$ )
- 0.16
  - 0.05
  - 0.1
  - 0.2
133. Freezing point of an aqueous solution is  $-0.186^\circ\text{C}$ . If the values of  $K_b$  and  $K_f$  of water are respectively 0.52 K kg mol $^{-1}$  and 1.86 K kg mol $^{-1}$ , then the elevation of boiling point of the solution in K is
- 0.52
  - 1.04
  - 1.34
  - 0.052

### STATEMENT TYPE QUESTIONS

134. Study the given statements and choose the correct option.
- 3.62 mass percentage of sodium hypochlorite in water is used as commercial bleaching solution.
  - 35% volume percentage of ethylene glycol is used as an antifreeze (as coolant in car engines).
  - Concentration of dissolved oxygen in a litre of sea water is 5.8 ppm.
- Statements (i) and (ii) are correct
  - Statements (i) and (iii) are correct
  - Statements (ii) and (iii) are correct
  - Statements (i), (ii) and (iii) are correct
135. Molarity and molality of a solution of NaOH is calculated. If now temperature of the solution is increased then which of the following statement(s) is/are correct ?
- Molarity of solution decreases
  - Molality of the solution increases
- Both statements are correct
  - Statement (i) is correct only
  - Statement (ii) is correct only
  - Both statements are incorrect.
136. "If temperature increases solubility of gas decreases". For this situation which of the following statement(s) is/are correct ?
- Reaction is endothermic
  - Le-chatelier's principle can be applied
- Statement (i) and (ii) both are correct
  - Statement (i) is correct only
  - Statement (ii) is correct only
  - Both statement(s) (i) and (ii) are incorrect
137. Read the following statements carefully and choose the correct option.
- Different gases have different  $K_H$  values at the same temperature.
  - Higher the value of  $K_H$  at a given temperature, lower is the solubility of the nature of gas in the liquid.
  - $K_H$  is a function of the nature of the gas.
  - Solubility of gases increases with increase of temperature.
- (i), (ii) and (iv) are correct.
  - (ii) and (iv) are correct.
  - (i), (ii) and (iii) are correct.
  - (i) and (iv) are correct.

138. Read the following statements and choose the correct option.

- (i) Polar solutes dissolve in a polar solvent.
- (ii) Polar solutes dissolve in a non-polar solvent.
- (iii) Non-polar solutes dissolve in a non-polar solvent.
- (iv) Non-polar solutes dissolve in a polar solvent.
- (a) (i) and (ii) are correct.
- (b) (i), (ii) and (iii) are correct.
- (c) (i) and (iii) are correct.
- (d) (ii) and (iv) are correct.

139. Read the following statements carefully and choose the correct option

- (i) The vapour pressure of a liquid decreases with increase of temperature.
- (ii) The liquid boils at the temperature at which its vapour pressure is equal to the atmospheric pressure.
- (iii) Vapour pressure of the solvent decreases in the presence of non-volatile solute.
- (iv) Vapour pressure of the pure solvent and solution is a function of temperature.
- (a) (i), (ii) and (iv) are correct
- (b) (i), (iii), and (iv) are correct
- (c) (ii), (iii), and (iv) are correct
- (d) (i), (ii) and (iii) are correct

140. On the basis of information given below mark the correct option.

- (i) In bromoethane and chloroethane mixture intermolecular interactions of A-A and B-B type are nearly same as A-B type interactions.
- (ii) In ethanol and acetone mixture A-A or B-B type intermolecular interactions are stronger than A-B type interactions.
- (iii) In chloroform and acetone mixture A-A or B-B type intermolecular interactions are weaker than A-B type interactions.
- (a) Solution (ii) and (iii) will follow Raoult's law.
- (b) Solution (i) will follow Raoult's law.
- (c) Solution (ii) will show negative deviation from Raoult's law.
- (d) Solution (iii) will show positive deviation from Raoult's law.

141. Which observation(s) reflect(s) colligative properties?

- (i) A 0.5 m NaBr solution has a higher vapour pressure than a 0.5 m BaCl<sub>2</sub> solution at the same temperature
- (ii) Pure water freezes at the higher temperature than pure methanol
- (iii) a 0.1 m NaOH solution freezes at a lower temperature than pure water

Choose the correct answer from the codes given below

- (a) (i), (ii) and (iii)
- (b) (i) and (ii)
- (c) (ii) and (iii)
- (d) (i) and (iii)

142. Read the following statements carefully and choose the correct option

- (i) Osmotic pressure is not a colligative property.
- (ii) For dilute solutions, osmotic pressure is proportional to the molarity, C of the solution at a given temperature T.
- (iii) During osmosis, solvent molecules always flow from higher concentration to lower concentration of solution.
- (iv) The osmotic pressure has been found to depend on the concentration of the solution
- (a) (i), (ii) and (iv) are correct
- (b) (ii) and (iv) are correct
- (c) (iii), and (iv) are correct
- (d) (i), (ii) and (iii) are correct

### MATCHING TYPE QUESTIONS

143. Match the columns

Column-I	Column-II
(A) Mass percentage	(p) Medicine and pharmacy
(B) Mass by volume	(q) Concentration of pollutants in water
(C) ppm	(r) Industrial chemical application
(D) Volume percentage	(s) Liquid solutions
(a) A – (q), B – (p), C – (s), D – (r)	
(b) A – (s), B – (r), C – (p), D – (q)	
(c) A – (r), B – (q), C – (s), D – (p)	
(d) A – (r), B – (p), C – (q), D – (s)	

144. Match the columns

Column-I	Column-II
(A) Na-Hg Amalgam	(p) gas - solid
(B) H <sub>2</sub> in Pd	(q) gas - liquid
(C) Camphor in nitrogen gas	(r) liquid - solid
(D) Oxygen dissolved in water	(s) solid - gas
(a) A – (q), B – (s), C – (r), D – (p)	
(b) A – (t), B – (p), C – (q), D – (s)	
(c) A – (r), B – (p), C – (s), D – (q)	
(d) A – (s), B – (q), C – (p), D – (p)	

145. Match the Column I, II & III and choose the correct option.

Column-I	Column-II	Column-III
(A) Gaseous solutions	(p) Solid-liquid	(h) Copper dissolved in gold
(B) Liquid solutions	(q) Solid-solid	(i) Chloroform mixed with nitrogen
(C) Solid solutions	(r) Liquid-gas	(j) Common salt dissolved in water
(a) (A) – (r) – (h), (B) – (r) – (i), (C) – (p) – (j)		
(b) (A) – (r) – (i), (B) – (p) – (j), (C) – (q) – (h)		
(c) (A) – (r) – (j), (B) – (p) – (h), (C) – (q) – (i)		
(d) (A) – (r) – (j), (B) – (q) – (i), (C) – (p) – (h)		

146. Match the columns

Column-I	Column-II
(A) Saturated solution	(p) Solution having same osmotic pressure at a given temperature as that of given solution.
(B) Binary solution	(q) A solution whose osmotic pressure is less than that of another.
(C) Isotonic solution	(r) Solution with two components
(D) Hypotonic solution	(s) A solution which contains maximum amount of solute that can be dissolved in a given amount of solvent at a given temperature.

- (a) A – (s), B – (r), C – (p), D – (q)  
 (b) A – (r), B – (p), C – (s), D – (q)  
 (c) A – (r), B – (s), C – (q), D – (p)  
 (d) A – (q), B – (p), C – (r), D – (s)

147. Match the laws given in the Column-I with expression given in Column-II.

Column-I	Column-II
(A) Raoult's law	(p) $\Delta T_f = K_f m$
(B) Henry's law	(q) $\pi = CRT$
(C) Elevation of boiling point	(r) $p = x_1 p_1^0 + x_2 p_2^0$
(D) Depression in freezing point	(s) $\Delta T_b = K_b m$
(E) Osmotic pressure	(t) $p = K_H \cdot x$
(a) A – (r), B – (t), C – (s), D – (p), E – (q)	
(b) A – (t), B – (r), C – (q), D – (s), E – (p)	
(c) A – (p), B – (t), C – (r), D – (q), E – (s)	
(d) A – (s), B – (p), C – (q), D – (r), E – (t)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

148. **Assertion :** Molarity of a solution in liquid state changes with temperature.

**Reason :** The volume of a solution changes with change in temperature.

149. **Assertion :** If a liquid solute more volatile than the solvent is added to the solvent, the vapour pressure of the solution may increase i.e.,  $p_s > p^0$ .

**Reason :** In the presence of a more volatile liquid solute, only the solute will form the vapours and solvent will not.

150. **Assertion :** If one component of a solution obeys Raoult's law over a certain range of composition, the other component will not obey Henry's law in that range.

**Reason :** Raoult's law is a special case of Henry's law.

151. **Assertion :** Azeotropic mixtures are formed only by non-ideal solutions and they may have boiling points either greater than both the components or less than both the components.

**Reason :** The composition of the vapour phase is same as that of the liquid phase of an azeotropic mixture.

152. **Assertion :** When methyl alcohol is added to water, boiling point of water increases.

**Reason :** When a volatile solute is added to a volatile solvent elevation in boiling point is observed.

153. **Assertion :** When NaCl is added to water a depression in freezing point is observed.

**Reason :** The lowering of vapour pressure of a solution causes depression in the freezing point.

154. **Assertion :** When a solution is separated from the pure solvent by a semi-permeable membrane, the solvent molecules pass through it from pure solvent side to the solution side

**Reason :** Diffusion of solvent occurs from a region of high concentration solution to a region of low concentration solution.

### CRITICAL THINKING TYPE QUESTIONS

155. The normality of orthophosphoric acid having purity of 70 % by weight and specific gravity 1.54 is

- (a) 11 N (b) 22 N  
 (c) 33 N (d) 44 N

156. Which of the following statements, regarding the mole fraction ( $x$ ) of a component in solution, is incorrect?

- (a)  $0 \leq x \leq 1$   
 (b)  $x \leq 1$   
 (c)  $x$  is always non-negative  
 (d) None of these

157. Which one of the following gases has the lowest value of Henry's law constant?

- (a)  $N_2$  (b) He  
 (c)  $H_2$  (d)  $CO_2$

158. Equal masses of methane and oxygen are mixed in an empty container at 25°C. The fraction of the total pressure exerted by oxygen is

- (a) 1/2 (b) 2/3  
 (c)  $\frac{1}{3} \times \frac{273}{298}$  (d) 1/3

159. When a gas is bubbled through water at 298 K, a very dilute solution of the gas is obtained. Henry's law constant for the gas at 298 K is 100 kbar. If the gas exerts a partial pressure of 1 bar, the number of millimoles of the gas dissolved in one litre of water is

- (a) 0.555 (b) 5.55  
 (c) 0.0555 (d) 55.5

160.  $K_H$  value for Ar(g),  $CO_2$ (g), HCHO (g) and  $CH_4$ (g) are 40.39, 1.67,  $1.83 \times 10^{-5}$  and 0.413 respectively.

Arrange these gases in the order of their increasing solubility.

- (a)  $HCHO < CH_4 < CO_2 < Ar$   
 (b)  $HCHO < CO_2 < CH_4 < Ar$   
 (c)  $Ar < CO_2 < CH_4 < HCHO$   
 (d)  $Ar < CH_4 < CO_2 < HCHO$



161. What is the ratio of no. of moles of nitrogen to that of oxygen in a container of 5 litre at atmospheric pressure?  
 (a) 1 : 1.71 (b) 1 : 2  
 (c) 2 : 1 (d) 1 : 24
162. Consider a and b are two components of a liquid mixture, their corresponding vapour pressure (mmHg) are respectively 450 and 700 in pure states and total pressure given is 600. Then corresponding composition in liquid phase will be  
 (a) 0.4, 0.6 (b) 0.5, 0.5  
 (c) 0.6, 0.4 (d) 0.3, 0.7
163. Which will form maximum boiling point azeotrope  
 (a)  $\text{HNO}_3 + \text{H}_2\text{O}$  solution (b)  $\text{C}_2\text{H}_5\text{OH} + \text{H}_2\text{O}$  solution  
 (c)  $\text{C}_6\text{H}_6 + \text{C}_6\text{H}_5\text{CH}_3$  solution (d) None of these
164. If two liquids A and B form minimum boiling azeotrope at some specific composition then \_\_\_\_\_  
 (a) A – B interactions are stronger than those between A – A or B – B  
 (b) vapour pressure of solution increases because more number of molecules of liquids A and B can escape from the solution.  
 (c) vapour pressure of solution decreases because less number of molecules of only one of the liquids escape from the solution  
 (d) A – B interactions are weaker than those between A – A or B – B
165. Chloroform and acetone are added to each other, Raoult's law shows negative deviation. what does this suggests ?  
 (a) Exothermic reaction  
 (b) Endothermic reaction  
 (c) Zero change in enthalpy  
 (d) None of these
166. At 300 K the vapour pressure of an ideal solution containing 1 mole of liquid A and 2 moles of liquid B is 500 mm of Hg. The vapour pressure of the solution increases by 25 mm of Hg, if one more mole of B is added to the above ideal solution at 300 K. Then the vapour pressure of A in its pure state is  
 (a) 300 mm of Hg (b) 400 mm of Hg  
 (c) 500 mm of Hg (d) 600 mm of Hg
167. Someone has added a non electrolyte solid to the pure liquid but forgot that among which of the two beakers he has added that solid. This problem can be solved by checking  
 (a) relative lower in vapour pressure  
 (b) elevation in boiling point  
 (c) depression in Freezing point  
 (d) all above
168. The vapour pressure of a solvent decreases by 10 mm of Hg when a non-volatile solute was added to the solvent. The mole fraction of the solute in the solution is 0.2. What should be the mole fraction of the solvent if the decrease in the vapour pressure is to be 20 mm of Hg ?  
 (a) 0.8 (b) 0.6  
 (c) 0.4 (d) 0.2
169. Vapour pressure of benzene at  $30^\circ\text{C}$  is 121.8 mm. When 15g of a non-volatile solute is dissolved in 250 g of benzene, its vapour pressure is decreased to 120.2 mm. The molecular weight of the solute is  
 (a) 35.67 g (b) 356.7 g  
 (c) 432.8 g (d) 502.7 g
170. For a dilute solution containing 2.5 g of a non-volatile non-electrolyte solute in 100 g of water, the elevation in boiling point at 1 atm pressure is  $2^\circ\text{C}$ . Assuming concentration of solute is much lower than the concentration of solvent, the vapour pressure (mm of Hg) of the solution is (take  $K_b = 0.76 \text{ K kg mol}^{-1}$ )  
 (a) 724 (b) 740  
 (c) 736 (d) 718
171. The difference between the boiling point and freezing point of an aqueous solution containing sucrose (molecular wt = 342 g mole $^{-1}$ ) in 100 g of water is  $105^\circ\text{C}$ . If  $K_f$  and  $K_b$  of water are 1.86 and  $0.51 \text{ K kg mol}^{-1}$  respectively, the weight of sucrose in the solution is about  
 (a) 34.2 g (b) 342 g  
 (c) 7.2 g (d) 72 g
172. If the elevation in boiling point of a solution of non-volatile, non-electrolytic and non-associating solute in a solvent ( $K_b = x \text{ K kg mol}^{-1}$ ) is y K, then the depression in freezing point of solution of same concentration would be ( $K_f$  of the solvent = z K kg mol $^{-1}$ )  
 (a)  $\frac{2xz}{y}$  (b)  $\frac{yz}{x}$   
 (c)  $\frac{xz}{y}$  (d)  $\frac{yz}{2x}$
173. 1 g of a non-volatile, non-electrolyte solute of molar mass 250 g/mol was dissolved in 51.2 g of benzene. If the freezing point depression constant  $K_f$  of benzene is  $5.12 \text{ kg K mol}^{-1}$ . The freezing point of benzene is lowered by  
 (a) 0.3 K (b) 0.5 K  
 (c) 0.2 K (d) 0.4 K
174. The boiling point of 0.2 mol kg $^{-1}$  solution of X in water is greater than equimolar solution of Y in water. Which one of the following statements is true in this case ?  
 (a) Molecular mass of X is greater than the molecular mass of Y.  
 (b) Molecular mass of X is less than the molecular mass of Y  
 (c) Y is undergoing dissociation in water while X undergoes no change.  
 (d) X is undergoing dissociation in water.
175. What is the freezing point of a solution containing 8.1 g HBr in 100 g water assuming the acid to be 90% ionised ? ( $K_f$  for water =  $1.86 \text{ K kg mol}^{-1}$ ) :  
 (a)  $0.85^\circ\text{C}$  (b)  $-3.53^\circ\text{C}$   
 (c)  $0^\circ\text{C}$  (d)  $-0.35^\circ\text{C}$
176. An 1% solution of KCl (I), NaCl (II),  $\text{BaCl}_2$  (III) and urea (IV) have their osmotic pressure at the same temperature in the ascending order (molar masses of NaCl, KCl,  $\text{BaCl}_2$  and urea are respectively 58.5, 74.5, 208.4 and 60 g mole $^{-1}$ ). Assume 100% ionization of the electrolytes at this temperature  
 (a)  $\text{I} < \text{III} < \text{II} < \text{IV}$  (b)  $\text{III} < \text{I} < \text{II} < \text{IV}$   
 (c)  $\text{I} < \text{II} < \text{III} < \text{IV}$  (d)  $\text{III} < \text{IV} < \text{I} < \text{II}$



# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (d)
2. (c) Sodium fluoride is used as rat poison.
3. (b) Almost all the processes in our body occur in liquid solution.
4. (c) In homogeneous mixtures composition and properties both are uniform throughout the mixture.
5. (a) Hexane is not water soluble, hence solution is not formed.
6. (d) Dilute, concentrated and saturated terms are qualitative methods of description of concentration of solution whereas molar or molarity is quantitative method.
7. (d)
8. (b) Density = 1.17 gm/cc (Given)

$$\text{As } d = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{volume} = 1 \text{ cc} \quad \therefore \text{mass} = d = 1.17 \text{ g}$$

$$\text{Molarity} = \frac{\text{No. of moles}}{\text{Volume in litre}} = \frac{1.17 \times 1000}{36.5 \times 1}$$

$$= \frac{1170}{36.5} = 32.05 \text{ M}$$

9. (c) From molarity equation  
 $M_1 V_1 + M_2 V_2 = M_3 (V_1 + V_2)$   
 $1 \times 2.5 + 0.5 \times 3 = M_3 \times 5.5$   
 $M_3 = \frac{4}{5.5} = 0.73 \text{ M}$
10. (b) Relation between molality and mole fraction is  
 $m = \frac{1000 \times x_2}{x_1 M_1} = \frac{1000 \times 2}{0.8 \times 78} = 3.2$   
 Thus,  $X(m) = 3.2$

$$11. (b) \quad M = \frac{\text{Wt} \times 1000}{\text{M.Wt.} \times V}; \quad M = \frac{7.1 \times 1000}{142 \times 100} = 0.5 \text{ M}$$

$$12. (a) \quad \frac{\Delta p}{p^\circ} = \frac{n_2}{n_1 + n_2} \quad \text{or} \quad \frac{n_2}{n_1 + n_2} = \frac{640 - 630}{640} = \frac{0.0156}{1}$$

or 1 mole i.e., 78 g benzene contains solute = 0.0156 mol

$$\therefore \text{Molality of solution} = \frac{0.0156 \times 10^3}{78} = 0.2 \text{ m}$$

$$13. (d) \quad \text{Normality} = \frac{\text{Moles of solute}}{\text{Volume of solution in litre}}$$

Given mass of solute = 4.0 g  
 No. of moles of NaOH = 4/40  
 Volume of solution = 100 ml = 100/1000 L

$$\text{Normality} = \frac{4/40}{100/1000} \approx 1 \text{ N}$$

$$14. (c) \quad \text{Molarity} = \frac{\text{Number of moles}}{\text{Volume of solution (L)}}$$

$$\text{Moles of water} = \frac{\text{Mass}}{\text{Molar mass}} = \frac{1000}{18} = 55.6$$

$$\text{Molarity} = \frac{55.6}{1} = 55$$

$$15. (b) \quad \therefore 10 \text{ g glucose is dissolved in} = 100 \text{ ml solution.}$$

$$\therefore 180 \text{ g (g mole) is dissolved in}$$

$$= \frac{100}{10} \times 180 = 1800 \text{ ml} = 1.8 \text{ L}$$

$$16. (d) \quad \text{ppm} = \frac{\text{Mass of solute}}{\text{Mass of solution}} \times 10^6$$

$$\therefore \text{ppm} = \frac{10}{10^6} \times 10^6 = 10 \text{ ppm}$$

$$17. (a) \quad \frac{p^\circ - p}{p^\circ} = x_{\text{solute}}$$

$$\text{Given, } p^\circ = 0.8 \text{ atm, } p = 0.6 \text{ atm, } x_{\text{solute}} = ?$$

$$\frac{0.8 - 0.6}{0.8} = x_{\text{solute}} \quad \text{or} \quad \frac{0.2}{0.8} = x_{\text{solute}}$$

$$\text{or } x_{\text{solute}} = 0.25$$

$$18. (b) \quad \text{Molarity} = \frac{\text{No. of moles of solute}}{\text{Volume in litres}} = \frac{5}{2.5} = 2 \text{ M}$$

$$19. (b) \quad \text{One molal solution means one mole of solute is present in 1 kg (1000 g) solvent}$$

i.e., mole of solute = 1

$$\text{Mole of solvent (H}_2\text{O)} = \frac{1000 \text{ g}}{18 \text{ g}} = \frac{1000}{18}$$

$$\text{Mole fraction of solute} = \frac{1}{\left(1 + \frac{1000}{18}\right)} = \frac{18}{1008} = 0.018.$$

$$20. (d) \quad NV = N_1 V_1 + N_2 V_2 + N_3 V_3$$

$$\text{or, } 1000N = 1 \times 5 + \frac{1}{2} \times 20 + \frac{1}{3} \times 30 \quad \text{or } N = \frac{1}{40}$$

$$21. (a) \quad \text{For HCl}$$

$$M = N = 0.1$$

$$N_1 V_1 = N_2 V_2; \quad 25 \times N_1 = 0.1 \times 35$$

$$N_1 = \frac{0.1 \times 35}{25}; \quad \therefore M = \frac{0.1 \times 35}{25 \times 2} = 0.07$$

$$22. (b) \quad 1 \text{ molal solution means 1 mole of solute dissolved in 1000 gm solvent.}$$

$$\therefore n_{\text{solute}} = 1 \quad w_{\text{solvent}} = 1000 \text{ gm}$$

$$\therefore n_{\text{solvent}} = \frac{1000}{18} = 55.56$$

$$x_{\text{solute}} = \frac{1}{1+55.56} = 0.0177$$

23. (d)  $\text{H}_3\text{PO}_4$  is tribasic so  $N = 3M = 3 \times 1N = 3N$ .

24. (c)  $N_1V_1 + N_2V_2 = NV$   
 $4x + 10(1-x) = 6 \times 1$ ;  $-6x = -4$ ;  $x = 0.67$   
 Thus 0.67 litre of 4N HCl  
 $1-x = 1-0.67 = 0.33$  litre of 10 N HCl

25. (c) Molality (m) = 
$$\frac{\text{Molarity}}{\text{Density} - \frac{\text{Molarity} \times \text{Molecular mass}}{1000}}$$

$$= \frac{18}{1.8 - \frac{18 \times 98}{1000}} = 5000$$

26. (d) No. of millimoles =  $500 \times 0.2 = 100$   
 Thus, molarity of diluted solution  
 $= \frac{100}{700}$   
 (Molarity = No. of moles  $\text{L}^{-1}$  = No. of millimoles  $\text{mL}^{-1}$ )  
 $= 0.1428 \text{ M}$

27. (d) Molarity (M) = 
$$\frac{\text{wt} \times 1000}{\text{mol. wt.} \times \text{vol (ml)}}$$

$$2 = \frac{\text{wt.}}{63} \times \frac{1000}{250}$$

$$\text{wt.} = \frac{63}{2} \text{ gm}$$

$$\text{wt. of 70\% acid} = \frac{100}{70} \times 31.5 = 45 \text{ gm}$$

28. (b) More than theoretical weight since impurity will not contribute.

29. (c) Applying the law of equivalence,  
 $N_1V_1 + N_2V_2 + N_3V_3 = N_RV_R$   
 $\frac{N}{10} \times 50 + \frac{N}{3} \times 30 + \frac{N}{2} \times 10 = N_R \times 1000$   
 $5N + 10N + 5N = 1000 \times N_R$   
 $\Rightarrow N_R = \frac{N}{50}$

30. (c) 40 g NaOH = 1 mole

$$\therefore \text{molality} = \frac{\text{moles of the solute}}{\text{mass of the solvent in kg}} = \frac{1}{1} = 1 \text{ molal}$$

31. (b) Both molality and mole fraction are not related to the volume of solution, thus they are both independent of temperature.

32. (a) Given  $w = 10 \text{ g}$  Mol. mass = 40  
 Weight of solvent =  $1250 \times 0.8 \text{ g} = 1000 \text{ g} = 1 \text{ kg}$   
 $\therefore \text{molality} = \frac{10}{40 \times 1} = 0.25$

33. (a)

34. (c) In a given solution sum of all the mole fraction is unity i.e.,

$$(a) x_1 + x_2 + x_3 + x_4 = 1$$

$$(b) \frac{n_3}{n_1 + n_2 + n_3 + n_4} = x_3$$

35. (d) Volume is temperature dependent, hence expression involving volume term (normality, molarity and formality) varies with temperature

$$\text{Normality} = \frac{\text{geq of solute}}{\text{vol. of solution in L}}$$

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{vol. of solution in L}}$$

$$\text{Formality} = \frac{\text{formula mass}}{\text{vol. of solution in L}}$$

$$\text{Molality} = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$

Since molality does not include the volume term, it is independent of temperature.

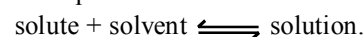
36. (b) An increase in temperature of the solution increases the solubility of a solid solute.

The amount of solute that dissolve depends on what type of solute it is.

For solids and liquid solutes, changes in pressure have practically no effect on solubility.

37. (d)

38. (b) Number of solute particles going into solution will be equal to the solute particles separating out and a state of dynamic equilibrium is reached.



i.e., rate of dissolution = rate of crystallization.

39. (d) The maximum amount of solute dissolved in a given amount of solvent is its solubility.

40. (d)

41. (b) According to Le-chateliers principle, for an exothermic reaction ( $\Delta H < 0$ ) increase in temperature decreases the solubility.

42. (c) On increasing the pressure over the solution phase by compressing the gas to a smaller volume (in fig b) increase the number of gaseous particles per unit volume over the solution and also the rate at which the gaseous particles are striking the surface of solution to enter it. The solubility of the gas will increase until a new equilibrium is reached resulting in an increase in the pressure of a gas above the solution and thus its solubility increases.

43. (d)

44. (a) According to Henry's law at a constant temperature, the solubility of a gas in a liquid is directly proportional to the pressure of the gas.

45. (d) According to Henry's law,  
 $m = k \times p$   
 given  $K_H = 1.4 \times 10^{-3}$   
 $p_{O_2} = 0.5$  or  
 $p_{O_2} = K_H \times x_{O_2}$   
 $\therefore x_{O_2} = \frac{0.5}{1.4 \times 10^{-3}}$   
 No. of moles;  $n = \frac{m}{M}$   
 $0.7 \times 10^{-4} = \frac{m}{32}$   
 $m = 22.4 \times 10^{-4} \text{ g} = 2.24 \text{ mg}$
46. (c)
47. (b) [Hint : If added substance dissolves, the solution is unsaturated. If it does not dissolve solution is saturated. If precipitation occurs solution is supersaturated.]
48. (c)
49. (b) Body temperature of human beings remains constant.
50. (a) 51. (b) 52. (a)
53. (c) The partial pressure of the gas in vapour phase (p) is proportional to the mole fraction of the gas (x).  
 $p = K_H \cdot x$   
 Where  $K_H$  is Henry's constant.
54. (d) To increase the solubility of  $\text{CO}_2$  in soft drinks and soda water, the bottle is sealed under high pressure.
55. (d) Scuba divers must cope with high concentrations of dissolved gases while breathing air at high pressure underwater. Increased pressure increases the solubility of atmospheric gases in blood. When the divers come towards surface, the pressure gradually decreases. This releases the dissolved gases and leads to the formation of bubbles of nitrogen in the blood. This blocks capillaries and creates a medical condition known as bends, which are painful and dangerous to life. To avoid bends, as well as, the toxic effects of high concentrations of nitrogen in the blood, the tanks used by scuba divers are filled with air diluted with helium (11.7% helium, 56.2% nitrogen and 32.1% oxygen).
56. (a) At high altitudes the partial pressure of oxygen is less than that at the ground level. This leads to low concentrations of oxygen in the blood and tissues of people living at high altitudes or climbers. Low blood oxygen causes climbers to become weak and unable to think clearly, symptoms of a condition known as anoxia.
57. (c)
58. (a) Raoult's law becomes special case of Henry's law when  $K_H$  become equal to  $p_1^\circ$ .
59. (c) 60. (d)
61. (b) In the solution, the surface has both solute and solvent molecules; thereby the fraction of the surface covered by the solvent molecules gets reduced. Consequently, the number of solvent molecules escaping from the surface is correspondingly reduced, thus, the vapour pressure is also reduced.
62. (a) For example, decrease in the vapour pressure of water by adding 1.0 mol of sucrose to one kg of water is nearly similar to that produced by adding 1.0 mol of urea to the same quantity of water at the same temperature.
63. (d)
64. (a) Given  $V.P_p = 80 \text{ torr}$   
 $V.P_Q = 60 \text{ torr}$   
 $P_{\text{total}} = V \cdot P_p \times x_p + V \cdot P_q \times x_q$   
 $= \left[ 80 \times \frac{3}{5} + 60 \times \frac{2}{5} \right] = 16 \times 3 + 12 \times 2$   
 $P_{\text{total}} = 48 + 24 = 72 \text{ torr}$
65. (b) Moles of glucose  $= \frac{18}{180} = 0.1$   
 Moles of water  $= \frac{178.2}{18} = 9.9$   
 Total moles  $= 0.1 + 9.9 = 10$   
 $P_{\text{H}_2\text{O}} = \text{Mole fraction} \times \text{Total pressure} = \frac{9.9}{10} \times 760$   
 $= 752.4 \text{ Torr}$
66. (d)  $p = p_A x_A + p_B x_B$   
 $= p_A x_A + p_B (1 - x_A)$   
 $\Rightarrow p_A x_A + p_B - p_B x_A$   
 $\Rightarrow p_B + x_A (p_A - p_B)$
67. (b)  $p_A^\circ = ?$ , Given  $p_B^\circ = 200 \text{ mm of Hg}$ ,  $x_A = 0.6$ ,  
 $x_B = 1 - 0.6 = 0.4$ ,  $P = 290 \text{ of Hg}$   
 $P = p_A + p_B = p_A^\circ x_A + p_B^\circ x_B$   
 $\Rightarrow 290 = p_A^\circ \times 0.6 + 200 \times 0.4 \therefore p_A^\circ = 350 \text{ mm of Hg}$
68. (b)  $p_{\text{total}} = p_A^\circ x_A + p_B^\circ x_B$   
 $550 = p_A^\circ \times \frac{1}{4} + p_B^\circ \times \frac{3}{4}$   
 $p_A^\circ + 3p_B^\circ = 550 \times 4 \quad \dots(i)$   
 In second case  
 $p_{\text{total}} = p_A^\circ \times \frac{1}{5} + p_B^\circ \times \frac{4}{5}$   
 $p_A^\circ + 4p_B^\circ = 560 \times 5 \quad \dots(ii)$   
 Subtract (i) from (ii)  
 $\therefore p_B^\circ = 560 \times 5 - 550 \times 4 = 600$   
 $\therefore p_A^\circ = 400$
69. (d) According to given information  
 $p_X = 80 \text{ Torr}$   
 $p_Y = 60 \text{ Torr}$   
 $n_X = 3 \text{ moles}$   
 $n_Y = 2 \text{ moles}$   
 $\text{mole fraction of X}(x_X) = \frac{n_X}{n_X + n_Y} = \frac{3}{3+2} = \frac{3}{5}$

$$\text{mole fraction of Y}(x_Y) = \frac{n_Y}{n_X + n_Y} = \frac{2}{3+2} = \frac{2}{5}$$

$$\text{Total Pressure, } P = p_X x_X + p_Y x_Y$$

$$= \frac{3}{5} \times 80 + \frac{2}{5} \times 60 = 48 + 24 = 72 \text{ Torr.}$$

70. (a) Total vapour pressure = vapour pressure of pure benzene + vapour pressure of toluene  
 $= 100 + 50 = 150 \text{ mm}$

We know,

$$P_{C_6H_6}^\circ = P \times x_{C_6H_6}$$

$$100 = 150 \times x_{C_6H_6}$$

$$x_{C_6H_6} = \frac{100}{150} = 0.67$$

71. (c) These two components A and B follows the condition of Raoult's law if the force of attraction between A and B is equal to the force of attraction between A and A or B and B.

72. (b) According to Raoult's law "The partial pressure of a volatile component of a solution is directly proportional to its mole fraction in solution at any temperature".

$$p = P_x^\circ$$

where,  $p$  = Partial pressure of component

$P^\circ$  = Vapour pressure of component in pure form

$x$  = mole fraction of component in solution.

73. (c) For an ideal solution,  $\Delta H = 0$ ,  $\Delta V = 0$

Hence, option (c) is incorrect.

74. (c) For ideal solution,

$$\Delta V_{\text{mixing}} = 0 \text{ and } \Delta H_{\text{mixing}} = 0.$$

75. (d)  $C_2H_5I$  and  $C_2H_5OH$  form non-ideal solution.

76. (d)

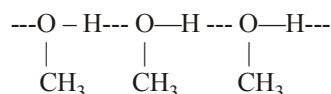
77. (a) On adding acetone, its molecules get in between the host molecules and break some of the hydrogen bonds between them. Due to weakening of interactions, the solution shows positive deviation from Raoult's law.

78. (d) A solution containing A and B components shows negative deviation when A-A and B-B interactions are weaker than that of A-B interactions. For such solutions.

$$\Delta H = -ve \text{ and } \Delta V = -ve$$

79. (b) Positive deviations are shown by such solutions in which solvent-solvent and solute-solute interactions are stronger than the solute-solvent interactions. In such solution, the interactions among molecules becomes weaker. Therefore their escaping tendency increases which results in the increase in their partial vapour pressures.

In pure methanol there exists intermolecular H-bonding.



On adding benzene, its molecules come between ethanol molecules there by breaking H-bonds which weaken intermolecular forces. This results in increase in vapour pressure.

80. (a) A solution of acetone in ethanol shows positive deviation from Raoult's law. It is because ethanol molecules are strongly hydrogen bonded. When acetone is added, these molecules break the hydrogen bonds and ethanol becomes more volatile. Therefore its vapour pressure is increased.

81. (a) Acetone and chloroform shows negative deviation from Raoult's law when these are mixed, the hydrogen bonding takes place between the two molecular species due to which escaping tendency of either liquid molecules becomes less and boiling point of solution increases.

82. (b)

83. (b) For this solution intermolecular interactions between  $n$ -heptane and ethanol are weaker than  $n$ -heptane- $n$ -heptane & ethanol-ethanol interactions hence the solution of  $n$ -heptane and ethanol is non-ideal and shows positive deviation from Raoult's law.

84. (a) For an ideal solution  $\Delta S_{\text{mix}} > 0$

85. (b)

86. (d) Azeotropic mixture is constant boiling mixture, it is not possible to separate the components of azeotropic mixture by boiling.

87. (c)

88. (a) Minimum boiling azeotrope is formed by solution showing positive deviation. e.g. acetone – ethanol.

89. (b)

90. (c) Relative lowering of vapour pressure depends upon the mole fraction of solute.

$$\text{i.e., } \frac{P^\circ - P}{P^\circ} = \text{mole fraction of solute}$$

91. (b) According to Raoult's law, the relative lowering in vapour pressure of a dilute solution is equal to the mole fraction of the solute present in the solution.

$$\frac{P^\circ - p}{p} = \text{Mole fraction of solute} = \frac{n}{n + N}$$

92. (a) Given vapour pressure of pure solvent ( $P^\circ$ ) = 121.8 mm Hg; Weight of solute ( $w$ ) = 15 g  
 Weight of solvent ( $W$ ) = 250 g; Vapour pressure of solution ( $P$ ) = 120.2 mm Hg and Molecular weight of solvent ( $M$ ) = 78

From Raoult's law

$$= \frac{P^\circ - P}{P^\circ} = \frac{w}{m} \times \frac{M}{W}$$

$$\frac{121.8 - 120.2}{121.8} = \frac{15}{m} \times \frac{78}{250}$$

$$\text{or } m = \frac{15 \times 78}{250} \times \frac{121.8}{1.6} = 356.2$$

93. (d)  $\frac{P^\circ - P}{P^\circ} = \frac{n_2}{n_1 + n_2}$   
 $\frac{640 - 600}{640} = \frac{2.5/x}{39/78}$   
 $x = \frac{640 \times 78 \times 2.5}{39 \times 40} = 80$
94. (c) According to Raoult's law  
 $\frac{P^\circ - P}{P^\circ} = x_B$   
 $\left[ \begin{array}{l} x_B = \text{Mole fraction of solute} = \frac{.2}{.2 + .8} = \frac{1}{5} \\ p = 60 \text{ mm of Hg} \end{array} \right]$   
 $\frac{P^\circ - P}{P^\circ} = \frac{1}{5}$  or  $4P^\circ = (P) \times 5$   
 $\Rightarrow P^\circ = \frac{60 \times 5}{4} = 75 \text{ mm of Hg}$
95. (c)  $\frac{P^\circ - P_s}{P^\circ} = \frac{n}{N} = \frac{w}{m} \times \frac{M}{W}$   
 $0.1 = \frac{12}{m} \times \frac{18}{108}$   
 $m = \frac{12 \times 18}{0.1 \times 108} = 20$
96. (b)  $\left[ \frac{P^\circ - P}{P^\circ} \right] \times 100 = \frac{w_2}{M_2} \times \frac{M_1}{w_1} \times 100 = 10$   
 $\frac{w_2}{60} \times \frac{18}{180} \times 100 = 10$  or  $w_2 = 60 \text{ g}$   
 Thus, 60 g of the solute must be added to 180 g of water so that the vapour pressure of water is lowered by 10%.
97. (a) The vapour pressure of a solution of glucose in water can be calculated using the relation  
 $\frac{P^\circ - P_s}{P_s} = \frac{\text{Moles of glucose in solution}}{\text{Moles of water in solution}}$   
 or  $\frac{17.5 - P_s}{P_s} = \frac{18/180}{178.2/18}$  [ $\because P^\circ = 17.5$ ]  
 or  $17.5 - P_s = \frac{0.1 \times P_s}{9.9}$  or  $P_s = 17.325 \text{ mm Hg}$ .  
 Hence (a) is correct answer.
98. (c) Osmotic pressure is a colligative property.
99. (c)  $\Delta T_b = K_b \times m$   
 Elevation in boiling point is a colligative property, which depends upon the no. of particles (concentration of solution). Thus greater the number of particles, greater is the elevation in boiling point and hence greater will be its boiling point.  
 $\text{Na}_2\text{SO}_4 \rightleftharpoons 2\text{Na}^+ + \text{SO}_4^{2-}$   
 Since  $\text{Na}_2\text{SO}_4$  has maximum number of particles (c) hence has maximum boiling point.
100. (c)  $K_b = \frac{0.1 \times 180 \times 100}{1.8 \times 1000} = 1 \text{ K/m}$
101. (b)  $\Delta T_b = K_b \times i \times m$   
 Where  $\Delta T_b$  = Elevation in boiling point  
 $K_b$  = molal elevation constant  
 $i$  = vant Hoff factor  
 $\therefore \Delta T_b \propto \text{molality}$ .
102. (a)  $\Delta T_f = i \times K_f \times m$   
 Van't Hoff factor,  $i = 2$  for NaCl,  $m = 0.01$   
 hence  $\Delta T_f = 0.02 K_f$  which is maximum in the present case.  
 Hence  $\Delta T_f$  is maximum or freezing point is minimum.
103. (c)  $\Delta T = K_f m = \frac{K_f \times W_2 \times 1000}{M_2 W_1} = 5.12 \times \frac{1}{250} \times \frac{1000}{51.2} = 0.4 \text{ K}$
104. (d)  $(\text{HX} \rightleftharpoons \overset{+}{\text{H}} + \overset{-}{\text{X}}, i = 1.3); \Delta T_f = K_f \times m \times i$   
 $\Delta T_f = 1.85 \times 0.2 \times 1.3 = 0.481^\circ \text{C}$   
 $\therefore T_f = T_f^\circ - \Delta T_f = 0 - 0.481^\circ \text{C} = -0.481^\circ \text{C}$
105. (b) Benzoic acid exists as dimer in benzene.
106. (b)  $\Delta T_f = K_f \times m = 1.86 \times 0.5 = 0.93^\circ \text{C}; T_f = -0.93^\circ \text{C}$
107. (b) As  $\Delta T_f = K_f \cdot m$   
 $\Delta T_b = K_b \cdot m$   
 Hence, we have  $m = \frac{\Delta T_f}{K_f} = \frac{\Delta T_b}{K_b}$   
 or  $\Delta T_f = \Delta T_b \frac{K_f}{K_b}$   
 $\Rightarrow [\Delta T_b = 100.18 - 100 = 0.18^\circ \text{C}]$   
 $= 0.18 \times \frac{1.86}{0.512} = 0.654^\circ \text{C}$   
 As the Freezing Point of pure water is  $0^\circ \text{C}$ ,  
 $\Delta T_f = 0 - T_f$   
 $0.654 = 0 - T_f$   
 $\therefore T_f = -0.654$   
 Thus the freezing point of solution will be  $-0.654^\circ \text{C}$ .
108. (d) Addition of solute to water decreases the freezing point of water (pure solvent).  
 $\therefore$  When 1% lead nitrate (solute) is added to water, the freezing point of water will be below  $0^\circ \text{C}$ .
109. (a)  $\Delta T_f = K_f \frac{1000 W_2}{M_2 W_1} = \frac{1.86 \times 1000 \times 68.5}{342 \times 1000} = 0.372$   
 $T_f = T_f^\circ - \Delta T_f$   
 $T_f = -0.372^\circ \text{C}$
110. (d)  $\Delta T_f = K_f \times m$   
 $M = \frac{1000 \times K_f \times w_2 (\text{solute})}{\Delta T_f \times w_1 (\text{solvent})}$   
 $= \frac{1000 \times 1.86 \times 1.8}{0.465 \times 40} \Rightarrow M = 180$



Molecular formula = (empirical formula)<sub>n</sub>

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{180}{30} = 6$$

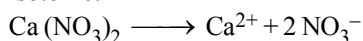
Molecular formula = (CH<sub>2</sub>O)<sub>6</sub> = C<sub>6</sub>H<sub>12</sub>O<sub>6</sub>.

111. (b) Blood cells neither swell nor shrink in isotonic solution. As isotonic solutions have equal concentration therefore there is no flow of solvent occurs and hence solvent neither enters nor flow out of the blood cells.

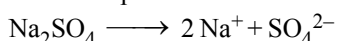
112. (a) Isotonic solutions have same molar concentration at given temperature provided the Van't Hoff factor (*i*) is same.

113. (b)

114. (a) The solution which provide same number of ions are isotonic.



Total ions produced = 3



Total ions produced = 3

∴ 0.1 M Ca(NO<sub>3</sub>)<sub>2</sub> and 0.1 M Na<sub>2</sub>SO<sub>4</sub> are isotonic.

115. (d) Osmotic pressure is a colligative property. Hence resulting osmotic pressure of the solution is given by

$$\pi_T = \pi_1 + \pi_2 + \pi_3 \dots\dots\dots$$

$$\pi_T = 1.64 + 2.46 = 4.10 \text{ atm.}$$

116. (a) According to Boyle-van't Hoff law,

$$\pi \propto C \text{ (at constant temp)}$$

117. (c) Isotonic solutions have same osmotic pressure

$$\pi_{\text{glucose}} = \pi_{\text{unknown solute}}$$

$$\therefore \frac{m_1}{M_1} = \frac{m_2}{M_2} \text{ or } \frac{5}{180} = \frac{2}{M_2} \Rightarrow M_2 = 72$$

118. (b)  $\Delta T_f = K_f \times m$

$K_f$  is a characteristic of a particular solvent *i.e.*, it will be different for different solvents.

119. (b)

120. (c) During osmosis water flows through semipermeable membrane from lower concentration to higher concentration.

121. (a) As both the solutions are isotonic hence there is no net movement of the solvent occurs through the semipermeable membrane between two solutions.

122. (c) If compound dissociates in solvent  $i > 1$  and on association  $i < 1$ .

123. (a) Van't Hoff equation is

$$\pi V = inRT$$

For depression in freezing point.

$$\Delta T_f = i \times K_f \times m$$

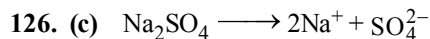
For elevation in boiling point.

$$\Delta T_b = i \times K_b \times m$$

For lowering of vapour pressure,

$$\frac{P_{\text{solvent}}^\circ - P_{\text{solution}}}{P_{\text{solvent}}^\circ} = i \left( \frac{n}{N+n} \right).$$

124. (d) 125. (c)



Mol. before dissociation 1 0 0

Mol. after dissociation 1 - α 2α 1α

$$i = 1 - \alpha + 2\alpha + \alpha = 1 + 2\alpha$$

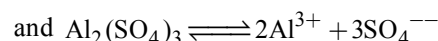
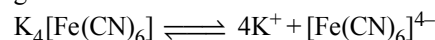
127. (d) The salt that ionises to least extent will have highest freezing point. [ *i.e.*, minimum  $\Delta T_f$  ]

128. (b) AlCl<sub>3</sub> furnishes more ions than CaCl<sub>2</sub> and thus possess higher boiling point *i.e.*,  $t_1 > t_2$ .

129. (a) Concentration of particles in CaCl<sub>2</sub> solution will be maximum as  $i = 3$  for CaCl<sub>2</sub> and  $i = 2$  for KCl.

Glucose and Urea do not dissociate into ions, as they are nonelectrolytes.

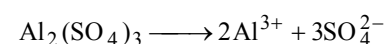
130. (a) K<sub>4</sub>[Fe(CN)<sub>6</sub>] and Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> both dissociates to give 5 ions or  $i = 5$



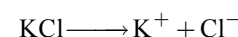
131. (a) Depression in freezing point  $\propto$  No. of particles.

(when concentration of different solutions is equal)

Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> provides five ions on ionisation



while KCl provides two ions

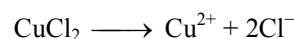


C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> and C<sub>12</sub>H<sub>22</sub>O<sub>11</sub> are not ionised so they have single particle in solution.

Hence, Al<sub>2</sub>(SO<sub>4</sub>)<sub>3</sub> have maximum value of depression in freezing point or lowest freezing point.

132. (a) (i)  $i = \frac{\text{No. of particles after ionisation}}{\text{No. of particles before ionisation}}$

$$(ii) \Delta T_b = i \times K_b \times m$$



1 0 0  
(1-α) α 2α

$$i = \frac{1+2\alpha}{1}, i = 1+2\alpha$$

Assuming 100% ionization

$$\text{So, } i = 1 + 2 = 3$$

$$\Delta T_b = 3 \times 0.52 \times 0.1 = 0.156 \approx 0.16 \quad [m = \frac{13.44}{134.4} = 0.1]$$

133. (d)  $\Delta T_f = i \cdot k_f \cdot m$ ;  $\Delta T_b = i \cdot k_b \cdot m$

$$\frac{\Delta T_f}{\Delta T_b} = \frac{k_f}{k_b}$$

$$\Delta T_f = 0 - (-0.186^\circ\text{C}) = 0.186^\circ\text{C}$$

$$\frac{0.186}{\Delta T_b} = \frac{1.86}{0.52} \Rightarrow \Delta T_b = \frac{0.52 \times 0.186}{1.86} = 0.052$$

### STATEMENT TYPE QUESTIONS

134. (d)  
 135. (b) Molarity include volume thus with increase in temperature increases' volume increases, hence molarity decreases while in case of molality mass of solvent is taken, which is not effected by temperature.  
 136. (c) As temperature increases solubility of gas decreases, so dissolution of gas can be considered as exothermic process.  
 137. (c) Solubility of gases increase with decrease of temperature.  
 138. (c) A solute dissolves in a solvent if intermolecular interactions are similar in the two or we may say like dissolves like.  
 139. (c) The vapour pressure of a liquid increases with increase of temperature.  
 140. (b)  
 141. (d) Colligative properties depends upon the no. of particles. Since methanol is non electrolyte hence cannot be considered.  
 142. (b) Osmotic pressure is a colligative property as it depends on the number of solute molecules and not on their identity. For dilute solutions, during osmosis solvent molecules always flow from lower concentration to higher concentration of solution.

### MATCHING TYPE QUESTIONS

143. (d)      144. (c)      145. (b)      146. (a)      147. (a)

### ASSERTION-REASON TYPE QUESTIONS

148. (a)  
 149. (c) Both the solute and solvent will form the vapours but vapour phase will become richer in the more volatile component.  
 150. (b)      151. (b)      152. (d)      153. (a)      154. (b)

### CRITICAL THINKING TYPE QUESTIONS

155. (c) Equivalent weight of orthophosphoric acid

$$(\text{H}_3\text{PO}_4) = \frac{3 + 31 + 64}{3} = \frac{98}{3}$$

Now 100 gm solution contains 70 gm  $\text{H}_3\text{PO}_4$

$$\frac{100}{1000 \times 1.54} \text{ litre of solution contains } \frac{70}{98/3} \text{ gm}$$

equivalent of  $\text{H}_3\text{PO}_4$

Normality of solution

$$= \frac{\frac{70 \times 3}{98}}{\frac{1}{10 \times 1.54}} = \frac{70 \times 3}{98} \times 10 \times 1.54 = 33 \text{ N}$$

156. (a) Mole fraction of any component A in solution

$$x = \frac{\text{No. of moles of A}}{\text{Total No. of moles of solution}}$$

As total no. of moles of solution > No. of moles of A  
 Thus x can never be equal to one or zero.

157. (d) According to Henry's law the mass of a gas dissolved per unit volume of solvent is proportional to the pressure of the gas at constant temperature  $m = K p$  i.e. as the solubility increases, value of Henry's law constant decreases. Since  $\text{CO}_2$  is most soluble in water among the given set of gases. Therefore  $\text{CO}_2$  has the lowest value of Henry's law constant.

158. (d) Let the mass of methane and oxygen = m gm.

Mole fraction of  $\text{O}_2$

$$= \frac{\text{Moles of } \text{O}_2}{\text{Moles of } \text{O}_2 + \text{Moles of } \text{CH}_4}$$

$$= \frac{m/32}{m/32 + m/16} = \frac{m/32}{3m/32} = \frac{1}{3}$$

Partial pressure of  $\text{O}_2$  = Total pressure  $\times$  mole fraction

$$\text{of } \text{O}_2, P_{\text{O}_2} = P \times \frac{1}{3} = \frac{1}{3}P$$

159. (a)  $k_H = 100 \text{ kbar} = 10^5 \text{ bar}$ ,  $p = 1 \text{ bar}$

$$p = k_H \times x_A$$

$$x_A = \frac{p}{k_H} = \frac{1}{100 \times 10^3} = 10^{-5}$$

$$\text{Moles of water} = \frac{1000}{18} = 55.5$$

Weight of water = 1000 g ( $\because 1000 \text{ mL} = 1000 \text{ g}$ )

$$\text{Mole fraction} = 10^{-5} = \frac{x}{55.5 + x}$$

As  $55.5 \gg x$ , thus neglecting x from denominator

$$10^{-5} = \frac{x}{55.5} \Rightarrow x = 55.5 \times 10^{-5} \text{ moles}$$

or 0.555 millimoles.

160. (c)

161. (a) % of  $\text{N}_2$  in atmosphere = 78.9%

% of  $\text{O}_2$  in atmosphere = 20.95%

Partial pressure of  $\text{N}_2$  = 0.789 atm = 0.799 bar

Partial pressure of  $\text{O}_2$  = 0.2095 atm = 0.212 bar

According to Henry's law,

$$P = (K_H)_{\text{O}_2} x \Rightarrow \frac{0.212}{(34.86 \times 1000)} = x_{\text{O}_2} = 6.08 \times 10^{-6}$$

$$P = (K_H)_{N_2} x \Rightarrow \frac{0.799}{(76.48 \times 1000)} = x_{N_2} = 1.0447 \times 10^{-5}$$

$$\Rightarrow \left( \frac{n_{O_2}}{n_{O_2} + n_{H_2O} + n_{N_2}} \right) : \left( \frac{n_{N_2}}{n_{O_2} + n_{H_2O} + n_{N_2}} \right)$$

$$\Rightarrow x_{O_2} : x_{N_2}$$

$$6.08 \times 10^{-6} : 1.04 \times 10^{-5}$$

$$= 1 : 1.71$$

162. (a) According to idea of Raoult's law "partial pressure of one of the component is proportional to mole fraction of that component in the solution."

$$P = P_1^\circ x_1 + P_2^\circ x_2$$

$$600 = 450 x_1 + 700 x_2$$

$$4.5 x_1 + 7 x_2 = 6$$

$$\therefore x_1 + x_2 = 1$$

$$\therefore x_1 = 0.6, x_2 = 0.4$$

$$\Rightarrow x_1 = 0.4, x_2 = 0.6$$

163. (a) The solutions (liquid mixture) which boils at constant temperature and can distil as such without any change in composition are called azeotropes.

Solution of  $HNO_3$  and  $H_2O$  will form maximum boiling point azeotrope. Maximum boiling azeotropes show negative deviation from Raoult's law.

	Composition (%)	Boiling Point
$HNO_3$	68.0	359 K
$H_2O$	32.0	373 K

Boiling point of the azeotrope of these two solutions is 393.5 K.

164. (a)

165. (a) Since formation of hydrogen bonding takes place, due to this bond energy is supposed to be released and hence change in enthalpy is negative, so reaction is exothermic.

166. (a) According to Raoult's law,

$$P_T = x_A P_A^\circ + x_B P_B^\circ$$

$$\text{Given, } = P_T \quad 500 \text{ mm Hg}$$

$$n_A = 1 \text{ and } n_B = 2 \therefore x_A = 1/3 \text{ and } x_B = 2/3$$

$$\Rightarrow 500 = \frac{1}{3} P_A^\circ + \frac{2}{3} P_B^\circ$$

$$\Rightarrow 1500 = P_A^\circ + 2P_B^\circ \quad \dots(i)$$

Also given Qn that one more mole of B is added to the solution, the pressure of the ideal solution increases by 25 mm Hg.

$$\therefore P_{T_2} = 500 + 25 = 525 \text{ mm Hg}$$

$$\text{Also, } n_B = 3 \therefore x_A = 1/4 \text{ and } x_B = 3/4$$

$$525 = \frac{1}{4} P_A^\circ + \frac{3}{4} P_B^\circ \quad \dots(ii)$$

$$2100 = P_A^\circ + 3P_B^\circ \quad \text{Subtract (i) and (ii),}$$

$$P_B^\circ = 600 \text{ mm Hg}$$

$$P_A^\circ + 2P_B^\circ = 1500 \Rightarrow P_A^\circ = 300 \text{ mm Hg.}$$

167. (d)

168. (b) According to Raoult's law

$$\frac{\Delta p}{p^\circ} = \frac{n}{n+N} \quad (\text{mole fraction of solute})$$

$$\frac{10}{p^\circ} = 0.2 \therefore p^\circ = 50 \text{ mm of Hg}$$

For other solution of same solvent

$$\frac{20}{p^\circ} = \frac{n}{n+N} \quad (\text{Mole fraction of solute})$$

$$\Rightarrow \frac{20}{50} = \text{Mole fraction of solute}$$

$$\Rightarrow \text{Mole fraction of solute} = 0.4$$

As mole fraction of solute + mole fraction of solvent = 1

Hence, mole fraction of solvent =  $1 - 0.4 = 0.6$

- 169 (b) Relative lowering of vapour pressure is given by :

$$\frac{P^\circ - P_s}{P^\circ} = \frac{w/m}{w/m + W/M}$$

where,  $P^\circ$  = vapour pressure of pure solvent

$P_s$  = vapour pressure of solution

$w$  = mass of solute

$m$  = molecular mass of solute

$W$  = mass of solvent

$M$  = molecular mass of solvent

For dilute solution

$$\Rightarrow \frac{121.8 - 120.2}{121.8} = \frac{15/m}{250/78} = \frac{15}{m} \times \frac{78}{250} = 1.3 \times 10^{-2}$$

$$\Rightarrow m = 356.265$$

170. (a) From Raoult law

$$\frac{P^\circ - p}{P^\circ}$$

$$= \frac{\text{No. of moles of solute}}{\text{No. of moles of solvent} + \text{No. of moles of solute}}$$

When the concentration of solute is much lower than the concentration of solvent,

$$\frac{P^\circ - p}{P^\circ} = \frac{\text{No. of moles of solute}}{\text{No. of moles of solvent}}$$

$$\Delta T_b = K_b \times m$$

$$m = \frac{\text{Number of moles of the solute}}{\text{Mass of solvent in grams}} \times 1000$$

$$\Delta T_b = K_b \times \frac{\text{Number of moles of the solute}}{\text{Mass of solvent in grams}} \times 1000$$

Number of moles of solute

$$= \frac{\Delta T_b \times \text{Mass of solvent in grams}}{K_b \times 1000}$$

$$= \frac{2 \times 100}{0.76 \times 1000} = 0.26,$$

$$\text{Number of moles of solvent} = \frac{100}{18} = 5.56$$

$$\text{From equation (i) we get, } \frac{760-p}{760} = \frac{0.26}{5.56}$$

$$\text{On solving, } p = 724.46 \approx 724$$

$$171. (d) (100 + \Delta T_b) - (0 - \Delta T_f) = 105$$

$$\Delta T_b + \Delta T_f = 5$$

$$m(k_b + k_f) = 5$$

$$m = \frac{5}{2.37} \quad \text{i.e., } \frac{5}{2.37} \text{ moles in 1000 g water}$$

$$(\text{or}) \frac{5}{2.37 \times 10} \text{ moles in 100 g water}$$

$$\therefore \text{Wt. of sucrose} = \frac{5}{2.37 \times 10} \times 342 = 72 \text{ g}$$

$$172. (b) \text{ Given } k_b = x \text{ K kg mol}^{-1}$$

$$\Delta T_b = k_b \times m$$

$$\therefore y = x \times m$$

$$m = \frac{y}{x}$$

We know

$$\Delta T_f = k_f \times m$$

On substituting value of m,

$$\Delta T_t = \frac{yz}{x}$$

$$173. (d) \text{ Mass of non-volatile solute} = 1 \text{ g}$$

$$\text{Molar mass of solute} = 250 \text{ g mol}^{-1}$$

$$\text{Mass of benzene} = 51.2 \text{ g, } K_f = 5.12 \text{ K kg mol}^{-1}$$

$$\Delta T_f = \frac{K_f \times 1000 \times w_2}{M_2 \times w_1}$$

where,  $w_2$  = mass of the solute

$M_2$  = molar mass of solute

$w_1$  = mass of the solvent

$$\text{On substituting given values, } \Delta T_f = \frac{5.12 \times 1000 \times 1}{51.2 \times 250}$$

$$\therefore \Delta T_f = 0.4 \text{ K}$$

$$174. (d) \Delta T_b = iK_b m$$

$$\text{Given, } (\Delta T_b)_x > (\Delta T_b)_y$$

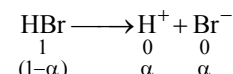
$$\therefore i_x K_b m > i_y K_b m \quad (K_b \text{ is same for same solvent})$$

$i_x > i_y$   
So, x is undergoing dissociation in water.

$$175. (b) \text{ Given mass of solute} = 8.1 \text{ g}$$

$$\text{Mass of solvent} = 100 \text{ g}$$

For HBr



$$\alpha = 90\% = 0.9$$

$$i = 1 + \alpha = 1 + 0.9 = 1.9$$

$$\Delta T_f = K_f \times m \times i$$

$$= 1.86 \times \frac{\text{moles of solute}}{\text{mass of solvent in kg}} \times 1.9$$

$$= 1.86 \times \frac{8.1/81}{100/1000} \times 1.9$$

$$= 1.86 \times 1 \times 1.9 = 3.534 \text{ K}$$

$$T_f = T_f^\circ - \Delta T_f$$

$$\text{or } T_f = 0 - 3.534 \text{ K}$$

$$\therefore T_f = -3.534 \text{ K}$$

$$176. (d) 1\% \text{ solution contains 1 g of the solute in 100 g of solution.}$$

Osmotic pressure,  $\pi = CRT$

The value of R and T is same for all the solute however, all of them undergo 100% dissociation

$$\therefore \pi \propto i \times C$$

$$i_{\text{KCl}} = 2, i_{\text{NaCl}} = 2, i_{\text{BaCl}_2} = 3 \text{ and } i_{\text{urea}} = 1.$$

$$n_{\text{KCl}} = 1/74.5$$

$$C_{\text{KCl}} = \frac{1/74.5}{100} \times 1000 = 0.13$$

$$\text{or } \pi_{\text{KCl}} = 2 \times 0.13 = 0.26$$

$$n_{\text{NaCl}} = \frac{1}{58.5}$$

$$C_{\text{NaCl}} = \frac{1/58.5}{100} \times 1000 = 0.17$$

$$\therefore \pi_{\text{NaCl}} = 2 \times 0.17 = 0.34$$

$$n_{\text{BaCl}_2} = \frac{1}{208.4}$$

$$C_{\text{BaCl}_2} = \frac{1/208.4}{100} \times 1000 = 0.048$$

$$\text{or } \pi_{\text{BaCl}_2} = 3 \times 0.048 = 0.14$$

$$n_{\text{urea}} = \frac{1}{60}$$

$$C_{\text{urea}} = \frac{1/60}{100} \times 1000 = 0.16$$

$$\therefore \pi_{\text{urea}} = 1 \times 0.16 = 0.16$$

$$\therefore \pi_{\text{BaCl}_2} < \pi_{\text{urea}} < \pi_{\text{KCl}} < \pi_{\text{NaCl}}$$

$$\text{or III} < \text{IV} < \text{I} < \text{II}$$

## 17

# ELECTROCHEMISTRY

### FACT/DEFINITION TYPE QUESTIONS

- Which of the following statements is incorrect regarding electrochemistry?
  - It is the study of production of electricity from energy released during spontaneous chemical reactions.
  - $\text{NaOH}$ ,  $\text{Cl}_2$ , alkali and alkaline earth metals are prepared by electrochemical methods.
  - The demerit associated with electrochemical methods is that they are more polluting. Thus they are eco-destructive.
  - Electrochemical reactions are more energy efficient and less polluting.
- What flows in the internal circuit of a galvanic cell?
  - Ions
  - Electrons
  - Electricity
  - Atoms
- Which of the following statements about galvanic cell is incorrect
  - anode is positive
  - oxidation occurs at the electrode with lower reduction potential
  - cathode is positive
  - reduction occurs at cathode
- Reaction that takes place at graphite anode in dry cell is
  - $\text{Zn}^{2+} + 2\text{e}^- \longrightarrow \text{Zn(s)}$
  - $\text{Zn(s)} \longrightarrow \text{Zn}^{2+} + 2\text{e}^-$
  - $\text{Mn}^{2+} + 2\text{e}^- \longrightarrow \text{Mn(s)}$
  - $\text{Mn(s)} \longrightarrow \text{Mn}^+ + \text{e}^- + 1.5\text{V}$
- In which of the following conditions salt bridge is not required in a galvanic cell?
  - When galvanic cell is used in geyser.
  - When distance between oxidation half cell and reduction half cell is negligible.
  - Electrolytic solutions used in both the half cells are of same concentration.
  - When both the electrodes are dipped in the same electrolytic solution.
- Which device converts chemical energy of a spontaneous redox reaction into electrical energy?
  - Galvanic cell
  - Electrolytic cell
  - Daniell cell
  - Both (a) and (c)
- $\text{Cl}^- \rightarrow \frac{1}{2}\text{Cl}_2 + \text{e}^-$       (b)  $\text{Cu} \rightarrow \text{Cu}^{++} + 2\text{e}^-$ 
  - $\text{Hg}^+ \rightarrow \text{Hg}^{++} + \text{e}^-$
  - $\text{Zn}^{2+} + 2\text{e}^- \rightarrow \text{Zn}$
- The cell reaction  $\text{Cu} + 2\text{Ag}^+ \rightarrow \text{Cu}^{+2} + 2\text{Ag}$  is best represented by
  - $\text{Cu(s)} | \text{Cu}^{+2}(\text{aq}) || \text{Ag}^+(\text{aq}) | \text{Ag(s)}$
  - $\text{Pt} | \text{Cu}^{+2} || \text{Ag}^+(\text{aq}) | \text{Ag(s)}$
  - $\text{Cu}^{+2} | \text{Cu} || \text{Pt} | \text{Ag}$
  - None of the above representations
- $\text{Zn(s)} | \underset{\text{(anode)}}{\text{Zn}^{2+}(\text{aq})} || \underset{\text{(cathode)}}{\text{Cu}^{2+}(\text{aq})} | \text{Cu(s)}$  is
  - Weston cell
  - Daniel cell
  - Calomel cell
  - Faraday cell
- The tendency of an electrode to lose electrons is known as
  - electrode potential
  - reduction potential
  - oxidation potential
  - e.m.f.
- The chemical reaction,  
 $2\text{AgCl(s)} + \text{H}_2(\text{g}) \longrightarrow 2\text{HCl(aq)} + 2\text{Ag(s)}$ taking place in a galvanic cell is represented by the notation
  - $\text{Pt(s)} | \text{H}_2(\text{g}), 1 \text{ bar} | 1\text{MKCl(aq)} | \text{AgCl(s)} | \text{Ag(s)}$
  - $\text{Pt(s)} | \text{H}_2(\text{g}), 1 \text{ bar} | 1\text{MHCl(aq)} | 1\text{MAg}^+(\text{aq}) | \text{Ag(s)}$
  - $\text{Pt(s)} | \text{H}_2(\text{g}), 1 \text{ bar} | 1\text{MHCl(aq)} | \text{AgCl(s)} | \text{Ag(s)}$
  - $\text{Pt(s)} | \text{H}_2(\text{g}), 1 \text{ bar} | 1\text{MHCl(aq)} | \text{Ag(s)} | \text{AgCl(s)}$
- Given that the standard reduction potentials for  $\text{M}^+/\text{M}$  and  $\text{N}^+/\text{N}$  electrodes at 298 K are 0.52 V and 0.25 V respectively. Which of the following is correct in respect of the following electrochemical cell ?
$$\text{M}/\text{M}^+ || \text{N}^+/\text{N}$$
  - The overall cell reaction is a spontaneous reaction.
  - The standard EMF of the cell is -0.27 V.
  - The standard EMF of the cell is 0.77 V.
  - The standard EMF of the cell is -0.77 V.



13. The difference between the electrode potentials of two electrodes when no current is drawn through the cell is called \_\_\_\_\_.

(a) Cell potentials (b) Cell emf  
(c) Potential difference (d) Cell voltage

14. For the given Nernst equation

$$E_{\text{cell}} = E^{\circ}_{\text{cell}} - \frac{RT}{2F} \ln \frac{[\text{Mg}^{2+}]}{[\text{Ag}^+]^2}$$

Which of the following representation is correct?

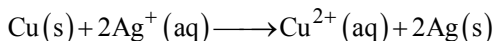
(a)  $\text{Ag}^+|\text{Ag}||\text{Mg}^{2+}|\text{Mg}$  (b)  $\text{Mg}^{2+}|\text{Mg}||\text{Ag}|\text{Ag}^+$   
(c)  $\text{Mg}|\text{Mg}^{2+}||\text{Ag}^+|\text{Ag}$  (d)  $\text{Mg}|\text{Mg}^{2+}||\text{Ag}|\text{Ag}^+$

15. For cell representation:



Which of the following is correct?

(i) Cu is reducing agent.  
(ii) Overall cell reaction is



(iii) Cu is cathode

(iv) Ag is anode

(a) (ii), (iii) and (iv) (b) (ii), (iii) and (iv)  
(c) (iii) and (iv) (d) (i) and (ii)

16. The reference electrode is made by using

(a)  $\text{ZnCl}_2$  (b)  $\text{CuSO}_4$   
(c)  $\text{Hg}_2\text{Cl}_2$  (d)  $\text{Hg}_2\text{Cl}_2$

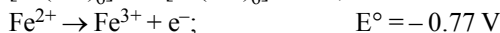
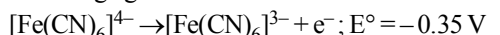
17. The standard hydrogen electrode potential is zero, because

(a) hydrogen oxidized easily  
(b) electrode potential is considered as zero  
(c) hydrogen atom has only one electron  
(d) hydrogen is a very light element

18. Without losing its concentration  $\text{ZnCl}_2$  solution cannot be kept in contact with

(a) Au (b) Al  
(c) Pb (d) Ag

19. On the basis of the following  $E^{\circ}$  values, the strongest oxidizing agent is :



(a)  $[\text{Fe}(\text{CN})_6]^{4-}$  (b)  $\text{Fe}^{2+}$   
(c)  $\text{Fe}^{3+}$  (d)  $[\text{Fe}(\text{CN})_6]^{3-}$

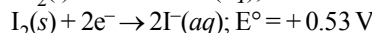
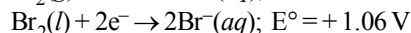
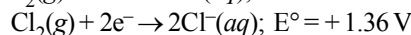
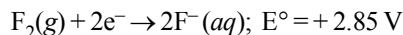
20. Standard electrode potential of three metals X, Y and Z are  $-1.2 \text{ V}$ ,  $+0.5 \text{ V}$  and  $-3.0 \text{ V}$ , respectively. The reducing power of these metals will be :

(a)  $Y > Z > X$  (b)  $X > Y > Z$   
(c)  $Z > X > Y$  (d)  $X > Y > Z$

21. Standard electrode potential for  $\text{Sn}^{4+}/\text{Sn}^{2+}$  couple is  $+0.15 \text{ V}$  and that for the  $\text{Cr}^{3+}/\text{Cr}$  couple is  $-0.74 \text{ V}$ . These two couples in their standard state are connected to make a cell. The cell potential will be

(a)  $+1.19 \text{ V}$  (b)  $+0.89 \text{ V}$   
(c)  $+0.18 \text{ V}$  (d)  $+1.83 \text{ V}$

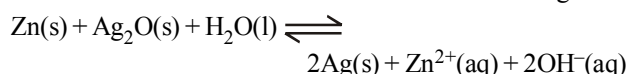
22. Standard reduction potentials of the half reactions are given below :



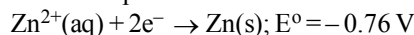
The strongest oxidising and reducing agents respectively are

(a)  $\text{F}_2$  and  $\text{I}^-$  (b)  $\text{Br}_2$  and  $\text{Cl}^-$   
(c)  $\text{Cl}_2$  and  $\text{Br}^-$  (d)  $\text{Cl}_2$  and  $\text{I}_2$

23. A button cell used in watches functions as following



If half cell potentials are :



The cell potential will be :

(a)  $0.42 \text{ V}$  (b)  $0.84 \text{ V}$   
(c)  $1.34 \text{ V}$  (d)  $1.10 \text{ V}$

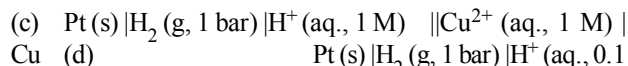
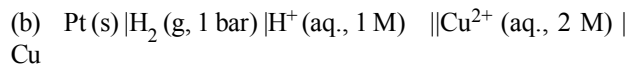
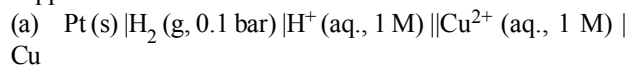
24. The oxidation potentials of A and B are  $+2.37$  and  $+1.66 \text{ V}$  respectively. In chemical reactions

(a) A will be replaced by B  
(b) A will replace B  
(c) A will not replace B  
(d) A and B will not replace each other

25. A smuggler could not carry gold by depositing iron on the gold surface since

(a) gold is denser  
(b) iron rusts  
(c) gold has higher reduction potential than iron  
(d) gold has lower reduction potential than iron

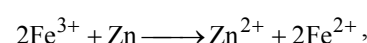
26. Which cell will measure standard electrode potential of copper electrode ?



27. Which of the following statement is not correct about an inert electrode in a cell ?

(a) It does not participate in the cell reaction.  
(b) It provides surface either for oxidation or for reduction reaction.  
(c) It provides surface for conduction of electrons.  
(d) It provides surface for redox reaction.

28. In the electrochemical reaction



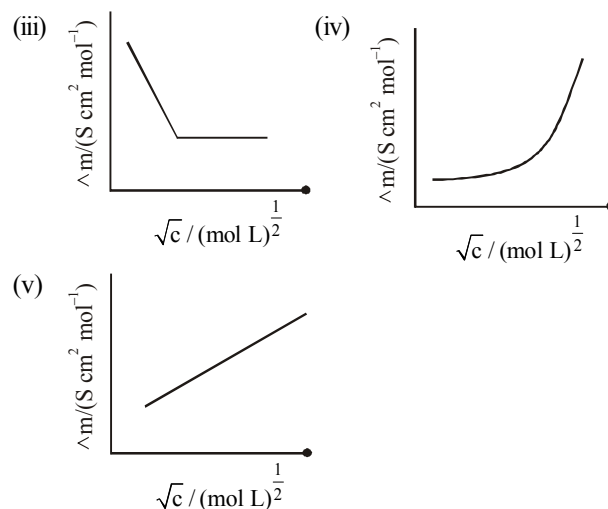
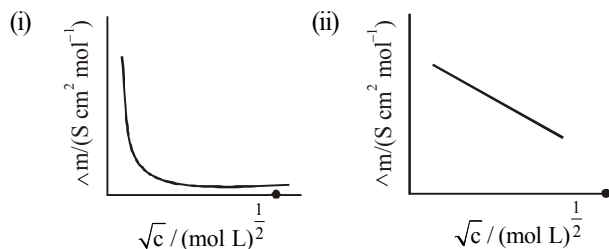
on increasing the concentration of  $\text{Fe}^{2+}$

(a) increases cell emf  
(b) increases the current flow  
(c) decreases the cell emf  
(d) alters the pH of the solution

29. The standard e.m.f. of a galvanic cell involving cell reaction with  $n = 2$  is found to be 0.295 V at 25°C. The equilibrium constant of the reaction would be  
(Given  $F = 96500 \text{ C mol}^{-1}$ ;  $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$ )  
(a)  $2.0 \times 10^{11}$  (b)  $4.0 \times 10^{12}$   
(c)  $1.0 \times 10^2$  (d)  $1.0 \times 10^{10}$
30. What will be the emf for the given cell  
 $\text{Pt} | \text{H}_2 (P_1) | \text{H}^+ (aq) || \text{H}_2 (P_2) | \text{Pt}$   
(a)  $\frac{RT}{F} \log_e \frac{P_1}{P_2}$  (b)  $\frac{RT}{2F} \log_e \frac{P_1}{P_2}$   
(c)  $\frac{RT}{F} \log_e \frac{P_2}{P_1}$  (d) None of these
31. The value of electrode potential ( $10^{-4} \text{ M}$ )  $\text{H}^+ | \text{H}_2 (1 \text{ atm}) | \text{Pt}$  at 298 K would be  
(a)  $-0.236 \text{ V}$  (b)  $+0.404 \text{ V}$   
(c)  $+0.236 \text{ V}$  (d)  $-0.476 \text{ V}$
32. According to Nernst equation, which is not correct if  $Q = K_c$ :  
(a)  $E_{\text{cell}} = 0$  (b)  $\frac{RT}{nF} \ln Q = E_{\text{cell}}^\circ$   
(c)  $K_c = e^{\frac{nFE_{\text{cell}}^\circ}{RT}}$  (d)  $E_{\text{cell}} = E_{\text{cell}}^\circ$
33. The standard emf of a cell, involving one electron change is found to be 0.591 V at 25°C. The equilibrium constant of the reaction is ( $F = 96500 \text{ C mol}^{-1}$ )  
(a)  $1.0 \times 10^1$  (b)  $1.0 \times 10^5$   
(c)  $1.0 \times 10^{10}$  (d)  $1.0 \times 10^{30}$
34. For the galvanic cell  
 $\text{Zn} | \text{Zn}^{2+} (0.1 \text{ M}) || \text{Cu}^{2+} (1.0 \text{ M}) | \text{Cu}$  the cell potential increase if  
(a)  $[\text{Zn}^{2+}]$  is increased  
(b)  $[\text{Cu}^{2+}]$  is increased  
(c)  $[\text{Cu}^{2+}]$  is decreased  
(d) surface area of anode is increased
35. Consider the following cell reaction:  
 $2\text{Fe}(s) + \text{O}_2(g) + 4\text{H}^+(aq) \rightarrow 2\text{Fe}^{2+}(aq) + 2\text{H}_2\text{O}(l); E^\circ = 1.67 \text{ V}$   
At  $[\text{Fe}^{2+}] = 10^{-3} \text{ M}$ ,  $p(\text{O}_2) = 0.1 \text{ atm}$  and  $\text{pH} = 3$ , the cell potential at 25°C is  
(a) 1.47 V (b) 1.77 V  
(c) 1.87 V (d) 1.57 V
36. The e.m.f. of a Daniell cell at 298 K is  $E_1$ .  
 $\text{Zn} \left| \text{ZnSO}_4 \right| \left| \text{CuSO}_4 \right| \text{Cu}$   
(0.01 M) (1.0 M)  
When the concentration of  $\text{ZnSO}_4$  is 1.0 M and that of  $\text{CuSO}_4$  is 0.01 M, the e.m.f. changed to  $E_2$ . What is the relationship between  $E_1$  and  $E_2$ ?  
(a)  $E_2 = 0 \neq E_1$  (b)  $E_1 > E_2$   
(c)  $E_1 < E_2$  (d)  $E_1 = E_2$
37. The electrode potential  $E_{(\text{Zn}^{2+}/\text{Zn})}$  of a zinc electrode at 25°C with an aqueous solution of 0.1 M  $\text{ZnSO}_4$  is  
 $[E_{(\text{Zn}^{2+}/\text{Zn})}^\circ = -0.76 \text{ V. Assume } \frac{2.303RT}{F} = 0.06 \text{ at } 298 \text{ K.}]$   
(a) +0.73 (b) -0.79  
(c) -0.82 (d) -0.70
38. In the cell reaction  
 $\text{Cu}(s) + 2\text{Ag}^+(aq) \longrightarrow \text{Cu}^{2+}(aq) + 2\text{Ag}(s)$ ,  
 $E_{\text{cell}}^\circ = 0.46 \text{ V}$ . By doubling the concentration of  $\text{Cu}^{2+}$ ,  $E_{\text{cell}}^\circ$  will become  
(a) doubled  
(b) halved  
(c) increases but less than double  
(d) decreases by a small fraction
39.  $E^\circ$  of a cell  $a\text{A} + b\text{B} \longrightarrow c\text{C} + d\text{D}$  is  
(a)  $E + RT \ln \frac{[a]^A [b]^B}{[c]^C [d]^D}$  (b)  $E + \frac{RT}{nF} \ln \frac{[C]^c [D]^d}{[A]^a [B]^b}$   
(c)  $E + \frac{RT}{nF} \ln \frac{[C]^c [d]^D}{[A]^A [B]^B}$  (d)  $E + \frac{RT}{nF} \ln \frac{[a]^A [B]^B}{[C]^C [d]^D}$
40.  $E^\circ$  for the cell,  
 $\text{Zn} | \text{Zn}^{2+}(aq) || \text{Cu}^{2+}(aq) | \text{Cu}$  is 1.10 V at 25°C. The equilibrium constant for the cell reaction  
 $\text{Zn} + \text{Cu}^{2+}(aq) \rightleftharpoons \text{Cu} + \text{Zn}^{2+}(aq)$   
is of the order of  
(a)  $10^{-37}$  (b)  $10^{37}$   
(c)  $10^{-17}$  (d)  $10^{17}$
41. What is the standard cell potential  $E^\circ$  for an electrochemical cell in which the following reaction takes place spontaneously?  
 $\text{Cl}_2(g) + 2\text{Br}^- \rightarrow \text{Br}_2(aq) + 2\text{Cl}^-$   $\Delta G^\circ = -50.6 \text{ kJ}$   
(a) 1.2 V (b) 0.53 V  
(c) 0.26 V (d) -0.53 V
42. If 0.01 M solution of an electrolyte has a resistance of 40 ohms in a cell having a cell constant of  $0.4 \text{ cm}^{-1}$ , then its molar conductance in  $\text{ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$  is  
(a)  $10^2$  (b)  $10^4$   
(c) 10 (d)  $10^3$
43. Specific conductance of a 0.1 N KCl solution at 23°C is  $0.012 \text{ ohm}^{-1} \text{ cm}^{-1}$ . Resistance of cell containing the solution at same temperature was found to be 55 ohm. The cell constant is  
(a)  $0.0616 \text{ cm}^{-1}$  (b)  $0.66 \text{ cm}^{-1}$   
(c)  $6.60 \text{ cm}^{-1}$  (d)  $660 \text{ cm}^{-1}$
44. The unit of equivalent conductivity is  
(a) ohm cm  
(b)  $\text{ohm}^{-1} \text{ cm}^2 (\text{g equivalent})^{-1}$   
(c)  $\text{ohm cm}^2 (\text{g equivalent})$   
(d)  $\text{S cm}^{-2}$

45. The resistance of 0.01 N solution of an electrolyte was found to be 220 ohm at 298 K using a conductivity cell with a cell constant of  $0.88 \text{ cm}^{-1}$ . The value of equivalent conductance of solution is –  
 (a)  $400 \text{ mho cm}^2 \text{ g eq}^{-1}$  (b)  $295 \text{ mho cm}^2 \text{ g eq}^{-1}$   
 (c)  $419 \text{ mho cm}^2 \text{ g eq}^{-1}$  (d)  $425 \text{ mho cm}^2 \text{ g eq}^{-1}$
46. Specific conductance of 0.1 M  $\text{HNO}_3$  is  $6.3 \times 10^{-2} \text{ ohm}^{-1} \text{ cm}^{-1}$ . The molar conductance of the solution is  
 (a)  $100 \text{ ohm}^{-1} \text{ cm}^2$  (b)  $515 \text{ ohm}^{-1} \text{ cm}^2$   
 (c)  $630 \text{ ohm}^{-1} \text{ cm}^2$  (d)  $6300 \text{ ohm}^{-1} \text{ cm}^2$
47. The specific conductance of a 0.1 N KCl solution at  $23^\circ\text{C}$  is  $0.012 \text{ ohm}^{-1} \text{ cm}^{-1}$ . The resistance of cell containing the solution at the same temperature was found to be 55 ohm. The cell constant will be  
 (a)  $0.142 \text{ cm}^{-1}$  (b)  $0.66 \text{ cm}^{-1}$   
 (c)  $0.918 \text{ cm}^{-1}$  (d)  $1.12 \text{ cm}^{-1}$
48. The unit of specific conductivity is  
 (a)  $\text{ohm cm}^{-1}$  (b)  $\text{ohm cm}^{-2}$   
 (c)  $\text{ohm}^{-1} \text{ cm}$  (d)  $\text{ohm}^{-1} \text{ cm}^{-1}$
49. Which of the following solutions of KCl will have the highest value of specific conductance?  
 (a) 1.0 N (b) 0.1 N  
 (c)  $1.0 \times 10^{-2} \text{ N}$  (d)  $1.0 \times 10^{-3} \text{ N}$
50. The cell constant of a conductivity cell \_\_\_\_\_.  
 (a) changes with change of electrolyte.  
 (b) changes with change of concentration of electrolyte.  
 (c) changes with temperature of electrolyte.  
 (d) remains constant for a cell.
51. Which of the following pair(s) is/are incorrectly matched?  
 (i) R (resistance) – ohm ( $\Omega$ )  
 (ii)  $\rho$  (resistivity) – ohm metre ( $\Omega\text{m}$ )  
 (iii) G (conductance) – seimens or ohm (S)  
 (iv)  $\kappa$  (conductivity) – seimens metre $^{-1}$  ( $\text{Sm}^{-1}$ )  
 (a) (i), (ii) and (iii) (b) (ii) and (iii)  
 (c) (i), (ii) and (iv) (d) (iii) only
52. On which of the following magnitude of conductivity does not depends?  
 (a) Nature of material (b) Temperature  
 (c) Pressure (d) Mass of the material
53. Which of the following expression correctly represents molar conductivity?  
 (a)  $\Lambda_m = \frac{K}{C}$  (b)  $\Lambda_m = \frac{KA}{l}$   
 (c)  $\Lambda_m = KV$  (d) All of these

54. Which of the following represents variation of molar conductance of electrolyte with (concentration) $^{1/2}$  respectively for weak and strong electrolyte?



	Weak acid	Strong acid
(a)	(iv)	(v)
(b)	(ii)	(iv)
(c)	(i)	(ii)
(d)	(iii)	(ii)

55.

Electrolyte:	KCl	$\text{KNO}_3$	HCl	NaOAc	NaCl
$\Lambda^\infty (\text{S cm}^2 \text{ mol}^{-1})$ :	149.9	145	426.2	91	126.5

Calculate  $\Lambda_{\text{HOAc}}^\infty$  using appropriate molar conductances of the electrolytes listed above at infinite dilution in  $\text{H}_2\text{O}$  at  $25^\circ\text{C}$

- (a) 217.5 (b) 390.7  
 (c) 552.7 (d) 517.2
56. Kohlrausch's law states that at  
 (a) finite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte, whatever be the nature of the other ion of the electrolyte.  
 (b) infinite dilution each ion makes definite contribution to equivalent conductance of an electrolyte depending on the nature of the other ion of the electrolyte.  
 (c) infinite dilution, each ion makes definite contribution to conductance of an electrolyte whatever be the nature of the other ion of the electrolyte.  
 (d) infinite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte, whatever be the nature of the other ion of the electrolyte.
57. Which of the following expressions correctly represents the equivalent conductance at infinite dilution of  $\text{Al}_2(\text{SO}_4)_3$ ,

Given that  $\Lambda_{\text{Al}^{3+}}^\circ$  and  $\Lambda_{\text{SO}_4^{2-}}^\circ$  are the equivalent conductances at infinite dilution of the respective ions?

- (a)  $\frac{1}{3} \Lambda_{\text{Al}^{3+}}^\circ + \frac{1}{2} \Lambda_{\text{SO}_4^{2-}}^\circ$  (b)  $2 \Lambda_{\text{Al}^{3+}}^\circ + 3 \Lambda_{\text{SO}_4^{2-}}^\circ$   
 (c)  $\Lambda_{\text{Al}^{3+}}^\circ + \Lambda_{\text{SO}_4^{2-}}^\circ$  (d)  $(\Lambda_{\text{Al}^{3+}}^\circ + \Lambda_{\text{SO}_4^{2-}}^\circ) \times 6$

58. Limiting molar conductivity of  $\text{NH}_4\text{OH}$  (i.e.,  $\Lambda_m^\circ(\text{NH}_4\text{OH})$ ) is equal to :
- $\Lambda_m^\circ(\text{NH}_4\text{Cl}) + \Lambda_m^\circ(\text{NaCl}) - \Lambda_m^\circ(\text{NaOH})$
  - $\Lambda_m^\circ(\text{NaOH}) + \Lambda_m^\circ(\text{NaCl}) - \Lambda_m^\circ(\text{NH}_4\text{Cl})$
  - $\Lambda_m^\circ(\text{NH}_4\text{OH}) + \Lambda_m^\circ(\text{NH}_4\text{Cl}) - \Lambda_m^\circ(\text{HCl})$
  - $\Lambda_m^\circ(\text{NH}_4\text{Cl}) + \Lambda_m^\circ(\text{NaOH}) - \Lambda_m^\circ(\text{NaCl})$
59. Molar conductivities ( $\Lambda_m^\circ$ ) at infinite dilution of  $\text{NaCl}$ ,  $\text{HCl}$  and  $\text{CH}_3\text{COONa}$  are 126.4, 425.9 and  $91.0 \text{ S cm}^2 \text{ mol}^{-1}$  respectively.  $\Lambda_m^\circ$  for  $\text{CH}_3\text{COOH}$  will be
- $425.5 \text{ S cm}^2 \text{ mol}^{-1}$
  - $180.5 \text{ S cm}^2 \text{ mol}^{-1}$
  - $290.8 \text{ S cm}^2 \text{ mol}^{-1}$
  - $390.5 \text{ S cm}^2 \text{ mol}^{-1}$
60. At  $25^\circ\text{C}$ , the molar conductance at infinite dilution for the strong electrolytes  $\text{NaOH}$ ,  $\text{NaCl}$  and  $\text{BaCl}_2$  are  $248 \times 10^{-4}$ ,  $126 \times 10^{-4}$  and  $280 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$  respectively.  $\Lambda_m^\circ \text{ Ba(OH)}_2$  in  $\text{S m}^2 \text{ mol}^{-1}$  is
- $52.4 \times 10^{-4}$
  - $524 \times 10^{-4}$
  - $402 \times 10^{-4}$
  - $262 \times 10^{-4}$
61.  $\Lambda_{\text{ClCH}_2\text{COONa}} = 224 \text{ ohm}^{-1} \text{ cm}^2 \text{ gmeq}^{-1}$ ,  
 $\Lambda_{\text{NaCl}} = 38.2 \text{ ohm}^{-1} \text{ cm}^2 \text{ gmeq}^{-1}$ ,  
 $\Lambda_{\text{HCl}} = 203 \text{ ohm}^{-1} \text{ cm}^2 \text{ gmeq}^{-1}$ ,  
 What is the value of  $\Lambda_{\text{ClCH}_2\text{COOH}}$
- $288.5 \text{ ohm}^{-1} \text{ cm}^2 \text{ gmeq}^{-1}$
  - $289.5 \text{ ohm}^{-1} \text{ cm}^2 \text{ gmeq}^{-1}$
  - $388.8 \text{ ohm}^{-1} \text{ cm}^2 \text{ gmeq}^{-1}$
  - $59.5 \text{ ohm}^{-1} \text{ cm}^2 \text{ gmeq}^{-1}$
62. At  $25^\circ\text{C}$  molar conductance of 0.1 molar aqueous solution of ammonium hydroxide is  $9.54 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$  and at infinite dilution its molar conductance is  $238 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$ . The degree of ionisation of ammonium hydroxide at the same concentration and temperature is:
- 20.800%
  - 4.008%
  - 40.800%
  - 2.080%
63. The electrical properties and their respective SI units are given below. Identify the wrongly matched pair.
- | Electrical property        | SI unit                            |
|----------------------------|------------------------------------|
| (a) Specific conductance   | $\text{S m}^{-1}$                  |
| (b) Conductance            | S                                  |
| (c) Equivalent conductance | $\text{S m}^2 \text{ gequiv}^{-1}$ |
| (d) Cell constant          | m                                  |
64. The ion of least limiting molar conductivity among the following is
- $\text{SO}_4^{2-}$
  - $\text{H}^+$
  - $\text{Ca}^{2+}$
  - $\text{CH}_3\text{COO}^-$
65. Molar ionic conductivities of a two-bivalent electrolytes  $x^{2+}$  and  $y^{2-}$  are 57 and 73 respectively. The molar conductivity of the solution formed by them will be
- $130 \text{ S cm}^2 \text{ mol}^{-1}$
  - $65 \text{ S cm}^2 \text{ mol}^{-1}$
  - $260 \text{ S cm}^2 \text{ mol}^{-1}$
  - $187 \text{ S cm}^2 \text{ mol}^{-1}$
66. On electrolysis of dilute sulphuric acid using platinum electrodes, the product obtained at the anode will be
- hydrogen
  - oxygen
  - hydrogen sulphide
  - Sulphur dioxide
67. If 0.5 amp current is passed through acidified silver nitrate solution for 100 minutes. The mass of silver deposited on cathode, is (eq.wt. of silver nitrate = 108)
- 2.3523 g
  - 3.3575 g
  - 5.3578 g
  - 6.3575 g
68. Aluminium oxide may be electrolysed at  $1000^\circ\text{C}$  to furnish aluminium metal (At. Mass = 27 amu; 1 Faraday = 96,500 Coulombs). The cathode reaction is—  $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$   
 To prepare 5.12 kg of aluminium metal by this method we require electricity of
- $5.49 \times 10^1 \text{ C}$
  - $5.49 \times 10^4 \text{ C}$
  - $1.83 \times 10^7 \text{ C}$
  - $5.49 \times 10^7 \text{ C}$
69. Which of the following is the use of electrolysis?
- Electrorefining
  - Electroplating
  - Both (a) & (b)
  - None of these
70. An electrolytic cell contains a solution of  $\text{Ag}_2\text{SO}_4$  and has platinum electrodes. A current is passed until 1.6 gm of  $\text{O}_2$  has been liberated at anode. The amount of silver deposited at cathode would be
- 107.88 gm
  - 1.6 gm
  - 0.8 gm
  - 21.60 gm
71. When 9650 coulombs of electricity is passed through a solution of copper sulphate, the amount of copper deposited is (given at. wt. of Cu = 63.6)
- 0.318 g
  - 3.18 g
  - 31.8 g
  - 63.6 g
72. Find the charge in coulombs required to convert 0.2 mole  $\text{VO}_3^{2-}$  into  $\text{VO}_4^{3-}$ —
- $1.93 \times 10^4$
  - $9.65 \times 10^4$
  - $1.93 \times 10^5$
  - $9.65 \times 10^5$
73. A silver cup is plated with silver by passing 965 coulombs of electricity. The amount of Ag deposited is :
- 107.89 g
  - 9.89 g
  - 1.0002 g
  - 1.08 g
74. The number of coulombs required to reduce 12.3 g of nitrobenzene to aniline is :
- 115800 C
  - 5790 C
  - 28950 C
  - 57900 C
75. The amount of electricity that can deposit 108 g of Ag from  $\text{AgNO}_3$  solution is:
- 1 F
  - 2 A
  - 1 C
  - 1 A

76. To deposit one equivalent weight of silver at cathode, the charge required will be  
 (a)  $9.65 \times 10^4 \text{ C}$  (b)  $9.65 \times 10^3 \text{ C}$   
 (c)  $9.65 \times 10^5 \text{ C}$  (d)  $9.65 \times 10^7 \text{ C}$
77. The volume of oxygen gas liberated at NTP by passing a current of 9650 coulombs through acidified water is  
 (a) 1.12 litre (b) 2.24 litre  
 (c) 11.2 litre (d) 22.4 litre
78. Three faradays electricity was passed through an aqueous solution of iron (II) bromide. The weight of iron metal (at. wt = 65) deposited at the cathode (in gm) is  
 (a) 56 (b) 84  
 (c) 112 (d) 168
79. On passing  $C$  ampere of electricity through a electrolyte solution for  $t$  second.  $m$  gram metal deposits on cathode. The equivalent weight  $E$  of the metal is  
 (a)  $E = \frac{C \times t}{m \times 96500}$  (b)  $E = \frac{C \times m}{t \times 96500}$   
 (c)  $E = \frac{96500 \times m}{C \times t}$  (d)  $E = \frac{C \times t \times 96500}{m}$
80. The number of electrons passing per second through a cross-section of copper wire carrying  $10^{-6}$  amperes of current per second is found to be  
 (a)  $1.6 \times 10^{-19}$  (b)  $6 \times 10^{-35}$   
 (c)  $6 \times 10^{-16}$  (d)  $6 \times 10^{12}$
81. Faraday's laws of electrolysis will fail when  
 (a) temperature is increased  
 (b) inert electrodes are used  
 (c) a mixture of electrolytes is used  
 (d) None of these cases
82. The electric charge for electrode decomposition of one gram equivalent of a substance is  
 (a) one ampere per second  
 (b) 96500 coulombs per second  
 (c) one ampere for one hour  
 (d) charge on one mole of electrons
83. In electrolysis of dilute  $\text{H}_2\text{SO}_4$  using platinum electrodes  
 (a)  $\text{H}_2$  is evolved at cathode  
 (b)  $\text{NH}_2$  is produced at anode  
 (c)  $\text{Cl}_2$  is obtained at cathode  
 (d)  $\text{O}_2$  is produced
84. In electrolysis of  $\text{NaCl}$  when Pt electrode is taken then  $\text{H}_2$  is liberated at cathode while with Hg cathode it forms sodium amalgam. This is because  
 (a) Hg is more inert than Pt  
 (b) more voltage is required to reduce  $\text{H}^+$  at Hg than at Pt  
 (c) Na is dissolved in Hg while it does not dissolve in Pt  
 (d) conc. of  $\text{H}^+$  ions is larger when Pt electrode is taken
85. Electrolysis of fused  $\text{NaCl}$  will give  
 (a) Na (b) NaOH  
 (c) NaClO (d) None of these
86. How many moles of Pt may be deposited on the cathode when 0.80 F of electricity is passed through a 1.0 M solution of  $\text{Pt}^{4+}$ ?  
 (a) 1.0 mol (b) 0.20 mol  
 (c) 0.40 mol (d) 0.80 mol
87. A current strength of 9.65 amperes is passed through excess fused  $\text{AlCl}_3$  for 5 hours. How many litres of chlorine will be liberated at STP? ( $F = 96500 \text{ C}$ )  
 (a) 2.016 (b) 1.008  
 (c) 11.2 (d) 20.16
88. A solution of copper sulphate ( $\text{CuSO}_4$ ) is electrolysed for 10 minutes with a current of 1.5 amperes. The mass of copper deposited at the cathode (at. mass of Cu = 63u) is  
 (a) 0.3892g (b) 0.2938g  
 (c) 0.2398g (d) 0.3928g
89. When 0.1 mol  $\text{MnO}_4^{2-}$  is oxidised the quantity of electricity required to completely oxidise  $\text{MnO}_4^{2-}$  to  $\text{MnO}_4^-$  is  
 (a) 96500 C (b)  $2 \times 96500 \text{ C}$   
 (c) 9650 C (d) 96.50 C
90. The weight of silver (at wt. = 108) displaced by a quantity of electricity which displaces 5600 mL of  $\text{O}_2$  at STP will be  
 (a) 5.4 g (b) 10.8 g  
 (c) 54.9 g (d) 108.0 g
91. Electrolysis of a salt solution was carried out, after some time solution turned yellow than salt can be  
 (i) NaCl (ii) KCl  
 (iii) RbCl (iv) KBr  
 (a) (i), (ii) and (iii) (b) (ii), (ii) and (iv)  
 (c) (i), (ii) and (iv) (d) (i), (iii) and (iv)
92. Which of the following statements is incorrect?  
 (a) Both electronic and electrolytic conductance depends on the nature of conducting material.  
 (b) Both electronic and electrolytic conductance varies similarly with temperature.  
 (c) Electronic conductance is independent but electrolytic conductance depends on the amount of the conducting substance.  
 (d) All the above statements are incorrect.
93. Which of the following statements is incorrect?  
 (a) Electrodes made up of gold participates in the chemical reaction.  
 (b) Electrolytic products of  $\text{NaCl}$  are Na and  $\text{Cl}_2$  whereas of aqueous  $\text{NaCl}$  are NaOH,  $\text{Cl}_2$  and  $\text{H}_2$ .  
 (c) During electrolysis at cathode, reaction with higher value of  $E^\ominus$  is preferred.  
 (d) All of the above statements are incorrect.
94. During electrolysis of sulphuric acid, which of the following processes is possible at anode?  
 A.  $2\text{H}_2\text{O}(\text{l}) \longrightarrow \text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{e}^-$   $E_{\text{cell}}^\ominus + 1.23 \text{ V}$   
 B.  $2\text{SO}_4^{2-}(\text{aq}) \longrightarrow \text{S}_2\text{O}_8^{2-}(\text{aq}) + 2\text{e}^-$   $E_{\text{cell}}^\ominus 1.96 \text{ V}$



- Choose the correct option based on following statements.
- Process A is preferred at higher concentration of sulphuric acid.
  - Process B is preferred at higher concentration of sulphuric acid.
  - Process A is preferred for dilute sulphuric acid.
  - Process B is preferred for dilute sulphuric acid.
  - Both A and B are equally possible at higher concentration.
- Which of the following metals is not produced by electrochemical reduction?
    - Na
    - Fe
    - Mg
    - Al
  - As lead storage battery is charged
    - lead dioxide dissolves
    - sulphuric acid is regenerated
    - lead electrode becomes coated with lead sulphate
    - the concentration of sulphuric acid decreases
  - During the charging of lead storage battery, the reaction at anode is represented by
    - $\text{Pb}^{2+} + \text{SO}_4^{2-} \longrightarrow \text{PbSO}_4$
    - $\text{PbSO}_4 + 2\text{H}_2\text{O} \longrightarrow \text{PbO}_2 + \text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^-$
    - $\text{Pb} \longrightarrow \text{Pb}^{2+} + 2\text{e}^-$
    - $\text{Pb}^{2+} + 2\text{e}^- \longrightarrow \text{Pb}$
  - Which colourless gas evolves, when  $\text{NH}_4\text{Cl}$  reacts with zinc in a dry cell battery
    - $\text{NH}_4$
    - $\text{N}_2$
    - $\text{H}_2$
    - $\text{Cl}_2$
  - In a hydrogen-oxygen fuel cell, combustion of hydrogen occurs to
    - produce high purity water
    - create potential difference between two electrodes
    - generate heat
    - remove adsorbed oxygen from electrode surfaces
  - Among the following cells:
 

Leclanche cell (i)

Nickel-Cadmium cell (ii)

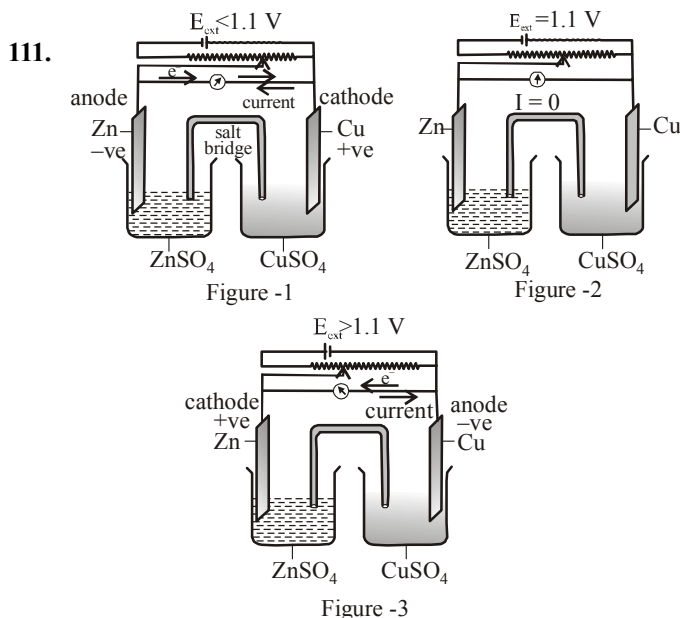
Lead storage battery (iii)

Mercury cell (iv)

primary cells are

    - (i) and (ii)
    - (i) and (iii)
    - (ii) and (iii)
    - (i) and (iv)
  - The electrolyte used in Leclanche cell is
    - paste of KOH and ZnO
    - 38% solution of  $\text{H}_2\text{SO}_4$
    - moist paste of  $\text{NH}_4\text{Cl}$  and  $\text{ZnCl}_2$
    - moist sodium hydroxide
  - A device that converts energy of combustion of fuels like hydrogen and methane, directly into electrical energy is known as :
    - Electrolytic cell
    - Dynamo
    - Ni-Cd cell
    - Fuel Cell
  - Which one of the following cells can convert chemical energy of  $\text{H}_2$  and  $\text{O}_2$  directly into electrical energy?
    - Mercury cell
    - Daniell cell
    - Fuel cell
    - Lead storage cell
  - Hydrogen-Oxygen fuel cells are used in space craft to supply
    - power for heat and light
    - power for pressure
    - oxygen
    - water
  - Prevention of corrosion of iron by zinc coating is called
    - electrolysis
    - photoelectrolysis
    - cathodic protection
    - galvanization
  - The best way to prevent rusting of iron is
    - making it cathode
    - putting in saline water
    - Both of these
    - None of these
  - Several blocks of magnesium are fixed to the bottom of a ship to
    - make the ship lighter
    - prevent action of water and salt
    - prevent puncturing by under-sea rocks
    - keep away the sharks
  - Which of the following batteries cannot be reused?
    - Lead storage battery
    - Ni-Cd cell
    - Mercury cell
    - Both (b) and (c)
  - Which of the following is a merit of Ni-Cd cell over lead storage battery?
    - Ni-Cd cell can be re-used.
    - Ni-Cd cell is comparatively economical to manufacture
    - Ni-Cd cell has comparatively longer life
    - All the above are the merits of Ni-Cd cell over lead storage battery.
  - Which of the following statements regarding fuel cell is incorrect?
    - These cells are eco-friendly.
    - These cells convert energy of combustion of fuels like  $\text{H}_2$ ,  $\text{CH}_4$ ,  $\text{CH}_3\text{OH}$  etc., directly into electrical energy.
    - $\text{H}_2 - \text{O}_2$  fuel cell is used in Apollo space programme.
    - Fuel cells produce electricity with an efficiency of about 100%.

### STATEMENT TYPE QUESTIONS

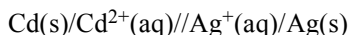


- (i) Figure 1 represents electrochemical and Figure 3 represents electrolytic cell.
- (ii) Figure 2 represents electrolytic and Figure 3 represents electrochemical cell.
- (iii) Figure 2 represents a cell which is not working i.e. no current flows through the cell.
- (iv) Energy conversion shown in Figure 1 is chemical to electrical whereas energy conversion shown in Figure 2 is electrical to chemical.

Which of the following is the correct coding for the statements above.

- (a) TFFT (b) TTTT
- (c) TFFT (d) FTFF

112. Which of the following statements regarding given cell representation is/are correct?



- (i) In the given cell Cd electrode act as an anode whereas Ag electrode acts as a cathode.
- (ii) In the given cell Cd electrode acts as a cathode whereas Ag electrode acts as a anode.

$$\text{(iii)} \quad E_{\text{cell}} = E_{\text{Ag}^{+}/\text{Ag}} - E_{\text{Cd}^{2+}/\text{Cd}}$$

- (a) (i) and (ii) (b) Only (ii)
- (c) Only (i) (d) (i) and (iii)

113. Which of the following is/are correct statement(s) for the addition of Li, K, Rb to the aqueous solution of  $\text{Na}^{+}$ .

- (i) The correct order of metals in which they reduce the  $\text{Na}^{+}$  ion is  $\text{Rb} < \text{K} < \text{Li}$ .
- (ii) Reduction of metal ions would not take place.
- (a) Statement (i) and (ii) are correct.
- (b) Statement (i) is correct only.
- (c) Statement (ii) is correct only.
- (d) Neither (i) nor (ii) is correct.

114. Read the following statements carefully.

- (i) According to a convention cell potential of hydrogen electrode (S.H.E.) is considered to be zero at all temperatures.
- (ii) e.m.f. of the cell  $\text{Pt(s)}/\text{H}_2(\text{g}, 1 \text{ bar})/\text{H}^{+}(\text{aq}, 1 \text{ M})//\text{Zn}^{2+}(\text{aq}, 1\text{M})/\text{Zn}$  is  $-0.76$ . This negative value indicates that  $\text{Zn}^{2+}$  ion reduces less easily than  $\text{H}^{+}$  ions.
- (iii) Copper does not dissolve in  $\text{HCl}$  but dissolves in  $\text{HNO}_3$  as in nitric acid it gets oxidised by nitrate ion.
- (iv) Inert metals like Pt or Au are used in certain electrodes i.e., these metals does not participate in reaction but provide surface for oxidation and reduction reactions.
- (v) Fluorine has the highest electrode potential thereby making it strongest oxidising agent whereas lithium with lowest electrode potential is the weakest oxidising and strongest reducing agent.

Which of the following is the correct coding for the statements above.

- (a) TTTTT (b) TTFTF
- (c) FFTTT (d) FFFTT

115. Which of the following statement(s) is/are correct?

- (i) Molar conductivity for strong electrolytes increases gradually and of weak electrolytes increases rapidly on dilution.
- (ii) If  $\alpha$  is the degree of dissociation of weak electrolytes.

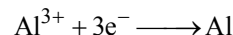
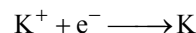
$$\text{Then, } \alpha = \frac{\Lambda_m}{\Lambda_m^{\circ}}$$

- (iii) Molar conductivity of  $\text{CaX}_2$  increases rapidly on dilution.

- (a) (i) and (iii) (b) (ii) only
- (c) (i) only (d) (i) and (ii)

116. Read the following statements.

- (i) According to Faraday's second law amounts of different substances liberated by same quantity of electricity passing through the electrolytic solution are proportional to their chemical equivalent weights.
- (ii)  $1 \text{ F} = 96487 \text{ Cmol}^{-1} \approx 96500 \text{ Cmol}^{-1}$  (for more accurate calculation).
- (iii) As per electrode reactions



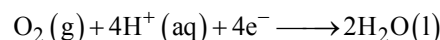
one mole of  $\text{K}^{+}$  and  $\text{Al}^{3+}$  require 1(1F) and 3(3F) mol of electrons respectively.

Which of the following is the correct coding for the above statements?

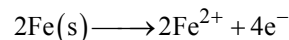
- (a) TTT (b) FFT
- (c) TFT (d) FTF

117. Which of the following statement(s) is/ are incorrect for corrosion of iron?

- (i) Reaction occurring at anode is



- (ii) Reaction occurring at cathode is



- (iii) Rust is  $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
- (iv)  $\text{H}^{+}$  involved in corrosion reaction is provided from  $\text{H}_2\text{CO}_3$  which is formed due to dissolution of carbon dioxide from air in to water.

- (a) (iv) only (b) (i) only
- (c) (i) and (ii) (d) (i), (ii) and (iv)

**MATCHING TYPE QUESTIONS**

118. Match the Column-I (functioning of Daniel cell) with Column-II (value of  $E_{\text{ext}}$ ) and choose the correct option.

**Column-I**

**Column-II**

- |   |                         |
|---|-------------------------|
| (A) Flow of electrons from Cu to Zn and current flows from Zn to Cu | (p) $E = 1.1 \text{ V}$ |
| (B) No flow of electrons or current                                 | (q) $E < 1.1 \text{ V}$ |
| (C) Zn dissolves at anode and copper deposits at cathode            | (r) $E > 1.1 \text{ V}$ |
| (a) (A) – (q), (B) – (p), (C) – (r)                                 |                         |
| (b) (A) – (r), (B) – (p), (C) – (q)                                 |                         |
| (c) (A) – (p), (B) – (r), (C) – (q)                                 |                         |
| (d) (A) – (r), (B) – (q), (C) – (p)                                 |                         |

119. Match the items of Column I and Column II on the basis of data given below :

$$E_{\text{F}_2/\text{F}^-}^\ominus = 2.87 \text{ V}, E_{\text{Li}^+/\text{Li}}^\ominus = -3.5 \text{ V}, E_{\text{Au}^{3+}/\text{Au}}^\ominus = 1.4 \text{ V},$$

$$E_{\text{Br}_2/\text{Br}^-}^\ominus = 1.09 \text{ V}$$

**Column-I**

**Column-II**

- |  |  |
|--|--|
| (A) $\text{F}_2$                               | (p) metal is the strongest reducing agent.         |
| (B) Li   | (q) anion that can be oxidised by $\text{Au}^{3+}$ |
| (C) $\text{Au}^{3+}$                           | (r) non metal which is the best oxidising agent    |
| (D) $\text{Br}^-$                              | (s) metal ion which is an oxidising agent          |
| (a) (A) – (r), (B) – (p), (C) – (s), (D) – (q) |  |
| (b) (A) – (p), (B) – (r), (C) – (s), (D) – (q) |  |
| (c) (A) – (q), (B) – (p), (C) – (s), (D) – (r) |  |
| (d) (A) – (r), (B) – (s), (C) – (p), (D) – (q) |  |

120. Match the columns.

**Column-I**

**Column-II**

- |  |                                       |
|--|---------------------------------------|
| (A) $\Lambda_m$                                | (p) intensive property                |
| (B) $E_{\text{cell}}^\ominus$                  | (q) Depends on number of ions/ volume |
| (C) $\kappa$                                   | (r) Extensive property                |
| (D) $\Delta_r G_{\text{cell}}$                 | (s) Increases with dilution           |
| (a) (A) – (p), (B) – (s), (C) – (q), (D) – (r) |                                       |
| (b) (A) – (s), (B) – (p), (C) – (q), (D) – (r) |                                       |
| (c) (A) – (s), (B) – (q), (C) – (p), (D) – (r) |                                       |
| (d) (A) – (s), (B) – (p), (C) – (r), (D) – (q) |                                       |

121. Match the columns.

**Column-I**

**Column-II**

- |  |                                     |
|--|-------------------------------------|
| (A) $\kappa$                                   | (p) $I \times t$                    |
| (B) $\Lambda_m$                                | (q) $\Lambda_m / \Lambda_m^\ominus$ |
| (C) $\alpha$                                   | (r) $\frac{\kappa}{c}$              |
| (D) Q  | (s) $\frac{G^*}{R}$                 |
| (a) (A) – (p), (B) – (r), (C) – (q), (D) – (s) |                                     |
| (b) (A) – (s), (B) – (q), (C) – (r), (D) – (p) |                                     |
| (c) (A) – (r), (B) – (s), (C) – (q), (D) – (p) |                                     |
| (d) (A) – (s), (B) – (r), (C) – (q), (D) – (p) |                                     |

122. Match the columns

**Column-I**

**Column-II**

- |  |   |
|--|---|
| (A) Cell in which electrolyte is a paste of KOH and ZnO. This cell is used in low current devices like hearing aids, watches, etc. | (p) $\text{H}_2 - \text{O}_2$ fuel cell |
| (B) Cell in which 38% $\text{H}_2\text{SO}_4$ solution is used as an electrolyte.  | (q) Mercury cell                        |
| (C) Cell in which vapours produced during electro-chemical reaction were condensed and added to drinking water                     | (r) Lead storage battery                |
| (D) Cell having longer life than lead storage cell and is expensive to manufacture   | (s) Nickel – Cadmium cell               |
| (a) (A) – (r), (B) – (q), (C) – (p), (D) – (s)   |   |
| (b) (A) – (q), (B) – (r), (C) – (p), (D) – (s)   |   |
| (c) (A) – (q), (B) – (r), (C) – (p), (D) – (s)   |   |
| (d) (A) – (q), (B) – (r), (C) – (s), (D) – (p)   |   |

**ASSERTION-REASON TYPE QUESTIONS**

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
- (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
- (c) Assertion is correct, reason is incorrect
- (d) Assertion is incorrect, reason is correct.

123. **Assertion :** The resistivity for a substance is its resistance when it is one meter long and its area of cross section is one square meter.

**Reason :** The SI units of resistivity is ohm metre ( $\Omega\text{m}$ ).

**124. Assertion :** On increasing dilution, the specific conductance keep on increasing.

**Reason :** On increasing dilution, degree of ionisation of weak electrolyte increases and molality of ions also increases.

**125. Assertion :** Galvanised iron does not rust.

**Reason :** Zinc has a more negative electrode potential than iron.

### CRITICAL THINKING TYPE QUESTIONS

**126.** If salt bridge is removed from two half-cells the voltage

- (a) drops to zero (b) does not change  
(c) increases gradually (d) increases rapidly

**127.** In the electrolytic cell, flow of electrons is from

- (a) cathode to anode in solution  
(b) cathode to anode through external supply  
(c) cathode to anode through internal supply  
(d) anode to cathode through internal supply

**128.** Standard potentials ( $E^\circ$ ) for some half-reactions are given below :

- (i)  $\text{Sn}^{4+} + 2\text{e}^- \rightarrow \text{Sn}^{2+}$  ;  $E^\circ = +0.15 \text{ V}$   
(ii)  $2\text{Hg}^{2+} + 2\text{e}^- \rightarrow \text{Hg}_2^{2+}$  ;  $E^\circ = +0.92 \text{ V}$   
(iii)  $\text{PbO}_2 + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{Pb}^{2+} + 2\text{H}_2\text{O}$  ;  $E^\circ = +1.45 \text{ V}$

Based on the above, which one of the following statements is correct ?

- (a)  $\text{Sn}^{4+}$  is a stronger oxidising agent than  $\text{Pb}^{4+}$   
(b)  $\text{Sn}^{2+}$  is a stronger reducing agent than  $\text{Hg}_2^{2+}$   
(c)  $\text{Hg}_2^{2+}$  is a stronger oxidising agent than  $\text{Pb}^{4+}$   
(d)  $\text{Pb}^{2+}$  is a stronger reducing agent than  $\text{Sn}^{2+}$

**129.** Consider the following relations for emf of an electrochemical cell:

- (i)  $\text{emf of cell} = (\text{Oxidation potential of anode}) - (\text{Reduction potential of cathode})$   
(ii)  $\text{emf of cell} = (\text{Oxidation potential of anode}) + (\text{Reduction potential of cathode})$   
(iii)  $\text{emf of cell} = (\text{Reduction potential of anode}) + (\text{Reduction potential of cathode})$   
(iv)  $\text{emf of cell} = (\text{Oxidation potential of anode}) - (\text{Oxidation potential of cathode})$

Which of the above relations are correct?

- (a) (ii) and (iv) (b) (iii) and (i)  
(c) (i) and (ii) (d) (iii) and (iv)

**130.** The correct order of  $E^\circ_{\text{M}^{2+}/\text{M}}$  values with negative sign

for the four successive elements Cr, Mn, Fe and Co is

- (a)  $\text{Mn} > \text{Cr} > \text{Fe} > \text{Co}$  (b)  $\text{Cr} < \text{Fe} > \text{Mn} > \text{Co}$   
(c)  $\text{Fe} > \text{Mn} > \text{Cr} > \text{Co}$  (d)  $\text{Cr} > \text{Mn} > \text{Fe} > \text{Co}$

**131.** Consider the following four electrodes:

P =  $\text{Cu}^{2+}$  (0.0001 M)/Cu(s)

Q =  $\text{Cu}^{2+}$  (0.1 M)/Cu(s)

R =  $\text{Cu}^{2+}$  (0.01 M)/Cu(s)

S =  $\text{Cu}^{2+}$  (0.001 M)/Cu(s)

If the standard reduction potential of  $\text{Cu}^{2+}/\text{Cu}$  is +0.34 V, the reduction potentials in volts of the above electrodes follow the order.

- (a)  $\text{P} > \text{S} > \text{R} > \text{Q}$  (b)  $\text{S} > \text{R} > \text{Q} > \text{P}$   
(c)  $\text{R} > \text{S} > \text{Q} > \text{P}$  (d)  $\text{Q} > \text{R} > \text{S} > \text{P}$

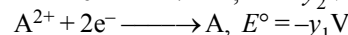
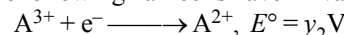
**132.** At 298K the standard free energy of formation of  $\text{H}_2\text{O}(\ell)$  is  $-237.20 \text{ kJ/mole}$  while that of its ionisation into  $\text{H}^+$  ion and hydroxyl ions is  $80 \text{ kJ/mole}$ , then the emf of the following cell at 298 K will be

[Take Faraday constant  $F = 96500 \text{ C}$ ]

$\text{H}_2(\text{g}, 1 \text{ bar}) | \text{H}^+(1 \text{ M}) || \text{OH}^-(1 \text{ M}) | \text{O}_2(\text{g}, 1 \text{ bar})$

- (a) 0.40V (b) 0.81V  
(c) 1.23 V (d)  $-0.40 \text{ V}$

**133.** If the following half cells have  $E^\circ$  values as



The  $E^\circ$  of the half cell  $\text{A}^{3+} + 3\text{e}^- \longrightarrow \text{A}$  will be

- (a)  $\frac{2y_1 - y_2}{3}$  (b)  $\frac{y_2 - 2y_1}{3}$   
(c)  $2y_1 - 3y_2$  (d)  $y_2 - 2y_1$

**134.**  $\text{Cu}^+(\text{aq})$  is unstable in solution and undergoes simultaneous oxidation and reduction according to the reaction :



Choose correct  $E^\circ$  for given reaction if  $E^\circ \text{ Cu}^{2+}/\text{Cu} = 0.34 \text{ V}$  and  $E^\circ \text{ Cu}^{2+}/\text{Cu}^+ = 0.15 \text{ V}$

- (a)  $-0.38 \text{ V}$  (b)  $+0.49 \text{ V}$   
(c)  $+0.38 \text{ V}$  (d)  $-0.19 \text{ V}$

**135.** In a cell that utilises the reaction

$\text{Zn}(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{H}_2(\text{g})$  addition of  $\text{H}_2\text{SO}_4$  to cathode compartment, will

- (a) increase the E and shift equilibrium to the right  
(b) lower the E and shift equilibrium to the right  
(c) lower the E and shift equilibrium to the left  
(d) increase the E and shift equilibrium to the left

**136.** For a cell reaction involving two electron change, the standard EMF of the cell is  $0.295 \text{ V}$  at  $2^\circ\text{C}$ . The equilibrium constant of the reaction at  $25^\circ\text{C}$  will be:

- (a)  $29.5 \times 10^{-2}$  (b) 10  
(c)  $1 \times 10^{10}$  (d)  $2.95 \times 10^{-10}$

**137.** Standard cell voltage for the cell  $\text{Pb} | \text{Pb}^{2+} || \text{Sn}^{2+} | \text{Sn}$  is  $-0.01 \text{ V}$ . If the cell is to exhibit  $E_{\text{cell}} = 0$ , the value of  $[\text{Sn}^{2+}] / [\text{Pb}^{2+}]$  should be antilog of –

- (a) +0.3 (b) 0.5  
(c) 1.5 (d)  $-0.5$

**138.** The cell,  $\text{Zn} | \text{Zn}^{2+}(1 \text{ M}) || \text{Cu}^{2+}(1 \text{ M}) | \text{Cu}$  ( $E^\circ_{\text{cell}} = 1.10 \text{ V}$ ) was allowed to be completely discharged at 298 K. The

relative concentration of  $\text{Zn}^{2+}$  to  $\text{Cu}^{2+}$   $\left( \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \right)$  is

- (a)  $9.65 \times 10^4$  (b)  $\text{antilog}(24.08)$   
(c) 37.3 (d)  $10^{37.3}$

139. What is the potential of half-cell consisting of zinc electrode in 0.01 M  $\text{ZnSO}_4$  solution at  $25^\circ\text{C}$  ( $E^\circ_{\text{ox}} = 0.763 \text{ V}$ )
- (a) 0.8221 V (b) 8.221 V  
(c) 0.5282 V (d) 9.282 V
140. The oxidation potential of 0.05 M  $\text{H}_2\text{SO}_4$  is
- (a)  $-2 \times 0.0591$  (b)  $-0.01 \times 0.0591$   
(c)  $-2.321 \times 0.0591$  (d)  $+1 \times 0.0591$
141. For a relation  $\Delta_r G = -nFE_{\text{cell}}$   
 $E_{\text{cell}} = E^\circ_{\text{cell}}$  in which of the following condition?
- (a) Concentration of any one of the reacting species should be unity  
(b) Concentration of all the product species should be unity.  
(c) Concentration of all the reacting species should be unity.  
(d) Concentration of all reacting and product species should be unity.
142. A 0.5 M NaOH solution offers a resistance of 31.6 ohm in a conductivity cell at room temperature. What shall be the approximate molar conductance of this NaOH solution if cell constant of the cell is  $0.367 \text{ cm}^{-1}$ .
- (a)  $234 \text{ S cm}^2 \text{ mole}^{-1}$  (b)  $23.2 \text{ S cm}^2 \text{ mole}^{-1}$   
(c)  $4645 \text{ S cm}^2 \text{ mole}^{-1}$  (d)  $5464 \text{ S cm}^2 \text{ mole}^{-1}$
143. The equivalent conductances of two strong electrolytes at infinite dilution in  $\text{H}_2\text{O}$  (where ions move freely through a solution) at  $25^\circ\text{C}$  are given below :
- $\Lambda^\circ_{\text{CH}_3\text{COONa}} = 91.0 \text{ S cm}^2 / \text{equiv.}$   
 $\Lambda^\circ_{\text{HCl}} = 426.2 \text{ S cm}^2 / \text{equiv.}$
- What additional information/ quantity one needs to calculate  $\Lambda^\circ$  of an aqueous solution of acetic acid?
- (a)  $\Lambda^\circ$  of chloroacetic acid ( $\text{ClCH}_2\text{COOH}$ )  
(b)  $\Lambda^\circ$  of NaCl  
(c)  $\Lambda^\circ$  of  $\text{CH}_3\text{COOK}$   
(d) the limiting equivalent conductance of  $\text{H}^+$  ( $\lambda^\circ_{\text{H}^+}$ ).
144. Resistance of 0.2 M solution of an electrolyte is  $50 \Omega$ . The specific conductance of the solution is  $1.3 \text{ S m}^{-1}$ . If resistance of the 0.4 M solution of the same electrolyte is  $260 \Omega$ , its molar conductivity is :
- (a)  $6.25 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$  (b)  $625 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$   
(c)  $62.5 \text{ S m}^2 \text{ mol}^{-1}$  (d)  $6250 \text{ S m}^2 \text{ mol}^{-1}$
145. The limiting molar conductivities of HCl,  $\text{CH}_3\text{COONa}$  and NaCl are respectively 425, 90 and  $125 \text{ mho cm}^2 \text{ mol}^{-1}$  at  $25^\circ\text{C}$ . The molar conductivity of 0.1 M  $\text{CH}_3\text{COOH}$  solutions is  $7.8 \text{ mho cm}^2 \text{ mol}^{-1}$  at the same temperature. The degree of dissociation of 0.1 M acetic acid solution at the same temperature is
- (a) 0.10 (b) 0.02  
(c) 0.15 (d) 0.03
146. A weak electrolyte having the limiting equivalent conductance of  $400 \text{ S cm}^2 \text{ equivalent}^{-1}$  at  $298 \text{ K}$  is 2% ionized in its 0.1 N solution. The resistance of this solution (in ohms) in an electrolytic cell of cell constant  $0.4 \text{ cm}^{-1}$  at this temperature is
- (a) 200 (b) 300  
(c) 400 (d) 500
147. Conductivity  $\kappa$ , is equal to \_\_\_\_\_.
- (i)  $\frac{1}{R} \frac{l}{A}$  (ii)  $\frac{G^*}{R}$   
(iii)  $\Lambda_m$  (iv)  $\frac{l}{A}$
- (a) (i) and (iii) (b) (i) and (ii)  
(c) (i), (ii) and (iii) (d) (ii), (iii) and (iv)
148. Arrange the following in increasing order of their conductivity  $\text{Na}^+$  (A),  $\text{K}^+$  (B),  $\text{Ca}^{2+}$  (C),  $\text{Mg}^{2+}$  (D)
- (a) A, B, C, D (b) B, A, C, D  
(c) C, A, D, B (d) A, B, D, C
149. The conductivity of electrolytic solutions depends upon which of the following?
- (i) Size of ions produced  
(ii) Viscosity of the solvent  
(iii) Concentration of electrolyte  
(iv) Solvation of ions produced
- (a) (i) and (iii) (b) (i), (ii) and (iii)  
(c) (i), (iii) and (iv) (d) All of these
150. Mark the false statement?
- (a) A salt bridge is used to eliminate liquid junction potential  
(b) The Gibbs free energy change,  $\Delta G$  is related with electromotive force  $E$  as  $\Delta G = -nFE$   
(c) Nernst equation for single electrode potential is  $E = E^\circ - \frac{RT}{nF} \log_a M^{n+}$   
(d) The efficiency of a hydrogen-oxygen fuel cell is 23%
151. When electric current is passed through acidified water, 112 ml of hydrogen gas at STP collected at the cathode in 965 seconds. The current passed in amperes is
- (a) 1.0 (b) 0.5  
(c) 0.1 (d) 2.0
152. On passing current through two cells, connected in series containing solution of  $\text{AgNO}_3$  and  $\text{CuSO}_4$ , 0.18 g of Ag is deposited. The amount of the Cu deposited is:
- (a) 0.529 g (b) 10.623 g  
(c) 0.0529 g (d) 1.2708 g
153. In the electrolysis of water, one faraday of electrical energy would liberate
- (a) one mole of oxygen (b) one gram atom of oxygen  
(c) 8 g oxygen (d) 22.4 lit. of oxygen
154. Electrolysis of dilute aqueous NaCl solution was carried out by passing 10 milli ampere current. The time required to liberate 0.01 mol of  $\text{H}_2$  gas at the cathode is (1 Faraday =  $96500 \text{ C mol}^{-1}$ )
- (a)  $9.65 \times 10^4 \text{ sec}$  (b)  $19.3 \times 10^4 \text{ sec}$   
(c)  $28.95 \times 10^4 \text{ sec}$  (d)  $38.6 \times 10^4 \text{ sec}$



- 155.** What is the amount of chlorine evolved when 2 amperes of current is passed for 30 minutes in an aqueous solution of NaCl?
- (a) 66 g (b) 1.32 g  
(c) 33 g (d) 99 g
- 156.** On passing a current of 1.0 ampere for 16 min and 5 sec through one litre solution of  $\text{CuCl}_2$ , all copper of the solution was deposited at cathode. The strength of  $\text{CuCl}_2$  solution was (Molar mass of Cu = 63.5; Faraday constant = 96,500  $\text{Cmol}^{-1}$ )
- (a) 0.01 N (b) 0.01 M  
(c) 0.02 M (d) 0.2 N
- 157.** 0.2964 g of copper was deposited on passage of a current of 0.5 amp for 30 mins through a solution of copper sulphate. Calculate the oxidation state of Cu (At. mass 63.56).
- (a) +1 (b) +2  
(c) +3 (d) +4
- 158.** One Faraday of electricity is passed through molten  $\text{Al}_2\text{O}_3$ , aqueous solution of  $\text{CuSO}_4$  and molten NaCl taken in three different electrolytic cells connected in series. The mole ratio of Al, Cu and Na deposited at the respective cathode is
- (a) 2 : 3 : 6 (b) 6 : 2 : 3  
(c) 6 : 3 : 2 (d) 1 : 2 : 3
- 159.** What will happen during the electrolysis of aqueous solution of  $\text{CuSO}_4$  by using platinum electrodes?
- (i) Copper will deposit at cathode.  
(ii) Copper will deposit at anode.  
(iii) Oxygen will be released at anode.  
(iv) Copper will dissolve at anode.
- (a) (i) and (iii) (b) (ii) and (iv)  
(c) (i) and (ii) (d) (ii) and (iii)
- 160.** How much charge is required, when 1 mole of  $\text{Cr}_2\text{O}_7^{2-}$  reduce to form 1 mole of  $\text{Cr}^{3+}$ ?
- (a) 6F (b) 3F  
(c) 1F (d) 2F
- 161.** When a lead storage battery is discharged
- (a)  $\text{SO}_2$  is evolved  
(b) Lead sulphate is consumed  
(c) Lead is formed  
(d) Sulphuric acid is consumed
- 162.** The most durable metal plating on iron to protect against corrosion is
- (a) nickel plating (b) copper plating  
(c) tin plating (d) zinc plating
- 163.** Which of the following statements is incorrect regarding dry (Leclanche) cell?
- (a) Cathode used in the cell is coated by powdered manganese dioxide and carbon.  
(b) Most common application of this cell is in our transistors and clocks.  
(c) At cathode, Mn is oxidised from + 3 to + 4.  
(d) At anode Zn is oxidised from 0 to + 2.

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

- (c) Electrochemical reactions are more energy efficient and less polluting. Thus study of electrochemistry is important to create new eco-friendly technologies.
- (a) We know that in the internal circuit of a galvanic cell ions flow whereas in the external circuit, the electrons flow from one electrode to another.
- (a) Anode has negative polarity.
- (b)
- (d) When both the electrodes are kept in the same solution there will be no requirement of salt bridge.
- (d)
- (d) 
$$\begin{array}{c} \text{Reduction} \\ \text{Zn}^{2+} + 2e^- \longrightarrow \text{Zn} \end{array}$$
 It shows reduction reaction.
- (a)
- (b) The cell in which Cu and Zn rods are dipped in its solution is called Daniel cell.
- (c) The magnitude of the electrode potential of a metal is a measure of its relative tendency to loose or gain electrons. i.e., it is a measure of the relative tendency to undergo oxidation (loss of electrons) or reduction (gain of electrons).  

$$\text{M} \rightarrow \text{M}^{n+} + ne^- \text{ (oxidation potential)}$$

$$\text{M}^{n+} + ne^- \rightarrow \text{M} \text{ (reduction potential)}$$
- (b)  $2\text{AgCl(s)} + \text{H}_2(\text{g}) \rightarrow 2\text{HCl(aq)} + 2\text{Ag(s)}$   
 The activities of solids and liquids are taken as unity and at low concentrations, the activity of a solute is approximated to its molarity.  
 The cell reaction will be  

$$\text{Pt(s)} | \text{H}_2(\text{g}), 1\text{bar} | \text{H}^+(\text{aq}) 1\text{M} | \text{AgCl(aq)} 1\text{M} | \text{Ag(s)}$$
- (b)  $E_{\text{cell}}^{\circ} = E_{\text{cathode}}^{\circ} - E_{\text{anode}}^{\circ} = E_{\text{right}}^{\circ} - E_{\text{left}}^{\circ}$   

$$E_{\text{cell}}^{\circ} = 0.25 - 0.52 = -0.27\text{V}$$
- (b) 14. (c)
- (d) Cu is anode and  $\text{Ag}^+$  is cathode.
- (d) Calomel electrode is used as reference electrode.
- (b) Electrode potential is considered as zero.
- (b) Without losing its concentration  $\text{ZnCl}_2$  solution cannot kept in contact with Al because Al is more reactive than Zn due to its highly negative electrode reduction potential.
- (c) From the given data we find  $\text{Fe}^{3+}$  is strongest oxidising agent. More the positive value of  $E^{\circ}$ , more is the tendency to get oxidized. Thus correct option is (c).
- (c) As the value of standard reduction potential decreases the reducing power increases i.e.,  

$$\begin{array}{ccc} \text{Z} & > & \text{X} & > & \text{Y} \\ (-3.0) & & (-1.2) & & (+0.5) \end{array}$$
- (b) Given  $E_{\text{Sn}^{+4}/\text{Sn}^{+2}} = +0.15\text{V}$   

$$E_{\text{Cr}^{+3}/\text{Cr}} = -0.74\text{V}$$

$$E_{\text{cell}}^{\circ} = E_{\text{ox}}^{\circ} + E_{\text{red}}^{\circ}$$

$$= 0.74 + 0.15$$

$$= 0.89\text{V}$$
- (a) Higher the value of reduction potential higher will be the oxidising power whereas the lower the value of reduction potential higher will be the reducing power.
- (d)  $E_{\text{cell}}^{\circ} = E_{\text{OP}}^{\circ} + E_{\text{RP}}^{\circ}$   

$$= 0.76 + 0.314 = 1.10\text{V}$$
- (b) Follow ECS, A will replace B.
- (c) Gold having higher  $E_{\text{Red}}^{\circ}$  and oxidises  $\text{Fe} \longrightarrow \text{Fe}^{++}$ .
- (c) 27. (d)
- (c) Nernst equation  $E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{RT}{nF} \ln \frac{[\text{Fe}^{2+}]^2}{[\text{Fe}^{3+}]^2} [\text{Zn}^{2+}]$   
 increasing  $[\text{Fe}^{2+}]$  will decrease the  $E_{\text{cell}}$ .
- (d)  $E^{\circ} = \frac{0.0591}{n} \log K$   
 Here,  $n = 2, E^{\circ} = 0.295$   

$$\therefore \log K = \frac{2 \times 0.295}{0.0591} = 9.98 \approx 10 \text{ or } K = 10^{10}$$
- (b) RHS :  $2\text{H}^+ + 2e^- \rightleftharpoons \text{H}_2(\text{P}_2)$   
 LHS :  $\text{H}_2(\text{P}_1) \rightleftharpoons 2\text{H}^+ + 2e^-$   
 overall reaction :  $\text{H}_2(\text{P}_1) \rightleftharpoons \text{H}_2(\text{P}_2)$   

$$E = E^{\circ} - \frac{RT}{nF} \ln \frac{\text{P}_2}{\text{P}_1} = 0 - \frac{RT}{nF} \ln \frac{\text{P}_2}{\text{P}_1} = \frac{RT}{nF} \ln \frac{\text{P}_1}{\text{P}_2}$$
- (a)  $E = E^{\circ} - \frac{0.059}{n} \log \frac{1}{[\text{H}^+]}$   

$$= 0 - \frac{0.059}{1} \log \frac{1}{10^{-4}} = -0.236\text{V}$$
- (d)  $E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{RT}{nF} \ln Q$   
 At equilibrium,  
 $E_{\text{cell}} = 0$  and  $Q = K_c$   

$$\therefore E_{\text{cell}} \neq E_{\text{cell}}^{\circ}$$

33. (c) The  $E^\circ_{\text{cell}}$  is given by

$$E^\circ_{\text{cell}} = \frac{0.0591}{n} \log K_{\text{eq}}$$

$$\therefore 0.591 = \frac{0.0591}{1} \log K_{\text{eq}}$$

$$\text{or } \log K_{\text{eq}} = \frac{0.591}{0.0591} = 10$$

$$\text{or } K_{\text{eq}} = 1 \times 10^{10}$$

34. (b) For the given cell

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.059V}{2} \log \frac{[\text{Zn}^{2+}(aq)]}{[\text{Cu}^{2+}(aq)]}$$

The cell potential will decrease with increase in  $[\text{Zn}^{2+}(aq)]$  and will increase with increase in  $[\text{Cu}^{2+}(aq)]$ .

35. (d) Here  $n = 4$ , and  $[\text{H}^+] = 10^{-3}$  (as  $\text{pH} = 3$ )

Applying Nernst equation

$$E = E^\circ - \frac{0.059}{n} \log \frac{[\text{Fe}^{2+}]^2}{[\text{H}^+]^4(p_{\text{O}_2})}$$

$$= 1.67 - \frac{0.059}{4} \log \frac{(10^{-3})^2}{(10^{-3})^4 \times 0.1}$$

$$= 1.67 - \frac{0.059}{4} \log 10^7 = 1.67 - 0.103 = 1.567$$

36. (b) Cell reaction is,  $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{RT}{nF} \ln \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]}$$

Greater the factor  $\left[ \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \right]$ , less is the EMF

Hence  $E_1 > E_2$

37. (b) For  $\text{Zn}^{2+} \rightarrow \text{Zn}$

$$E_{\text{Zn}^{2+}/\text{Zn}} = E^\circ_{\text{Zn}^{2+}/\text{Zn}} - \frac{2.303RT}{nF} \log \frac{[\text{Zn}]}{[\text{Zn}^{2+}]}$$

$$= -0.76 - \frac{0.06}{2} \log \frac{1}{[0.1]} = -0.76 - 0.03$$

$$E_{\text{Zn}^{2+}/\text{Zn}} = -0.79V$$

38. (d) emf will decrease.

39. (b)  $E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{RT}{nF} \ln \frac{[\text{C}]^c [\text{D}]^d}{[\text{A}]^a [\text{B}]^b}$

$$\text{Hence } E^\circ_{\text{cell}} = E_{\text{cell}} + \frac{RT}{nF} \ln \frac{[\text{C}]^c [\text{D}]^d}{[\text{A}]^a [\text{B}]^b}$$

$$40. (b) E^\circ_{\text{cell}} = \frac{0.059}{2} \log K_C \text{ or } \frac{1.10 \times 2}{0.059} = \log K_C$$

$$\therefore K_C = 1.9 \times 10^{37}$$

$$41. (c) \Delta G^\circ = -nFE^\circ; E^\circ = \frac{-\Delta G^\circ}{nF};$$

$$E^\circ = \frac{-(-50.61 \text{ kJ})}{2 \times 96500 \times 10^{-3}} = 0.26V$$

42. (d) Molarity = 0.01 M ; Resistance = 40 ohm;

$$\text{Cell constant } \frac{l}{A} = 0.4 \text{ cm}^{-1}.$$

Specific conductivity ( $\kappa$ )

$$= \frac{\text{cell constant}}{\text{resistance}} = \frac{0.4}{40} = 0.01 \text{ ohm}^{-1} \text{ cm}^{-1}$$

$$\text{Molar conductance } (\Lambda_m) = \frac{1000\kappa}{\text{Molarity}}$$

$$= \frac{1000 \times 0.01}{0.01} = 10^3 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

43. (b) Specific conductance of the solution ( $\kappa$ ) = 0.012 ohm<sup>-1</sup> cm<sup>-1</sup> and resistance (R) = 55 ohm.

Cell constant = Specific conductance  $\times$  Observed

resistance

$$= 0.012 \times 55 = 0.66 \text{ cm}^{-1}.$$

44. (b) ohm<sup>-1</sup> cm<sup>2</sup> (geq)<sup>-1</sup>

$$45. (a) \Lambda_{\text{eq}} = \kappa \times \frac{1000}{N} = \frac{1}{R} \times \frac{l}{a} \times \frac{1000}{N}$$

$$= \frac{1}{R} \times \text{cell constant} \times \frac{1000}{N} = \frac{1}{220} \times 0.88 \times \frac{1000}{0.01}$$

$$= 400 \text{ mho cm}^2 \text{ g eq}^{-1}$$

46. (c) Molar conductance of solution is related to specific conductance as follows :

$$\Lambda_m = \kappa \times \frac{1000}{C} \quad \dots(a)$$

where  $C$  is molar concentration.

Putting  $\kappa = 6.3 \times 10^{-2} \text{ ohm}^{-1} \text{ cm}^{-1}$  and  $C = 0.1M$

$$\Lambda_m = (6.3 \times 10^{-2} \text{ ohm}^{-1} \text{ cm}^{-1}) \times \frac{1000}{(0.1 \text{ mol/cm}^3)}$$

$$= 6.3 \times 10^{-2} \times 10^4 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

$$= 630 \text{ ohm}^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

47. (b)  $\kappa = \frac{1}{R} \times \text{Cell constant}$

$$\text{Cell constant} = \kappa \times R; 0.012 \times 55 = 0.66 \text{ cm}^{-1}.$$

48. (d) ohm<sup>-1</sup> cm<sup>-1</sup>

49. (a) The specific conductance increases with concentration. The number of ions per cm<sup>-3</sup> increase with increase of concentration.

50. (d)
51. (c) Correct matching for pair (iii) will be  
[G (conductance) – siemens or  $\text{ohm}^{-1}(\text{S})$ .]
52. (d) Conductivity does not depend upon mass or weight of material.
53. (d)
54. (c) (i) represents weak electrolyte  
(ii) represents strong electrolyte.
55. (b)  $\Lambda_{\text{HCl}}^{\infty} = 426.2$  (i)  
 $\Lambda_{\text{AcONa}}^{\infty} = 91.0$  (ii)  
 $\Lambda_{\text{NaCl}}^{\infty} = 126.5$  (iii)  
 $\Lambda_{\text{AcOH}}^{\infty} = (\text{i}) + (\text{ii}) - (\text{iii})$   
 $= [426.2 + 91.0 - 126.5] = 390.7$
56. (d) Kohlrausch's Law states that at infinite dilution, each ion migrates independent of its co-ion and contributes to the total equivalent conductance of an electrolyte a definite share which depends only on its own nature. From this definition we can see that option (d) is the correct answer.
57. (c) Conductivity of an electrolyte depends on the mobility of ions and concentration of ions. The motion of an ionic species in an electric field is retarded by the oppositely charged ions due to their interionic attraction. On dilution, concentration of electrolyte decreases and the retarding influence of oppositely charged ions decreases. Therefore mobility of ions increases.
58. (d)  $\Lambda_{\text{m}}^{\circ}(\text{NH}_4\text{Cl}) = \Lambda_{\text{m}}^{\circ}(\text{NH}_4^+) + \Lambda_{\text{m}}^{\circ}(\text{Cl}^-)$   
 $\Lambda_{\text{m}}^{\circ}(\text{NaOH}) = \Lambda_{\text{m}}^{\circ}(\text{Na}^+) + \Lambda_{\text{m}}^{\circ}(\text{OH}^-)$   
 $\Lambda_{\text{m}}^{\circ}(\text{NaCl}) = \Lambda_{\text{m}}^{\circ}(\text{Na}^+) + \Lambda_{\text{m}}^{\circ}(\text{Cl}^-)$   
 $\therefore \Lambda_{\text{m}}^{\circ}(\text{NH}_4^+) + \Lambda_{\text{m}}^{\circ}(\text{OH}^-)$   
 $= \Lambda_{\text{m}}^{\circ}(\text{NH}_4^+) + \Lambda_{\text{m}}^{\circ}(\text{Cl}^-) + \Lambda_{\text{m}}^{\circ}(\text{Na}^+)$   
 $+ \Lambda_{\text{m}}^{\circ}(\text{OH}^-) - \left[ \Lambda_{\text{m}}^{\circ}(\text{Na}^+) + \Lambda_{\text{m}}^{\circ}(\text{Cl}^-) \right]$   
 $\Lambda_{\text{m}}^{\circ}(\text{NH}_4\text{OH}) = \Lambda_{\text{m}}^{\circ}(\text{NH}_4\text{Cl}) + \Lambda_{\text{m}}^{\circ}(\text{NaOH}) - \Lambda_{\text{m}}^{\circ}(\text{NaCl})$
59. (d)  $\Lambda_{\text{CH}_3\text{COOH}}^{\circ} = \Lambda_{\text{CH}_3\text{COONa}}^{\circ} + \Lambda_{\text{HCl}}^{\circ} - \Lambda_{\text{NaCl}}^{\circ}$   
 $= 91 + 425.9 - 126.4 = 390.5 \text{ S cm}^2 \text{ mol}^{-1}$
60. (b)  $\Lambda_{\text{Na}^+}^{\circ} + \Lambda_{\text{OH}^-}^{\circ} = 248 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$   
 $\Lambda_{\text{Na}^+}^{\circ} + \Lambda_{\text{Cl}^-}^{\circ} = 126 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$   
 $\Lambda_{\text{Ba}^{2+}}^{\circ} + \Lambda_{\text{Cl}^-}^{\circ} = 280 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$   
Now,  $\Lambda_{\text{Ba}(\text{OH})_2}^{\circ} = \Lambda_{\text{BaCl}_2}^{\circ} + 2\Lambda_{\text{NaOH}}^{\circ} - 2\Lambda_{\text{NaCl}}^{\circ}$   
 $\Lambda_{\text{Ba}(\text{OH})_2}^{\circ} = 280 \times 10^{-4} + 2 \times 248 \times 10^{-4} - 2 \times 126 \times 10^{-4}$   
 $\Lambda_{\text{Ba}(\text{OH})_2}^{\circ} = 524 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$
61. (c)  $\text{ClCH}_2\text{COONa} + \text{HCl} \rightarrow \text{ClCH}_2\text{COOH} + \text{NaCl}$   
 $\Lambda_{\text{ClCH}_2\text{COONa}} + \Lambda_{\text{HCl}} = \Lambda_{\text{ClCH}_2\text{COOH}} + \Lambda_{\text{NaCl}}$   
 $224 + 203 = \Lambda_{\text{ClCH}_2\text{COOH}} + 38.2$   
 $\Lambda_{\text{ClCH}_2\text{COOH}} = 427 - 38.2$   
 $= 388.8 \text{ ohm}^{-1} \text{ cm}^2 \text{ gm eq}^{-1}$
62. (b)  $\alpha = \frac{\Lambda_{\text{M}}}{\Lambda_{\text{M}}^{\infty}} = \frac{9.54}{238} = 0.04008 = 4.008 \%$
63. (d) Cell constant =  $l/a$   
Unit =  $\text{m/m}^2 = \text{m}^{-1}$ .
64. (d) Larger the size, lower the speed.
65. (a)  $\Lambda_{\text{m}}^{\infty} = 57 + 73 = 130 \text{ S cm}^2 \text{ mol}^{-1}$
66. (b) At anode :  
 $2\text{HO}^- \rightleftharpoons \text{H}_2\text{O} + \frac{1}{2} \text{O}_2$
67. (b) Given current (i) = 0.5 amp;  
Time (t) = 100 minutes  $\times 60 = 6000 \text{ sec}$   
Equivalent weight of silver nitrate (E) = 108.  
According to Faraday's first law of electrolysis  
 $W = \frac{Eit}{96500} = \frac{108 \times 0.5 \times 6000}{96500} = 3.3575 \text{ g}$
68. (d) 1 mole of  $\text{e}^- = 1\text{F} = 96500 \text{ C}$   
27g of Al is deposited by  $3 \times 96500 \text{ C}$   
5120 g of Al will be deposited by  
 $= \frac{3 \times 96500 \times 5120}{27} = 5.49 \times 10^7 \text{ C}$
69. (c) Electrefining and electroplating are done by electrolysis.
70. (d)  $\frac{W_{\text{A}}}{E_{\text{A}}} = \frac{W_{\text{B}}}{E_{\text{B}}}$ ,  $\frac{1.6}{8} = \frac{\text{Wt. of Ag}}{108}$   
 $\therefore \text{Wt. of Ag} = 21.6 \text{ g}$
71. (b)  $\text{Cu}^{+2} + 2\text{e}^- \rightarrow \text{Cu (s)}$   
 $2 \times 96500 \text{ C} \quad 63.6 \text{ g}$   
 $9650 \text{ C will deposit} = \frac{63.6}{2 \times 96500} \times 9650 = 3.18 \text{ g}$

72. (a) Charge =  $0.2 \times 1$  Faraday  
 $= 0.2 \times 96500$  coulombs  
 $= 19300 = 1.93 \times 10^4$  coulombs
73. (d)  $\text{Ag}^+ + e^- \longrightarrow \text{Ag}$   
 $96500$  coulombs deposit =  $108$  g of Ag  
 $\therefore 965$  coulombs deposit =  $\frac{108}{96500} \times 965 = 1.08$  g Ag
74. (d)  $\text{C}_6\text{H}_5\text{NO}_2 + 6\text{H}^+ + 6e^- \longrightarrow \text{C}_6\text{H}_5\text{NH}_2 + 2\text{H}_2\text{O}$   
 $E_{\text{C}_6\text{H}_5\text{NO}_2}(\text{eq. wt}) = \frac{123}{6} = 20.5$   
 Number of coulombs required =  $\frac{w \times 96500}{\text{Eq. wt}}$   
 $= \frac{12.3 \times 96500}{20.5} = 57900 \text{ C}$
75. (a) According to Faraday law's of electrolysis, amount of electricity required to deposit 1 mole of metal =  $96500 \text{ C} = 1 \text{ F}$   
 i.e., for deposition of  $108 \text{ g Ag}$  electricity required =  $1 \text{ F}$
76. (a) For deposition of silver, reaction is  
 $\text{Ag}^+ + e^- \longrightarrow \text{Ag}$   
 $1 \text{ mol of Ag}$  will be deposited by  
 $= 1 \text{ F} = 96500 \text{ C} = 9.65 \times 10^4 \text{ C}$   
 Since 1 equivalent weight of Ag is also equal to the weight of its 1 mol, hence 1 equivalent weight of Ag will be deposited by =  $9.65 \times 10^4 \text{ C}$
77. (b) A current of  $96500$  coulombs liberate 1 mole of  $\text{O}_2$ .  
 $\Rightarrow 96500 \text{ C}$  liberates =  $22.4 \text{ L of O}_2$  at NTP  
 $\Rightarrow 9650 \text{ C}$  liberates =  $\frac{22.4}{96500} \times 9650$   
 $= 2.24 \text{ L of O}_2$  at NTP
78. (b)  $\text{Fe}^{2+} + 2e^- \rightarrow \text{Fe}$ ;  $E_{\text{Fe}} = \frac{56}{2} = 28$   
 $1 \text{ Faraday}$  liberates =  $28 \text{ g of Fe}$   
 $3 \text{ Faraday}$  liberates =  $3 \times 28 = 84 \text{ gm}$
79. (c)
80. (d) Charge (Coulombs) pass per second =  $10^{-6}$   
 number of electrons passed per second  
 $= \frac{10^{-6}}{1.602 \times 10^{-19}} = 6.24 \times 10^{12}$
81. (d)
82. (d) Charge on one mole of electrons =  $96500 \text{ C}$ .
83. (a) When platinum electrodes are dipped in dilute solution  $\text{H}_2\text{SO}_4$  than  $\text{H}_2$  is evolved at cathode.
84. (b) In electrolysis of  $\text{NaCl}$  when Pt electrode is taken then  $\text{H}_2$  liberated at cathode while with Hg cathode it forms sodium amalgam because more voltage is required to reduce  $\text{H}^+$  at Hg than Pt.
85. (a) When molten or fused  $\text{NaCl}$  is electrolysed, it yields metallic sodium and gaseous chlorine. Reactions involved are as follows:
- $\text{NaCl (s)} \longrightarrow \text{Na}^+ (\text{l}) + \text{Cl}^- (\text{l})$   
 $\text{Na}^+ + e^- \longrightarrow \text{Na (l)} \quad (\text{at cathode})$   
 $\text{Cl}^- (\text{l}) \longrightarrow \text{Cl (g)} + e^- \quad (\text{at anode})$   
 $\text{Cl (g)} + \text{Cl (g)} \longrightarrow \text{Cl}_2 (\text{g})$
86. (b)  $\text{Pt}^{4+} + 4e^- \longrightarrow \text{Pt}$   
 $4 \text{ F}$  electricity is required to deposit 1 mole of Pt.  
 $\therefore 0.80 \text{ F}$  of electricity will deposit  
 $= \frac{1}{4} \times 0.80$  moles of Pt =  $0.20 \text{ mol}$ .
87. (d)  $1 \text{ F} \rightarrow 11.2 \text{ L Cl}_2$  at STP  
 $\therefore \text{No. of Faradays} = \frac{9.65 \times 5 \times 60 \times 60}{96500} = 1.8$   
 $\therefore \text{Vol. of Cl}_2 = 1.8 \times 11.2 \text{ L} = 20.16$
88. (b)  $\text{W} = \text{Zit}$   
 where Z = Electrochemical equivalent  
 $\text{Eq. wt. of copper} = \frac{63}{2} = 31.5$   
 $Z = \frac{31.5}{96500}$   
 $\text{W} = \text{Zit} = \frac{31.5}{96500} \times 1.5 \times 10 \times 60 = 0.2938 \text{ g}$
89. (c)  $\text{MnO}_4^{2-} \xrightarrow{0.1 \text{ mole}} \text{MnO}_4^- + e^-$   
 (+6) (+7)  
 Quantity of electricity required  
 $= 0.1 \text{ F} = 0.1 \times 96500 = 9650 \text{ C}$
90. (d)  $w_{\text{O}_2} = n_{\text{O}_2} \times 32$   
 $w_{\text{O}_2} = \frac{5600}{22400} \times 32 = 8 \text{ g}$   
 $= 1 \text{ equivalent of O}_2$   
 $= 1 \text{ equivalent of Ag} = 108$
91. (a) Electrolysis of these (i), (ii) and (iii) salt release Chlorine which is yellowish in colour while  $\text{Br}_2$  is reddish brown in colour
92. (b) Electronic conductance decreases with increase in temperature whereas electrolytic conductance increases with increase in temperature as no. of ions or charge carriers increases with increase in temperature.
93. (a) Gold is an inert metal. Electrodes made up of inert metals does not participate in chemical reaction.
94. (b) Reaction A is preferred for electrolysis of dilute sulphuric acid and B is preferred for electrolysis of concentrated sulphuric acid.
95. (b) Iron can be easily reduced with carbon it does not require electrochemical reduction.
96. (b)  $\text{H}_2\text{SO}_4$  is regenerated.
97. (b) During charging, the lead storage battery behaves like an electrolytic cell. So, at anode the reaction is  
 $\text{PbSO}_4 + 2\text{H}_2\text{O} \longrightarrow \text{PbO}_2 + 4\text{H}^+ + \text{SO}_4^{2-} + 2e^-$
98. (c)  $2\text{NH}_4\text{Cl} + \text{Zn} \rightarrow 2\text{NH}_3 + \text{ZnCl}_2 + \text{H}_2 \uparrow$



99. (b) In  $H_2 - O_2$  fuel cell, the combustion of  $H_2$  occurs to create potential difference between the two electrodes.
100. (d) Primary cells are those cells, in which the reaction occurs only once and after use over a period of time, it becomes dead and cannot be reused again. e.g., Leclanche cell and mercury cell.
101. (c) The electrolyte used in Leclanche cell is moist paste of  $NH_4Cl$  and  $ZnCl_2$ .
102. (d) A device that converts energy of combustion of fuels, directly into electrical energy is known as fuel cell.
103. (c)
104. (b)  $H_2 - O_2$  fuel cell supply power for pressure.
105. (d) Prevention of corrosion by zinc coating is called galvanization.
106. (a) Cathodic protection is best method to prevent iron from rusting. In this method iron is made cathode by application of external current.  
Saline water is highly conducting and hence accelerates the formation of rust.
107. (b) Magnesium provides cathodic protection and prevent rusting or corrosion.
108. (c) Mercury cell being primary in nature can be used only once.
109. (c)
110. (d) Fuel cells produce electricity with an efficiency of about 70% compared to thermal plants whose efficiency is about 40%.

### STATEMENT TYPE QUESTIONS

111. (a) Statement (ii) is false as in Figure 2 equal potential is applied from either side thereby making his cell non-functional. Figure 3 represents electrolytic cell as current flows from anode to cathode.
112. (d) According to an accepted convention anode is written on the left side and cathode on the right while representing the galvanic cell.
113. (c) Because reduction potential of water is higher than that of  $Na^+$  so  $H_2$  will be evolved and no reduction of metal ions occurs.
114. (a) All statements given above are correct.
115. (d)  $CaX_2$  is a strong electrolyte thus its molar conductivity increases slowly on dilution.
116. (c) We consider,  
 $96487 C mol^{-1} \approx 96500 C mol^{-1}$  for approximate calculations not for accurate calculations.
117. (c) Reaction occurring at anode  
 $2Fe(s) \longrightarrow 2Fe^{2+} + 4e^-$   
Reaction occurring at cathode  
 $O_2(g) + 4H^+(aq) + 4e^- \longrightarrow 2H_2O$

### MATCHING TYPE QUESTIONS

118. (b)      119. (a)      120. (b)      121. (d)      122. (b)

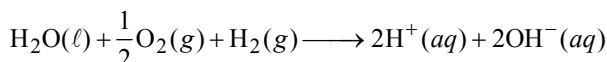
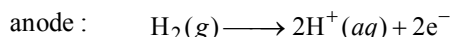
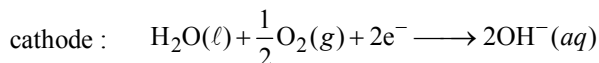
### ASSERTION-REASON TYPE QUESTIONS

123. (b) We know,  $R \propto \frac{\ell}{A}$  or  $R = \rho \left( \frac{\ell}{A} \right)$ , where proportionality constant  $\rho$  is called resistivity. If  $\ell = 1m$  and  $A = 1m^2$ , then  $R = \rho$  i.e., Resistance = Resistivity.
124. (d) The specific conductivity decreases while equivalent and molar conductivities increase with dilution.
125. (a) Zinc metal which has a more negative electrode potential than iron will provide electrons in preference of the iron, and therefore corrodes first. Only when all the zinc has been oxidised, the iron start to rust.

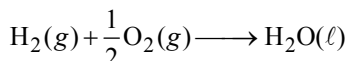
### CRITICAL THINKING TYPE QUESTIONS

126. (a) Salt bridge allows the flow of current by completing circuit. No current will flow and voltage will drop to zero, if salt bridge is removed.
127. (d) In electrolytic cell the flow of electrons is from anode to cathode through internal supply.
128. (b)  $E_{Sn^{2+}/Sn^{4+}}^\circ = -0.15V > E_{Hg_2^{2+}/Hg^{2+}}^\circ = -0.92$   
Hence,  $Sn^{2+}$  is stronger reducing agent than  $Hg_2^{2+}$ .
129. (a) Option (ii) and (iv) are correct.
130. (a) The value of  $E_{M^{2+}/M}^\circ$  for given metal ions are  
 $E_{Mn^{2+}/Mn}^\circ = -1.18 V$ ,  
 $E_{Cr^{2+}/Cr}^\circ = -0.9 V$ ,  
 $E_{Fe^{2+}/Fe}^\circ = -0.44 V$  and  
 $E_{Co^{2+}/Co}^\circ = -0.28 V$ .  
The correct order of  $E_{M^{2+}/M}^\circ$  values without considering negative sign would be  
 $Mn^{2+} > Cr^{2+} > Fe^{2+} > Co^{2+}$ .
131. (d)  $E_{red} = E_{red}^\circ + \frac{0.591}{n} \log[M^{n+}]$   
Lower the concentration of  $M^{n+}$ , lower is the reduction potential.  
Hence order of reduction potential is :  
 $Q > R > S > P$

132. (a) Cell reaction



Also we have



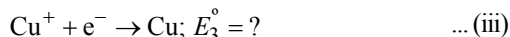
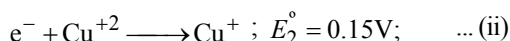
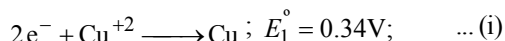
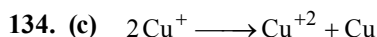
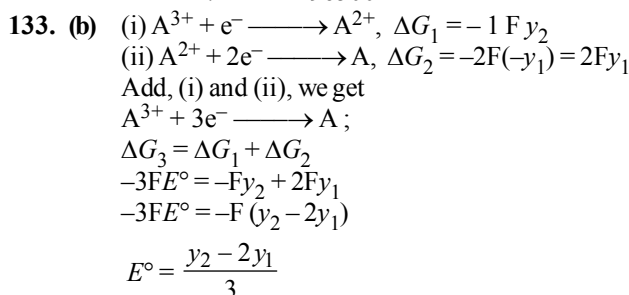
$$\Delta G_f^\circ = -237.2 \text{ kJ/mole}$$



Hence for cell reaction

$$\Delta G^\circ = -237.2 + (2 \times 80) = -77.20 \text{ kJ/mole}$$

$$\therefore E^\circ = -\frac{\Delta G^\circ}{nF} = \frac{77200}{2 \times 96500} = 0.40 \text{ V}$$



$$\text{Now, } \Delta G_1^\circ = -nFE_1^\circ = -2 \times 0.34F$$

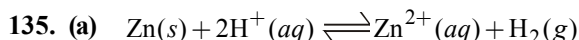
$$\Delta G_2^\circ = -1 \times 0.15F, \Delta G_3^\circ = -1 \times E_3^\circ F$$

$$\text{Again, } \Delta G_1^\circ = \Delta G_2^\circ + \Delta G_3^\circ$$

$$\Rightarrow -0.68F = -0.15F - E_3^\circ F$$

$$\Rightarrow E_3^\circ = 0.68 - 0.15 = 0.53 \text{ V}$$

$$E_{\text{cell}}^\circ = E_{\text{cathode}}^\circ(\text{Cu}^+/\text{Cu}) - E_{\text{anode}}^\circ(\text{Cu}^{+2}/\text{Cu}^+) \\ = 0.53 - 0.15 = 0.38 \text{ V.}$$



$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.059}{2} \log \frac{[\text{Zn}^{2+}][\text{H}_2]}{[\text{H}^+]^2}$$

Addition of  $\text{H}_2\text{SO}_4$  will increase  $[\text{H}^+]$  and  $E_{\text{cell}}$  will also increase and the equilibrium will shift towards RHS.

136. (c) Using the relation,

$$E_{\text{cell}}^\circ = \frac{2.303RT}{nF} \log K_c = \frac{0.0591}{n} \log K_c$$

$$\therefore 0.295 \text{ V} = \frac{0.0591}{2} \log K_c$$

$$\text{or } \log K_c = \frac{2 \times 0.295}{0.0591} = 10$$

$$\text{or } K_c = 1 \times 10^{10}$$

137. (a) Apply Nernst equation to the reaction  
 $\text{Pb} + \text{Sn}^{2+} \rightarrow \text{Pb}^{2+} + \text{Sn}$

$$\text{or } E^\circ + \frac{0.059}{2} \log \frac{[\text{Sn}^{2+}]}{[\text{Pb}^{2+}]} = E_{\text{cell}}$$

$$\text{or } \log \frac{[\text{Sn}^{2+}]}{[\text{Pb}^{2+}]} = \frac{0.01 \times 2}{0.059} = 0.3 \quad (\because E_{\text{cell}} = 0)$$

$$\text{or } \frac{[\text{Sn}^{2+}]}{[\text{Pb}^{2+}]} = \text{antilog}(0.3)$$

138. (d)  $E_{\text{cell}} = 0$ ; when cell is completely discharged.

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.059}{2} \log \left( \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \right)$$

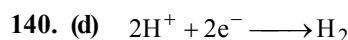
$$\text{or } 0 = 1.1 - \frac{0.059}{2} \log \left( \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \right)$$

$$\log \left( \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} \right) = \frac{2 \times 1.1}{0.059} = 37.3$$

$$\therefore \frac{[\text{Zn}^{2+}]}{[\text{Cu}^{2+}]} = 10^{37.3}$$

139. (a) The Half cell reaction is  $\text{Zn}^{++} + 2\text{e}^- \longrightarrow \text{Zn}$ .

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.059}{2} \log \frac{1}{[\text{Zn}^{++}]} \\ = -0.763 - \frac{0.059}{2} \log \frac{1}{0.01} = -0.822 \text{ V} \\ E_{\text{oxi}} = 0.822 \text{ V}$$



$$E_{\text{Red}} = E_{\text{Red}}^\circ - \frac{0.059}{n} \log \frac{1}{[\text{H}^+]^2};$$

$$E_{\text{Red}} = 0 - \frac{0.059}{2} \log \frac{1}{(0.1)^2}; E_{\text{Red}} = -0.059 \text{ V,} \\ E_{\text{oxi}} = 0.059 \text{ V.}$$

141. (c) When the concentration of all reacting species kept unity, then  $E_{\text{cell}} = E^{\circ}_{\text{cell}}$  and the given relation will become

$$\Delta_r G = -nFE^{\circ}_{\text{cell}}$$

142. (b) Here,  $R = 31.6 \text{ ohm}$

$$\therefore \text{Conductance} = \frac{1}{R} = \frac{1}{31.6} \text{ ohm}^{-1} = 0.0316 \text{ ohm}^{-1}$$

$$\begin{aligned} \text{Specific conductance} &= \text{conductance} \times \text{cell constant} \\ &= 0.0316 \text{ ohm}^{-1} \times 0.367 \text{ cm}^{-1} \\ &= 0.0116 \text{ ohm}^{-1} \text{ cm}^{-1} \end{aligned}$$

$$\begin{aligned} \text{Now, molar concentration} &= 0.5 \text{ M} \quad (\text{given}) \\ &= 0.5 \times 10^{-3} \text{ mole cm}^{-3} \end{aligned}$$

$$\begin{aligned} \therefore \text{Molar conductance} &= \frac{\kappa}{C} = \frac{0.0116}{0.5 \times 10^{-3}} \\ &= 23.2 \text{ S cm}^2 \text{ mol}^{-1} \end{aligned}$$

143. (b) According to Kohlrausch's law, molar conductivity of weak electrolyte acetic acid ( $\text{CH}_3\text{COOH}$ ) can be calculated as follows:

$$\Lambda^{\circ}_{\text{CH}_3\text{COOH}} = (\Lambda^{\circ}_{\text{CH}_3\text{COONa}} + \Lambda^{\circ}_{\text{HCl}}) - \Lambda^{\circ}_{\text{NaCl}}$$

$\therefore$  Value of  $\Lambda^{\circ}_{\text{NaCl}}$  should also be known for calculating value of  $\Lambda^{\circ}_{\text{CH}_3\text{COOH}}$ .

144. (a)  $\kappa = \frac{1}{R} \times \frac{\ell}{A}$

$$1.3 = \frac{1}{50} \times \frac{\ell}{A}$$

$$\frac{\ell}{A} = 65 \text{ m}^{-1}$$

$$\Lambda = \frac{\kappa \times 1000}{\text{molarity}}$$

[molarity is in moles/litre but 1000 is used to convert liter into  $\text{cm}^3$ ]

$$= \frac{\left(\frac{1}{260} \times 65 \text{ m}^{-1}\right) \times 1000 \text{ cm}^3}{0.4 \text{ moles}}$$

$$= \frac{650 \text{ m}^{-1}}{260 \times 4 \text{ mol}} \times \frac{1}{1000} \text{ m}^3$$

$$= 6.25 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$$

145. (b)  $\Lambda^{\circ}$  for  $\text{CH}_3\text{COOH}$

$$= \lambda^{\circ}_{\text{CH}_3\text{COO}^-} + \lambda^{\circ}_{\text{Na}^+} + \lambda^{\circ}_{\text{H}^+} + \lambda^{\circ}_{\text{Cl}^-} - \lambda^{\circ}_{\text{Na}^+} - \lambda^{\circ}_{\text{Cl}^-}$$

$$= \lambda^{\circ}_{\text{CH}_3\text{COO}^-} + \lambda^{\circ}_{\text{H}^+}$$

$$= 90 + 425 - 125 = 390 \text{ mho cm}^2 \text{ mol}^{-1}$$

$$\text{Degree of dissociation } (\alpha) = \frac{\Lambda^{\circ}_m}{\Lambda_m} = \frac{7.8}{390} = 0.02$$

146. (d)  $\Lambda_C = \Lambda_0 \times \alpha = 8$

$$\Lambda_C = \frac{1}{R} \times \frac{\ell}{A} \times \frac{1000}{N}$$

$$R = \frac{0.4 \times 1000}{8 \times 0.1} = 500 \text{ Ohms}$$

147. (b)

148. (d) Charge on Mg and Ca ion is greater than that of Na and K, so Mg and Ca ions possess higher conductivity, also solvation of metal ion decreases as we move down the group, hence conductivity increases)

149. (d) The conductivity of electrolytic solution depends upon all of the given factors.

150. (c) Correct Nernst equation is

$$E = E^{\circ} + \frac{2.303 RT}{nF} \log_a M^{n+}$$

151. (a)  $2\text{H}^+ + 2\text{e}^- \longrightarrow \text{H}_2$

$$E_{\text{H}} (\text{Eq. wt}) = \frac{2}{2} = 1 \text{ g} = \frac{22400}{2} = 11200 \text{ ml (STP)}$$

$$\text{Total charge passed} = \frac{96500 \times 112}{11200} = 965$$

$$Q = It = 965$$

$$I = \frac{965}{965} = 1 \text{ amp.}$$

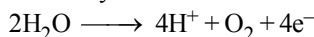
152. (c) Using Faraday's second law of electrolysis,

$$\frac{\text{Weight of Cu deposited}}{\text{Weight of Ag deposited}} = \frac{\text{Equ. wt. of Cu}}{\text{Equ. wt. of Ag}}$$

$$\Rightarrow \frac{w_{\text{Cu}}}{0.18} = \frac{63.5}{2} \times \frac{1}{108}$$

$$\Rightarrow w_{\text{Cu}} = \frac{63.5 \times 18}{2 \times 108 \times 100} = 0.0529 \text{ g.}$$

153. (c) According to the definition 1 F or 96500 C is the charge carried by 1 mol of electrons when water is electrolysed

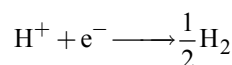


So, 4 Faraday of electricity liberate = 32 g of  $\text{O}_2$ .

Thus 1 Faraday of electricity liberate

$$= \frac{32}{4} \text{ g of } \text{O}_2 = 8 \text{ g of } \text{O}_2$$

154. (b)  $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$



$\therefore$  0.5 mole of  $\text{H}_2$  is liberated by 1 F = 96500 C  
0.01 mole of  $\text{H}_2$  will be liberated by

$$= \frac{96500}{0.5} \times 0.01 = 1930 \text{ C}$$

$$Q = I \times t$$

$$t = \frac{Q}{I} = \frac{1930 \text{ C}}{10 \times 10^{-3} \text{ A}} = 19.3 \times 10^4 \text{ sec}$$

155. (b) At Anode,  $\text{Cl}^- \rightarrow \frac{1}{2}\text{Cl}_2 + \text{e}^-$

$$\text{Equivalent wt. of chlorine } (E_{\text{Cl}_2}) = \frac{35.5 \times 2}{2} = 35.5$$

$$W_{\text{Cl}_2} = \frac{E_{\text{Cl}_2} \times I \times t}{96500} = \frac{35.5 \times 2 \times 30 \times 60}{96500} = 1.32 \text{ gm.}$$

156. (a) By Faraday's 1<sup>st</sup> Law of electrolysis,  $\frac{W}{E} = \frac{Q}{96500}$

(where  $Q = it = \text{charge of ion}$ )

We know that no. of gram equivalent

$$= \frac{W}{E} = \frac{it}{96500} = \frac{1 \times 965}{96500} = \frac{1}{100}$$

(where  $i = 1 \text{ A}$ ,  $t = 16 \times 60 + 5 = 965 \text{ sec.}$ )

Since, we know that

$$\text{Normality} = \frac{\text{No. of gram equivalent}}{\text{Volume (in litre)}} = \frac{1}{100} = 0.01 \text{ N}$$

157. (b) Quantity of charge passed =  $0.5 \times 30 \times 60 = 900$  coulomb  
900 coulomb will deposit = 0.2964g of copper  
 $\therefore$  96500 coulomb will deposit

$$= \frac{0.2964}{900} \times 96500 = 31.75 \text{ g of copper}$$

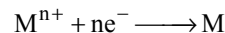
Thus, 31.75 is the eq. mass of copper

At. mass = Eq. mass  $\times$  Valency

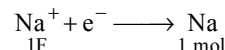
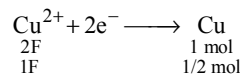
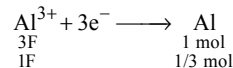
$$63.56 = 31.75 \times x$$

$$x = +2.$$

158. (a) The charge carried by 1 mole of electrons is one faraday.  
Thus for a reaction



$nF = 1 \text{ mole of M}$



The mole ratio of Al, Cu and Na deposited at the respective cathode is  $\frac{1}{3} : \frac{1}{2} : 1$  or  $2 : 3 : 6$ .

159. (a)

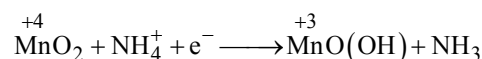
160. (b) Total of 6 electrons are required to form 2 moles of  $\text{Cr}^{3+}$  therefore to form 1 mole 3F of charge is required.

161. (d)  $\text{Pb} + \text{PbO}_2 + 2\text{H}_2\text{SO}_4 \xrightleftharpoons[\text{Recharge}]{\text{Discharge}} 2\text{PbSO}_4 + 2\text{H}_2\text{O}$

Sulphuric acid is consumed on discharging.

162. (d) This is because zinc has higher oxidation potential than Ni, Cu and Sn. The process of coating of iron surface with zinc is known as galvanization. Galvanized iron sheets maintain their lustre due to the formation of protective layer of basic zinc carbonate.

163. (c) At cathode reduction occurs according to following reaction.





### FACT/DEFINITION TYPE QUESTIONS

- The term  $-dc/dt$  in a rate equation refers to :
  - the conc. of a reactant
  - the decrease in conc. of the reactant with time
  - the velocity constant of reaction
  - None of these
- The rate law for the single- step reaction  $2A + B \longrightarrow 2C$ , is given by:
  - rate =  $k[A].[B]$
  - rate =  $k[A]^2.[B]$
  - rate =  $k[2A].[B]$
  - rate =  $k[A]^2.[B]^0$
- Rate of which reaction increases with temperature :
  - of any type of reactions
  - of exothermic reactions
  - of endothermic reactions
  - of none
- In a slow reaction, rate of reaction generally ..... with time:
  - decreases
  - increases
  - sometimes increases and sometimes decreases.
  - remains constant
- The rate of a chemical reaction tells us about,
  - the reactants taking part in reaction
  - the products formed in the reaction
  - how slow or fast the reaction is taking place
  - None of the above
- For the reaction  $2A + B \rightarrow 3C + D$  which of the following does not express the reaction rate ?
  - $-\frac{d[B]}{dt}$
  - $\frac{d[D]}{dt}$
  - $-\frac{1}{2} \frac{d[A]}{dt}$
  - $-\frac{1}{3} \frac{d[C]}{dt}$
- Consider the reaction  $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$   
The equality relationship between  $\frac{d[NH_3]}{dt}$  and  $-\frac{d[H_2]}{dt}$  is
  - $+\frac{d[NH_3]}{dt} = -\frac{2}{3} \frac{d[H_2]}{dt}$
  - $+\frac{d[NH_3]}{dt} = -\frac{3}{2} \frac{d[H_2]}{dt}$
  - $\frac{d[NH_3]}{dt} = -\frac{d[H_2]}{dt}$
  - $\frac{d[NH_3]}{dt} = -\frac{1}{3} \frac{d[H_2]}{dt}$
- For the reaction  $2A + B \rightarrow 3C + D$  which of the following does not express the reaction rate ?
  - $-\frac{d[B]}{dt}$
  - $\frac{d[D]}{dt}$
  - $-\frac{1}{2} \frac{d[A]}{dt}$
  - $-\frac{1}{3} \frac{d[C]}{dt}$
- Which of the following reaction does not occur fastly ?
  - Precipitation of AgCl by mixing aqueous solutions of AgNO<sub>3</sub> and NaCl.
  - Burning of gasoline
  - Rusting of iron
  - Burning of LPG for cooking
- Chemical kinetics is a study to find out
  - the feasibility of a chemical reaction
  - extent to which a reaction will proceed
  - speed of a reaction
  - All of the above
- Rate of a reaction can be defined as
  - the rate of decrease in concentration of any one of the reactants
  - the rate of increase in concentration of any one of the products
  - the rate of decrease in concentration of any one of the reactants or the rate of increase in concentration of any one of the products
  - the sum of rate of decrease in concentration of all the reactants or the rate of increase in concentration of all the products
- The rate of reaction
  - increases as the reaction proceeds
  - decreases as the reaction proceeds
  - remains the same as the reaction proceeds
  - may decrease or increase as the reaction proceeds



13. The unit of rate of reaction is  
(a) mole/dm<sup>3</sup> (b) mole/pound  
(c) mole/dm<sup>3</sup> sec (d) mole/cm<sup>3</sup>
14. In the rate equation, when the conc. of reactants is unity then rate is equal to  
(a) specific rate constant  
(b) average rate constant  
(c) instantaneous rate constant  
(d) None of above
15. The rate of reaction between two specific time intervals is called  
(a) instantaneous rate (b) average rate  
(c) specific rate (d) ordinary rate
16. Instantaneous rate of a chemical reaction is  
(a) rate of reaction in the beginning  
(b) rate of reaction at the end  
(c) rate of reaction at a given instant  
(d) rate of reaction between two specific time intervals
17. At the beginning the decrease in the conc. of reactants is  
(a) slow (b) moderate  
(c) rapid (d) None of above
18. The average rate and instantaneous rate of a reaction are equal  
(a) at the start  
(b) at the end  
(c) in the middle  
(d) when two rate have time interval equal to zero
19. The rate of reaction depends upon the  
(a) volume (b) force  
(c) pressure (d) conc. of reactants
20. For the following reaction:  $\text{NO}_2(\text{g}) + \text{CO}(\text{g}) \rightarrow \text{NO}(\text{g}) + \text{CO}_2(\text{g})$ , the rate law is:  $\text{Rate} = k [\text{NO}_2]^2$ . If 0.1 mole of gaseous carbon monoxide is added at constant temperature to the reaction mixture which of the following statements is true?  
(a) Both  $k$  and the reaction rate remain the same  
(b) Both  $k$  and the reaction rate increase  
(c) Both  $k$  and the reaction rate decrease  
(d) Only  $k$  increases, the reaction rate remain the same
21. Which one of the following statements for the order of a reaction is incorrect?  
(a) Order can be determined only experimentally.  
(b) Order is not influenced by stoichiometric coefficient of the reactants.  
(c) Order of reaction is sum of power to the concentration terms of reactants to express the rate of reaction.  
(d) Order of reaction is always whole number.
22. The rate of the reaction  $2\text{NO} + \text{Cl}_2 \longrightarrow 2\text{NOCl}$  is given by the rate equation  $\text{rate} = k [\text{NO}]^2 [\text{Cl}_2]$ . The value of the rate constant can be increased by:  
(a) increasing the concentration of NO.  
(b) increasing the temperature.  
(c) increasing the concentration of the  $\text{Cl}_2$   
(d) doing all of the above
23. Order of reaction can be  
(a) 0 (b) fraction  
(c) whole number (d) integer, fraction, zero
24. Units of rate constant of first and zero order reactions in terms of molarity M unit are respectively  
(a)  $\text{sec}^{-1}$ ,  $\text{Msec}^{-1}$  (b)  $\text{sec}^{-1}$ , M  
(c)  $\text{Msec}^{-1}$ ,  $\text{sec}^{-1}$  (d) M,  $\text{sec}^{-1}$ .
25. A reaction involving two different reactants can never be  
(a) bimolecular reaction (b) second order reaction  
(c) first order reaction (d) unimolecular reaction
26.  $3\text{A} \rightarrow \text{B} + \text{C}$ , it would be a zero order reaction when  
(a) the rate of reaction is proportional to square of concentration of A  
(b) the rate of reaction remains same at any concentration of A  
(c) the rate remains unchanged at any concentration of B and C  
(d) the rate of reaction doubles if concentration of B is increased to double
27. For the following homogeneous reaction,  
$$\text{A} + \text{B} \xrightarrow{k} \text{C}$$
  
the unit of rate constant is  
(a)  $\text{sec}^{-1}$  (b)  $\text{sec}^{-1} \text{ mol L}^{-1}$   
(c)  $\text{sec}^{-1} \text{ mol}^{-1} \text{ L}$  (d)  $\text{sec}^{-1} \text{ mol}^{-2} \text{ L}^2$
28. Order of reaction is decided by  
(a) temperature  
(b) mechanism of reaction as well as relative concentration of reactants  
(c) molecularity  
(d) pressure
29. Velocity constant  $k$  of a reaction is affected by  
(a) change in the concentration of the reactant  
(b) change of temperature  
(c) change in the concentration of the product  
(d) None of the above
30. The rate constant for the reaction  $2\text{N}_2\text{O}_5 \longrightarrow 4\text{NO}_2 + \text{O}_2$  is  $3.10 \times 10^{-5} \text{ sec}^{-1}$ . If the rate is  $2.4 \times 10^{-5} \text{ mol litre}^{-1} \text{ sec}^{-1}$  then the concentration of  $\text{N}_2\text{O}_5$  (in  $\text{mol litre}^{-1}$ ) is:  
(a) 0.04 (b) 0.8  
(c) 0.07 (d) 1.4
31. A zero order reaction is one whose rate is independent of  
(a) the concentration of the reactants  
(b) the temperature of reaction  
(c) the concentration of the product  
(d) the material of the vessel in which reaction is carried out
32. The rate law for a reaction between the substances A and B is given by  $\text{Rate} = k [\text{A}]^n [\text{B}]^m$ . On doubling the concentration of A and halving the concentration of B, the ratio of the new rate to the earlier rate of the reaction will be as  
(a)  $(m+n)$  (b)  $(n-m)$   
(c)  $2^{(n-m)}$  (d)  $\frac{1}{2^{(m+n)}}$

33. In the reaction  $2A + B \rightarrow A_2B$ , if the concentration of A is doubled and that of B is halved, then the rate of the reaction will:  
 (a) increase 2 times (b) increase 4 times  
 (c) decrease 2 times (d) remain the same
34. The order of a reaction, with respect to one of the reacting component Y, is zero. It implies that:  
 (a) the reaction is going on at a constant rate  
 (b) the rate of reaction does not vary with temperature  
 (c) the reaction rate is independent of the concentration of Y  
 (d) the rate of formation of the activated complex is zero
35. If the rate of a gaseous reaction is independent of pressure, the order of reaction is:  
 (a) 0 (b) 1  
 (c) 2 (d) 3
36. If the rate of the reaction is equal to the rate constant, the order of the reaction is  
 (a) 3 (b) 0  
 (c) 1 (d) 2
37. In a reaction, when the concentration of reactant is increased two times, the increase in rate of reaction was four times. Order of reaction is:  
 (a) zero (b) 1  
 (c) 2 (d) 3
38. For the reaction  $A + 2B \rightarrow C$ , rate is given by  $R = [A][B]^2$  then the order of the reaction is  
 (a) 3 (b) 6  
 (c) 5 (d) 7
39. The unit of rate constant for a zero order reaction is  
 (a)  $\text{mol L}^{-1} \text{s}^{-1}$  (b)  $\text{L mol}^{-1} \text{s}^{-1}$   
 (c)  $\text{L}^2 \text{mol}^{-2} \text{s}^{-1}$  (d)  $\text{s}^{-1}$
40. Which one of the following reactions is a true first order reaction?  
 (a) Alkaline hydrolysis of ethyl acetate  
 (b) Acid catalyst hydrolysis of ethyl acetate  
 (c) Decomposition of  $\text{N}_2\text{O}$   
 (d) Decomposition of gaseous ammonia on a hot platinum surface
41. For a reaction  $A + B \rightarrow C + 2D$ , experimental results were collected for three trials and the data obtained are given below:

Trial	[A], M	[B], M	Initial Rate, $\text{M s}^{-1}$
1	0.40	0.20	$5.5 \times 10^{-4}$
2	0.80	0.20	$5.5 \times 10^{-4}$
3	0.40	0.40	$2.2 \times 10^{-3}$

The correct rate law of the reaction is

- (a)  $\text{rate} = k[A]^0[B]^2$  (b)  $\text{rate} = k[A][B]^2$   
 (c)  $\text{rate} = k[A][B]$  (d)  $\text{rate} = k[A][B]^0$
42. The rate law for the reaction  $x\text{A} + y\text{B} \rightarrow m\text{P} + n\text{Q}$  is  $\text{Rate} = k[A]^c[B]^d$ . What is the total order of the reaction?  
 (a)  $(x+y)$  (b)  $(m+n)$   
 (c)  $(c+d)$  (d)  $x/y$

43. What is order with respect to A, B, C, respectively

[A]	[B]	[C]	rate ( $\text{M/sec.}$ )
0.2	0.1	0.02	$8.08 \times 10^{-3}$
0.1	0.2	0.02	$2.01 \times 10^{-3}$
0.1	1.8	0.18	$6.03 \times 10^{-3}$
0.2	0.1	0.08	$6.464 \times 10^{-2}$
(a) -1, 1, 3/2	(b) -1, 1, 1/2		
(c) 1, 3/2, -1	(d) 1, -1, 3/2		

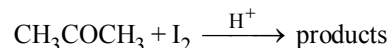
44. Select the rate law that corresponds to the data shown for the following reaction :

$A + B \rightarrow C$			
Expt. No.	(A)	(B)	Initial Rate
1	0.012	0.035	0.10
2	0.024	0.070	0.80
3	0.024	0.035	0.10
4	0.012	0.070	0.80

- (a)  $\text{Rate} = k[B]^3$  (b)  $\text{Rate} = k[B]^4$   
 (c)  $\text{Rate} = k[A][B]^3$  (d)  $\text{Rate} = k[A]^2[B]^2$
45. The order of a reaction with rate equal to  $k[A]^{3/2}[B]^{-1/2}$  is :

- (a) 1 (b)  $-\frac{1}{2}$   
 (c)  $-\frac{3}{2}$  (d) 2

46. For the reaction,



The rate is governed by expression

$$\frac{dx}{dt} = k[\text{acetone}][\text{H}^+]$$

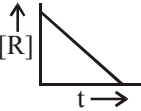
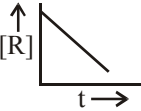
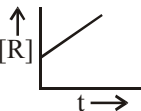
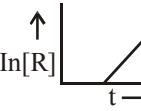
The order w.r.t.  $\text{I}_2$  is:

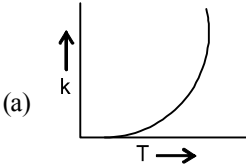
- (a) 1 (b) 0  
 (c) 3 (d) 2
47. The rate constant of a reaction is  $3.00 \times 10^3 \text{ L mol}^{-1} \text{sec}^{-1}$ . The order of this reaction will be:  
 (a) 0 (b) 1  
 (c) 2 (d) 3
48. During the kinetic study of the reaction,  $2A + B \rightarrow C + D$ , following results were obtained:

Run	[A] ( $\text{mol L}^{-1}$ )	[B] ( $\text{mol L}^{-1}$ )	Initial rate of formation of D ( $\text{mol L}^{-1} \text{min}^{-1}$ )
I	0.1	0.1	$6.0 \times 10^{-3}$
II	0.3	0.2	$7.2 \times 10^{-2}$
III	0.3	0.4	$2.88 \times 10^{-1}$
IV	0.4	0.1	$2.40 \times 10^{-2}$

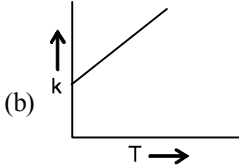
Based on the above data which one of the following is correct?

- (a)  $\text{rate} = k[A]^2[B]$  (b)  $\text{rate} = k[A][B]$   
 (c)  $\text{rate} = k[A]^2[B]^2$  (d)  $\text{rate} = k[A][B]^2$

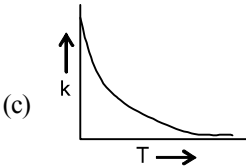
49. For the reaction  $\text{H}_2(\text{g}) + \text{Br}_2(\text{g}) \rightarrow 2\text{HBr}(\text{g})$ , the experimental data suggest,  $\text{rate} = k[\text{H}_2][\text{Br}_2]^{1/2}$ . The molecularity and order of the reaction are respectively
- (a)  $2, \frac{3}{2}$  (b)  $\frac{3}{2}, \frac{3}{2}$   
(c) 1, 1 (d)  $1, \frac{1}{2}$
50. The chemical reaction  $2\text{O}_3 \longrightarrow 3\text{O}_2$  proceeds as follows:  
 $\text{O}_3 \xrightarrow{\text{Fast}} \text{O}_2 + \text{O}; \text{O} + \text{O}_3 \xrightarrow{\text{Slow}} 2\text{O}_2$  the rate law expression should be  
 (a)  $r = k[\text{O}_3]^2$  (b)  $r = k[\text{O}_3]^2[\text{O}_2]^{-1}$   
 (c)  $r = k^3[\text{O}_3][\text{O}_2]^2$  (d)  $r = [\text{O}_3][\text{O}_2]^2$
51. Nitrogen monoxide, NO, reacts with hydrogen,  $\text{H}_2$ , according to the following equation:  
 $2\text{NO}(\text{g}) + 2\text{H}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$   
 If the mechanism for this reaction were,  
 $2\text{NO}(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + \text{H}_2\text{O}_2(\text{g}); \text{slow}$   
 $\text{H}_2\text{O}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g}); \text{fast}$   
 Which of the following rate laws would we expect to obtain experimentally?  
 (a)  $\text{Rate} = k[\text{H}_2\text{O}_2][\text{H}_2]$  (b)  $\text{Rate} = k[\text{NO}]^2[\text{H}_2]$   
 (c)  $\text{Rate} = k[\text{NO}]^2[\text{H}_2]^2$  (d)  $\text{Rate} = k[\text{NO}][\text{H}_2]$
52. Which of the following is not a first order reaction?  
 (a) Hydrogenation of ethene  
 (b) Natural radioactive decay of unstable nuclei  
 (c) Decomposition of HI on gold surface  
 (d) Decomposition of  $\text{N}_2\text{O}$
53. The plot that represents the zero order reaction is:
- (a)  (b)   
 (c)  (d) 
54. The plot of concentration of the reactant vs time for a reaction is a straight line with a negative slope. The reaction follows a rate equation  
 (a) zero order (b) first order  
 (c) second order (d) third order
55. The half-life of a reaction is inversely proportional to the square of the initial concentration of the reactant. Then the order of the reaction is  
 (a) 0 (b) 1  
 (c) 2 (d) 3
56. The rate equation for a reaction,  
 $\text{N}_2\text{O} \longrightarrow \text{N}_2 + 1/2\text{O}_2$   
 is  $\text{Rate} = k[\text{N}_2\text{O}]^0 = k$ . If the initial concentration of the reactant is  $a \text{ mol Lit}^{-1}$ , the half-life period of the reaction is  
 (a)  $t_{1/2} = \frac{a}{2k}$  (b)  $-t_{1/2} = ka$   
 (c)  $t_{1/2} = \frac{a}{k}$  (d)  $t_{1/2} = \frac{k}{a}$
57. Half life of a first order reaction is 4s and the initial concentration of the reactant is 0.12 M. The concentration of the reactant left after 16 s is  
 (a) 0.0075 M (b) 0.06 M  
 (c) 0.03 M (d) 0.015 M
58. The reaction  $\text{A} \rightarrow \text{B}$  follows first order kinetics. The time taken for 0.8 mole of A to produce 0.6 mole of B is 1 hour. What is the time taken for conversion of 0.9 mole of A to produce 0.675 mole of B?  
 (a) 2 hours (b) 1 hour  
 (c) 0.5 hour (d) 0.25 hour
59. The rate of a first order reaction is  $1.5 \times 10^{-2} \text{ mol L}^{-1} \text{ min}^{-1}$  at 0.5 M concentration of the reactant. The half life of the reaction is  
 (a) 0.383 min (b) 23.1 min  
 (c) 8.73 min (d) 7.53 min
60. The rate constant for a first order reaction whose half-life, is 480 seconds is :  
 (a)  $2.88 \times 10^{-3} \text{ sec}^{-1}$  (b)  $2.72 \times 10^{-3} \text{ sec}^{-1}$   
 (c)  $1.44 \times 10^{-3} \text{ sec}^{-1}$  (d)  $1.44 \text{ sec}^{-1}$
61. The rate constant of a first order reaction is  $6.9 \times 10^{-3} \text{ s}^{-1}$ . How much time will it take to reduce the initial concentration to its  $1/8^{\text{th}}$  value?  
 (a) 100 s (b) 200 s  
 (c) 300 s (d) 400 s
62. A reaction proceeds by first order, 75% of this reaction was completed in 32 min. The time required for 50% completion is  
 (a) 8 min (b) 16 min  
 (c) 20 min (d) 24 min
63. Point out the wrong statement:  
 For a first order reaction  
 (a) time for half-change ( $t_{1/2}$ ) is independent of initial concentration  
 (b) change in the concentration unit does not change the rate constant ( $k$ )  
 (c) time for half-change  $\times$  rate constant = 0.693  
 (d) the unit of  $k$  is  $\text{mole}^{-1} \text{ min}^{-1}$
64.  $t_{1/4}$  can be taken as the time taken for the concentration of a reactant to drop to  $\frac{3}{4}$  of its initial value. If the rate constant for a first order reaction is  $k$ , the  $t_{1/4}$  can be written as  
 (a)  $0.75/k$  (b)  $0.69/k$   
 (c)  $0.29/k$  (d)  $0.10/k$
65. In a first-order reaction  $\text{A} \rightarrow \text{B}$ , if  $k$  is rate constant and initial concentration of the reactant A is 0.5 M, then the half-life is  
 (a)  $\frac{\log 2}{k}$  (b)  $\frac{\log 2}{k\sqrt{0.5}}$   
 (c)  $\frac{\ln 2}{k}$  (d)  $\frac{0.693}{0.5k}$

66. Consider the reaction,  $2A + B \rightarrow \text{products}$ . When concentration of B alone was doubled, the half-life did not change. When the concentration of A alone was doubled, the rate increased by two times. The unit of rate constant for this reaction is  
 (a)  $\text{s}^{-1}$  (b)  $\text{L mol}^{-1} \text{s}^{-1}$   
 (c) no unit (d)  $\text{mol L}^{-1} \text{s}^{-1}$ .
67. The decomposition of  $\text{N}_2\text{O}_5$  occurs as  $2\text{N}_2\text{O}_5 \longrightarrow 4\text{NO}_2 + \text{O}_2$  and follows 1st order kinetics, hence:  
 (a) the reaction is unimolecular  
 (b) the reaction is bimolecular  
 (c)  $t_{1/2} \propto a^0$   
 (d) None of these
68. In a first-order reaction  $A \rightarrow B$ , if  $k$  is rate constant and initial concentration of the reactant A is 0.5 M, then the half-life is  
 (a)  $\frac{\log 2}{k}$  (b)  $\frac{\log 2}{k\sqrt{0.5}}$   
 (c)  $\frac{\ln 2}{k}$  (d)  $\frac{0.693}{0.5k}$
69. For a first order reaction, a plot of  $\log(a-x)$  against time is a straight line with a negative slope equal to  
 (a)  $\frac{-k}{2.303}$  (b)  $-2.303 k$   
 (c)  $\frac{2.303}{k}$  (d)  $-\frac{E_a}{2.303 R}$
70. In a reaction  $A \rightarrow \text{Products}$ , when start is made from  $8.0 \times 10^{-2} \text{ M}$  of A, half-life is found to be 120 minute. For the initial concentration  $4.0 \times 10^{-2} \text{ M}$ , the half-life of the reaction becomes 240 minute. The order of the reaction is :  
 (a) zero (b) one  
 (c) two (d) 0.5
71. The value of rate constant of a pseudo first order reaction \_\_\_\_\_.  
 (a) depends on the concentration of reactants present in small amount.  
 (b) depends on the concentration of reactants present in excess.  
 (c) is independent on the concentration of reactants.  
 (d) depends only on temperature.
72. In the Haber process for the manufacture of ammonia the following catalyst is used  
 (a) Platinized asbestos  
 (b) Iron with molybdenum as promoter  
 (c) Copper oxide  
 (d) Alumina
73. What is the activation energy for a reaction if its rate doubles when the temperature is raised from  $20^\circ\text{C}$  to  $35^\circ\text{C}$ ? ( $R = 8.314 \text{ J mol}^{-1} \text{K}^{-1}$ )  
 (a)  $269 \text{ kJ mol}^{-1}$  (b)  $34.7 \text{ kJ mol}^{-1}$   
 (c)  $15.1 \text{ kJ mol}^{-1}$  (d)  $342 \text{ kJ mol}^{-1}$
74. A reaction having equal energies of activation for forward and reverse reaction has :  
 (a)  $\Delta G = 0$  (b)  $\Delta H = 0$   
 (c)  $\Delta H = \Delta G = \Delta S = 0$  (d)  $\Delta S = 0$
75. In an exothermic reaction if  $\Delta H$  is the enthalpy then activation energy is  
 (a) more than  $\Delta H$  (b) less than  $\Delta H$   
 (c) equal to  $\Delta H$  (d) none of the above
76. In the Arrhenius plot of  $\ln k$  vs  $\frac{1}{T}$ , a linear plot is obtained with a slope of  $-2 \times 10^4 \text{ K}$ . The energy of activation of the reaction (in  $\text{kJ mole}^{-1}$ ) is ( $R$  value is  $8.3 \text{ J K}^{-1} \text{mol}^{-1}$ )  
 (a) 83 (b) 166  
 (c) 249 (d) 332
77. The rate of reaction is doubled for every  $10^\circ\text{C}$  rise in temperature. The increase in reaction rate as a result of temperature rise from  $10^\circ\text{C}$  to  $100^\circ\text{C}$  is  
 (a) 112 (b) 512  
 (c) 400 (d) 614
78. Plots showing the variation of the rate constant ( $k$ ) with temperature ( $T$ ) are given below. The plot that follows Arrhenius equation is
- 

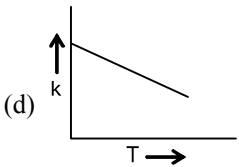
(a)



(b)



(c)



(d)
79. If the activation energy for the forward reaction is  $150 \text{ kJ mol}^{-1}$  and that of the reverse reaction is  $260 \text{ kJ mol}^{-1}$ , what is the enthalpy change for the reaction ?  
 (a)  $410 \text{ kJ mol}^{-1}$  (b)  $-110 \text{ kJ mol}^{-1}$   
 (c)  $110 \text{ kJ mol}^{-1}$  (d)  $-410 \text{ kJ mol}^{-1}$
80. Activation energy of a chemical reaction can be determined by  
 (a) evaluating rate constant at standard temperature  
 (b) evaluating velocities of reaction at two different temperatures  
 (c) evaluating rate constants at two different temperatures  
 (d) changing concentration of reactants
81. In respect of the equation  $k = Ae^{-E_a/RT}$  in chemical kinetics, which one of the following statements is correct ?  
 (a)  $A$  is adsorption factor  
 (b)  $E_a$  is energy of activation  
 (c)  $R$  is Rydberg's constant  
 (d)  $k$  is equilibrium constant

82. Rate of a reaction can be expressed by Arrhenius equation as:  $k = Ae^{-E_a/RT}$   
In this equation,  $E_a$  represents
- the total energy of the reacting molecules at a temperature,  $T$
  - the fraction of molecules with energy greater than the activation energy of the reaction
  - the energy below which all the colliding molecules will react
  - the energy below which colliding molecules will not react
83. The minimum energy required for the reacting molecules to undergo reaction is :
- potential energy
  - kinetic energy
  - thermal energy
  - activation energy
84. The reason for almost doubling the rate of reaction on increasing the temperature of the reaction system by  $10^\circ\text{C}$  is
- the value of threshold energy increases
  - collision frequency increases
  - the fraction of the molecule having energy equal to threshold energy or more increases
  - activation energy decreases
85. The slope in Arrhenius plot, is equal to:
- $-\frac{E_a}{2.303R}$
  - $\frac{E_a}{R}$
  - $-\frac{R}{2.303E_a}$
  - None of these
86. The activation energy for a reaction is 9.0 kcal/mol. The increase in the rate constant when its temperature is increased from 298K to 308K is
- 63%
  - 50%
  - 100%
  - 10%
87. In a reversible reaction the energy of activation of the forward reaction is 50 kcal. The energy of activation for the reverse reaction will be
- < 50 kcal
  - either greater than or less than 50 kcal
  - 50 kcal
  - > 50 kcal
88. A catalyst
- increases the rate of reaction by decreasing  $\Delta G$  of a reaction.
  - increases the rate of reaction by increasing  $\Delta G$  of a reaction.
  - increases the rate of reaction by decreasing activation energy of the forward reaction.
  - increases the rate of reaction by providing an alternative pathway via an intermediate with lower activation energy.
89. Which of the following statements best describes how a catalyst works?
- A catalyst changes the potential energies of the reactants and products.
  - A catalyst decreases the temperature of the reaction which leads to a faster rate.
  - A catalyst lowers the activation energy for the reaction by providing a different reaction mechanism.
  - A catalyst destroys some of the reactants, which lowers the concentration of the reactants.
90. In terms of the 'Collision Theory of Chemical Kinetics', the rate of a chemical reaction is proportional to
- the change in free energy per second
  - the change in temperature per second
  - the number of collisions per second
  - the number of products molecules
91. According to collision theory, which of the following is NOT a true statement concerning a catalyst?
- A catalyst changes the temperature of reaction.
  - The mechanism of a reaction will change when a catalyst is added.
  - A catalyst provides a different activation energy for a reaction.
  - A catalyst changes the speed of a reaction, but not the equilibrium constant.
92. Which of the following influences the rate of a chemical reaction performed in solution?
- Temperature
  - Activation energy
  - Presence of a catalyst
  - All of the above influence the rate
93. How can be activation energy for a reaction be determined graphically?
- Plot  $k$  versus  $T$ , the slope of the line will be equal to  $E_a$
  - Plot  $1/[A]_t$  versus  $t$ , the slope of the line will be equal to  $E_a$
  - Plot  $\ln [A]_t$  versus  $t$ , the slope of the line will be equal to  $-E_a$
  - Plot  $\ln k$  versus  $1/T$ , the slope of the line will be equal to  $-E_a/R$
94. The Arrhenius equation expressing the effect of temperature on the rate constant of the reaction is
- $k = e^{-E_a/RT}$
  - $k = \frac{E_a}{RT}$
  - $k = \log_e \frac{E_a}{RT}$
  - $k = Ae^{-E_a/RT}$
95. In Arrhenius plot, intercept is equal to
- $-\frac{E_a}{R}$
  - $\ln A$
  - $\ln k$
  - $\log_{10} a$
96. A chemical reaction was carried out at 300 K and 280 K. The rate constants were found to be  $k_1$  and  $k_2$  respectively. then
- $k_1 = 4k_2$
  - $k_2 = 2k_1$
  - $k_2 = 0.25 k_1$
  - $k_2 = 0.5 k_1$



97. For a first order reaction, the plot of  $\log K$  against  $1/T$  is a straight line. The slope of the line is equal to

- (a)  $-\frac{E_a}{R}$  (b)  $-\frac{2.303}{E_a R}$   
(c)  $-\frac{E_a}{2.303}$  (d)  $\frac{-E_a}{2.303 R}$

98. Collision theory is applicable to

- (a) first order reactions (b) zero order reactions  
(c) bimolecular reactions (d) intra-molecular reactions

99. According to the collision theory of reaction rates, the rate of reaction increases with temperature due to

- (a) greater number of collision  
(b) higher velocity of reacting molecules  
(c) greater number of molecules having the activation energy  
(d) decrease in the activation energy

100. Which of the following has been used to explain the subject of chemical kinetics

- (a) Collision theory of bimolecular reactions  
(b) The activated complex theory  
(c) Arrhenius equation  
(d) All of these

101. A catalyst increases rate of reaction by

- (a) decreasing enthalpy  
(b) decreasing internal energy  
(c) decreasing activation energy  
(d) increasing activation energy

102. Activation energy of the reaction is

- (a) the energy released during the reaction  
(b) the energy evolved when activated complex is formed  
(c) minimum amount of energy needed to overcome the potential barrier  
(d) the energy needed to form one mole of the product

103. In a reaction, the threshold energy is equal to

- (a) activation energy + normal energy of reactants  
(b) activation energy - normal energy of reactants  
(c) normal energy of reactants - activation energy  
(d) average kinetic energy of molecules of reactants

104. The temperature dependence of rate constant ( $k$ ) of a chemical reaction is written in terms of Arrhenius equation,

$k = A \cdot e^{-E_a}$  Activation energy ( $E_a$ ) of the reaction can be calculated by plotting

- (a)  $k$  vs.  $\frac{1}{\log T}$  (b)  $\log k$  vs  $\frac{1}{T}$   
(c)  $\log k$  vs.  $\frac{1}{\log T}$  (d)  $k$  vs.  $T$

105. Consider an endothermic reaction  $X \rightarrow Y$  with the activation energies  $E_b$  and  $E_f$  for the backward and forward reactions, respectively. In general

- (a) there is no definite relation between  $E_b$  and  $E_f$

(b)  $E_b = E_f$

(c)  $E_b > E_f$

(d)  $E_b < E_f$

106. The energies of activation for forward and reverse reactions for  $A_2 + B_2 \rightleftharpoons 2AB$  are  $180 \text{ kJ mol}^{-1}$  and  $200 \text{ kJ mol}^{-1}$  respectively. The presence of a catalyst lowers the activation energy of both (forward and reverse) reactions by  $100 \text{ kJ mol}^{-1}$ . The enthalpy change of the reaction ( $A_2 + B_2 \rightarrow 2AB$ ) in the presence of a catalyst will be (in  $\text{kJ mol}^{-1}$ )

- (a) 20 (b) 300  
(c) 120 (d) 280

107. For the exothermic reaction  $A + B \rightarrow C + D$ ,  $\Delta H$  is the heat of reaction and  $E_a$  is the energy of activation. The energy of activation for the formation of  $A + B$  will be

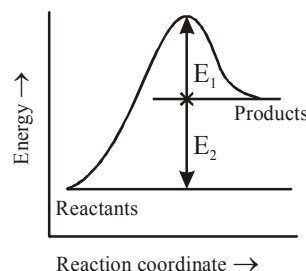
- (a)  $E_a$  (b)  $\Delta H$   
(c)  $E_a + \Delta H$  (d)  $\Delta H - E_a$

108. In most cases, for a rise of  $10\text{K}$  temperature the rate constant is doubled to tripled. This is due to the reason that

- (a) collision frequency increases by a factor of 2 to 3.  
(b) fraction of molecules possessing threshold energy increases by a factor of 2 to 3  
(c) Activation energy is lowered by a factor of 2 to 3.  
(d) none of these

109. Consider Fig. and mark the correct option.

Activated complex



- (a) Activation energy of forward reaction is  $E_1 + E_2$  and product is less stable than reactant.  
(b) Activation energy of forward reaction is  $E_1 + E_2$  and product is more stable than reactant.  
(c) Activation energy of both forward and backward reaction is  $E_1 + E_2$  and reactant is more stable than product.  
(d) Activation energy of backward reaction is  $E_1$  and product is more stable than reactant.

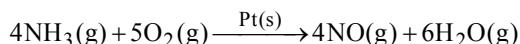
110. Activation energy of a chemical reaction can be determined by \_\_\_\_\_

- (a) determining the rate constant at standard temperature.  
(b) determining the rate constants at two temperatures.  
(c) determining probability of collision.  
(d) using catalyst.

111. According to which theory activation energy and proper orientation of the molecules together determine the criteria for an effective collision ?
- Arrhenius theory
  - Activated complex theory
  - Collision theory
  - Both (a) and (c)

### STATEMENT TYPE QUESTIONS

112. Consider the following reaction :



- (i) Rate of reaction with respect to  $\text{NH}_3$  will be

$$-\frac{1}{4} \frac{\Delta[\text{NH}_3]}{\Delta t}$$

- (ii) For the given reaction  $-\frac{1}{5} \frac{\Delta[\text{O}_2]}{\Delta t} = -\frac{1}{6} \frac{\Delta[\text{H}_2\text{O}]}{\Delta t}$

- (iii) For the given reaction  $-\frac{1}{4} \frac{\Delta[\text{NH}_3]}{\Delta t} = \frac{1}{4} \frac{\Delta[\text{NO}]}{\Delta t}$

- (iv) For the given reaction,

$$\begin{aligned} \text{Rate} &= -\frac{1}{4} \frac{\Delta[\text{NH}_3]}{\Delta t} = -\frac{1}{5} \frac{\Delta[\text{O}_2]}{\Delta t} \\ &= \frac{4\Delta[\text{NO}]}{\Delta t} = \frac{6\Delta[\text{H}_2\text{O}]}{\Delta t} \end{aligned}$$

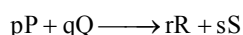
Which of the following is the correct code for the statements above.

- TTTT
- TFTF
- FTFT
- TFFT

113. Which of the following statement(s) is/are correct?

- (i) Rate of reaction decreases with passage of time as the concentration of reactants decrease.

- (ii) For a reaction

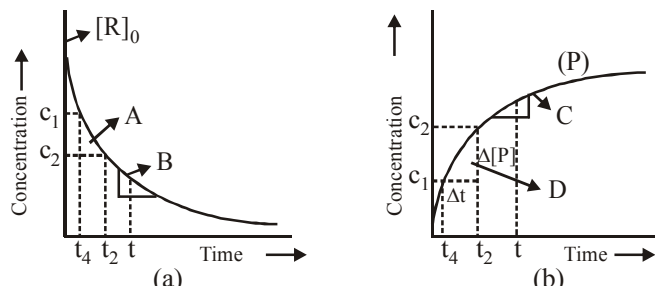


$$\text{Rate} = k[\text{P}]^x [\text{Q}]^y \text{ where } x = p \text{ and } y = q$$

- (iii) Rate law is the expression in which reaction rate is given in terms of molar concentration of reactants with each term raised to some power, which may or may not be same as the stichiometric coefficient of the reacting species in a balanced chemical equation.

- (i) and (iii)
- (i) and (ii)
- (ii) and (iii)
- (i) only

114. Study the following graphs and choose the correct option



- (i) in fig. a, A represents average rate and B represents instantaneous rate

- (ii) in fig. b, D represents average rate and C represents instantaneous rate

- (iii) fig. a, A represents instantaneous rate and B represents average rate

- (iv) fig. b, C represents average rate and D represents instantaneous rate

- (a) (i) and (ii) are correct (b) (ii) and (iv) are correct

- (c) (i) and (iv) are correct (d) (ii) and (iii) are correct

115. Choose correct option based on following statements. Here T stands for true statement and F for false statement.

- (i) Molecularity is defined as the number of reacting species taking part in a complex reaction,

- (ii) Molecularity helps in understanding the mechanism of reaction.

- (iii) Reactions with the molecularity three are very rare and slow to proceed.

- (iv) Complex reactions involving more than three molecules take place in more than one step.

- (a) TTTF (b) TFTF

- (c) FTTF (d) FTTT

116. Read the following statements

- (i) Order of reaction can be fractional or zero.

- (ii) Molecularity of a reaction can be fractional but cannot be zero.

- (iii) Slowest step in the complex reaction is considered as a rate determining step.

- (iv) Units of rate constant for second order reaction are  $\text{mol L}^{-1} \text{s}^{-1}$ .

- (v) Order is applicable to elementary as well as complex reactions whereas molecularity is applicable only for elementary reactions.

Which of the following is the correct code for the statements above ?

- (a) TFFFT (b) TFTFT

- (c) FFFFT (d) FTTF

117. Consider the following statements with respect of zero order reaction

- (i) The rate of the reaction is independent of reactant concentration

- (ii) The rate of the reaction is independent of temperature

- (iii) The rate constant of the reaction is independent of temperature

- (iv) The rate constant of the reaction is independent of reactant concentration

Choose the correct statement(s).

- (a) (i) only (b) (i) and (ii) only

- (c) (iii) and (iv) only (d) (i) and (iv) only

118. Which of the following statement(s) is/are correct ?

- (i) For a zero order reaction concentration  $[\text{R}]$  vs time (t) gives a straight line plot

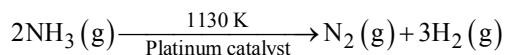
- (ii) For a first order reaction  $\log \frac{[\text{R}]_0}{[\text{R}]}$  does not vary linearly with time.

- (iii) Inversion of cane sugar is a pseudo first order reaction.

- (a) (i) and (iii) (b) (i) only

- (c) (ii) and (iii) (d) (iii) only

119. At high pressure the following reaction is of zero order.



Which of the following statements are correct for above reaction?

- (i) Rate of reaction = Rate constant
  - (ii) Rate of reaction depends on concentration of ammonia.
  - (iii) Rate of decomposition of ammonia will remain constant until ammonia disappears completely.
  - (iv) Further increase in pressure will change the rate of reaction.
- (a) (i), (iii) and (iv)                      (b) (i), (ii) and (iii)  
(c) (ii) and (iv)                              (d) (i), (ii) and (iv)

120. Consider the following statements:

- (i) Increase in concentration of reactant increases the rate of a zero order reaction.
- (ii) Rate constant  $k$  is equal to collision frequency  $A$  if  $E_a = 0$ .
- (iii) Rate constant  $k$  is equal to collision frequency  $A$  if  $E_a = \infty$ .
- (iv)  $\ln k$  vs  $T$  is a straight line.
- (v)  $\ln k$  vs  $1/T$  is a straight line.

Correct statements are

- (a) (i) and (iv)                              (b) (ii) and (v)  
(c) (iii) and (iv)                              (d) (ii) and (iii)

121. According to collision theory, not all collisions between molecules lead to reaction. Which of the following statements provide reasons for the same?

- (i) The total energy of the two colliding molecules is less than some minimum amount of energy.
  - (ii) Molecules cannot react with each other unless a catalyst is present.
  - (iii) Molecules that are improperly oriented during collision will not react.
  - (iv) Molecules in different states of matter cannot react with each other.
- (a) (i) and (ii)                              (b) (i) and (iii)  
(c) (ii) and (iii)                              (d) (i) and (iv)

122. Consider the following statements

- (i) Rate constant for every physical and chemical change gets doubled with  $10^\circ\text{C}$  rise in temperature
- (ii) On taking log both side Arrhenius equation will become

$$\log k = -\frac{E_a}{RT} + \log A$$

- (iii) The energy required to form activated complex is known as activation energy

Which of the following is the correct code for statements above?

- (a) TTT    (b) FTT  
(c) FTF    (d) TFT

123. Read the following statements.

- (i)  $e^{-E_a/RT}$  corresponds to the fraction of molecules that have kinetic energy greater than  $E_a$ .
  - (ii)  $E_a$  can be calculated as follows
- $$\log \frac{k_1}{k_2} = \frac{E_a}{2.303R} \left[ \frac{T_2 - T_1}{T_1 T_2} \right]$$
- (iii) Catalyst can alter a reaction both ways means it can either decrease or increase rate of reaction
  - (iv) A catalyst always decreases the activation energy of the reaction but does not alter Gibbs's energy.
  - (v) A catalyst does not alter equilibrium constant rather, it helps in attaining the equilibrium faster.

Which of the following is the correct codes for above statements?

- (a) TTTFF                                      (b) TFFTT  
(c) TFFTF                                      (d) FTFTT

124. The following statement(s) is (are) correct:

- (i) A plot of  $\log k_p$  versus  $1/T$  is linear
  - (ii) A plot of  $\log [X]$  versus time is linear for a first order reaction,  $X \rightarrow P$
  - (iii) A plot of  $\log p$  versus  $1/T$  is linear at constant volume
  - (iv) A plot of  $p$  versus  $1/V$  is linear at constant temperature
- (a) (i) only                                      (b) (ii) only  
(c) (i) and (iv)                                      (d) (i), (ii) and (iv)

### MATCHING TYPE QUESTIONS

125. Match the columns

Column-I	Column-II
(A) Mathematical expression for rate of reaction	(p) rate constant of reaction
(B) Rate of reaction for zero order reaction is equal to	(q) rate law
(C) Units of rate constant for zero order reaction is same as that of	(r) order of slowest step
(D) Order of a complex reaction is determined by	(s) rate of reaction
(a) A – (q), B – (p), C – (s), D – (r)	
(b) A – (r), B – (p), C – (s), D – (q)	
(c) A – (q), B – (s), C – (p), D – (r)	
(d) A – (p), B – (q), C – (s), D – (r)	

126. Match the columns

Column-I	Column-II
(A) Zero order reaction	(p) $\text{L mole}^{-1} \text{sec}^{-1}$
(B) First order reaction	(q) $\text{mole L}^{-1} \text{sec}^{-1}$
(C) Second order reaction	(r) $\text{sec}^{-1}$
(a) A – (q), B – (r), C – (p)	
(b) A – (q), B – (p), C – (r)	
(c) A – (p), B – (q), C – (r)	
(d) A – (p), B – (r), C – (q)	

127. Match the columns

- | Column-I  | Column-II                                |
|---|--|
| (A) The decomposition of gaseous ammonia on a hot platinum surface  | (p) Zero order reaction                  |
| (B) The thermal decomposition of HI on gold surface                 | (q) Pseudo first order reaction.         |
| (C) All natural and artificial radioactive decay of unstable nuclei | (r) Zero order reaction at high pressure |
| (D) Inversion of cane sugar   | (s) First order reaction.                |
- (a) A – (r), B – (p), C – (s), D – (q)  
 (b) A – (r), B – (s), C – (q), D – (p)  
 (c) A – (q), B – (s), C – (p), D – (r)  
 (d) A – (q), B – (p), C – (s), D – (p)

128. Match the columns.

- | Column-I  | Column-II                                   |
|---|---|
| (A) Catalyst alters the rate of reaction                  | (p) cannot be fraction or zero              |
| (B) Molecularity  | (q) proper orientation is not there always. |
| (C) Second half life of first order reaction              | (r) by lowering the activation energy       |
| (D) Energetically favourable reactions are sometimes slow | (s) is same as the first                    |
- (a) A – (q), B – (r), C – (s), D – (p)  
 (b) A – (r), B – (s), C – (p), D – (q)  
 (c) A – (r), B – (p), C – (s), D – (q)  
 (d) A – (p), B – (r), C – (s), D – (q)

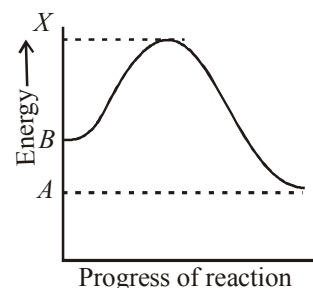
129. Match the columns

- | Column-I   | Column-II                                  |
|--|--|
| (A) $k = \frac{[R_0] - [R]}{t}$  | (p) $k = \frac{2.303}{t_{1/2}} \log 2$     |
| (B) $k = \frac{2.303}{t} \log \frac{[R_0]}{[R]}$                                       | (q) Rate constant for zero order reaction  |
| (C) Value of k for first order reaction when $t = t_{1/2}$ and $[R] = \frac{[R]_0}{2}$ | (r) $k = \frac{[R]_0}{2t_{1/2}}$           |
| (D) Value of k for zero order reaction when $t = t_{1/2}$ and $[R] = \frac{[R]_0}{2}$  | (s) Rate constant for first order reaction |
- (a) A – (s), B – (q), C – (p), D – (r)  
 (b) A – (q), B – (s), C – (p), D – (r)  
 (c) A – (q), B – (p), C – (s), D – (r)  
 (d) A – (q), B – (s), C – (p), D – (t)

130. Match the columns

- | Column-I  | Column-II                 |
|---|---------------------------|
| (A) Number of collisions per second per unit volume of the reaction mixture.          | (p) Effective collisions. |
| (B) Fraction of molecules with energies equal to or greater than $E_a$                | (q) Collision frequency   |
| (C) Molecules for which Rate = $Z_{AB}e^{-E_a/RT}$ shows significant deviations       | (r) $e^{-E_a/RT}$         |
| (D) Collision in which molecules collide with sufficient K.E. and proper orientation. | (s) Complex molecules     |
- (a) A – (q), B – (r), C – (s), D – (p)  
 (b) A – (r), B – (q), C – (s), D – (p)  
 (c) A – (q), B – (s), C – (r), D – (p)  
 (d) A – (q), B – (r), C – (p), D – (s)

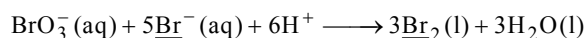
131. Consider the energy diagram of a reaction :  $B \rightarrow A$ , on the basis of given diagram select the correct code for matching Column-I and Column-II.



- | Column-I  | Column-II                                  |
|-----------|--|
| (A) X – A | (p) Enthalpy of reaction                   |
| (B) X – B | (q) Energy of transition state             |
| (C) A – B | (r) Activation energy of forward reaction  |
| (D) X     | (s) Activation energy of backward reaction |
- (a) A – (s), B – (r), C – (q), D – (p)  
 (b) A – (q), B – (r), C – (p), D – (s)  
 (c) A – (r), B – (s), C – (p), D – (q)  
 (d) A – (s), B – (r), C – (p), D – (q)

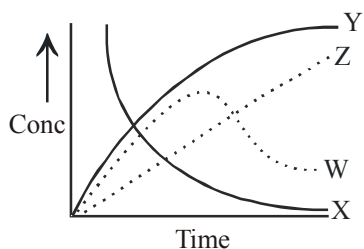
### CRITICAL THINKING TYPE QUESTIONS

132. In the following reaction, how is the rate of appearance of underlined product related to the rate of disappearance of the underlined reactant ?



- (a)  $\frac{d[\text{Br}_2]}{dt} = -\frac{d[\text{Br}^-]}{dt}$  (b)  $\frac{d[\text{Br}_2]}{dt} = +\frac{3}{5} \frac{d[\text{Br}^-]}{dt}$   
 (c)  $\frac{d[\text{Br}_2]}{dt} = -\frac{3}{5} \frac{d[\text{Br}^-]}{dt}$  (d)  $\frac{d[\text{Br}_2]}{dt} = -\frac{5}{3} \frac{d[\text{Br}^-]}{dt}$

133. For the reaction  $A + B \longrightarrow C + D$ . The variation of the concentration of the products is given by the curve



- (a) Z (b) Y  
(c) W (d) X
134. The rate of the reaction  $2N_2O_5 \rightarrow 4NO_2 + O_2$  can be written in three ways :

$$\frac{-d[N_2O_5]}{dt} = k [N_2O_5]$$

$$\frac{d[NO_2]}{dt} = k' [N_2O_5]$$

$$\frac{d[O_2]}{dt} = k'' [N_2O_5]$$

The relationship between  $k$  and  $k'$  and between  $k$  and  $k''$  are:

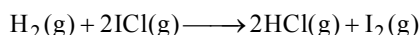
- (a)  $k' = 2k$  ;  $k'' = k$  (b)  $k' = 2k$  ;  $k'' = k/2$   
(c)  $k' = 2k$  ;  $k'' = 2k$  (d)  $k' = k$  ;  $k'' = k$
135.  $CHCl_3 + Cl_2 \longrightarrow CCl_4 + HCl$

Rate law for above reaction will be

$$\text{Rate} = k[CHCl_3][Cl_2]^{\frac{1}{2}}$$

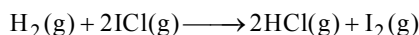
On the basis of information provided which of the following option will be correct ?

- (a) Rate law for any chemical reaction can be predicted accurately by looking at balanced chemical equation.  
(b) Rate law for a chemical reaction has to determine experimentally.  
(c) Either determined experimentally or obtained from balanced chemical reaction, rate law will be same.  
(d) None of the above is correct.
136. The reaction of hydrogen and iodine monochloride is given as:

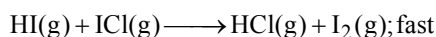
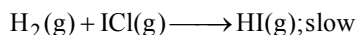


The reaction is of first order with respect to  $H_2(g)$  and  $ICl(g)$ , following mechanisms were proposed.

Mechanism A:



Mechanism B:



Which of the above mechanism(s) can be consistent with the given information about the reaction?

- (a) A and B both (b) Neither A nor B  
(c) A only (d) B only
137. The hypothetical reaction  $A_2 + B_2 \longrightarrow 2AB$  ; follows the following mechanism  $A_2 \xrightarrow{\text{Fast}} A + A$  ,  
 $A + B_2 \xrightarrow{\text{Slow}} AB + B$  ,  $A + B \xrightarrow{\text{Fast}} AB$  .  
The order of the overall reaction is  
(a) 0 (b) 1  
(c) 2 (d)  $3/2$

138. The initial rates of reaction  $3A + 2B + C \longrightarrow \text{Products}$ , at different initial concentrations are given below:

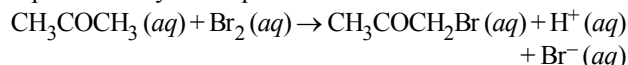
Initial rate, $\text{Ms}^{-1}$	$[A]_0, \text{M}$	$[B]_0, \text{M}$	$[C]_0, \text{M}$
$5.0 \times 10^{-3}$	0.010	0.005	0.010
$5.0 \times 10^{-3}$	0.010	0.005	0.015
$1.0 \times 10^{-2}$	0.010	0.010	0.010
$1.25 \times 10^{-3}$	0.005	0.005	0.010

The order with respect to the reactants, A, B and C are respectively

- (a) 3, 2, 0 (b) 3, 2, 1  
(c) 2, 2, 0 (d) 2, 1, 0
139. The rate law for the reaction  $2X + Y \rightarrow Z$  is  $\text{Rate} = k[X][Y]$ . The correct statement with regard to this relation is

- (a) the rate of the reaction is independent of  $[X]$  and  $[Y]$   
(b) for this reaction  $t_{1/2}$  is independent of initial concentrations of reactant  
(c) the rate of formation of Z is twice the rate of disappearance of X  
(d) the rate of disappearance of X is equal to rate of disappearance of Y

140. The bromination of acetone that occurs in acid solution is represented by this equation.



These kinetic data were obtained for given reaction concentrations.

Initial Concentrations, M			Initial rate, disappearance of $Br_2$ , $\text{Ms}^{-1}$
$[CH_3COCH_3]$	$[Br_2]$	$[H^+]$	
0.30	0.05	0.05	$5.7 \times 10^{-5}$
0.30	0.10	0.05	$5.7 \times 10^{-5}$
0.30	0.10	0.10	$1.2 \times 10^{-4}$
0.40	0.05	0.20	$3.1 \times 10^{-4}$

Based on given data, the rate equations is:

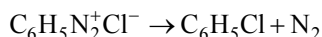
- (a)  $\text{Rate} = k[CH_3COCH_3][H^+]$   
(b)  $\text{Rate} = k[CH_3COCH_3][Br_2]$   
(c)  $\text{Rate} = k[CH_3COCH_3][Br_2][H^+]^2$   
(d)  $\text{Rate} = k[CH_3COCH_3][Br_2][H^+]$



141. Consider a reaction  $aG + bH \rightarrow \text{Products}$ . When concentration of both the reactants  $G$  and  $H$  is doubled, the rate increases by eight times. However, when concentration of  $G$  is doubled keeping the concentration of  $H$  fixed, the rate is doubled. The overall order of the reaction is

(a) 0 (b) 1  
(c) 2 (d) 3

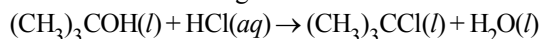
142. Diazonium salt decomposes as



At  $0^\circ\text{C}$ , the evolution of  $\text{N}_2$  becomes two times faster when the initial concentration of the salt is doubled. Therefore, it is

(a) a first order reaction  
(b) a second order reaction  
(c) independent of the initial concentration of the salt  
(d) a zero order reaction

143. Consider the following reaction at  $25^\circ\text{C}$ :



The experimentally determined rate law for this reaction indicates that the reaction is of first order in  $(\text{CH}_3)_3\text{COH}$  and that the reaction is of first order overall. Which of the following would produce an increase in the rate of this reaction?

(a) Increasing the concentration of  $(\text{CH}_3)_3\text{COH}$   
(b) Increasing the concentration of  $\text{HCl}$   
(c) Decreasing the concentration of  $\text{HCl}$   
(d) Decreasing the concentration of  $(\text{CH}_3)_3\text{CCl}$

144. The following data pertains to reaction between  $A$  and  $B$ :

S. No.	$[A] \text{ mol L}^{-1}$	$[B] \text{ mol L}^{-1}$	Rate ( $\text{mol L}^{-1} \text{ time}^{-1}$ )
1	$1.0 \times 10^{-2}$	$2.0 \times 10^{-2}$	$2.0 \times 10^{-4}$
2	$2.0 \times 10^{-2}$	$2.0 \times 10^{-2}$	$4.0 \times 10^{-4}$
3	$2.0 \times 10^{-2}$	$4.0 \times 10^{-2}$	$8.0 \times 10^{-4}$

Which of the following inference(s) can be drawn from the above data ?

(i) Rate constant of the reaction is  $1.0 \times 10^{-4}$ .  
(ii) Rate law of the reaction is :  $\text{rate} = k[A][B]$   
(iii) Rate of reaction increases four times on doubling the concentration of both the reactants.

Select the correct answer using the codes given below :

(a) (i), (ii) and (iii) (b) (i) and (ii)  
(c) (ii) and (iii) (d) (iii) only

145. The decomposition of ammonia on tungsten surface at  $500 \text{ K}$  follows zero order kinetics. The half-life period of this reaction is 45 minutes when the initial pressure is 4 bar. The half-life period (minutes) of the reaction when the initial pressure is 16 bar at the same temperature is

(a) 120 (b) 60  
(c) 240 (d) 180

146. A substance 'A' decomposes by a first order reaction starting initially with  $[A] = 2.00 \text{ M}$  and after 200 min,  $[A]$  becomes  $0.15 \text{ M}$ . For this reaction  $t_{1/2}$  is

(a) 53.72 min (b) 50.49 min  
(c) 48.45 min (d) 46.45 min

147. If half-life of a substance is 5 yrs, then the total amount of substance left after 15 years, when initial amount is 64 grams is

(a) 16 grams (b) 2 grams  
(c) 32 grams (d) 8 grams.

148. In a 1st order reaction, reactant concentration  $C$  varies with time  $t$  as :

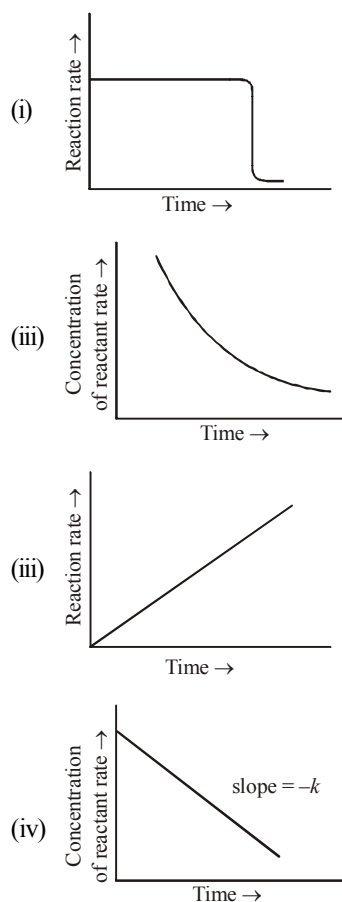
(a)  $\frac{1}{C}$  increases linearly with  $t$   
(b)  $\log C$  decreases linearly with  $t$   
(c)  $C$  decreases with  $\frac{1}{t}$   
(d)  $\log C$  decreases with  $\frac{1}{t}$

149. For the first order reaction

$\text{C}_2\text{H}_4\text{O}(g) \rightarrow \text{CH}_4(g) + \text{CO}(g)$ , the initial pressure of  $\text{C}_2\text{H}_4\text{O}(g)$  is 80 torr and total pressure at the end of 20 minutes is 120 torr. The time needed for 75% decomposition of  $\text{C}_2\text{H}_4\text{O}$  would be :

(a) 20 minutes (b) 40 minutes  
(c) 80 minutes (d) 120 minutes

150. Which of the following graph(s) is/are correct for a zero order reaction?



(a) (ii) and (iii) (b) (i), (ii) and (iii)  
(c) (ii), (iii) and (iv) (d) (i) and (iv)

151. The integrated rate equations can be determined for

- (a) zero order reactions
- (b) first order reactions
- (c) second order reactions
- (d) Both (a) and (b)

152. In a zero-order reaction for every  $10^\circ$  rise of temperature, the rate is doubled. If the temperature is increased from  $10^\circ\text{C}$  to  $100^\circ\text{C}$ , the rate of the reaction will become :

- (a) 256 times
- (b) 512 times
- (c) 64 times
- (d) 128 times

153. For a first order reaction  $A \rightarrow P$ , the temperature (T) dependent rate constant (k) was found to follow the

equation  $\log k = - (2000) \frac{1}{T} + 6.0$ . The pre-exponential factor

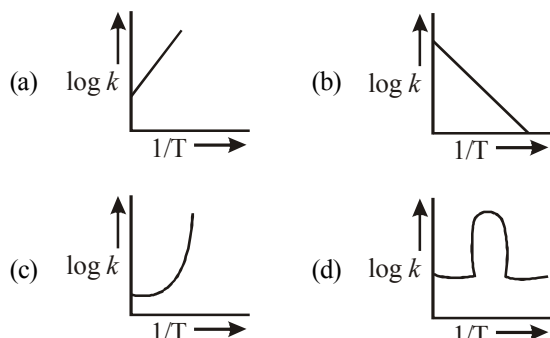
A and the activation energy  $E_a$ , respectively, are

- (a)  $1.0 \times 10^6 \text{ s}^{-1}$  and  $9.2 \text{ kJ mol}^{-1}$
- (b)  $6.0 \text{ s}^{-1}$  and  $16.6 \text{ kJ mol}^{-1}$
- (c)  $1.0 \times 10^6 \text{ s}^{-1}$  and  $16.6 \text{ kJ mol}^{-1}$
- (d)  $1.0 \times 10^6 \text{ s}^{-1}$  and  $38.3 \text{ kJ mol}^{-1}$

154. The activation energies of two reactions are  $E_1$  and  $E_2$  ( $E_1 > E_2$ ). If the temperature of the system is increased from  $T_1$  to  $T_2$ , the rate constant of the reactions changes from  $k_1$  to  $k_1'$  in the first reaction and  $k_2$  to  $k_2'$  in the second reaction. Predict which of the following expression is correct?

- (a)  $\frac{k_1'}{k_1} = \frac{k_2'}{k_2}$
- (b)  $\frac{k_1'}{k_1} > \frac{k_2'}{k_2}$
- (c)  $\frac{k_1'}{k_1} < \frac{k_2'}{k_2}$
- (d)  $\frac{k_1'}{k_1} = \frac{k_2'}{k_2} = 1$

155. A graph plotted between  $\log k$  vs  $1/T$  for calculating activation energy is shown by



156. The rate constant, the activation energy and the arrhenius parameter of a chemical reaction at  $25^\circ\text{C}$  are  $3.0 \times 10^{-4} \text{ s}^{-1}$ ,  $104.4 \text{ kJ mol}^{-1}$  and  $6.0 \times 10^{14} \text{ s}^{-1}$  respectively. The value of the rate constant as  $T \rightarrow \infty$  is

- (a)  $2.0 \times 10^{18} \text{ s}^{-1}$
- (b)  $6.0 \times 10^{14} \text{ s}^{-1}$
- (c) Infinity
- (d)  $3.6 \times 10^{30} \text{ s}^{-1}$

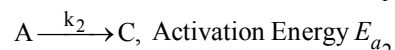
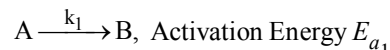
157. Collision theory is used to explain how chemical species undergo a reaction. Using this theory and the kinetic molecular model, which of the following does NOT influence the rate of a chemical reaction?

- (a) The temperature of the system
- (b) The geometry or orientation of the collision
- (c) The velocity of the reactants at the point of collision
- (d) All of the above influence the rate

158. The activation energy for a hypothetical reaction,  $A \rightarrow \text{Product}$ , is  $12.49 \text{ kcal/mole}$ . If temperature is raised from  $295$  to  $305$ , the rate of reaction increased by

- (a) 60%
- (b) 100%
- (c) 50%
- (d) 20%

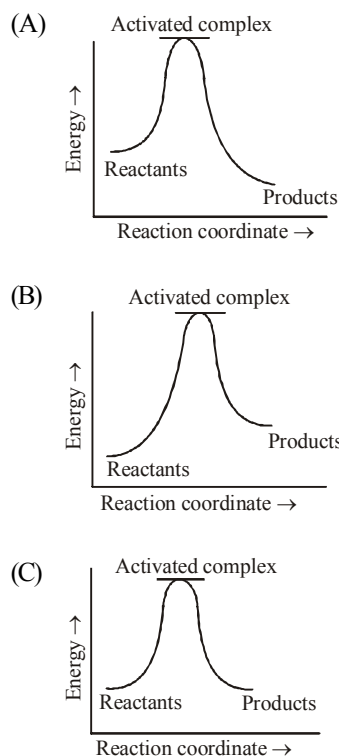
159. A reactant (A) forms two products :



If  $E_{a_2} = 2 E_{a_1}$ , then  $k_1$  and  $k_2$  are related as :

- (a)  $k_2 = k_1 e^{E_{a_1}/RT}$
- (b)  $k_2 = k_1 e^{E_{a_2}/RT}$
- (c)  $k_1 = A k_2 e^{E_{a_1}/RT}$
- (d)  $k_1 = 2 k_2 e^{E_{a_2}/RT}$

160. Which of the following graph(s) represents exothermic reaction?

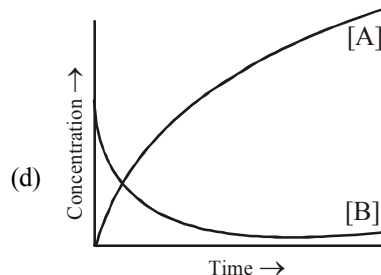
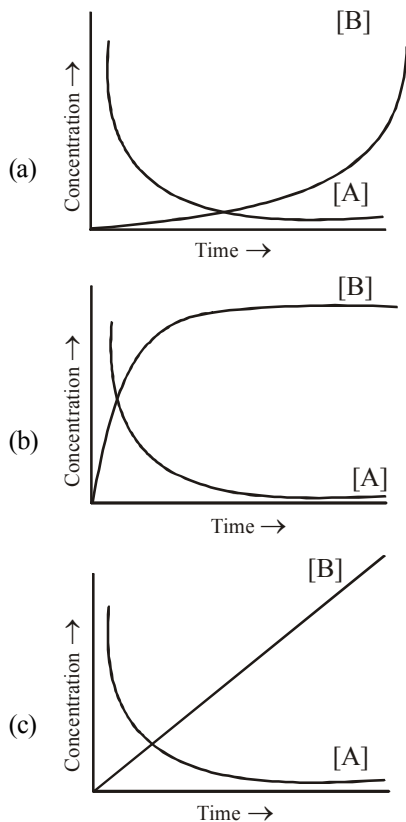


- (a) (A) only
- (b) (B) only
- (c) (C) only
- (d) (A) and (B)

161. Which of the following statements is **not** correct for the catalyst?

- (a) It catalyses the forward and backward reaction to the same extent.
- (b) It alters  $\Delta G$  of the reaction.
- (c) It is a substance that does not change the equilibrium constant of a reaction.
- (d) It provides an alternate mechanism by reducing activation energy between reactants and products.

**162.** Consider the reaction  $A \rightarrow B$ . The concentration of both the reactants and the products varies exponentially with time. Which of the following figures correctly describes the change in concentration of reactants and products with time?



**163.** During decomposition of an activated complex.

- (i) energy is always released
  - (ii) energy is always absorbed
  - (iii) energy does not change
  - (iv) reactants may be formed
- (a) (i), (ii) and (iii)      (b) (i) and (iv)  
 (c) (ii) and (iii)      (d) (ii), (iii) and (iv)

**164.** Which of the following statements is incorrect ?

- (a) Energy is always released when activated complex decomposes to form products.
- (b) Peak of the energy distribution curve corresponds to the most probable potential energy.
- (c) Peak of the energy distribution curve corresponds to the most probable kinetic energy.
- (d) When the temperature is raised maximum of energy distribution curve moves to higher energy value and broadens out.

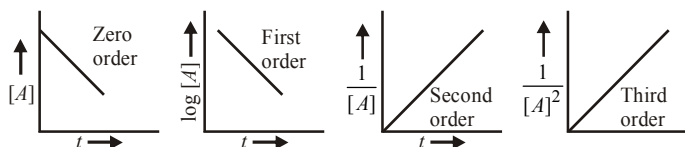
# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (b)      2. (b)      3. (a)      4. (a)      5. (c)
6. (d) In the given options  $-\frac{d[C]}{3dt}$  will not represent the reaction rate. It should not have -ve sign as it is product.  
since  $\frac{1}{3} \frac{dC}{dt}$  show the rate of formation of product C which will be positive.
7. (a) If we write rate of reaction in terms of concentration of  $\text{NH}_3$  and  $\text{H}_2$ , then  
Rate of reaction  $= \frac{1}{2} \frac{d[\text{NH}_3]}{dt} = -\frac{1}{3} \frac{d[\text{H}_2]}{dt}$   
So,  $\frac{d[\text{NH}_3]}{dt} = -\frac{2}{3} \frac{d[\text{H}_2]}{dt}$
8. (d) In the given options  $-\frac{d[C]}{3dt}$  will not represent the reaction rate. It should not have -ve sign as it is product.  
since  $\frac{1}{3} \frac{dC}{dt}$  show the rate of formation of product C which will be positive.
9. (c) Rusting of iron is a slow change.
10. (c) The feasibility of a chemical reaction can be predicted by thermodynamics. Extent to which a reaction will proceed can be determined from chemical equilibrium. Speed of a reaction i.e. time taken by a reaction to reach equilibrium, can be predicted by chemical kinetics
11. (c)      12. (d)      13. (c)      14. (a)      15. (b)
16. (c)      17. (c)      18. (d)
19. (d) The rate of a reaction is the speed at which the reactants are converted into products. It depends upon the concentration of reactants. e.g for the reaction  
 $\text{A} + \text{B} \longrightarrow \text{Product}; \quad r \propto [\text{A}][\text{B}]$
20. (a) k remains constant at constant temperature and CO does not effect the rate of reaction.
21. (d) order of reaction may be zero, whole number or fractional.
22. (b)  $2\text{NO}(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons 2\text{NOCl}(\text{g})$   
Rate  $= k[\text{NO}]^2[\text{Cl}]$   
The value of rate constant can be increased by increasing the temperature.
23. (d) Order of reaction is equal to the number of molecules whose concentration is changing with time. It can be zero or in fractions or an integer.
24. (a) For a zero order reaction.  
rate  $= k[\text{A}]^0$  i.e. rate  $= k$   
hence unit of  $k = \text{M} \cdot \text{sec}^{-1}$   
For a first order reaction.  
rate  $= k[\text{A}]$   
 $k = \text{M} \cdot \text{sec}^{-1} / \text{M} = \text{sec}^{-1}$
25. (d) The reaction involving two different reactant can never be unimolecular.
26. (b) For reaction  $3\text{A} \longrightarrow \text{B} + \text{C}$   
If it is zero order reaction  $r = k[\text{A}]^0$ , i.e the rate remains same at any concentration of 'A'. i.e independent upon concentration of A.
27. (c)  $k = (\text{mol lit}^{-1})^{1-n} \text{time}^{-1}$ . For given reaction  $n = 2$ .  $\therefore k = \text{mol}^{-1} \text{lit sec}^{-1}$
28. (b) The order of a chemical reaction is given by concentration of reactants appearing in the lowest step.
29. (b) Velocity constant 'k' is characteristic constant of a reaction and depends only on temperature and catalyst.
30. (b) Given  $dx/dt = 2.400 \times 10^{-5} \text{ mol litre}^{-1} \text{ sec}^{-1}$   
 $k = 3.10 \times 10^{-5} \text{ sec}^{-1}$   
For first order reaction  
 $2\text{N}_2\text{O}_5 \longrightarrow 2\text{NO}_2 + \text{O}_2$   
 $\frac{dx}{dt} = k[\text{N}_2\text{O}_5]$   
or  $2.4 \times 10^{-5} = 3.0 \times 10^{-5} [\text{N}_2\text{O}_5]$   
or  $[\text{N}_2\text{O}_5] = \frac{2.4 \times 10^{-5}}{3.0 \times 10^{-5}} = 0.8 \text{ mol. litre}^{-1}$
31. (a) For zero order reaction,  $\frac{dx}{dt} = k[\text{reactant}]^0$   
Thus the rate of zero order reaction is independent of concentration of reactants.
32. (c) Rate<sub>1</sub>  $= k[\text{A}]^n [\text{B}]^m$ ; Rate<sub>2</sub>  $= k[2\text{A}]^n [\frac{1}{2}\text{B}]^m$   
 $\therefore \frac{\text{Rate}_2}{\text{Rate}_1} = \frac{k[2\text{A}]^n [\frac{1}{2}\text{B}]^m}{k[\text{A}]^n [\text{B}]^m} = [2]^n [\frac{1}{2}]^m = 2^n \cdot 2^{-m} = 2^{n-m}$
33. (a)  $2\text{A} + \text{B} \longrightarrow \text{A}_2\text{B}$   
 $r_1 = k[\text{A}]^2 [\text{B}] \quad \dots(i)$   
When,  $[\text{A}] = [2\text{A}]$ ,  $[\text{B}] = \left[\frac{\text{B}}{2}\right]$   
 $r_2 = k[2\text{A}]^2 \left[\frac{\text{B}}{2}\right] = k 4[\text{A}]^2 \frac{[\text{B}]}{2}$   
 $= k 2[\text{A}]^2 [\text{B}] = 2r_1 \quad (\because r_1 = k[\text{A}]^2 [\text{B}])$   
 $\therefore$  Rate of reaction is increased two times.

34. (c) Let us consider a reaction,  
 $xX + yY \longrightarrow aA + bB$   
 $\text{rate} = [X]^x [Y]^y$   
 It is given that order of reaction w.r.t. component Y is zero.  
 Hence,  $\text{rate} = [X]^x$   
 i.e., rate becomes independent of the concentration of Y.
35. (a)  $\text{rate} \propto [\text{p}_{\text{reactant}}]^0$   
 i.e.,  $\text{rate} = k$   
 So, the order of reaction will be zero.
36. (b)  $\therefore r = k[A]^n$   
 if  $n = 0$   
 $r = k[A]^0$   
 or  $r = k$  thus for zero order reactions rate is equal to  
 rate constant.
37. (c) Since rate of reaction becomes four times on doubling concentration of reactant, it is second order reaction.
38. (b) Order is the sum of the power of the concentration terms in rate law expression.  
 Hence the order of reaction is  $= 1 + 2 = 3$
39. (a)  $\text{Rate} = k[A]^0$   
 Unit of  $k = \text{mol L}^{-1} \text{sec}^{-1}$
40. (c)  $\text{N}_2\text{O} \longrightarrow \text{N}_2 + \frac{1}{2}\text{O}_2$   
 $\frac{dx}{dt} \propto [\text{N}_2\text{O}]^1$   
 i.e. order of reaction = 1
41. (a) From the first set of data (i) and (ii) it is observed that on keeping concentration of [B] constant and on doubling the concentration of [A] rate does not change hence order of reaction with respect to A is zero.  
 From the second set of data (i) and (iii) it is observed that rate becomes 4 times on doubling the concentration of [B] keeping [A] constant hence order with respect to [B] will be 2  
 $\text{rate} = k[A]^0 [B]^2$
42. (c) Order is the sum of the powers to which the concentration terms are raised in the rate equation.
43. (d) If  $\text{rate} = k[A]^x [B]^y [C]^z$   
 From first two given data  
 $8.08 \times 10^{-3} = k [0.2]^x [0.1]^y [0.02]^z$  .... (1)  
 $2.01 \times 10^{-3} = k [0.1]^x [0.2]^y [0.02]^z$  .... (2)  
 Divide (1) by (2) we get,  $4 = 2^x (1/2)^y$   
 Similarly, from second and third data  
 $(9)^y (9)^z = 3$   
 $2y + 2z = 1$   
 From first and fourth data  $4^z = 8 = 2^3$   
 $2z = 3$ . So  $z = 3/2$ ,  $y = -1$ ,  $x = 1$
44. (a) Let the rate law be  $r = k[A]^x [B]^y$   
 Divide (3) by (1)  $\frac{0.10}{0.10} = \frac{[0.024]^x [0.035]^y}{[0.012]^x [0.035]^y}$   
 $\therefore 1 = [2]^x$ ,  $x = 0$   
 Divide (2) by (3)  $\frac{0.80}{0.10} = \frac{[0.024]^x [0.070]^y}{[0.024]^x [0.035]^y}$   
 $\therefore 8 = (2)^y$ ,  $y = 3$   
 Hence, rate equation,  $R = k[A]^0 [B]^3 = k[B]^3$
45. (a) Given  $r = k[A]^{3/2} [B]^{-1/2}$   
 Order  $= 3/2 - 1/2 = \frac{3-1}{2} = \frac{2}{2} = 1$
46. (b) The order w.r.t.  $\text{I}_2$  is zero because the rate is not dependent on the concentration of  $\text{I}_2$ .
47. (c) As we know that, units of rate constant.  
 $= (\text{unit of conc.})^{1-n} (\text{unit of time})^{-1}$   
 $= (\text{mol L}^{-1})^{1-n} (\text{sec})^{-1}$   
 On comparing these units with the given units of rate constant, we get  
 $(\text{mol L}^{-1})^{1-n} (\text{sec})^{-1} = \text{L mol}^{-1} \text{sec}^{-1}$   
 $\Rightarrow \text{L}^{n-1} \text{mol}^{1-n} \text{sec}^{-1} = \text{L mol}^{-1} \text{sec}^{-1}$   
 On comparing the powers, we get  
 $n - 1 = 1 \Rightarrow n = 2$   
 So, reaction is of second order.
48. (d) In case of (II) and (III), keeping concentration of [A] constant, when the concentration of [B] is doubled, the rate quadruples. Hence it is second order with respect to B. In case of I & IV Keeping the concentration of [B] constant, when the concentration of [A] is increased four times, rate also increases four times. Hence, the order with respect to A is one. hence  
 $\text{Rate} = k[A][B]^2$
49. (a) The order of reaction is  $\frac{3}{2}$  and molecularity is 2.
50. (b)  $\text{O}_3 \xrightarrow{\text{Fast}} \text{O}_2 + \text{O}; \text{O} + \text{O}_3 \xrightarrow{\text{Slow}} 2\text{O}_2$   
 $k = \frac{[\text{O}_2][\text{O}]}{[\text{O}_3]}$  (I)  $\text{Rate} = k'[\text{O}_3][\text{O}]$  put [O] from (I)  
 $r = \frac{k'[\text{O}_3]K[\text{O}_3]}{[\text{O}_2]} = k[\text{O}_3]^2 [\text{O}_2]^{-1}$   
 Note intermediates are never represented in rate law equation.
51. (c)
52. (c) Thermal decomposition of HI on gold surface is an example of zero order reaction.
53. (c) For zero order reaction,  
 $\text{rate}, r = k[R]^0$   
 $\Rightarrow \frac{dR}{dt} = k$   
 $\Rightarrow R = kt + R_0$   
 where  $R_0$  is the concentration of reactant at time  $t = 0$ .  
 Thus [R] increases with time



54. (a) Plots of conc.  $[A]$  Vs time,  $t$ 

55. (d)  $t_{1/2} \propto \frac{1}{a^2}$

We know that  $t_{1/2} \propto \frac{1}{a^{n-1}}$ i.e.  $n = 3$ Thus reaction is of 3<sup>rd</sup> order.

56. (a) For a zero order reaction

$$t_{1/2} = \frac{a}{2k}$$

57. (a)  $t_{1/2} = 4s$        $T = 16s$

$$n = \frac{T}{t_{1/2}} = \frac{16}{4} = 4 \quad (\because T = n \times t_{1/2})$$

$$[A] = [A]_0 \left(\frac{1}{2}\right)^n = 0.12 \times \left(\frac{1}{2}\right)^4 = \frac{0.12}{16} = 0.0075 \text{ M}$$

Where  $[A]_0$  = initial concentration and  $[A]$  = concentration left after time  $t$ 58. (b)  $A \rightarrow B$  For a first order reactionGiven  $a = 0.8 \text{ mol}$ ,  $(a - x) = 0.8 - 0.6 = 0.2$ 

$$k = \frac{2.303}{1} \log \frac{0.8}{0.2} \text{ or } k = 2.303 \log 4$$

again  $a = 0.9$ ,  $a - x = 0.9 - 0.675 = 0.225$ 

$$k = \frac{2.303}{t} \log \frac{0.9}{0.225}$$

$$2.303 \log 4 = \frac{2.303}{t} \log 4$$

Hence  $t = 1 \text{ hour}$ 59. (b) For a first order reaction,  $A \rightarrow \text{products}$ 

$$r = k[A] \text{ or } k = \frac{r}{[A]}$$

$$\Rightarrow k = \frac{1.5 \times 10^{-2}}{0.5} = 3 \times 10^{-2}$$

$$\text{Further, } t_{1/2} = \frac{0.693}{k} = \frac{0.693}{3 \times 10^{-2}} = 23.1$$

60. (c) For first order reaction,  $k = \frac{0.693}{t_{1/2}}$

where  $k$  = rate constant $t_{1/2}$  = half life period = 480 sec.

$$\therefore k = \frac{0.693}{480} = 1.44 \times 10^{-3} \text{ sec}^{-1}$$

61. (c)  $[A] = [A]_0 \left(\frac{1}{2}\right)^n$

where  $[A]_0$  = initial concentration

$$\frac{1}{8} = 1 \left(\frac{1}{2}\right)^n; n = 3$$

$$t_{1/2} = \frac{0.693}{6.9 \times 10^{-3}} = 100 \text{ sec}$$

$$\therefore T = n \times t_{1/2} = 3 \times 100 = 300 \text{ sec.}$$

62. (b) Given: 75% reaction gets completed in 32 min

$$\begin{aligned} \text{Thus, } k &= \frac{2.303}{t} \log \frac{a}{(a-x)} = \frac{2.303}{32} \log \frac{100}{(100-75)} \\ &= \frac{2.303}{32} \log 4 = 0.0433 \text{ min}^{-1} \end{aligned}$$

Now we can use this value of  $k$  to get the value of time required for 50% completion of reaction

$$\begin{aligned} t &= \frac{2.303}{k} \log \frac{a}{(a-x)} = \frac{2.303}{0.0433} \log \frac{100}{50} \\ &= \frac{2.303}{0.0433} \log 2 = 16 \text{ min} \end{aligned}$$

63. (d) Unit of  $k$  for 1<sup>st</sup> order reaction is (Time)<sup>-1</sup>

$$\begin{aligned} 64. (c) \quad t_{1/4} &= \frac{2.303}{k} \log \frac{1}{3/4} = \frac{2.303}{k} \log \frac{4}{3} \\ &= \frac{2.303}{k} (\log 4 - \log 3) = \frac{2.303}{k} (2 \log 2 - \log 3) \\ &= \frac{2.303}{k} (2 \times 0.301 - 0.4771) = \frac{0.29}{k} \end{aligned}$$

65. (c) For a first order reaction

$$k = \frac{2.303}{t} \log \frac{a}{a-x}$$

when  $t = t_{1/2}$ 

$$k = \frac{2.303}{t_{1/2}} \log \frac{a}{a-a/2}$$

$$\text{or } t_{1/2} = \frac{2.303}{k} \log 2 = \frac{\ln 2}{k}$$

66. (b) Since doubling the concentration of  $B$  does not change half life, the reaction is of 1<sup>st</sup> order w.r.t.  $B$ .Order of reaction with respect to  $A = 1$  because rate of reaction doubles when concentration of  $A$  is doubled keeping concentration of  $B$  constant. $\therefore$  Order of reaction =  $1 + 1 = 2$  and units of second order reaction are  $\text{L mol}^{-1} \text{ sec}^{-1}$ .67. (c) Half life time ( $t_{1/2}$ ) for  $n^{\text{th}}$  order reaction is given by,

$$t_{1/2} \propto [a]^{1-n}$$

where  $n$  is the order of reaction and  $a$  is concentration of reactant.

As decomposition of  $N_2O_5$  follows 1st order kinetic.  
So,

$$\Rightarrow t_{1/2} \propto [a]^{1-1} \Rightarrow t_{1/2} \propto a^0$$

68. (c) For a first order reaction

$$k = \frac{2.303}{t} \log_{10} \frac{a}{a-x}$$

when  $t = t_{1/2}$

$$k = \frac{2.303}{t_{1/2}} \log_{10} \frac{a}{a-a/2}$$

$$\text{or } t_{1/2} = \frac{2.303}{k} \log_{10} 2 = \frac{\ln 2}{k}$$

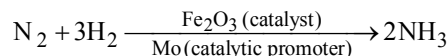
69. (a)  $t = \frac{2.303}{k} \log \frac{a}{a-x}$

$$\text{or } t = \frac{2.303}{k} \log a - \frac{2.303}{k} \log(a-x)$$

70. (c)  $\frac{(t_{1/2})_1}{(t_{1/2})_2} = \left(\frac{a_2}{a_1}\right)^{n-1}$ ;  $\frac{120}{240} = \left(\frac{4 \times 10^{-2}}{8 \times 10^{-2}}\right)^{n-1}$ ;  $n = 2$

71. (b)

72. (b) In Haber's process, ammonia is manufactured from  $N_2$  and  $H_2$  using iron as catalyst with molybdenum as promoter at high temperature and pressure



73. (b)  $\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left( \frac{1}{T_1} - \frac{1}{T_2} \right)$

$$\log 2 = \frac{E_a}{2.303 \times 8.314} \left[ \frac{1}{293} - \frac{1}{308} \right]$$

$$0.3 = \frac{E_a}{2.303 \times 8.314} \times \frac{15}{293 \times 308}$$

$$E_a = \frac{0.3 \times 2.303 \times 8.314 \times 293 \times 308}{15}$$

$$= 34673 \text{ J mole}^{-1}$$

$$= 34.7 \text{ J mole}^{-1}$$

74. (b)  $\Delta H = E_{af} - E_{ab} = 0$

75. (d) The activation energy depends upon the nature of chemical bonds undergoing rupture during chemical reaction and is independent of enthalpies of reactants and products.

76. (b)  $k = Ae^{-E_a/RT}$

$$\ln k = \ln A - E_a/RT$$

For  $\ln k$  vs  $1/T$

$\ln A = \text{intercept}$

$$-E_a/R = \text{slope} = -2 \times 10^4 \text{ K}$$

$$\therefore E_a = 8.3 \times 2 \times 10^4 \text{ J mol}^{-1}$$

$$= 16.6 \times 10^4 \text{ J mol}^{-1} \text{ or } 166 \text{ kJ mol}^{-1}$$

77. (b) As the rate of reaction get doubled for every  $10^\circ\text{C}$  rise in temperature. Hence the increase in reaction rate as a result of temperature rise from  $10^\circ\text{C}$  to  $100^\circ\text{C}$  is equal to  $= 2^9 = 512$

78. (a) As per Arrhenius equation ( $k = Ae^{-E_a/RT}$ ), the rate constant increases exponentially with temperature.

79. (b) For a reversible reaction,  
 $\Delta H = E_a (\text{forward}) - E_a (\text{backward})$   
 $\Delta H = 150 - 260 = -110 \text{ kJ mol}^{-1}$

80. (c) We know that the activation energy of chemical reaction

$$\text{is given by formula } = \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[ \frac{T_2 - T_1}{T_1 T_2} \right], \text{ where}$$

$k_1$  is the rate constant at temperature  $T_1$  and  $k_2$  is the rate constant at temperature  $T_2$  and  $E_a$  is the activation energy. Therefore activation energy of chemical reaction is determined by evaluating rate constant at two different temperatures.

81. (b) In equation  $k = Ae^{-E_a/RT}$ ;  $A$  = Frequency factor  
 $k$  = velocity constant,  $R$  = gas constant and  $E_a$  = energy of activation

82. (d) In Arrhenius equation  $k = Ae^{-E_a/RT}$ ,  $E_a$  is the energy of activation, which is required by the colliding molecules to react resulting in the formation of products.

83. (d)

84. (b) When the temperature is increased, energy in form of heat is supplied which increases the kinetic energy of the reacting molecules. This will increase the number of collisions and ultimately the rate of reaction will be enhanced.

85. (a) Arrhenius equation is given by

$$k = Ae^{-E_a/(2.303RT)}$$

Taking log on both sides, we get

$$\log k = \log A - \frac{E_a}{2.303RT}$$

Arrhenius plot a graph between  $\log k$  and  $\frac{1}{T}$  whose

$$\text{slope is } \frac{-E_a}{2.303R}$$

86. (a)  $2.303 \log \frac{k_2}{k_1} = \frac{E_a}{R} \left[ \frac{T_2 - T_1}{T_1 T_2} \right]$

$$\log \frac{k_2}{k_1} = \frac{9.0 \times 10^3}{2.303 \times 2} \left[ \frac{308 - 298}{308 \times 298} \right]$$

$$\frac{k_2}{k_1} = 1.63; k_2 = 1.63k_1;$$

$$\begin{aligned}\text{Increase in } k_1 &= \frac{k_2 - k_1}{k_1} \times 100 \\ &= \frac{1.63k_1 - k_1}{k_1} \times 100 = 63.0\%\end{aligned}$$

87. (b)  $\Delta H = E_{a(f)} - E_{a(b)}$

Thus energy of activation for reverse reaction depend upon whether reaction is exothermic or endothermic.

If reaction is exothermic,  $\Delta H = -ve$ ,  $E_{a(b)} > E_{a(f)}$

If reaction is endothermic,  $\Delta H = +ve$ ,  $E_{a(b)} < E_{a(f)}$

88. (d)      89. (c)      90. (c)      91. (a)      92. (d)

93. (d)

94. (d)  $k = Ae^{-E_a/RT}$

95. (b)  $\ln k = \ln A - \frac{E_a}{RT}$ , intercept is  $\ln A$ .

96. (c) The rate constant doubles for  $10^\circ\text{C}$  rise in temperature. For  $20^\circ\text{C}$  rise, the rate constant will be 4 times  
 $\therefore k_1 = 4k_2$  or  $k_2 = 0.25 K_1$

97. (d)  $k = Ae^{-E_a/RT}$   $\log k = \log A - \frac{E_a}{2.303R} \cdot \frac{1}{T}$

Equation of straight line slope =  $\frac{-E_a}{2.303R}$

98. (c) Applicable to bimolecular reactions.

99. (a)

100. (d) All the statements are correct (see text).

101. (c) Activation energy is lowered in presence of +ve catalyst.

102. (c)

103. (a) Threshold Energy = Energy of activation + Internal energy

104. (b)  $k = Ae^{-E_a/RT}$   $\log k = \log A - \frac{E_a}{2.303R} \cdot \frac{1}{T}$

Plot of  $\log k$  Vs.  $\frac{1}{T}$

Straight line Slope =  $\frac{-E_a}{2.303R}$

105. (d) Enthalpy of reaction ( $\Delta H$ ) =  $E_{a(f)} - E_{a(b)}$   
 for an endothermic reaction  $\Delta H = +ve$  hence for  $\Delta H$  to be positive  
 $E_{a(b)} < E_{a(f)}$

106. (a) Presence of catalyst does not affect enthalpy change of reaction  $\Delta H_R = E_f - E_b = 180 - 200 = -20 \text{ kJ/mol}$

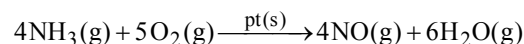
107. (c) For the exothermic reaction the energy of products is always less than the reactants. If  $E_a$  is the energy of activation for the forward reaction, the energy of activation for backward reaction is  $E_a + \Delta H$

108. (b) For a  $10 \text{ K}$  rise in temperature, collision frequency increases merely by 1 to 2% but the number of effective collisions increases by 100 to 200%.

109. (a)      110. (b)      111. (c)

### STATEMENT TYPE QUESTIONS

112. (b) For the given reaction



$$\text{Rate} = \frac{-1}{4} \frac{\Delta[\text{NH}_3]}{\Delta t} = \frac{-1}{5} \frac{\Delta[\text{O}_2]}{\Delta t} = \frac{1}{4} \frac{\Delta[\text{NO}]}{\Delta t} = \frac{1}{6} \frac{\Delta[\text{H}_2\text{O}]}{\Delta t}$$

113. (a) For given reaction x and y may or may not be equal to p and q respectively.

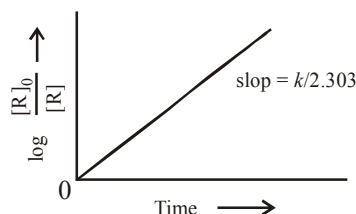
114. (a) Average rate depends upon the change in concentration of reactants or products and the time taken for that change to occur. Average rate cannot be used to predict the rate of a reaction at a particular instant as it would be constant for the time interval for which it is calculated. So, to express the rate at a particular moment of time we determine the instantaneous rate. It is obtained when we consider the average rate at the smallest time interval say  $dt$  (i.e. when it approaches zero).

115. (d) Molecularity is defined as the number of reacting species taking part in an elementary reaction,

116. (b) Molecularity cannot be fractional or zero. Correct units of rate constant for second order reaction are  $\text{mol}^{-1} \text{Ls}^{-1}$ .

117. (d) For zero order reaction, rate of reaction as well as rate constant are independent of reactant concentration.

118. (a) For a first order reaction  $\log \frac{[R]_0}{[R]}$  varies linearly with time as shown below.



119. (a)

120. (b) According to Arrhenius equation,  $k = Ae^{-E_a/RT}$   
 $\therefore$  when  $E_a = 0$ ,  $k = A$

Also  $\ln k$  vs  $1/T$  is a straight line with slope =  $-E_a/R$ .  
 $\therefore$  Statements (ii) and (v) are correct.

121. (b)

122. (b) Rate constant gets doubled with every  $10^\circ\text{C}$  in temperature for chemical change only not for physical change.

123. (b) Correct formula for calculation of  $E_a$  is

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[ \frac{T_2 - T_1}{T_1 T_2} \right]$$

The word catalyst should not be used when the added substance reduces the rate of reaction. The substance is then called inhibitor.

124. (d) The relevant expressions are as follows.

$$\log K_p = -\frac{\Delta H}{R} \frac{1}{T} + I$$

$$\log [X] = \log [X]_0 + kt$$

$$P/T = \text{constant (V constant)}$$

$$PV = \text{constant (T constant)}$$

### MATCHING TYPE QUESTIONS

125. (a)      126. (b)      127. (a)      128. (c)      129. (b)  
130. (a)      131. (d)

### CRITICAL THINKING TYPE QUESTIONS

132. (c)  $-\frac{1}{5} \frac{d[\text{Br}^-]}{dt} = \frac{1}{3} \frac{d[\text{Br}_2]}{dt}$

$$\therefore \frac{d[\text{Br}_2]}{dt} = -\frac{3}{5} \frac{d[\text{Br}^-]}{dt}$$

133. (b) The curve Y shows the increase in concentration of products with time.

134. (b) Rate of disappearance of reactants = Rate of appearance of products

$$-\frac{1}{2} \frac{d(\text{N}_2\text{O}_5)}{dt} = \frac{1}{4} \frac{d(\text{NO}_2)}{dt} = \frac{d(\text{O}_2)}{dt}$$

$$\frac{1}{2} k(\text{N}_2\text{O}_5) = \frac{1}{4} k'(\text{N}_2\text{O}_5) = k''(\text{N}_2\text{O}_5)$$

$$\frac{k}{2} = \frac{k'}{4} = k''$$

$$k' = 2k, \quad k'' = \frac{k}{2}$$

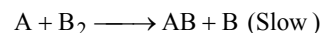
135. (b) Rate law has to be determined experimentally as  $\text{Cl}_2$  is raised to power  $\frac{1}{2}$  in rate law whereas its stichiometric coefficient in balanced chemical equation is 1.

136. (d) As the slowest step is the rate determining step thus the mechanism B will be more consistent with the given information also because it involve one molecule of  $\text{H}_2$  and one molecule of  $\text{ICl}$  it can expressed as

$$r = k [\text{H}_2][\text{ICl}]$$

Which shows that the reaction is first order w.r.t. both  $\text{H}_2$  &  $\text{ICl}$ .

137. (d)  $\text{A}_2 + \text{B}_2 \longrightarrow 2\text{AB}$  ;



Rate law =  $k[\text{A}][\text{B}_2]$  put value of  $[\text{A}]$  from Ist reaction

since A is intermediate  $\sqrt{k[\text{A}_2]} = \text{A}$

$$\therefore \text{Rate law equation} = K\sqrt{k[\text{A}_2]}[\text{B}_2]$$

$$\therefore \text{Order} = \frac{1}{2} + 1 = \frac{3}{2}$$

138. (d) From 1<sup>st</sup> and 2<sup>nd</sup> sets of data - no change in rate is observed with the change in concentration of 'C'. So the order with respect to 'C' is zero.

From 1<sup>st</sup> and 4<sup>th</sup> sets of data

Dividing eq. (4) by eq. (1)

$$\frac{1.25 \times 10^{-3}}{5.0 \times 10^{-3}} = \left[ \frac{0.005}{0.010} \right]^x$$

$$\text{or } 0.25 = (0.5)^x \text{ or } (0.5)^2 = (0.5)^x$$

$$\therefore x = 2$$

The order with respect to 'A' is 2 from the 1<sup>st</sup> and 3<sup>rd</sup> sets of data dividing eq. (1) by eq. (3)

$$\frac{5.0 \times 10^{-3}}{1.0 \times 10^{-2}} = \left[ \frac{0.005}{0.010} \right]^y$$

$$\text{or } (0.5)^1 = (0.5)^y \Rightarrow y = 1$$

The order with respect to 'B' is 1

So the order with respect to the reactants A, B and C is 2, 1 and 0.

139. (N) None of the given options is correct.

The given reaction is :  $2\text{X} + \text{Y} \longrightarrow \text{Z}$

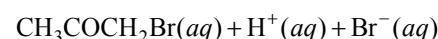
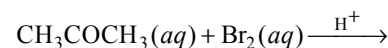
$$-\frac{d[\text{X}]}{2dt} = \frac{d[\text{Z}]}{dt}$$

$\therefore$  Rate of formation of Z is half of the rate of disappearance of X.

$$\frac{-d[\text{X}]}{2dt} = \frac{-d[\text{Y}]}{dt}$$

Rate of disappearance of X is not equal to rate of disappearance of Y.

140. (a) Rewriting the given data for the reaction



S. No.	Initial concentration of $\text{CH}_3\text{COCH}_3$ in M	Initial concentration of $\text{Br}_2$ in M	Initial concentration of $\text{H}^+$ in M	Rate of disappearance of $\text{Br}_2$ in $\text{Ms}^{-1}$ i.e. $-\frac{d[\text{Br}_2]}{dt}$ or $\frac{dx}{dt}$
1	0.30	0.05	0.05	$5.7 \times 10^{-5}$
2	0.30	0.10	0.05	$5.7 \times 10^{-5}$
3	0.30	0.10	0.10	$1.2 \times 10^{-4}$
4	0.40	0.05	0.20	$3.1 \times 10^{-4}$

Actually this reaction is autocatalyzed and involves complex calculation for concentration terms.

We can look at the above results in a simple way to find the dependence of reaction rate (i.e., rate of disappearance of  $\text{Br}_2$ ).

From data (1) and (2) in which concentration of  $\text{CH}_3\text{COCH}_3$  and  $\text{H}^+$  remain unchanged and only the concentration of  $\text{Br}_2$  is doubled, there is no change in rate of reaction. It means the rate of reaction is **independent of concentration of  $\text{Br}_2$** .

Again from (2) and (3) in which ( $\text{CH}_3\text{COCH}_3$ ) and ( $\text{Br}_2$ ) remain constant but  $\text{H}^+$  increases from 0.05 M to 0.10 i.e. doubled, the rate of reaction changes from  $5.7 \times 10^{-5}$  to  $1.2 \times 10^{-4}$  (or  $12 \times 10^{-5}$ ), thus it also becomes almost doubled. It shows that rate of reaction is directly proportional to  $[\text{H}^+]$ . From (3) and (4), the rate should have doubled due to increase in conc of  $[\text{H}^+]$  from 0.10 M to 0.20 M but the rate has changed from  $1.2 \times 10^{-4}$  to  $3.1 \times 10^{-4}$ . This is due to change in concentration of  $\text{CH}_3\text{COCH}_3$  from 0.30 M to 0.40 M. Thus the rate is directly proportional to  $[\text{CH}_3\text{COCH}_3]$ .

We now get

$$\begin{aligned}\text{rate} &= k[\text{CH}_3\text{COCH}_3]^1[\text{Br}_2]^0[\text{H}^+]^1 \\ &= k[\text{CH}_3\text{COCH}_3][\text{H}^+]\end{aligned}$$

141. (d) Overall order = sum of orders w.r.t each reactant.  
Let the order be  $x$  and  $y$  for G and H respectively

Exp.No.	[G]mole litre <sup>-1</sup>	[H]mole litre <sup>-1</sup>	rate(mole litre <sup>-1</sup> time <sup>-1</sup> )
1	$a$	$b$	$r$
2	$2a$	$2b$	$8r$
3	$2a$	$b$	$2r$

$\therefore$  For (1) and (3), the rate is doubled when conc. of G is doubled keeping that of H constant i.e.,

$$\text{rate} \propto [\text{G}] \therefore x = 1$$

From (2) and (3),  $y = 2$

$\therefore$  Overall order is 3.

142. (a) As doubling the initial conc. doubles the rate of reaction, order = 1

143. (a)

144. (c) Rate law :  $-\frac{d[A]}{dt} = k[A]^x[B]^y$

Doubling  $[A]$ , rate is doubled. Hence  $2^x = 2$ ,  $x = 1$

Similarly  $y = 1$ ;  $-\frac{d[A]}{dt} = k[A][B]$

$$k = \frac{\text{rate}}{[A][B]} = \frac{2.0 \times 10^{-4}}{1 \times 10^{-2} \times 2 \times 10^{-2}} = 1$$

$$\frac{(\text{rate})_2}{(\text{rate})_1} = \frac{k(2[A])(2[B])}{k[A][B]} = 4$$

145. (d) For a zero order reaction,  
 $t_{1/2} \propto a_0$  (initial concentration or initial pressure)  
 $(t_{1/2})_1 \propto P_1$   
 $(t_{1/2})_2 \propto P_2$

$$\frac{(t_{1/2})_2}{(t_{1/2})_1} = \frac{P_2}{P_1}, \quad \frac{(t_{1/2})_2}{45} = \frac{16}{4}$$

$$(t_{1/2})_2 = \frac{16}{4} \times 45 = 180 \text{ min}$$

146. (a) Given initial concentration ( $a$ ) = 2.00 M; Time taken ( $t$ ) = 200 min and final concentration ( $a - x$ ) = 0.15 M. For a first order reaction rate constant,

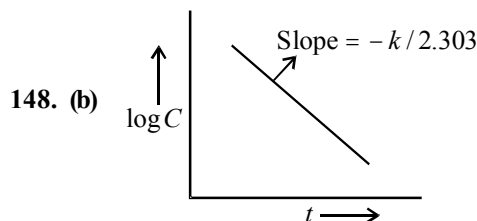
$$\begin{aligned}k &= \frac{2.303}{t} \log \frac{a}{a-x} = \frac{2.303}{200} \log \frac{2.00}{0.15} \\ &= \frac{2.303}{200} \times (0.301 + 0.824) = 1.29 \times 10^{-2} \text{ min}^{-1}.\end{aligned}$$

Further

$$(t_{1/2}) = \frac{0.693}{k} = \frac{0.693}{1.29 \times 10^{-2}} = 53.72 \text{ min}.$$

147. (d)  $t_{1/2} = 5$  years,  $T = 15$  years hence total number of half life periods =  $\frac{15}{5} = 3$ .

$$\therefore \text{Amount left} = \frac{64}{(2)^3} = 8\text{g}$$



149. (b) Let  $x$  torr of  $\text{C}_2\text{H}_4\text{O}$  decompose after 20 min. Then,  $80 - x + 2x = 120$ ;  $x = 40$  torr = 50% of initial pressure. Hence  $t_{1/2} = 20$  min. For 75% reaction, fraction left

$$= \frac{25}{100} = \frac{1}{4} = \left(\frac{1}{2}\right)^2$$

No. of half lives = 2. Time needed for 75% reaction.,  $2 \times 20 = 40$  min



150. (d)

151. (d) The integrated rate equations are different for the reactions of different reaction orders. We shall determine these equations only for zero and first order chemical reactions.

152. (b)  $\frac{r_{100^\circ\text{C}}}{r_{10^\circ\text{C}}} = 2^{\left(\frac{T_2 - T_1}{10}\right)} = 2^{\left(\frac{100 - 10}{10}\right)} = 2^9 = 512$  (where 2 is temperature coefficient of reaction)

153. (d)  $\log k = \log A - \frac{E_a}{2.303RT} \quad \dots(1)$

Also given  $\log k = 6.0 - (2000)\frac{1}{T} \quad \dots(2)$

On comparing equations, (1) and (2)

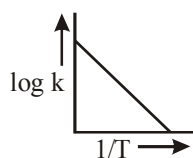
$$\log A = 6.0 \Rightarrow A = 10^6 \text{ s}^{-1}$$

$$\text{and } \frac{E_a}{2.303 R} = 2000 ;$$

$$\Rightarrow E_a = 2000 \times 2.303 \times 8.314 = 38.29 \text{ kJ mol}^{-1}$$

154. (b) We know more will be activation energy lesser will be rate constant. Thus if  $E_1 > E_2$  then  $k_1 < k_2$ . As temperature increases, it will effect both rates in similar way.

155. (b) A graph plotted between  $\log k$  vs  $\frac{1}{T}$  for calculating activation energy is shown as



from Arrhenius equation

$$\log k = \log A - \frac{E_a}{2.303 RT}$$

156. (b)  $T_2 = T$  (say),  $T_1 = 25^\circ\text{C} = 298\text{K}$ ,  
 $E_a = 104.4 \text{ kJ mol}^{-1} = 104.4 \times 10^3 \text{ J mol}^{-1}$   
 $k_1 = 3 \times 10^{-4}$ ,  $k_2 = ?$ ,

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left[ \frac{1}{T_1} - \frac{1}{T_2} \right]$$

$$\log \frac{k_2}{3 \times 10^{-4}} = \frac{104.4 \times 10^3 \text{ J mol}^{-1}}{2.303 \times (8.314 \text{ J K}^{-1} \text{ mol}^{-1})} \left[ \frac{1}{298} - \frac{1}{T} \right]$$

$$\text{As } T \rightarrow \infty, \frac{1}{T} \rightarrow 0$$

$$\therefore \log \frac{k_2}{3 \times 10^{-4}} = \frac{104.4 \times 10^3 \text{ J mol}^{-1}}{2.303 \times 8.314 \times 298}$$

$$\log \frac{k_2}{3 \times 10^{-4}} = 18.297, \frac{k_2}{3 \times 10^{-4}} = 1.98 \times 10^{18}$$

$$k_2 = (1.98 \times 10^{18}) \times (3 \times 10^{-4}) = 6 \times 10^{14} \text{ s}^{-1}$$

157. (d)

158. (b) For  $10^\circ\text{C}$  rise of temperature the rate is almost doubled.

159. (c)  $k_1 = A_1 e^{-E_{a1}/RT} \quad \dots\dots\dots(i)$

$$k_2 = A_2 e^{-E_{a2}/RT} \quad \dots\dots\dots(ii)$$

On dividing eqn (i) from eqn. (ii)

$$\frac{k_1}{k_2} = \frac{A_1}{A_2} (E_{a2} - E_{a1}) / RT \quad \dots\dots\dots(iii)$$

$$\text{Given } E_{a2} = 2E_{a1}$$

On substituting this value in eqn. (iii)

$$k_1 = k_2 A \times e^{E_{a1}/RT}$$

160. (a)

161. (b)

162. (b)

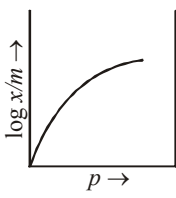
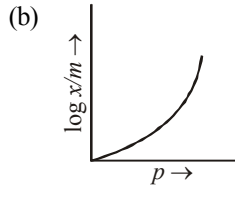
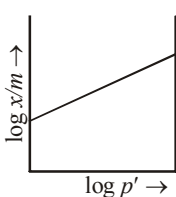
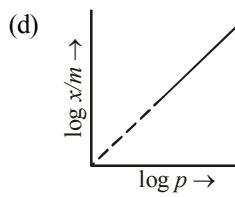
163. (b)

164. (b)



### FACT/DEFINITION TYPE QUESTIONS

- Adsorbed acetic acid on activated charcoal is:
  - adsorber
  - absorber
  - adsorbent
  - adsorbate
- Adsorption is always
  - endothermic
  - exothermic
  - exothermic in case of physical and endothermic in case of chemical
  - Either (a) or (b)
- Which is not correct regarding the physical adsorption of a gas on surface of solid ?
  - On increasing temperature, adsorption increases continuously
  - Enthalpy and entropy changes are negative
  - Adsorption is more for some specific substance
  - Reversible
- How many layers are adsorbed in chemical adsorption ?
  - One
  - Two
  - Many
  - Zero
- Adsorption due to strong chemical forces is called
  - Chemisorption
  - Physisorption
  - Reversible adsorption
  - Both (b) and (c)
- In physical adsorption, gas molecules are bound on the solid surface by
  - chemical forces
  - electrostatic forces
  - gravitational forces
  - van der Waal's forces
- Which of the following statements is not correct ?
  - Physical adsorption is due to van der Waal's forces
  - Chemical adsorption first decreases with increase in temperature.
  - Physical adsorption is reversible
  - Adsorption energy for a chemical adsorption is generally greater than that of physical adsorption.
- Adsorption of gases on solid surface is exothermic reaction because
  - free energy increases
  - enthalpy is positive
  - entropy increases
  - enthalpy is negative
- The gas which is least adsorbed on charcoal (under identical conditions) is
  - HCl
  - O<sub>2</sub>
  - CO<sub>2</sub>
  - NH<sub>3</sub>
- Adsorption is accompanied by
  - decrease in enthalpy and increase in entropy
  - increase in enthalpy and increase in entropy
  - decrease in enthalpy and decrease in entropy
  - increase in enthalpy and decrease in entropy
- Choose the incorrect statement in respect of physisorption?
  - It is not specific in nature
  - It arises because of van der Waal's force
  - It is reversible in nature
  - Enthalpy of adsorption is in the range 80-240 kJ mol<sup>-1</sup>
- The term 'sorption' stands for \_\_\_\_\_.
  - absorption
  - adsorption
  - both absorption and adsorption
  - desorption
- Extent of physisorption of a gas increases with \_\_\_\_\_.
  - increase in temperature.
  - decrease in temperature.
  - decrease in surface area of adsorbent.
  - decrease in strength of van der Waal's forces.
- Extent of adsorption of adsorbate from solution phase increases with \_\_\_\_\_.
  - increase in amount of adsorbate in solution.
  - decrease in surface area of adsorbent.
  - increase in temperature of solution.
  - decrease in amount of adsorbate in solution.
- Which of the following is **not** a favourable condition for physical adsorption ?
  - High pressure
  - Negative  $\Delta H$
  - Higher critical temperature of adsorbate
  - High temperature
- Physical adsorption of a gaseous species may change to chemical adsorption with \_\_\_\_\_.
  - decrease in temperature
  - increase in temperature
  - increase in surface area of adsorbent
  - decrease in surface area of adsorbent

17. In physisorption adsorbent does not show specificity for any particular gas because \_\_\_\_\_.
- involved van der Waal's forces are universal.
  - gases involved behave like ideal gases.
  - enthalpy of adsorption is low.
  - it is a reversible process.
18. Which of the following is an example of absorption ?
- Water on silica gel
  - Water on calcium chloride.
  - Hydrogen on finely divided nickel.
  - Oxygen on metal surface.
19. For adsorption of a gas on a solid, the plot of  $\log x/m$  vs  $\log P$  is linear with slope equal to ( $n$  being whole number)
- $k$
  - $\log k$
  - $n$
  - $\frac{1}{n}$
20. The adsorption of a gas on a solid surface varies with pressure of the gas in which of the following manner
- Fast  $\rightarrow$  slow  $\rightarrow$  independent of the pressure
  - Slow  $\rightarrow$  fast  $\rightarrow$  independent of the pressure
  - Independent of the pressure  $\rightarrow$  fast  $\rightarrow$  slow
  - Independent of the pressure  $\rightarrow$  slow  $\rightarrow$  fast
21. If  $x$  is amount of adsorbate and  $m$  is amount of adsorbent, which of the following relations is not related to adsorption process ?
- $x/m = f(p)$  at constant  $T$ .
  - $x/m = f(T)$  at constant  $p$ .
  - $p = f(T)$  at constant  $(x/m)$ .
  - $\frac{x}{m} = p \times T$
22. In Freundlich adsorption isotherm, the value of  $1/n$  is :
- between 0 and 1 in all cases
  - between 2 and 4 in all cases
  - 1 in case of physical adsorption
  - 1 in case of chemisorption
23. Which is adsorbed in maximum amount by activated charcoal ?
- $N_2$
  - $CO_2$
  - $Cl_2$
  - $O_2$
24. Freundlich equation for adsorption of gases (in amount of  $x$  g) on a solid (in amount of  $m$  g) at constant temperature can be expressed as
- $\log \frac{x}{m} = \log p + \frac{1}{n} \log K$
  - $\log \frac{x}{m} = \log K + \frac{1}{n} \log p$
  - $\frac{x}{m} \propto p^n$
  - $\frac{x}{m} = \log p + \frac{1}{n} \log K$
25. According to Freundlich adsorption isotherm, the amount of gas adsorbed at very high pressure
- reaches a constant limiting value
  - goes on increasing with pressure
  - goes on decreasing with pressure
  - increase first and decreases later with pressure
26. Which is not correct regarding the adsorption of a gas on surface of solid?
- On increasing temperature, adsorption increases continuously
  - Enthalpy and entropy changes are  $-ve$
  - Adsorption is more for some specific substance
  - This Phenomenon is reversible
27. Which of the following curves is in accordance with Freundlich adsorption isotherm ?
- 
  - 
  - 
  - 
28. Which of the following is related to adsorption?
- $\Delta H = -ve$
  - $\Delta S = -ve$
  - $-T\Delta S = -ve$
  - $\Delta G = -ve$
- (i), (ii) and (iv)
  - (ii) and (iii)
  - (iii) only
  - (i), (iii) and (iv)
29. The role of a catalyst in a reversible reaction is to
- increase the rate of forward reaction
  - decrease the rate of backward reaction
  - alter the equilibrium constant of the reaction
  - allow the equilibrium to be achieved quickly
30. Catalytic poisons act by :
- making the products chemically inactive.
  - increasing the rate of the backward reaction.
  - chemical combination with any one of the reactants.
  - preferential adsorption on the catalyst surface.
31. A catalyst :
- lowers the activation energy
  - changes the rate constant
  - changes the product
  - itself destroyed in the reaction
32. Active charcoal is a good catalyst because it
- is made up of carbon atoms.
  - is very reactive.
  - has more adsorption power.
  - has inert nature toward reagents.
33. Which of the following kind of catalysis can be explained by the adsorption theory ?
- Homogeneous catalysis
  - Acid - base catalysis
  - Heterogeneous catalysis
  - Enzyme catalysis

34. According to the adsorption theory of catalysis, the speed of the reaction increases because-
- Adsorption lowers the activation energy of the reaction
  - The concentration of reactant molecules at the active centres of the catalyst becomes high due to strong adsorption
  - In the process of adsorption, the activation energy of the molecules becomes large
  - Adsorption produces heat which increases the speed of the reaction
35. Catalyst increases the rate of reaction by
- decreasing threshold energy
  - decreasing activation energy
  - increasing activation energy
  - decreasing equilibrium constant
36. A catalyst can affect reversible reaction by
- changing equilibrium constant
  - slowing forward reaction
  - attaining equilibria in both directions
  - None of these
37. Which one of the following is an example of homogeneous catalysis ?
- Haber's process of synthesis of ammonia
  - Catalytic conversion of  $\text{SO}_2$  to  $\text{SO}_3$  in contact process
  - Catalytic hydrogenation of oils
  - Acid hydrolysis of methyl acetate.
38. Identify the correct statement regarding enzymes
- Enzymes are specific biological catalysts that cannot be poisoned.
  - Enzymes are normally heterogeneous catalysts that are very specific in their action.
  - Enzymes are specific biological catalysts that can normally function at very high temperatures ( $T \approx 1000\text{K}$ ).
  - Enzymes are specific biological catalysts that possess well-defined active sites.
39. A biological catalyst is
- an enzyme
  - a carbohydrate
  - an amino acid
  - a nitrogenous base
40. The action of enzymes in living system is to :
- supply energy to tissues
  - enhance immunity
  - circulate oxygen
  - enhance the rate of biochemical reactions.
41. Hydrolysis of urea is an example of
- homogenous catalysis
  - heterogenous catalysis
  - biochemical catalysis
  - zeolite catalysis
42. The efficiency of an enzyme in catalysing a reaction is due to its capacity
- to form a strong enzyme-substrate complex
  - to decrease the bond energies of substrate molecule
  - to change the shape of the substrate molecule
  - to lower the activation energy of the reaction
43. What is the role of molybdenum in Haber's process for manufacture of ammonia?
- As catalytic poison
  - As a catalytic promoter
  - As a catalyst
  - As a reactant
44. Which of the following step(s) is/are not involved in the mechanism of adsorption theory of heterogeneous catalyst?
- Diffusion of reactants to the surface of the catalyst.
  - Sorption of reactant molecules on the surface of the catalyst.
  - Occurrence of chemical reaction on the catalyst's surface through formation of an intermediate.
  - Desorption of reaction products from the catalyst's surface.
  - Diffusion of reaction products away from the catalyst's surface.
- (i) only
  - (ii) and (iv)
  - (ii) only
  - (i), (ii) and (v)
45. Which of the following equation does not represent homogeneous catalysis?
- $\text{CH}_3\text{COOCH}_3(l) + \text{H}_2\text{O}(l) \xrightarrow{\text{H}_2\text{SO}_4(l)} \text{CH}_3\text{COOH}(aq) + \text{CH}_3\text{OH}(aq)$
  - $4\text{NH}_3(g) + 5\text{O}_2(g) \xrightarrow{\text{Pt}(s)} 4\text{NO}(g) + 6\text{H}_2\text{O}(g)$
  - $2\text{SO}_2(g) + \text{O}_2(g) \xrightarrow{\text{NO}(g)} 2\text{SO}_3(g)$
  - Both (a) and (b)
46. Milk is a colloid in which a
- liquid is dispersed in a liquid
  - solid is dispersed in a liquid
  - gas is dispersed in a liquid
  - sugar is dispersed in a liquid
47. Butter is a colloid formed when
- Fat is dispersed in water
  - Fat globules are dispersed in water
  - Water is dispersed in fat
  - None of the above
48. The size of colloidal particles is between
- $10^{-7} - 10^{-9} \text{ cm}$
  - $10^{-9} - 10^{-11} \text{ cm}$
  - $10^{-5} - 10^{-7} \text{ cm}$
  - $10^{-2} - 10^{-3} \text{ cm}$
49. An aerosol is a :
- dispersion of a solid or liquid in a gas
  - dispersion of a solid in a liquid
  - dispersion of a liquid in a liquid
  - solid solution
50. An example of dispersion of a liquid in a gas is :
- milk
  - vegetable oil
  - foam
  - mist
51. Alloy is an example of
- gel
  - solidified emulsion
  - solid solution
  - sol

52. If dispersed phase is a liquid and the dispersion medium is a solid, the colloid is known as  
(a) a sol (b) a gel  
(c) an emulsion (d) a foam
53. Hair cream is an example of  
(a) gel (b) sol  
(c) aerosol (d) foam
54. Which one of the following is correctly matched?  
(a) Emulsion-smoke (b) Gel-butter  
(c) Aerosol-hair cream (d) Sol-whipped cream
55. Cheese is an example of  
(a) solid sol (b) emulsion  
(c) gel (d) foam
56. Which one of the following is not a colloidal solution?  
(a) Smoke (b) Ink  
(c) Blood (d) Air
57. Small liquid droplets dispersed in another liquid is called  
(a) gel (b) suspension  
(c) emulsion (d) true solution
58. When dispersed phase is liquid and dispersion medium is gas then the colloidal system is called  
(a) Smoke (b) Clouds  
(c) Jellies (d) Emulsions
59. Which one is a colloid?  
(a) Sodium chloride (b) Urea  
(c) Cane sugar (d) Blood
60. Suspensions are  
(a) Visible to naked eye  
(b) Not visible by any means  
(c) Invisible under electron microscope  
(d) Invisible through microscope
61. Cloud or fog is an example of colloidal system of  
(a) Liquid dispersed in gas  
(b) Gas dispersed in gas  
(c) Solid dispersed in gas  
(d) Solid dispersed in liquid
62. A colloid always :  
(a) Contains two phases  
(b) Is a true solution  
(c) Contains three phases  
(d) Contains only water soluble particles
63. Which one of the following is correctly matched ?  
(a) Emulsion - curd (b) Foam - mist  
(c) Aerosol - smoke (d) Solid sol - cake
64. At the critical micelle concentration (CMC) the surfactant molecules  
(a) decompose  
(b) dissociate  
(c) associate  
(d) become completely soluble
65. How non-polar and polar part in micelle are arranged ?  
(a) Polar at outer surface and non-polar at inner surface  
(b) Polar at inner surface and non-polar at outer surface  
(c) Both polar and non-polar at inner surface  
(d) Distributed all over the surface
66. Surface tension of lyophilic sols is  
(a) lower than that of  $H_2O$   
(b) more than that of  $H_2O$   
(c) equal to that of  $H_2O$   
(d) either less or more than  $H_2O$  depending upon the nature of disperse phase
67. Which of the following is a lyophilic colloid ?  
(a) Milk (b) Gum  
(c) Fog (d) Blood
68. Lyophobic colloids are :  
(a) gun proteins (b) protective colloids  
(c) irreversible colloids (d) reversible colloids
69. Which one is an example of multimolecular colloid system  
(a) Soap dispersed in water  
(b) Protein dispersed in water  
(c) Gold dispersed in water  
(d) Gum dispersed in water
70. Example of intrinsic colloid is  
(a) glue (b) sulphur  
(c) Fe (d)  $As_2S_3$
71. Associated colloid among the following is  
(a) enzymes (b) proteins  
(c) cellulose (d) sodium stearate
72. The formation of micelles takes place only above  
(a) inversion temperature  
(b) Boyle temperature  
(c) critical temperature  
(d) Kraft temperature
73. A precipitate is changed to colloidal solution by the following process :  
(a) dialysis (b) ultrafiltration  
(c) peptization (d) electrophoresis
74. Which of the following is used for neutralising charge on colloidal solution?  
(a) Electrons  
(b) Electrolytes  
(c) Positively charged ions  
(d) Compounds
75. Pure water can be obtained from sea water by  
(a) Centrifugation (b) Plasmolysis  
(c) Reverse osmosis (d) Sedimentation
76. Blood may be purified by  
(a) Dialysis (b) Electro-osmosis  
(c) Coagulation (d) Filtration
77. During dialysis  
(a) only solvent molecules can diffuse  
(b) solvent molecules, ions and colloidal particles can diffuse  
(c) all kinds of particles can diffuse through the semi-permeable membrane  
(d) solvent molecules and ions can diffuse
78. The electrolytic impurities of a sol can most easily be separated by  
(a) dialysis (b) electrosmosis  
(c) electrophoresis (d) electro dialysis



79. The formation of colloid from suspension is  
(a) Peptisation (b) Condensation  
(c) Sedimentation (d) Fragmentation
80. The separation of colloidal particles from particles of molecular dimensions is known as  
(a) sedimentation (b) dispersion  
(c) pyrolysis (d) dialysis
81. Which one of the following impurities present in colloidal solution cannot be removed by electrodialysis?  
(a) Sodium chloride (b) Potassium sulphate  
(c) Urea (d) Calcium chloride
82. The migration of dispersion medium under the influence of an electric potential is called :  
(a) Cataphoresis (b) Electroosmosis  
(c) Electrophoresis (d) Sedimentation
83. The movement of colloidal particles towards their respective electrodes in the presence of an electric field is known as :  
(a) electrolysis (b) Brownian movement  
(c) electrodialysis (d) electrophoresis
84. Peptization denotes  
(a) Digestion of food  
(b) Hydrolysis of proteins  
(c) Breaking and dispersion into the colloidal state  
(d) Precipitation of solid from colloidal dispersion
85. Colloidal gold is prepared by  
(a) Mechanical dispersion (b) Peptisation  
(c) Bredig's Arc method (d) Hydrolysis
86. Peptization involves  
(a) precipitation of colloidal particles  
(b) disintegration of colloidal aggregates  
(c) evaporation of dispersion medium  
(d) impact of molecules of the dispersion medium on the colloidal particles
87. Hardy-Schulze rule explains the effect of electrolytes on the coagulation of colloidal solution. According to this rule, coagulation power of cations follow the order  
(a)  $Ba^{+2} > Na^{+} > Al^{+3}$  (b)  $Al^{+3} > Na^{+} > Ba^{+2}$   
(c)  $Al^{+3} > Ba^{+2} > Na^{+}$  (d)  $Ba^{+2} > Al^{+3} > Na^{+}$
88. Tyndall effect is shown by  
(a) sol (b) solution  
(c) plasma (d) precipitate
89. The cause of Brownian movement is  
(a) heat changes in liquid state  
(b) convectional currents  
(c) the impact of molecules of the dispersion medium on the colloidal particles.  
(d) attractive forces between the colloidal particles and molecules of dispersion medium.
90. When a strong beam of light is passed through a colloidal solution, the light will  
(a) be reflected (b) be scattered  
(c) be refracted (d) give a rainbow
91. The simplest way to check whether a system is colloidal or not is by  
(a) Tyndall effect (b) Brownian movement  
(c) Electrodialysis (d) Measuring particle size
92. Which of the following is most effective in causing the coagulation of ferric hydroxide sol?  
(a) KCl (b)  $KNO_3$   
(c)  $K_2SO_4$  (d)  $K_3[Fe(CN)_6]$
93. The ability of an ion to bring about coagulation of a given colloid depends upon  
(a) its size  
(b) the magnitude of its charge  
(c) the sign of its charge  
(d) both magnitude and sign of its charge
94. Which of the following electrolytes is least effective in coagulating ferric hydroxide solution?  
(a) KBr (b)  $K_2SO_4$   
(c)  $K_2CrO_4$  (d)  $K_4[Fe(CN)_6]$
95. Which of the following acts as protective colloid?  
(a) Silica gel (b) Gelatin  
(c) Sodium acetate (d) None of these
96. Tyndall effect shown by colloids is due to :  
(a) scattering of light by the particles  
(b) movement of particles  
(c) reflection of light by the particles  
(d) coagulation of particles
97. Which of the following is not a property of colloidal solution?  
(a) Heterogeneity (b) Particle size  $> 100$  nm  
(c) Tyndall effect (d) Brownian movement
98. Which of the following is most powerful to coagulate the negative colloid?  
(a)  $ZnSO_4$  (b)  $Na_3PO_4$   
(c)  $AlCl_3$  (d)  $K_4[Fe(CN)_6]$
99. The charge on colloidal particles is due to  
(a) presence of electrolyte  
(b) very small size of particles  
(c) adsorption of ions from the solution  
(d) None of these
100. The ion that is more effective for the coagulation of  $As_2S_3$  sol is  
(a)  $Ba^{2+}$  (b)  $Na^{+}$   
(c)  $PO_4^{3-}$  (d)  $Al^{3+}$
101. Which one of the following impurities present in colloidal solution cannot be removed by electrodialysis?  
(a) Sodium chloride (b) Potassium sulphate  
(c) Urea (d) Calcium chloride
102. Brownian movement is found in  
(a) Colloidal solution (b) Suspension  
(c) Saturated solution (d) Unsaturated solution
103. Random motion of colloidal particles is known as  
(a) Dialysis (b) Brownian movement  
(c) Electroosmosis (d) Tyndall effect
104. In which of the following Tyndall effect is not observed ?  
(a) Suspensions (b) Emulsions  
(c) Sugar solution (d) Gold sol

- 105.** Which of the following is not true about the emulsion?  
 (a) Emulsion can be broken into constituent liquids by heat, freezing  
 (b) Emulsion of oil in water is generally unstable  
 (c) Emulsion do not show the Tyndall effect  
 (d) They show brownian motion
- 106.** Which of the following process is responsible for the formation of delta at a place where rivers meet the sea?  
 (a) Emulsification (b) Colloid formation  
 (c) Coagulation (d) Peptisation
- 107.** Which of the following colloid does not contain liquid as a dispersion medium?  
 (a) Sol (b) Gel  
 (c) Emulsion (d) Foam
- 108.** Which of the following method is used for coagulation of the sol?  
 (a) By mixing two oppositely charged sols.  
 (b) By electrophoresis.  
 (c) By addition of electrolytes.  
 (d) All of the above.
- 109.** Which of the following phenomenon occurs when the precipitate of  $\text{Mg}(\text{OH})_2$  attains blue colour in presence of mageson reagent?  
 (i) Absorption of solvent  
 (ii) Adsorption of coloured substance  
 (iii) Absorption and adsorption both of solvent  
 (iv) Adsorption of solvent  
 (a) (i) and (ii) (b) (ii) only  
 (c) (ii) and (iv) (d) (iii) only
- 110.** Which of the following is not the condition for Tyndall effect?  
 (a) The refractive indices of dispersed phase and dispersion medium should differ greatly in magnitude.  
 (b) The diameter of the dispersed particles is not much smaller than the wavelength of light used.  
 (c) Tyndall effect is observed only when viewed from the direction of the passage of light.  
 (d) All of these are required conditions for Tyndall effect.
- 111.** Which of the following is not emulsifying agent for W/O emulsion?  
 (a) Lampblack  
 (b) Long chain alcohol  
 (c) Proteins  
 (d) Heavy metal salts of fatty acids
- 112.** Emulsions can be broken into constituent liquid by \_\_\_\_\_.  
 (a) heating (b) freezing  
 (c) centrifuging (d) All of these
- (a) Only (iv) is correct  
 (b) (i) and (ii) are correct  
 (c) (i), (ii) and (iv) are correct  
 (d) (i), (ii) and (iii) are correct
- 114.** Read the following statements related to physisorption.  
 (i) Adsorbent shows preference for gases with high molecular weight.  
 (ii) Easily liquefiable gases gets readily adsorbed.  
 (iii) Adsorption varies with change in temperature and pressure.  
 (iv) Finely divided and solid metals adsorb gases equally.  
 (v) It is exothermic with low value of enthalpy of adsorption.  
 Which of the following is the correct code for the statements above ?  
 (a) TFFTF (b) FTTFT  
 (c) TFFTT (d) FTTTF
- 115.** Read the following statements related to chemisorption  
 (i) It is highly specific.  
 (ii) It increases with increase in temperature and pressure.  
 (iii) It is reversible.  
 (iv) It increases with increase in surface area of adsorbent.  
 Which of the following is correct code for the statements above?  
 (a) TTFT (b) TFFT  
 (c) FTFT (d) FTF
- 116.** Which of the following statement(s) is/are correct about solid catalyst?  
 (i) Same reactants may give different product by using different catalysts.  
 (ii) Catalyst is required in large quantities to catalyse reactions.  
 (iii) Catalyst does not change  $\Delta H$  of reaction.  
 (iv) Catalytic activity of a solid catalyst does not depend upon the strength of chemisorption.  
 (a) (i) and (iii) (b) (i) only  
 (c) (ii), (iii) and (iv) (d) (iii) and (iv)
- 117.** Which of the following statement(s) is/are correct?  
 (i) Zeolites are good shape selective catalysts because of their honeycomb-like structures.  
 (ii) All zeolites are naturally occurring substance.  
 (iii) An important zeolite catalyst used in the petroleum industry in ZSM-5.  
 (a) (i) only (b) (ii) only  
 (c) (i) and (iii) (d) (ii) and (iii)
- 118.** Read the following statements regarding enzyme catalysis  
 (i) Enzyme catalysis is highly specific in nature.  
 (ii) Enzyme catalysis to work effectively requires optimum temperature (298-310 K) and optimum pH (3-5)  
 (iii) Metal ions like  $\text{Na}^+$ ,  $\text{Mn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Cu}^{2+}$  etc. increases the activity of enzymes.  
 (iv) Catalyst used in Ostwald's process is platinised asbestos at 673 K.  
 (v) Catalyst used in contact process is platinised asbestos or  $\text{V}_2\text{O}_5$  at 673-723 K.  
 Which of the following is the correct coding for the above statements?  
 (a) FTFTF (b) TFFTF  
 (c) TTTFF (d) FTFTF

### STATEMENT TYPE QUESTIONS

- 113.** Read the following statements regarding adsorption and choose the correct option.  
 (i) It is a surface phenomenon.  
 (ii) The material which is adsorbed is termed as adsorbate.  
 (iii) The material on the surface of which the adsorption takes place is called adsorbent.  
 (iv) Adsorption is a bulk phenomenon.

119. Which of the following statements are correct?

- (i) Gelatine sol if evaporated off it can be reobtained simply by mixing gelatine obtained on evaporation with suitable dispersion medium.
  - (ii) Metal sulphide sols need stabilising agents for their preservation
  - (iii)  $S_8$  being a macromolecule forms macromolecular colloid.
  - (iv) Starch and proteins are natural whereas polythene and polystyrene are man-made macromolecules.
  - (v) Micelles are formed above kraft temperature at any concentration
- (a) (i), (ii) and (iii)                      (b) (i), (ii) and (iv)  
(c) (iii), (iv) and (v)                      (d) (ii), (iv) and (v)

120. Read the following statements

- (i) Tyndall effect is used to distinguish between a colloidal and true solution.
- (ii) Values of colligative properties are same for true and colloidal solutions.
- (iii) Random bombardment of the colloidal particles by the molecules of the dispersion medium does not allow colloids to settle thereby providing stability to them.
- (iv) Most acceptable phenomena to account for the charge of sol particles is electrodispersion.

Which of the following is the correct code for statements above?

- (a) TFTF                                      (b) TTFF  
(c) FTFT                                      (d) TFFT

### MATCHING TYPE QUESTIONS

121. Match the columns

- | Column-I   | Column-II                                    |
|--|--|
| (A) $\frac{x}{m} = kc^{1/n}$   | (p) Adsorption varies directly with pressure |
| (B) $\log \frac{x}{m} = \log k + \frac{1}{n} \log p$<br>$\left(\frac{1}{n} = 0\right)$ | (q) Adsorption from solution phase           |
| (C) $\log \frac{x}{m} = \log k + \frac{1}{n} \log p$<br>$\left(\frac{1}{n} = 1\right)$ | (r) Freundlich isotherm cannot be explained  |
| (D) $\frac{x}{m} = kp^{1/n}$<br>(high pressure)  | (s) Adsorption is independent of pressure    |
- (a) A – (q), B – (s), C – (p), D – (r)  
(b) A – (q), B – (p), C – (s), D – (r)  
(c) A – (r), B – (p), C – (s), D – (q)  
(d) A – (r), B – (s), C – (p), D – (q)

122. Match the columns

- | Column-I<br>(Biochemical reactions)  | Column-II<br>(Enzymes) |
|--|------------------------|
| (A) $C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$                            | (p) Zymase             |
| (B) $NH_2CONH_2(aq) + H_2O(l) \longrightarrow 2NH_3(g) + CO_2(g)$                          | (q) Pepsin             |
| (C) Proteins $\longrightarrow$ Peptides  | (r) Urease             |
| (D) $C_{12}H_{22}O_{11}(aq) + H_2O(l) \longrightarrow C_6H_{12}O_6(aq) + C_6H_{12}O_6(aq)$ | (s) Invertase          |
- (a) A – (p), B – (r), C – (q), D – (s)  
(b) A – (p), B – (q), C – (r), D – (s)  
(c) A – (r), B – (p), C – (q), D – (s)  
(d) A – (p), B – (r), C – (s), D – (q)

123. Match the columns

- | Column-I<br>(Catalyst) | Column-II<br>(Industrial product) |
|------------------------|-----------------------------------|
| (A) $V_2O_5$           | (p) High density poly-ethylene    |
| (B) Ziegler-Natta      | (q) Polyacrylonitrile             |
| (C) Peroxide           | (r) $NH_3$                        |
| (D) Finely divided Fe  | (s) $H_2SO_4$                     |
- (a) A – (s), B – (p), C – (q), D – (r)  
(b) A – (s), B – (r), C – (q), D – (p)  
(c) A – (r), B – (p), C – (q), D – (s)  
(d) A – (s), B – (q), C – (p), D – (r)

124. Match the columns

- | Column-I  | Column-II              |
|---|------------------------|
| (A) Oil in water emulsion   | (p) Clouds             |
| (B) Aerosols containing small droplets of water suspended in air      | (q) Vanishing cream    |
| (C) When river water meets the sea water                              | (r) Smoke              |
| (D) Colloidal solution of carbon, arsenic compounds, dust etc. in air | (s) Formation of delta |
- (a) A – (q), B – (p), C – (s), D – (r)  
(b) A – (p), B – (q), C – (s), D – (r)  
(c) A – (q), B – (s), C – (p), D – (r)  
(d) A – (q), B – (p), C – (r), D – (s)

125. Match the columns

- | Column-I  | Column-II                |
|---|--------------------------|
| (A) $As_2S_3$ sol   | (p) Bredig's Arc method  |
| (B) $Fe(OH)_3$ sol  | (q) Double decomposition |
| (C) Colloidal sols of metals like Au, Ag, Pt, etc.                  | (r) Peptization          |
| (D) Conversion of freshly prepared precipitate into a colloidal sol | (s) Hydrolysis           |
- (a) A – (q), B – (s), C – (r), D – (p)  
(b) A – (q), B – (p), C – (s), D – (r)  
(c) A – (s), B – (q), C – (p), D – (r)  
(d) A – (q), B – (s), C – (p), D – (r)

126. Match the columns

- | Column-I   | Column-II            |
|--|----------------------|
| (A) In this process molecules and ions diffuse through membrane outside and pure colloidal solution is left behind.                  | (p) Dialysis         |
| (B) This process is used if the dissolved substance in the impure colloidal solution is only an electrolyte                          | (q) Ultrafiltration  |
| (C) In this process ordinary filter paper is soaked into collodion (4% solution of nitrocellulose in a mixture of alcohol and ether) | (r) Electro-dialysis |
| (a) A – (p), B – (r), C – (q)  |                      |
| (b) A – (r), B – (p), C – (q)  |                      |
| (c) A – (p), B – (q), C – (r)  |                      |
| (d) A – (q), B – (r), C – (p)  |                      |

127. Match the columns

- | Column-I   | Column-II                       |
|--|---------------------------------|
| (A) Sulphur vapours passed through cold water                  | (p) Normal electrolyte solution |
| (B) Soap mixed with water above critical micelle concentration | (q) Molecular colloids          |
| (C) White of egg whipped with water                            | (r) Associated colloid          |
| (D) Soap mixed with water below critical micelle concentration | (s) Macro molecular colloids    |
| (a) A – (q), B – (r), C – (s), D – (p)                         |                                 |
| (b) A – (r), B – (q), C – (s), D – (p)                         |                                 |
| (c) A – (p), B – (r), C – (s), D – (q)                         |                                 |
| (d) A – (q), B – (s), C – (r), D – (p)                         |                                 |

128. Match the columns

- | Column-I                               | Column-II                              |
|--|--|
| (A) Protective colloid                 | (p) $\text{FeCl}_3 + \text{NaOH}$      |
| (B) Liquid - liquid colloid            | (q) Lyophilic colloids                 |
| (C) Positively charged colloid         | (r) Emulsion                           |
| (D) Negatively charged colloid         | (s) $\text{FeCl}_3 + \text{hot water}$ |
| (a) A – (q), B – (r), C – (p), D – (s) |  |
| (b) A – (p), B – (r), C – (s), D – (q) |  |
| (c) A – (q), B – (r), C – (s), D – (p) |  |
| (d) A – (r), B – (q), C – (s), D – (p) |  |

129. Match the columns

- | Column-I            | Column-II                    |
|---------------------|------------------------------|
| (A) Dialysis        | (p) Cleansing action of soap |
| (B) Peptisation     | (q) Coagulation              |
| (C) Emulsification  | (r) Colloidal sol formation  |
| (D) Electrophoresis | (s) Purification             |

- (a) A – (s), B – (r), C – (p), D – (q)  
 (b) A – (q), B – (r), C – (p), D – (s)  
 (c) A – (s), B – (p), C – (r), D – (q)  
 (d) A – (s), B – (r), C – (q), D – (p)

130. Match the columns

- | Column-I                               | Column-II                          |
|--|------------------------------------|
| (A) Butter                             | (p) dispersion of liquid in liquid |
| (B) Pumice stone                       | (q) dispersion of solid in liquid  |
| (C) Milk                               | (r) dispersion of gas in solid     |
| (D) Paints                             | (s) dispersion of liquid in solid  |
| (a) A – (r), B – (s), C – (p), D – (q) |                                    |
| (b) A – (s), B – (r), C – (p), D – (q) |                                    |
| (c) A – (q), B – (r), C – (p), D – (s) |                                    |
| (d) A – (s), B – (r), C – (q), D – (p) |                                    |

131. Match the columns

- | Column-I                               | Column-II                   |
|--|-----------------------------|
| (A) Argyrol                            | (p) Kalazar                 |
| (B) Antimony                           | (q) Intramuscular injection |
| (C) Colloidal gold                     | (r) Stomach disorders       |
| (D) Milk of magnesia                   | (s) Eye lotion              |
| (a) A – (r), B – (p), C – (s), D – (q) |                             |
| (b) A – (r), B – (p), C – (q), D – (s) |                             |
| (c) A – (s), B – (q), C – (p), D – (s) |                             |
| (d) A – (s), B – (p), C – (q), D – (r) |                             |

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contains two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

132. **Assertion :** The relation  $\frac{x}{m} = k \cdot p^{1/n}$  is known as Freundlich adsorption isotherm, where x is the mass of gas adsorbed by m grams of adsorbate, p is the equilibrium pressure, k and n are constants for given system and temperature.

**Reason :** When several substances have same value of  $\frac{1}{n}$ , the lines by which their adsorption isotherms can be represented will meet at a point.

133. **Assertion :** The enthalpy of physisorption is greater than chemisorption.

**Reason :** Molecules of adsorbate and adsorbent are held by van der Waal's forces in physisorption and by chemical bonds in chemisorption.



**134. Assertion :** According to Freundlich:  $\frac{x}{m} = K \cdot p^{1/n}$ .

**Reason :** The isotherm shows variation of the amount of gas adsorbed by the adsorbent with temperature.

**135. Assertion:** Detergents with low CMC are more economical to use.

**Reason:** Cleansing action of detergents involves the formation of micelles. These are formed when the concentration of detergents becomes equal to CMC.

**136. Assertion:** An ordinary filter paper impregnated with collodion solution stops the flow of colloidal particles.

**Reason:** Pore size of the filter paper becomes more than the size of colloidal particle.

**137. Assertion :** The value of colligative properties are of small order for colloids as compared to true solution.

**Reason :** Number of particles in colloidal solution is comparatively smaller than true solutions.

### CRITICAL THINKING TYPE QUESTIONS

**138.** Which of the following statements is incorrect regarding physisorptions?

- (a) More easily liquefiable gases are adsorbed readily.
- (b) Under high pressure it results into multimolecular layer on adsorbent surface.
- (c) Enthalpy of adsorption ( $\Delta H_{\text{adsorption}}$ ) is low and positive.
- (d) It occurs because of van der Waal's forces.

**139.** Which is correct about physical adsorption?

- (a) High temperature and high pressure favour adsorption
- (b) High temperature and low pressure favour adsorption
- (c) Low temperature and high pressure favour adsorption
- (d) Low temperature and low pressure favour adsorption

**140.** Which one of the following is **not** applicable to the phenomenon of adsorption ?

- (a)  $\Delta H > 0$  (b)  $\Delta G < 0$
- (c)  $\Delta S < 0$  (d)  $\Delta H < 0$

**141.** Methylene blue, from its aqueous solution, is adsorbed on activated charcoal at 25°C. For this process, which of the following statement is correct ?

- (a) The adsorption requires activation at 25°C
- (b) The adsorption is accompanied by a decrease in enthalpy
- (c) The adsorption increases with increase of temperature
- (d) The adsorption is irreversible

**142.** In the adsorption of a gas on solid, Freundlich isotherm is obeyed. The slope of the plot is zero. Then the extent of adsorption is

- (a) directly proportional to the pressure of the gas
- (b) inversely proportional to the pressure of the gas
- (c) directly proportional to the square root of the pressure of the gas
- (d) independent of the pressure of the gas

**143.** On the basis of data given below predict which of the following gases shows least adsorption on a definite amount of charcoal?

Gas	CO <sub>2</sub>	SO <sub>2</sub>	CH <sub>4</sub>	H <sub>2</sub>
Critical temp./K	304	630	190	33
(a) CO <sub>2</sub>		(b) SO <sub>2</sub>		
(c) CH <sub>4</sub>		(d) H <sub>2</sub>		

**144.** Which of the following statements regarding difference between adsorption and absorption is incorrect?

- (a) Adsorption is a surface whereas absorption is a bulk phenomena.
- (b) Water vapours are absorbed by anhydrous CaCl<sub>2</sub> but adsorbed by silica gel.
- (c) Adsorption and absorption take place individually. They can not occur simultaneously.
- (d) All of the above statements are correct.

**145.** Which of the following is not an application of adsorption?

- (a) In metallurgy for concentration of sulphide ores.
- (b) In heterogeneous catalysis involving solid catalyst.
- (c) In homogeneous catalysis.
- (d) Separation of inert gas.

**146.** Which of the following statements regarding catalyst is not true ?

- (a) A catalyst remains unchanged in composition and quantity at the end of the reaction
- (b) A catalyst can initiate a reaction
- (c) A catalyst does not alter the equilibrium in a reversible reaction
- (d) Catalysts are sometimes very specific in respect of reaction

**147.** Which of the following statements about a catalyst is true ?

- (a) A catalyst accelerates the reaction by bringing down the free energy of activation
- (b) A catalyst also takes part in the reaction mechanism
- (c) A catalyst makes the reaction more feasible by making the  $\Delta G^\circ$  more negative
- (d) A catalyst makes the equilibrium constant of the reaction more favourable for the forward reaction

**148.** Which one of the following, statements is incorrect about enzyme catalysis?

- (a) Enzymes are mostly proteinous in nature.
- (b) Enzyme action is specific.
- (c) Enzymes are denaturated by ultraviolet rays and at high temperature.
- (d) Enzymes are least reactive at optimum temperature.

**149.** Given below, catalyst and corresponding process/reaction are matched. The one with mismatch is

- (a) [RhCl(PPh<sub>3</sub>)<sub>2</sub>] : Hydrogenation
- (b) TiCl<sub>4</sub> + Al (C<sub>2</sub>H<sub>5</sub>)<sub>3</sub> : Polymerization
- (c) V<sub>2</sub>O<sub>5</sub> : Haber-Bosch process
- (d) Nickel : Hydrogenation



150. Which one of the following statements is incorrect in the case of heterogeneous catalysis ?  
 (a) The catalyst lowers the energy of activation  
 (b) The catalyst actually forms a compound with the reactant  
 (c) The surface of the catalyst plays a very important role  
 (d) There is no change in the energy of activation.
151. In petrochemical industry alcohols are directly converted to gasoline by passing over heated  
 (a) Platinum (b) ZSM-5  
 (c) Iron (d) Nickel
152. Which of the following feature of catalysts is described in reactions given below?  
 (i)  $\text{CO(g)} + 2\text{H}_2\text{(g)} \xrightarrow{\text{Cu/ZnO-Cr}_2\text{O}_3} \text{CH}_3\text{OH(g)}$   
 (ii)  $\text{CO(g)} + \text{H}_2\text{(g)} \xrightarrow{\text{Cu}} \text{HCHO(g)}$   
 (iii)  $\text{CO(g)} + 3\text{H}_2\text{(g)} \xrightarrow{\text{Ni}} \text{CH}_4\text{(g)} + \text{H}_2\text{O(g)}$   
 (a) Activity (b) Selectivity  
 (c) Catalytic promoter (d) Catalytic poison
153. The dispersed phase and dispersion medium in soap lather are respectively  
 (a) gas and liquid (b) liquid and gas  
 (c) solid and gas (d) solid and liquid
154. Which of the following is not a colloid ?  
 (a) Chlorophyll (b) Smoke  
 (c) Ruby glass (d) Milk
155. Which of the following forms a colloidal solution in water ?  
 (a) NaCl (b) Glucose  
 (c) Starch (d) Barium nitrate
156. Which of the following forms cationic micelles above certain concentration?  
 (a) Sodium dodecyl sulphate  
 (b) Sodium acetate  
 (c) Urea  
 (d) Cetyl trimethyl ammonium bromide
157. Which of the following does not contain a hydrophobic structure ?  
 (a) Linseed oil (b) Lanolin  
 (c) Glycogen (d) Rubber
158. Which one of the following is an example for multimolecular colloid?  
 (a) Aqueous starch sol  
 (b) Aqueous enzyme sol  
 (c) Alcoholic polystyrene sol  
 (d) Aqueous sol of sodium laurylsulphate
159. Bredig arc method cannot be used to prepare colloidal solution of which of the following  
 (a) Pt (b) Fe  
 (c) Ag (d) Au
160. Colloidal solutions are not purified by  
 (a) Dialysis (b) Electrodialysis  
 (c) Ultrafiltration (d) Electrophoresis
161. Colloid of which one of the following can be prepared by electrical dispersion method as well as reduction method ?  
 (a) Sulphur (b) Ferric hydroxide  
 (c) Arsenious sulphide (d) Gold
162. Which of the following ions can cause coagulation of proteins ?  
 (a)  $\text{Ag}^+$  (b)  $\text{Na}^+$   
 (c)  $\text{Mg}^{2+}$  (d)  $\text{Ca}^{2+}$
163. Which of the following will be most effective in the coagulation of  $\text{Al(OH)}_3$  sol ?  
 (a) KCN (b)  $\text{BaCl}_2$   
 (c) NaCl (d)  $\text{Mg}_3(\text{PO}_4)_2$
164. Point out the false statement :  
 (a) The colloidal solution of a liquid in liquid is called gel  
 (b) Hardy Schulze rule is related with coagulation  
 (c) Brownian movement and Tyndall effect are shown by colloidal system  
 (d) Gold number is a measure of the protective power of lyophilic colloid
165. The disperse phase in colloidal iron (III) hydroxide and colloidal gold is positively and negatively charged, respectively. Which of the following statements is NOT correct?  
 (a) Coagulation in both sols can be brought about by electrophoresis  
 (b) Mixing the sols has no effect  
 (c) Sodium sulphate solution causes coagulation in both sols  
 (d) Magnesium chloride solution coagulates, the gold sol more readily than the iron (III) hydroxide sol.
166. A colloidal solution is subjected to an electric field. The particles move towards anode. The coagulation of same sol is studied using NaCl,  $\text{BaCl}_2$  and  $\text{AlCl}_3$  solutions. The order of their coagulation power should be –  
 (a)  $\text{NaCl} > \text{BaCl}_2 > \text{AlCl}_3$  (b)  $\text{BaCl}_2 > \text{AlCl}_3 > \text{NaCl}$   
 (c)  $\text{AlCl}_3 > \text{BaCl}_2 > \text{NaCl}$  (d)  $\text{BaCl}_2 > \text{NaCl} > \text{AlCl}_3$
167. Flocculation value of  $\text{BaCl}_2$  is much less than that of KCl for sol A and flocculation value of  $\text{Na}_2\text{SO}_4$  is much less than that of NaBr for sol B. The correct statement among the following is :  
 (a) Both the sols A and B are negatively charged.  
 (b) Sol A is positively charged and Sol B is negatively charged.  
 (c) Both the sols A and B are positively charged.  
 (d) Sol A is negatively charged and sol B is positively charged.
168. In Brownian movement or motion, the paths of the particles are  
 (a) Linear (b) Zig-zag  
 (c) Uncertain (d) Curved

169. How does a delta form at the meeting place of sea and river water?
- The electrolyte present in sea water coagulate the clay
  - the electrolyte present in sea water has no role
  - the electrolyte present in river water coagulate the clay
  - Both (a) and (c) are correct
170. .... is a silver sol used as an eye lotion. Fill in the blank with an appropriate answer.
- Amytol
  - Argyrol
  - Ciprofloxacin
  - Both (a) and (b)
171. Which of the following will show Tyndall effect?
- Aqueous solution of soap below critical micelle concentration.
  - Aqueous solution of soap above critical micelle concentration.
  - Aqueous solution of sodium chloride.
  - Aqueous solution of sugar.
172. Which of the following combinations of dispersed phase and dispersion medium will not form a colloid ?
- Dispersed phase – Solid, Dispersion medium – Solid.
  - Dispersed phase – Solid, Dispersion medium – Gas.
  - Dispersed phase – Gas, Dispersion medium – Gas.
  - Dispersed phase – Liquid, Dispersion medium – Gas.
173. Which of the following statements is incorrect?
- Colloidal gold is used for intramuscular injection.
  - Colloidal solution of latex is used in preparation of rubber.
  - Photographic films are prepared by coating an emulsion of AgBr in gelatin over glass plate.
  - Tannin used in leather industry contains positively charged colloidal particles.
174. Which of the following is not correctly matched ?
- Sulphur sol – Oxidation
  - Gold sol – Double decomposition
  - $\text{Fe}(\text{OH})_3$  sol – Hydrolysis
  - Both (b) and (c)
175. How many of the following are negatively charged sols?
- Eosin dye, sol of charcoal, haemoglobin,  $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ ,  $\text{As}_2\text{S}_3$ ,  $\text{TiO}_2$ .sol, copper sol
- 3
  - 4
  - 6
  - All of these

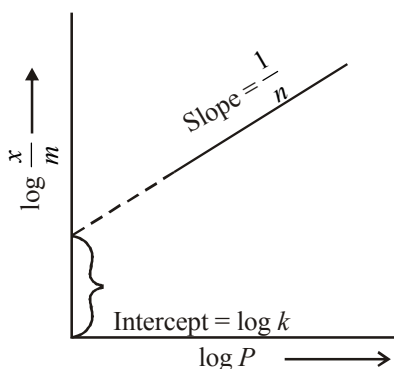
# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (d) The substance which is adsorbed is called adsorbate.
2. (b) Adsorption is an exothermic process.
3. (a) On increasing temperature physical adsorption of a gas on surface of solid decreases. Solid adsorb greater amount of gas at lower temperature.
4. (a) Chemical adsorption involves formation of monolayer.
5. (a) Chemisorption involves strong chemical forces.
6. (d) In physisorption, gas molecules are held on the solid surface by weak van der Waal's forces.
7. (b)
8. (d) Adsorption is accompanied by evolution of heat as the residual forces acting along the surface of adsorbent decrease i.e., adsorption is accompanied by decrease in enthalpy.
9. (b) The more readily soluble and easily liquefiable gases such as  $\text{NH}_3$ ,  $\text{HCl}$  and  $\text{SO}_2$  are adsorbed more than the so called permanent gases like  $\text{O}_2$ . This is due to the van der Waals or intermolecular forces which are involved in adsorption.
10. (c) Adsorption is an exothermic process i.e.  $\Delta H$  of adsorption is always negative. When a gas is adsorbed, the freedom of movement of its molecules becomes restricted i.e.  $\Delta S$  is negative. Hence adsorption accompanied by decrease in enthalpy as well as decrease in entropy of the system.
11. (d) The heat evolved in physisorption is quite low varying generally between  $20\text{--}40 \text{ kJ mol}^{-1}$ .
12. (c)      13. (b)      14. (a)      15. (d)      16. (b)
17. (a)      18. (b)
19. (d) According to Freundlich adsorption isotherm.

At intermediate pressure, extent of adsorption

$$\frac{x}{m} = kP^{1/n} \text{ or } \log \frac{x}{m} = \log k + \frac{1}{n} \log P;$$



plot of  $\log \frac{x}{m}$  vs  $\log P$  is linear with slope =  $\frac{1}{n}$

20. (a) Adsorption of a gas on solid is represented by following equilibria,



Gas adsorbed on solid + Heat

Initially adsorption increases with increase in pressure at a particular temperature then got slow. After attaining equilibrium adsorption become independent of pressure.

21. (d)

22. (a) According to Freundlich adsorption isotherm

$$\frac{x}{m} = kP^{1/n}$$

at low pressure  $\frac{1}{n} = 1$

$$\therefore \frac{x}{m} \propto P^1$$

at high pressure  $\frac{1}{n} = 0$

$$\frac{x}{m} \propto P^0$$

i.e., the value of  $n$  varies between 0 to 1.

23. (b) The gases having higher values for critical temperature are easily liquified and are adsorbed to the greater extent.  $\text{CO}_2$  has highest critical temperature of  $304\text{K}$ .

24. (b) According to Freundlich equation.

$$\frac{x}{m} \propto P^{1/n} \text{ or } \frac{x}{m} = Kp^{1/n}$$

$$\text{or } \log \frac{x}{m} = \log Kp^{1/n} \text{ or } \log \frac{x}{m} = \log K + \frac{1}{n} \log p$$

25. (a) According to Freundlich adsorption isotherm

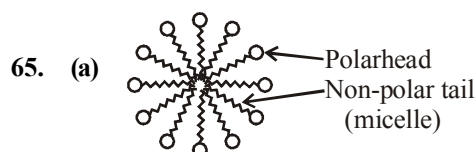
$$\frac{x}{m} = kp^{1/n} \text{ (where } n > 1)$$

At very high pressure  $x/m = kp^0$

26. (a) On increasing temperature adsorption of a gas on surface of solid decreases. Solid adsorb greater amount of substances at lower temperature.
27. (c)
28. (a) For adsorption to occur  $\Delta G = -ve$  as in adsorption  $\Delta H = -ve$ ,  $\Delta S = -ve$ .  $-\Delta S$  is positive for adsorption.
29. (d) For a reaction in equilibrium, the increase in rate of reaction in forward direction by catalyst increases the concentration of product(s) and thus the rate of backward reaction also increases with the same magnitude and allow the equilibrium to be achieved quickly.

30. (d) The catalytic poisons decrease the activity of the catalyst because they are preferentially adsorbed on the surface of catalyst.
31. (a) A catalyst increases the rate of reaction by decreasing the activation energy.
32. (c) Active charcoal has more adsorption power due to greater surface area.
33. (c) Adsorption theory is applied to heterogeneous catalysis.
34. (a) According to the adsorption theory of catalysis, the activity of catalysis is due to the presence of free valencies on its surface due to which surface of catalyst has chemical force of attraction. When a gas comes in contact with this surface molecules get attached attached through these valencies. Further the rate of reaction is always increases by decreases in activation energy. When any of the reactants is strongly adsorbed on the surface of catalyst, the rate becomes inversely proportional to the concentration of that reaction. The reaction is then said to be inhibited by such reactant. The lowering of activation energy always leads to the increase in speed of reaction.
35. (b) Catalyst decreases the activation energy of the reaction by forming an intermediate product. So no of molecules having activation energy increases hence rate of reaction increases.
36. (c) A catalyst can affect reversible reaction by attaining equilibria in both directions.
37. (d) In acid hydrolysis of methyl acetate all are present in one phase (liquid).
38. (d) Enzymes are specific biological catalysts possessing well - defined active sites.
39. (a) Enzymes are biological catalysts.
40. (d) Enzymes are biological catalysts and enhance the rate of biochemical reactions.
41. (c) Hydrolysis of urea can be represented as follows
- $$\text{H}_2\text{N}-\underset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{NH}_2 + \text{H}_2\text{O} \xrightarrow[\text{(enzyme)}]{\text{Urease}} 2\text{NH}_3 + \text{CO}_2$$
- Since it involves biological catalyst (enzyme) so it is an example of biochemical catalysis.
42. (d) Efficiency of catalysing property of a catalyst is inversely proportional to activation energy.
43. (b) Molybdenum acts as a promoter for iron which is used as a catalyst in Haber's process.
44. (c) Second step involves adsorption of reactant molecules on the surface of the catalyst.
45. (b)
46. (a) Milk is a emulsion in which liquid is dispersed in liquid.
47. (c) In butter (liquid – solid) water is dispersed in fat.
48. (c) Size of colloidal particles is  $10^{-5}$  -  $10^{-7}$  cm.
49. (a)
50. (d) Mist is a colloid (aerosol) in which liquid is dispersed in gas.
51. (c) Alloy is an example of solid solution.

- | Colloid  | Dispersed phase | Dispersion medium |
|----------|-----------------|-------------------|
| Sol      | Solid           | Liquid            |
| Gel      | Liquid          | Solid             |
| Emulsion | Liquid          | Liquid            |
| Foam     | Gas             | Liquid            |
52. (b)
53. (d) Emulsions are liquid-liquid colloidal systems, Generally one of the two liquids is water.
54. (b) Butter is an example of gel.
55. (c) Cheese is a liquid dispersed in solid phase.
56. (d) Air is a homogeneous mixture of gases, mainly nitrogen and oxygen.
57. (c) When the dispersed phase and dispersion medium both are liquid, the colloidal system is called as an emulsion like milk, vanishing cream etc.
58. (b) Cloud consists of fine droplets of water suspended in air.
59. (d) Blood is a -vely charged colloidal system. Rest of the compounds, i.e., NaCl, urea & cane sugar form true solution in water.
60. (a) Suspension particles are visible under a microscope and sometimes even to a naked eye.
61. (a) Fog is a colloidal system consisting water droplets dispersed in air.
62. (a) A collidal solution is biphasic and heterogeneous. It is composed of two phases :  
1. Dispersed phase; 2. Dispersion medium.
63. (c) Smoke is solid gas system, solid (D. P) and gas (D.M.)  
Note : D.P. : Dispersed phase  
D.M. : Dispersion medium
64. (c) The critical micelle concentration is the lowest concentration at which micelle formation appears when surfactants are present above that CMC, they can act as emulsifiers that will solubilise a compound which is normally insoluble in the solvent being used.



66. (a) Surface tension of lyophilic sols is lower than water (dispersion medium).
67. (b) Gum is lyophilic colloid.
68. (c) Lyophobic colloids are irreversible colloids. They are protected by lyophilic colloids.
69. (c) Example of multimolecular colloid system is a gold dispersed in water.
70. (a) On shaking with the dispersion medium, colloids directly form the colloidal sol. Hence they are called intrinsic colloids. i.e., glue.
71. (d) Sodium stearate is a soap. Soaps and detergents are surface agents which when dissolved in a medium, forms aggregated particles, called associated colloids.
72. (d) The formation of micelles takes place only above a particular temperature called kraft temperature ( $T_K$ ).

73. (c) Electrolytes are used for neutralising charge on colloidal particles.
74. (b) The osmotic pressure of sea water is 25 atm at 15°C. When pressure greater than 26 atm is applied on sea water separated by a rigid emipermeable membrane, pure water is obtained.
75. (c) Blood is purified by dialysis.
76. (a) The use of membrane for separating colloidal particles is termed as dialysis. Hence it is clear that colloidal particle cannot pass through animal membrane. Hence only solvent molecules and ions (in case of electrodialysis) can diffuse.
77. (d) Electrolytic (Ionic) impurities can be most easily removed on application of electric field.
78. (a) Formation of colloid from suspension is known as peptization.
79. (d) The separation of colloidal particles of molecular dimension is known as dialysis. It is a purification method of colloid.
80. (c) Electrodialysis involves movement of ions towards oppositely charged electrodes. Urea being a covalent compound does not dissociate to give ions and hence it cannot be removed by electrodialysis. However all the other given compounds are ionic which can undergo dissociation to give oppositely charged ions and thus can be separated.
81. (b) The motion of a liquid through a membrane under the influence of an applied electric field is known as electro-osmosis.
82. (d)
83. (c) Peptization comes under dispersion methods of preparation of colloids.
84. (c) Colloidal gold is prepared by Bredig's arc method.
85. (b) Peptisation is disintegration of colloidal aggregate.
86. (c) According to this law the coagulating effect of an ion on dispersed phase of opposite charge increases with the increase in valency of the ion. The precipitating power of  $\text{Al}^{3+}$ ,  $\text{Ba}^{++}$ ,  $\text{Na}^+$  ions is in order  $\text{Al}^{3+} > \text{Ba}^{2+} > \text{Na}^+$ .
87. (a) Tyndall effect is shown by sols.
88. (c) It is due to impact of molecules of dispersion medium on the colloidal particles.
89. (b) It is due to Tyndall effect.
90. (a) Tyndall effect is the simplest way to check colloidal system since path of light beam becomes visible due to scattering of light.
91. (d)  $\text{Fe}(\text{OH})_3$  is positive sol.  $\text{K}_3[\text{Fe}(\text{CN})_6]$  will provide  $[\text{Fe}(\text{CN})_6]^{3-}$  for coagulation having highest magnitude of -ve charge among given options.
92. (d) According to the Hardy schulze rule the coagulating effect of an ion on dispersed phase of opposite charge increases with the valency of the ion. Therefore more the charge on oppositely charged ion higher is the coagulation value.
93. (a) Smaller the charge on anion, lesser will be its coagulating power.  $\therefore$  KBr have  $\text{Br}^-$  with least charge of -1 on Br thus KBr is least effective in coagulating  $\text{Fe}(\text{OH})_3$ .
94. (b) 96. (a)
95. (b) The size of colloidal particles is between 1 nm and 1000 nm i.e., it is not always greater than 100 nm. So (b) is not a property of colloidal solution. All others are the properties of colloidal solution.
96. (a) According to Hardy-Schulze rule "The amount of electrolyte required to coagulate a fixed amount of a sol depends upon the sign of charge and valency of the flocculating ion." Thus, the coagulating power vary in the order.  $\text{Al}^{3+} > \text{Zn}^{++} > \text{Na}^+$
97. (c)
98. (d) A negative ion causes the precipitation of positively charged sol and *vice-versa*. Since  $\text{As}_2\text{S}_3$  is a negative sol so more will be the positive charge on cation more effective it will be in causing coagulation of  $\text{As}_2\text{S}_3$  sol. Among the given ions,  $\text{Al}^{3+}$  has the greatest valency and thus is the most effective coagulating agent.
99. (c) Electrodialysis involves movement of ions towards oppositely charged electrodes. Urea being a covalent compound does not dissociate to give ions and hence it cannot be removed by electrodialysis. However all the other given compounds are ionic which can undergo dissociation to give oppositely charged ions and thus can be separated.
100. (d) Brownian movement is exhibited by colloidal system.
101. (a) Brownian movement is random motion.
102. (c) Sugar forms homogeneous solution hence no Tyndall effect is exhibited.
103. (c) Emulsion show the tyndal! effect. Refers to ans 280.
104. (c)
105. (b) For gel dispersed phase is liquid and dispersion medium is solid.
106. (d) 109. (c) 110. (c)
107. (c) Protein is an emulsifying agent for O/W emulsion.
108. (d)
109. (c)
110. (c)
111. (c)
112. (d)

#### STATEMENT TYPE QUESTIONS

113. (d) Adsorption is a surface phenomenon.
114. (b) Statements (i) and (iv) are incorrect. A given surface of an adsorbent does not show any preference for a particular gas as the van der Waal's forces are universal. Finely divided metals are better adsorbent as compared to solid metals because they have large surface area and extent of adsorption increases with surface area.
115. (a) As chemisorption involves compound formation, it is usually irreversible in nature.
116. (a)
117. (c) Zeolites are found in nature as well as synthesised for catalytic selectivity.



118. (b) Optimum pH for the enzyme catalysis is 5-7. Catalyst used in Ostwald's process is platinised asbestos at 573 K.
119. (b)  $S_8$  forms a multimolecular colloid. Micelles are formed above Kraft temperature and above a particular concentration called Critical Micelle Concentration (CMC).
120. (a) Values of colligative properties for colloids are of small order as compared to values shown by true solution. Most acceptable phenomena to account for the charge of sol particles in preferential adsorption.

### MATCHING TYPE QUESTIONS

121. (a) 122. (a)  
123. (a) (A)  $V_2O_5$  is used as a catalyst during the preparation of  $H_2SO_4$   
(B) Ziegler-Natta is used as a catalyst during the preparation of HDPE.  
(C) Peroxide is used as a catalyst during the preparation of polyacrylonitrile.  
(D) Finely divided Fe is used as a catalyst during the preparation of ammonia.
124. (a) 125. (d) 126. (a) 127. (a) 128. (c)  
129. (a) 130. (b)  
131. (d) Argyrol is used as an eye lotion.  
Antimony is used in Kalazar.  
Colloidal gold is used in intramuscular injection.  
Milk of magnesia is used in the stomach disorder.

### ASSERTION-REASON TYPE QUESTIONS

132. (c) Assertion is true, reason is false. When several lines have the same value of  $\frac{1}{n}$ , then the lines by which their adsorption isotherms can be represented will be parallel and will not meet at a point.
133. (d) Assertion is false but Reason is true. The enthalpy of chemisorption is of the order of 40 - 400  $\text{kJmol}^{-1}$  while for physical adsorption it is of the order of 20 - 40  $\text{kJmol}^{-1}$ .
134. (c) Assertion is true but Reason is false. Freundlich adsorption isotherm gives an empirical relationship between the quantity of gas adsorbed by unit mass of solid adsorbent and pressure at a particular temperature.
135. (a) 136. (c)  
137. (a) Colligative properties depend upon number of particles.

### CRITICAL THINKING TYPE QUESTIONS

138. (c) Adsorption is an exothermic process, hence  $\Delta H$  will always be negative.

139. (c) Physical adsorption involves weak forces, physical in nature with small heat of adsorption. Thus low temperature and high pressure favours physical adsorption.

140. (a)

141. (b) The adsorption of methylene blue on activated charcoal is an example of physisorption which is exothermic, multilayer and does not have energy barrier.

142. (d) Freundlich's isothermal adsorption equation can be given as

$$\frac{x}{m} = kp^{1/n}$$

$$\log \frac{x}{m} = \log k + \frac{1}{n} \log p; \text{ slope} = \frac{1}{n} = 0$$

$$\text{Thus, } \frac{x}{m} = kp^0$$

143. (d)

144. (c) Both adsorption and absorption can take place simultaneously. The term sorption is used to describe both the processes.

145. (c) Homogenous catalysis does not involve adsorption.

146. (b) A catalyst can not initiate a reaction.

147. (a)

148. (d) Enzymes are most reactive at optimum temperature. The optimum temperature for enzyme activity lies between 40°C to 60°C.

149. (c)  $V_2O_5$  is used as catalyst in contact process of manufacturing  $H_2SO_4$ .

150. (c) The theory of heterogeneous catalysis is based upon the phenomenon of adsorption. The activity of catalyst is due to the presence of free valencies on its surface due to which surface of catalyst has force of attraction.

151. (b) ZSM-5 is a shape selective catalyst. Zeolites are good shape selective catalysts because of the honey comb like structure.

152. (b) Given reactions show that the selectivity of different catalysts for same reactants is different.

153. (a) Soap lather is a colloid containing gas as a dispersed phase and liquid as a dispersion medium.

154. (a) Chlorophyll. Smoke is an example of solid-gas colloid system. Ruby glass is an example of solid-solid colloid system. Milk is a liquid-liquid colloid system.

155. (c) Starch molecules have colloidal dimensions whereas NaCl, glucose and  $Ba(NO_3)_2$  are crystalloids and soluble in water.

156. (d) Cetyl trimethyl ammonium bromide,



157. (d) Linseed oil, lanolin and glycogen attract water hence contain a hydrophilic structure but rubber does not attract water and thus does not contain a hydrophobic structure.

- 158. (a)** Multimolecular colloids consist of aggregates of atoms or small molecules. Sulphur sol is an example of multimolecular colloids
- 159. (b)** Bredig's arc method is suitable for the preparation of colloidal solution of metals like gold, silver, platinum etc. An arc is struck between the metal electrode under the surface of water containing some stabilizing agent such as a trace of KOH. However, Fe does not react with alkalies that is why it is not obtained by Bredig's-arc method.
- 160. (d)** Colloidal solutions are not purified by electrophoresis. Movement of colloidal particles under the influence of electric field is called electrophoresis. So, it can make easier. Electrophoresis is the property of colloids not the purification method.
- 161. (d)** Gold by Bredig's method (Dispersion method) and by reduction method  

$$\text{AuCl}_3 + \text{Tannic acid} \rightarrow \text{Gold sol}$$
- 162. (a)** Proteins are coagulated by some heavy metal ions like  $\text{Ag}^+$ ,  $\text{Hg}^{2+}$  and  $\text{Pb}^{2+}$ .
- 163. (d)**  $\text{Al}(\text{OH})_3$  is a positive sol so salt having anion with maximum negative charged (i.e. phosphate ion) will be most effective in coagulation.
- 164. (a)** Colloid of liquid in liquid is called emulsion. Colloid of liquid in solid is gel.
- 165. (b)** When oppositely charged sols are mixed their charges are neutralised. Both sols may be partially or completely precipitated.
- 166. (c)** As colloidal particles move towards anode so these particles are negatively charged and coagulated by cations of electrolyte.  
 According to Hardy Schulze rule,  
 Coagulation power  $\propto$  charge of ion  
 $\therefore$  Order of coagulation power is  $\text{Al}^{3+} > \text{Ba}^{2+} > \text{Na}^+$
- 167. (b)** In first case the given compounds have same anion but different cations having different charge hence they will precipitate negatively charged sol i.e. 'A'.  
 In second case the given compounds have similar cation but different anion with different charge. Hence they will precipitate positively charged sol. i.e. 'B'.
- 168. (b)** Brownian movement is zig zag motion of sol particles.
- 169. (a)**      **170. (a)**      **171. (b)**
- 172. (c)** A gas mixed with another gas forms a homogeneous mixture and hence is not a colloidal system.
- 173. (d)** Tannin used in leather industry contains negatively charged colloidal particles.
- 174. (b)** Gold sol is prepared by reduction as  

$$2\text{AuCl}_3 + 3\text{HCHO} + 3\text{H}_2\text{O} \xrightarrow{\text{Reduction}} 2\text{Au}(\text{sol}) + 3\text{HCOOH} + 6\text{HCl}$$
- 175. (b)** Eosin dye, sol of charcoal,  $\text{As}_2\text{S}_3$  and copper sol are example of negatively charged sol.

## CHAPTER 20

# GENERAL PRINCIPLES AND PROCESSES OF ISOLATION OF ELEMENTS

### FACT/DEFINITION TYPE QUESTIONS

- Which one of the following is an ore of silver ?  
(a) Argentite (b) Stibnite  
(c) Haematite (d) Bauxite
- Cinnabar is an ore of  
(a) Hg (b) Cu  
(c) Pb (d) Zn
- An example of an oxide ore is  
(a) Bauxite (b) Malachite  
(c) Zinc blende (d) Feldspar
- The natural materials from which an element can be extracted economically are called  
(a) ores (b) minerals  
(c) gangue (d) None of these
- The most abundant metal on the surface of the earth is  
(a) Fe (b) Al  
(c) Ca (d) Na
- Which of the following is an ore of tin ?  
(a) Carborundum (b) Epsomite  
(c) Cassiterite (d) Spodumene
- Which of the following is chalcopyrite?  
(a)  $\text{CuFeS}_2$  (b)  $\text{FeS}_2$   
(c)  $\text{KMgCl}_3 \cdot 6\text{H}_2\text{O}$  (d)  $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
- Haematite is the ore of  
(a) Pb (b) Cu  
(c) Fe (d) Au
- Composition of azurite mineral is  
(a)  $\text{CuCO}_3 \cdot \text{CuO}$  (b)  $\text{Cu}(\text{HCO}_3)_2 \cdot \text{Cu}(\text{OH})_2$   
(c)  $2\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$  (d)  $\text{CuCO}_3 \cdot 2\text{Cu}(\text{OH})_2$
- Which one of the following is a mineral of iron ?  
(a) Malachite (b) Cassiterite  
(c) Pyrolusite (d) Magnetite
- All ores are minerals, while all minerals are not ores because  
(a) the metal can't be extracted economically from all the minerals  
(b) minerals are complex compounds  
(c) the minerals are obtained from mines  
(d) all of these are correct
- Which one of the following is not a sulphide ore?  
(a) Magnetite (b) Iron pyrites  
(c) Copper glance (d) Sphalerite
- The impurities associated with mineral used in metallurgy are called collectively?  
(a) Slag (b) Flux  
(c) Gangue (d) Ore
- The most abundant element in the earth's crust (by weight) is  
(a) Si (b) Al  
(c) O (d) Fe
- Malachite is an ore of  
(a) iron (b) copper  
(c) mercury (d) zinc
- Cassiterite is an ore of  
(a) Mn (b) Ni  
(c) Sb (d) Sn
- Galena is an ore of  
(a) Pb (b) Hg  
(c) Zn (d) None of these
- The metal always found in the free states is  
(a) Au (b) Ag  
(c) Cu (d) Na
- Matrix is defined as –  
(a) the unwanted foreign material present in the ore  
(b) the flux added to remove the unwanted impurities from ore  
(c) the slag formed as a result of the reaction of flux with gangue  
(d) the material used in the reduction of metal oxide to metal
- Which of the following pair is incorrectly matched ?  
(a) Magnetite –  $\text{Fe}_3\text{O}_4$  (b) Copper glance –  $\text{Cu}_2\text{S}$   
(c) Calamine –  $\text{ZnCO}_3$  (d) Zincite –  $\text{ZnS}$
- Which one of the following ores is best concentrated by froth-flotation method ?  
(a) Galena (b) Cassiterite  
(c) Magnetite (d) Malachite
- Froth floatation process is used for the metallurgy of  
(a) chloride ores (b) amalgams  
(c) oxide ores (d) sulphide ores

23. Cassiterite is concentrated by
  - (a) levigation
  - (b) electromagnetic separation
  - (c) floatation
  - (d) liquefaction
24. While extracting an element from its ore, the ore is grounded and leached with dil. potassium cyanide solution to form the soluble product potassium argento cyanide. The element is
  - (a) Lead
  - (b) Chromium
  - (c) Manganese
  - (d) Silver
25. The method of concentrating the ore which makes use of the difference in density between ore and impurities is called
  - (a) levigation
  - (b) leaching
  - (c) magnetic separation
  - (d) liquifaction
26. Leaching is a process of
  - (a) reduction
  - (b) concentration
  - (c) refining
  - (d) oxidation
27. Which one of the following ores is concentrated by chemical leaching method?
  - (a) Galena
  - (b) Copper pyrite
  - (c) Cinnabar
  - (d) Argentite
28. Electromagnetic separation is used in the concentration of
  - (a) copper pyrites
  - (b) bauxite
  - (c) cassiterite
  - (d) cinnabar
29. For which ore of the metal, froth floatation method is used for concentration?
  - (a) Horn silver
  - (b) Bauxite
  - (c) Cinnabar
  - (d) Heamatite
30. Which of the following metal is leached by cyanide process ?
  - (a) Ag
  - (b) Na
  - (c) Al
  - (d) Cu
31. Which one of the following ores is not concentrated by froth floatation process?
  - (a) Copper pyrites
  - (b) Pyrargyrite
  - (c) Pyrolusite
  - (d) Zinc blende
32. In froth flotation process many chemicals (frother, collector, activator, and depressant) are used. Which of the following is a frother ?
  - (a)  $\text{CuSO}_4$
  - (b)  $\text{NaCN} + \text{alkali}$
  - (c) Pine oil
  - (d) Potassium xanthate
33. Froth flotation process is based on
  - (a) wetting properties of ore particle
  - (b) specific gravity of ore particles
  - (c) magnetic properties of ore particles
  - (d) electrical properties of ore particles
34. In the froth flotation process of concentration of ores, the ore particles float because they:
  - (a) are light
  - (b) are insoluble
  - (c) have the surface which is not wetted easily
  - (d) have a constant electrical charge
35. Main function of roasting is
  - (a) to remove volatile substances
  - (b) oxidation
  - (c) reduction
  - (d) slag formation
36. Roasting is generally done in case of the
  - (a) oxide ores
  - (b) silicate ores
  - (c) sulphide ores
  - (d) carbonate ores
37. Heating of pyrites in air for oxidation of sulphur is called
  - (a) roasting
  - (b) calcination
  - (c) smelting
  - (d) slagging
38. The role of calcination in metallurgical operations is
  - (a) to remove moisture
  - (b) to decompose carbonates
  - (c) to drive off organic matter
  - (d) to decompose carbonates and drive off moisture and organic matter
39. General method for the extraction of metal from oxide ore is
  - (a) carbon reduction
  - (b) reduction by aluminium
  - (c) reduction by hydrogen
  - (d) electrolytic reduction
40. Function of the flux added during smelting is
  - (a) to make ore porous
  - (b) to remove gangue
  - (c) to make reduction easier
  - (d) to precipitate slag
41. Process followed before reduction of carbonate ore is
  - (a) calcination
  - (b) roasting
  - (c) liquation
  - (d) polling
42. Calcination is the process in which :
  - (a) ore is heated above its melting point to expel  $\text{H}_2\text{O}$  or  $\text{CO}_2$  or  $\text{SO}_2$
  - (b) ore is heated below its melting point to expel volatile impurities
  - (c) ore is heated above its melting point to remove S, As and Sb as  $\text{SO}_2$ ,  $\text{As}_2\text{O}_3$  and  $\text{Sb}_2\text{O}_3$  respectively
  - (d) ore is heated below its melting point to expel  $\text{H}_2\text{O}$  or  $\text{CO}_2$
43. When a metal is to be extracted from its ore and the gangue associated with the ore is silica, then
  - (a) an acidic flux is needed
  - (b) a basic flux is needed
  - (c) both acidic and basic fluxes are needed
  - (d) Neither of them is needed
44. Which of the following fluxes is used to remove acidic impurities in metallurgical process?
  - (a) Silica
  - (b) Lime stone
  - (c) Sodium chloride
  - (d) Sodium carbonate

45. Which of the following reactions is an example for calcination process ?  
 (a)  $2\text{Ag} + 2\text{HCl} + (\text{O}) \rightarrow 2\text{AgCl} + \text{H}_2\text{O}$   
 (b)  $2\text{Zn} + \text{O}_2 \rightarrow 2\text{ZnO}$   
 (c)  $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2$   
 (d)  $\text{MgCO}_3 \rightarrow \text{MgO} + \text{CO}_2$
46. After partial roasting the sulphide of copper is reduced by  
 (a) cyanide process (b) electrolysis  
 (c) reduction with carbon (d) self reduction
47. Hydro-metallurgical process of extraction of metals is based on  
 (a) complex formation (b) hydrolysis  
 (c) dehydration (d) dehydrogenation
48.  $2\text{CuFeS}_2 + \text{O}_2 \longrightarrow \text{Cu}_2\text{S} + 2\text{FeS} + \text{SO}_2$   
 Which process of metallurgy of copper is represented by above equation?  
 (a) Concentration (b) Roasting  
 (c) Reduction (d) Purification
49. Which of the following is not used as a collector ?  
 (a) Pine oil (b) Xanthates  
 (c) Cresols (d) Fatty acids
50. Which of the following reaction represents calcination process ?  
 (a)  $2\text{PbS} + 3\text{O}_2 \longrightarrow 2\text{PbO} + 2\text{SO}_2$   
 (b)  $\text{CaCO}_3 \cdot \text{MgCO}_3(\text{s}) \longrightarrow \text{CaO}(\text{s}) + \text{MgO}(\text{s}) + 2\text{CO}_2(\text{g})$   
 (c)  $\text{ZnO} + \text{C} \xrightarrow{\text{coke, 1673K}} \text{Zn} + \text{CO}$   
 (d)  $\text{Fe}_2\text{O}_3 + \text{CO} \longrightarrow 2\text{FeO} + \text{CO}_2$
51. According to Ellingham diagram, the oxidation reaction of carbon to carbon monoxide may be used to reduce which one of the following oxides at the lowest temperature ?  
 (a)  $\text{Al}_2\text{O}_3$  (b)  $\text{Cu}_2\text{O}$   
 (c)  $\text{MgO}$  (d)  $\text{ZnO}$
52. Which of the following condition favours the reduction of a metal oxide to metal?  
 (a)  $\Delta H = +\text{ve}$ ,  $T\Delta S = +\text{ve}$  at low temperature  
 (b)  $\Delta H = +\text{ve}$ ,  $T\Delta S = -\text{ve}$  at any temperature  
 (c)  $\Delta H = -\text{ve}$ ,  $T\Delta S = -\text{ve}$  at high temperature  
 (d)  $\Delta H = -\text{ve}$ ,  $T\Delta S = +\text{ve}$  at any temperature
53. Ellingham diagram normally consists of plots of  
 (a)  $\Delta S^\circ$  vs  $T$  (b)  $\Delta_f G^\circ$  vs  $\Delta S^\circ$   
 (c)  $\Delta G^\circ$  vs  $T$  (d)  $\Delta H^\circ$  vs  $\Delta T$
54.  $\Delta G^\circ$  vs  $T$  plot in the Ellingham's diagram slopes downward for the reaction  
 (a)  $\text{Mg} + \frac{1}{2}\text{O}_2 \rightarrow \text{MgO}$  (b)  $2\text{Ag} + \frac{1}{2}\text{O}_2 \rightarrow \text{Ag}_2\text{O}$   
 (c)  $\text{C} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}$  (d)  $\text{CO} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}_2$
55. In the blast furnace iron oxide is reduced by  
 (a) silica (b) CO  
 (c) carbon (d) limestone
56. Furnaces are lined with calcium oxide because  
 (a) it gives off oxygen on heating  
 (b) it gives strong light on heating  
 (c) it is refractory and basic  
 (d) it is not affected by acids
57. The following reactions take place in the blast furnace in the preparation of impure iron. Identify the reaction pertaining to the formation of the slag.  
 (a)  $\text{Fe}_2\text{O}_3(\text{s}) + 3\text{CO}(\text{g}) \rightarrow 2\text{Fe}(\text{l}) + 3\text{CO}_2(\text{g})$   
 (b)  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$   
 (c)  $\text{CaO}(\text{s}) + \text{SiO}_2(\text{s}) \rightarrow \text{CaSiO}_3(\text{s})$   
 (d)  $2\text{C}(\text{s}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}(\text{g})$
58. Refractory materials are generally used in furnaces because  
 (a) they possess great structural strength  
 (b) they can withstand high temperature  
 (c) they are chemically inert  
 (d) they do not require replacement
59. Which of the following reactions taking place in the blast furnace during extraction of iron is endothermic?  
 (a)  $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$   
 (b)  $2\text{C} + \text{O}_2 \rightarrow 2\text{CO}$   
 (c)  $\text{C} + \text{O}_2 \rightarrow \text{CO}_2$   
 (d)  $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
60. Cast iron is  
 (a) made by melting pig iron with scrap iron and coke using hot air blast  
 (b) having slightly lower carbon content (about 3%) as compared to pig iron  
 (c) extremely hard and brittle  
 (d) All of the above statements are true
61. In the extraction of copper from its sulphide ore, the metal is finally obtained by the reduction of cuprous oxide with :  
 (a) Copper (I) sulphide ( $\text{Cu}_2\text{S}$ )  
 (b) Sulphur dioxide ( $\text{SO}_2$ )  
 (c) Iron sulphide ( $\text{FeS}$ )  
 (d) Carbon monoxide ( $\text{CO}$ )
62. Extraction of zinc from zinc blende is achieved by  
 (a) electrolytic reduction  
 (b) roasting followed by reduction with carbon  
 (c) roasting followed by reduction with another metal  
 (d) roasting followed by self-reduction
63. In the extraction of Cu, the metal is formed in the bessemer converter due to the reaction :  
 (a)  $\text{Cu}_2\text{S} + 2\text{Cu}_2\text{O} \longrightarrow 6\text{Cu} + \text{SO}_2$   
 (b)  $\text{Cu}_2\text{S} \longrightarrow 2\text{Cu} + \text{S}$   
 (c)  $\text{Fe} + \text{Cu}_2\text{O} \longrightarrow 2\text{Cu} + \text{FeO}$   
 (d)  $2\text{Cu}_2\text{O} \longrightarrow 4\text{Cu} + \text{O}_2$
64. Aluminothemic process is used for the extraction of metals, whose oxides are  
 (a) fusible  
 (b) not easily reduced by carbon  
 (c) not easily reduced by hydrogen  
 (d) strongly basic



65. Electrometallurgical process is used to extract  
(a) Fe (b) Pb  
(c) Na (d) Ag
66. The electrolytic method of reduction is employed for the preparation of metals that  
(a) are weakly electropositive  
(b) are moderately electropositive  
(c) are strongly electropositive  
(d) form oxides
67. Aluminium is extracted from alumina ( $\text{Al}_2\text{O}_3$ ) by electrolysis of a molten mixture of  
(a)  $\text{Al}_2\text{O}_3 + \text{HF} + \text{NaAlF}_4$   
(b)  $\text{Al}_2\text{O}_3 + \text{CaF}_2 + \text{NaAlF}_4$   
(c)  $\text{Al}_2\text{O}_3 + \text{Na}_3\text{AlF}_6 + \text{CaF}_2$   
(d)  $\text{Al}_2\text{O}_3 + \text{KF} + \text{Na}_3\text{AlF}_6$
68. In the extraction of aluminium by Hall-Heroult process, purified  $\text{Al}_2\text{O}_3$  is mixed with  $\text{CaF}_2$  to  
(i) lower the melting point of  $\text{Al}_2\text{O}_3$ .  
(ii) increase the conductivity of molten mixture.  
(iii) reduce  $\text{Al}^{3+}$  into  $\text{Al(s)}$ .  
(iv) acts as catalyst.  
(a) (i) and (ii) (b) (i), (ii) and (iii)  
(c) (iii) and (iv) (d) (ii), (iii) and (iv)
69. In the extraction of chlorine by electrolysis of brine \_\_\_\_\_.  
(a) oxidation of  $\text{Cl}^-$  ion to chlorine gas occurs.  
(b) reduction of  $\text{Cl}^-$  ion to chlorine gas occurs.  
(c) For overall reaction  $\Delta G^\ominus$  has negative value.  
(d) a displacement reaction takes place.
70. Brine is electrolysed by using inert electrodes. The reaction at anode is \_\_\_\_\_.  
(a)  $\text{Cl}^-(\text{aq.}) \longrightarrow \frac{1}{2}\text{Cl}_2(\text{g}) + \text{e}^-$ ;  $E_{\text{Cell}}^\ominus = 1.36\text{V}$   
(b)  $2\text{H}_2\text{O(l)} \longrightarrow \text{O}_2(\text{g}) + 4\text{H}^+ + 4\text{e}^-$ ;  $E_{\text{Cell}}^\ominus = 1.23\text{V}$   
(c)  $\text{Na}^+(\text{aq.}) + \text{e}^- \longrightarrow \text{Na(s)}$ ;  $E_{\text{Cell}}^\ominus = 2.71\text{V}$   
(d)  $\text{H}^+(\text{aq.}) + \text{e}^- \longrightarrow \frac{1}{2}\text{H}_2(\text{g})$ ;  $E_{\text{Cell}}^\ominus = 0.00\text{V}$
71. Blister copper is  
(a) Impure Cu (b) Cu alloy  
(c) Pure Cu (d) Cu having 1% impurity
72. The furnace used to prepare commercial iron is lined with which of the following ?  
(a) Haematite (b) Magnetite  
(c) Ironpyrites (d) Both (a) and (b)
73. Which form of the iron contains 4% carbon ?  
(a) Cast iron (b) Pig iron  
(c) Wrought iron (d) Both (a) and (b)
74. Which of the following reaction takes place in blast furnace during extraction of copper ?  
(a)  $2\text{Cu}_2\text{S} + 3\text{O}_2 \longrightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$   
(b)  $2\text{FeS} + 3\text{O}_2 \longrightarrow 2\text{FeO} + 2\text{SO}_2$   
(c)  $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \longrightarrow 6\text{Cu} + \text{SO}_2$   
(d) All of these
75. The main reactions occurring in blast furnace during extraction of iron from haematite are \_\_\_\_\_.  
(i)  $\text{Fe}_2\text{O}_3 + 3\text{CO} \longrightarrow 2\text{Fe} + 3\text{CO}_2$   
(ii)  $\text{FeO} + \text{SiO}_2 \longrightarrow \text{FeSiO}_3$   
(iii)  $\text{Fe}_2\text{O}_3 + 3\text{C} \longrightarrow 2\text{Fe} + 3\text{CO}$   
(iv)  $\text{CaO} + \text{SiO}_2 \longrightarrow \text{CaSiO}_3$   
(a) (i) and (iii) (b) (ii) and (iv)  
(c) (i) and (iv) (d) (i), (ii) and (iii)
76. The process of zone refining is used in the purification of  
(a) Si (b) Al  
(c) Ag (d) Cu
77. Van Arkel method of purification of metals involves converting the metal to a  
(a) volatile stable compound  
(b) volatile unstable compound  
(c) non volatile stable compound  
(d) None of the above
78. The method not used in metallurgy to refine the impure metal is  
(a) Mond's process  
(b) Van-Arkel process  
(c) Amalgamation process  
(d) Liquation
79. Which of the following pairs of metals is purified by van Arkel method ?  
(a) Ga and In (b) Zr and Ti  
(c) Ag and Au (d) Ni and Fe
80. The method of zone refining of metals is based on the principle of  
(a) greater solubility of the impurities in the molten state than in the solid  
(b) greater mobility of the pure metal than that of the impure  
(c) higher melting point of the impurities than that of the pure metal  
(d) greater noble character of the solid metal than that of the impurities
81. Method used for obtaining highly pure silicon which is used as a semiconductor material, is  
(a) oxidation (b) electrochemical  
(c) crystallization (d) zone refining
82. What is anode mud?  
(a) Fan of anode  
(b) Metal of anode  
(c) Impurities collected at anode in electrolysis during purification of metals  
(d) All of these
83. The process of zone refining is used in the purification of  
(a) Si (b) Al  
(c) Ag (d) Cu

84. Which of the following statements regarding chromatography is incorrect ?
- It is based on the principle that different components of mixture gets adsorbed differently on an adsorbent
  - Column chromatography involves column of  $\text{Al}_2\text{O}_3$  in a glass tube as a stationary phase.
  - The mobile phase may be a gas, a liquid or a solid.
  - Component which is more soluble is stationary phase takes longer time to travel.
85. Which of the following metal is used in the manufacture of dye-stuffs and paints ?
- Copper
  - Zinc
  - Aluminium
  - Magnesium

### STATEMENT TYPE QUESTIONS

86. Read the following statements
- Magnetic separation method is employed when one component either ore or gangue is magnetic in nature.
  - Depressant  $\text{NaCN}$  used in case of ore containing mixture of  $\text{ZnS}$  and  $\text{PbS}$  allows  $\text{ZnS}$  to come with froth and prevents  $\text{PbS}$  from coming to the froth.
  - For concentration powdered bauxite ore is digested with conc.  $\text{NaOH}$  at 473–523K and 35–36 bar pressure.
- Which of the following is the correct code for the statements above ?
- TFT
  - TTF
  - FTF
  - FFT
87. Which of the following statements related to Ellingham diagrams are correct ?
- It provides a sound basis for the choice of reducing agent in the reduction of oxides.
  - Each Ellingham plot is represented by a straight line untill unless there is some change in phase i.e. solid  $\rightarrow$  liquid, liquid  $\rightarrow$  gas and gas  $\rightarrow$  liquid occurs.
  - Diagrams similar to Ellingham can be constructed for sulphides and halides which clearly indicates why reduction of  $\text{M}_x\text{S}$  is difficult in comparison to  $\text{M}_x\text{O}$ .
  - Ellingham diagrams predicts the tendency of reduction with a reducing agent and kinetics of the reduction process.
- (i), (ii) and (iii)
  - (i) and (iii)
  - (i), (ii) and (iv)
  - (ii) and (iv)
88. Which of the following statement(s) is/are correct ?
- Cast iron is used in the manufacture of railway sleepers
  - Wrought iron is used in the manufacture of anchors, bolts, chains etc.
  - Nickel steel is used in making pendulums.
- Only (i)
  - (i) and (ii)
  - (i), (ii) and (iii)
  - Only (iii)

89. Read the following statements
- The principle that the impurities are more soluble in the melt than in the solid state is used in the manufacture of high purity semiconductors.
  - Van Arkel method of refining Zr involves heating of crude metal with  $\text{Cl}_2$  to form corresponding halide.
  - Mond process for refining of nickel involves formation of metal carbonyls as an intermediate.
- Which of the following is the correct code for the statements above ?
- TTT
  - FFT
  - TFT
  - FTF

### MATCHING TYPE QUESTIONS

90. Match the columns
- | Column - I   | Column - II                 |
|--|-----------------------------|
| (A) $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}(\text{s}) \xrightarrow{\Delta} \text{Fe}_2\text{O}_3(\text{s}) + x\text{H}_2\text{O}(\text{g})$ | (p) Slag formation          |
| (B) $\text{FeO} + \text{SiO}_2 \longrightarrow \text{FeSiO}_3$   | (q) Reduction of iron oxide |
| (C) Discharge gas produced during this process is utilised in manufacture of $\text{H}_2\text{SO}_4$ .   | (r) Calcination             |
| (D) $\text{Fe}_2\text{O}_3 + 3\text{C} \longrightarrow 2\text{Fe} + 3\text{CO}$  | (s) Roasting                |
| (a) A – (r), B – (p), C – (s), D – (q)   |                             |
| (b) A – (p), B – (r), C – (s), D – (q)   |                             |
| (c) A – (r), B – (s), C – (p), D – (q)   |                             |
| (d) A – (r), B – (p), C – (q), D – (s)   |                             |
91. Match the columns
- | Column - I  | Column - II                                     |
|---|---|
| (A) According to $\Delta_r G^\ominus$ vs T graph, oxide of this metal can be easily reduced to corresponding metal by heating with coke | (p) Sulphur oxide                               |
| (B) Substance responsible for the blistered appearance of the copper obtained as result of extraction of copper from cuprous oxide      | (q) Copper                                      |
| (C) Metal which during purification is distilled off and collected by rapid chilling  | (r) $\text{Na}_3\text{AlF}_6$ or $\text{CaF}_2$ |
| (D) On addition to $\text{Al}_2\text{O}_3$ its melting point gets reduced and conductivity gets enhanced                                | (s) Zinc  |
| (a) A – (p), B – (q), C – (s), D – (r)  |   |
| (b) A – (q), B – (s), C – (p), D – (r)  |   |
| (c) A – (q), B – (p), C – (s), D – (r)  |   |
| (d) A – (q), B – (p), C – (r), D – (s)  |   |

92. Match the columns.

Column-I	Column-II
(A) Blistered Cu	(p) Aluminium
(B) Blast furnace	(q) $2\text{Cu}_2\text{O} + \text{Cu}_2\text{S} \rightarrow 6\text{Cu} + \text{SO}_2$
(C) Reverberatory furnace	(r) Iron
(D) Hall-Heroult process	(s) $\text{FeO} + \text{SiO}_2 \rightarrow \text{FeSiO}_3$
	(t) $2\text{Cu}_2\text{S} + 3\text{O}_2 \rightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$
(a) A – (q), B – (r), C – (s), D – (p)	
(b) A – (p), B – (q), C – (r), D – (t)	
(c) A – (t), B – (s), C – (r), D – (q)	
(d) A – (s), B – (t), C – (r), D – (q)	

93. Match the columns.

Column-I	Column-II
(A) Coloured bands	(p) Zone refining
(B) Impure metal to volatile complex	(q) Fractional distillation
(C) Purification of Ge and Si	(r) Mond Process
(D) Purification of mercury	(s) Chromatography
	(t) Liquation
(a) A – (p), B – (q), C – (s), D – (t)	
(b) A – (s), B – (r), C – (p), D – (q)	
(c) A – (r), B – (s), C – (p), D – (q)	
(d) A – (t), B – (s), C – (r), D – (q)	

94. Match the columns.

Column-I	Column-II
(A) Cyanide process	(p) Ultrapure Ge
(B) Froth Floatation Process	(q) Dressing of ZnS
(C) Electrolytic reduction	(r) Extraction of Al
(D) Zone refining	(s) Extraction of Au
	(t) Purification of Ni
(a) A – (s), B – (q), C – (r), D – (p)	
(b) A – (q), B – (r), C – (p), D – (t)	
(c) A – (p), B – (q), C – (r), D – (s)	
(d) A – (r), B – (s), C – (t), D – (p)	

95. Match the columns

Column-I	Column-II
(A) Cyanide process	(p) Ultrapure Ge
(B) Floatation process	(q) Pine oil
(C) Electrolytic reduction	(r) Extraction of Al
(D) Zone refining	(s) Extraction of Au
(a) A – (r), B – (p), C – (s), D – (q)	
(b) A – (s), B – (q), C – (r), D – (p)	
(c) A – (r), B – (q), C – (s), D – (p)	
(d) A – (s), B – (p), C – (r), D – (q)	

96. Match the columns

Column-I	Column-II
(A) Distillation	(p) Zr
(B) Electrolytic refining	(q) Ga
(C) Liquation	(r) Cu
(D) Zone refining	(s) Hg
(E) Vapour phase refining	(t) Sn

- (a) A – (r), B – (s), C – (t), D – (q), E – (p)  
 (b) A – (s), B – (r), C – (t), D – (q), E – (p)  
 (c) A – (s), B – (t), C – (r), D – (q), E – (p)  
 (d) A – (s), B – (r), C – (p), D – (q), E – (t)

97. Match the columns

Column-I	Column-II
(A) This metal is used in extraction of chromium and manganese.	(p) Zinc
(B) Common metal in brass and bronze.	(q) Aluminium
(C) Common metal in brass and german silver.	(r) Copper
(D) Substance used in making cycles, automobiles, utensils, etc.	(s) Stainless steel
(a) A – (q), B – (r), C – (p), D – (s)	
(b) A – (r), B – (q), C – (p), D – (s)	
(c) A – (q), B – (p), C – (r), D – (s)	
(d) A – (q), B – (r), C – (s), D – (p)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

98. **Assertion :** Levigation is used for the separation of oxide ores from impurities.

**Reason :** Ore particles are removed by washing in a current of water.

99. **Assertion :** Zinc can be used while copper cannot be used in the recovery of Ag from the complex  $[\text{Ag}(\text{CN})_2]^-$ .

**Reason :** Zinc is a powerful reducing agent than copper.

100. **Assertion :** Leaching is a process of reduction.

**Reason :** Leaching involves treatment of the ore with a suitable reagent so as to make it soluble while impurities remains insoluble.

101. **Assertion :** Coke and flux are used in smelting.

**Reason :** The phenomenon in which ore is mixed with suitable flux and coke is heated to fusion is known as smelting.

102. **Assertion :** Copper obtained after bessemerization is known as blister copper.

**Reason :** Blisters are produced on the surface of the metal due to escaping of dissolved  $\text{SO}_2$ .

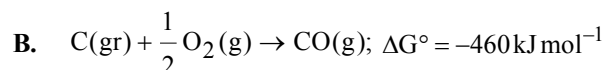
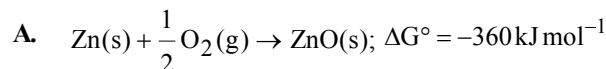
103. **Assertion :** Lead, tin and bismuth are purified by liquation method.

**Reason :** Lead, tin and bismuth have low m.p. as compared to impurities.

**CRITICAL THINKING TYPE QUESTIONS**

104. Copper can be extracted from  
 (a) Kupfernickel (b) Dolomite  
 (c) Malachite (d) Galena
105. Which of the following metal is correctly matched with its ore?
- | Metal         | Ore         |
|---------------|-------------|
| (a) Zinc      | Calamine    |
| (b) Silver    | Ilmenite    |
| (c) Magnesium | Cassiterite |
| (d) Tin       | Azurite     |
106. Which ore contains both iron and copper?  
 (a) Cuprite (b) Chalcocite  
 (c) Chalcopyrite (d) Malachite
107. Sulfide ores are common for the metals  
 (a) Ag, Cu and Pb (b) Ag, Mg and Pb  
 (c) Ag, Cu and Sn (d) Al, Cu and Pb
108. Which one of the following does not occur as sulphide ore?  
 (a) Zn (b) Cr  
 (c) Ag (d) Fe
109. Pyrolusite is a/an  
 (a) oxide ore (b) sulphide ore  
 (c) carbide ore (d) Not an ore
110. Sulphide ores of metals are usually concentrated by froth flotation process. Which one of the following sulphide ores offer an exception and is concentrated by chemical leaching?  
 (a) Galena (b) Copper pyrite  
 (c) Sphalerite (d) Argentite
111. Which of the following statements is correct ?  
 (a) Gangues are carefully chosen to combine with the slag present in the ore to produce easily fusible flux to carry away the impurities  
 (b) Slags are carefully chosen to combine with the flux present in the ore to produce easily fusible gangue to carry away the impurities  
 (c) Gangues are carefully chosen to combine with the flux present in the ore to produce easily fusible slag to carry away the impurities  
 (d) Fluxes are carefully chosen to combine with the gangue present in the ore to produce easily fusible slag to carry away the impurities
112. Carbon and CO gas are used to reduce which of the following pairs of metal oxides for extraction of metals ?  
 (a) FeO, SnO (b) SnO, ZnO  
 (c) BaO, Na<sub>2</sub>O<sub>2</sub> (d) FeO, ZnO
113. In the cyanide extraction process of silver from argentite ore, the oxidising and reducing agents used are  
 (a) O<sub>2</sub> and CO respectively  
 (b) O<sub>2</sub> and Zn dust respectively  
 (c) HNO<sub>3</sub> and Zn dust respectively  
 (d) HNO<sub>3</sub> and CO respectively

114. Consider the following reactions at 1000°C



Choose the correct statement at 1000°C

- (a) zinc can be oxidised by carbon monoxide.  
 (b) zinc oxide can be reduced by graphite  
 (c) carbon monoxide can be reduced by zinc.  
 (d) both statements (a) and (b) are true
115. Which of the following statements, about the advantage of roasting of sulphide ore before reduction is not true?  
 (a) The  $\Delta G_f^\circ$  of the sulphide is greater than those for CS<sub>2</sub> and H<sub>2</sub>S.  
 (b) The  $\Delta G_f^\circ$  is negative for roasting of sulphide ore to oxide.  
 (c) Roasting of the sulphide to the oxide is thermodynamically feasible.  
 (d) Carbon and hydrogen are suitable reducing agents for reduction of metal sulphides.
116. Which of the following statement is not correct about Ellingham diagram?  
 (a)  $\Delta G$  increases with an increase in temperature  
 (b) It consists of plots of  $\Delta_f G^\circ$  vs T for formation of oxides  
 (c) a coupling reaction can be well expressed by this diagram  
 (d) It express the kinetics of the reduction process
117. A coupled reaction takes place as follow—  
 $\text{A} + \text{B} \longrightarrow \text{C} + \text{D}, \quad \Delta G^\circ = +x \text{ kJ}$   
 $\text{D} + \text{E} \longrightarrow \text{F} \quad \Delta G^\circ = -y \text{ kJ}$   
 for the spontaneity of reaction  $\text{A} + \text{B} + \text{E} \longrightarrow \text{C} + \text{F}$ , which of the following is correct?  
 (a)  $2x = y$  (b)  $x < y$   
 (c)  $x > y$  (d)  $x = (y) \times T\Delta S$
118. The value of  $\Delta_f G^\circ$  for formation of Cr<sub>2</sub>O<sub>3</sub> is – 540 kJmol<sup>–1</sup> and that of Al<sub>2</sub>O<sub>3</sub> is – 827 kJ mol<sup>–1</sup> What is the value of  $\Delta_r G^\circ$  for the reaction?  

$$\frac{4}{3} \text{Al(s)} + \frac{2}{3} \text{Cr}_2\text{O}_3(\text{s}) \rightarrow \frac{2}{3} \text{Al}_2\text{O}_3(\text{s}) + \frac{4}{3} \text{Cr(s)}.$$
  
 (a) – 574 kJ mol<sup>–1</sup> (b) – 287 kJ mol<sup>–1</sup>  
 (c) + 574 kJ mol<sup>–1</sup> (d) + 287 kJ mol<sup>–1</sup>
119. Before introducing FeO in blast furnace, it is converted to Fe<sub>2</sub>O<sub>3</sub> by roasting so that  
 (a) it may not be removed as slag with silica  
 (b) it may not evaporate in the furnace  
 (c) presence of it may increase the m.pt. of charge  
 (d) None of these.
120. The temperature in °C at which Fe<sub>2</sub>O<sub>3</sub> is finally reduced to Fe in the blast furnace is  
 (a) 993 (b) 797  
 (c) 897 (d) 1597

121. When copper ore is mixed with silica, in a reverberatory furnace copper matte is produced. The copper matte contains \_\_\_\_\_.
- sulphides of copper (II) and iron (II)
  - sulphides of copper (II) and iron (III)
  - sulphides of copper (I) and iron (II)
  - sulphides of copper (I) and iron (III)
122. In the metallurgy of aluminium \_\_\_\_\_.
- $\text{Al}^{3+}$  is oxidised to Al (s).
  - graphite anode is oxidised to carbon monoxide and carbon dioxide.
  - oxidation state of oxygen changes in the reaction at anode.
  - oxidation state of oxygen changes in the overall reaction involved in the process.
123. In the extraction of chlorine from brine \_\_\_\_\_.
- $\Delta G^\ominus$  for the overall reaction is negative.
  - $\Delta G^\ominus$  for the overall reaction is positive.
  - $E^\ominus$  for overall reaction has negative value.
  - $E^\ominus$  for overall reaction has positive value.
- (i) and (ii)
  - (ii) and (iii)
  - (i) and (iv)
  - (iii) and (iv)
124.  $\text{Cu}_2\text{S} + 2\text{Cu}_2\text{O} \longrightarrow 6\text{Cu} + \text{SO}_2$   
In which process of metallurgy of copper, above equation is involved?
- Roasting
  - Self reduction
  - Refining
  - Purification
125. Which of the following statements regarding metallurgy of iron is incorrect ?
- Reaction  $\text{Fe}_3\text{O}_4 + 4\text{CO} \longrightarrow 3\text{Fe} + 4\text{CO}_2$  belongs to lower temperature range (500 – 800K) of the blast furnace.
  - Reaction  $\text{FeO} + \text{CO} \longrightarrow \text{Fe} + \text{CO}_2$  belongs to higher temperature range (900 – 1500K) of the blast furnace.
  - The iron obtained from blast furnace is cast iron with 3% carbon.
  - For reduction of iron oxide to occur  $\Delta G$  of the couple of following reactions should be negative
- $$\text{FeO(s)} \longrightarrow \text{Fe(s)} + \frac{1}{2}\text{O}_2(\text{g})$$
- $$\text{C(s)} + \frac{1}{2}\text{O}_2(\text{g}) \longrightarrow \text{CO(g)}$$
126. Extraction of which of the following is based on oxidation ?
- Highly reactive metals
  - Moderately reactive metals
  - Non-metals
  - Both (a) and (c)
127. Which of the following reaction(s) occur in temperature range 500 – 800 K in blast furnace.
- $\text{Fe}_2\text{O}_3 + \text{CO} \longrightarrow 2\text{FeO} + \text{CO}_2$
  - $\text{Fe}_3\text{O}_4 + 4\text{CO} \longrightarrow 3\text{Fe} + 4\text{CO}_2$
  - $\text{FeO} + \text{CO} \longrightarrow \text{Fe} + \text{CO}_2$
  - $\text{C} + \text{CO}_2 \longrightarrow 2\text{CO}$
- (i) and (ii)
  - (i), (ii) and (iii)
  - (iii) and (iv)
  - (iv) only
128. In Hall-Heroult process how much carbon anode is burnt away to produce each 1kg of aluminium ?
- 0.3 kg
  - 0.5 kg
  - 1 kg
  - 0.1 kg
129. In electro-refining of metal the impure metal is used to make the anode and a strip of pure metal as the cathode, during the electrolysis of an aqueous solution of a complex metal salt. This method cannot be used for refining of
- Silver
  - Copper
  - Aluminium
  - Sodium
130. During the process of electrolytic refining of copper, some metals present as impurity settle as 'anode mud'. These are
- Fe and Ni
  - Ag and Au
  - Pb and Zn
  - Sn and Ag
131. If the impurities in a metal has a greater affinity for oxygen and is more easily oxidised than the metal, then the purification of metal may be carried out by
- distillation
  - zone refining
  - electrolytic refining
  - cupellation
132. Germanium of very high purity is obtained by
- liquation
  - vapour phase refining
  - distillation
  - zone refining
133. Which of the following statements regarding electrolytic refining of copper is incorrect ?
- In this process anode is made up of impure copper and pure copper strips are taken as cathode.
  - Acidic or basic solution of copper sulphate is used as electrolyte
  - Antimony, tellurium, silver and gold are some of the metals deposits as anode mud during this process
  - Zinc can be also refined by electrolytic refining method.
134. Which of the following is incorrectly matched ?
- | Metal            | Uses                                    |
|------------------|---|
| (a) Wrought iron | Casting stoves, gutter pipes, toys etc. |
| (b) Copper       | Coinage alloy                           |
| (c) Aluminium    | Extraction of chromium and manganese    |
| (d) Nickel steel | Measuring tapes                         |

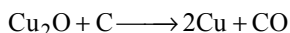


# HINTS AND SOLUTIONS

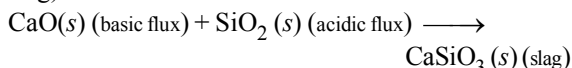
## FACT/DEFINITION TYPE QUESTIONS

1. (a) Argentite or silver glance ( $\text{Ag}_2\text{S}$ ) is an ore of Ag.
2. (a) Cinnabar ( $\text{HgS}$ ) is an ore of Hg.
3. (a) Bauxite ore of aluminium is  $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ .
4. (a)
5. (b) Al is most abundant metal on the surface of the earth.
6. (c) Carborundum - SiC  
Epsomite or Epsom salt -  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$   
Cassiterite -  $\text{SnO}_2$   
Spodumene - Ore of lithium
7. (a) Chalcopyrite :  $\text{CuFeS}_2$   
Fool's gold :  $\text{FeS}_2$   
Carnalite :  $\text{KMgCl}_3 \cdot 6\text{H}_2\text{O}$   
Bauxite :  $\text{Al}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$
8. (c) Haematite is  $\text{Fe}_2\text{O}_3$ . Thus it is the ore of iron (Fe).
9. (c) Azurite is a basic carbonate ore of copper.  
 $2\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$
10. (d)  $\text{Fe}_3\text{O}_4$  - Magnetite  
 $\text{CuCO}_3 \cdot \text{Cu}(\text{OH})_2$  - Malachite  
Pyrolusite -  $\text{MnO}_2$  and Cassiterite -  $\text{SnO}_2$ .
11. (a)
12. (a) The formula of magnetite is  $\text{Fe}_3\text{O}_4$ .
13. (c) Impurities associated with minerals are called gangue or matrix.
14. (c)
15. (b) Malachite is an ore of copper  $\text{Cu}(\text{OH})_2 \cdot \text{CuCO}_3$ .
16. (d) Cassiterite is an ore of Sn also known as tin stone  $\text{SnO}_2$ .
17. (a) Galena is an ore of lead. It is PbS.
18. (a) Gold being least reactive found native.
19. (a)
20. (c) Zincite is  $\text{ZnO}$ .
21. (c) Galena is PbS and thus purified by froth floatation method.  
Froth floatation method is used to concentrate sulphide ores. This method is based on the fact that the surface of sulphide ores is preferentially wetted by oils while that of gangue is preferentially wetted by water.
22. (d) Froth floatation process is used for the concentration of sulphide ores.
23. (b) Cassiterite contains the magnetic impurities of  $\text{FeSO}_4$  and thus concentrated by electromagnetic separation.
24. (d) Cyanide process is used in the metallurgy of Ag  
 $2\text{Ag}_2\text{S} + 8\text{NaCN} + \text{O}_2 + 2\text{H}_2\text{O} \longrightarrow$   
 $4\text{Na}[\text{Ag}(\text{CN})_2] + 4\text{NaOH} + 2\text{S}$   
 $2\text{Na}[\text{Ag}(\text{CN})_2] + \text{Zn} \longrightarrow \text{Na}_2[\text{Zn}(\text{CN})_4] + 2\text{Ag} \downarrow$
25. (a)
26. (b) Leaching is a process used for concentration of ore. In this process, a powdered ore is treated with a suitable reagent (such as acids, bases or other chemicals) which can selectively dissolve the ore, but not the impurities.
27. (d) Au and Ag can be extracted from their native ores by leaching (Mac-Arthur Forrest cyanide process).
28. (c)
29. (c) Cinnabar is sulphide ore ( $\text{HgS}$ ). Hence purified by froth floatation process.
30. (a) Ag is leached by cyanide process.
31. (c) Pyrolusite is  $\text{MnO}_2$ . Hence not concentrated by froth floatation process.
32. (c) Froth reduces the surface tension of water and the solution forms froth.
33. (a) Froth floatation process is based on wetting properties of ore particles.
34. (c) The surface of particles not wetted hence they float at the surface
35. (a) To remove moisture and non-metallic impurities like S, P and As are oxidised and are removed as volatile substances.  
 $\text{S}_8 + 8\text{O}_2 \rightarrow 8\text{SO}_2 \uparrow$ ;  $\text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10} \uparrow$   
 $4\text{As} + 3\text{O}_2 \rightarrow 2\text{As}_2\text{O}_3 \uparrow$
36. (c) In this process sulphide ores are converted into oxide ores.  
 $2\text{ZnS} + 3\text{O}_2 \rightarrow 2\text{ZnO} + 2\text{SO}_2 \uparrow$
37. (a)
38. (d)
39. (a) Carbon reduction,  $\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$
40. (b) Flux + Gangue  $\rightarrow$  Slag
41. (a) Calcination is heating ore in absence of air to remove moisture and volatile impurities. Carbonate ores decomposed to corresponding oxides as a result of calcination.
42. (d) Calcination is a process of heating a substance to a high temperature but below the melting or fusion point, causing loss of moisture, reduction or oxidation and dissociation into simpler substances.
43. (b) Since silica is acidic impurity the flux must be basic.  
 $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$
44. (b) To remove acidic impurities basic flux is added which is  $\text{CaCO}_3$ .
45. (d) Decomposition of carbonates and hydrated oxides.
46. (d)  $2\text{CuO} + \text{CuS} \rightarrow 3\text{Cu} + \text{SO}_2$  (Self-reduction)
47. (a) For example,  $\text{Ag}_2\text{S}$  is converted into  $\text{Na}[\text{Ag}(\text{CN})_2]$ . When Zn is added, Ag is displaced.
48. (b)

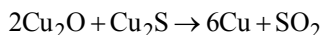
49. (c) Cresol is used as froth stabiliser.  
 50. (b) Calcination involves heating when the volatile matter escapes leaving behind the metal oxide.  
 51. (b) In the graph of  $\Delta_f G^\circ$  vs T for formation of oxides, the  $\text{Cu}_2\text{O}$  line is almost at the top. So, it is quite easy to reduce oxide ores of copper directly to the metal by heating with coke both the lines of C, CO and C,  $\text{CO}_2$  are at much lower temperature (500 - 600 K).



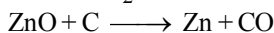
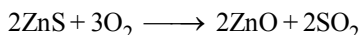
52. (d)  
 53. (c) Ellingham diagram normally consists of plots of  $\Delta_f G^\circ$  Vs T for the formation of oxides of elements.  
 54. (c)  
 55. (b)  $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$   
 56. (c)  
 57. (c) In blast furnace at about 1270 K, calcium carbonate is almost completely decomposed to give CaO which acts as a flux and combines with  $\text{SiO}_2$  present as impurity (gangue) in the ore to form calcium silicate (fusible slag)



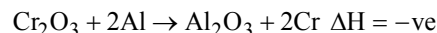
58. (b) These are the substances which can withstand very high temperature without melting or becoming soft.  
 59. (a)  
 60. (d) Cast iron is different from pig iron and is made by melting pig iron with scrap iron and coke using hot air blast. It has slightly lower carbon content (about 3%) and is extremely hard and brittle.  
 61. (a) Cuprous oxide formed during roasting of cuprous sulphide is mixed with few amount of cuprous sulphide and heated in a reverberatory furnace to get metallic copper.



62. (b) Extraction of Zn from ZnS (Zinc blende) is achieved by roasting followed by reduction with carbon.



63. (d) Decomposition of carbonates and hydrated oxides.  
 64. (b) Aluminothermite process involves reduction of oxides which are not satisfactorily reduced by carbon such as  $\text{Fe}_2\text{O}_3$ ,  $\text{Mn}_3\text{O}_4$ ,  $\text{Cr}_2\text{O}_3$ , etc. to metals with aluminium.

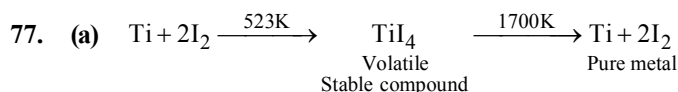


65. (c) Because Na is very reactive and cannot be extracted by means of the reduction by C, CO etc. So it is extracted by electrolysis.  
 66. (c)  
 67. (c) Fused alumina ( $\text{Al}_2\text{O}_3$ ) is a bad conductor of electricity. Therefore, cryolite ( $\text{Na}_3\text{AlF}_6$ ) and fluorspar ( $\text{CaF}_2$ ) are added to purified alumina which not only make alumina a good conductor of electricity but also reduce the melting point of the mixture to around 1140 K.

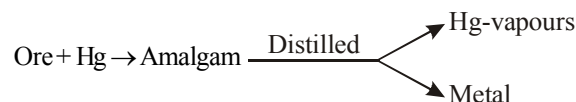
68. (a) 69. (c) 70. (a)  
 71. (d) Blister-Copper contains 1 – 2 % impurities. It is obtained after Bessemerisation of crude copper.

72. (a)  
 73. (b) Pig iron contains 4% carbon and many impurities in smaller amount.

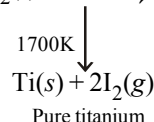
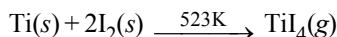
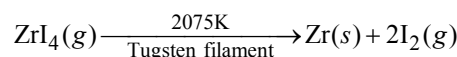
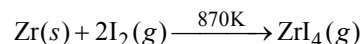
74. (d) 75. (c) 76. (a)



78. (c) Liquation process, Mond's process and, van Arkel process these are the refining processes that are applied depending upon the nature of the metal under treatment and nature of the impurities whereas amalgamation process is used for the extraction of noble metals like gold, silver, etc, from native ores. The metal is recovered from the amalgam by subjecting it to distillation, where the mercury distils over leaving behind the metal.



79. (b) Zr and Ti are purified by van Arkel method.



80. (a) Zone refining is based on the difference in solubility of impurities in molten and solid state of the metal. This method is used for obtaining metals of very high purity.  
 81. (d) Si obtained by reduction of  $\text{SiCl}_4$  with  $\text{H}_2$  is further purified by zone refining method to get Si of very high purity. Silicon is purified by zone-refining process because the impurities present in it are more soluble in the liquid phase than in the solid phase.  
 82. (c) 83. (a)  
 84. (c) Mobile phase cannot be solid.  
 85. (b) Zinc dust is used as a reducing agent in the manufacture of dye-stuffs, paints etc.

### STATEMENT TYPE QUESTIONS

86. (a) For ore containing mixture of ZnS and PbS, depressant NaCN allows PbS to come with froth and prevents ZnS from coming to the froth.  
 87. (b) Ellingham diagram represents plot between  $\Delta G$  and T therefore with increase in temperature phase change Gas  $\rightarrow$  Liquid is not possible. Ellingham diagram does not give any information about kinetics of the reduction reaction.

88. (c)  
89. (c) Van Arkel method involves heating crude Zr with iodine to form corresponding iodide. The metal iodide being more covalent volatilises.

### MATCHING TYPE QUESTIONS

90. (a)      91. (c)      92. (a)      93. (b)      94. (a)  
95. (b) Cyanide process is for gold (A - s); floatation process - pine oil (B - q); Electrolytic reduction - Al (C - r); Zone refining - Ge (D - p).  
96. (b)      97. (a)

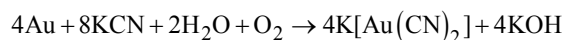
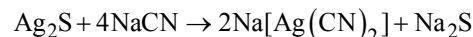
### ASSERTION-REASON TYPE QUESTIONS

98. (c) Assertion is true but reason is false.  
Oxide ores being heavier than the earthy or rocky gangue particles, settle down while lighter impurities are washed away.  
99. (a)  
100. (d) Assertion is false but reason is true. Leaching is a process of concentration.  
101. (b) Both assertion and reason are true but reason is not the correct explanation of assertion. Non fusible mass present in ore in mixing with suitable flux are fused which are then reduced by coke to give free metal.  
102. (a) Both assertion and reason are correct and reason is the correct explanation of assertion.  
103. (a)

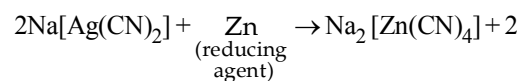
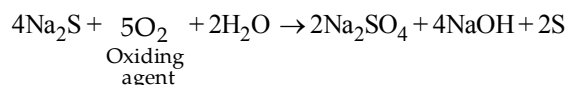
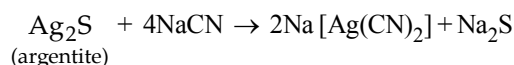
### CRITICAL THINKING TYPE QUESTIONS

104. (c) Malachite is  $\text{CuCO}_3 \cdot \text{Cu(OH)}_2$  it is ore of copper.  
105. (a) (a) Zinc      Calamine is  $\text{ZnCO}_3$   
(b) Silver      Ilmenite is  $\text{FeTiO}_3$   
(c) Magnesium      Cassiterite is  $\text{SnO}_2$   
(d) Tin      Azurite is  $[2\text{CuCO}_3 \cdot \text{Cu(OH)}_2]$   
106. (c) Cuprite:  $\text{Cu}_2\text{O}$ ; Chalcocite:  $\text{Cu}_2\text{S}$ ; Chalcopyrite:  $\text{CuFeS}_2$ ; Malachite:  $\text{Cu(OH)}_2 \cdot \text{CuCO}_3$ . We see that  $\text{CuFeS}_2$  contains both Cu and Fe.  
107. (a) Silver, copper and lead are commonly found in earth's crust as  $\text{Ag}_2\text{S}$  (silver glance),  $\text{CuFeS}_2$  (copper pyrites) and  $\text{PbS}$  (galena)  
108. (b) Except chromium all the given metals exists as their sulphides.  
Zn exists as zinc blende  $\text{ZnS}$ .  
Silver exists as silver glance  $\text{Ag}_2\text{S}$ .  
Iron exists as iron pyrites  $\text{FeS}_2$ .  
Mercury exists as mercuric sulphide  $\text{HgS}$ .  
109. (a)  $\text{MnO}_2$  is pyrolusite (oxide ore).

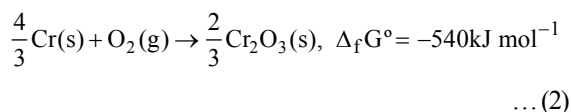
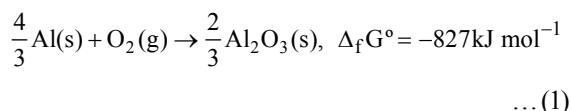
110. (d) Leaching is the selective dissolution of the desired mineral leaving behind the impurities in a suitable dissolving agent e.g.,  
Argentite or Silver glance,  $\text{Ag}_2\text{S}$  is an ore of silver. Silver is extracted from argentite by the mac-Arthur and Forest process (leaching process).



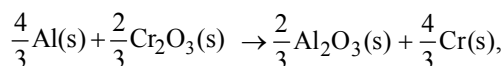
111. (d)      112. (d)  
113. (b) The reactions involved in cyanide extraction process are :



114. (b)  
115. (d) The sulphide ore is roasted to oxide before reduction because the  $\Delta G_f^\circ$  of most of the sulphides are greater than those of  $\text{CS}_2$  and  $\text{H}_2\text{S}$ , therefore neither C nor H can reduce metal sulphide to metal. Further, the standard free energies of formation of oxide are much less than those of  $\text{SO}_2$ . Hence oxidation of metal sulphides to metal oxide is thermodynamically favourable.  
116. (d) Ellingham diagrams are based on thermodynamic concepts. It does not tell anything about the kinetics of the reduction process.  
117. (d) For a spontaneous reaction,  $\Delta G^\circ$  must be negative and it can be possible only in this case when  $x < y$   
118. (b) The two equation are:



Subtracting equation (ii) from equation (i) we have,



$$\Delta_r G^\circ = -287\text{kJ mol}^{-1}$$

- 119. (a)** FeO is capable forming slag with  $\text{SiO}_2$   
 $\text{SiO}_2 + \text{FeO} \rightarrow \text{FeSiO}_3$
- 120. (a)** In blast furnace  $\text{Fe}_2\text{O}_3$  is finally reduced to Fe at  $993^\circ\text{C}$
- 121. (c)**      **122. (b)**      **123. (b)**
- 124. (b)** This process is also called autoreduction process or air reduction process. The sulphide ores of less electropositive metals are heated in air to convert part of the ore into oxide or sulphate which then react with the remaining sulphide ore to give the metal and sulphur dioxide.  

$$2\text{Cu}_2\text{S} + 3\text{O}_2 \longrightarrow 2\text{Cu}_2\text{O} + 2\text{SO}_2$$

$$\text{Cu}_2\text{S} + 2\text{Cu}_2\text{O} \longrightarrow 6\text{Cu} + \text{SO}_2$$
- 125. (c)** The iron obtained from blast furnace is pig iron with 4% carbon and impurities like S, P, Mn etc., in small amount.
- 126. (c)** Extraction of non-metals are based on oxidation. For example extraction of chlorine from brine.  

$$2\text{Cl}^-(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{OH}^-(\text{aq}) + \text{H}_2(\text{g}) + \text{Cl}_2(\text{g})$$
- 127. (a)** (iii) and (iv) reactions occur in the temperature range of  $900 - 1500\text{K}$  in blast furnace.
- 128. (b)** For each kg of Al produced, about 0.5 kg of carbon anode is burnt away.
- 129. (d)** Na reacts vigorously with water (exothermic process)
- 130. (b)** During the process of electrolytic refining of copper Ag and Au are obtained as anode mud.
- 131. (d)**
- 132. (d)** Metals of high purity are obtained by zone refining e.g., silicon, germanium, boron, gallium, indium.
- 133. (b)** During electrolytic refining of copper electrolyte used is acidified solution of copper sulphate.
- 134. (a)** Wrought iron is used in making anchors, wires, bolts chains and agricultural implements.

# CHAPTER 21

## THE p-BLOCK ELEMENTS (GROUP 15, 16, 17 AND 18)

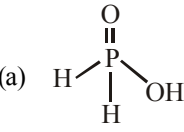
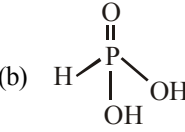
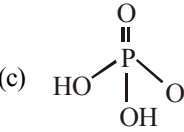
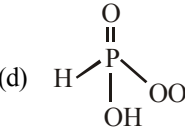
### FACT/DEFINITION TYPE QUESTIONS

- Ionic radii (in Å) of  $\text{As}^{3+}$ ,  $\text{Sb}^{3+}$  and  $\text{Bi}^{3+}$  follow the order  
(a)  $\text{As}^{3+} > \text{Sb}^{3+} > \text{Bi}^{3+}$  (b)  $\text{Sb}^{3+} > \text{Bi}^{3+} > \text{As}^{3+}$   
(c)  $\text{Bi}^{3+} > \text{As}^{3+} > \text{Sb}^{3+}$  (d)  $\text{Bi}^{3+} > \text{Sb}^{3+} > \text{As}^{3+}$
- Which of the following statements is not correct for nitrogen?  
(a) Its electronegativity is very high  
(b)  $d$ -orbitals are available for bonding  
(c) It is a typical non-metal  
(d) Its molecular size is small
- Collectively the elements of group 15 are called –  
(a) pnictogens (b) pnictopens  
(c) nicopen (d) None of these
- Which one of the following elements is most metallic?  
(a) P (b) As  
(c) Sb (d) Bi
- Which of the following statement is incorrect for group 15 elements?  
(a) Order of ionization enthalpies is  $\Delta_i H_1 < \Delta_i H_2 < \Delta_i H_3$   
(b) The boiling point and melting point increases from top to bottom in the group  
(c) Dinitrogen is a gas while all others are solids  
(d) All statements are correct
- Which of the follow group 15 element forms metallic bonds in elemental state?  
(a) As (b) P  
(c) Sb (d) Bi
- The three important oxidation states of phosphorus are  
(a)  $-3, +3$  and  $+5$  (b)  $-3, +3$  and  $-5$   
(c)  $-3, +3$  and  $+2$  (d)  $-3, +3$  and  $+4$
- Nitrogen is relatively inactive element because  
(a) its atom has a stable electronic configuration  
(b) it has low atomic radius  
(c) its electronegativity is fairly high  
(d) dissociation energy of its molecule is fairly high
- Which of the following has the highest  $p\pi - p\pi$  bonding tendency?  
(a) N (b) P  
(c) As (d) Sb
- Pick out the wrong statement.  
(a) Nitrogen has the ability to form  $p\pi - p\pi$  bonds with itself.  
(b) Bismuth forms metallic bonds in elemental state.  
(c) Catenation tendency is higher in nitrogen when compared with other elements of the same group.  
(d) Nitrogen has higher first ionisation enthalpy when compared with other elements of the same group.
- Nitrogen forms  $\text{N}_2$ , but phosphorus is converted into  $\text{P}_4$  from P, the reason is  
(a) Triple bond is present between phosphorus atom  
(b)  $p\pi - p\pi$  bonding is strong  
(c)  $p\pi - p\pi$  bonding is weak  
(d) Multiple bond is formed easily
- What causes nitrogen to be chemically inert?  
(a) Multiple bond formation in the molecule  
(b) Absence of bond polarity  
(c) Short internuclear distance  
(d) High bond energy
- Among the 15th group elements, as we move from nitrogen to bismuth, the pentavalency becomes less pronounced and trivalency becomes more pronounced due to  
(a) Non metallic character (b) Inert pair effect  
(c) High electronegativity (d) Large ionization energy
- Pentavalence in phosphorus is more stable when compared to that of nitrogen even though they belong to same group. This is due to  
(a) dissimilar electronic configuration  
(b) due to presence of vacant  $d$ -orbitals  
(c) reactivity of phosphorus  
(d) inert nature of nitrogen
- Which one has the lowest boiling point?  
(a)  $\text{NH}_3$  (b)  $\text{PH}_3$   
(c)  $\text{AsH}_3$  (d)  $\text{SbH}_3$
- Most acidic oxide among the following is –  
(a)  $\text{N}_2\text{O}_5$  (b)  $\text{P}_2\text{O}_5$   
(c)  $\text{N}_2\text{O}_4$  (d)  $\text{As}_2\text{O}_3$
- Which of the following species has the highest dipole moment?  
(a)  $\text{NH}_3$  (b)  $\text{PH}_3$   
(c)  $\text{AsH}_3$  (d)  $\text{SbH}_3$



18. The correct decreasing order of basic strength is:
  - (a)  $\text{AsH}_3 > \text{SbH}_3 > \text{PH}_3 > \text{NH}_3$
  - (b)  $\text{SbH}_3 > \text{AsH}_3 > \text{PH}_3 > \text{NH}_3$
  - (c)  $\text{NH}_3 > \text{PH}_3 > \text{AsH}_3 > \text{SbH}_3$
  - (d)  $\text{PH}_3 > \text{AsH}_3 > \text{SbH}_3 > \text{NH}_3$
19. Which of the following fluorides does not exist?
  - (a)  $\text{NF}_5$
  - (b)  $\text{PF}_5$
  - (c)  $\text{AsF}_5$
  - (d)  $\text{SbF}_5$
20. The p-block element of group 15 that forms predominantly basic oxide is
  - (a) N
  - (b) P
  - (c) As
  - (d) Bi
21. With respect to protonic acids, which of the following statements is correct?
  - (a)  $\text{PH}_3$  is more basic than  $\text{NH}_3$
  - (b)  $\text{PH}_3$  is less basic than  $\text{NH}_3$
  - (c)  $\text{PH}_3$  is equally basic as  $\text{NH}_3$
  - (d)  $\text{PH}_3$  is amphoteric while  $\text{NH}_3$  is basic
22.  $\text{PCl}_5$  is possible but  $\text{NCl}_5$  does not exist :
  - (a) in N, d-sub-shell is absent
  - (b) ionization energy of N is very high
  - (c) it does not like Cl
  - (d) None of these
23. Maximum covalency of nitrogen is \_\_\_\_\_.
  - (a) 3
  - (b) 5
  - (c) 4
  - (d) 6
24. Elements of group-15 form compounds in +5 oxidation state. However, bismuth forms only one well characterised compound in +5 oxidation state. The compound is
  - (a)  $\text{Bi}_2\text{O}_5$
  - (b)  $\text{BiF}_5$
  - (c)  $\text{BiCl}_5$
  - (d)  $\text{Bi}_2\text{S}_5$
25. Pure nitrogen is prepared in the laboratory by heating a mixture of
  - (a)  $\text{NH}_4\text{OH} + \text{NaCl}$
  - (b)  $\text{NH}_4\text{NO}_3 + \text{NaCl}$
  - (c)  $\text{NH}_4\text{Cl} + \text{NaOH}$
  - (d)  $\text{NH}_4\text{Cl} + \text{NaNO}_2$
26. On heating ammonium dichromate and barium azide separately we get
  - (a)  $\text{N}_2$  in both cases
  - (b)  $\text{N}_2$  with ammonium dichromate and NO with barium azide
  - (c)  $\text{N}_2\text{O}$  with ammonium dichromate and  $\text{N}_2$  with barium azide
  - (d)  $\text{N}_2\text{O}$  with ammonium dichromate and  $\text{NO}_2$  with barium azide
27. In Haber's process for the manufacture of  $\text{NH}_3$  :
  - (a) finely divided nickel is used as a catalyst
  - (b) finely divided iron is used as a catalyst
  - (c) finely divided molybdenum is used as a catalyst
  - (d) no catalyst is necessary
28. Ammonia on reaction with hypochlorite anion can form :
  - (a) NO
  - (b)  $\text{N}_2\text{H}_4$
  - (c)  $\text{NH}_4\text{Cl}$
  - (d) Both (b) and (c)
29.  $\text{NH}_3$  gas is dried over :
  - (a) CaO
  - (b)  $\text{HNO}_3$
  - (c)  $\text{P}_2\text{O}_5$
  - (d)  $\text{CuSO}_4$
30. The shape of ammonia molecule is
  - (a) tetrahedral
  - (b) pyramidal
  - (c) planar triangle
  - (d) octahedral
31. When ammonia is heated with cupric oxide, a molecule of ammonia will
  - (a) gain 3 electrons
  - (b) lose 3 electrons
  - (c) gain 2 electrons
  - (d) lose 2 electrons
32. In which the  $\text{NH}_3$  is not used?
  - (a) Cold storage
  - (b) Anaesthetic
  - (c) Manufacture of rayon and plastic
  - (d) None of these
33. Liquid ammonia bottles are opened after cooling them in ice for sometime. It is because liquid  $\text{NH}_3$ 
  - (a) Brings tears to the eyes
  - (b) Has a high vapour pressure
  - (c) Is a corrosive liquid
  - (d) Is a mild explosive
34. Ammonia is generally manufactured for fertilizers by the reaction
  - (a)  $2\text{NH}_4\text{Cl} + \text{Ca}(\text{OH})_2 \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O} + 2\text{NH}_3$
  - (b) By passing an electric discharge in a mixture of  $\text{N}_2$  and  $\text{H}_2$
  - (c) By passing a mixture of  $\text{N}_2$  and  $\text{H}_2$  under high pressure and moderate temperature over a catalyst
  - (d) None of these
35. Nitrogen dioxide cannot be obtained by heating :
  - (a)  $\text{KNO}_3$
  - (b)  $\text{Pb}(\text{NO}_3)_2$
  - (c)  $\text{Cu}(\text{NO}_3)_2$
  - (d)  $\text{AgNO}_3$
36. Which of the following oxides is neutral?
  - (a)  $\text{N}_2\text{O}_3$
  - (b)  $\text{N}_2\text{O}_4$
  - (c)  $\text{N}_2\text{O}_5$
  - (d)  $\text{N}_2\text{O}$
37. The bonds present in  $\text{N}_2\text{O}_5$  are :
  - (a) only ionic
  - (b) covalent and coordinate
  - (c) only covalent
  - (d) covalent and ionic
38. Which of the following oxides of nitrogen is a coloured gas?
  - (a)  $\text{N}_2\text{O}$
  - (b) NO
  - (c)  $\text{N}_2\text{O}_5$
  - (d)  $\text{NO}_2$
39. Which of the following shows nitrogen with its increasing order of oxidation number?
  - (a)  $\text{NO} < \text{N}_2\text{O} < \text{NO}_2 < \text{NO}_3^- < \text{NH}_4^+$
  - (b)  $\text{NH}_4^+ < \text{N}_2\text{O} < \text{NO}_2 < \text{NO}_3^- < \text{NO}$
  - (c)  $\text{NH}_4^+ < \text{N}_2\text{O} < \text{NO} < \text{NO}_2 < \text{NO}_3^-$
  - (d)  $\text{NH}_4^+ < \text{NO} < \text{N}_2\text{O} < \text{NO}_2 < \text{NO}_3^-$
40. In which one of the following oxides of nitrogen, one nitrogen atom is not directly linked to oxygen?
  - (a) NO
  - (b)  $\text{N}_2\text{O}_4$
  - (c)  $\text{N}_2\text{O}$
  - (d)  $\text{N}_2\text{O}_3$

41. Which of the following oxides of nitrogen reacts with  $\text{FeSO}_4$  to form a dark brown compound  
(a)  $\text{N}_2\text{O}$  (b)  $\text{NO}$   
(c)  $\text{NO}_2$  (d)  $\text{N}_2\text{O}_3$
42. Which oxide of nitrogen is obtained on heating ammonium nitrate at  $250^\circ\text{C}$ ?  
(a) Nitric oxide (b) Nitrous oxide  
(c) Nitrogen dioxide (d) Dinitrogen tetraoxide
43. Which of the following can be used as an anaesthesia?  
(a)  $\text{N}_2\text{O}$  (b)  $\text{NO}$   
(c)  $\text{NCl}_3$  (d)  $\text{NO}_2$
44. A deep brown gas is formed by mixing two colourless gases which are  
(a)  $\text{NO}_2$  and  $\text{O}_2$  (b)  $\text{N}_2\text{O}$  and  $\text{NO}$   
(c)  $\text{NO}$  and  $\text{O}_2$  (d)  $\text{NH}_3$  and  $\text{HCl}$
45. Which of the following elements does not form stable diatomic molecules?  
(a) Iodine (b) Phosphorus  
(c) Nitrogen (d) Oxygen
46. The catalyst used in the manufacture of  $\text{HNO}_3$  by Ostwald's process is :  
(a) platinum gauze (b) vanadium pentoxide  
(c) finely divided nickel (d) platinum black
47. Concentrated nitric acid, upon long standing, turns yellow brown due to the formation of  
(a)  $\text{NO}$  (b)  $\text{NO}_2$   
(c)  $\text{N}_2\text{O}$  (d)  $\text{N}_2\text{O}_4$
48. Which of the following trihalide is unstable?  
(a)  $\text{NF}_3$  (b)  $\text{AsCl}_3$   
(c)  $\text{SbBr}_3$  (d)  $\text{NCl}_3$
49. What will be the A and B in the following equations.  
$$8\text{NH}_3 + 3\text{Cl}_2 \longrightarrow 6\text{NH}_4\text{Cl} + \text{N}_2$$
  
(A)  
$$\text{NH}_3 + 3\text{Cl}_2 \longrightarrow \text{NCl}_3 + 3\text{HCl}$$
  
(B)  
(a) A = Excess, B = Excess  
(b) A = Limited, B = Excess  
(c) A = Excess, B = Limited  
(d) A = Limited, B = Limited
50. Which of the following is the strongest reducing agent?  
(a)  $\text{NH}_3$  (b)  $\text{PH}_3$   
(c)  $\text{BiH}_3$  (d)  $\text{SbH}_3$
51. Which of the following element will form acidic oxides of type  $\text{E}_2\text{O}_3$ ?  
(a) As (b) Sb  
(c) Bi (d) P
52. Which one of the following is not an use of ammonia?  
(a) To produce various nitrogenous fertilizers.  
(b) In manufacture of nitric acid  
(c) As a refrigerate  
(d) In the pickling of stainless steel
53. The nitrogen oxides that contain(s) N–N bond(s) is /are  
(i)  $\text{N}_2\text{O}$  (ii)  $\text{N}_2\text{O}_3$   
(iii)  $\text{N}_2\text{O}_4$  (iv)  $\text{N}_2\text{O}_5$   
(a) (i), (ii) (b) (ii), (iii), (iv)  
(c) (iii), (iv) (d) (i), (ii) and (iii)
54. Zinc on reaction with dilute  $\text{HNO}_3$  gives x and zinc on reaction with concentrated  $\text{HNO}_3$  gives y. Identify x and y.  
(a)  $x = \text{NO}_2$ ,  $y = \text{N}_2\text{O}$  (b)  $x = \text{N}_2\text{O}$ ,  $y = \text{NO}$   
(c)  $x = \text{NO}$ ,  $y = \text{NO}_2$  (d)  $x = \text{N}_2\text{O}$ ,  $y = \text{NO}_2$
55. Which of the following is incorrect for white and red phosphorus?  
(a) They are both soluble in  $\text{CS}_2$   
(b) They can be oxidised by heating in air  
(c) They consist of the same kind of atoms  
(d) They can be converted into one another
56. Which of the following phosphorus is most reactive?  
(a) Red phosphorus (b) White phosphorus  
(c) Scarlet phosphorus (d) Violet phosphorus
57. White phosphorus is  
(a) a monoatomic gas (b)  $\text{P}_4$ , a tetrahedral solid  
(c)  $\text{P}_8$ , a crown (d) a linear diatomic molecule
58. Which property of white phosphorus is common to red phosphorus?  
(a) It burns when heated in air.  
(b) It reacts with hot caustic soda solution to give phosphine.  
(c) It shows chemiluminescence.  
(d) It is soluble in carbon disulphide.
59. Which of the following statements regarding allotropic forms of phosphorus is incorrect?  
(a) White phosphorus is more reactive than red and black due to high angular strain.  
(b) Red phosphorus on heating catches fire and give dense red fumes of  $\text{P}_4\text{O}_{10}$ .  
(c) Red phosphorus is polymeric in nature consisting of chains of  $\text{P}_4$  tetrahedral.  
(d) Black phosphorus has two forms  $\alpha$ -black and  $\beta$ -black phosphorus
60. Which of the following is incorrect?  
(a) M.p of monoclinic sulphur > m.p. of rhombic sulphur.  
(b) Specific gravity of rhombic sulphur > specific gravity of monoclinic sulphur.  
(c) Monoclinic sulphur is stable below 369 K.  
(d) Both rhombic sulphur and monoclinic sulphur have  $\text{S}_8$  molecules.
61. One mole of calcium phosphide on reaction with excess water gives  
(a) one mole of phosphine  
(b) two moles of phosphoric acid  
(c) two moles of phosphine  
(d) one mole of phosphorus pentoxide
62.  $\text{PH}_3$ , the hydride of phosphorus is  
(a) metallic (b) ionic  
(c) non-metallic (d) covalent

63. Phosphine is not obtained by which of the following reaction  
 (a) White P is heated with NaOH  
 (b) Red P is heated with NaOH  
 (c)  $\text{Ca}_3\text{P}_2$  reacts with water  
 (d) Phosphorus trioxide is boiled with water
64. Phosphine is not evolved when  
 (a) white phosphorus is boiled with a strong solution of  $\text{Ba}(\text{OH})_2$   
 (b) phosphorus acid is heated  
 (c) calcium hypophosphite is heated  
 (d) metaphosphoric acid is heated.
65. Pure phosphine is not combustible while impure phosphine is combustible, this combustibility is due to presence of  
 (a)  $\text{P}_2\text{H}_4$  (b)  $\text{N}_2$   
 (c)  $\text{PH}_3$  (d)  $\text{P}_2\text{O}_5$
66. When orthophosphoric acid is heated to  $600^\circ\text{C}$ , the product formed is  
 (a)  $\text{PH}_3$  (b)  $\text{P}_2\text{O}_5$   
 (c)  $\text{H}_3\text{PO}_3$  (d)  $\text{HPO}_3$
67.  $\text{P}_2\text{O}_5$  is heated with water to give  
 (a) hypophosphorous acid (b) phosphorous acid  
 (c) hypophosphoric acid (d) orthophosphoric acid
68. Basicity of orthophosphoric acid is  
 (a) 2 (b) 3  
 (c) 4 (d) 5
69.  $\text{PCl}_3$  reacts with water to form  
 (a)  $\text{PH}_3$  (b)  $\text{H}_3\text{PO}_4$  and  $\text{HCl}$   
 (c)  $\text{POCl}_3$  (d)  $\text{H}_3\text{PO}_4$
70.  $\text{H}_3\text{PO}_2$  is the molecular formula of an acid of phosphorus. Its name and basicity respectively are  
 (a) phosphorus acid and two  
 (b) hypophosphorous acid and two  
 (c) hypophosphorous acid and one  
 (d) hypophosphoric acid and two
71. The structural formula of hypophosphorous acid is  
 (a)  (b)   
 (c)  (d) 
72. Number of sigma bonds in  $\text{P}_4\text{O}_{10}$  is  
 (a) 6 (b) 7  
 (c) 17 (d) 16.
73. The number of hydrogen atom(s) attached to phosphorus atom in hypophosphorous acid is  
 (a) three (b) one  
 (c) two (d) zero
74. The number of P – O – P bonds in cyclic metaphosphoric acid is  
 (a) zero (b) two  
 (c) three (d) four
75. Oxidation states of P in  $\text{H}_4\text{P}_2\text{O}_5$ ,  $\text{H}_4\text{P}_2\text{O}_6$ , and  $\text{H}_4\text{P}_2\text{O}_7$ , are respectively:  
 (a) +3, +5, +4 (b) +5, +3, +4  
 (c) +5, +4, +3 (d) +3, +4, +5
76. How many bridging oxygen atoms are present in  $\text{P}_4\text{O}_{10}$ ?  
 (a) 5 (b) 6  
 (c) 4 (d) 2
77. Which of the following statements is not valid for oxoacids of phosphorus?  
 (a) Orthophosphoric acid is used in the manufacture of triple superphosphate.  
 (b) Hypophosphorous acid is a diprotic acid.  
 (c) All oxoacids contain tetrahedral four coordinated phosphorus.  
 (d) All oxoacids contain atleast one P = O and one P — OH group.
78. What is hybridization of P in  $\text{PCl}_5$ ?  
 (a)  $sp^3$  (b)  $sp^3d^2$   
 (c)  $sp^3d$  (d)  $sp^2$
79. Which of the following is a cyclic phosphate?  
 (a)  $\text{H}_3\text{P}_3\text{O}_{10}$  (b)  $\text{H}_6\text{P}_4\text{O}_{13}$   
 (c)  $\text{H}_5\text{P}_5\text{O}_{15}$  (d)  $\text{H}_7\text{P}_5\text{O}_{16}$
80. P—O—P bond is present in  
 (a)  $\text{H}_4\text{P}_2\text{O}_6$  (b)  $\text{H}_4\text{P}_2\text{O}_5$   
 (c) Both (a) and (b) (d) Neither (a) nor (b)
81. Orthophosphoric acid is  
 (a) monobasic (b) dibasic  
 (c) tribasic (d) tetrabasic
82. The oxyacid of phosphorous in which phosphorous has the lowest oxidation state is  
 (a) hypophosphorous acid  
 (b) orthophosphoric acid  
 (c) pyrophosphoric acid  
 (d) metaphosphoric acid
83. The number of P—O—P bonds in cyclic metaphosphoric acid is  
 (a) zero (b) two  
 (c) three (d) four
84. Among the oxyacids of phosphorus, the dibasic acid is  
 (a)  $\text{H}_4\text{P}_2\text{O}_7$  (b)  $\text{H}_3\text{PO}_2$   
 (c)  $\text{HPO}_3$  (d)  $\text{H}_3\text{PO}_3$
85. The basicity of pyrophosphorus acid is  
 (a) 2 (b) 4  
 (c) 1 (d) 5
86. The oxidation state of phosphorus in cyclotrimetaphosphoric acid is  
 (a) +3 (b) +5  
 (c) -3 (d) +2
87. Which acid has P – P linkage?  
 (a) Hypophosphoric acid (b) Pyrophosphoric acid  
 (c) Metaphosphoric acid (d) Orthophosphoric acid

88. In a cyclotrimetaphosphoric acid molecule, how many single and double bonds are present?  
 (a) 3 double bonds; 9 single bonds  
 (b) 6 double bonds; 6 single bonds  
 (c) 3 double bonds; 12 single bonds  
 (d) Zero double bonds; 12 single bonds
89. Strong reducing behaviour of  $\text{H}_3\text{PO}_2$  is due to  
 (a) Low oxidation state of phosphorus  
 (b) Presence of two  $-\text{OH}$  groups and one  $\text{P}-\text{H}$  bond  
 (c) Presence of one  $-\text{OH}$  group and two  $\text{P}-\text{H}$  bonds  
 (d) High electron gain enthalpy of phosphorus
90. In solid state  $\text{PCl}_5$  is a \_\_\_\_\_.  
 (a) covalent solid  
 (b) octahedral structure  
 (c) ionic solid with  $[\text{PCl}_6]^+$  octahedral and  $[\text{PCl}_4]^-$  tetrahedra  
 (d) ionic solid with  $[\text{PCl}_4]^+$  tetrahedral and  $[\text{PCl}_6]^-$  octahedra
91. Electron affinity of sulphur is  
 (a) more than O and Se  
 (b) more than O but less than Se  
 (c) less than O but more than Se  
 (d) equal to O and Se
92. All the elements of oxygen family are  
 (a) non metals (b) metalloids  
 (c) radioactive (d) polymorphic
93. Which shows maximum catenation property?  
 (a) S (b) Se  
 (c) Te (d) O
94. Oxygen and sulphur both are the members of the same group in periodic table but  $\text{H}_2\text{O}$  is liquid while  $\text{H}_2\text{S}$  is gas because  
 (a) molecular weight of water is more  
 (b) electronegativity of sulphur is more  
 (c)  $\text{H}_2\text{S}$  is weak acid  
 (d) water molecules are having weak hydrogen bonds between them
95. Which of the following hydrides has the lowest boiling point?  
 (a)  $\text{H}_2\text{O}$  (b)  $\text{H}_2\text{S}$   
 (c)  $\text{H}_2\text{Se}$  (d)  $\text{H}_2\text{Te}$
96. Which of the following hydrides is most acidic?  
 (a)  $\text{H}_2\text{Te}$  (b)  $\text{H}_2\text{Se}$   
 (c)  $\text{H}_2\text{O}$  (d)  $\text{H}_2\text{S}$
97. Which of the following hydrides shows the highest boiling point?  
 (a)  $\text{H}_2\text{O}$  (b)  $\text{H}_2\text{S}$   
 (c)  $\text{H}_2\text{Se}$  (d)  $\text{H}_2\text{Te}$
98. Which is the best oxidising agent among the following?  
 (a) S (b) O  
 (c) Se (d) Te
99. Which of the following oxide is amphoteric?  
 (a)  $\text{SnO}_2$  (b)  $\text{CaO}$   
 (c)  $\text{SiO}_2$  (d)  $\text{CO}_2$
100. Which of the following is not correctly matched?  
 (a)  $\text{SF}_4$  – gas (b)  $\text{SeF}_4$  – liquid  
 (c)  $\text{TeF}_4$  – solid (d)  $\text{SF}_6$  – solid
101. The compound which gives off oxygen on moderate heating is:  
 (a) cupric oxide (b) mercuric oxide  
 (c) zinc oxide (d) aluminium oxide
102. Oxygen molecule is  
 (a) diamagnetic with no-unpaired electron(s)  
 (b) diamagnetic with two unpaired electrons  
 (c) paramagnetic with two unpaired electrons  
 (d) paramagnetic with no unpaired electron(s)
103. The number of electrons that are paired in oxygen molecule are  
 (a) 16 (b) 12  
 (c) 14 (d) 7
104. On heating  $\text{KClO}_3$  we get  
 (a)  $\text{KClO}_2 + \text{O}_2$  (b)  $\text{KCl} + \text{O}_2$   
 (c)  $\text{KCl} + \text{O}_3$  (d)  $\text{KCl} + \text{O}_2 + \text{O}_3$
105. Which of the following is not oxidized by  $\text{O}_3$ ?  
 (a) KI (b)  $\text{FeSO}_4$   
 (c)  $\text{KMnO}_4$  (d)  $\text{K}_2\text{MnO}_4$
106. About 20 km above the earth, there is an ozone layer. Which one of the following statements about ozone and ozone layer is true?  
 (a) Ozone has a triatomic linear molecule  
 (b) It is harmful as it stops useful radiation  
 (c) It is beneficial to us as it stops U.V radiation  
 (d) Conversion of  $\text{O}_3$  to  $\text{O}_2$  is an endothermic reaction
107. Oxygen gas can be prepared from solid  $\text{KMnO}_4$  by :  
 (a) treating the solid with  $\text{H}_2$  gas  
 (b) strongly heating the solid  
 (c) dissolving the solid in dil.  $\text{H}_2\text{SO}_4$   
 (d) dissolving solid in dil.  $\text{HCl}$
108. Which of the following statements is correct :  
 (a) Ozone is a resonance hybrid of oxygen  
 (b) Ozone is an isomer of oxygen  
 (c) Ozone has no relationship with oxygen  
 (d) Ozone is an allotropic modification of oxygen
109. Which of the following on thermal decomposition gives oxygen gas?  
 (a)  $\text{Ag}_2\text{O}$  (b)  $\text{Pb}_3\text{O}_4$   
 (c)  $\text{PbO}_2$  (d) All of these
110. Which of the following is an acidic oxide?  
 (a)  $\text{Mn}_2\text{O}_7$  (b)  $\text{Na}_2\text{O}$   
 (a)  $\text{N}_2\text{O}$  (b)  $\text{BaO}$
111. Atomicity of sulphur in rhombic sulphur is  
 (a) 1 (b) 2  
 (c) 8 (d) 6
112. Which of the following form of the sulphur shows paramagnetic behaviour?  
 (a)  $\text{S}_8$  (b)  $\text{S}_6$   
 (c)  $\text{S}_2$  (d) All of these

113. What is X in the following reaction ?  

$$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \xrightarrow{\text{X}} 2\text{SO}_3(\text{g})$$
 (a)  $\text{V}_2\text{O}_5$  (b)  $\text{CuO}$   
 (c)  $\text{CuCl}_2$  (d)  $\text{MnO}_2$
114. Which of the following oxo acid of sulphur has O–O bond ?  
 (a)  $\text{H}_2\text{S}_2\text{O}_7$  (b)  $\text{H}_2\text{S}_2\text{O}_8$   
 (c)  $\text{H}_2\text{S}_2\text{O}_6$  (d)  $\text{H}_2\text{S}_2\text{O}_5$
115. Carbohydrates on reaction with conc.  $\text{H}_2\text{SO}_4$  becomes charred due to  
 (a) hydrolysis (b) dehydration  
 (c) hydration (d) oxidation
116. Which of the following is the key step in the manufacture of sulphuric acid ?  
 (a) Burning of sulphur or sulphide ores in air to generate  $\text{SO}_2$   
 (b) Conversion of  $\text{SO}_2$  to  $\text{SO}_3$  by the reaction with oxygen in presence of catalyst.  
 (c) Absorption of  $\text{SO}_3$  in  $\text{H}_2\text{SO}_4$  to give oleum.  
 (d) Both (b) and (c)
117. Hybridization of S in  $\text{SO}_3$  is  
 (a)  $\text{sp}^2$  (b)  $\text{sp}^3$   
 (c)  $\text{sp}^2\text{d}$  (d)  $\text{sp}^3\text{d}^2$
118. By which of the following  $\text{SO}_2$  is formed ?  
 (a) Reaction of dil.  $\text{H}_2\text{SO}_4$  with  $\text{O}_2$   
 (b) Hydrolysis of dil.  $\text{H}_2\text{SO}_4$   
 (c) Reaction of conc.  $\text{H}_2\text{SO}_4$  with Cu  
 (d) None of these
119. Number of bonds in  $\text{SO}_2$  are  
 (a) two  $\sigma$  and two  $\pi$  (b) two  $\sigma$  and one  $\pi$   
 (c) two  $\sigma$  and three  $\pi$  (d) None of these
120. Bleaching action of  $\text{SO}_2$  is due to its  
 (a) oxidising property (b) acidic property  
 (c) reducing property (d) basic property
121. The acid which has a peroxy linkage is  
 (a) Sulphurous acid (b) Pyrosulphuric acid  
 (c) Dithionic acid (d) Caro's acid
122. S – S bond is not present in  
 (a)  $\text{S}_2\text{O}_4^{2-}$  (b)  $\text{S}_2\text{O}_5^{2-}$   
 (c)  $\text{S}_2\text{O}_3^{2-}$  (d)  $\text{S}_2\text{O}_7^{2-}$
123. Oleum is  
 (a) castor Oil (b) oil of vitriol  
 (c) fuming  $\text{H}_2\text{SO}_4$  (d) None of them
124. On addition of conc.  $\text{H}_2\text{SO}_4$  to a chloride salt, colourless fumes are evolved but in case of iodide salt, violet fumes come out. This is because  
 (a)  $\text{H}_2\text{SO}_4$  reduces HI to  $\text{I}_2$   
 (b) HI is of violet colour  
 (c) HI gets oxidised to  $\text{I}_2$   
 (d) HI changes to  $\text{HIO}_3$
125. Which of the following are peroxyacids of sulphur?  
 (a)  $\text{H}_2\text{SO}_5$  and  $\text{H}_2\text{S}_2\text{O}_8$  (b)  $\text{H}_2\text{SO}_5$  and  $\text{H}_2\text{S}_2\text{O}_7$   
 (c)  $\text{H}_2\text{S}_2\text{O}_7$  and  $\text{H}_2\text{S}_2\text{O}_8$  (d)  $\text{H}_2\text{S}_2\text{O}_6$  and  $\text{H}_2\text{S}_2\text{O}_7$
126. Hot conc.  $\text{H}_2\text{SO}_4$  acts as moderately strong oxidising agent. It oxidises both metals and nonmetals. Which of the following element is oxidised by conc.  $\text{H}_2\text{SO}_4$  into two gaseous products?  
 (a) Cu (b) S  
 (c) C (d) Zn
127. Caro's acid is  
 (a)  $\text{H}_2\text{SO}_3$  (b)  $\text{H}_3\text{S}_2\text{O}_5$   
 (c)  $\text{H}_2\text{SO}_5$  (d)  $\text{H}_2\text{S}_2\text{O}_8$
128. Sulphuric acid reacts with  $\text{PCl}_5$  to give  
 (a) thionyl chloride (b) sulphur monochloride  
 (c) sulphuryl chloride (d) sulphur tetrachloride
129. Which one of the following reacts with conc.  $\text{H}_2\text{SO}_4$ ?  
 (a) Au (b) Ag  
 (c) Pt (d) Pb
130. The number of dative bonds in sulphuric acid molecule is  
 (a) 0 (b) 1  
 (c) 2 (d) 4
131. What is the number of sigma ( $\sigma$ ) and pi ( $\pi$ ) bonds present in sulphuric acid molecule ?  
 (a)  $6\sigma, 2\pi$  (b)  $6\sigma, 0\pi$   
 (c)  $2\sigma, 4\pi$  (d)  $2\sigma, 2\pi$
132. Which characteristic is not correct about  $\text{H}_2\text{SO}_4$  ?  
 (a) Reducing agent (b) Oxidising agent  
 (c) Sulphonating agent (d) Highly viscous
133. Among F, Cl, Br and I the lowest ionization potential will be of  
 (a) fluorine (b) chlorine  
 (c) bromine (d) iodine
134. The electronegativity follows the order  
 (a)  $\text{F} > \text{O} > \text{Cl} > \text{Br}$  (b)  $\text{F} > \text{Cl} > \text{Br} > \text{O}$   
 (c)  $\text{O} > \text{F} > \text{Cl} > \text{Br}$  (d)  $\text{Cl} > \text{F} > \text{O} > \text{Br}$
135. The bond energies of  $\text{F}_2$ ,  $\text{Cl}_2$ ,  $\text{Br}_2$  and  $\text{I}_2$  are 155, 244, 193 and 151  $\text{kJ mol}^{-1}$  respectively. The weakest bond will be in  
 (a)  $\text{Br}_2$  (b)  $\text{Cl}_2$   
 (c)  $\text{F}_2$  (d)  $\text{I}_2$
136. The outer electronic structure of  $3s^2 3p^5$  is possessed by  
 (a) O (b) Cl  
 (c) Br (d) Ar
137. Electron gain enthalpy with negative sign of fluorine is less than that of chlorine due to :  
 (a) High ionization enthalpy of fluorine  
 (b) Smaller size of chlorine atom  
 (c) Smaller size of fluorine atom  
 (d) Bigger size of  $2p$  orbital of fluorine
138. Which one of the following order is correct for the bond energies of halogen molecules ?  
 (a)  $\text{I}_2 > \text{Cl}_2 > \text{Br}_2$  (b)  $\text{Br}_2 > \text{Cl}_2 > \text{I}_2$   
 (c)  $\text{I}_2 > \text{Br}_2 > \text{Cl}_2$  (d)  $\text{Cl}_2 > \text{Br}_2 > \text{I}_2$
139. The correct order of reactivity of halogens with alkalis is  
 (a)  $\text{F} > \text{Cl} > \text{Br} > \text{I}$  (b)  $\text{F} < \text{Cl} < \text{Br} < \text{I}$   
 (c)  $\text{F} < \text{Cl} < \text{Br} < \text{I}$  (d)  $\text{F} < \text{Cl} < \text{Br} > \text{I}$



140. The correct order of increasing oxidising power is  
 (a)  $F_2 > Br_2 > Cl_2 > I_2$  (b)  $F_2 < Cl_2 < Br_2 < I_2$   
 (c)  $Cl_2 > Br_2 > F_2 > I_2$  (d)  $I_2 < Br_2 < Cl_2 < F_2$
141. Fluorine is a stronger oxidising agent than chlorine in aqueous solution. This is attributed to many factors except  
 (a) heat of dissociation (b) ionisation potential  
 (c) heat of hydration (d) electron affinity
142. Fluorine exhibits an oxidation state of only  $-1$  because  
 (a) it can readily accept an electron  
 (b) it is very strongly electronegative  
 (c) it is a non-metal  
 (d) it belongs to halogen family
143. Which of the following halogen does not exhibit positive oxidation state in its compounds?  
 (a) Cl (b) Br  
 (c) I (d) F
144. The halogen that is most easily reduced is  
 (a)  $F_2$  (b)  $Cl_2$   
 (c)  $Br_2$  (d)  $I_2$
145. Which one of the following elements shows more than one oxidation states?  
 (a) Sodium (b) Fluorine  
 (c) Chlorine (d) Potassium
146. Which of the following halogens exhibit only one oxidation state in its compounds?  
 (a) Bromine (b) Chlorine  
 (c) Fluorine (d) Iodine
147. Which of the following is the best description for the behaviour of bromine in the reaction given below?  
 $H_2O + Br_2 \rightarrow HOBr + HBr$   
 (a) Proton acceptor only  
 (b) Both oxidized and reduced  
 (c) Oxidized only  
 (d) Reduced only
148. Among the following which is the strongest oxidising agent?  
 (a)  $Br_2$  (b)  $I_2$   
 (c)  $Cl_2$  (d)  $F_2$
149. The correct order of heat of formation of halogen acids is  
 (a)  $HI > HBr > HCl > HF$  (b)  $HF > HCl > HBr > HI$   
 (c)  $HCl > HF > HBr > HI$  (d)  $HCl > HBr > HF > HI$
150. Which is the weakest out of HF, HCl, HBr and HI?  
 (a) HF (b) HCl  
 (c) HBr (d) HI
151. Which of the following is most volatile?  
 (a) HI (b) HBr  
 (c) HCl (d) HF
152. At room temperature, HCl is a gas while HF is a low boiling liquid. This is because  
 (a) H-F bond is covalent (b) H-F bond is ionic  
 (c) HF has metallic bond (d) HF has hydrogen bond
153. The bleaching action of chlorine is due to  
 (a) reduction (b) hydrogenation  
 (c) chlorination (d) oxidation
154.  $Cl_2$  reacts with hot and conc. NaOH to give –  
 (a) NaClO (b)  $NaClO_3$   
 (c)  $NaClO_2$  (d)  $NaClO_4$
155. When chlorine reacts with cold and dilute solution of sodium hydroxide, the products obtained are  
 (a)  $Cl^- + ClO^-$  (b)  $Cl^- + ClO_2^-$   
 (c)  $Cl^- + ClO_3^-$  (d)  $Cl^- + ClO_4^-$
156. Chlorine is liberated when we heat  
 (a)  $KMnO_4 + NaCl$  (b)  $K_2Cr_2O_7 + MnO_2$   
 (c)  $Pb(NO_3)_2 + MnO_2$  (d)  $K_2Cr_2O_7 + HCl$
157. Which of the following is used in the preparation of chlorine?  
 (a) Only  $MnO_2$   
 (b) Only  $KMnO_4$   
 (c) Both  $MnO_2$  and  $KMnO_4$   
 (d) Either  $MnO_2$  or  $KMnO_4$
158. The reaction of  $KMnO_4$  and HCl results in  
 (a) oxidation of Mn in  $KMnO_4$  and production of  $Cl_2$   
 (b) reduction of Mn in  $KMnO_4$  and production of  $H_2$   
 (c) oxidation of Mn in  $KMnO_4$  and production of  $H_2$   
 (d) reduction of Mn in  $KMnO_4$  and production of  $Cl_2$
159. Bleaching powder on standing forms mixture of:  
 (a)  $CaO + Cl_2$  (b)  $CaO + CaCl_2$   
 (c)  $HOCl + Cl_2$  (d)  $CaCl_2 + Ca(ClO_3)_2$
160. Hydrochloric acid at  $25^\circ C$  is  
 (a) ionic and liquid (b) covalent and liquid  
 (c) ionic and gas (d) None of these
161. Gaseous HCl is a poor conductor of electricity while its aqueous solution is a good conductor this is because  
 (a)  $H_2O$  is a good conductor of electricity  
 (b) a gas cannot conduct electricity but a liquid can  
 (c) HCl gas does not obey Ohm's law, whereas the solution does  
 (d) HCl ionises in aqueous solution
162. Which one is most stable to heat –  
 (a) HClO (b)  $HClO_2$   
 (c)  $HClO_3$  (d)  $HClO_4$
163. Interhalogen compounds are more reactive than the individual halogen because  
 (a) two halogens are present in place of one  
 (b) they are more ionic  
 (c) their bond energy is less than the bond energy of the halogen molecule  
 (d) they carry more energy
164. Which of the following is not the characteristic of interhalogen compounds?  
 (a) They are more reactive than halogens  
 (b) They are quite unstable but none of them is explosive  
 (c) They are covalent in nature  
 (d) They have low boiling points and are highly volatile.
165. The hybridization in  $ICl_7$  is  
 (a)  $sp^3d^3$  (b)  $d^2sp^3$   
 (c)  $sp^3d$  (d)  $sp^3$

166. In which of the following reactions chlorine is both reduced and oxidized?  
 (a)  $2\text{KMnO}_4 + 16\text{HCl} \longrightarrow 2\text{KCl} + 2\text{MnCl}_2 + 8\text{H}_2\text{O} + 5\text{Cl}_2$   
 (b)  $6\text{NaOH} + 3\text{Cl}_2 \longrightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$   
 (c)  $\text{NH}_3 + 3\text{Cl}_2 \longrightarrow \text{NCl}_3 + 3\text{HCl}$   
 (d)  $\text{I}_2 + 6\text{H}_2\text{O} + 5\text{Cl}_2 \longrightarrow 2\text{HIO}_3 + 10\text{HCl}$
167. Which of the following is observed when  $\text{Cl}_2$  reacts with hot and concentrated  $\text{NaOH}$ ?  
 (a)  $\text{NaCl}, \text{NaOCl}$  (b)  $\text{NaCl}, \text{NaClO}_2$   
 (c)  $\text{NaCl}, \text{NaClO}_3$  (d)  $\text{NaOCl}, \text{NaClO}_3$
168. Which one of the following noble gases is not found in the atmosphere  
 (a) Rn (b) Kr  
 (c) Ne (d) Ar
169. The last member of the family of inert gases is  
 (a) argon (b) radon  
 (c) xenon (d) neon
170. Which of the following is the correct sequence of the noble gases in their group in the periodic table?  
 (a) Ar, He, Kr, Ne, Rn, Xe (b) He, Ar, Ne, Kr, Xe, Rn  
 (c) He, Ne, Kr, Ar, Xe, Rn (d) He, Ne, Ar, Kr, Xe, Rn
171. Which of the following noble gases *do not* have an octet of electrons in its outermost shell?  
 (a) Neon (b) Radon  
 (c) Argon (d) Helium
172. Number of unpaired electrons in inert gas is  
 (a) zero (b) 8  
 (c) 4 (d) 18
173. In the following four elements, the ionisation potential of which one is the highest?  
 (a) Oxygen (b) Argon  
 (c) Barium (d) Cesium
174. Gradual addition of electronic shells in the noble gases causes a decrease in their  
 (a) ionisation energy (b) atomic radius  
 (c) boiling point (d) density
175. Which of the following noble gas is least polarisable?  
 (a) He (b) Xe  
 (c) Ar (d) Ne
176. In which of the following groups, when He is placed, its all the properties are satisfied  
 (a) with alkali metals (b) with halogens  
 (c) with inert gases (d) None of these
177. The most abundant inert gas in the atmosphere is  
 (a) He (b) Ne  
 (c) Ar (d) Kr
178. The lowest boiling point of helium is due to its  
 (a) inertness  
 (b) gaseous nature  
 (c) high polarisability  
 (d) weak van der Waal's forces between atoms
179. Which of the noble gas has highest polarisability?  
 (a) He (b) Ar  
 (c) Kr (d) Xe
180. The noble gas which was discovered first in the sun and then on the earth  
 (a) argon (b) xenon  
 (c) neon (d) helium
181. A radioactive element X decays to give two inert gases X is  
 (a)  ${}_{92}^{238}\text{U}$  (b)  ${}_{88}^{226}\text{Ra}$   
 (c) Both (a) and (b) (d) Neither (a) nor (b)
182. Which of the following noble gases has the highest positive electron gain enthalpy value?  
 (a) Helium (b) Krypton  
 (c) Argon (d) Neon
183. Which inert gas show abnormal behaviour on liquefaction  
 (a) Xe (b) He  
 (c) Ar (d) Kr
184. The ease of liquefaction of noble gases increases in the order  
 (a)  $\text{He} < \text{Ne} < \text{Ar} < \text{Kr} < \text{Xe}$   
 (b)  $\text{Xe} < \text{Kr} < \text{Ne} < \text{Ar} < \text{He}$   
 (c)  $\text{Kr} < \text{Xe} < \text{He} < \text{Ne} < \text{Ar}$   
 (d)  $\text{Ar} < \text{Kr} < \text{Xe} < \text{Ne} < \text{He}$
185. The correct order of solubility in water for He, Ne, Ar, Kr, Xe is  
 (a)  $\text{He} > \text{Ne} > \text{Ar} > \text{Kr} > \text{Xe}$   
 (b)  $\text{Ne} > \text{Ar} > \text{Kr} > \text{He} > \text{Xe}$   
 (c)  $\text{Xe} > \text{Kr} > \text{Ar} > \text{Ne} > \text{He}$   
 (d)  $\text{Ar} > \text{Ne} > \text{He} > \text{Kr} > \text{Xe}$
186. Which one of the following elements is most reactive?  
 (a) He (b) Ne  
 (c) Ar (d) Xe
187. Noble gases are group of elements which exhibit very  
 (a) high chemical activity  
 (b) low chemical activity  
 (c) minimum electronegativity  
 (d) much paramagnetic properties
188. In  $\text{XeF}_2$ ,  $\text{XeF}_4$ ,  $\text{XeF}_6$  the number of lone pairs on Xe are respectively  
 (a) 2, 3, 1 (b) 1, 2, 3  
 (c) 4, 1, 2 (d) 3, 2, 1.
189. Total number of lone pair of electrons in  $\text{XeOF}_4$  is  
 (a) 0 (b) 1  
 (c) 2 (d) 3
190. Noble gases do not react with other elements because  
 (a) they have completely filled valence shell ( $ns^2np^6$ )  
 (b) the sizes of their atoms are very small  
 (c) they are not found in abundance  
 (d) they are monoatomic
191. Which one of the following reactions of xenon compounds is not feasible?  
 (a)  $3\text{XeF}_4 + 6\text{H}_2\text{O} \longrightarrow 2\text{Xe} + \text{XeO}_3 + 12\text{HF} + 1.5\text{O}_2$   
 (b)  $2\text{XeF}_2 + 2\text{H}_2\text{O} \longrightarrow 2\text{Xe} + 4\text{HF} + \text{O}_2$   
 (c)  $\text{XeF}_6 + \text{RbF} \longrightarrow \text{Rb}[\text{XeF}_7]$   
 (d)  $\text{XeO}_3 + 6\text{HF} \longrightarrow \text{XeF}_6 + 3\text{H}_2\text{O}$

192. Which of the following has maximum number of lone pairs associated with Xe ?  
 (a)  $\text{XeF}_4$  (b)  $\text{XeF}_6$   
 (c)  $\text{XeF}_2$  (d)  $\text{XeO}_3$
193. The shape of  $\text{XeO}_2\text{F}_2$  molecule is  
 (a) trigonal bipyramidal (b) square planar  
 (c) tetrahedral (d) see-saw
194.  $\text{XeF}_4$  on partial hydrolysis produces  
 (a)  $\text{XeF}_4$  (b)  $\text{XeOF}_2$   
 (c)  $\text{XeOF}_4$  (d)  $\text{XeO}_3$
195. Which element out of He, Ar, Kr and Xe forms least number of compounds ?  
 (a) He (b) Ar  
 (c) Kr (d) Xe
196. The element which has not yet been reacted with  $\text{F}_2$  is  
 (a) Ar (b) Xe  
 (c) Kr (d) Rn
197.  $\text{XeF}_6$  on complete hydrolysis gives  
 (a) Xe (b)  $\text{XeO}_2$   
 (c)  $\text{XeO}_3$  (d)  $\text{XeO}_4$
198.  $\text{XeF}_4$  involves which hybridization  
 (a) sp (b)  $sp^2$   
 (c)  $sp^2d$  (d)  $sp^3d^2$
199. Shape of  $\text{XeOF}_4$  is  
 (a) octahedral (b) square pyramidal  
 (c) pyramidal (d) T-shaped
200. The hybridization of Xe in  $\text{XeF}_2$  is  
 (a)  $sp^3$  (b)  $sp^2$   
 (c)  $sp^3d$  (d)  $sp^2d$
201. Which is a planar molecule ?  
 (a)  $\text{XeO}_4$  (b)  $\text{XeF}_4$   
 (c)  $\text{XeOF}_4$  (d)  $\text{XeO}_2\text{F}_2$
202. Which of the following has  $sp^3$  hybridization ?  
 (a)  $\text{XeO}_3$  (b)  $\text{BCl}_3$   
 (c)  $\text{XeF}_4$  (d)  $\text{BBR}_3$
203. The number of lone pair of electrons present on Xe in  $\text{XeF}_2$  is  
 (a) 3 (b) 4  
 (c) 2 (d) 1
204. Hybridization and structure of  $\text{XeF}_4$  is  
 (a)  $sp^3d$ , trigonal bipyramidal  
 (b)  $sp^3$ , tetrahedral  
 (c)  $sp^3d^2$ , square planar  
 (d)  $sp^3d^2$ , hexagonal
205. Number of lone pairs of electrons on Xe atoms  $\text{XeF}_2$ ,  $\text{XeF}_4$  and  $\text{XeF}_6$  molecules are respectively  
 (a) 3, 2 and 1 (b) 4, 3 and 2  
 (c) 2, 3 and 1 (d) 3, 2 and 0
206. Which one of the following is correct pair with respect to molecular formula of xenon compound and hybridization state of Xenon in it?  
 (a)  $\text{XeF}_4$ ,  $sp^3$  (b)  $\text{XeF}_2$ ,  $sp$   
 (c)  $\text{XeF}_2$ ,  $sp^3d$  (d)  $\text{XeF}_4$ ,  $sp^2$
207. Which statement about noble gases is not correct?  
 (a) Xe forms  $\text{XeF}_6$   
 (b) Ar is used in electric bulbs  
 (c) Kr is obtained during radioactive disintegration  
 (d) He has the lowest b.pt among all the noble gases
208. The geometry of  $\text{XeF}_6$  is  
 (a) planar hexagon (b) regular octahedron  
 (c) distorted octahedron (d) square bipyramid
209. Trigonal bipyramidal geometry is shown by :  
 (a)  $\text{XeO}_3\text{F}_2$  (b)  $\text{XeO}_3\text{F}_2$   
 (c)  $\text{FXeOSO}_2\text{F}$  (d)  $[\text{XeF}_8]^{2-}$
210. Which has trigonal bipyramidal shape ?  
 (a)  $\text{XeOF}_4$  (b)  $\text{XeO}_3$   
 (c)  $\text{XeO}_3\text{F}_2$  (d)  $\text{XeOF}_2$
211. Argon is used  
 (a) in filling airships  
 (b) to obtain low temperature  
 (c) in high temperature welding  
 (d) in radiotherapy for treatment of cancer
212. Noble gases are used in discharge tubes to give different colours. Reddish orange glow is due to  
 (a) Ar (b) Ne  
 (c) Xe (d) Kr
213. Which one of the following statements regarding helium is incorrect ?  
 (a) It is used to produce and sustain powerful superconducting magnets.  
 (b) It is used as a cryogenic agent for carrying out experiments at low temperatures.  
 (c) It is used to fill gas balloons instead of hydrogen because it is lighter and non-inflammable.  
 (d) It is used in gas-cooled nuclear reactors.
214. The coloured discharge tubes for advertisement mainly contain  
 (a) xenon (b) helium  
 (c) neon (d) argon
215. Sea divers go deep in the sea water with a mixture of which of the following gases  
 (a)  $\text{O}_2$  and He (b)  $\text{O}_2$  and Ar  
 (c)  $\text{O}_2$  and  $\text{CO}_2$  (d)  $\text{CO}_2$  and Ar
216. Which of the following is the life saving mixture for an asthma patient ?  
 (a) Mixture of helium and oxygen  
 (b) Mixture of neon and oxygen  
 (c) Mixture of xenon and nitrogen  
 (d) Mixture of argon and oxygen
217. Which of the following statements are true?  
 (i) Only type of interactions between particles of noble gases are due to weak dispersion forces.  
 (ii) Ionisation enthalpy of molecular oxygen is very close to that of xenon.  
 (iii) Hydrolysis of  $\text{XeF}_6$  is redox reaction.  
 (iv) Xenon fluorides are not reactive.  
 (a) (i) and (iii) (b) (i) and (ii)  
 (c) (ii) and (iii) (d) (iii) and (iv)

218. Which of the following element has the property of diffusing through most commonly used laboratory materials such as rubber, glass or plastics.
- (a) Xe (b) Rn  
(c) He (d) Ar
219. Which of the following is used to produce and sustain powerful superconducting magnets to form an essential part of NMR spectrometer ?
- (a) Ar (b) Ne  
(c) Rn (d) He

### STATEMENT TYPE QUESTIONS

220. Which of the following statements are correct?
- (i) Arsenic and antimony are metalloids.  
(ii) Phosphorus, arsenic and antimony are found mainly as sulphide minerals.  
(iii) Covalent radii increases equally from N to Bi.  
(iv) Elements of group 15 have extra stability and higher ionisation energy due to exactly half filled  $ns^2np^3$  electronic configuration.  
(v) In group 15 elements only nitrogen is gas whereas all others are solids.
- (a) (i), (iv) and (v) (b) (ii), (iii) and (iv)  
(c) (i), (ii) and (iii) (d) (ii), (iii) and (v)
221. Read the following statements regarding chemical reactivity of group 15 elements.
- (i) Only compound of Bi with +5 oxidation state is  $\text{BiF}_5$ .  
(ii) Intermediate oxidation states for both nitrogen and phosphorus disproportionate in both acid and alkali.  
(iii) Nitrogen due to absence of d-orbitals in its valence shell cannot form  $d\pi-p\pi$  bond as the heavier elements thus  $\text{R}_3\text{P}=\text{O}$  exists but  $\text{R}_3\text{N}=\text{O}$  does not exist.  
(iv)  $\text{BiH}_3$  is the strongest reducing agent amongst the hydrides of nitrogen family.  
(v)  $\text{P}_2\text{O}_3$  is more acidic than  $\text{P}_2\text{O}_5$ .
- Which of the following is the correct code for the statements above?
- (a) FTFFT (b) FFTTF  
(c) TFTTF (d) TFTFT
222. Which of the following statements are correct?
- (i) All the three N—O bond lengths in  $\text{HNO}_3$  are equal.  
(ii) All P—Cl bond lengths in  $\text{PCl}_5$  molecule in gaseous state are equal.  
(iii)  $\text{P}_4$  molecule in white phosphorus have angular strain therefore white phosphorus is very reactive.  
(iv)  $\text{PCl}_5$  is ionic in solid state in which cation is tetrahedral and anion is octahedral.
- (a) (i) and (iv) (b) (iii) and (iv)  
(c) (ii) and (iii) (d) (ii) only
223. Which of the following is the correct code for statements below ?
- (i) Due to small size oxygen has less negative electron gain enthalpy than sulphur.  
(ii) Oxygen shows only -2 oxidation state whereas S, Se and Te shows +4 O.S in their compounds with oxygen and +6 with fluorine.

- (iii) All hydrides of oxygen family possess reducing property which increases from  $\text{H}_2\text{S}$  to  $\text{H}_2\text{Te}$ .  
(iv) Among hexahalides of group 16 hexafluorides are the only stable halides.  
(v) Dimeric monohalides of group 16 undergo disproportionation.
- (a) TFFTT (b) FTTF  
(c) FTFTF (d) TFTFT
224. The correct statement(s) about  $\text{O}_3$  is(are)
- (i) O—O bond lengths are equal  
(ii) Thermal decomposition of  $\text{O}_3$  is endothermic  
(iii)  $\text{O}_3$  is diamagnetic in nature  
(iv)  $\text{O}_3$  has a bent structure
- (a) (i) and (iii) (b) (ii) and (iii)  
(c) (i), (ii) and (iv) (d) (i) and (iv)

225. Consider the following statements

- (i) Reaction  $2\text{Fe}^{3+} + \text{SO}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{Fe}^{2+} + \text{SO}_4^{2-} + 4\text{H}^+$  shows reducing character of sulphur dioxide  
(ii)  $\text{H}_2\text{S}_2\text{O}_8$  contains four S = O, two S—OH and one O—O bond  
(iii)  $\text{NH}_3$  gas can be dried effectively by using conc.  $\text{H}_2\text{SO}_4$ .  
(iv) One of the major use of  $\text{H}_2\text{SO}_4$  is in the manufacture of fertilizers.

Which of the following is the correct code for the statements above?

- (a) TTFF (b) TTFT  
(c) FTFT (d) TFTT
226. Which of the following statements regarding properties of halogens are correct?
- (i) Due to small size electron gain enthalpy of fluorine is less than that of chlorine.  
(ii) Iodine has same physical state but different colour as compare to other members of the group.  
(iii) Fluorine shows no positive oxidation state.  
(iv) In  $\text{X}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \longrightarrow \text{HX}(\text{aq}) + \text{HOX}(\text{aq})$  (where  $\text{X}_2 = \text{Cl}$  or  $\text{Br}$ )
- (a) (i), (ii) and (iv) (b) (i), (iii) and (iv)  
(c) (ii), (iii) and (iv) (d) (iii) and (iv)
227. Consider the following statements regarding interhalogen compounds
- (i) For all types of interhalogen compounds  $(\text{XX}^1, \text{XX}_3^1, \text{XX}_5^1 \text{ and } \text{XX}_7^1)$  X is the halogen of lesser electronegativity in comparison to  $\text{X}^1$ .  
(ii) At 298 K all interhalogen compounds are either volatile solids or liquids.  
(iii)  $\text{ClF}$  undergoes hydrolysis as below,  
 $\text{ClF} + \text{H}_2\text{O} \longrightarrow \text{HF} + \text{HOCl}$   
(iv) Fluorine containing interhalogen compounds are very useful as fluorinating agents.
- (a) TTFF (b) TTFT  
(c) FTFT (d) TFTT

228. Which of the following statements are correct?
- Among halogens, radius ratio between iodine and fluorine is maximum.
  - Leaving F—F bond, all halogens have weaker X—X bond than X—X' bond in interhalogens.
  - Among interhalogen compounds maximum number of atoms are present in iodine fluoride.
  - Interhalogen compounds are more reactive than halogen compounds.
- (i) and (ii)
  - (i), (ii) and (iii)
  - (ii) and (iii)
  - (i), (iii) and (iv)
229. Which of the following statements are correct?
- Natural abundance of noble gases is ~ 1% by volume of which Ar is the major constituent.
  - Noble gases have high positive values of electron gain enthalpy.
  - Preparation of XeF<sub>2</sub> requires F<sub>2</sub> in excess amount.
  - Complete hydrolysis of all three XeF<sub>2</sub>, XeF<sub>4</sub> and XeF<sub>6</sub> gives Xe as one of product.
- (i) and (iii)
  - (ii) and (iv)
  - (i) and (ii)
  - (ii) and (iii)

### MATCHING TYPE QUESTIONS

230. Match the columns

- | Column-I  | Column-II   |
|---|---|
| (A) $2\text{Pb}(\text{NO}_3)_2 \xrightarrow{673\text{K}} 4\text{NO}_2 + 2\text{PbO} + \text{O}_2$ | (p) High pressure favours the formation of product          |
| (B) $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g})$         | (q) Product formed is acidic brown gas                      |
| (C) $\text{NH}_4\text{NO}_3 \xrightarrow{\Delta} \text{N}_2\text{O} + 2\text{H}_2\text{O}$        | (r) This reaction occurs at a high temperature about 2000 K |
| (D) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$      | (s) Product formed is a neutral colourless gas              |
- A – (r, s), B – (q), C – (s), D – (p)
  - A – (q), B – (r, s), C – (s), D – (p)
  - A – (q), B – (s), C – (r, s), D – (p)
  - A – (q), B – (r, s), C – (p), D – (s)

231. Match the columns

- | Column - I                                   | Column - II     |
|--|-----------------|
| (A) Used in manufacture of calcium cyanamide | (p) Ammonia     |
| (B) Used in manufacture of nitric acid       | (q) Nitric acid |
| (C) Used in pickling of stainless steel      | (r) Dinitrogen  |
- A – (r), B – (p), C – (q)
  - A – (p), B – (r), C – (q)
  - A – (r), B – (q), C – (p)
  - A – (q), B – (p), C – (r)

232. Match the columns.

- | Column-I<br>(Oxyacid)                            | Column-II<br>(Materials for preparation)              |
|--|---|
| (A) H <sub>3</sub> PO <sub>2</sub>               | (p) Red P + alkali                                    |
| (B) H <sub>3</sub> PO <sub>3</sub>               | (q) P <sub>4</sub> O <sub>10</sub> + H <sub>2</sub> O |
| (C) H <sub>3</sub> PO <sub>4</sub>               | (r) P <sub>2</sub> O <sub>3</sub> + H <sub>2</sub> O  |
| (D) H <sub>4</sub> P <sub>2</sub> O <sub>6</sub> | (s) White P + alkali                                  |
- (A) – (s), (B) – (r), (C) – (q), (D) – (p)
  - (A) – (p), (B) – (r), (C) – (q), (D) – (s)
  - (A) – (s), (B) – (r), (C) – (p), (D) – (q)
  - (A) – (q), (B) – (r), (C) – (p), (D) – (s)

233. Match the columns

- | Column - I                                       | Column - II   |
|--|---|
| (A) POCl <sub>3</sub>                            | (p) Contains four P – OH two P = O and one P – O – P                        |
| (B) H <sub>4</sub> P <sub>2</sub> O <sub>5</sub> | (q) Yellowish white chloride of phosphorus reacts with moist air            |
| (C) H <sub>4</sub> P <sub>2</sub> O <sub>6</sub> | (r) Contains four P – OH, two P = O and one P – P bond                      |
| (D) H <sub>4</sub> P <sub>2</sub> O <sub>7</sub> | (s) Colourless oily chloride of phosphorus reacts with orthophosphoric acid |
- A – (q), B – (s), C – (p), D – (r)
  - A – (s), B – (q), C – (r), D – (p)
  - A – (q), B – (s), C – (r), D – (p)
  - A – (q), B – (r), C – (s), D – (p)

234. Match the columns

- | Column - I  | Column - II   |
|---|---------------|
| (A) Metal that shows no reaction with dioxygen  | (p) Platinum  |
| (B) Metal forms strong acidic oxide with oxygen   | (q) Nitrogen  |
| (C) A non-metal discharge of whose oxide might be slowly depleting the concentration of the ozone layer | (r) Manganese |
- (a) A – (p), B – (r), C – (q), D – (s)
  - (b) A – (r), B – (p), C – (q), D – (s)
  - (c) A – (p), B – (q), C – (r), D – (s)
  - (d) A – (p), B – (r), C – (s), D – (q)



235. Match the columns.

Column-I	Column-II
(A) $\text{Pb}_3\text{O}_4$	(p) Neutral oxide
(B) $\text{N}_2\text{O}$	(q) Acidic oxide
(C) $\text{Mn}_2\text{O}_7$	(r) Basic oxide
(D) $\text{Bi}_2\text{O}_3$	(s) Mixed oxide
(a) A – (p), B – (q), C – (r), D – (s)	
(b) A – (s), B – (p), C – (q), D – (r)	
(c) A – (r), B – (q), C – (s), D – (p)	
(d) A – (s), B – (r), C – (p), D – (q)	

236. Match the columns.

Column-I	Column-II
(A) $\text{SF}_4$	(p) Tetrahedral
(B) $\text{BrF}_3$	(q) Pyramidal
(C) $\text{BrO}_3^-$	(r) Sea-saw shaped
(D) $\text{NH}_4^+$	(s) Bent T-shaped
(a) A – (r), B – (q), C – (p), D – (s)	
(b) A – (r), B – (s), C – (q), D – (p)	
(c) A – (p), B – (q), C – (r), D – (s)	
(d) A – (p), B – (s), C – (r), D – (q)	

237. Match the columns

Column - I	Column - II
(A) $\text{HClO}_2$	(p) Contains all different bonds
(B) $\text{HClO}_3$	(q) Contains maximum Cl = O bond
(C) $\text{HClO}$	(r) Contains Cl with lowest O.S.
(D) $\text{HClO}_4$	(s) Contains three types of bonds
(a) A – (s), B – (p, s), C – (p, r), D – (q, s)	
(b) A – (p, s), B – (s), C – (p, r), D – (q, s)	
(c) A – (s), B – (p, r), C – (p, s), D – (q, s)	
(d) A – (p, s), B – (s), C – (q, s), D – (p, r)	

238. Match the columns.

Column - I (Oxides of halogens)	Column - II (Uses)
(A) $\text{O}_2\text{F}_2$	(p) in water treatment
(B) $\text{ClO}_2$	(q) in estimation of CO
(C) $\text{I}_2\text{O}_5$	(r) for removing plutonium from spent nuclear fuel.
(a) A – (q), B – (p), C – (r)	
(b) A – (r), B – (p), C – (q)	
(c) A – (p), B – (r), C – (q)	
(d) A – (r), B – (q), C – (p)	

239. Match the columns

Column - I	Column - II
(A) $\text{XeF}_4$	(p) Contains similar types of bonds
(B) $\text{XeOF}_4$	(q) Contains maximum lone pair
(C) $\text{XeF}_2$	(r) Square pyramidal geometry
(D) $\text{XeO}_3$	(s) Contains one lone pair

- (a) A – (p), B – (r, s), C – (p, q), D – (p, s)  
 (b) A – (r, s), B – (p), C – (r, s), D – (p, s)  
 (c) A – (p), B – (p, q), C – (r, s), D – (p, s)  
 (d) A – (p), B – (r, s), C – (p, s), D – (p, q)

240. Match the columns.

Column-I	Column-II
(A) Partial hydrolysis of the compound does not change oxidation state of central atom	(p) He
(B) It is used in modern diving apparatus	(q) $\text{XeF}_6$
(C) It is used to provide inert atmosphere for filling electrical bulbs	(r) $\text{XeF}_4$
(D) Its central atom is in $sp^3d^2$ hybridisation	(s) Ar
(a) A – (p), B – (s), C – (p), D – (r)	
(b) A – (p), B – (q), C – (r), D – (s)	
(c) A – (q), B – (p), C – (s), D – (r)	
(d) A – (p), B – (r), C – (q), D – (s)	

241. Match the columns.

Column-I	Column-II
(A) $\text{XeF}_6$	(p) $sp^3d^3$ – distorted octahedral
(B) $\text{XeO}_3$	(q) $sp^3d^2$ – square planar
(C) $\text{XeOF}_4$	(r) $sp^3$ – pyramidal
(D) $\text{XeF}_4$	(s) $sp^3d^2$ – square pyramidal
(a) A – (p), B – (r), C – (s), D – (q)	
(b) A – (p), B – (q), C – (s), D – (r)	
(c) A – (s), B – (r), C – (p), D – (q)	
(d) A – (s), B – (p), C – (q), D – (s)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

242. **Assertion :** Dinitrogen is inert at room temperature.

**Reason :** Dinitrogen directly combines with lithium to form ionic nitrides.

243. **Assertion :**  $\text{N}_2$  is less reactive than  $\text{P}_4$ .

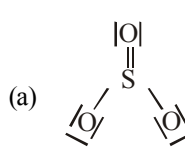
**Reason :** Nitrogen has more electron gain enthalpy than phosphorus.

244. **Assertion :** When a metal is treated with conc.  $\text{HNO}_3$  it generally yields a nitrate,  $\text{NO}_2$  and  $\text{H}_2\text{O}$ .

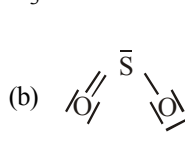
**Reason :** Conc.  $\text{HNO}_3$  reacts with metal and first produces a metal nitrate and nascent hydrogen. The nascent hydrogen then further reduces  $\text{HNO}_3$  to  $\text{NO}_2$ .

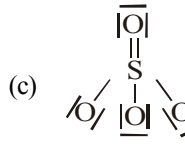
- 245. Assertion :** White phosphorus is more reactive than red phosphorus.  
**Reason :** Red phosphorus consists of  $P_4$  tetrahedral units linked to one another to form linear chains.
- 246. Assertion :** Bond angle of  $H_2S$  is smaller than  $H_2O$ .  
**Reason :** Electronegativity of the central atom increases, bond angle decreases.
- 247. Assertion :** Both rhombic and monoclinic sulphur exist as  $S_8$  but oxygen exists as  $O_2$ .  
**Reason :** Oxygen forms  $p\pi - p\pi$  multiple bond due to small size and small bond length but  $p\pi - p\pi$  bonding is not possible in sulphur.
- 248. Assertion :**  $SF_6$  cannot be hydrolysed but  $SF_4$  can be.  
**Reason :** Six F atoms in  $SF_6$  prevent the attack of  $H_2O$  on sulphur atom of  $SF_6$ .

### CRITICAL THINKING TYPE QUESTIONS

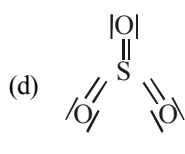
- 249.** In nitrogen family, the H-M-H bond angle in the hydrides gradually becomes closer to  $90^\circ$  on going from N to Sb. This shows that gradually  
 (a) The basic strength of the hydrides increases  
 (b) Almost pure p-orbitals are used for M-H bonding  
 (c) The bond energies of M-H bonds increase  
 (d) The bond pairs of electrons become nearer to the central atom
- 250.** Bond dissociation enthalpy of E—H (E = element) bonds is given below. Which of the compounds will act as strongest reducing agent?
- | Compound                           | $NH_3$ | $PH_3$ | $AsH_3$ | $SbH_3$ |
|------------------------------------|--------|--------|---------|---------|
| $\Delta_{diss} (E-H)/kJ\ mol^{-1}$ | 389    | 322    | 297     | 255     |
- (a)  $NH_3$  (b)  $PH_3$   
 (c)  $AsH_3$  (d)  $SbH_3$
- 251.** The deep blue colour produced on adding excess of ammonia to copper sulphate is due to presence of  
 (a)  $Cu^{2+}$  (b)  $Cu(NH_3)_4^{2+}$   
 (c)  $Cu(NH_3)_6^{2+}$  (d)  $Cu(NH_3)_2^{2+}$
- 252.** Blue solid which is obtained on reacting equimolar amounts of two gases at 245K is?  
 (a)  $N_2O$  (b)  $N_2O_3$   
 (c)  $N_2O_4$  (d)  $N_2O_5$
- 253.** Concentrated nitric acid, upon long standing, turns yellow brown due to the formation of  
 (a) NO (b)  $NO_2$   
 (c)  $N_2O$  (d)  $N_2O_4$
- 254.** In the reaction  
 $4HNO_3 + P_4O_{10} \rightarrow 4HPO_3 + X$ , the product X is  
 (a)  $N_2O_5$  (b)  $N_2O_3$   
 (c)  $NO_2$  (d)  $H_2O$
- 255.** Ammonia on catalytic oxidation gives an oxide from which nitric acid is obtained. The oxide is :  
 (a)  $N_2O_3$  (b) NO  
 (c)  $NO_2$  (d)  $N_2O_5$
- 256.** What is the change observed when AgCl reacts with  $NH_3$ ?  
 (a) White ppt is formed  
 (b) Solution become colourless  
 (c) Yellow ppt is formed  
 (d) No change is observed
- 257.** In which of the following equations the product formed has similar oxidation state for nitrogen?  
 (i)  $NH_4NO_3 \xrightarrow{\Delta} N_2O + 2H_2O$   
 (ii)  $2Pb(NO_3)_2 \xrightarrow{673K} 4NO_2 + 2PbO + O_2$   
 (iii)  $4HNO_3 + P_4O_{10} \rightarrow 4HPO_3 + 2N_2O_5$   
 (iv)  $2NO_2 \xrightleftharpoons[Heat]{Cool} N_2O_4$   
 (a) (i) and (iii) (b) (ii) and (iv)  
 (c) (i) and (v) (d) (iii) and (iv)
- 258.** What is Z in following reaction  
 $CuSO_4 + Z \rightarrow Cu_3P_2 + H_2SO_4$   
 $HgCl_2 + Z \rightarrow Hg_3P_2 + HCl$   
 (a) White phosphorus (b) Red phosphorus  
 (c) Phosphine (d) Orthophosphoric acid
- 259.** Electronegativity of oxygen is more than sulphur yet  $H_2S$  is acidic while water is neutral. This is because  
 (a) water is highly associated compound  
 (b) molecular mass of  $H_2S$  is more than  $H_2O$   
 (c)  $H_2S$  is gas while  $H_2O$  is a liquid  
 (d) H—S bond is weaker than H—O bond
- 260.** It is possible to obtain oxygen from air by fractional distillation because  
 (a) oxygen is in a different group of the periodic table from nitrogen  
 (b) oxygen is more reactive than nitrogen  
 (c) oxygen has higher b.p. than nitrogen  
 (d) oxygen has a lower density than nitrogen.
- 261.** Which of the following structures is the most preferred and hence of lowest energy for  $SO_3$  ?
- 

(a)



(b)
- 

(c)



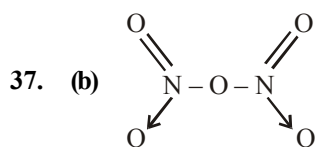
(d)
- 262.** Which one of the following arrangements does not give the correct picture of the trends indicated against it ?  
 (i)  $F_2 > Cl_2 > Br_2 > I_2$  : Oxidizing power  
 (ii)  $F_2 > Cl_2 > Br_2 > I_2$  : Electron gain enthalpy  
 (iii)  $F_2 > Cl_2 > Br_2 > I_2$  : Bond dissociation energy  
 (iv)  $F_2 > Cl_2 > Br_2 > I_2$  : Electronegativity.  
 (a) (ii) and (iv) (b) (i) and (iii)  
 (c) (ii) and (iii) (d) (ii), (iii) and (iv)

- 263.** The correct order of the thermal stability of hydrogen halides (H-X) is  
 (a)  $\text{HI} > \text{HCl} < \text{HF} > \text{HBr}$  (b)  $\text{HCl} < \text{HF} > \text{HBr} < \text{HI}$   
 (c)  $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$  (d)  $\text{HI} < \text{HBr} > \text{HCl} < \text{HF}$
- 264.** In the case of alkali metals, the covalent character decreases in the order:  
 (a)  $\text{MF} > \text{MCl} > \text{MBr} > \text{MI}$  (b)  $\text{MF} > \text{MCl} > \text{MI} > \text{MBr}$   
 (c)  $\text{MI} > \text{MBr} > \text{MCl} > \text{MF}$  (d)  $\text{MCl} > \text{MI} > \text{MBr} > \text{MF}$
- 265.** Which of the following order is/are incorrect regarding the property indicated against it?  
 (i)  $\text{HF} > \text{HI} > \text{HBr} > \text{HCl}$  : Thermal stability  
 (ii)  $\text{Cl}_2\text{O}_7 > \text{Cl}_2\text{O}_6 > \text{ClO}_2 > \text{Cl}_2\text{O}$  : Acidic character  
 (iii)  $\text{SbCl}_3 > \text{SbCl}_5$  : Covalent character  
 (iv)  $\text{MCl} > \text{MBr}$  : Ionic character  
 (a) (iii) only (b) (ii) only  
 (c) (i) and (iii) (d) (ii) and (iv)
- 266.** What is X and Y in the given reactions ?  
 $2\text{X}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{H}^+(\text{aq}) + 4\text{X}^-(\text{aq}) + \text{O}_2(\text{g})$   
 $\text{Y}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{HY}(\text{aq}) + \text{HOY}(\text{aq})$   
 (a)  $\text{X} = \text{Cl}, \text{Y} = \text{F}$  (b)  $\text{X} = \text{Cl}, \text{Y} = \text{Br}$   
 (c)  $\text{X} = \text{F}, \text{Y} = \text{Cl}$  (d)  $\text{X} = \text{I}, \text{Y} = \text{F}$
- 267.** Which of the following is correct about the reaction?  
 $3\text{NaClO} \xrightarrow{\text{heat}} \text{NaClO}_3 + 2\text{NaCl}$   
 (a) It is disproportionation reaction  
 (b) Oxidation number of Cl decreases as well as increases in this reaction  
 (c) This reaction is used for the manufacture of halates  
 (d) All of these
- 268.** Which pair gives  $\text{Cl}_2$  at room temperature :  
 (a)  $\text{NaCl} + \text{Conc. H}_2\text{SO}_4$  (b)  $\text{Conc. HCl} + \text{KMnO}_4$   
 (c)  $\text{NaCl} + \text{Conc. HNO}_3$  (d)  $\text{NaCl} + \text{MnO}_2$
- 269.** The elements which occupy the peaks of ionisation energy curve are  
 (a) Na, K, Rb, Cs (b) Na, Mg, Cl, I  
 (c) Cl, Br, I, F (d) He, Ne, Ar, Kr
- 270.** End-product of the hydrolysis of  $\text{XeF}_6$  is  
 (a)  $\text{XeF}_4\text{O}$  (b)  $\text{XeF}_2\text{O}_2$   
 (c)  $\text{XeO}_3$  (d)  $\text{XeO}_3^-$
- 271.** The formation of  $\text{O}_2^+[\text{PtF}_6]^-$  is the basis for the formation of xenon fluorides. This is because  
 (a)  $\text{O}_2$  and Xe have comparable sizes  
 (b) both  $\text{O}_2$  and Xe are gases  
 (c)  $\text{O}_2$  and Xe have comparable ionisation energies  
 (d) Both (a) and (c)
- 272.** What are the products formed in the reaction of xenon hexafluoride with silicon dioxide ?  
 (a)  $\text{XeSiO}_4 + \text{HF}$  (b)  $\text{XeF}_2 + \text{SiF}_4$   
 (c)  $\text{XeOF}_4 + \text{SiF}_4$  (d)  $\text{XeO}_3 + \text{SiF}_2$
- 273.**  $\text{XeO}_4$  molecule is tetrahedral having :  
 (a) Two  $\text{p}\pi - \text{d}\pi$  bonds (b) One  $\text{p}\pi - \text{d}\pi$  bonds  
 (c) Four  $\text{p}\pi - \text{d}\pi$  bonds (d) Three  $\text{p}\pi - \text{d}\pi$  bonds

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (d) Ionic radii increases down the group
2. (b) In case of nitrogen, d-orbitals are not available.
3. (a) Collectively these elements are called pnictogens and their compound pniconides.
4. (d) Metallic character increases down the group, Bi is most metallic
5. (b) The melting point in group 15 increases upto arsenic and then decreases upto bismuth.
6. (d) Bismuth forms metallic bonds in elemental state.
7. (a)  $-3, +3, +5$
8. (d)  $N_2$  molecule contains triple bond between N atoms having very high dissociation energy ( $946 \text{ kJ mol}^{-1}$ ) due to which it is relatively inactive.
9. (a) Nitrogen due to small size is able to show  $p\pi-p\pi$  lateral overlap forming  $N \equiv N$ , rest elements due to bigger size are not able to show  $p\pi-p\pi$  lateral overlap.
10. (c) Catenation tendency is higher in phosphorus when compared with other elements of same group.
11. (c) Nitrogen form  $N_2$  (i.e.  $N \equiv N$ ) but phosphorus form  $P_4$ , because in  $P_2$ ,  $p\pi-p\pi$  bonding is present which is a weaker bonding.
12. (d) The cause of inert nature of  $N_2$  is the presence of triple bond  $\ddot{N} \equiv \ddot{N}$
13. (b)
14. (b) Phosphorous can achieve coordination number 5 due to vacant d atomic orbitals in valence shell which is not possible in nitrogen
15. (b) The order of boiling points of the group 15 hydrides is :  $BiH_3 > SbH_3 > NH_3 > AsH_3 > PH_3$
16. (a) Oxide in which central atom has higher charge and more electronegativity is more acidic, i.e.  $N_2O_5 > N_2O_4 > P_2O_5 > As_2O_3$ .
17. (a) Order of dipole moment  $NH_3 > PH_3 > AsH_3 > SbH_3$  (Based upon electronegativity)
18. (c) As the size of central atom increases the lone pair of electrons occupies a larger volume. In other words electron density on the central atom decreases and consequently its tendency to donate a pair of electrons decreases along with basic character from  $NH_3$  to  $BiH_3$ .
19. (a)  $NF_5$  does not exist because N does not form pentahalides due to the absence of d-orbital in its valence shell. While P, As and Sb form pentahalides of the general formula  $MX_5$  (where, M = P, As and Sb) due to the presence of vacant d-orbitals in their respective valence shell.
20. (d) Bi forms basic oxides whereas N and P form acidic and As and Sb form amphoteric oxides.
21. (b) The basic character decreases from  $NH_3$  to  $BiH_3$ . The basic nature is due to the presence of lone pair of electrons on the central atom.  $NH_3$  is the strongest electron pair donor due to its small size as the electron density of the electron pair is concentrated over a small region. As the size increases the electron density gets diffused over a large region and hence the ability to donate the electron pair (basic nature) decreases.
22. (a)  $NCl_5$  is not possible because N does not contain d-orbitals.  
Only nitrogen has a tendency to form  $p\pi-p\pi$  multiple bonds. Other forms  $d\pi-p\pi$  multiple bonds easily.
23. (c) 24. (b)
25. (d) 
$$NH_4Cl + NaNO_2 \xrightarrow[-NaCl]{Heat} NH_4NO_2$$
  
$$\xrightarrow{Heat} N_2 + 2H_2O.$$
26. (a)
27. (b) In Haber's process for manufacture of  $NH_3$ , finely divided iron is used as catalyst and molybdenum is used as catalytic promoter  
$$N_2(g) + 3H_2(g) \xrightarrow[800K, \text{ High P}]{Fe + Mo} 2NH_3(g)$$
28. (d)  $N_2H_4$  and  $NH_4Cl$  are obtained by reaction of ammonia with hypochlorite anion.  
$$3NH_3 + NaOCl \longrightarrow N_2H_4 + NH_4Cl + NaOH$$
29. (a)  $HNO_3$  and  $CuSO_4$  are not drying agents, while  $P_2O_5$  reacts with  $NH_3$ . The moisture present in  $NH_3$  is removed by passing it through a tower packed with quicklime (CaO).
30. (b) Ammonia has pyramidal shape with  $sp^3$  hybridisation.
31. (b)  $3CuO + 2NH_3 \rightarrow 3Cu + 3H_2O + N_2$ ,  
O.S. of N in  $NH_3$  is  $-3$  and in  $N_2$  is zero. Hence loss of 3 electrons
32. (b)  $NH_3$  is not used as anaesthetic
33. (b) Liquid ammonia has high vapour pressure which is lowered down by cooling, otherwise the liquid will bump.
34. (c) By Haber's process
35. (a) Only nitrates of heavy metals and lithium decompose on heating to produce  $NO_2$ .
36. (d)  $N_2O_3$ ,  $N_2O_4$  and  $N_2O_5$  are acidic oxides. Only  $N_2O$  is neutral oxide.



The structure clearly shows the presence of covalent and co-ordinate bonds.

38. (d) NO<sub>2</sub> is reddish brown coloured gas. Rest of the oxides are colourless.

Compound	O.S. of N
N <sub>2</sub> O	+1
NO	+2
NO <sub>2</sub>	+4
NO <sub>3</sub> <sup>-</sup>	+5
NH <sub>4</sub> <sup>+</sup>	-3

Therefore increasing order of oxidation state of N is:



40. (c) In N<sub>2</sub>O (nitrous oxide) two N atoms are covalently bonded through triple bond  
[ N ≡ N —→ O ]

41. (b) FeSO<sub>4</sub> + NO → FeSO<sub>4</sub>.NO

42. (b)

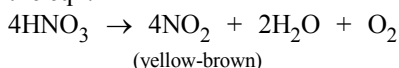
43. (a) N<sub>2</sub>O is used as anaesthetic

44. (c) 2NO + O<sub>2</sub> → 2NO<sub>2</sub> brown

45. (b) Phosphorus from stable P<sub>4</sub> molecule.

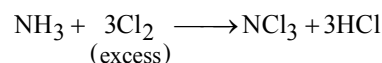
46. (a) 4NH<sub>3</sub> + 5O<sub>2</sub>  $\xrightarrow{\text{Pt. gauge}}$  4NO + 6H<sub>2</sub>O

47. (b) The slow decomposition of HNO<sub>3</sub> is represented by the eqn.



48. (d) For nitrogen, only NF<sub>3</sub> is known to be stable.

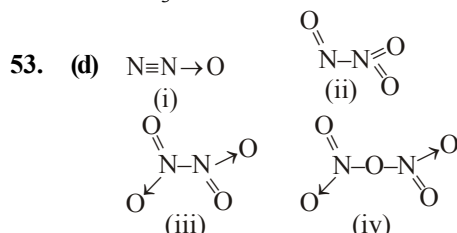
49. (a) 8NH<sub>3</sub> + 3Cl<sub>2</sub> → 6NH<sub>4</sub>Cl + N<sub>2</sub>  
(excess)



50. (c) BiH<sub>3</sub> is the strongest reducing agent while NH<sub>3</sub> is the weakest reducing agent.

51. (d) The oxides of the type E<sub>2</sub>O<sub>3</sub> of nitrogen and phosphorus are purely acidic.

52. (d) NH<sub>3</sub> is not used in the pickling of stainless steel.



54. (d) 4 Zn + 10 HNO<sub>3</sub> (dil.) → 4 Zn(NO<sub>3</sub>)<sub>2</sub> + 5H<sub>2</sub>O + N<sub>2</sub>O  
Zn + 4 HNO<sub>3</sub> (conc.) → Zn(NO<sub>3</sub>)<sub>2</sub> + 2H<sub>2</sub>O + 2NO<sub>2</sub>

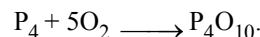
55. (a) Both white and red phosphorus are not soluble in CS<sub>2</sub> only white phosphorus is soluble in CS<sub>2</sub>.

56. (b) White phosphorous is most reactive

57. (b) White phosphorous is P<sub>4</sub> and tetrahedral

58. (a) Except (a) all other properties are shown by white phosphorous.

59. (b) White phosphorus on heating readily catches fire in air to give dense white fumes of P<sub>4</sub>O<sub>10</sub>.



60. (c) Monoclinic sulphur is stable above 369 K.

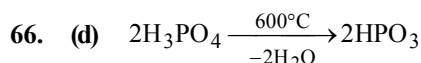
61. (c) Ca<sub>3</sub>P<sub>2</sub> + 6H<sub>2</sub>O → 3Ca(OH)<sub>2</sub> + 2PH<sub>3</sub>; i.e 2 moles of phosphine are produced from one mole of calcium phosphide.

62. (d) PH<sub>3</sub> is covalent hydride

63. (b) Red P does not react with NaOH to give PH<sub>3</sub>.

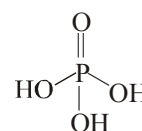
64. (d) PH<sub>3</sub> is not obtained when metaphosphoric acid is heated.

65. (a) The combustibility of PH<sub>3</sub> is due to presence of P<sub>2</sub>H<sub>4</sub>. The pure PH<sub>3</sub> is not combustible.



67. (d) P<sub>2</sub>O<sub>5</sub> + 3H<sub>2</sub>O  $\xrightarrow{\Delta}$  2H<sub>3</sub>PO<sub>4</sub>

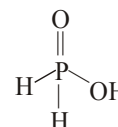
68. (b) Orthophosphoric acid, H<sub>3</sub>PO<sub>4</sub> contains three P – OH bonds and is therefore, tribasic.



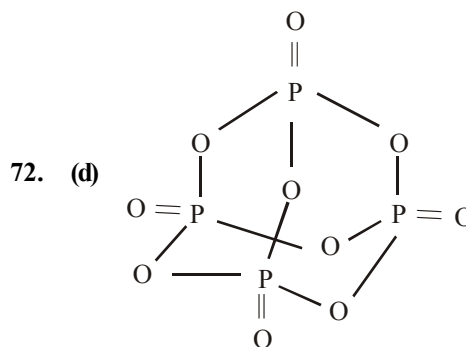
orthophosphoric acid

69. (b) PCl<sub>3</sub> + H<sub>2</sub>O → POCl<sub>3</sub> + 2HCl  
POCl<sub>3</sub> + 3H<sub>2</sub>O → H<sub>3</sub>PO<sub>4</sub> + 3HCl

70. (c) H<sub>3</sub>PO<sub>2</sub> is named as hypophosphorous acid. It is monobasic as it contains only one P – OH bond, its basicity is one.

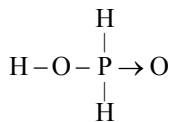


71. (a) We know that empirical formula of hypophosphorus acid is H<sub>3</sub>PO<sub>2</sub>. In this only one ionisable hydrogen atom is present i.e. it is monobasic. Therefore option (a) is correct structural formula of it.



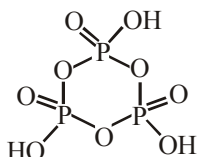


73. (c) Structure of hypophosphorous acid



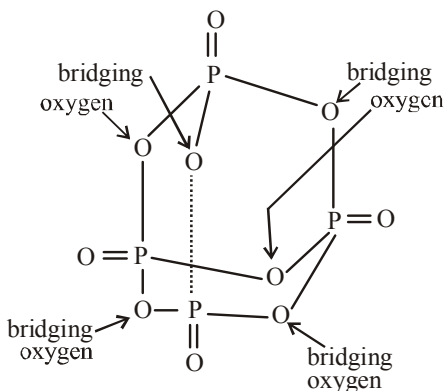
Two H-atoms are attached to P atom.

74. (c) In cyclic metaphosphoric acid number of P—O—P bonds is three.



75. (d)

76. (b)



77. (b)  $\left[ \begin{array}{c} \text{O} \\ || \\ \text{H}-\text{P}-\text{H} \\ | \\ \text{O} \\ | \\ \text{H} \end{array} \right]$  Hypophosphorous acid ( $\text{H}_3\text{PO}_2$ ) is a monobasic acid. i.e., it has only one ionisable hydrogen atom or one OH is present.

78. (c) Hybridisation in  $\text{PCl}_5 = \frac{1}{2}(5+5+0-0) = 5 \text{ sp}^3\text{d}$

79. (c)  $\text{H}_5\text{P}_5\text{O}_{15}$  ( $\text{HPO}_3$ )<sub>5</sub>. It is metaphosphoric acid which is a cyclic phosphate.

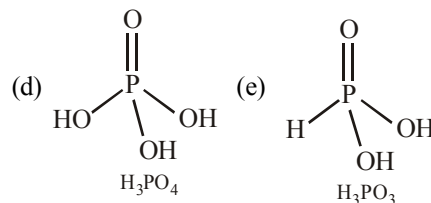
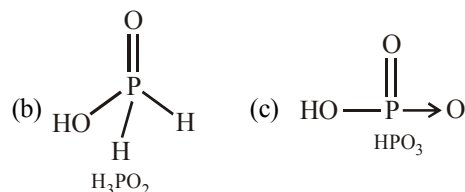
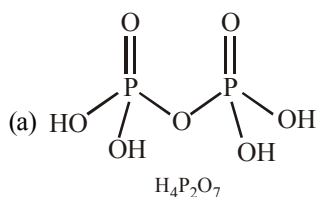
80. (b)  $\text{H}_4\text{P}_2\text{O}_5$  is pyrophosphorous acid it contains P—O—P bond

81. (c)  $\text{H}_3\text{PO}_4$  is tribasic

82. (a) Hypophosphorous acid is  $\text{H}_3\text{PO}_2$  in which O.S. of P is +1

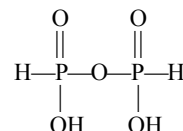
83. (c)

84. (d) Structures of given oxyacids are following



The H-atom of the —OH group is ionisable whereas H-atom which is directly linked to P-atom is non-ionisable. Thus  $\text{H}_3\text{PO}_3$  is dibasic acid.

85. (a) Pyrophosphorous acid ( $\text{H}_4\text{P}_2\text{O}_5$ ) is a dibasic acid as it contains two P—OH bonds.

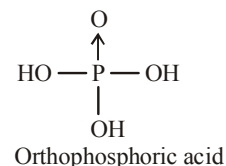
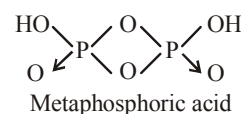
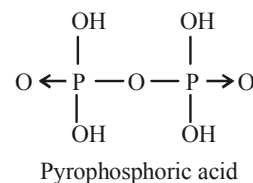
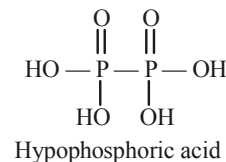


86. (b) Formula of cyclotrimetaphosphoric acid is  $(\text{HPO}_3)_3$

Oxidation state of 'P' is  $3(+1+x+3(-2))=0$

$$x+(-6)+1=0 \Rightarrow x=+5$$

87. (a)



88. (a) 89. (c) 90. (d)

91. (a) Electron affinity increases from left to right in period and decreases from top to bottom in a group but electron affinity of O is less than S due to small size.

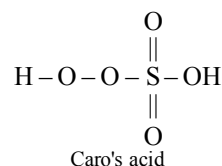
92. (d) All exhibit polymorphism

93. (a)

94. (d)  $\text{H}_2\text{O}$  is liquid but  $\text{H}_2\text{S}$  is a gas. This can be attributed to the presence of intermolecular hydrogen bonding in case of  $\text{H}_2\text{O}$ .
95. (b)
96. (a)
97. (a)  $\text{H}_2\text{O}$  (due to intermolecular H - bonding)
98. (b) Oxygen being more electronegative
99. (a)  $\text{SnO}_2$  is an amphoteric oxide because it reacts with acids as well as with bases to form corresponding salts.  
 $\text{SnO}_2 + 2\text{H}_2\text{SO}_4(\text{conc}) \longrightarrow \text{Sn}(\text{SO}_4)_2 + 2\text{H}_2\text{O}$   
 $\text{SnO}_2 + 2\text{NaOH} \longrightarrow \text{Na}_2\text{SnO}_3 + \text{H}_2\text{O}$
100. (d) All hexafluorides of group 16 elements are gaseous in nature.
101. (b) Oxygen can be prepared by heating oxides of Hg, Pb, Ag, Mn and Ba.  
 $2\text{HgO} \xrightarrow{\Delta} 2\text{Hg} + \text{O}_2$
102. (c) It is paramagnetic with two unpaired electrons
103. (c) Total number of electrons in  $\text{O}_2$  is 16. It has 2 unpaired electrons, the rest 14 are paired.
104. (b)  $2\text{KClO}_3 \xrightarrow{\Delta} 2\text{KCl} + 3\text{O}_2$
105. (c) In  $\text{KMnO}_4$  manganese is already present in its highest possible oxidation state i.e. +7. So no further oxidation is possible.
106. (c) Ozone layer is beneficial to us, because it stops harmful ultraviolet radiations from reaching the earth.
107. (b)  $2\text{KMnO}_4 \xrightarrow{\Delta} \text{K}_2\text{MnO}_4 + 4\text{MnO}_2 + \text{O}_2$
108. (d) Ozone is an allotrope of oxygen.
109. (d)  $2\text{Ag}_2\text{O}(\text{s}) \rightarrow 4\text{Ag}(\text{s}) + \text{O}_2(\text{g})$   
 $2\text{Pb}_3\text{O}_4(\text{s}) \rightarrow 6\text{PbO}(\text{s}) + \text{O}_2(\text{g})$   
 $2\text{PbO}_2(\text{s}) \rightarrow 2\text{PbO}(\text{s}) + \text{O}_2(\text{g})$
110. (a)  $\text{Mn}_2\text{O}_7$  is an acidic oxide.  $\text{BaO}$  and  $\text{Na}_2\text{O}$  are basic oxides while  $\text{N}_2\text{O}$  is a neutral oxides.
111. (c) It is 8
112. (c)  $\text{S}_2$  is paramagnetic. It contains two unpaired electrons in the antibonding  $\pi^*$  orbital
113. (a)  $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \xrightarrow{\text{V}_2\text{O}_5} 2\text{SO}_3(\text{g})$
114. (b)  $\begin{array}{c} \text{O} & & \text{O} \\ || & & || \\ \text{O}=\text{S}-\text{O}-\text{O}-\text{S}=\text{O} \\ | & & | \\ \text{OH} & & \text{OH} \end{array}$   
 Peroxodisulphuric acid  
 $(\text{H}_2\text{S}_2\text{O}_8)$
115. (b) Conc.  $\text{H}_2\text{SO}_4$  is a strong dehydrating agent due to which carbohydrates becomes charred on reaction with conc.  $\text{H}_2\text{SO}_4$  acid.
116. (b) The key step in the manufacture of  $\text{H}_2\text{SO}_4$  is catalytic oxidation of  $\text{SO}_2$  with  $\text{O}_2$  to give  $\text{SO}_3$  in presence of  $\text{V}_2\text{O}_5$ .
117. (a) In  $\text{SO}_3$ ,  $\text{sp}^2$  hybridisation
118. (c)  $\text{Cu} + 2\text{H}_2\text{SO}_4(\text{conc}) \longrightarrow \text{CuSO}_4 + \text{SO}_2 + 2\text{H}_2\text{O}$
119. (b)  $2\sigma$ , one  $\pi$  see structure

120. (c)  $\text{SO}_2 + 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4 + 2\text{H}$ . Bleaching action is due to reduction.

121. (d) Caro's acid is  $\text{H}_2\text{SO}_5$  which contains one  $\text{S} - \text{O} - \text{O} - \text{H}$  peroxy linkage. It is also known as permonosulphuric acids.



122. (d)

123. (c) Oleum is  $\text{H}_2\text{S}_2\text{O}_7$  ( $\text{H}_2\text{SO}_4 + \text{SO}_3$ ) which is obtained by dissolving  $\text{SO}_3$  in  $\text{H}_2\text{SO}_4$  and is called fuming sulphuric acid.

124. (c) 125. (a) 126. (c)

127. (c) It is  $\text{H}_2\text{SO}_5$ .

128. (c)  $\text{HO.SO}_2\text{OH} + 2\text{PCl}_5 \rightarrow \text{ClSO}_2\text{Cl} + 2\text{POCl}_3 + 2\text{HCl}$   
 Sulphuryl chloride

129. (b)  $2\text{Ag} + 2\text{H}_2\text{SO}_4 \rightarrow 2\text{H}_2\text{O} + \text{SO}_2 + \text{Ag}_2\text{SO}_4$ .  
 Au, Pt does not react. Pb forms insoluble  $\text{PbSO}_4$

130. (c)

131. (a)  $\begin{array}{c} \text{O} \\ || \\ \text{H}-\text{O}-\text{S}-\text{O}-\text{H} \\ || \\ \text{O} \end{array}$ ;  $6\sigma$  &  $2\pi$

132. (a) In  $\text{H}_2\text{SO}_4$ , the S atom is present in its highest oxidation state of +6. Hence  $\text{H}_2\text{SO}_4$  can act an oxidant only by gain of electrons

133. (d) Ionisation potential decreases down the group.

134. (a)

135. (d) The lesser the bond energy, the weaker is the bond

136. (b)  $3s^2 3p^5$  is electronic configuration of Cl

137. (c) The electron gain enthalpy order for halogens is  $\text{Cl} > \text{F} > \text{Br} > \text{I}$

Due to small size of fluorine the extra electron to be added feels more electron-electron repulsion. Therefore fluorine has less value for electron affinity than chlorine.

138. (d)

139. (a) Reactivity follows the order  $\text{F} > \text{Cl} > \text{Br} > \text{I}$

140. (d)

141. (b) Except ionisation potential other factors are true to explain the oxidising (strong) behaviour of  $\text{F}_2$ .

142. (b)

143. (d) Fluorine exhibit -ve oxidation state

144. (a) Since  $\text{F}_2$  is most oxidising, it is easily reduced

145. (c) Chlorine shows O.S. from -1, +1 to +7, whereas others show O.S. as  $\text{Na} \rightarrow +1$ ;  $\text{K} \rightarrow +1$ ;  $\text{F} \rightarrow -1$

146. (c) Fluorine always exhibit  $-1$  oxidation state.
147. (b) 
$$\text{H}_2\text{O} + \text{Br}_2 \xrightarrow{\quad} \text{HOBr} + \text{HBr}$$
  
 Thus here oxidation number of Br increases from 0 to  $+1$  and also decreases from 0 to  $-1$ . Thus it is oxidised as well as reduced.
148. (d) Since all the halogens have a strong tendency to accept electrons. Therefore halogens act as strong oxidising agents and their oxidising power decreases from fluorine to iodine.
149. (b) On moving from top to bottom of halogen group the bond dissociation energy of hydrogen halides decreases and so the heat of formation of halogen acids also decreases.
150. (a) HF, due to intermolecular H-bonding is weakest among HX acids
151. (c) Volatile character  $\text{HCl} > \text{HBr} > \text{HI} > \text{HF}$
152. (d) Due to hydrogen bonding HF is a liquid
153. (d) Bleaching action of chlorine is due to oxidation in presence of moisture.  

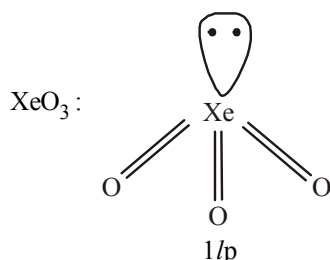
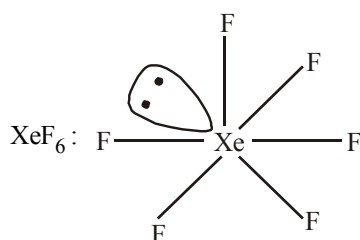
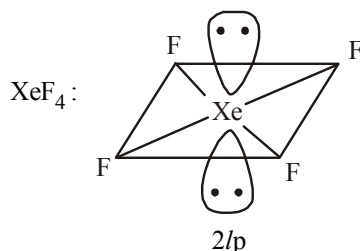
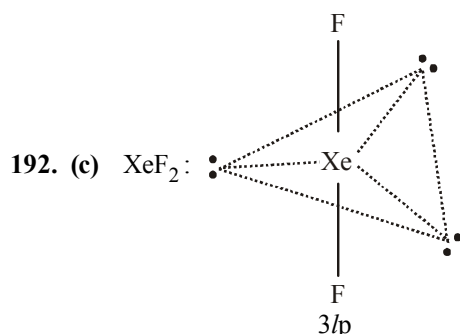
$$\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{HClO}$$
  

$$\text{HClO} \rightarrow \text{HCl} + \text{O}$$
  
 Colouring matter +  $[\text{O}] \rightarrow$  Colourless matter
154. (b) 
$$\text{Cl}_2 + 2\text{NaOH} \rightarrow \text{NaCl} + \text{NaClO} + \text{H}_2\text{O}$$
  
 (cold & dil)  

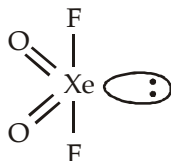
$$3\text{Cl}_2 + 6\text{NaOH} \rightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$$
  
 (hot & conc.)
155. (a) 
$$2\text{NaOH} + \text{Cl}_2 \rightarrow \text{NaCl} + \text{NaOCl} + \text{H}_2\text{O}$$
  
 hence  $\text{Cl}^-$  and  $\text{OCl}^-$
156. (d)  $\text{K}_2\text{Cr}_2\text{O}_7 + \text{conc. HCl} \rightarrow \text{Cl}_2$
157. (d)  $\text{MnO}_2$  or  $\text{KMnO}_4$  with conc HCl give  $\text{Cl}_2$ .
158. (d) 
$$2\text{KMnO}_4 + 16\text{HCl} \rightarrow 2\text{MnCl}_2 + 2\text{KCl} + 8\text{H}_2\text{O} + 5\text{Cl}_2$$
  
 O.S of Mn changes from  $+7$  to  $+2$  hence reduction occurs and  $\text{Cl}_2$  is formed.
159. (d) 
$$6\text{CaOCl}_2 \rightarrow \text{Ca}(\text{ClO}_3)_2 + 5\text{CaCl}_2$$
  
 It is autooxidation.
160. (d) HCl acid at  $25^\circ\text{C}$  is a gas and polar in nature
161. (d) In gaseous state the HCl is covalent in nature while in aqueous solution it ionises to give  $\text{H}^+$  and  $\text{Cl}^-$  ions
162. (d) As the oxidation state of the central halogen atom increases, the halogen-oxygen bond becomes more and more covalent. As a result the thermal stability of the oxoacid increases. Thus,  $\text{HClO}_4$  is most stable to heat, whereas  $\text{HClO}$  is least stable to heat.
163. (c) The bond energy of interhalogen compounds is less than the bond energy of halogens.
164. (d) Interhalogen compounds are not highly volatile
165. (a)  $\text{ICl}_7$ . The hybridisation is  $\frac{1}{2}(7+7+0-0) = 7$  ( $\text{sp}^3\text{d}^3$ )
166. (b) 
$$6\text{NaOH} + 3\text{Cl}_2 \xrightarrow{\quad} 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$$
167. (c) 
$$6\text{NaOH} + 3\text{Cl}_2 \rightarrow 5\text{NaCl} + \text{NaClO}_3 + 3\text{H}_2\text{O}$$
  
 (hot and conc.)
168. (a) Rn because it is radioactive element obtained by the disintegration of radium  

$${}_{88}\text{Ra}^{226} \rightarrow {}_{86}\text{Rn}^{222} + {}_2\text{He}^4$$
169. (b) Radon is the last member of family
170. (d)
171. (d) Electronic configuration of He is  $1s^2$
172. (a) Inert gases do not contain unpaired electrons
173. (b) Ionization potential of inert gases is highest in periodic table due to stable electronic configuration.
174. (a) Ionisation energy decreases as we move away from nucleus due to less electrostatic attraction between electrons and nucleus
175. (a) The smaller the size the least is the polarisability
176. (c) The differentiating electron enter in s subshell in case of He, hence it is s-block element. Its electronic configuration  $1s^2$  makes it inert in nature hence it is placed with inert gases.
177. (c) Ar is the most abundant in atmosphere
178. (d) Due to weak van der Waal's forces, He has lowest boiling point
179. (d) The larger the size the more is the polarisability
180. (d) He was observed in the spectrum of the sun
181. (b) 
$${}_{88}\text{Ra}^{226} \rightarrow {}_{86}\text{Rn}^{222} + {}_2\text{He}^4$$
. Both are inert gases
182. (d) Electron gain enthalpy for noble gases is positive and it becomes less positive with increase in size of atom. Value of electron gain enthalpy  
 $\text{He} - 48 \text{ kJ mol}^{-1}$ ,  $\text{Ne} - 116 \text{ kJ mol}^{-1}$   
 $\text{Ar}$ ,  $\text{Kr} - 96 \text{ kJ mol}^{-1}$ ,  $\text{Xe} - 77 \text{ kJ mol}^{-1}$   
 Hence, Ne has highest positive electron gain enthalpy.
183. (b)
184. (a) As size increases, van der Waal's forces of attraction between noble gas atoms also increases. Consequently, ease of their liquefaction increases.
185. (c) Solubility increases from He to Rn
186. (d) Xe forms maximum compounds hence it is most reactive
187. (b) Noble gases exhibit low chemical activity
188. (d)
189. (b) In  $\text{XeOF}_4$ , Xenon is  $\text{sp}^3\text{d}^2$  hybridised and has one lone pair of electrons.
190. (a)
191. (d) The products of the concerned reaction react each other forming back the reactants.  

$$\text{XeF}_6 + 3\text{H}_2\text{O} \rightarrow \text{XeO}_3 + 6\text{HF}$$



193. (d) Hence  $\text{XeF}_2$  has maximum no. of lone pairs of electrons.  $\text{XeO}_2\text{F}_2$  has trigonal bipyramidal geometry, but due to presence of lone pair of electrons on equatorial position, its actual shape is *see-saw*.



194. (b)  $\text{XeF}_4 + \text{H}_2\text{O} \rightarrow 2\text{HF} + \text{XeOF}_2$   
 195. (a) No compound of He as yet been reported  
 196. (a) No compound of Ar as yet been reported with  $\text{F}_2$   
 197. (c)  $\text{XeF}_6 + 3\text{H}_2\text{O} \rightarrow 6\text{HF} + \text{XeO}_3$

198. (d) Hybridisation in

$$\text{XeF}_4 = \frac{1}{2}(8 + 4 + 0 - 0) = 6 \text{ } sp^3d^2$$

199. (b)  $\text{XeOF}_4$  square pyramidal

200. (c) Hybridisation of  $\text{XeF}_2$  is  $sp^3d$

201. (b)  $\text{XeF}_4$  is planar

202. (a) In  $\text{XeO}_3$  the hybridisation is  $sp^3$

203. (a)  $\text{XeF}_2$  has structure hence number of lone pair of electrons 3

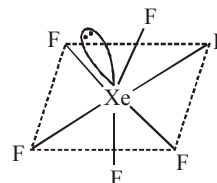
204. (c) Hybridisation of  $\text{XeF}_4$  is  $sp^3d^2$  and structure is square planar

205. (a)
- |                                      | $\text{XeF}_2$ | $\text{XeF}_4$ | $\text{XeF}_6$ |
|--------------------------------------|----------------|----------------|----------------|
| Valence electrons of Xe              | 8              | 8              | 8              |
| Electrons involved in bond formation | 2              | 4              | 6              |
| Lone pairs left                      | 3              | 2              | 1              |

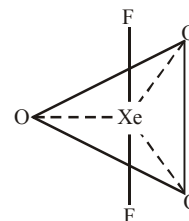
206. (c) Hybridisation in each case is  $\text{XeF}_4sp^3d^2$ ,  $\text{XeF}_2sp^3d$ ,

207. (c) He is obtained during radioactive decay

208. (c) The geometry of  $\text{XeF}_6$  is distorted octahedral in which all the six positions are occupied by fluorine atoms and the lone pair of electrons of Xe atom is present at the corner of one of the triangular faces.



209. (b) The hybridization of  $\text{XeO}_3\text{F}_2$  is  $sp^3d$  and its structure is trigonal bipyramidal in which oxygen atoms are situated on the plane and the fluoride atoms are on the top and bottom.



210. (b) The shape of  $\text{XeO}_3$  is Trigonal Pyramidal.



(Trigonal Pyramidal Structure)

211. (c) Argon is used in high temperature welding and other operations which require a non-oxidising atmosphere and the absence of nitrogen.

212. (b) Neon gives a distinct reddish glow when used in either low-voltage neon glow lamps or in high voltage discharge tube.

213. (c) Helium is twice as heavy as hydrogen it is inflammable but not lighter than hydrogen. Helium has the lowest melting and boiling point of any element which makes liquid helium an ideal coolant for many extremely low temperature application such as super conducting magnet and cryogenic research where temperature close to absolute zero are needed. He is used in gas cooled atomic reactors as a heat transfer agent.
214. (c) Coloured discharge tubes mainly contain Neon
215. (a) Breathing mixture is ( $O_2 + He$ )
216. (a) Mixture of ( $He + O_2$ ) is used for asthma patient
217. (b)      218. (c)      219. (d)

### STATEMENT TYPE QUESTIONS

220. (a) Phosphorus occurs in minerals of the apatite family,  $Ca_9(PO_4)_6$ ,  $CaX_2$  ( $X = F, Cl$  or  $OH$ ) which are main components of phosphate rocks whereas arsenic and antimony are found as sulphide minerals. The increase in covalent radii from N to P is greater in comparison to increase from As to Bi.
221. (c) For nitrogen oxidation states from +1 to +4 disproportionate in acidic solution only. Oxidation state of phosphorous in  $P_2O_5$  is +5 whereas in  $P_2O_3$  is +3 thus  $P_2O_5$  is more acidic than  $P_2O_3$ .
222. (b)
223. (a) Oxygen shows oxidation state of +2 in  $OF_2$ .  $H_2O$  which is a hydride of oxygen element of group 16 is neutral in nature.
224. (c)



Ozone is diamagnetic in nature (due to presence of paired electron) and both the O – O bond length are equal. It has a bent structure.

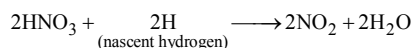
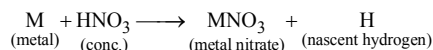
225. (b)  $NH_3$  being basic reacts with acidic  $H_2SO_4$  thus  $H_2SO_4$  cannot be used for drying  $NH_3$ .
226. (b) Physical state of iodine is different from other halogens as iodine is solid, bromine is a liquid whereas fluorine and chlorine are gases.
227. (b) At 298K,  $ClF$  exists as a gas.
228. (d)
229. (c) For statement (iii) preparation of  $XeF_2$  requires Xe in excess amount
- $$Xe(g) + F_2(g) \xrightarrow{673K, 1\text{ bar}} XeF_2(s)$$
- (excess)
- For statements (iv)
- $$2XeF_2(s) + 2H_2O(l) \longrightarrow 2Xe(g) + 4HF(aq) + O_2(g)$$
- $$6XeF_4 + 12H_2O \longrightarrow 4Xe + XeO_3 + 24HF + 3O_2$$
- $$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$$

### MATCHING TYPE QUESTIONS

- |          |          |          |          |          |
|----------|----------|----------|----------|----------|
| 230. (b) | 231. (a) | 232. (a) | 233. (c) | 234. (a) |
| 235. (b) | 236. (b) | 237. (b) | 238. (b) | 239. (a) |
| 240. (c) | 241. (a) |          |          |          |

### ASSERTION-REASON TYPE QUESTIONS

242. (c) At higher temperatures, dinitrogen combines with metals to form ionic nitrides.
243. (c)
244. (a) Both assertion and reason are true and reason is the correct explanation of assertion.



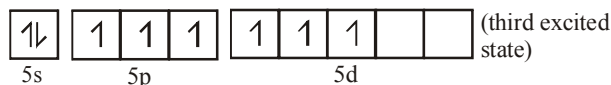
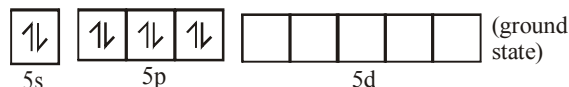
245. (b) White phosphorus exists as  $P_4$  tetrahedral molecule having P-P-P bond angle  $60^\circ$ . Hence the molecule is under strain and more reactive. On the other hand red phosphorus exists as  $P_4$  tetrahedra which are joined together through covalent bonds giving polymeric structure.
246. (c) Bond angle of  $H_2S$  ( $92^\circ$ ) <  $H_2O$  ( $104^\circ 31'$ ). As the electronegativity of the central atom decreases, bond angle decreases. In the present case, S is less electronegative than oxygen. Thus bond pairs in  $H_2S$  are more away from the central atom than in  $H_2O$  and thus repulsive forces between bond pairs are smaller producing smaller bond angle.
247. (a)      248. (a)

### CRITICAL THINKING TYPE QUESTIONS

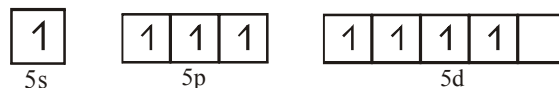
249. (b) With the decrease in the electronegativity of central atom the bond angle decreases
250. (d)
251. (b)  $CuSO_4 + 4NH_3 \rightarrow [Cu(NH_3)_4]SO_4$
- Blue complex due to  $Cu(NH_3)_4^{2+}$
252. (b)  $2NO + N_2O_4 \xrightarrow{250K} 2N_2O_3$
253. (b) The slow decomposition of  $HNO_3$  is represented by the eqn.
- $$4HNO_3 \rightarrow 4NO_2 + 2H_2O + O_2$$
- (yellow-brown)
254. (a)
255. (c)  $[Fe(H_2O)_5NO]^{2+}$  ion is formed
256. (b)  $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$
- Colourless                      White ppt
- $$AgCl(s) + 2NH_3(aq) \rightarrow [Ag(NH_3)_2]Cl(aq)$$
- White ppt                      Colourless
257. (b)  $NO_2$  and  $N_2O_4$  has +4 oxidation state for nitrogen.
258. (c)  $3CuSO_4 + 2PH_3 \rightarrow Cu_3P_2 + 3H_2SO_4$
- $$3HgCl_2 + 2PH_3 \rightarrow Hg_3P_2 + 6HCl$$



266. (c)  $2\text{F}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{H}^+(\text{aq}) + 4\text{F}^-(\text{aq}) + \text{O}_2(\text{g})$   
 $\text{Cl}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{HCl}(\text{aq}) + \text{HOCl}$
267. (d)  $\overset{+1}{\text{NaClO}} \longrightarrow \overset{+5}{\text{NaClO}_3} + 2\overset{-1}{\text{NaCl}}$  All statements are correct as evident from the reaction
268. (b)  $2\text{KMnO}_4 + 16\text{HCl} \rightarrow 2\text{KCl} + 2\text{MnCl}_2 + 8\text{H}_2\text{O} + 5\text{Cl}_2$
269. (d)
270. (c)  $\text{XeF}_6 + 3\text{H}_2\text{O} \longrightarrow \text{XeO}_3 + 6\text{HF}$   
 $\therefore$  Complete hydrolysis of  $\text{XeF}_6$  gives  $\text{XeO}_3$  (an explosive).
271. (d) (i) The first ionization energy of xenon ( $1, 170 \text{ kJ mol}^{-1}$ ) is quite close to that of dioxygen ( $1, 180 \text{ kJ mol}^{-1}$ ).  
(ii) The molecular diameters of xenon and dioxygen are almost identical.
- Based on the above similarities Barlett (who prepared  $\text{O}_2^+[\text{PtF}_6]^-$  compound) suggested that since oxygen combines with  $\text{PtF}_6$ , so xenon should also form similar compound with  $\text{PtF}_6$ .
272. (c)  $2\text{XeF}_6 + \text{SiO}_2 \rightarrow \text{SiF}_4 + 2\text{XeOF}_4$
273. (c) Xenon undergo  $sp^3$  hybridization.



In the fourth excited state xenon atom, has 8 unpaired electrons



One  $s$  and three  $p$  orbital undergo  $sp^3$  hybridization. Four  $sp^3$  hybrid orbitals form four  $\sigma$  bonds with oxygen atoms. They are  $\sigma sp^3 - p$ . Four  $p\pi - d\pi$  bonds are also formed with oxygen atoms by the unpaired electrons.

# CHAPTER 22

## THE *d*-AND *f*-BLOCK ELEMENTS

### FACT/DEFINITION TYPE QUESTIONS

- The transition elements have a general electronic configuration  
 (a)  $ns^2, np^6, nd^{1-10}$   
 (b)  $(n-1)d^{1-10}, ns^{0-2}, np^{0-6}$   
 (c)  $(n-1)d^{1-10}, ns^{1-2}$   
 (d)  $nd^{1-10}, ns^{1-2}$
- Correct electronic configuration of Cr ( $Z=24$ ) is  
 (a)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^1$   
 (b)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$   
 (c)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$   
 (d)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
- Which of the following configuration is correct for iron ?  
 (a)  $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^4$   
 (b)  $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6 4s^2$   
 (c)  $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^2$   
 (d)  $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^2 4s^2$
- Which one of the following ions has electronic configuration  $[Ar] 3d^6$  ?  
 (a)  $Ni^{3+}$  (b)  $Mn^{3+}$   
 (c)  $Fe^{3+}$  (d)  $Co^{3+}$   
 (At. Nos. Mn = 25, Fe = 26, Co = 27, Ni = 28)
- Which of the following element does not belong to first transition series?  
 (a) Fe (b) V  
 (c) Ag (d) Cu
- $(n-1)d^{10} ns^2$  is the general electronic configuration of  
 (a) Fe, Co, Ni (b) Cu, Ag, Au  
 (c) Zn, Cd, Hg (d) Se, Y, La
- The last electron in d-block elements goes to  
 (a)  $(n-1)d$  (b)  $nd$   
 (c)  $np$  (d)  $(n-1)s$
- The elements which exhibit both vertical and horizontal similarities are  
 (a) inert gas elements (b) representative elements  
 (c) rare elements (d) transition elements
- An atom has electronic configuration  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$  in which group would it be placed?  
 (a) Fifth (b) Fifteenth  
 (c) Second (d) Third
- In 3d-series atomic number ( $Z$ ) varies from  
 (a)  $Z = 21 - 30$  (b)  $Z = 22 - 30$   
 (c)  $Z = 20 - 30$  (d)  $Z = 31 - 40$
- The valence shell of transition elements consists of  
 (a)  $nd$  orbitals (b)  $(n-1)d$  orbitals  
 (c)  $ns np nd$  orbitals (d)  $(n-1)d ns$  orbitals
- Number of unpaired electrons in  $Ni^{2+}$  ( $Z=28$ ) is  
 (a) 4 (b) 2  
 (c) 6 (d) 8
- Which of the following element is not a member of transition elements ?  
 (a) Zn (b) Pt  
 (c) Ce (d) Mo
- The number of unpaired electrons in gaseous species of  $Mn^{3+}$ ,  $Cr^{3+}$  and  $V^{3+}$  respectively are.  
 (a) 4, 3 and 2 (b) 3, 3 and 2  
 (c) 4, 3 and 2 (d) 3, 3 and 3
- The first element in the 3d-transition series is  
 (a) Sc (b) Ti  
 (c) V (d) Ca
- Which of the following has more unpaired d-electrons?  
 (a)  $Zn^+$  (b)  $Fe^{2+}$   
 (c)  $Ni^+$  (d)  $Cu^+$
- The number of unpaired electrons in a nickel atom in ground state are (At. No. of Ni = 28)  
 (a) 2 (b) 5  
 (c) 3 (d) 7
- Which one of the following is an example of non-typical transition elements ?  
 (a) Li, K, Na (b) Be, Al, Pb  
 (c) Zn, Cd, Hg (d) Ba, Ga, Sr

19. Which of the following has the maximum number of unpaired electrons?  
(a)  $\text{Ti}^{2+}$  (b)  $\text{Fe}^{2+}$   
(c)  $\text{Cr}^+$  (d)  $\text{Cu}^+$
20. The outer electronic configuration of Ag is  $4d^{10} 5s^1$ , it belongs to  
(a) 5<sup>th</sup> period, group 4 (b) 4<sup>th</sup> period, group 5  
(c) 5<sup>th</sup> period, group 11 (d) 6<sup>th</sup> period, group 9
21. Manganese belongs to  
(a) 1<sup>st</sup> transition series (b) 2<sup>nd</sup> transition series  
(c) 3<sup>rd</sup> transition series (d) 4<sup>th</sup> transition series
22. The no. of unpaired electrons in  $\text{Mn}^{7+}$  ions (At. no. of Mn = 25) is  
(a) 0 (b) 1  
(c) 2 (d) 3
23. Which one of the following species is paramagnetic?  
(a)  $\text{N}_2$  (b) Co  
(c)  $\text{Cu}^+$  (d) Zn
24. Which of the following species is/are paramagnetic?  
 $\text{Fe}^{2+}$ ,  $\text{Zn}^0$ ,  $\text{Hg}^{2+}$ ,  $\text{Ti}^{4+}$   
(a)  $\text{Fe}^{2+}$  only (b)  $\text{Zn}^0$  and  $\text{Ti}^{4+}$   
(c)  $\text{Fe}^{2+}$  and  $\text{Hg}^{2+}$  (d)  $\text{Zn}^0$  and  $\text{Hg}^{2+}$
25. In first transition series, the melting point of Mn is low because  
(a) due to  $d^{10}$  configuration, metallic bonds are strong  
(b) due to  $d^7$  configuration, metallic bonds are weak  
(c) due to  $d^5$  configuration, metallic bonds are weak  
(d) None of these
26. The transition metals have a less tendency to form ions due to  
(a) high ionisation energy  
(b) low heat of hydration of ions  
(c) high heat of sublimation  
(d) All of these
27. The common oxidation states of Ti are  
(a) +2 and +3 (b) +3 and +4  
(c) -3 and -4 (d) +2, +3 and +4
28. Maximum oxidation state is shown by  
(a) Os (b) Mn  
(c) Co (d) Cr
29. Which one of the elements with the following outer orbital configurations may exhibit the largest number of oxidation states?  
(a)  $3d^5 4s^1$  (b)  $3d^5 4s^2$   
(c)  $3d^2 4s^2$  (d)  $3d^3 4s^2$
30. Which of the following pairs has the same size?  
(a)  $\text{Fe}^{2+}$ ,  $\text{Ni}^{2+}$  (b)  $\text{Zr}^{4+}$ ,  $\text{Ti}^{4+}$   
(c)  $\text{Zr}^{4+}$ ,  $\text{Hf}^{4+}$  (d)  $\text{Zn}^{2+}$ ,  $\text{Hf}^{4+}$
31. For the four successive transition elements (Cr, Mn, Fe and Co), the stability of +2 oxidation state will be there in which of the following order?  
(a)  $\text{Mn} > \text{Fe} > \text{Cr} > \text{Co}$  (b)  $\text{Fe} > \text{Mn} > \text{Co} > \text{Cr}$   
(c)  $\text{Co} > \text{Mn} > \text{Fe} > \text{Cr}$  (d)  $\text{Cr} > \text{Mn} > \text{Co} > \text{Fe}$
32. Iron exhibits +2 and +3 oxidation states. Which of the following statements about iron is incorrect?  
(a) Ferrous oxide is more basic in nature than the ferric oxide.  
(b) Ferrous compounds are relatively more ionic than the corresponding ferric compounds.  
(c) Ferrous compounds are less volatile than the corresponding ferric compounds.  
(d) Ferrous compounds are more easily hydrolysed than the corresponding ferric compounds.
33. Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionization enthalpy?  
(a) Vanadium ( $Z = 23$ ) (b) Chromium ( $Z = 24$ )  
(c) Manganese ( $Z = 25$ ) (d) Iron ( $Z = 26$ )
34. Of the following outer electronic configurations of atoms, the highest oxidation state is achieved by which one of them?  
(a)  $(n-1)d^3 ns^2$  (b)  $(n-1)d^5 ns^1$   
(c)  $(n-1)d^8 ns^2$  (d)  $(n-1)d^5 ns^2$
35. For *d* block elements the first ionization potential is of the order  
(a)  $\text{Zn} > \text{Fe} > \text{Cu} > \text{Cr}$  (b)  $\text{Sc} = \text{Ti} < \text{V} = \text{Cr}$   
(c)  $\text{Zn} < \text{Cu} < \text{Ni} < \text{Co}$  (d)  $\text{V} > \text{Cr} > \text{Mn} > \text{Fe}$
36. Which of the following does not represent the correct order of the properties indicated?  
(a)  $\text{Ni}^{2+} > \text{Cr}^{2+} > \text{Fe}^{2+} > \text{Mn}^{2+}$  (size)  
(b)  $\text{Sc} > \text{Ti} > \text{Cr} > \text{Mn}$  (size)  
(c)  $\text{Mn}^{2+} > \text{Ni}^{2+} < \text{Co}^{2+} < \text{Fe}^{2+}$  (unpaired electron)  
(d)  $\text{Fe}^{2+} > \text{Co}^{2+} > \text{Ni}^{2+} > \text{Cu}^{2+}$  (unpaired electron)
37. Zinc and mercury do not show variable valency like *d*-block elements because  
(a) they are soft  
(b) their *d*-shells are complete  
(c) they have only two electrons in the outermost subshell  
(d) their *d*-shells are incomplete
38. Which of the following transition element shows the highest oxidation state?  
(a) Mn (b) Fe  
(c) V (d) Cr
39. Which of the following elements does not show variable oxidation states?  
(a) Copper (b) Iron  
(c) Zinc (d) Titanium
40. Which one of the following transition elements does not exhibit variable oxidation state?  
(a) Ni (b) Cu  
(c) Fe (d) Sc
41. Electronic configuration of a transition element X in +3 oxidation state is  $[\text{Ar}]3d^5$ . What is its atomic number?  
(a) 25 (b) 26  
(c) 27 (d) 24

42. Metallic radii of some transition elements are given below. Which of these elements will have highest density ?
- | Element           | Fe  | Co  | Ni  | Cu  |
|-------------------|-----|-----|-----|-----|
| Metallic radii/pm | 126 | 125 | 125 | 128 |
- (a) Fe (b) Ni  
(c) Co (d) Cu
43. Transition metals mostly are  
(a) diamagnetic  
(b) paramagnetic  
(c) neither diamagnetic nor paramagnetic  
(d) both diamagnetic and paramagnetic
44. Transition metals usually exhibit highest oxidation states in their  
(a) chlorides (b) fluorides  
(c) bromides (d) iodides
45. Which of the following statements is incorrect?  
(a) Zn, Cd and Hg due to presence of completely filled  $d$ -orbitals  $[(n-1)d^{10}ns^2]$  are not studied along with other transition metals.  
(b) Zn, Cd and Hg have low m.p and are comparatively softer than other transition metals.  
(c) Metallic bond made by elements with  $d^5$  configuration is stronger as compared to metallic bond made by elements with  $d^3$  configuration.  
(d) Metals of  $5d$  series forms strong metallic bonds as compared with metals of  $3d$  series.
46. Which of the following is incorrect?  
(a) Mn shows oxidation state of +7 in  $MnF_7$   
(b) Fe and Co shows +3 oxidation state in  $FeX_3$  and  $CoF_3$ .  
(c) V shows oxidation state of +5 in  $VF_5$ .  
(d) Cu does not shows +2 oxidation state with  $I^-$ .
47. Which of the following is not correct about transition metals?  
(a) Their melting and boiling points are high  
(b) Their compounds are generally coloured  
(c) They can form ionic or covalent compounds  
(d) They do not exhibit variable valency
48. Transition elements  
(a) have low melting point  
(b) exhibit variable oxidation states  
(c) do not form coloured ions  
(d) show inert pair effect
49. Which one of the following ions is the most stable in aqueous solution?  
(a)  $V^{3+}$  (b)  $Ti^{3+}$   
(c)  $Mn^{3+}$  (d)  $Cr^{3+}$   
(At.No. Ti = 22, V = 23, Cr = 24, Mn = 25)
50. Which one of the following does not correctly represent the correct order of the property indicated against it?  
(a)  $Ti < V < Cr < Mn$  : increasing number of oxidation states  
(b)  $Ti^{3+} < V^{3+} < Cr^{3+} < Mn^{3+}$  : increasing magnetic moment  
(c)  $Ti < V < Cr < Mn$  : increasing melting points  
(d)  $Ti < V < Mn < Cr$  : increasing 2<sup>nd</sup> ionization enthalpy
51. What is wrong about transition metals?  
(a) Diamagnetic  
(b) Paramagnetic  
(c) Form complexes  
(d) Shows variable oxidation state
52. Which of the following ions has the maximum magnetic moment?  
(a)  $Mn^{+2}$  (b)  $Fe^{+2}$   
(c)  $Ti^{3+}$  (d)  $Cr^{+2}$ .
53. Four successive members of the first row transition elements are listed below with atomic numbers. Which one of them is expected to have the highest  $E_{M^{3+}/M^{2+}}^\circ$  value ?  
(a)  $Cr(Z=24)$  (b)  $Mn(Z=25)$   
(c)  $Fe(Z=26)$  (d)  $Co(Z=27)$
54. Which one of the following ions exhibit highest magnetic moment?  
(a)  $Cu^{2+}$  (b)  $Ti^{3+}$   
(c)  $Ni^{2+}$  (d)  $Mn^{2+}$
55. A compound of a metal ion  $M^{x+}$  ( $Z = 24$ ) has a spin only magnetic moment of  $\sqrt{15}$  Bohr Magnetons. The number of unpaired electrons in the compound are  
(a) 2 (b) 4  
(c) 5 (d) 3
56. Titanium shows magnetic moment of 1.73 B.M. in its compound. What is the oxidation number of Ti in the compound?  
(a) +1 (b) +4  
(c) +3 (d) +2
57. Which of the following ions having following electronic structure would have maximum magnetic moment?  
(a)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$   
(b)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$   
(c)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$   
(d)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^9$
58. If  $n$  is the number of unpaired electrons, the magnetic moment (in BM) of transition metal/ion is given by  
(a)  $\sqrt{n(n+2)}$  (b)  $\sqrt{2n(n+1)}$   
(c)  $\sqrt{n(n-2)}$  (d)  $\sqrt{2n(n-1)}$
59. Which one of the following ions has the maximum magnetic moment?  
(a)  $Sc^{3+}$  (b)  $Ti^{3+}$   
(c)  $Cr^{3+}$  (d)  $Fe^{3+}$
60. The magnetic nature of elements depend on the presence of unpaired electrons. Identify the configuration of transition element, which shows highest magnetic moment.  
(a)  $3d^7$  (b)  $3d^5$   
(c)  $3d^8$  (d)  $3d^2$

61. Transition elements show magnetic moment due to spin and orbital motion of electrons. Which of the following metallic ions have almost same spin only magnetic moment?  
 (i)  $\text{Co}^{2+}$  (ii)  $\text{Cr}^{2+}$   
 (iii)  $\text{Mn}^{2+}$  (iv)  $\text{Cr}^{3+}$   
 (a) (i) and (iii) (b) (i) and (iv)  
 (c) (ii) and (iii) (d) (ii) and (iv)
62. The aqueous solution containing which one of the following ions will be colourless? (Atomic number:  $\text{Sc} = 21$ ,  $\text{Fe} = 26$ ,  $\text{Ti} = 22$ ,  $\text{Mn} = 25$ )  
 (a)  $\text{Sc}^{3+}$  (b)  $\text{Fe}^{2+}$   
 (c)  $\text{Ti}^{3+}$  (d)  $\text{Mn}^{2+}$
63. Transition elements form coloured ions due to  
 (a) *d-d* transition (b) fully filled *d*-orbitals  
 (c) smaller atomic radii (d) availability of *s*-electrons
64. The catalytic activity of transition metals and their compounds is mainly due to  
 (a) their magnetic behaviour  
 (b) their unfilled *d*-orbitals  
 (c) their ability to adopt variable oxidation state  
 (d) their chemical reactivity
65. Which of the following is colourless in water?  
 (a)  $\text{Ti}^{3+}$  (b)  $\text{V}^{3+}$   
 (c)  $\text{Cu}^{3+}$  (d)  $\text{Sc}^{3+}$
66. Which group contains coloured ions out of  
 (i)  $\text{Cu}^{2+}$  (ii)  $\text{Ti}^{4+}$   
 (iii)  $\text{Co}^{2+}$  (iv)  $\text{Fe}^{2+}$   
 (a) (i), (ii), (iii), (iv) (b) (i), (iii), (iv)  
 (c) (ii), (iii) (d) (i), (ii)
67. Which of the following statements about the interstitial compounds is incorrect?  
 (a) They are chemically reactive.  
 (b) They are much harder than the pure metal.  
 (c) They have higher melting points than the pure metal.  
 (d) They retain metallic conductivity.
68. Formation of interstitial compound makes the transition metal  
 (a) more soft (b) more ductile  
 (c) more metallic (d) more hard
69. If a non metal is added to the interstitial sites of a metal, then the metal becomes  
 (a) softer (b) less tensile  
 (c) less malleable (d) more ductile
70. Gun metal is an alloy of  
 (a) Cu and Al (b) Cu and Sn  
 (c) Cu, Zn and Sn (d) Cu, Zn and Ni
71. Brass is an alloy of  
 (a) Zn and Sn (b) Zn and Cu  
 (c) Cu, Zn and Sn (d) Cu and Sn
72. Which one of the following is coinage metal?  
 (a) Zn (b) Cu  
 (c) Sn (d) Pb.
73. Bronze is an alloy of  
 (a) Pb + Sn + Zn (b) Cu + Sn  
 (c) Pb + Zn (d) Cu + Zn
74. An alloy of transition metal containing a non transition metal as a constituent is  
 (a) invar (b) bronze  
 (c) chrome steel (d) stainless steel
75. Choose the correct increasing order of the oxidation state of the central metal atom in the following oxoanions.  
 $\text{VO}_2^+$ ,  $\text{VO}^{2+}$ ,  $\text{TiO}^{2+}$ ,  $\text{CrO}_4^{2-}$   
 (a)  $\text{VO}^{2+} \approx \text{VO}_2^+ < \text{TiO}^{2+} < \text{CrO}_4^{2-}$   
 (b)  $\text{VO}^{2+} \approx \text{TiO}^{2+} < \text{VO}_2^+ < \text{CrO}_4^{2-}$   
 (c)  $\text{CrO}_4^{2-} < \text{TiO}^{2+} < \text{VO}_2^+ < \text{VO}^{2+}$   
 (d)  $\text{TiO}^{2+} < \text{VO}^{2+} \approx \text{VO}_2^+ < \text{CrO}_4^{2-}$
76. Which of the following ion(s) is/are oxidising in nature?  
 (i)  $\text{V}^{2+} \left( E_{\text{M}^{2+}/\text{M}}^\circ = -1.18 \right)$   
 (ii)  $\text{Mn}^{3+} \left( E_{\text{M}^{3+}/\text{M}^{2+}}^\circ = +1.57 \right)$   
 (iii)  $\text{Cr}^{2+} \left( E_{\text{M}^{2+}/\text{M}}^\circ = -0.91 \right)$   
 (a) (i) and (iii) (b) only (ii)  
 (c) (ii) and (iii) (d) only (iii)
77. Which of the following transition metal ion is colourless in aqueous solution?  
 (a)  $\text{Ti}^{4+}$  (b)  $\text{Zn}^{2+}$   
 (c)  $\text{V}^{4+}$  (d) Both (a) and (b)
78. Transition metals show catalytic activity  
 (a) Due to their ability to form complexes.  
 (b) Due to their ability to show multiple oxidation state.  
 (c) Due to availability of *d* orbitals for bond formation.  
 (d) Both (a) and (b).
79. Which of the following transition metal on catalysis the reaction between iodide and persulphate ion?  
 (a)  $\text{Fe}^{2+}$  (b)  $\text{Fe}^{3+}$   
 (c)  $\text{Ni}^{2+}$  (d) Both (a) and (c)
80. Which of the following reactions are disproportionation reactions?  
 (i)  $\text{Cu}^+ \longrightarrow \text{Cu}^{2+} + \text{Cu}$   
 (ii)  $3\text{MnO}_4^- + 4\text{H}^+ \longrightarrow 2\text{MnO}_4^- + \text{MnO}_2 + 2\text{H}_2\text{O}$   
 (iii)  $2\text{KMnO}_4 \longrightarrow \text{K}_2\text{MnO}_4 + \text{MnO}_2 + \text{O}_2$   
 (iv)  $2\text{MnO}_4^- + 3\text{Mn}^{2+} + 2\text{H}_2\text{O} \longrightarrow 5\text{MnO}_2 + 4\text{H}^+$   
 (a) (i) and (ii) (b) (i), (ii) and (iii)  
 (c) (ii), (iii) and (iv) (d) (i) and (iv)



81. In the form of dichromate, Cr (VI) is a strong oxidising agent in acidic medium but Mo (VI) in  $\text{MoO}_3$  and W (VI) in  $\text{WO}_3$  are not because \_\_\_\_\_.
- Cr (VI) is more stable than Mo(VI) and W (VI).
  - Mo (VI) and W(VI) are more stable than Cr(VI).
  - Higher oxidation states of heavier members of group-6 of transition series are more stable.
  - Lower oxidation states of heavier members of group-6 of transition series are more stable.
- (i) and (ii)
  - (ii) and (iii)
  - (i) and (iv)
  - (ii) and (iv)
82.  $\text{K}_2\text{Cr}_2\text{O}_7$  on heating with aqueous NaOH gives
- $\text{CrO}_4^{2-}$
  - $\text{Cr(OH)}_3$
  - $\text{Cr}_2\text{O}_7^{2-}$
  - $\text{Cr(OH)}_2$
83.  $\text{CrO}_3$  dissolves in aqueous NaOH to give
- $\text{Cr}_2\text{O}_7^{2-}$
  - $\text{CrO}_4^{2-}$
  - $\text{Cr(OH)}_3$
  - $\text{Cr(OH)}_2$
84. The oxidation state of chromium in the final product formed by the reaction between KI and acidified potassium dichromate solution is
- +3
  - +2
  - +6
  - +4
85. The bonds present in the structure of dichromate ion are
- four equivalent Cr – O bonds only
  - six equivalent Cr – O bonds and one O – O bond
  - six equivalent Cr – O bonds and one Cr – Cr bond
  - six equivalent Cr – O bonds and one Cr – O – Cr bond
86. Potassium dichromate when heated with concentrated sulphuric acid and a soluble chloride, gives brown-red vapours of
- $\text{CrO}_3$
  - $\text{CrCl}_3$
  - $\text{CrO}_2\text{Cl}_2$
  - $\text{Cr}_2\text{O}_3$
87. The acidic, basic or amphoteric nature of  $\text{Mn}_2\text{O}_7$ ,  $\text{V}_2\text{O}_5$  and  $\text{CrO}$  are respectively
- acidic, acidic and basic
  - basic, amphoteric and acidic
  - acidic, amphoteric and basic
  - acidic, basic and amphoteric
88. Which of the following oxides of Cr is amphoteric
- $\text{CrO}_2$
  - $\text{Cr}_2\text{O}_3$
  - $\text{CrO}_5$
  - $\text{CrO}_3$
89. Which of the following is amphoteric oxide?
- $\text{Mn}_2\text{O}_7$ ,  $\text{CrO}_3$ ,  $\text{Cr}_2\text{O}_3$ ,  $\text{CrO}$ ,  $\text{V}_2\text{O}_5$ ,  $\text{V}_2\text{O}_4$
- $\text{V}_2\text{O}_5$ ,  $\text{Cr}_2\text{O}_3$
  - $\text{Mn}_2\text{O}_7$ ,  $\text{CrO}_3$
  - $\text{CrO}$ ,  $\text{V}_2\text{O}_5$
  - $\text{V}_2\text{O}_5$ ,  $\text{V}_2\text{O}_4$
90. When acidified  $\text{K}_2\text{Cr}_2\text{O}_7$  solution is added to  $\text{Sn}^{2+}$  salts then  $\text{Sn}^{2+}$  changes to
- Sn
  - $\text{Sn}^{3+}$
  - $\text{Sn}^{4+}$
  - Sn
91. In neutral or faintly alkaline medium, thiosulphate is quantitatively oxidized by  $\text{KMnO}_4$  to
- $\text{SO}_3^{2-}$
  - $\text{SO}_4^{2-}$
  - $\text{SO}_2$
  - $\text{SO}_5^{2-}$
92.  $\text{KMnO}_4$  can be prepared from  $\text{K}_2\text{MnO}_4$  as per the reaction:
- $$3\text{MnO}_4^{2-} + 2\text{H}_2\text{O} \rightleftharpoons 2\text{MnO}_4^{2-} + \text{MnO}_2 + 4\text{OH}^-$$
- The reaction can go to completion by removing  $\text{OH}^-$  ions by adding.
- KOH
  - $\text{CO}_2$
  - $\text{SO}_2$
  - HCl
93. In the laboratory, manganese (II) salt is oxidised to permanganate ion in aqueous solution by
- hydrogen peroxide
  - conc. nitric acid
  - peroxy disulphate
  - dichromate
94. The starting material for the manufacture of  $\text{KMnO}_4$  is
- pyrolusite
  - manganite
  - magnetite
  - haematite
95. An explosion take place when conc.  $\text{H}_2\text{SO}_4$  is added to  $\text{KMnO}_4$ . Which of the following is formed?
- $\text{Mn}_2\text{O}_7$
  - $\text{MnO}_2$
  - $\text{MnSO}_4$
  - $\text{M}_2\text{O}_3$
96. If  $\text{KMnO}_4$  is reduced by oxalic acid in an acidic medium then oxidation number of Mn changes from
- 4 to 2
  - 6 to 4
  - +7 to +2
  - 7 to 4
97.  $\text{KMnO}_4$  acts as an oxidising agent in alkaline medium. When alkaline  $\text{KMnO}_4$  is treated with KI, iodide ion is oxidised to \_\_\_\_\_.
- $\text{I}_2$
  - $\text{IO}^-$
  - $\text{IO}_3^-$
  - $\text{IO}_4^-$
98. On the basis of data given below,
- $$E_{\text{Sc}^{3+}/\text{Sc}^{2+}}^\ominus = -0.37, E_{\text{Mn}^{3+}/\text{Mn}^{2+}}^\ominus = +1.57$$
- $$E_{\text{Cr}^{2+}/\text{Cr}}^\ominus = -0.90, E_{\text{Cu}^{2+}/\text{Cu}}^\ominus = 0.34$$
- Which of the following statements is incorrect?
- $\text{Sc}^{3+}$  has good stability due of  $[\text{Ar}]3d^04s^0$  configuration.
  - $\text{Mn}^{3+}$  is more stable than  $\text{Mn}^{2+}$ .
  - $\text{Cr}^{2+}$  is reducing in nature.
  - Copper does not give  $\text{H}_2$  on reaction with dil.  $\text{H}_2\text{SO}_4$ .
99. Which of the following is most acidic?
- $\text{Mn}_2\text{O}_7$
  - $\text{V}_2\text{O}_5$
  - $\text{Fe}_2\text{O}_3$
  - $\text{Cr}_2\text{O}_3$
100. Which of the following is the use of potassium permanganate?
- Bleaching of wool, cotton and silk fibers.
  - decolourisation of oils.
  - In analytical chemistry.
  - All of these.

- 101.** Which of the following is not correctly matched?
- | Compound of transition metal      | Use   |
|-----------------------------------|---|
| (a) TiO                           | Pigment industry                              |
| (b) MnO <sub>2</sub>              | Dry battery cell                              |
| (c) V <sub>2</sub> O <sub>5</sub> | Manufacture of H <sub>2</sub> SO <sub>4</sub> |
| (d) PdCl <sub>2</sub>             | Manufacture of polyethylene                   |
- 102.** A series I metal ion, M(II) aqueous solution react with the KI to form iodine and a precipitate is formed, this M(II) can be:
- |                      |                      |
|----------------------|----------------------|
| (a) Zn <sup>2+</sup> | (b) Mn <sup>2+</sup> |
| (c) Cu <sup>2+</sup> | (d) Ni <sup>2+</sup> |
- 103.** Total number of inner transition elements in the periodic table is
- |        |        |
|--------|--------|
| (a) 10 | (b) 14 |
| (c) 28 | (d) 30 |
- 104.** Which of the following ions will exhibit colour in aqueous solutions?
- |                             |                             |
|-----------------------------|-----------------------------|
| (a) La <sup>3+</sup> (Z=57) | (b) Ti <sup>3+</sup> (Z=22) |
| (c) Lu <sup>3+</sup> (Z=71) | (d) Sc <sup>3+</sup> (Z=21) |
- 105.** The lanthanide contraction is responsible for the fact that
- Zr and Y have about the same radius
  - Zr and Nb have similar oxidation state
  - Zr and Hf have about the same radius
  - Zr and Zn have the same oxidation state
- (Atomic numbers: Zr=40, Y=39, Nb=41, Hf=72, Zn=30)
- 106.** Which one of the following elements shows maximum number of different oxidation states in its compounds?
- |        |        |
|--------|--------|
| (a) Eu | (b) La |
| (c) Gd | (d) Am |
- 107.** Lanthanoids are
- 14 elements in the sixth period (atomic no. = 90 to 103) that are filling 4*f* sublevel
  - 14 elements in the seventh period (atomic no. = 90 to 103) that are filling 5*f* sublevel
  - 14 elements in the sixth period (atomic no. = 58 to 71) that are filling 4*f* sublevel
  - 14 elements in the seventh period (atomic no. = 58 to 71) that are filling 4*f* sublevel
- 108.** Which of the following factors may be regarded as the main cause of lanthanide contraction?
- Greater shielding of 5*d* electrons by 4*f* electrons
  - Poorer shielding of 5*d* electrons by 4*f* electrons
  - Effective shielding of one of 4*f* electrons by another in the subshell
  - Poor shielding of one of 4*f* electron by another in the subshell
- 109.** Lanthanoid which has the smallest size in +3 state is
- |        |        |
|--------|--------|
| (a) Tb | (b) Er |
| (c) Ce | (d) Lu |
- 110.** Lanthanum is grouped with *f*-block elements because
- it has partially filled *f*-orbitals
  - it is just before Ce in the periodic table
  - it has both partially filled *f* and *d*-orbitals
  - properties of lanthanum are very similar to the elements of *f*-block
- 111.** A reduction in atomic size with increase in atomic number is a characteristic of elements of
- |                        |                        |
|------------------------|------------------------|
| (a) high atomic masses | (b) <i>d</i> -block    |
| (c) <i>f</i> -block    | (d) radioactive series |
- 112.** Which of the following oxidation states is the most common among the lanthanoids?
- |       |       |
|-------|-------|
| (a) 3 | (b) 4 |
| (c) 2 | (d) 5 |
- 113.** Identify the incorrect statement among the following:
- 4*f* and 5*f* orbitals are equally shielded.
  - d*-Block elements show irregular and erratic chemical properties among themselves.
  - La and Lu have partially filled *d*-orbitals and no other partially filled orbitals.
  - The chemistry of various lanthanoids is very similar.
- 114.** In context of the lanthanoids, which of the following statements is not correct?
- There is a gradual decrease in the radii of the members with increasing atomic number in the series.
  - All the members exhibit +3 oxidation state.
  - Because of similar properties the separation of lanthanoids is not easy.
  - Availability of 4*f* electrons results in the formation of compounds in +4 state for all the members of the series.
- 115.** The outer electronic configuration of Gd (Atomic No. : 64) is
- |   |   |
|---|---|
| (a) 4 <i>f</i> <sup>3</sup> 5 <i>d</i> <sup>5</sup> 6 <i>s</i> <sup>2</sup> | (b) 4 <i>f</i> <sup>8</sup> 5 <i>d</i> <sup>0</sup> 6 <i>s</i> <sup>2</sup> |
| (c) 4 <i>f</i> <sup>4</sup> 5 <i>d</i> <sup>4</sup> 6 <i>s</i> <sup>2</sup> | (d) 4 <i>f</i> <sup>7</sup> 5 <i>d</i> <sup>1</sup> 6 <i>s</i> <sup>2</sup> |
- 116.** The correct order of ionic radii of Y<sup>3+</sup>, La<sup>3+</sup>, Eu<sup>3+</sup> and Lu<sup>3+</sup> is
- |  |
|--|
| (a) La <sup>3+</sup> < Eu <sup>3+</sup> < Lu <sup>3+</sup> < Y <sup>3+</sup> |
| (b) Y <sup>3+</sup> < La <sup>3+</sup> < Eu <sup>3+</sup> < Lu <sup>3+</sup> |
| (c) Y <sup>3+</sup> < Lu <sup>3+</sup> < Eu <sup>3+</sup> < La <sup>3+</sup> |
| (d) Lu <sup>3+</sup> < Eu <sup>3+</sup> < La <sup>3+</sup> < Y <sup>3+</sup> |
- (Atomic nos. Y=39, La=57, Eu=63, Lu=71)
- 117.** Which of the following lanthanoid ions is diamagnetic?
- (At nos. Ce=58, Sm=62, Eu=63, Yb=70)
- |                      |                      |
|----------------------|----------------------|
| (a) Sm <sup>2+</sup> | (b) Eu <sup>2+</sup> |
| (c) Yb <sup>2+</sup> | (d) Ce <sup>2+</sup> |
- 118.** Lanthanide contraction can be observed in
- |        |        |
|--------|--------|
| (a) At | (b) Gd |
| (c) Ac | (d) Lw |
- 119.** The approximate percentage of iron in mischmetal is
- |        |        |
|--------|--------|
| (a) 10 | (b) 20 |
| (c) 50 | (d) 5  |
- 120.** The most common lanthanide is
- |               |               |
|---------------|---------------|
| (a) lanthanum | (b) cerium    |
| (c) samarium  | (d) plutonium |

121. Non-lanthanide atom is  
 (a) La (b) Lu  
 (c) Pr (d) Pm
122. In which of the following lanthanides oxidation state +2 is most stable?  
 (a) Ce (b) Eu  
 (c) Tb (d) Dy
123. Actinoides  
 (a) are all synthetic elements  
 (b) include element 104  
 (c) have any short lived isotopes  
 (d) have variable valency
124. Which of the following exhibit only +3 oxidation state?  
 (a) U (b) Th  
 (c) Ac (d) Pa
125. Larger number of oxidation states are exhibited by the actinoids than those by the lanthanoids, the main reason being  
 (a)  $4f$  orbitals more diffused than the  $5f$  orbitals  
 (b) lesser energy difference between  $5f$  and  $6d$  than between  $4f$  and  $5d$  orbitals  
 (c) more energy difference between  $5f$  and  $6d$  than between  $4f$  and  $5d$  orbitals  
 (d) more reactive nature of the actinoids than the lanthanoids
126. The maximum oxidation state exhibited by actinide ions is  
 (a) +5 (b) +4  
 (c) +7 (d) +8
127. There are 14 elements in actinoid series. Which of the following elements does not belong to this series?  
 (a) U (b) Np  
 (c) Tm (d) Fm
128. Which of the following actinoids show oxidation states upto +7?  
 (i) Am (ii) Pu  
 (iii) U (iv) Np  
 (a) (i) and (ii) (b) (ii) and (iv)  
 (c) (iii) and (iv) (d) (i) and (iii)
129. Which of the following lanthanoid element is steel hard in nature?  
 (a) Eu (b) Pm  
 (c) Sm (d) Ce
130. What is the percentage of lanthanoid metal in mischmetal?  
 (a) 90% (b) 20%  
 (c) 5% (d) 95%
131. Which of the following is the use of mischmetal?  
 (a) In bullets  
 (b) In lighter flint  
 (c) As catalyst in petroleum cracking  
 (d) Both (a) and (b)
132. Which of the following actinoid element has  $5f^7 6d^1 7s^2$  configuration?  
 (a) Bk (b) Gm  
 (c) Pa (d) No

133. The increasing order of the shielding of electrons by the orbitals  $ns, np, nd, nf$  is  
 (a)  $ns, np, nd, nf$  (b)  $np, ns, nd, nf$   
 (c)  $nd, nf, np, ns$  (d)  $nf, nd, np, ns$
134. Which of the following in its oxidation state shows the paramagnetism?  
 (a) Tb(IV) (b) Lu(III)  
 (c) Ce(IV) (d) La(III)

### STATEMENT TYPE QUESTIONS

135. Mark the correct statement(s).  
 (i) Manganese exhibits +7 oxidation state  
 (ii) Zinc forms coloured ions  
 (iii)  $[\text{CoF}_6]^{3-}$  is diamagnetic  
 (iv) Sc forms +4 oxidation state  
 (v) Zn exhibits only +2 oxidation state  
 (a) (i) and (ii) (b) (i) and (v)  
 (c) (ii) and (iv) (d) (iii) and (iv)
136. Which of the following statements are correct?  
 (i) The maximum oxidation state of Mn with the oxygen is +VII while with fluorine is +IV.  
 (ii) Fluorine is more oxidizing in nature than oxygen.  
 (iii) Fluorine exhibit an oxidation state of -1.  
 (iv) Seven fluorine cannot be accommodated around Mn.  
 (a) (i), (ii) and (iii)  
 (b) (ii), (iii) and (iv)  
 (c) (i) and (iv)  
 (d) (i), (ii), (iii) and (iv)
137. Which of the following statements are correct?  
 (i) Chromium has the highest melting point among the series 1 metals.  
 (ii) Number of unpaired electrons is greater in Cr than other elements of series 1.  
 (iii) In any row the melting point of transition metal increases as the atomic number increases.  
 (a) (i) and (iii) (b) (i) and (ii)  
 (c) (ii) and (iii) (d) (i), (ii) and (iii)
138. Read the following statements?  
 (i) Aqueous solutions formed by all ions of Ti are colourless.  
 (ii) Aqueous solution of ferrous ions is green in colour.  
 (iii) Small size and presence of vacant  $d$ -orbitals make transition metal ions suitable for formation of complex compounds.  
 (iv) Catalytic action of transition metals involves the increase of reactant concentration at catalyst surface and weakening of the bonds in the reacting molecules.
- Which of the following is the correct code for above statements?  
 (a) FTTT (b) TFFT  
 (c) TFTT (d) FFTT

139. Which of the following statements are correct?
- Interstitial compounds contain non-metal atoms trapped inside the metal crystal whereas alloys are homogeneous blend of metals.
  - Steel and bronze are alloys of transition and non-transition metals.
  - Some boride containing interstitial compounds are very hard comparable to that of diamond.
  - Interstitial compounds are chemically more reactive than parent metal.
- (a) (i) and (iii) (b) (ii) and (iv)  
(c) (ii) and (iii) (d) (i), (ii) and (iii)

140. Which of the following statements are correct?
- As a result of lanthanoid contraction members of  $4d$  and  $5d$  series exhibit similar radii.
  - $IE_2$  is high for Cr and Cu whereas  $IE_3$  is very high for Zn.
  - Heavier members of  $d$ -block elements like  $p$ -block elements favours lower oxidation states.
  - In any transition series maximum number of oxidation states is shown by middle elements or elements near middle elements.
- (a) (i) and (ii) (b) (i), (ii) and (iv)  
(c) (i), (ii) and (iii) (d) (ii) and (iv)

141. Consider the following statements
- $La(OH)_3$  is the least basic among hydroxides of lanthanides.
  - $Zr^{4+}$  and  $Hf^{4+}$  possess almost the same ionic radii.
  - $Ce^{4+}$  can act as an oxidizing agent.
- Which of the above is/are true?
- (a) (i) and (iii) (b) (ii) and (iii)  
(c) (ii) only (d) (i) and (ii)

142. Read the following statements.
- Chemistry of actinoids is complex in comparison to chemistry of lanthanoids.
  - $Ce^{4+}$  is a very good reducing agent.
  - $Eu^{2+}$  is a strong reducing agent.
  - Out of all lanthanides Ce, Pr, Nd, Dy and Ho shows +4 oxidation state.

Which of the following is the correct code for the statements above?

- (a) TTFF (b) TFTF  
(c) FTFT (d) FTTF

143. Read the following statements?
- Only Pu show maximum oxidation state of +7 in actinoids.
  - $M^{4+}$  ion of Th is the only diamagnetic  $M^{4+}$  ion of actinoid series.
  - Electrons present in the  $5f$  orbitals of actinides can participate in bonding to a far greater extent as compared to electrons present in  $4f$  orbitals of lanthanides.
  - Magnetic properties of actinoids are more complex than lanthanoids.

Which of the following is the correct code for the statements above?

- (a) FTTF (b) TFTT  
(c) TTFF (d) FTTF

144. Which of the following statement(s) regarding Hf and Zr is/are correct?
- Hf has greater density than Zr.
  - Lanthanoid contraction is responsible for such radii.
- (a) Both (i) and (ii) are correct.  
(b) Both (i) and (ii) are incorrect  
(c) Statement (i) is correct only  
(d) Statement (ii) is correct only.

### MATCHING TYPE QUESTIONS

145. Match the columns

Column-I	Column-II
(A) Metal of the $3d$ -series which does not form MO type oxide.	(p) Manganese
(B) Metal of the $3d$ -series which forms most covalent oxide.	(q) Vanadium
(C) Metal of the $3d$ -series which forms the amphoteric oxide.	(r) Scandium
(a) A – (p), B – (r), C – (q)	
(b) A – (r), B – (p), C – (q)	
(c) A – (r), B – (q), C – (p)	
(d) A – (q), B – (p), C – (r)	

146. Match the columns

Column-I (Ion)	Column-II ( $M_{\text{calculated}}$ )
(A) $Ti^{2+}$	(p) 2.84
(B) $Zn^{2+}$	(q) 5.92
(C) $Mn^{2+}$	(r) 0
(D) $Sc^{3+}$	(s) 4.90
(a) A – (s), B – (p), C – (q), D – (r).	
(b) A – (r), B – (p), C – (q), D – (s).	
(c) A – (p), B – (r), C – (q), D – (s).	
(d) A – (p), B – (s), C – (q), D – (r).	

147. Match the columns

Column-I	Column-II
(A) Compound formed when yellow $CrO_4^{2-}$ is acidified.	(p) acidified $MnO_4^-$
(B) reagent oxidises $Fe^{2+}$ to $Fe^{3+}$	(q) $Cr_2O_7^{2-}$
(C) Compound produced when $MnO_2$ is fused with $KNO_3$	(r) $K_2MnO_4$
(D) Compound having dark purple crystals isostructural with $KClO_4$	(s) $KMnO_4$
(a) A – (q), B – (p), C – (r), D – (s)	
(a) A – (p), B – (q), C – (r), D – (s)	
(a) A – (q), B – (r), C – (p), D – (s)	
(a) A – (q), B – (p), C – (s), D – (r)	

148. Match the columns

Column-I	Column-II
(A) Lanthanide hard as steel.	(p) Lu
(B) Lanthanide with maximum paramagnetic character in $\text{Ln}^{4+}$ state.	(q) Tb
(C) Lanthanide with maximum value of $E^\circ$ for reaction $\text{Ln}^{3+}(\text{aq}) + 3\text{e}^- \rightarrow \text{Ln}(\text{s})$ .	(r) Sm
(D) Lanthanide whose $\text{Ln}^{3+}$ ion is diamagnetic in nature	(s) Eu
(a) A – (r), B – (s), C – (p), D – (q)	
(b) A – (r), B – (q), C – (s), D – (p)	
(c) A – (s), B – (r), C – (q), D – (p)	
(d) A – (r), B – (s), C – (q), D – (p)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

149. **Assertion :** Cuprous ion ( $\text{Cu}^+$ ) has unpaired electrons while cupric ion ( $\text{Cu}^{2+}$ ) does not.

**Reason :** Cuprous ion ( $\text{Cu}^+$ ) is colourless whereas cupric ion ( $\text{Cu}^{2+}$ ) is blue in the aqueous solution

150. **Assertion :** Transition metals show variable valency.

**Reason :** Transition metals have a large energy difference between the  $ns^2$  and  $(n-1)d$  electrons.

151. **Assertion :** Transition metals are good catalysts.

**Reason :**  $\text{V}_2\text{O}_5$  or Pt is used in the preparation of  $\text{H}_2\text{SO}_4$  by contact process.

152. **Assertion :** Magnetic moment values of actinides are lesser than the theoretically predicted values.

**Reason :** Actinide elements are strongly paramagnetic.

### CRITICAL THINKING TYPE QUESTIONS

153. Among the following series of transition metal ions, the one where all metal ions have  $3d^2$  electronic configuration is (At. nos. Ti = 22; V = 23; Cr = 24; Mn = 25)

- (a)  $\text{Ti}^{3+}$ ,  $\text{V}^{2+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Mn}^{4+}$   
 (b)  $\text{Ti}^+$ ,  $\text{V}^{4+}$ ,  $\text{Cr}^{6+}$ ,  $\text{Mn}^{7+}$   
 (c)  $\text{Ti}^{4+}$ ,  $\text{V}^{3+}$ ,  $\text{Cr}^{2+}$ ,  $\text{Mn}^{3+}$   
 (d)  $\text{Ti}^{2+}$ ,  $\text{V}^{3+}$ ,  $\text{Cr}^{4+}$ ,  $\text{Mn}^{5+}$

154. The electronic configuration of Cu(II) is  $3d^9$  whereas that of Cu(I) is  $3d^{10}$ . Which of the following is correct ?

- (a) Cu (II) is more stable  
 (b) Cu (II) is less stable  
 (c) Cu (I) and (II) are equally stable  
 (d) Stability of Cu (I) and Cu (II) depends on nature of copper salts

155. Highest oxidation state of manganese in fluoride is +4 ( $\text{MnF}_4$ ) but highest oxidation state in oxides is +7 ( $\text{Mn}_2\text{O}_7$ ) because \_\_\_\_\_.

- (a) fluorine is more electronegative than oxygen.  
 (b) fluorine does not possess d-orbitals.  
 (c) fluorine stabilises lower oxidation state.  
 (d) in covalent compounds fluorine can form single bond only while oxygen forms double bond.

156. Four successive members of the first series of the transition metals are listed below. For which one of them the standard

potential ( $E_{\text{M}^{2+}/\text{M}}^\circ$ ) value has a positive sign?

- (a) Co (Z = 27) (b) Ni (Z = 28)  
 (c) Cu (Z = 29) (d) Fe (Z = 26)

157. The standard redox potentials for the reactions  $\text{Mn}^{2+} + 2\text{e}^- \rightarrow \text{Mn}$  and  $\text{Mn}^{3+} + \text{e}^- \rightarrow \text{Mn}^{2+}$  are -1.18 V and 1.51 V respectively. What is the redox potential for the reaction  $\text{Mn}^{3+} + 3\text{e}^- \rightarrow \text{Mn}$ ?

- (a) 0.33 V (b) 1.69 V  
 (c) -0.28 V (d) -0.85 V

158. Which one of the following transition metal ions shows magnetic moment of 5.92 BM?

- (a)  $\text{Mn}^{2+}$  (b)  $\text{Ti}^{3+}$   
 (c)  $\text{Cr}^{3+}$  (d)  $\text{Cu}^{2+}$

159. In the following salts the lowest value of magnetic moment is observed in

- (a)  $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$  (b)  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$   
 (c)  $\text{FeSO}_4 \cdot 6\text{H}_2\text{O}$  (d)  $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$

160. In which of the following pairs both the ions are coloured in aqueous solutions ?

- (a)  $\text{Sc}^{3+}$ ,  $\text{Ti}^{3+}$  (b)  $\text{Sc}^{3+}$ ,  $\text{Co}^{2+}$   
 (c)  $\text{Ni}^{2+}$ ,  $\text{Cu}^+$  (d)  $\text{Ni}^{2+}$ ,  $\text{Ti}^{3+}$

(At. no. : Sc = 21, Ti = 22, Ni = 28, Cu = 29, Co = 27)

161. For the ions  $\text{Zn}^{2+}$ ,  $\text{Ni}^{2+}$  and  $\text{Cr}^{3+}$  which among the following statements is correct?

(atomic number of Zn = 30, Ni = 28 and Cr = 24)

- (a) All these are colourless  
 (b) All these are coloured  
 (c) Only  $\text{Ni}^{2+}$  is coloured and  $\text{Zn}^{2+}$  and  $\text{Cr}^{3+}$  are colourless  
 (d) Only  $\text{Zn}^{2+}$  is colourless and  $\text{Ni}^{2+}$  and  $\text{Cr}^{3+}$  are coloured

162. Cuprous ion is colourless while cupric ion is coloured because

- (a) both have half filled p-and d-orbitals  
 (b) cuprous ion has incomplete d-orbital and cupric ion has a complete d-orbital  
 (c) both have unpaired electrons in the d-orbitals  
 (d) cuprous ion has complete d-orbital and cupric ion has an incomplete d-orbital.



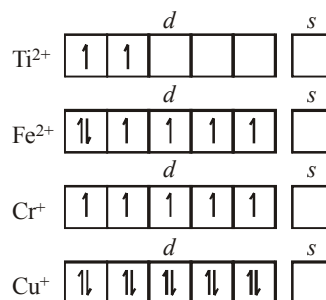
- 163.** The colour of the following ions  $V^{2+}$ ,  $V^{3+}$ ,  $V^{4+}$ ,  $Fe^{2+}$ ,  $Fe^{3+}$  are respectively  
 (a) green, violet, blue, green, yellow  
 (b) yellow, green, violet, green, blue  
 (c) violet, green, yellow, green, blue  
 (d) yellow, green, blue, green, violet
- 164.** Which of the following arrangements does not represent the correct order of the property stated against it ?  
 (a)  $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$  : Paramagnetic behaviour  
 (b)  $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$  : Ionic size  
 (c)  $Co^{3+} < Fe^{3+} < Cr^{3+} < Sc^{3+}$  : Stability in aqueous solution  
 (d)  $Sc < Ti < Cr < Mn$  : Number of oxidation states
- 165.** Acidified  $K_2Cr_2O_7$  solution turns green when  $Na_2SO_3$  is added to it. This is due to the formation of :  
 (a)  $Cr_2(SO_4)_3$  (b)  $CrO_4^{2-}$   
 (c)  $Cr_2(SO_3)_3$  (d)  $CrSO_4$
- 166.** Which of the statements is not true?  
 (a) On passing  $H_2S$  through acidified  $K_2Cr_2O_7$  solution, a milky colour is observed.  
 (b)  $Na_2Cr_2O_7$  is preferred over  $K_2Cr_2O_7$  in volumetric analysis.  
 (c)  $K_2Cr_2O_7$  solution in acidic medium is orange.  
 (d)  $K_2Cr_2O_7$  solution becomes yellow on increasing the pH beyond 7.
- 167.** Which one of the following is an amphoteric oxide ?  
 (i)  $Mn_2O_7$  (ii)  $CrO$   
 (iii)  $V_2O_4$  (iv)  $Cr_2O_3$   
 (a) (i) and (ii) (b) (ii), (iii) and (iv)  
 (c) (iii) and (iv) (d) (ii) and (iv)
- 168.** Among the oxides,  $Mn_2O_7$  (I),  $V_2O_3$  (II),  $V_2O_5$  (III),  $CrO$  (IV) and  $Cr_2O_3$  (V) the basic oxides are  
 (a) I and II (b) II and III  
 (c) III and IV (d) II and IV
- 169.** When a small amount of  $KMnO_4$  is added to concentrated  $H_2SO_4$ , a green oily compound is obtained which is highly explosive in nature. Compound may be  
 (a)  $MnSO_4$  (b)  $Mn_2O_7$   
 (c)  $MnO_2$  (d)  $Mn_2O_3$
- 170.** Identify the product and its colour when  $MnO_2$  is fused with solid  $KOH$  in the presence of  $O_2$ .  
 (a)  $KMnO_4$ , purple (b)  $K_2MnO_4$ , dark green  
 (c)  $MnO$ , colourless (d)  $Mn_2O_3$ , brown
- 171.** When  $KMnO_4$  solution is added to oxalic acid solution, the decolourisation is slow in the beginning but becomes instantaneous after some time because  
 (a)  $CO_2$  is formed as the product.  
 (b) reaction is exothermic.  
 (c)  $MnO_4^-$  catalyses the reaction.  
 (d)  $Mn^{2+}$  acts as autocatalyst.
- 172.** Which of the following oxidising reaction of  $KMnO_4$  occurs in acidic medium?  
 (i)  $Fe^{2+}$  (green) is converted to  $Fe^{3+}$  (yellow).  
 (ii) Iodide is converted to iodate.  
 (iii) Thiosulphate oxidised to sulphate.  
 (iv) Nitrite is oxidised to nitrate.  
 (a) (i) and (iii) (b) (i) and (iv)  
 (c) (iv) only (d) (ii) and (iv)
- 173.** Arrange the following increasing order of acidic character?  $Mn_2O_7$  (A),  $Mn_2O_3$  (B),  $MnO$  (C)?  
 (a) C, A, B (b) A, C, B  
 (c) B, A, C (d) C, B, A
- 174.** Solution of oxalate is colourless. It is made acidic by adding excess of  $H^+$ , then titrated with  $KMnO_4$ . Now at a moment if someone has added large amount of  $KMnO_4$ , in it then no. of possible products are  
 (a)  $CO_2$ ,  $Mn^{2+}$ ,  $H_2O$  (b)  $CO_2$ ,  $MnO_2$ ,  $H_2O$   
 (c)  $MnO_2$ ,  $H_2O$ ,  $CO_2$  (d)  $CO_2$ ,  $MnO_2$ ,  $H_2O$ ,  $Mn^{2+}$
- 175.** Knowing that the chemistry of lanthanoids (Ln) is dominated by its +3 oxidation state, which of the following statements is incorrect?  
 (a) The ionic size of Ln (III) decrease in general with increasing atomic number  
 (b) Ln (III) compounds are generally colourless.  
 (c) Ln (III) hydroxide are mainly basic in character.  
 (d) Because of the large size of the Ln (III) ions the bonding in its compounds is predominantly ionic in character.
- 176.** The +3 ion of which one of the following has half filled 4f subshell?  
 (a) La (b) Lu  
 (c) Gd (d) Ac
- 177.** Although +3 is the characteristic oxidation state for lanthanoids but cerium also shows +4 oxidation state because \_\_\_\_\_ .  
 (i) it has variable ionisation enthalpy  
 (ii) it has a tendency to attain noble gas configuration  
 (iii) it has a tendency to attain  $f^0$  configuration  
 (iv) it resembles  $Pb^{4+}$   
 (a) (ii) and (iii) (b) (i) and (iv)  
 (c) (ii) and (iv) (d) (i), (ii) and (iii)
- 178.** Dichromate  $[Cr(VI)]$  is a strong oxidizing agent whereas  $Mo(VI)$  and  $W(VI)$  are found to be not. This is due to  
 (a) Lanthanoid contraction  
 (b) Down the group metallic character increases  
 (c) Down the group metallic character decreases  
 (d) Both (a) and (b)
- 179.** Which of the following conversions can be carried out by both acidified  $K_2Cr_2O_4$  and acidified  $KMnO_4$ ?  
 (i)  $Fe^{2+} \rightarrow Fe^{3+} + e^-$  (ii)  $I^- \rightarrow$   
 (iii)  $I^- \rightarrow I_2$  (iv)  $H_2S \rightarrow S$   
 (a) (i) and (iii) (b) (ii) and (iv)  
 (c) (i), (iii) and (iv) (d) (i), (ii) and (iii)

# HINTS AND SOLUTIONS

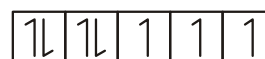
## FACT/DEFINITION TYPE QUESTIONS

- (c) General electronic configuration of transition elements is  $(n-1)d^{1-10}ns^{1-2}$
- (b)  $\text{Cr}(24) = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^5, 4s^1$ ,
- (b) Configuration of Fe ( $Z=26$ )  
 $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^6, 4s^2$
- (d)  $\text{Ni}^{3+} : [\text{Ar}] 3d^7$   
 $\text{Mn}^{3+} : [\text{Ar}] 3d^4$   
 $\text{Fe}^{3+} : [\text{Ar}] 3d^5$   
 $\text{Co}^{3+} : [\text{Ar}] 3d^6$
- (c) Ag belongs to second transition series.
- (c) 7. (a)
- (d) Transition elements due to similar (almost) sizes exhibit both vertical and horizontal similarities.
- (a) Group number is given by  $[ns + (n-1)d]$  electrons.  
 $\therefore [2+3] = 5$
- (a) 3d series starts from Sc( $Z=21$ ) and ends with Zn( $Z=30$ ).
- (d) Since transition metals can lose electrons from  $(n-1)d$   $ns$  orbitals hence they are valence orbitals.
- (b) Atomic no. of Ni = 28  
Ni (Ground state) =  $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^8, 4s^2$   
 $\text{Ni}^{2+} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^8, 4s^0$   
 $\begin{array}{c} 3d \\ \boxed{\uparrow\downarrow} \boxed{\uparrow\downarrow} \boxed{\uparrow\downarrow} \boxed{\uparrow} \boxed{\uparrow} \end{array}$   
 $\therefore$  It has 2 unpaired electrons
- (c) Cerium (Ce) belongs to lanthanide series and is member of inner-transition metals.
- (c)  $\text{Mn}^{3+} = [\text{Ar}] 3d^4$   
 $= [\text{Ar}] \boxed{\uparrow\downarrow} \boxed{\uparrow\downarrow} \boxed{\uparrow\downarrow} \boxed{\uparrow} \boxed{\uparrow}$   
Number of unpaired electrons = 4  
 $\text{Cr}^{3+} = [\text{Ar}] 3d^3$   
 $= [\text{Ar}] \boxed{\uparrow\downarrow} \boxed{\uparrow\downarrow} \boxed{\uparrow} \boxed{\uparrow} \boxed{\uparrow}$   
No. of unpaired electrons = 3  
 $\text{V}^{3+} = [\text{Ar}] 3d^2$   
 $= [\text{Ar}] \boxed{\uparrow\downarrow} \boxed{\uparrow\downarrow} \boxed{\uparrow} \boxed{\uparrow} \boxed{\uparrow}$   
No. of unpaired electrons = 2
- (a)

- (b)  $\text{Zn}^+ [\text{Ar}] 3d^{10} 4s^1, \text{Fe}^{2+} [\text{Ar}] 3d^6 4s^0, \text{Ni}^+ [\text{Ar}] 3d^8 4s^1, \text{Cu}^+ [\text{Ar}] 3d^{10} 4s^0$ ;  
 $\text{Fe}^{2+}$  contain maximum number of unpaired electrons.
- (a) Ni(28)  $[\text{Ar}] 3d^8 4s^2$  contain 2 unpaired electrons.
- (c) Zn, Cd, Hg do not show properties of transition elements hence they are known as non typical transition elements.
- (c) The outer electronic configuration of the given ions is as

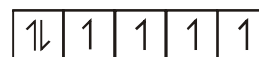


- (c) 21. (a)
- (a)  $\text{Mn}^{7+} = 25 - 7 = 18e^- = [\text{Ar}]$   
 $\therefore$  0 unpaired electrons.
- (b)  $\text{Co} \rightarrow [\text{Ar}] 3d^7 4s^2$



Since it contains three unpaired electrons. Hence it is paramagnetic.

- (a) The outermost electronic configuration of Fe is  
 $\text{Fe} = [\text{Ar}] 3d^6 4s^2$   
 $\text{Fe}^{2+} = [\text{Ar}] 3d^6 4s^0$



Since  $\text{Fe}^{2+}$  has 4 unpaired electrons it is paramagnetic in nature.

$\text{Zn} = [\text{Ar}] 3d^{10} 4s^2$  — no unpaired  $e^-$

$\text{Hg}^{2+} = [\text{Ar}] 4f^{14} 5d^{10}$  — no unpaired  $e^-$

$\text{Ti}^{4+} = [\text{Ar}] 3d^0 4s^0$  — no unpaired  $e^-$

- (c) Due to  $d^5$  configuration, Mn has exactly half filled d-orbitals. As a result the electronic configuration is stable means 3d electrons are more tightly held by the nucleus and this reduces the delocalization of electrons resulting in weaker metallic bonding.
- (d) All statements are correct.

27. (d) The minimum oxidation state in transition metal is equal to the number of electrons in 4s shell and the maximum oxidation state is equal to the sum of the 4s and 3d electrons.  
 $\text{Ti} = [\text{Ar}] 3d^2 4s^2$   
Hence minimum oxidation state is +2 and maximum oxidation state is +4. Thus the common oxidation states of Ti are +2, +3 and +4
28. (a) Os shows maximum oxidation state of +8.
29. (b) Mn -  $3d^5 4s^2$ 

1	1	1	1	1
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1	1
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The no. of various oxidation states possible are + 2, + 3, + 4, + 5, + 6 and + 7.
30. (c) Due to lanthanide contraction, the size of Zr and Hf (atom and ions) become nearly similar.
31. (a)
32. (d)  $\text{Fe}^{3+}$  is easily hydrolysed than  $\text{Fe}^{2+}$  due to more positive charge.
33. (c) Electronic configuration  
 $\text{V}^{2+} - 3d^3 4s^0$ 

1	1	1		
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 $\text{Cr} - 3d^4 4s^0$ 

1	1	1	1	
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 $\text{Mn} - 3d^5 4s^0$ 

1	1	1	1	1
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 $\text{Fe} - 3d^6 4s^0$ 

1	1	1	1	1	1
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For third ionization enthalpy Mn has stable configuration due to half filled d-orbital.
34. (d)  $(n-1)d^5 ns^2$  attains the maximum O.S. of + 7.
35. (a) The ionisation energies increase with increase in atomic number. However, the trend is some irregular among *d*-block elements. On the basis of electronic configuration, the  
 $\text{Zn} : 1s^2 2s^2 p^6 3s^2 p^6 d^{10} 4s^2$   
 $\text{Fe} : 1s^2 2s^2 p^6 3s^2 p^6 d^6 4s^2$   
 $\text{Cu} : 1s^2 2s^2 p^6 3s^2 p^6 d^{10} 4s^1$   
 $\text{Cr} : 1s^2 2s^2 p^6 3s^2 p^6 d^5 4s^1$   
 $\text{IE}_1$  follows the order :  $\text{Zn} > \text{Fe} > \text{Cu} > \text{Cr}$
36. (a) In a period on moving from left to right, ionic radii decreases.  
(a) So order of cationic radii is  
 $\text{Cr}^{2+} > \text{Mn}^{2+} > \text{Fe}^{2+} > \text{Ni}^{2+}$  and  
(b)  $\text{Sc} > \text{Ti} > \text{Cr} > \text{Mn}$  (correct order of atomic radii)  
(c) For unpaired electrons  
 $\text{Mn}^{2+}$  (Five)  $>$   $\text{Ni}^{2+}$  (Two)  
 $<$   $\text{Co}^{2+}$  (Three)  $<$   $\text{Fe}^{2+}$  (Four)  
(d) For unpaired electrons  $>$   
 $\text{Fe}^{2+}$  (Four)  $>$   $\text{Co}^{2+}$  (Three)  $>$   
 $\text{Ni}^{2+}$  (Two)  $>$   $\text{Cu}^{2+}$  (One)
37. (b)  $_{30}\text{Zn}$  and  $_{80}\text{Hg}$  have their d orbitals completely filled so they do not show any variable valency.
38. (a) Highest O.S. by Mn (+7)
39. (c) Zinc does not show variable oxidation state due to completely filled d-orbitals.
40. (d) Sc does not show variable valency.
41. (b) 42. (d)
43. (b) Transition metals are generally paramagnetic since they contain unpaired electrons.
44. (b) Since reduction potential of fluorine is highest transition metals exhibit highest oxidation state with fluorine.
45. (a) Zn, Cd and Hg due to presence of completely filled *d*-orbitals in ground state as well as in their common oxidation states are not regarded as a transition metals but they are studied along with the transition metals.
46. (a) The +7 oxidation state of Mn is not represented in simple halides but  $\text{MnO}_3\text{F}$  is known
47. (d) Transition metals exhibit variable valency
48. (b) In transition metals *d* electrons also take part in bonding, so they show variable oxidation states.
49. (d) For chromium ion + 3 oxidation state is most stable.
50. (c) The melting points of the transition element first rise to a maximum and then fall as the atomic number increases manganese have abnormally low melting point.
51. (a) They may or may not be diamagnetic
52. (a)  $\text{Mn}^{++} - 5$  unpaired electrons  
 $\text{Fe}^{++} - 4$  unpaired electrons  
 $\text{Ti}^{++} - 2$  unpaired electrons  
 $\text{Cr}^{++} - 4$  unpaired electrons  
Hence maximum no. of unpaired electron is present in  $\text{Mn}^{++}$ .  
Magnetic moment  $\propto$  number of unpaired electrons
53. (d)  $E^\circ_{\text{Cr}^{3+}/\text{Cr}^{2+}} = -0.41 \text{ V}$   $E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}} = +0.77 \text{ V}$   
 $E^\circ_{\text{Mn}^{3+}/\text{Mn}^{2+}} = +1.57 \text{ V}$ ,  $E^\circ_{\text{Co}^{3+}/\text{Co}^{2+}} = +1.97 \text{ V}$
54. (d) Since  $\text{Mn}^{2+}$  contains maximum number of unpaired electrons hence it has maximum magnetic moment
55. (d) Magnetic moment  $\mu = \sqrt{n(n+2)}$  where  $n$  = number of unpaired electrons  $\sqrt{15} = \sqrt{n(n+2)}$   $\therefore n = 3$
56. (c) Magnetic moment  $\mu = \sqrt{n(n+2)} \text{ BM}$   
 $1.73 = \sqrt{n(n+2)}$   $\therefore n = 1$ , it has one unpaired electron  
hence electronic configuration is  $[\text{Ar}]3d^1$  and  
electronic configuration for  $Z = 22$  is  $[\text{Ar}]3d^2 4s^2$ .  
Hence charge on Ti is +3
57. (b) The more the number of unpaired electrons, the more is magnetic moment. Therefore the answer is (b).
58. (a)

59. (d)  $\text{Fe}^{3+}(\text{d}^5)$  has 5 unpaired electrons therefore magnetic moment  $= \sqrt{n(n+2)} = \sqrt{5(5+2)} = 5.91$  which is maximum among given options. As  $\text{Sc}^{3+}$ ,  $\text{Ti}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{V}^{3+}$  contains 0, 1, 3, and 2 number of unpaired electrons respectively.
60. (b) 61. (b)
62. (a)  $\text{Sc}^{3+} \rightarrow 3\text{d}^0 4\text{s}^0$ 

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- $\text{Fe}^{2+} \rightarrow 3\text{d}^6 4\text{s}^0$ 

↑↓	↑	↑	↑	↑
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- $\text{Ti}^{3+} \rightarrow 3\text{d}^1 4\text{s}^0$ 

↑				
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- $\text{Mn}^{2+} \rightarrow 3\text{d}^5 4\text{s}^0$ 

↑	↑	↑	↑	↑
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- In  $\text{Sc}^{3+}$  there is/are no unpaired electrons. So the aqueous solution of  $\text{Sc}^{3+}$  will be colourless.
63. (a) Transition elements form coloured ions due to  $d-d$  transitions. In the presence of ligands, there is splitting of energy levels of  $d$ -orbitals. They no longer remain degenerated. So, electronic transition may occur between two  $d$ -orbitals. The required amount of energy to do this is obtained by absorption of light of a particular wavelength in the region of visible light.
64. (c) The transition metals and their compounds are used as catalysts. Because of the variable oxidation states they may form intermediate compound with one of the reactants. These intermediate provides a new path with low activation energy.  $\text{V}_2\text{O}_5 + \text{SO}_2 \rightarrow \text{V}_2\text{O}_4 + \text{SO}_3$   
 $2\text{V}_2\text{O}_4 + \text{O}_2 \rightarrow 2\text{V}_2\text{O}_5$
65. (d) Since  $\text{Sc}^{3+}$  does not contain any unpaired electron it is colourless in water.
66. (b)  $\text{Cu}^{2+}[\text{Ar}]3\text{d}^9$ ,  $\text{Ti}^{4+}[\text{Ar}]3\text{d}^0$ ,  $\text{Co}^{2+}[\text{Ar}]3\text{d}^7$ ,  $\text{Fe}^{2+}[\text{Ar}]3\text{d}^6$   
 1, 3, 4 are coloured ions hence the answer is b.
67. (a) In interstitial compounds small atoms like H, B and C enter into the void sites between the packed atoms of crystalline metal. They retain metallic conductivity and are chemically inert.
68. (d) A covalent bond is formed between small interstitial non-metal and transition metal which make it hard
69. (c) If non metal is added to the interstitial site the metal becomes less malleable due to formation of covalent bond between metal and non metal
70. (c) Gun metal is an alloy of Cu, Zn and Sn. It contains 88% Cu, 10% Sn and 2% Zn.
71. (b) Brass is an alloy of Cu and Zn
72. (b) Cu, Ag and Au are called coinage metals.
73. (b) Bronze is an alloy of Cu and Sn.
74. (b) Bronze - 10% Sn, 90% Cu  
 (Sn is a non transition element)
75. (b)  $\text{VO}^{2+} \approx \text{TiO}^{2+} < \text{VO}_2^+ < \text{CrO}_4^{2-}$
76. (b)
77. (d)  $\text{Ti}^{4+}(3\text{d}^0)$  and  $\text{Zn}^{2+}(3\text{d}^{10})$  are colourless.
78. (d)
79. (b)  $2\text{Fe}^{3+} + 2\text{I}^- \longrightarrow 2\text{Fe}^{2+} + \text{I}_2$   
 $2\text{Fe}^{2+} + \text{S}_2\text{O}_8^{2-} \longrightarrow 2\text{Fe}^{3+} + 2\text{SO}_4^{2-}$
80. (a)
81. (b)
82. (a)  $\text{Cr}_2\text{O}_7^{2-} + 2\text{OH}^- \longrightarrow 2\text{CrO}_4^{2-} + \text{H}_2\text{O}$   
 Hence  $\text{CrO}_4^{2-}$  ion is obtained.
83. (b)  $\text{CrO}_3 + 2\text{NaOH} \rightarrow \text{Na}_2\text{CrO}_4 + \text{H}_2\text{O}$
84. (a)  $\text{Cr}_2\text{O}_7^{2-} + 6\text{I}^- + 14\text{H}^+ \longrightarrow 3\text{I}_2 + 7\text{H}_2\text{O} + 2\text{Cr}^{3+}$   
 oxidation state of Cr is +3.
85. (d)  $\left[ \begin{array}{c} \text{O} \quad \text{O} \\ | \quad | \\ \text{Cr} \quad \text{Cr} \\ / \quad \backslash \quad / \quad \backslash \\ \text{O} \quad \text{O} \quad \text{O} \quad \text{O} \end{array} \right]^{2-}$   
 Dichromate ion
- There are six equivalent Cr — O bonds and one Cr — O — Cr bond.
86. (c) Solid potassium dichromate when heated with concentrated sulphuric acid and a soluble chloride gives orange red vapours of a volatile oily liquid  $\text{CrO}_2\text{Cl}_2$   
 $\text{K}_2\text{Cr}_2\text{O}_7 + 4\text{NaCl} + 6\text{H}_2\text{SO}_4 \longrightarrow 2\text{KHSO}_4 + 4\text{NaHSO}_4 + 2\text{CrO}_2\text{Cl}_2$   
 chromyl chloride
87. (c)  $\text{Mn}_2\text{O}_7$  is acidic,  $\text{V}_2\text{O}_5$  is amphoteric acid and  $\text{CrO}$  is basic.
88. (a)  $\text{CrO}_2$  is amphoteric in nature
89. (a) 90. (c)
91. (b) In neutral or faintly alkaline medium thiosulphate is quantitatively oxidized by  $\text{KMnO}_4$  to  $\text{SO}_4^{2-}$   
 $8\text{KMnO}_4 + 3\text{Na}_2\text{S}_2\text{O}_3 + \text{H}_2\text{O} \longrightarrow 3\text{K}_2\text{SO}_4 + 8\text{MnO}_2 + 3\text{Na}_2\text{SO}_4 + 2\text{KOH}$
92. (b)  $\text{HCl}$  and  $\text{SO}_2$  are reducing agents and can reduce  $\text{MnO}_4^-$ .  $\text{CO}_2$  which is neither oxidising and nor reducing will provide only acidic medium. It can shift reaction in forward direction and reaction can go to completion.
93. (c) In laboratory, manganese (II) ion salt is oxidised to permanganate ion in aqueous solution by peroxodisulphate.  
 $2\text{Mn}^{2+} + \text{S}_2\text{O}_8^{2-} + 8\text{H}_2\text{O} \rightarrow 2\text{MnO}_4^- + 10\text{SO}_4^{2-} + 16\text{H}^+$   
 peroxodisulphate ion
94. (a) Pyrolusite (It is  $\text{MnO}_2$ )
95. (a)  $2\text{KMnO}_4 + \text{H}_2\text{SO}_4 (\text{Conc}) \longrightarrow \text{K}_2\text{SO}_4 + \text{Mn}_2\text{O}_7 + \text{H}_2\text{O}$   
 Explosive
96. (c) In acid medium  $\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$   
 (O.S. of Mn changes from +7 to +2)

97. (c)
98. (b)  $\text{Mn}^{2+}$  ( $d^5$ ) is more stable than  $\text{Mn}^{3+}$  ( $d^4$ ), thus  
 $E_{\text{Mn}^{3+}/\text{Mn}^{2+}}^{\circ} = +ve$
99. (a) As the oxidation state of metal associated with oxygen increases, the acidic character of oxide increases.
100. (d)
101. (d)  $\text{PdCl}_2$  is used as a catalyst in Wacker's process.
102. (c) Only Cu in its +2 oxidation state is able to oxidize the  $\text{I}^-$  to  $\text{I}_2$
103. (c) The number is 28 (14 lanthanide + 14 Actinides)
104. (b)  $\text{La}^{3+} : 54 e^- = [\text{Xe}]$   
 $\text{Ti}^{3+} : 19 e^- = [\text{Ar}] 3d^1$  (Coloured)  
 $\text{Lu}^{3+} : 68 e^- = [\text{Xe}] 4f^{14}$   
 $\text{Sc}^{3+} : 18 e^- = [\text{Ar}]$
105. (c) A regular decrease in the size of the atoms and ions in lanthanoid series from  $\text{La}^{3+}$  to  $\text{Lu}^{3+}$  is called lanthanide contraction. The similarity in size of the atoms of Zr and Hf is due to the lanthanide contraction.
106. (d) We know that lanthanides La, Gd shows +3, oxidation state, while Eu shows oxidation state of +2 and +3. Am shows +3, +4, +5 and +6 oxidation states. Therefore Americium (Am) has maximum number of oxidation states.
107. (c) Lanthanides are 4*f*-series elements starting from cerium ( $Z = 58$ ) to lutetium ( $Z = 71$ ). These are placed in the sixth period and in third group.
108. (b) In lanthanides, there is poorer shielding of 5*d* electrons by 4*f* electrons resulting in greater attraction of the nucleus over 5*d* electrons and contraction of the atomic radii.
109. (d) On going from left to right in lanthanoid series ionic, size decreases i.e.  
 $\text{Ce}^{+3} > \text{Tb}^{+3} > \text{Er}^{+3} > \text{Lu}^{+3}$ .
110. (d)
111. (c) Lanthanide contraction results into decrease in atomic and ionic radii.
112. (a)
113. (a) 4*f* orbital is nearer to nucleus as compared to 5*f* orbital therefore, shielding of 4*f* is more than 5*f*.
114. (d)
115. (d) The configuration of Gd is  $[\text{Xe}] 4f^7 5d^1 6s^2$ .
116. (c) In lanthanide series there is a regular decrease in the atomic as well as ionic radii of trivalent ions ( $\text{M}^{3+}$ ) as the atomic number increases. Although the atomic radii do show some irregularities but ionic radii decreases from La (103 pm) to Lu (86 pm).  $\text{Y}^{3+}$  belong to second transition series therefore have greater ionic radii than other ions of third transition series.
117. (c)  $\text{Sm}^{2+}$  ( $Z = 62$ )  
 $[\text{Xe}] 4f^6 6s^2 - 6 \text{ unpaired } e^-$   
 $\text{Eu}^{2+}$  ( $Z = 63$ )  
 $[\text{Xe}] 4f^7 6s^2 - 7 \text{ unpaired } e^-$   
 $\text{Yb}^{2+}$  ( $Z = 70$ )  
 $[\text{Xe}] 4f^{14} 6s^2 - 0 \text{ unpaired } e^-$   
 $\text{Ce}^{2+}$  ( $Z = 58$ )  
 $[\text{Xe}] 4f^1 5d^1 6s^2 - 2 \text{ unpaired } e^-$   
 Only  $\text{Yb}^{2+}$  is diamagnetic.
118. (b) Amongst the given elements, only Gd is a lanthanide.
119. (d) Mischmetal is an alloy which contains rare earth elements (94-95%), iron (5%) and traces of sulphur, carbon, silicon, calcium and aluminium. It is used in gas lighters, tracer bullets and shells.
120. (b) Cerium is the most common lanthanide
121. (a) La (lanthanum) is non lanthanide atom
122. (b)  $\text{Eu}^{2+}$  has electronic configuration  $[\text{Xe}] 4f^7$  hence stable due to half filled atomic orbitals.
123. (d) Actinides have variable valency due to very small difference in energies of 5*f*, 6*d* and 7*s* orbitals. Actinides are the elements from atomic number 89 to 103.
124. (c)  $\text{Ac} (89) = [\text{Rn}] [6d^1] [7s^2]$
125. (b) The main reason for exhibiting larger number of oxidation states by actinoids as compared to lanthanoids is lesser energy difference between 5*f* and 6*d* orbitals as compared to that between 4*f* and 5*d* orbitals.  
 In case of actinoids we can remove electrons from 5*f* as well as from 6*d* and due to this actinoids exhibit larger number of oxidation state than lanthanoids.
126. (c) Actinoids exhibit variable oxidation states, which vary from +3 to +7.
127. (c) 128. (b) 129. (c)
130. (d) Mischmetall consists of a lanthanoid metal (~95%) and iron (~5%) and traces of S, C, Ca and Al.
131. (d)
132. (b) Curium (Cm) has configuration  $5f^7 6d^1 7s^2$ .
133. (d)
134. (a)  $\text{Tb}^{4+} = 4f^7$  — 3 unpaired  $e^-$   
 $\text{Lu}^{3+} = 4f^{14}$  — 0 unpaired  $e^-$   
 $\text{Ce}^{4+} = 4f^0$  — 0 unpaired  $e^-$   
 $\text{La}^{3+} = 4f^0$  — 0 unpaired  $e^-$

#### STATEMENT TYPE QUESTIONS

135. (b) (i) Outer electronic configuration of Mn is  $3d^5 4s^2$  and hence exhibits +7 oxidation state.  
 (ii) Zinc does not form coloured ions as it has completely filled  $3d^{10} 4s^2$  configuration.  
 (iii) In  $[\text{CoF}_6]^{3-}$ ,  $\text{Co}^{3+}$  is a  $d^7$  system. Fluoride is a weak field ligand and hence does not cause pairing of electrons.  
 $\text{Co}^{3+} \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow \uparrow$ ; Paramagnetic  
 (iv) Sc can form a maximum of +3 oxidation state as it has an outer electronic configuration of  $3d^1 4s^2$ .  
 (v) Zn exhibits only +2 oxidation state as this O.S. is the most stable one.



136. (d)  
 137. (b) In any row the melting points of transition metals rise to a maximum at  $d^5$  except for anomalous values of Mn and Tc and falls regularly as the atomic number increases.  
 138. (a) Aqueous solution formed by  $Ti^{3+}$  ions has purple colour.  
 139. (a) Steel is an alloy of Fe and C (non-metal). Interstitial compounds are chemically inert.  
 140. (b) Heavier members of *d*-block elements unlike *p*-block elements shows higher oxidation states. For example W(VI) is more stable than Cr(VI).  
 141. (b) As a result of lanthanide contraction  $Zr^{4+}$  and  $Hf^{4+}$  possess almost the same ionic radii.  $Ce^{4+}$  is an oxidising agent.  $Ce^{4+}$  gains electron to acquire more stable  $Ce^{3+}$  state.  $La(OH)_3$  is the most basic among lanthanide hydroxides.  
 142. (b)  $Ce^{4+}$  is a strong oxidant reverting to the common +3 state.  
 Ho does not show oxidation state of +4. Lanthanoids showing +4 oxidation state are Ce, Pr, Nd, Dy and Tb.  
 143. (a) Both Np and Pu shows oxidation state of +7.  
 144. (a) Atomic mass of Hf is greater than that of Zr, Hf is a series 3 metal, so for almost similar radius Hf has greater density, Lanthanoid contraction is responsible for almost similar radii.

### MATCHING TYPE QUESTIONS

145. (b)      146. (c)      147. (a)      148. (d)

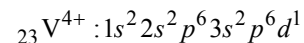
### ASSERTION-REASON TYPE QUESTIONS

149. (d)  
 150. (c) The assertion is correct but the reason is false. Actually transition metal show variable valency due to very small difference between the  $ns^2$  and  $(n-1)d$  electrons.  
 151. (b) Due to larger surface area and variable valencies to form intermediate absorbed complex easily, transition metals are used as catalysts.  
 152. (b) The magnetic moments are lesser than the fact that 5*f* electrons of actinides are less effectively shielded which results in quenching of orbital contribution.

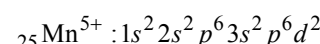
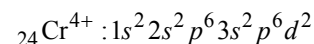
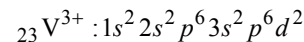
### CRITICAL THINKING TYPE QUESTIONS

153. (d) The electronic configuration of different species given in the question are  
 (a)  $_{22}Ti^{3+} : 1s^2 2s^2 p^6 3s^2 p^6 d^1$   
 (b)  $_{22}Ti^+ : 1s^2 2s^2 p^6 3s^2 .p^6 d^2 4s^1$   
 (c)  $_{22}Ti^{4+} : 1s^2 2s^2 p^6 3s^2 p^6$   
 (d)  $_{22}Ti^{2+} : 1s^2 2s^2 p^6 3s^2 p^6 d^2$

Thus options (a) and (c) are discarded; now let us observe the second point of difference.



Thus option (b) is discarded



154. (a)      155. (d)

156. (c)  $E_{Cu^{2+}/Cu}^{\circ} = 0.34 V$

other has – ve  $E_{R.P.}^{\circ}$ .

$$E_{Co^{++}/Co}^{\circ} = -0.28 V$$

$$E_{Ni^{++}/Ni}^{\circ} = -0.25 V$$

$$E_{Fe^{++}/Fe}^{\circ} = -0.44 V$$

157. (c)

	$E^{\circ}$	$nE^{\circ}$
$Mn^{2+} + 2e^{-} \rightarrow Mn$	-1.18	-2.36 V
$Mn^{3+} + e^{-} \rightarrow Mn^{2+}$	1.51	1.51 V
$Mn^{3+} + 3e^{-} \rightarrow Mn$	-0.28	-0.85 V

158. (a) Given magnetic moment of transition metal

$$= \sqrt{n(n+2)} = 5.92$$

i.e.,  $n = 5$

Number of unpaired electrons in  $Mn^{2+} = 5$

Number of unpaired electrons in  $Ti^{3+} = 1$

Number of unpaired electrons in  $Cr^{3+} = 3$

Number of unpaired electrons in  $Cu^{2+} = 1$

Number of unpaired electrons in  $Co^{2+} = 3$

Thus  $Mn^{2+}$  have magnetic moment = 5.92 BM

159. (a)  $Mn^{++} = 3d^5$  i.e. no. of unpaired  $e^{-} = 5$

$Cu^{++} = 3d^9$  i.e. no. of unpaired  $e^{-} = 1$

$Fe^{++} = 3d^6$  i.e. no. of unpaired  $e^{-} = 4$

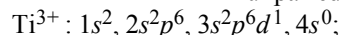
$Zn^{++} = 3d^{10}$  i.e. no. of unpaired  $e^{-} = 0$

$Ni^{++} = 3d^8$  i.e. no. of unpaired  $e^{-} = 3$

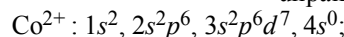
Higher the number of unpaired electrons higher will be the magnetic moment. Hence  $Mn^{++}$  having maximum unpaired electrons will have the maximum magnetic moment.

160. (d)  $Sc^{3+} : 1s^2, 2s^2 p^6, 3s^2 p^6 d^0, 4s^0$ ; no unpaired electron.  
 $Cu^{+} : 1s^2, 2s^2 p^6, 3s^2 p^6 d^{10}, 4s^0$ ; no unpaired electron.  
 $Ni^{2+} : 1s^2, 2s^2 p^6, 3s^2 p^6 d^8, 4s^0$ ;

unpaired electrons are present.



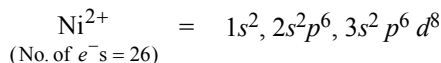
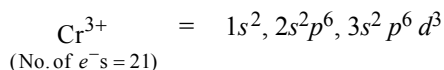
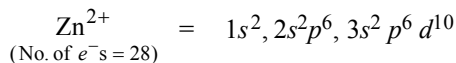
unpaired electron is present



unpaired electrons are present

So from the given options the only correct combination is  $Ni^{2+}$  and  $Ti^{3+}$ .

161. (d) The ions with unpaired electrons are coloured and those with paired electrons are colourless.



Thus  $\text{Zn}^{2+}$ ,  $\text{Cr}^{3+}$  and  $\text{Ni}^{2+}$  have zero, 3 and 2 unpaired electrons respectively.

162. (d) In  $\text{Cu}^+[\text{Ar}]3d^{10}$  there is no unpaired electron,

$\text{Cu}^{2+}[\text{Ar}]3d^9$  contains one unpaired electron hence coloured.

163. (d)  $\text{V}^{2+}$  – violet,  $\text{V}^{3+}$  – green,  $\text{V}^{4+}$  – blue  
 $\text{Fe}^{2+}$  – green,  $\text{Fe}^{3+}$  – yellow

164. (a)

(a)  $\text{V} = 3d^3 4s^2$ ;  $\text{V}^{2+} = 3d^3 = 3$  unpaired electrons

$\text{Cr} = 3d^5 4s^1$ ;  $\text{Cr}^{2+} = 3d^4 = 4$  unpaired electrons

$\text{Mn} = 3d^5 4s^2$ ;  $\text{Mn}^{2+} = 3d^5 = 5$  unpaired electrons

$\text{Fe} = 3d^6 4s^2$ ;  $\text{Fe}^{2+} = 3d^6 = 4$  unpaired electrons

Hence the correct order of paramagnetic behaviour  
 $\text{V}^{2+} < \text{Cr}^{2+} = \text{Fe}^{2+} < \text{Mn}^{2+}$

(b) For the same oxidation state, the ionic radii generally decreases as the atomic number increases in a particular transition series. hence the order is  
 $\text{Mn}^{++} > \text{Fe}^{++} > \text{Co}^{++} > \text{Ni}^{++}$

(c) In solution, the stability of the compound depends upon electrode potentials, SEP of the transitions metal ions are given as

$\text{Co}^{3+} / \text{Co} = +1.97$ ,  $\text{Fe}^{3+} / \text{Fe} = +0.77$ ;

$\text{Cr}^{3+} / \text{Cr}^{2+} = -0.41$ ,  $\text{Sc}^{3+}$  is highly stable as it does not show +2 O. S.

(d)  $\text{Sc} - (+2), (+3)$

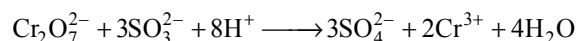
$\text{Ti} - (+2), (+3), (+4)$

$\text{Cr} - (+1), (+2), (+3), (+4), (+5), (+6)$

$\text{Mn} - (+2), (+3), (+4), (+5), (+6), (+7)$

i.e.  $\text{Sc} < \text{Ti} < \text{Cr} = \text{Mn}$

165. (a) The green colour appears due to the formation of  $\text{Cr}^{+++}$  ion



166. (b)  $\text{Na}_2\text{Cr}_2\text{O}_7$  is hygroscopic.

167. (c)  $\text{Mn}_2\text{O}_7 \rightarrow$  acidic

$\text{CrO} \rightarrow$  basic

$\text{V}_2\text{O}_4 \rightarrow$  amphoteric

$\text{Cr}_2\text{O}_3 \rightarrow$  amphoteric

168. (d) Oxide  $\text{Mn}_2\text{O}_7$  : Oxidation state of metal + 7

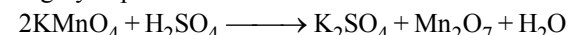
Oxide  $\text{V}_2\text{O}_3$  : Oxidation state of metal + 3

Oxide  $\text{V}_2\text{O}_5$  : Oxidation state of metal + 5

Oxide  $\text{CrO}$  : Oxidation state of metal + 2

Oxide  $\text{Cr}_2\text{O}_3$  : Oxidation state of metal + 3

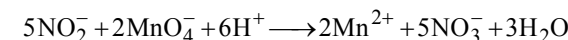
169. (b)  $\text{KMnO}_4$  reacts with  $\text{H}_2\text{SO}_4$  to form  $\text{Mn}_2\text{O}_7$  which is highly explosive substance.



170. (b)  $2\text{MnO}_2 + 4\text{KOH} + \text{O}_2 \longrightarrow 2\text{K}_2\text{MnO}_4 + 2\text{H}_2\text{O}$   
 dark green

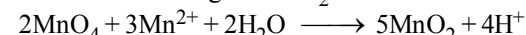
171. (d)

172. (b)  $5\text{Fe}^{2+} + \text{MnO}_4^- + 8\text{H}^+ \longrightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O} + 5\text{Fe}^{3+}$



173. (d) As the oxidation state increases the acidity increases.

174. (d) If  $\text{KMnO}_4$  was added slowly than option a was correct, but at a moment due to addition of large amount of  $\text{KMnO}_4$ , reduction of whole  $\text{KMnO}_4$  added does not take place, it also react with  $\text{Mn}^{2+}$  which had formed in the solution to give  $\text{MnO}_2$ .

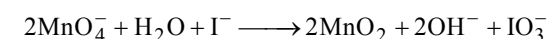


175. (b) Most of the  $\text{Ln}^{3+}$  compounds except  $\text{La}^{3+}$  and  $\text{Lu}^{3+}$  are coloured due to the presence of *f*-electrons.

176. (c) 177. (a)

178. (b) Down the group metallic character increases hence tendency to loose electron increases.

179. (c)  $\text{I}^-$  is converted to  $\text{IO}_3^-$  by neutral or faintly alkaline  $\text{MnO}_4^-$  as shown below.

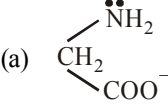


# CHAPTER 23

## COORDINATION COMPOUNDS

### FACT/DEFINITION TYPE QUESTIONS

- According to the postulates of Werner for coordination compounds
  - primary valency is ionizable
  - secondary valency is ionizable
  - primary and secondary valencies are non-ionizable
  - only primary valency is non-ionizable.
- Which of the following postulates of Werner's theory is incorrect?
  - Primary valencies are satisfied by negative ions.
  - Secondary valencies are satisfied by neutral molecules or negative ions.
  - Secondary valence is equal to the coordination number and it depends upon the nature of ligand attached to metal.
  - The ions/ groups bound by the secondary linkages to the metal have characteristic spatial arrangements.
- $\text{CrCl}_3$  has primary valence of
  - 3
  - 4
  - 2
  - 1
- One mole of the complex compound  $\text{Co}(\text{NH}_3)_5\text{Cl}_3$ , gives 3 moles of ions on dissolution in water. One mole of the same complex reacts with two moles of  $\text{AgNO}_3$  solution to yield two moles of  $\text{AgCl}$  (s). The structure of the complex is
  - $[\text{Co}(\text{NH}_3)_3\text{Cl}_3] \cdot 2 \text{NH}_3$
  - $[\text{Co}(\text{NH}_3)_4\text{Cl}_2] \text{Cl} \cdot \text{NH}_3$
  - $[\text{Co}(\text{NH}_3)_4\text{Cl}] \text{Cl}_2 \cdot \text{NH}_3$
  - $[\text{Co}(\text{NH}_3)_5\text{Cl}] \text{Cl}_2$
- When  $\text{AgNO}_3$  is added to a solution of  $\text{Co}(\text{NH}_3)_5\text{Cl}_3$ , the precipitate of  $\text{AgCl}$  shows two ionisable chloride ions. This means :
  - Two chlorine atoms satisfy primary valency and one secondary valency
  - One chlorine atom satisfies primary as well as secondary valency
  - Three chlorine atoms satisfy primary valency
  - Three chlorine atoms satisfy secondary valency
- Which one is the most likely structure of  $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$  if 1/3 of total chlorine of the compound is precipitated by adding
  - $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$
  - $[\text{Cr}(\text{H}_2\text{O})_3\text{Cl}_3] \cdot (\text{H}_2\text{O})_3$
  - $[\text{CrCl}_2(\text{H}_2\text{O})_4] \text{Cl} \cdot 2\text{H}_2\text{O}$
  - $[\text{CrCl}(\text{H}_2\text{O})_5] \text{Cl}_2 \cdot \text{H}_2\text{O}$
- $\text{K}_4[\text{Fe}(\text{CN})_6]$  is a :
  - double salt
  - complex compound
  - acid
  - base
- The number of ions formed on dissolving one molecule of  $\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$  in water is:
  - 4
  - 5
  - 3
  - 6
- The solution of  $\text{K}_4[\text{Fe}(\text{CN})_6]$  in water will
  - give a test  $\text{K}^+$
  - give a test  $\text{Fe}^{2+}$
  - give a test of  $\text{CN}^-$
  - give a test of  $[\text{Fe}(\text{CN})_6]^{4-}$
- In the coordination compound,  $\text{K}_4[\text{Ni}(\text{CN})_4]$ , the oxidation state of nickel is
  - 0
  - +1
  - +2
  - 1
- The coordination number of a central metal atom in a complex is determined by
  - the number of ligands around a metal ion bonded by sigma and pi-bonds both
  - the number of ligands around a metal ion bonded by pi-bonds
  - the number of ligands around a metal ion bonded by sigma bonds
  - the number of only anionic ligands bonded to the metal ion.
- The oxidation state of Cr in  $[\text{Cr}(\text{NH}_3)_4\text{Cl}_2]^+$  is
  - 0
  - +1
  - +2
  - +3
- In  $\text{Ni}(\text{CO})_4^-$ , oxidation number of Ni is :
  - 4
  - 4
  - 0
  - +2
- $[\text{EDTA}]^{4-}$  is a :
  - monodentate ligand
  - bidentate ligand
  - quadridentate ligand
  - hexadentate ligand

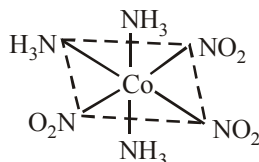
15. The compound having the lowest oxidation state of iron is:  
 (a)  $K_4Fe(CN)_6$  (b)  $K_2FeO_4$   
 (c)  $Fe_2O_3$  (d)  $Fe(CO)_5$
16. The coordination number and the oxidation state of the element 'E' in the complex  $[E(en)_2(C_2O_4)]NO_2$  (where en is ethylene diamine) are, respectively,  
 (a) 6 and 2 (b) 4 and 2  
 (c) 4 and 3 (d) 6 and 3
17. Some salts although containing two different metallic elements give test for only one of them in solution. Such salts are  
 (a) complex (b) double salts  
 (c) normal salts (d) None of these
18. Coordination number of Ni in  $[Ni(C_2O_4)_3]^{4-}$  is  
 (a) 3 (b) 6  
 (c) 4 (d) 5
19. According to Lewis, the ligands are  
 (a) acidic in nature  
 (b) basic in nature  
 (c) some are acidic and others are basic  
 (d) neither acidic nor basic
20. Ligand in a complex salt are  
 (a) anions linked by coordinate bonds to a central metal atom or ion  
 (b) cations linked by coordinate bonds to a central metal or ion  
 (c) molecules linked by coordinate bonds to a central metal or ion  
 (d) ions or molecules linked by coordinate bonds to a central atom or ion
21. The ligand  $N(CH_2CH_2NH_2)_3$  is  
 (a) tridentate (b) pentadentate  
 (c) tetradentate (d) bidentate
22. An example of ambidentate ligand is  
 (a) Ammine (b) Aquo  
 (c) Chloro (d) Thiocyanato
23. Which of the following does not form a chelate?  
 (a) EDTA (b) Oxalate  
 (c) Pyridine (d) Ethylenediamine
24. A *bidentate* ligand always  
 (a) has bonds formed to two metals ions  
 (b) has a charge of +2 or -2  
 (c) forms complex ions with a charge of +2 or -2  
 (d) has two donor atoms forming simultaneously two sigma ( $\sigma$ ) bonds.
25. An *ambident ligand* is one which  
 (a) is linked to the metal atom through two donor atoms  
 (b) has two donor atoms, but only one of them has the capacity to form a coordinate bond [or a sigma ( $\sigma$ ) bond]  
 (c) has two donor atoms, but either of two can form a coordinate bond  
 (d) forms chelate rings.
26.  $NH_2-NH_2$  serves as  
 (a) Monodentate ligand (b) Chelating ligand  
 (c) Bridging ligand (d) Both (a) and (c)
27. Which one of the following is NOT a ligand?  
 (a)  $PH_3$  (b)  $NO^+$   
 (c)  $Na^+$  (d)  $F^-$
28. Glycinato ligand is:  
  
 (a) bidentate ligand  
 (b) bidentate ligand  
 (c) two donor sites N and O-  
 (d) All of the above
29. Which one does not belong to ligand?  
 (a)  $PH_3$  (b)  $NO^+$   
 (c)  $BF_3$  (d)  $Cl^-$
30. Which ligand is expected to be bidentate?  
 (a)  $C_2O_4^{2-}$  (b)  $CH_3C \equiv N$   
 (c)  $Br^-$  (d)  $CH_3NH_2$
31. Which one of the following ligands forms a chelate  
 (a) Acetate (b) Oxalate  
 (c) Ammonia (d) Cyanide
32. Choose the correct statement.  
 (a) Coordination number has nothing to do with the number of groups or molecules attached to the central atom  
 (b) Coordination number is the number of coordinating sites of all the ligands connected to the central atom or the number of coordinate bonds formed by the metal atom with ligands  
 (c) Werner's coordination theory postulates only one type of valency  
 (d) All the above are correct
33.  $O_2$  is a  
 (a) Monodentate ligand (b) Bidentate ligand  
 (c) Tridentate ligand (d) Hexadentate ligand
34. The stabilisation of coordination compounds due to chelation is called the chelate effect. Which of the following is the most stable complex species?  
 (a)  $[Fe(CO)_5]$  (b)  $[Fe(CN)_6]^{3-}$   
 (c)  $[Fe(C_2O_4)_3]^{3-}$  (d)  $[Fe(H_2O)_6]^{3+}$
35. A chelating agent has two or more than two donor atoms to bind to a single metal ion. Which of the following is not a chelating agent?  
 (a) thiosulphato (b) oxalato  
 (c) glycinato (d) ethane-1,2-diamine
36. Which of the following species is not expected to be a ligand?  
 (a) NO (b)  $NH_4^+$   
 (c)  $NH_2CH_2CH_2NH_2$  (d) Both (a) and (b)

37. Which of the following complexes are homoleptic ?  
 (i)  $[\text{Co}(\text{NH}_3)_6]^{3+}$  (ii)  $[\text{Co}(\text{NH}_3)_4\text{Cl}]^+$   
 (iii)  $[\text{Ni}(\text{CN})_4]^{2-}$  (iv)  $[\text{Ni}(\text{NH}_3)_4\text{Cl}_2]$   
 (a) (i) and (ii) (b) (ii) and (iii)  
 (c) (iii) and (iv) (d) (i) and (iii)
38. Which of the following complexes are heteroleptic ?  
 (i)  $[\text{Cr}(\text{NH}_3)_6]^{3+}$  (ii)  $[\text{Fe}(\text{NH}_3)_4\text{Cl}_2]^+$   
 (iii)  $[\text{Mn}(\text{CN})_6]^{4-}$  (iv)  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]$   
 (a) (i), (iv) (b) (ii) and (iv)  
 (c) (i) and (ii) (d) (i) and (iv)
39. Central atoms/ions in coordination compounds are.  
 (a) Lewis acid (b) Lewis bases  
 (c) Neutral molecules (d) All of these
40. What is the denticity of the ligand ethylenediaminetetraacetate ion?  
 (a) 4 (b) 2  
 (c) 6 (d) 1
41.  $\text{K}_3[\text{Al}(\text{C}_2\text{O}_4)_3]$  is called  
 (a) Potassium aluminooxalate  
 (b) Potassium trioxalatoaluminate (III)  
 (c) Potassium aluminium (III) oxalate  
 (d) Potassium trioxalatoaluminate (VI)
42. The hypothetical complex chlorodiaquatrimminecobalt (III) chloride can be represented as  
 (a)  $[\text{CoCl}(\text{NH}_3)_3(\text{H}_2\text{O})_2]\text{Cl}_2$   
 (b)  $[\text{Co}(\text{NH}_3)_3(\text{H}_2\text{O})\text{Cl}_3]$   
 (c)  $[\text{Co}(\text{NH}_2)_3(\text{H}_2\text{O})_2\text{Cl}]$   
 (d)  $[\text{Co}(\text{NH}_3)_3(\text{H}_2\text{O})_3]\text{Cl}_3$
43. The IUPAC name of the coordination compound  $\text{K}_3[\text{Fe}(\text{CN})_6]$  is  
 (a) Tripotassium hexacyanoiron (II)  
 (b) Potassium hexacyanoiron (II)  
 (c) Potassium hexacyanoferrate (III)  
 (d) Potassium hexacyanoferrate (II)
44. The IUPAC name for the complex  $[\text{Co}(\text{ONO})(\text{NH}_3)_5]\text{Cl}_2$  is  
 (a) pentaamminenitrito-N-cobalt(II) chloride  
 (b) pentaamminenitrito-N-cobalt(III) chloride  
 (c) nitrito-N-pentaamminecobalt(III) chloride  
 (d) nitrito-N-pentaamminecobalt(II) chloride
45. The IUPAC name of  $\text{K}_2[\text{PtCl}_6]$  is  
 (a) hexachloroplatinate potassium  
 (b) potassium hexachloroplatinate (IV)  
 (c) potassium hexachloroplatinate  
 (d) potassium hexachloroplatinum (IV)
46. The IUPAC name of  $[\text{Ni}(\text{NH}_3)_4][\text{NiCl}_4]$  is  
 (a) Tetrachloronickel (II) - tetraamminenickel (II)  
 (b) Tetraamminenickel (II) - tetrachloronickel (II)  
 (c) Tetraamminenickel (II) - tetrachloronickelate (II)  
 (d) Tetrachloronickel (II) - tetrachloronickelate (0)
47. As per IUPAC nomenclature, the name of the complex  $[\text{Co}(\text{H}_2\text{O})_4(\text{NH}_3)_2]\text{Cl}_3$  is :  
 (a) Tetraaquadiamminecobalt (III) chloride  
 (b) Tetraaquadiamminecobalt (III) chloride  
 (c) Diaminetetraaquacobalt (II) chloride  
 (d) Diamminetetraaquacobalt (III) chloride
48. The IUPAC name of the complex  $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]\text{Cl}_2$  is  
 (a) aquatetramminechloridocobalt (III) chloride  
 (b) chloridoaquatetramminechloridocobalt (III) chloride  
 (c) chloridoaquatetramminechloridocobalt (III) chloride  
 (d) tetrammineaquachloridocobalt (III) chloride
49. As per IUPAC nomenclature, the name of the complex  $[\text{Co}(\text{H}_2\text{O})_4(\text{NH}_3)_2]\text{Cl}_3$  is :  
 (a) Tetraaquadiamminecobalt (III) chloride  
 (b) Tetraaquadiamminecobalt (III) chloride  
 (c) Diaminetetraaquacobalt (II) chloride  
 (d) Diamminetetraaquacobalt (III) chloride
50. Chemical formula for iron (III) hexacyanoferrate (II) is  
 (a)  $\text{Fe}[\text{Fe}(\text{CN})_6]$  (b)  $\text{Fe}_3[\text{Fe}(\text{CN})_6]$   
 (c)  $\text{Fe}_3[\text{Fe}(\text{CN})_6]_4$  (d)  $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$
51. The IUPAC name of  $\text{K}_3[\text{Ir}(\text{C}_2\text{O}_4)_3]$  is  
 (a) potassium trioxalatoiridium (III)  
 (b) potassium trioxalatoiridate (III)  
 (c) potassium tris (oxalato) iridium (III)  
 (d) potassium tris (oxalato) iridate (III)
52. IUPAC name of  $\text{Na}_3[\text{Co}(\text{ONO})_6]$  is  
 (a) Sodium cobaltinitrite  
 (b) Sodium hexanitrito cobaltate (III)  
 (c) Sodium hexanitrocobalt (III)  
 (d) Sodium hexanitritocobaltate (II)
53. Which of the following is the correct name of compound.  $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]\text{Cl}_2$   
 (a) Tetraamineaqua chloride cobalt (III) chloride  
 (b) Tetraamineaqua chlorido cobalt (II) chloride  
 (c) Tetraamineaqua chloride cobalt (II) chloride  
 (d) Tetraamineaqua chlorido cobalt (III) chloride
54. The number of geometrical isomers for  $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$  is  
 (a) 2 (b) 1  
 (c) 3 (d) 4
55. Which of the following will give maximum number of isomers?  
 (a)  $[\text{Ni}(\text{C}_2\text{O}_4)(\text{en})_2]^{2-}$  (b)  $[\text{Ni}(\text{en})(\text{NH}_3)_4]^{2+}$   
 (c)  $[\text{Cr}(\text{SCN})_2(\text{NH}_3)_4]^+$  (d)  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]$
56. Which one of the following octahedral complexes will not show geometric isomerism? (A and B are monodentate ligands)  
 (a)  $[\text{MA}_5\text{B}]$  (b)  $[\text{MA}_2\text{B}_4]$   
 (c)  $[\text{MA}_3\text{B}_3]$  (d)  $[\text{MA}_4\text{B}_2]$
57. Which of the following coordination compounds would exhibit optical isomerism?  
 (a) pentamminenitrocobalt(III) iodide  
 (b) diamminedichloroplatinum(II)  
 (c) trans-dicyanobis (ethylenediamine) chromium (III) chloride  
 (d) tris-(ethylenediamine) cobalt (III) bromide



58. The type of isomerism present in Pentamminenitrochromium (III) chloride is  
 (a) optical (b) linkage  
 (c) ionisation (d) polymerisation.
59. Which of the following compounds shows optical isomerism?  
 (a)  $[\text{Co}(\text{CN})_6]^{3-}$  (b)  $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$   
 (c)  $[\text{ZnCl}_4]^{2-}$  (d)  $[\text{Cu}(\text{NH}_3)_4]^{2+}$
60. Which of the following ions can exhibit optical isomerism—  
 (a)  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$  (b)  $[\text{Co}(\text{NH}_3)_2\text{Cl}_4]^-$   
 (c)  $\text{Cis-}[\text{Co}(\text{en})_2\text{Cl}_2]^+$  (d)  $\text{trans-}[\text{Co}(\text{en})_2\text{Cl}_2]^+$
61. Which would exhibit co-ordination isomerism  
 (a)  $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{CN})_6]$  (b)  $[\text{Co}(\text{en})_2\text{Cl}_2]$   
 (c)  $[\text{Cr}(\text{NH}_3)_6]\text{Cl}_3$  (d)  $[\text{Cr}(\text{en})_2\text{Cl}_2]^+$
62.  $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$  and  $[\text{Co}(\text{NH}_3)_5(\text{ONO})]\text{Cl}_2$  are related to each other as  
 (a) geometrical isomers (b) optical isomers  
 (c) linkage isomers (d) coordination isomers
63. Coordination isomerism is caused by the interchange of ligands between the  
 (a) cis and trans structure  
 (b) complex cation and complex anion  
 (c) inner sphere and outer sphere  
 (d) low oxidation and higher oxidation states
64. Change in composition of co-ordination sphere yields which type of isomers  
 (a) optical (b) geometrical  
 (c) ionisation (d) None of these
65. Which of the following **does not** show optical isomerism?  
 (a)  $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]^0$  (b)  $[\text{Co}(\text{en})\text{Cl}_2(\text{NH}_3)_2]^+$   
 (c)  $[\text{Co}(\text{en})_3]^{3+}$  (d)  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$   
 (en = ethylenediamine)
66. The complexes  $[\text{Co}(\text{NH}_3)_6]$ ,  $[\text{Cr}(\text{CN})_6]$  and  $[\text{Cr}(\text{NH}_3)_6]$   $[\text{Co}(\text{CN})_6]$  are the examples of which type of isomerism?  
 (a) Linkage isomerism  
 (b) Ionization isomerism  
 (c) Coordination isomerism  
 (d) Geometrical isomerism
67. The complex,  $[\text{Pt}(\text{py})(\text{NH}_3)\text{BrCl}]$  will have how many geometrical isomers?  
 (a) 3 (b) 4  
 (c) 0 (d) 2
68. Which of the following has a square planar geometry?  
 (a)  $[\text{PtCl}_4]^{2-}$  (b)  $[\text{CoCl}_4]^{2-}$   
 (c)  $[\text{FeCl}_4]^{2-}$  (d)  $[\text{NiCl}_4]^{2-}$   
 (At. nos.: Fe = 26, Co = 27, Ni = 28, Pt = 78)
69. Which of the following pairs represent linkage isomers?  
 (a)  $[\text{Pd}(\text{PPh}_3)_2(\text{NCS})_2]$  and  $[\text{Pd}(\text{PPh}_3)_2(\text{SCN})_2]$   
 (b)  $[\text{Co}(\text{NH}_3)_5\text{NO}_3]\text{SO}_4$  and  $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{NO}_3$   
 (c)  $[\text{PtCl}_2(\text{NH}_3)_4]\text{Br}_2$  and  $[\text{PtBr}_2(\text{NH}_3)_4]\text{Cl}_2$   
 (d)  $[\text{Cu}(\text{NH}_3)_4][\text{PtCl}_4]$  and  $[\text{Pt}(\text{NH}_3)_4][\text{CuCl}_4]$
70. Which one of the following has an optical isomer?  
 (a)  $[\text{Zn}(\text{en})(\text{NH}_3)_2]^{2+}$  (b)  $[\text{Co}(\text{en})_3]^{3+}$   
 (c)  $[\text{Co}(\text{H}_2\text{O})_4(\text{en})]^{3+}$  (d)  $[\text{Zn}(\text{en})_2]^{2+}$   
 (en = ethylenediamine)
71. Which one of the following complex ions has geometrical isomers?  
 (a)  $[\text{Ni}(\text{NH}_3)_5\text{Br}]^+$  (b)  $[\text{Co}(\text{NH}_3)_2(\text{en})_2]^{3+}$   
 (c)  $[\text{Cr}(\text{NH}_3)_4(\text{en})_2]^{3+}$  (d)  $[\text{Co}(\text{en})_3]^{3+}$   
 (en = ethylenediamine)
72. The ionisation isomer of  $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}(\text{NO}_2)]\text{Cl}$  is  
 (a)  $[\text{Cr}(\text{H}_2\text{O})_4(\text{O}_2\text{N})]\text{Cl}_2$   
 (b)  $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2](\text{NO}_2)$   
 (c)  $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}(\text{ONO})]\text{Cl}$   
 (d)  $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2(\text{NO}_2)]\cdot\text{H}_2\text{O}$
73. Isomerism exhibited by  $[\text{Cr}(\text{NH}_3)_2(\text{H}_2\text{O})_2\text{Cl}_2]^+$  are—  
 (a) ionization, optical (b) hydrate, optical  
 (c) geometrical, optical (d) coordinate, geometrical
74. Type of isomerism which exists between  $[\text{Pd}(\text{C}_6\text{H}_5)_2(\text{SCN})_2]$  and  $[\text{Pd}(\text{C}_6\text{H}_5)_2(\text{NCS})_2]$  is :  
 (a) Linkage isomerism (b) Coordination isomerism  
 (c) Ionisation isomerism (d) Solvate isomerism
75. Which of the following complex will show geometrical as well as optical isomerism (en=ethylenediamine)  
 (a)  $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$  (b)  $[\text{Pt}(\text{NH}_3)\text{Cl}_4]$   
 (c)  $[\text{Pt}(\text{en})_3]^{4+}$  (d)  $[\text{Pt}(\text{en})_2\text{Cl}_2]$
76. The number of geometrical isomers from  $[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$  is  
 (a) 2 (b) 3  
 (c) 4 (d) 0
77. The number of isomers exhibited by  $[\text{Cr}(\text{NH}_3)_3\text{Cl}_3]$  is  
 (a) 2 (b) 3  
 (c) 4 (d) 5
78. For the square planar complex  $[\text{M}(\text{a})(\text{b})(\text{c})(\text{d})]$  (where M = central metal and a, b, c and d are monodentate ligands), the number of possible geometrical isomers are  
 (a) 1 (b) 2  
 (c) 3 (d) 4
79. Which of the following will exhibit optical isomerism?  
 (a)  $[\text{Cr}(\text{en})(\text{H}_2\text{O})_4]^{3+}$   
 (b)  $[\text{Cr}(\text{en})_3]^{3+}$   
 (c)  $\text{trans-}[\text{Cr}(\text{en})(\text{Cl}_2)(\text{NH}_3)_2]^+$   
 (d)  $[\text{Cr}(\text{NH}_3)_6]^{3+}$
80. Which of the following will give maximum number of isomers?  
 (a)  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]$  (b)  $[\text{Ni}(\text{en})(\text{NH}_3)_4]^{2+}$   
 (c)  $[\text{Ni}(\text{C}_2\text{O}_4)(\text{en})_2]$  (d)  $[\text{Cr}(\text{SCN})_2(\text{NH}_3)_4]^{2+}$
81. The compounds  $[\text{PtCl}_2(\text{NH}_3)_4]\text{Br}_2$  and  $[\text{PtBr}_2(\text{NH}_3)_4]\text{Cl}_2$  constitutes a pair of  
 (a) coordination isomers (b) linkage isomers  
 (c) ionization isomers (d) optical isomers
82. Which one of the following will not show geometrical isomerism?  
 (a)  $[\text{Cr}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$  (b)  $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$   
 (c)  $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2$  (d)  $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$

83. A similarity between optical and geometrical isomerism is that  
 (a) each gives equal number of isomers for a given compound  
 (b) if in a compound one is present then so is the other  
 (c) both are included in stereoisomerism  
 (d) they have no similarity
84. The type of isomerism present in nitropentamminechromium(III) chloride is  
 (a) optical (b) linkage  
 (c) ionization (d) polymerization
85. What kind of isomerism exists between  $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$  (violet) and  $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$  (greyish-green)?  
 (a) linkage isomerism (b) solvate isomerism  
 (c) ionisation isomerism (d) coordination isomerism
86. Which of the following type of isomerism is shown by given complex compound?



- (a) Facial (b) Meridional  
 (c) Cis (d) Both b and c
87. Due to the presence of ambidentate ligands coordination compounds show isomerism. Palladium complexes of the type  $[\text{Pd}(\text{C}_6\text{H}_5)_2(\text{SCN})_2]$  and  $[\text{Pd}(\text{C}_6\text{H}_5)_2(\text{NCS})_2]$  are  
 (a) linkage isomers (b) coordination isomers  
 (c) ionisation isomers (d) geometrical isomers
88. The geometry of  $\text{Ni}(\text{CO})_4$  and  $\text{Ni}(\text{PPh}_3)_2\text{Cl}_2$  are  
 (a) both square planar  
 (b) tetrahedral and square planar  
 (c) both tetrahedral  
 (d) None of these
89. The number of unpaired electrons in the complex  $[\text{Cr}(\text{NH}_3)_6]\text{Br}_3$  is (Atomic number Cr = 24)  
 (a) 4 (b) 1  
 (c) 2 (d) 3
90. Which of the following facts about the complex  $[\text{Cr}(\text{NH}_3)_6]\text{Cl}_3$  is wrong?  
 (a) The complex involves  $d^2sp^3$  hybridisation and is octahedral in shape.  
 (b) The complex is paramagnetic.  
 (c) The complex is an outer orbital complex  
 (d) The complex gives white precipitate with silver nitrate solution.
91. Which of the following statements is correct?  
 (Atomic number of Ni = 28)  
 (a)  $\text{Ni}(\text{CO})_4$  is diamagnetic and  $[\text{NiCl}_4]^{2-}$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  are paramagnetic  
 (b)  $\text{Ni}(\text{CO})_4$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  are diamagnetic and  $[\text{NiCl}_4]^{2-}$  is paramagnetic

- (c)  $\text{Ni}(\text{CO})_4$  and  $[\text{NiCl}_4]^{2-}$  are diamagnetic and  $[\text{Ni}(\text{CN})_4]^{2-}$  is paramagnetic  
 (d)  $[\text{NiCl}_4]^{2-}$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  are diamagnetic and  $\text{Ni}(\text{CO})_4$  is paramagnetic
92. Which of the following species represent the example of  $dsp^2$  - hybridisation?  
 (a)  $[\text{Fe}(\text{CN})_6]^{3-}$  (b)  $[\text{Ni}(\text{CN})_4]^{2-}$   
 (c)  $[\text{Ag}(\text{CN})_2]^-$  (d)  $[\text{Co}(\text{CN})_6]^{3-}$
93. Which one of the following will show paramagnetism corresponding to 2 unpaired electrons?  
 (Atomic numbers : Ni = 28, Fe = 26)  
 (a)  $[\text{FeF}_6]^{3-}$  (b)  $[\text{NiCl}_4]^{2-}$   
 (c)  $[\text{Fe}(\text{CN})_6]^{3-}$  (d)  $[\text{Ni}(\text{CN})_4]^{2-}$
94. Atomic number of Cr and Fe are respectively 25 and 26, which of the following is paramagnetic?  
 (a)  $[\text{Cr}(\text{CO})_6]$  (b)  $[\text{Fe}(\text{CO})_5]$   
 (c)  $[\text{Fe}(\text{CN})_6]^{4-}$  (d)  $[\text{Cr}(\text{NH}_3)_6]^{3+}$
95.  $\text{CN}^-$  is a strong field ligand. This is due to the fact that  
 (a) it carries negative charge  
 (b) it is a pseudohalide  
 (c) it can accept electrons from metal species  
 (d) it forms high spin complexes with metal species
96. Which one of the following cyano complexes would exhibit the lowest value of paramagnetic behaviour?  
 (a)  $[\text{Co}(\text{CN})_6]^{3-}$  (b)  $[\text{Fe}(\text{CN})_6]^{3-}$   
 (c)  $[\text{Mn}(\text{CN})_6]^{3-}$  (d)  $[\text{Cr}(\text{CN})_6]^{3-}$   
 (At. Nos : Cr = 24, Mn = 25, Fe = 26, Co = 27)
97.  $[\text{Sc}(\text{H}_2\text{O})_6]^{3+}$  ion is :  
 (a) colourless and diamagnetic  
 (b) coloured and octahedral  
 (c) colourless and paramagnetic  
 (d) coloured and paramagnetic
98. Which has maximum paramagnetic nature?  
 (a)  $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$  (b)  $[\text{Cu}(\text{NH}_3)_4]^{2+}$   
 (c)  $[\text{Fe}(\text{CN})_6]^{4-}$  (d)  $[\text{Cu}(\text{H}_2\text{O})_4]^{2+}$
99. The compound which is not coloured is  
 (a)  $\text{K}_4[\text{Fe}(\text{CN})_6]$  (b)  $\text{K}_3[\text{Fe}(\text{CN})_6]$   
 (c)  $\text{Na}_2[\text{CdCl}_4]$  (d)  $\text{Na}_2[\text{CuCl}_4]$
100. Which of the following complexes exhibits the highest paramagnetic behaviour?  
 (a)  $[\text{V}(\text{gly})_2(\text{OH})_2(\text{NH}_3)_2]^+$  (b)  $[\text{Fe}(\text{en})(\text{bpy})(\text{NH}_3)_2]^{2+}$   
 (c)  $[\text{Co}(\text{ox})_2(\text{OH})_2]^{2-}$  (d)  $[\text{Ti}(\text{NH}_3)_6]^{3+}$   
 where gly = glycine, en = ethylenediamine and bpy = bipyridyl moieties  
 (At.nos Ti = 22, V = 23, Fe = 26, Co = 27)
101. Which of the following complex ion is not expected to absorb visible light?  
 (a)  $[\text{Ni}(\text{CN})_4]^{2-}$  (b)  $[\text{Cr}(\text{NH}_3)_6]^{3+}$   
 (c)  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$  (d)  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$

- 102.** Of the following complex ions, which is diamagnetic in nature?  
 (a)  $[\text{NiCl}_4]^{2-}$  (b)  $[\text{Ni}(\text{CN})_4]^{2-}$   
 (c)  $[\text{CuCl}_4]^{2-}$  (d)  $[\text{CoF}_6]^{3-}$
- 103.** Which one of the following is an outer orbital complex and exhibits paramagnetic behaviour?  
 (a)  $[\text{Ni}(\text{NH}_3)_6]^{2+}$  (b)  $[\text{Zn}(\text{NH}_3)_6]^{2+}$   
 (c)  $[\text{Cr}(\text{NH}_3)_6]^{3+}$  (d)  $[\text{Co}(\text{NH}_3)_6]^{3+}$
- 104.** Atomic number of Mn, Fe, Co and Ni are 25, 26, 27 and 28 respectively. Which of the following outer orbital octahedral complexes have same number of unpaired electrons?  
 (i)  $[\text{MnCl}_6]^{3-}$  (ii)  $[\text{FeF}_6]^{3-}$   
 (iii)  $[\text{CoF}_6]^{3-}$  (iv)  $[\text{Ni}(\text{NH}_3)_6]^{2+}$   
 (a) (ii) and (iii) (b) (i) and (iv)  
 (c) (i) and (ii) (d) (i) and (iii)
- 105.** Which of the following options are correct for  $[\text{Fe}(\text{CN})_6]^{3-}$  complex?  
 (i) Possess  $d^2sp^3$  hybridisation  
 (ii) Possess  $sp^3d^2$  hybridisation  
 (iii) It is paramagnetic  
 (iv) It is diamagnetic  
 (a) (i) and (iii) (b) (ii) and (iii)  
 (c) (i) and (iv) (d) (ii) and (iv)
- 106.** Which of these statements about  $[\text{Co}(\text{CN})_6]^{3-}$  is true?  
 (a)  $[\text{Co}(\text{CN})_6]^{3-}$  has four unpaired electrons and will be in a low-spin configuration.  
 (b)  $[\text{Co}(\text{CN})_6]^{3-}$  has four unpaired electrons and will be in a high spin configuration.  
 (c)  $[\text{Co}(\text{CN})_6]^{3-}$  has no unpaired electrons and will be in a high-spin configuration.  
 (d)  $[\text{Co}(\text{CN})_6]^{3-}$  has no unpaired electrons and will be in a low-spin configuration.
- 107.** The complex ion which has highest magnetic moment among the following is  
 (a)  $[\text{CoF}_6]^{3-}$  (b)  $[\text{Co}(\text{NH}_3)_6]^{3+}$   
 (c)  $[\text{Ni}(\text{NH}_3)_4]^{2+}$  (d)  $[\text{Ni}(\text{CN})_4]^{2-}$
- 108.** Which of the following complex ions is diamagnetic?  
 (a)  $[\text{FeF}_6]^{3-}$  (b)  $[\text{CoF}_6]^{3-}$   
 (c)  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$  (d)  $[\text{Fe}(\text{CN})_6]^{3-}$
- 109.** Which of the following has square planar structure?  
 (a)  $[\text{Ni}(\text{CO})_4]$  (b)  $[\text{NiCl}_4]^{2-}$   
 (c)  $[\text{Ni}(\text{CN})_4]^{2-}$  (d)  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
- 110.** Which of the following correctly explains the fact that  $[\text{Co}(\text{NH}_3)_6]^{3+}$  is an inner orbital complex whereas  $[\text{CoF}_6]^{3-}$  is an outer orbital complex?  
 (a)  $\text{NH}_3$  being a strong ligand results into pairing of 3d orbital electrons in  $\text{Co}^{3+}$ .  
 (b)  $\text{F}^-$  being a strong ligand results into pairing of 3d orbital electrons in  $\text{Co}^{3+}$ .  
 (c)  $\text{F}^-$  being a weak ligand cannot cause the pairing of electrons present in 3d orbital of  $\text{Co}^{3+}$ .  
 (d) Both (a) and (c).
- 111.** Which of the following statements is incorrect?  
 (a)  $[\text{MnCl}_6]^{3-}$  is more paramagnetic than  $[\text{Mn}(\text{CN})_6]^{3-}$   
 (b) Both  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$  and  $[\text{CoF}_6]^{3-}$  are paramagnetic.  
 (c)  $[\text{Fe}(\text{CN})_6]^{3-}$  forms inner orbital complex whereas  $[\text{FeF}_6]^{3-}$  forms outer orbital complex.  
 (d) Both (a) and (b).
- 112.** Which of the following is not correctly matched?
- | Coordination polyhedron               | Shape         |
|---------------------------------------|---------------|
| (A) $[\text{Co}(\text{NH}_3)_6]^{3+}$ | Octahedral    |
| (B) $[\text{Ni}(\text{CO})_4]$        | Square planar |
| (C) $[\text{PtCl}_4]^{2-}$            | Tetrahedral   |
- (a) C (b) B and C  
 (c) A and C (d) B
- 113.** Which of the following are inner orbital complex (i.e., involving  $d^2sp^3$  hybridisation) and is paramagnetic in nature?  
 (a)  $[\text{Mn}(\text{CN})_6]^{3-}$ ,  $[\text{Fe}(\text{CN})_6]^{3-}$ ,  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$   
 (b)  $[\text{MnCl}_6]^{3-}$ ,  $[\text{FeF}_6]^{3-}$ ,  $[\text{CoF}_6]^{3-}$   
 (c)  $[\text{Mn}(\text{CN})_6]^{3-}$ ,  $[\text{Fe}(\text{CN})_6]^{3-}$   
 (d)  $[\text{MnCl}_6]^{3-}$ ,  $[\text{Fe}(\text{CN})_6]^{3-}$ ,  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$
- 114.** Which of the following is the limitation of valence bond theory?  
 (a) It does not distinguish between weak and strong ligands.  
 (b) It does not give quantitative interpretation of magnetic data.  
 (c) It does not explain the colour exhibited by coordination compounds  
 (d) All of these
- 115.** Which complex of  $\text{Co}^{2+}$  will have the weakest crystal field splitting –  
 (a)  $[\text{CoCl}_6]^{4-}$  (b)  $[\text{Co}(\text{CN})_6]^{4-}$   
 (c)  $[\text{Co}(\text{NH}_3)_6]^{2+}$  (d)  $[\text{Co}(\text{en})_3]^{2+}$
- 116.** The crystal field stabilization energy (CFSE) is the highest for  
 (a)  $[\text{CoF}_4]^{2-}$  (b)  $[\text{Co}(\text{NCS})_4]^{2-}$   
 (c)  $[\text{Co}(\text{NH}_3)_6]^{3+}$  (d)  $[\text{CoCl}_4]^{2-}$
- 117.** In which of the following complexes of the Co (at. no. 27), will the magnitude of  $\Delta_o$  be the highest?  
 (a)  $[\text{Co}(\text{CN})_6]^{3-}$  (b)  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$   
 (c)  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$  (d)  $[\text{Co}(\text{NH}_3)_6]^{3+}$
- 118.** Among the ligands  $\text{NH}_3$ , en,  $\text{CN}^-$  and CO the correct order of their increasing field strength, is :  
 (a)  $\text{NH}_3 < \text{en} < \text{CN}^- < \text{CO}$   
 (b)  $\text{CN}^- < \text{NH}_3 < \text{CO} < \text{en}$   
 (c)  $\text{en} < \text{CN}^- < \text{NH}_3 < \text{CO}$   
 (d)  $\text{CO} < \text{NH}_3 < \text{en} < \text{CN}^-$
- 119.** Among the following complexes the one which shows zero crystal field stabilization energy (CFSE):  
 (a)  $[\text{Mn}(\text{H}_2\text{O})_6]^{3+}$  (b)  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$   
 (c)  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$  (d)  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$

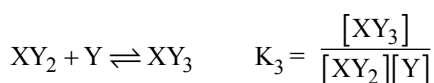
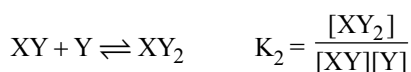
120. The crystal field splitting energy for octahedral ( $\Delta_o$ ) and tetrahedral ( $\Delta_t$ ) complexes is related as
- (a)  $\Delta_t = -\frac{1}{2}\Delta_o$  (b)  $\Delta_t = -\frac{4}{9}\Delta_o$   
 (c)  $\Delta_t = -\frac{3}{5}\Delta_o$  (d)  $\Delta_t = -\frac{2}{5}\Delta_o$
121. Which one of the following is the correct order of field strength of ligands in spectrochemical series?
- (a)  $I^- < Cl^- < F^- < H_2O < CN^-$   
 (b)  $F^- < H_2O < I^- < CN^- < Cl^-$   
 (c)  $CN^- < I^- < F^- < Cl^- < H_2O$   
 (d)  $H_2O < F^- < CN^- < Cl^- < I^-$
122. The colour of the coordination compounds depends on the crystal field splitting. What will be the correct order of absorption of wavelength of light in the visible region, for the complexes,
- $[Co(NH_3)_6]^{3+}$ ,  $[Co(CN)_6]^{3-}$ ,  $[Co(H_2O)_6]^{3+}$
- (a)  $[Co(NH_3)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$   
 (b)  $[Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+} > [Co(CN)_6]^{3-}$   
 (c)  $[Co(H_2O)_6]^{3+} > [Co(NH_3)_6]^{3+} > [Co(CN)_6]^{3-}$   
 (d)  $[Co(CN)_6]^{3-} > [Co(NH_3)_6]^{3+} > [Co(H_2O)_6]^{3+}$
123. Which of the following statements related to crystal field splitting in octahedral coordination entities is incorrect?
- (a) The  $d_{x^2-y^2}$  and  $d_{z^2}$  orbitals has more energy as compared to  $d_{xy}$ ,  $d_{yz}$  and  $d_{xz}$  orbitals.  
 (b) Crystal field splitting energy ( $\Delta_o$ ) depends directly on the charge of the metal ion and on the field produced by the ligand.  
 (c) In the presence of  $Br^-$  as a ligand the distribution of electrons for  $d^4$  configuration will be  $t_{2g}^3, e_g^1$ ,  
 (d) In the presence of  $CN^-$  as a ligand  $\Delta_o < P$ .
124. Which of the following is incorrect regarding spectrochemical series?
- (a)  $NH_3 > H_2O$  (b)  $F^- > C_2O_4^{2-}$   
 (c)  $NCS^- > SCN^-$  (d)  $en > edta^{4-}$
125. For which of the following ligands magnitude of the crystal field splitting ( $\Delta_o$ ) will be greater than pairing energy (P)?
- (a)  $Cl^-$  (b)  $SCN^-$   
 (c)  $CO$  (d)  $S^{2-}$
126. Violet colour of  $[Ti(H_2O)_6]Cl_3$  on heating changes to \_\_\_\_.
- (a) Green (b) Colourless  
 (c) White (d) Red
127. Which of the following is the limitation of crystal field theory?
- (i) Ligands are assumed as point charges.  
 (ii) It does not accounts for the covalent character of bonding between the ligand and the central atom.  
 (iii) It does not explain how colour of coordination compounds depends on ligand attached to central metal atom/ion.
- (a) (i) and (ii) (b) (ii) and (iii)  
 (c) (ii) only (d) (i), (ii) and (iii)
128. If magnetic moment of  $[MnBr_4]^{2-}$  is 5.9 BM. Predict the number of electrons?
- (a) 2 (b) 3  
 (c) 6 (d) 5
129. Arrange the following complexes in increasing order toward the wavelength of light they absorb? Where M is metal ion.  $[M(NH_3)_6]^{3+} = a$ ,  $[M(CN)_6]^{3-} = b$ ,  $[M(C_2O_4)_3]^{3-} = c$ ,  $[MF_6]^{3-} = d$ ,
- (a) d, c, a, b (b) d, a, c, b  
 (c) b, a, c, d (d) a, b, c, d
130. Which of the following does **not** have a metal- carbon bond?
- (a)  $Al(OC_2H_5)_3$  (b)  $C_2H_5MgBr$   
 (c)  $K[Pt(C_2H_4)Cl_3]$  (d)  $Ni(CO)_4$
131. In  $Fe(CO)_5$ , the Fe – C bond possesses
- (a) ionic character (b)  $\sigma$ -character only  
 (c)  $\pi$ -character (d) both  $\sigma$  and  $\pi$  characters
132. The charge on the central metal ion in the complex  $[Ni(CO)_4]$  is
- (a) +2 (b) +4  
 (c) 0 (d) +3
133. The unpaired electrons in  $Ni(CO)_4$  are
- (a) zero (b) one  
 (c) three (d) four
134. The correct structure of  $Fe(CO)_5$  is (Z=26 for Fe)
- (a) octahedral (b) tetrahedral  
 (c) square pyramidal (d) trigonal pyramidal
135. For the reaction of the type  $M + 4L \rightleftharpoons ML_4$
- (a) larger the stability constant, lower the proportion of  $ML_4$  that exists in solution  
 (b) larger the stability constant, higher the proportion of  $ML_4$  that exists in solution  
 (c) smaller the stability constant, higher the proportion of  $ML_4$  that exists in solution  
 (d) None of the above
136. Coordination compounds have great importance in biological systems. In this context which of the following statements is **incorrect** ?
- (a) Cyanocobalamin is  $B_{12}$  and contains cobalt  
 (b) Haemoglobin is the red pigment of blood and contains iron  
 (c) Chlorophylls are green pigments in plants and contain calcium  
 (d) Carboxypeptidase - A is an enzyme and contains zinc.
137. Which one of the following coordination compounds is used to inhibit the growth of tumours?
- (a) Trans-platin (b) EDTA complex of calcium  
 (c)  $[(Ph_3P)_3RhCl]$  (d) Cis-platin



138. For  $[\text{Co}_2(\text{CO})_8]$ , what is the total number of metal – carbon bonds and number of metal–metal bonds.

- (a) 10,1 (b) 8,2  
(c) 8,1 (d) 10,0

139. Consider the following reactions.



On the basis of reactions above which of the following is incorrect?

- (a) Overall stability constant =  $K_1 K_2 K_3$   
(b)  $K_1 K_2 K_3 = \frac{[\text{XY}_3]}{[\text{X}][\text{Y}]^3}$   
(c) Dissociation constant =  $\frac{1}{\text{Formation constant}}$   
(d) All of the above are correct.

140. Calculate the value of  $\log K_3$  when  $\log$  values of  $K_2$ ,  $K_1$ ,  $K_4$  and  $\beta_4$  respectively are 4.0, 3.20, 4.0 and 11.9?

- (a) 2.0 (b) 2.7  
(c) 3.0 (d) 2.5

### STATEMENT TYPE QUESTIONS

141. Identify the correct statements for the behaviour of ethane-1, 2-diamine as a ligand.

- (i) It is a neutral ligand.  
(ii) It is a didentate ligand.  
(iii) It is a chelating ligand.  
(iv) It is a unidentate ligand.  
(a) (i), (ii) and (iii) (b) (ii) and (iii)  
(c) (iii) and (iv) (d) (i), (iii) and (iv)

142. Read the following statements

- (i) Macromolecules cannot behave as a ligand.  
(ii)  $[\text{EDTA}]^{4-}$  can bind through two oxygen and four nitrogen atom.  
(iii) Chelate complexes are more stable than similar complexes containing unidentate ligands.  
(iv) Coordination number of the central atom/ion is determined only by the number of sigma bonds formed by the ligand with central atom/ion

Which of the following is the correct code for statements above?

- (a) FFTT (b) FTFT  
(c) TFTF (d) FFFT

143. Which of the following statements regarding formulas and naming of coordination compounds are correct?

- (i) During nomenclature names of neutral ligands are kept same except for  $\text{H}_2\text{O}$ ,  $\text{NH}_3$  and  $\text{CO}$ .  
(ii) If the complex is anion, the name of the metal ends with the suffix-ate.  
(iii) While writing formula of coordination compounds polydentate ligands are listed alphabetically.  
(iv) The cation is named first in both positively and negatively charged coordination entities.  
(a) (i), (ii) and (iii) (b) (ii), (iii) and (iv)  
(c) (i), (iii) and (iv) (d) (i), (ii), (iii) and (iv)

144. Which of the following statements are correct?

- (i) Square planar complexes of  $\text{MABXL}$  type show three isomers-two *cis* and one *trans*.  
(ii) Complexes of  $\text{Ma}_3\text{B}_3$  type show three isomers-two *cis* and one *trans*.  
(iii) Optical isomerism is common in octahedral complexes involving bidentate ligands.  
(iv)  $[\text{Co}(\text{NH}_3)_4\text{Cl}(\text{NO}_2)]\text{Cl}$  show linkage isomerism.  
(v) Hydrate isomerism is another name of solvate isomerism.  
(a) (i), (ii) and (iii) (b) (i), (iii) and (iv)  
(c) (ii), (iii) and (v) (d) (iii), (iv) and (v)

145. Which of the following statements are correct?

- (i) When light of wavelength 600nm is absorbed by complex  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  its configuration changes from  $t_{2g}^1 e_g^0 \longrightarrow t_{2g}^0 e_g^1$  and it appears violet in colour.  
(ii) Anhydrous  $\text{CuSO}_4$  is white but  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  is blue in colour as presence of  $\text{H}_2\text{O}$  as a ligand causes crystal field splitting.  
(iii) Ruby is aluminum oxide containing 0.5 – 1%  $\text{Cr}^{3+}$  ions with  $d^3$  configuration.  
(iv) Crystal field theory predict correctly that anionic ligands should exert the greater splitting effect.

- (a) (i), (ii) and (iii) (b) (ii) and (iii)  
(c) (i), and (ii) (d) (ii), (iii) and (iv)

146. Which of the following statement(s) is/are incorrect?

- (i) In metal carbonyls  $\text{M}-\text{C}$   $\sigma$  bond is formed by the donation of lone pair of electrons on the carbonyl carbon into a vacant orbital of metal.  
(ii)  $\text{M}-\text{C}$   $\pi$  bond is formed by the donation of a pair of electrons from a filled  $d$  orbital of metal into the vacant antibonding  $\pi^*$  orbital of  $\text{CO}$ .  
(iii) Bonding in metal carbonyls is called synergic bonding.  
(a) (i) and (ii) (b) (iii) only  
(c) (ii) only (d) None of these



### MATCHING TYPE QUESTIONS

147. Match the columns.

Column-I (Ligand)	Column-II (Type of ligand)
(A) Triphenylphosphine	(p) Unidentate
(B) $\text{BF}_3$	(q) Didentate
(C) Ethylenediamine	(r) Not a ligand
(D) Ethylenediaminetetracetate ion	(s) Hexadentate
(a) A – (p), B – (r), C – (q), D – (s)	
(b) A – (p), B – (q), C – (r), D – (s)	
(c) A – (p), B – (r), C – (q), D – (s)	
(d) A – (p), B – (q), C – (s), D – (p)	

148. Match the complex species given in Column-I with the isomerism exhibited in Column-II and assign the correct code:

Column-I (Complex species)	Column-II (Isomerism)
(A) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$	(p) optical
(B) $\text{cis}[\text{Co}(\text{en})_2\text{Cl}_2]^+$	(q) ionisation
(C) $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$	(r) coordination
(D) $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$	(s) geometrical
(a) A – (s), B – (p), C – (q), D – (r)	
(b) A – (p), B – (r), C – (q), D – (s)	
(c) A – (q), B – (s), C – (p), D – (r)	
(d) A – (p), B – (r), C – (s), D – (q)	

149. Match the columns.

Column-I	Column-II
(A) $[\text{Ni}(\text{CN})_4]^{2-}$	(p) $\text{Ti}^{4+}$
(B) Chlorophyll	(q) $\text{sp}^3$ ; paramagnetic
(C) Ziegler - Natta catalyst	(r) Non-planar
(D) $[\text{NiCl}_4]^{2-}$	(s) $\text{Mg}^{2+}$
(E) Deoxyhaemoglobin	(t) Planar
	(u) $\text{dsp}^2$ ; diamagnetic
(a) A – (u), B – (s), C – (p), D – (q), E – (r)	
(b) A – (q), B – (s), C – (p), D – (u), E – (r)	
(c) A – (q), B – (s), C – (p), D – (u), E – (t)	
(d) A – (u), B – (s), C – (p), D – (q), E – (t)	

150. Match the columns.

Column-I (Complexes)	Column-II (Absorbed Light)
(A) $[\text{Ni}(\text{H}_2\text{O})_4(\text{en})]^{2+}(\text{aq})$	(p) Yellow Orange
(B) $[\text{Ni}(\text{H}_2\text{O})_4(\text{en})_2]^{2+}(\text{aq})$	(q) Blue-Green
(C) $[\text{Ni}(\text{en})_3]^{2+}(\text{aq})$	(r) Red
(a) A – (r), B – (q), C – (p)	
(b) A – (p), B – (r), C – (q)	
(c) A – (q), B – (r), C – (p)	
(d) A – (r), B – (p), C – (q)	

151. Match the columns.

Column-I	Column-II
(A) Estimation of water hardness.	(p) $[\text{Ag}(\text{CN})_2]^-$
(B) Extraction of silver.	(q) $[\text{Ni}(\text{CO})_4]$
(C) Hydrogenation of alkenes.	(r) $\text{Na}_2\text{EDTA}$
(D) Photography	(s) $[(\text{Ph}_3\text{P})_3\text{RhCl}]$
(E) Purification of Nickel.	(t) $[\text{Ag}(\text{S}_2\text{O}_3)_2]^{3-}$
(a) A – (r), B – (p), C – (s), D – (t), E – (q)	
(b) A – (p), B – (r), C – (s), D – (t), E – (q)	
(c) A – (r), B – (s), C – (p), D – (t), E – (q)	
(d) A – (r), B – (p), C – (s), D – (q), E – (t)	

152. Match the columns.

Column-I (Coordination compound)	Column-II (Central metal atom)
(A) Chlorophyll	(p) Rhodium
(B) Blood pigment	(q) Cobalt
(C) Wilkinson catalyst	(r) Calcium
(D) Vitamin $\text{B}_{12}$	(s) Iron
	(t) Magnesium
(a) A – (t), B – (s), C – (p), D – (q)	
(b) A – (s), B – (q), C – (p), D – (r)	
(c) A – (p), B – (q), C – (r), D – (s)	
(d) A – (r), B – (t), C – (p), D – (q)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
- (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
- (c) Assertion is correct, reason is incorrect
- (d) Assertion is incorrect, reason is correct.

153. **Assertion :**  $\text{NF}_3$  is a weaker ligand than  $\text{N}(\text{CH}_3)_3$ .

**Reason :**  $\text{NF}_3$  ionizes to give  $\text{F}^-$  ions in aqueous solution.

154. **Assertion :**  $[\text{Fe}(\text{CN})_6]^{3-}$  is weakly paramagnetic while  $[\text{Fe}(\text{CN})_6]^{4-}$  is diamagnetic.

**Reason :**  $[\text{Fe}(\text{CN})_6]^{3-}$  has +3 oxidation state while  $[\text{Fe}(\text{CN})_6]^{4-}$  has +2 oxidation state.

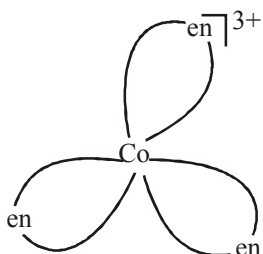
155. **Assertion :**  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  is coloured while  $[\text{Sc}(\text{H}_2\text{O})_6]^{3+}$  is colourless.

**Reason :** d-d transition is not possible in  $[\text{Sc}(\text{H}_2\text{O})_6]^{3+}$ .

### CRITICAL THINKING TYPE QUESTIONS

- 156.** A co-ordination complex compound of cobalt has the molecular formula containing five ammonia molecules, one nitro group and two chlorine atoms for one cobalt atom. One mole of this compound produces three mole ions in an aqueous solution. On reacting this solution with excess of  $\text{AgNO}_3$  solution, we get two moles of  $\text{AgCl}$  precipitate. The ionic formula for this complex would be
- $[\text{Co}(\text{NH}_3)_4(\text{NO}_2)\text{Cl}][(\text{NH}_3)\text{Cl}]$
  - $[\text{Co}(\text{NH}_3)_5\text{Cl}][\text{Cl}(\text{NO}_2)]$
  - $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$
  - $[\text{Co}(\text{NH}_3)_5][(\text{NO}_2)_2\text{Cl}_2]$
- 157.** What is the secondary valence of following compounds  $\text{PtCl}_2 \cdot 2\text{NH}_3$ ,  $\text{CoCl}_3 \cdot 4\text{NH}_3$  and  $\text{NiCl}_2 \cdot 6\text{H}_2\text{O}$  if moles of  $\text{AgCl}$  precipitated per mole of the given compounds with excess  $\text{AgNO}_3$  respectively are: 0, 1 and 2
- 6, 4, 4
  - 4, 6, 6
  - 4, 4, 6
  - 2, 4, 6
- 158.**  $\text{C}_{63}\text{H}_{88}\text{CoN}_{14}\text{O}_{14}\text{P}$  is the formulae of the Cyanocobalamine, (vitamin  $\text{B}_{12}$ ) it contain  $\text{CN}^-$  and  $\text{CN}^-$  is very poisonous, than why this compound does not prove to be fatal for us? (it inhibit the electron transport chain ?
- $\text{CN}^-$  forms covalent bond
  - $\text{CN}^-$  is coordinating to the cobalt as the ligand
  - $\text{CN}^-$  hydrolysis immediately
  - All of these
- 159.** Suppose someone made aqueous solution of  $\text{NiCl}_2$  and recrystallized its aqueous solution in excess of water and if two moles of precipitate  $\text{AgCl}$  was formed on treatment with  $\text{AgNO}_3$ , what is the most probable structure of the compound ?
- $[\text{Ni}(\text{Cl})_2(\text{H}_2\text{O})_4]$
  - $[\text{Ni}(\text{H}_2\text{O})_6]\text{Cl}_2$
  - $[\text{Ni}(\text{H}_2\text{O})_5\text{Cl}]$
  - $[\text{Ni}(\text{H}_2\text{O})_4\text{Cl}_2] \cdot 2\text{H}_2\text{O}$
- 160.** Total number of electron count in  $\text{Ni}(\text{CO})_4$  and  $\text{Fe}(\text{CO})_5$  respectively are.
- 36, 36
  - 34, 36
  - 36, 34
  - 34, 34
- 161.** The formula for the complex, dichlorobis (urea) copper (II) is
- $[\text{Cu}\{\text{O}=\text{C}(\text{NH}_2)_2\}]\text{Cl}_2$
  - $[\text{Cu}\{\text{O}=\text{C}(\text{NH}_2)_2\}\text{Cl}]\text{Cl}$
  - $[\text{CuCl}_2\{\text{O}=\text{C}(\text{NH}_2)_2\}_2]$
  - $[\text{CuCl}_2][\{\text{O}=\text{C}(\text{NH}_2)_2\}]_2$
- 162.** According to IUPAC nomenclature sodium nitroprusside is named as
- Sodium pentacyanonitrosylferrate (III)
  - Sodium nitroferrocyanide
  - Sodium nitroferrocyanide
  - Sodium pentacyanonitrosylferrate (II)
- 163.** The total number of possible isomers for the complex compound  $[\text{Cu}^{\text{II}}(\text{NH}_3)_4][\text{Pt}^{\text{II}}\text{Cl}_4]$
- 3
  - 6
  - 5
  - 4
- 164.** Which of the following will give a pair of enantiomorphs?
- $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{CN})_6]$
  - $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$
  - $[\text{Pt}(\text{NH}_3)_4][\text{PtCl}_6]$
  - $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{NO}_2$   
( $\text{en} = \text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ )
- 165.** The existence of two different coloured complexes with the composition of  $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$  is due to :
- linkage isomerism
  - geometrical isomerism
  - coordination isomerism
  - ionization isomerism
- 166.** Which of the following has an optical isomer
- $[\text{Co}(\text{en})(\text{NH}_3)_2]^{2+}$
  - $[\text{Co}(\text{H}_2\text{O})_4(\text{en})]^{3+}$
  - $[\text{Co}(\text{en})_2(\text{NH}_3)_2]^{3+}$
  - $[\text{Co}(\text{NH}_3)_3\text{Cl}]^+$
- 167.** Among the following complexes, optical activity is possible in
- $[\text{Co}(\text{NH}_3)_6]^{3+}$
  - $[\text{Co}(\text{H}_2\text{O})_2(\text{NH}_3)_2\text{Cl}_2]^+$
  - $[\text{Cr}(\text{H}_2\text{O})_2\text{Cl}_2]^+$
  - $[\text{Co}(\text{CN})_5\text{NC}]$
- 168.**  $[\text{Co}(\text{NH}_3)_4(\text{NO}_2)_2]\text{Cl}$  exhibits
- linkage isomerism, ionization isomerism and geometrical isomerism
  - ionization isomerism, geometrical isomerism and optical isomerism
  - linkage isomerism, geometrical isomerism and optical isomerism
  - linkage isomerism, ionization isomerism and optical isomerism
- 169.** Which of the following compounds exhibits linkage isomerism ?
- $[\text{Co}(\text{en})_2]\text{Cl}_3$
  - $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{en})_3]$
  - $[\text{Co}(\text{en})_2\text{NO}_2\text{Cl}]\text{Br}$
  - $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Br}_2$
- 170.** Among the following coordination compounds/ions
- $[\text{Fe}(\text{CN})_6]^{3-}$
  - $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
  - $[\text{Co}(\text{NH}_3)_6]^{3+}$
  - $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$
- Which species exhibit geometrical isomerism?
- (ii) only
  - (i) and (ii)
  - (ii) and (iv)
  - (i) and (iii)
- 171.** Identify the optically active compounds from the following :
- $[\text{Co}(\text{en})_3]^{3+}$
  - trans* -  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$
  - cis* -  $[\text{Co}(\text{en})_2\text{Cl}_2]^+$
  - $[\text{Cr}(\text{NH}_3)_5\text{Cl}]$
- (i) and (iii)
  - (ii) and (iii)
  - (iii) and (iv)
  - (i), (iii) and (iv)

172. For which value of the x, and y, the following square planar compound shows geometrical isomers  $[\text{Pt}(\text{Cl})_x(\text{Br})_y]^{2-}$
- (a) 1, 3 (b) 3, 1  
(c) 2, 2 (d) 1, 1
173. How many geometrical isomers are possible for following square planar compound  $[\text{M}(\text{Cl})(\text{Br})(\text{I})(\text{F})]$  (where M is a metal ion)
- (a) 2 (b) 3  
(c) 9 (d) 8
174. The tetrahedral complex  $[\text{M}(\text{A})(\text{B})(\text{X})(\text{Y})]$ , where A, B, X and Y are different ligands and M is a metal ion is
- (a) optically inactive  
(b) rotate plane polarized light  
(c) incomplete information  
(d) can't be said
175. The complex given is



- (i) non-superimposable on its mirror images  
(ii) optically inactive  
(iii) rotate plane polarised light  
(iv) planar
- (a) (i) and (ii) (b) (i) and (iv)  
(c) (i), (ii) and (iii) (d) (ii) only
176. The correct statement with respect to the complexes  $\text{Ni}(\text{CO})_4$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  is
- (a) nickel is in the same oxidation state in both  
(b) both have tetrahedral geometry  
(c) both have square planar geometry  
(d) have tetrahedral and square planar geometry respectively
177. Which one of the following complexes is an outer orbital complex?
- (a)  $[\text{Co}(\text{NH}_3)_6]^{3+}$  (b)  $[\text{Mn}(\text{CN})_6]^{4-}$   
(c)  $[\text{Fe}(\text{CN})_6]^{4-}$  (d)  $[\text{Ni}(\text{NH}_3)_6]^{2+}$   
(Atomic nos. : Mn = 25; Fe = 26; Co = 27, Ni = 28)
178. The d-electron configurations of  $\text{Cr}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Fe}^{2+}$  and  $\text{Co}^{2+}$  are  $d^4$ ,  $d^5$ ,  $d^6$  and  $d^7$ , respectively. Which one of the following will exhibit minimum paramagnetic behaviour?
- (a)  $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$  (b)  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$   
(c)  $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$  (d)  $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$   
(At. nos. Cr = 24, Mn = 25, Fe = 26, Co = 27)
179. Both  $[\text{Ni}(\text{CO})_4]$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  are diamagnetic. The hybridisations of nickel in these complexes, respectively, are
- (a)  $sp^3$ ,  $sp^3$  (b)  $sp^3$ ,  $dsp^2$   
(c)  $dsp^2$ ,  $sp^3$  (d)  $dsp^2$ ,  $sp^2$
180. Which one of the following is an inner orbital complex as well as diamagnetic in behaviour? (Atomic number: Zn = 30, Cr = 24, Co = 27, Ni = 28)
- (a)  $[\text{Zn}(\text{NH}_3)_6]^{2+}$  (b)  $[\text{Cr}(\text{NH}_3)_6]^{3+}$   
(c)  $[\text{Co}(\text{NH}_3)_6]^{3+}$  (d)  $[\text{Ni}(\text{NH}_3)_6]^{2+}$
181. The value of the 'spin only' magnetic moment for one of the following configurations is 2.84 BM. The correct one is
- (a)  $d^5$  (in strong ligand field)  
(b)  $d^3$  (in weak as well as in strong fields)  
(c)  $d^4$  (in weak ligand fields)  
(d)  $d^4$  (in strong ligand fields)
182. The d electron configurations of  $\text{Cr}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Fe}^{2+}$  and  $\text{Ni}^{2+}$  are  $3d^4$ ,  $3d^5$ ,  $3d^6$  and  $3d^8$  respectively. Which one of the following aqua complexes will exhibit the minimum paramagnetic behaviour?
- (a)  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$  (b)  $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$   
(c)  $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$  (d)  $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$   
(At. No. Cr = 24, Mn = 25, Fe = 26, Ni = 28)
183. According to valence bond theory which of the following statement is correct about the complexes  $\text{Ni}(\text{CO})_4$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  if both are diamagnetic in nature
- (a) both are tetrahedral  
(b) both are square planar  
(c) one is square planar and other is tetrahedral  
(d) one is tetrahedral and other is square planar
184. Correct statements about the following complexes  $[\text{MnCl}_6]^{3-}$  and  $[\text{Mn}(\text{CN})_6]^{3-}$  respectively are.
- (a) Magnetic moment is 4.8 and 2.8  
(b) inner sphere and outer sphere complexes.  
(c)  $sp^3d^2$  and  $d^2sp^3$  complexes.  
(d) Both (a) and (c).
185. In which of the following coordination entities the magnitude  $\Delta_0$  (CFSE in octahedral field) will be maximum?
- (a)  $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$  (b)  $[\text{Co}(\text{NH}_3)_6]^{3+}$   
(c)  $[\text{Co}(\text{CN})_6]^{3-}$  (d)  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$   
(At. No. Co = 27)
186. Which of the following complex ions is expected to absorb visible light?
- (a)  $[\text{Ti}(\text{en})_2(\text{NH}_3)_2]^{4+}$  (b)  $[\text{Cr}(\text{NH}_3)_6]^{3+}$   
(c)  $[\text{Zn}(\text{NH}_3)_6]^{2+}$  (d)  $[\text{Sc}(\text{H}_2\text{O})_3(\text{NH}_3)_3]^{3+}$   
(At. no. Zn = 30, Sc = 21, Ti = 22, Cr = 24)
187. Crystal field stabilization energy for high spin  $d^4$  octahedral complex is:
- (a)  $-1.8 \Delta_0$  (b)  $-1.6 \Delta_0 + P$   
(c)  $-1.2 \Delta_0$  (d)  $-0.6 \Delta_0$

**188.** Low spin complex of  $d^6$ -cation in an octahedral field will have the following energy :

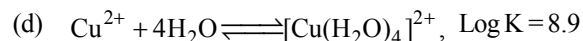
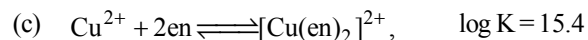
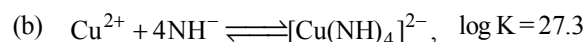
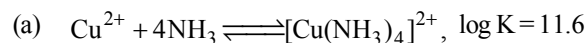
- (a)  $\frac{-12}{5}\Delta_0 + P$  (b)  $\frac{-12}{5}\Delta_0 + 3P$   
 (c)  $\frac{-2}{5}\Delta_0 + 2P$  (d)  $\frac{-2}{5}\Delta_0 + P$

( $\Delta_0$  = Crystal Field Splitting Energy in an octahedral field,  $P$  = Electron pairing energy)

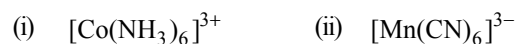
**189.** Which of the following carbonyls will have the strongest C – O bond ?

- (a)  $[\text{Mn}(\text{CO})_6]^+$  (b)  $[\text{Cr}(\text{CO})_6]$   
 (c)  $[\text{V}(\text{CO})_6]^-$  (d)  $[\text{Fe}(\text{CO})_5]$

**190.** Which of the following complexes formed by  $\text{Cu}^{2+}$  ions is most stable ?



**191.** Atomic number of Mn, Fe and Co are 25, 26 and 27 respectively. Which of the following inner orbital octahedral complex ions are diamagnetic ?

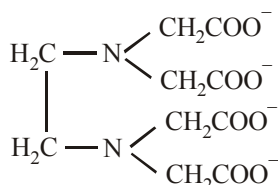


# HINTS AND SOLUTIONS

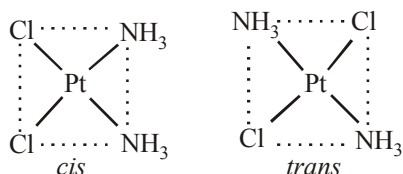
## FACT/DEFINITION TYPE QUESTIONS

- (a) The primary valencies are ionisable and represented by dotted line.
- (c)
- (a)  $\text{CrCl}_3$  has primary valence of 3.
- (d)  $\text{Co}(\text{NH}_3)_5\text{Cl}_3 \rightleftharpoons [\text{Co}(\text{NH}_3)_5\text{Cl}]^{+2} + 2\text{Cl}^-$   
 $\therefore$  Structure is  $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ .  
 Now  $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2 + 2\text{AgNO}_3$   
 $\rightarrow [\text{Co}(\text{NH}_3)_5\text{Cl}](\text{NO}_3)_2 + 2\text{AgCl}$
- (a) Since the precipitate of  $\text{AgCl}$  shows two ionisable chloride ion the complex must have the structure.  
 $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2 + 2\text{AgNO}_3 \rightarrow$   
 $[\text{Co}(\text{NH}_3)_5\text{Cl}](\text{NO}_3)_2 + 2\text{AgCl}$   
 Hence two chlorine atoms satisfy the primary valency and one, secondary valency
- (c) The ions present in the ionisation sphere are precipitated  
 Hence  $[\text{CrCl}_2(\text{H}_2\text{O})_4]\text{Cl} \cdot 2\text{H}_2\text{O}$  contains  $1/3$  Cl in ionisation sphere to be precipitated by  $\text{AgNO}_3$  as  $\text{AgCl}$
- (b) Complex compounds do not dissociate into constituent ions.  
 $\text{K}_4[\text{Fe}(\text{CN})_6] \longrightarrow 4\text{K}^+ + [\text{Fe}(\text{CN})_6]^{4-}$   
 $\therefore$  It is a complex because no  $\text{CN}^-$  is formed on dissociation.
- (b) It is a double salt:  
 $\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O} \longrightarrow$   
 $\text{Fe}^{2+} + 2\text{SO}_4^{2-} + 2\text{NH}_4^+$
- (a)
- (a) Let the o.s. of Ni in  $\text{K}_4[\text{Ni}(\text{CN})_4]$  be  $x$  then  
 $4(+1) + x + (-1) \times 4 = 0 \Rightarrow 4 + x - 4 = 0$   
 $x = 0$
- (c) The coordination number of central metal atom in a complex is equal to number of monovalent ligands, twice the number of bidentate ligands and so on, around the metal ion bonded by coordinate bonds.  
 Hence coordination number = no. of  $\sigma$  bonds formed by metals with ligands
- (d) Oxidation state of Cr in  $[\text{Cr}(\text{NH}_3)_4\text{Cl}_2]^+$ .  
 Let it be  $x$ ,  $1 \times x + 4 \times 0 + 2 \times (-1) = 1$  Therefore  $x = 3$ .
- (c) The oxidation state of metal in metal carbonyls is always zero.
- (d)  $[\text{EDTA}]^{4-}$  is a hexadentate ligand, because it has six donor atoms and donate 6 pairs of electrons to central metal atom in the complex.
- (d) In  $\text{Fe}(\text{CO})_5$ , Fe is in minimum oxidation state (zero).
- (d) In the given complex we have two bidentate ligands (i.e. en and  $\text{C}_2\text{O}_4$ ), so coordination number of E is 6 ( $2 \times 2 + 1 \times 2 = 6$ )  
 Let the oxidation state of E in complex be  $x$ , then  
 $[x + (-2) = 1]$  or  $x - 2 = 1$   
 or  $x = +3$ , so its oxidation state is +3  
 Thus option (d) is correct.
- (a) Salt may be complex salt. Metal atom present in the coordination sphere appears in the form of complex ion and not as simple cation
- (b) Coordination number is = 2 (number of bidentate ligands)  
 $\therefore$  C.N. of Ni =  $(2 \times 3) = 6$
- (b) In the complex formation the ligands whether negative, neutral or positive always donate electrons to the central metal atom hence they act as Lewis bases.
- (c)  $\text{K}[\text{Co}(\text{CN})_4]$  let the O. N. of Co be  $x$  then  
 $1 \times (+1) + 1(+x) + 4(-1) = 0 \Rightarrow x = +3$
- (c) Number of donor atoms (N) in  $\text{N}(\text{CH}_2\text{CH}_2\text{NH}_2)_3$  are four.  
 So,  $\text{N}(\text{CH}_2\text{CH}_2\text{NH}_2)_3$  is a tetradentate ligand.
- (d) Ambidentate ligands are those unidentate ligands which contain more than one coordinating atoms. Thiocyanate is an example of such a ligand.  
 $\text{M} \leftarrow \text{SCN} \quad \text{M} \leftarrow \text{NCS}$   
 Thiocyanato      Isothiocyanato
- (c)
- (d)
- (c) Ambident ligand has two donor atoms, either of two can form a coordinate bond.
- (c)
- (c)  $\text{Na}^+$  is not a ligand.
- (d) These are facts about glycinate ligand.
- (c)  $\text{BF}_3$  has incomplete octet and is Lewis acid; it cannot donate electron pair.
- (a) It has two donor atoms, i.e.,  $\begin{array}{c} \text{COO}_- \\ | \\ \text{COO}_- \end{array}$
- (b)
- (b)  $\text{O}_2$  is a bidentate ligand.
- (c)
- (a)
- (b)
- (a)
- (b)
- (c)
- (b)
- (c)  $\text{EDTA}^{4-}$  can bind through two nitrogen and four oxygen atoms to a central metal ion.



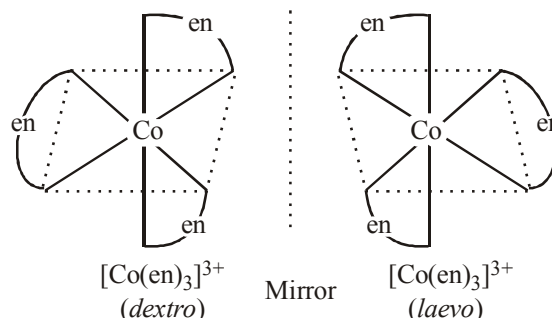


41. (b) IUPAC name is Potassium trioxalatoaluminate (III).
42. (a) Chlorodiaquatrimmincobalt (III) chloride is  $[\text{CoCl}(\text{NH}_3)_3(\text{H}_2\text{O})_2]\text{Cl}_2$ .
43. (c)  $\text{K}_3[\text{Fe}(\text{CN})_6]$  is Potassium hexacyanoferrate (III).
44. (b)  $[\text{Co}(\text{ONO})(\text{NH}_3)_5]\text{Cl}_2$   
pentaamminenitrito-N-cobalt (III) chloride
45. (b)  $\text{K}_2[\text{PtCl}_6]$   
Potassium hexachloroplatinate (IV)  
Oxidation state of Pt is + 4 in the complex and anion is present in form of complex.
46. (c) The correct IUPAC name of the given compound is tetramminenickel (II) - tetrachloronickelate (II) thus (c) is the correct answer.
47. (d)  $[\text{Co}(\text{H}_2\text{O})_4(\text{NH}_3)_2]\text{Cl}_3$   
= Diamminetetraaquacobalt (III) chloride.
48. (d)
49. (d)  $[\text{Co}(\text{H}_2\text{O})_4(\text{NH}_3)_2]\text{Cl}_3$   
= Diamminetetraaquacobalt (III) chloride.
50. (d) Chemical formula of iron (III) hexacyanoaoferrate (II) is  $\text{Fe}_4[\text{Fe}(\text{CN})_6]_3$
51. (b) IUPAC name of  $\text{K}_3[\text{Ir}(\text{C}_2\text{O}_4)_3]$  is potassium trioxalato iridate (III)
52. (b)  $\text{Na}_3[\text{Co}(\text{ONO})_6]$  IUPAC name is sodium hexanitritocobaltate (III)
53. (d) According to IUPAC nomenclature anionic ligands will end with -ido so that chloro would become chlorid.
54. (a)  $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$  is a disubstituted complex and shows only *cis*-& *trans*-isomers



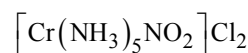
55. (c)  $[\text{Cr}(\text{SCN})_2(\text{NH}_3)_4]^+$  shows linkage, geometrical and optical isomerism. Hence produces maximum no. of isomers.
56. (a)  $\text{MA}_3\text{B}_3$  - 2 geometrical isomers  
 $\text{MA}_2\text{B}_4$  - 2 geometrical isomers  
 $\text{MA}_4\text{B}_2$  - 2 geometrical isomers  
The complexes of general formula  $\text{MA}_6$  and  $\text{MA}_5\text{B}$  having octahedral geometry do not show geometrical isomerism.

57. (d) The optical isomers are pair of molecules which are non superimposable mirror images of each other.

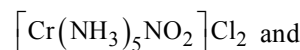


The two optically active isomers are collectively called enantiomers.

58. (b) The chemical formula of Pentamminenitrochromium (III) chloride is



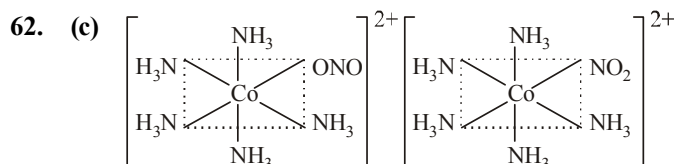
It can exist in following two structures



Therefore the type of isomerism found in this compound is linkage isomerism as nitro group is linked through N as  $-\text{NO}_2$  or through O as  $-\text{ONO}$ .

59. (b)
60. (c) *cis*- $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ : *cis*- $[\text{M}(\text{aa})_2\text{b}_2]$  can show optical isomerism.

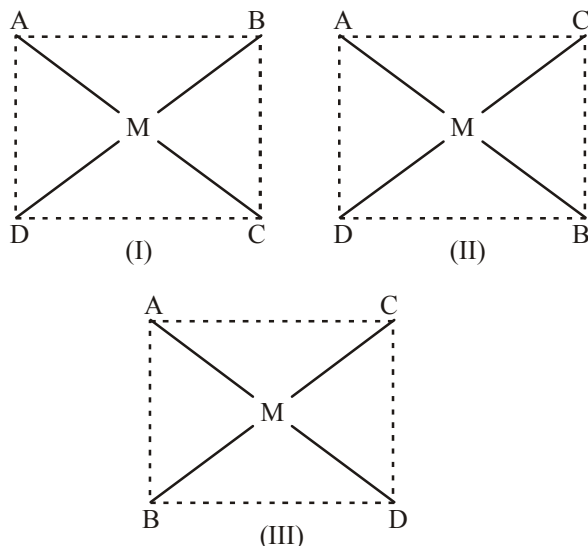
61. (a)



Here more than one atom function as donor, as oxygen in first one and nitrogen in second, so they show linkage isomerism.

63. (b) Co-ordination isomerism is caused by the interchange of ligands between cation and anion complexes.
64. (c) Change in composition of co-ordination sphere yield ionisation isomers.  
 $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$  and  $[\text{CrCl}_3(\text{H}_2\text{O})_3] \cdot 3\text{H}_2\text{O}$
65. (a) The octahedral coordination compounds of the type  $\text{MA}_3\text{B}_3$  exhibit fac-mer isomerism.
66. (c) Coordination isomerism occurs when cationic and anionic complexes of different metal ions are present in a salt. The two isomers differ in the distribution of ligands in cation and anion e.g.,  
 $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$  is an isomer of  $[\text{Co}(\text{CN})_6][\text{Cr}(\text{NH}_3)_6]$

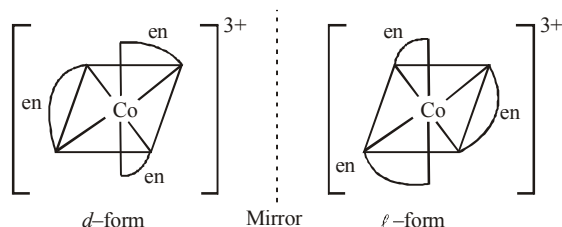
67. (a) Complexes of the type  $M_{ABCD}$  may exist in three isomeric forms.



Similarly,  $[Pt(py)(NH_3)BrCl]$  may exist in three isomeric form in which

$M = Pt, A = Py, B = NH_3, C = Br, D = Cl$ .

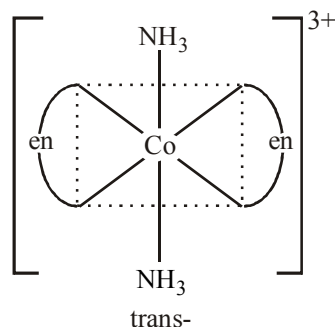
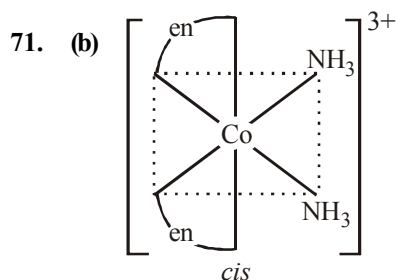
68. (a) Complexes with  $dsp^2$  hybridisation are square planar. So,  $[PtCl_4]^{2-}$  is square planar in shape.
69. (a) The  $SCN^-$  ion can coordinate through S or N atom giving rise to linkage isomerism  
 $M \leftarrow SCN$  thiocyanato  
 $M \leftarrow NCS$  isothiocyanato.
70. (b) Option (b) shows optical isomerism  $[Co(en)_3]^{3+}$



Complexes of  $Zn^{++}$  cannot show optical isomerism as they are tetrahedral complexes with plane of symmetry.

$[Co(H_2O)_4(en)]^{3+}$  have two planes of symmetry hence it is also optically inactive.

$[Zn(en)_2]^{2+}$  cannot show optical isomerism



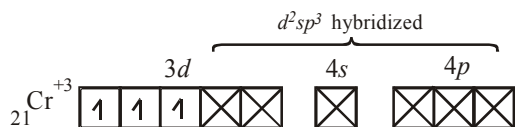
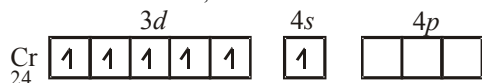
72. (b) Ionisation isomer of  $[Cr(H_2O)_4Cl(NO_2)]Cl$  is  $[Cr(H_2O)_4Cl_2]NO_2$ .
73. (c)  $Ma_2b_2c_2$  can show both optical & geometrical isomerism.
74. (a) The compound shows linkage isomerism because the ligand in the compound is an ambidentate ligand that can bond at more than one atomic site.  
*i.e.*,  $:NCS^-$  and  $:SCN^-$
75. (d)  $[Pt(en)_2Cl_2]$  is a complex of the type  $M(AA)_2B_2$  which is octahedral. Such compounds exhibit optical and geometrical isomerism both.
76. (a)  $[Co(NH_3)_3(NO_2)_3]$  is of the type  $MA_3B_3$ . They give two geometrical isomers.
77. (d)  $[Cr(NH_3)_3Cl_3]$  is of the type  $MA_3B_3$  and exists in two isomeric forms.
78. (d) Square planar complex of the formula  $Ma_bcd$  give three geometrical isomers.
79. (b)
80. (d) The complex ion  $[Cr(SCN)_2(NH_3)_4]^{2+}$  can exhibit geometrical and linkage isomerism.
81. (c)  $[PtCl_2(NH_3)_4]Br_2$  and  $[PtBr_2(NH_3)_4]Cl_2$  are ionisation isomers.
82. (c) Octahedral complex of the type  $MA_5B$  do not show geometrical isomerism.
83. (c) Similarity between optical and geometrical isomerism is that both are included in stereo isomerism.
84. (b) The compound is  $[Cr(NH_3)_5NO_2]Cl_2$  and can exhibit

linkage isomerism due to  $NO_2$  group ( $-N \begin{smallmatrix} \nearrow O \\ \searrow O \end{smallmatrix}$  or  $O-N=O$ )

85. (b)
86. (b) Given compound shows meridional isomerism.
87. (a)
88. (c)

	$Ni(CO)_4$	$Ni(PPh_3)_2Cl_2$
O.S.	$Ni^0$	$Ni^{2+}$
EC.	$[Ar]3d^84s^2$	$[Ar]3d^84s^0$
	Pairing of $e^-$	No pairing of $e^-$
Hybridization	$sp^3$ (tetrahedral)	$sp^3$ (tetrahedral)

89. (d) In  $[\text{Cr}(\text{NH}_3)_6]\text{Br}_3$ , Cr is in +3 oxidation state



Its ion is octahedral in nature. Due to the presence of three unpaired electrons it is paramagnetic.

90. (c)  $[\text{Cr}(\text{NH}_3)_6]\text{Cl}_3$  is an inner orbital complex, because in this complex inner d-orbital is used for hybridisation ( $d^2sp^3$ )

91. (b)

Atom/Ion Complex	Configuration	No. of unpaired electrons	Magnetic nature									
$\text{Ni}^{2+} (d^8)$ $[\text{NiCl}_4]^{2-}$	<table><tr><td><math>3d</math></td><td><math>4s</math></td><td><math>4p</math></td></tr><tr><td><math>\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow</math></td><td><math>\square</math></td><td><math>\square \square \square</math></td></tr><tr><td><math>\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow</math></td><td><math>:</math></td><td><math>:</math> <math>:</math> <math>:</math> <math>:</math></td></tr></table>	$3d$	$4s$	$4p$	$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow$	$\square$	$\square \square \square$	$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow$	$:$	$:$ $:$ $:$ $:$	2 2	Paramagnetic Paramagnetic
$3d$	$4s$	$4p$										
$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow$	$\square$	$\square \square \square$										
$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow$	$:$	$:$ $:$ $:$ $:$										
$[\text{Ni}(\text{CN})_4]^{2-}$	<table><tr><td><math>3d</math></td><td><math>4s</math></td><td><math>4p</math></td></tr><tr><td><math>\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow :</math></td><td><math>\square</math></td><td><math>\square \square \square</math></td></tr><tr><td><math>\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow :</math></td><td><math>:</math></td><td><math>:</math> <math>:</math> <math>:</math> <math>:</math></td></tr></table> <p>Rearrangement <math>dsp^2</math></p>	$3d$	$4s$	$4p$	$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow :$	$\square$	$\square \square \square$	$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow :$	$:$	$:$ $:$ $:$ $:$	0	Diamagnetic
$3d$	$4s$	$4p$										
$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow :$	$\square$	$\square \square \square$										
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$\text{Ni} (d^8s^2)$ $[\text{Ni}(\text{CO})_4]$	<table><tr><td><math>3d</math></td><td><math>4s</math></td><td><math>4p</math></td></tr><tr><td><math>\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow</math></td><td><math>\uparrow\downarrow</math></td><td><math>\square \square \square</math></td></tr><tr><td><math>\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow</math></td><td><math>:</math></td><td><math>:</math> <math>:</math> <math>:</math> <math>:</math></td></tr></table> <p>Rearrangement <math>sp^3</math></p>	$3d$	$4s$	$4p$	$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow$	$\uparrow\downarrow$	$\square \square \square$	$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow$	$:$	$:$ $:$ $:$ $:$	2 0	Paramagnetic Diamagnetic
$3d$	$4s$	$4p$										
$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow \uparrow$	$\uparrow\downarrow$	$\square \square \square$										
$\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow \uparrow\downarrow$	$:$	$:$ $:$ $:$ $:$										

92. (b)

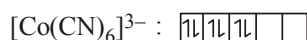
93. (b) As in  $[\text{NiCl}_4]^{2-}$  chloride ion being a weak ligand is not able to pair the electrons in d orbital.

94. (d)  $\text{Cr}^{3+}$  has  $4s^0 3d^3$  electronic configuration with 3 unpaired electrons, hence paramagnetic. In other cases pairing of d-electrons take place in presence of strong field ligands such as CO or  $\text{CN}^-$ .

In  $\text{Cr}(\text{CO})_6$  molecule 12 electrons are contributed by CO group and it contain no odd electron

95. (b)  $\text{CN}^-$  is a strong field ligand as it is a pseudohalide ion. These ions are strong coordinating ligands and hence have the tendency to form  $\sigma$ -bond (from the pseudo halide to the metal) and  $\pi$ -bond (from the metal to pseudo halide)

96. (a)  $\text{Co}^{3+}$  :  $1\downarrow 1\downarrow 1\downarrow 1\downarrow 1\downarrow$



$\text{CN}^-$  is a strong field ligand and it causes pairing of electrons as a result number of unpaired electrons in  $\text{Co}^{3+}$  becomes zero and hence it has lowest value of paramagnetic behaviour.

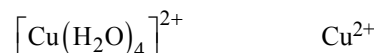
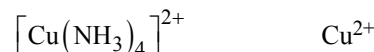
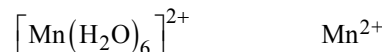
97. (a)  $\text{Sc} = [\text{Ar}] 3d^1 4s^2$   
Oxidation state of Sc in  $[\text{Sc}(\text{H}_2\text{O})_6]^{3+}$  is  $\text{Sc}^{3+}$   
 $\text{Sc}^{3+} = [\text{Ar}] 3d^0 4s^0$ .

$\therefore$  It does not have unpaired electron

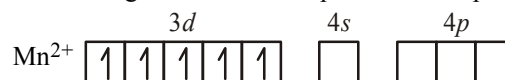
$\therefore \text{Sc}^{3+}$  is diamagnetic and colourless.

98. (a) Paramagnetic species has unpaired electron. More the no. of unpaired electrons, more will be paramagnetic character.

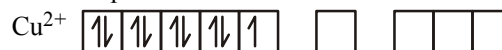
Complex O. S. of metal



Electronic configuration of the ion present in complex



No. of unpaired electrons = 5



No. of unpaired electron = 1



However,  $\text{CN}^-$  is a strong ligand, so pairing of electrons will occur in the complex having  $\text{CN}^-$  ions.

$\therefore \text{Fe}^{2+}$  in presence of  $\text{CN}^-$



$\therefore$  No. of unpaired electron = 0

Thus  $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$  having maximum no. of unpaired electrons has maximum paramagnetic nature.

99. (c) In  $\text{Na}_2[\text{CdCl}_4]$ , Cd has oxidation state +2.

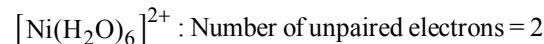
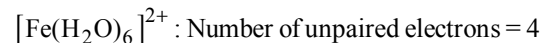
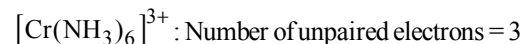
So, its electronic configuration is  $4d^{10}5s^0$

or all the 4d orbitals are fully filled.

Hence, there will be no d-d transition. So, it is colourless.

100. (c)

101. (a)  $[\text{Ni}(\text{CN})_4]^{2-}$  : Number of unpaired electrons = 0



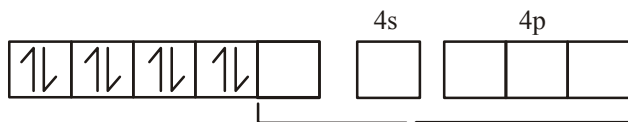
102. (b)  $\text{Ni}^{++} = 3d^8 4s^0$



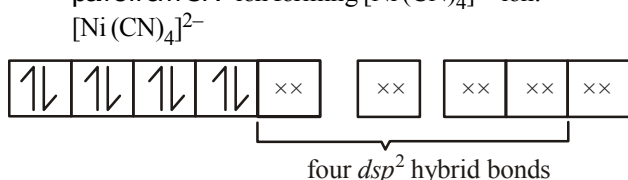
Since, the coordination number of Ni in this complex is 4, the configuration of  $\text{Ni}^{++}$  at first sight shows that the complex is paramagnetic with two unpaired electron. However, experiments show that the complex

is diamagnetic. This is possible when the 3d electrons rearrange against the Hund's rule as shown below. This is in accordance with the fact that the ligand involved here is strong i.e.,  $\text{CN}^-$  ion.

$\text{Ni}^{++}$  (after rearrangement)



Hence, now  $dsp^2$  hybridization involving one 3d, one 4s and two 4p orbitals, takes place leading to four  $dsp^2$  hybrid orbitals, each of which accepts four electron pairs from  $\text{CN}^-$  ion forming  $[\text{Ni}(\text{CN})_4]^{2-}$  ion.



Thus, the complex is diamagnetic as it has no unpaired electron.

103. (a)  $[\text{Ni}(\text{NH}_3)_6]^{2+}$

$\text{Ni}^{2+} = 3d^8$ , according to CFT =  $t_{2g}^6 e_g^2$  therefore, hybridisation is  $sp^3d^2$  and complex is paramagnetic.

104. (d) 105. (a)

106. (d) In  $[\text{Co}(\text{CN})_6]^{3-}$  O.N. of Co is +3

$\therefore \text{Co}^{+3} = 3d^6 4s^0$

$\text{CN}^-$  is a strong field ligand

$\therefore$  Pairing of electrons occurs so in this complex no unpaired electron is present and it is low spin complex.

107. (a)

Complex	Configuration	No. of unpaired electrons
$[\text{CoF}_6]^{3-}$		4
$[\text{Co}(\text{NH}_3)_6]^{3+}$		0
$[\text{Ni}(\text{NH}_3)_4]^{2+}$		0
$[\text{Ni}(\text{CN})_4]^{2-}$		0

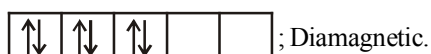
Rearrangement  $dsp^2$

Magnetic moment =  $\sqrt{n(n+2)}$ ,

where n = no. of unpaired electrons

$[\text{CoF}_6]^{3-}$  has highest magnetic moment (4.8) due to the presence of 4 unpaired electrons.

108. (c)  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$  has  $\text{Co}^{3+}$  ( $d^6$  system) due to presence of stronger  $\text{C}_2\text{O}_4^{2-}$  chelating ligand pairing of electrons occurs in this case.  $\text{Co}^{3+}$ :

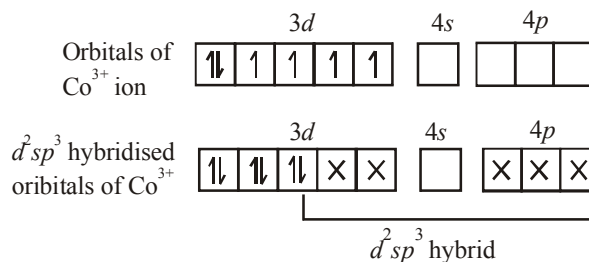


; Diamagnetic.

109. (c) Electronic configuration of  $\text{Ni}^{2+}$  is  $[\text{Ar}] 3d^8 4s^0 4p^0$ .  $\text{CN}^-$  is strong ligand and will do pairing of electrons so will have one d orbital left empty. C.N. is 4 so  $dsp^2$  hybridisation will take place which is square planar,  $\text{Ni}(\text{CO})_4$  and  $[\text{Ni}(\text{CN})_4]^{2-}$  are tetrahedral.

110. (d)

111. (b)  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$  is diamagnetic as oxalate is a strong ligand causing pairing of 3d electrons in  $\text{Co}^{3+}$  thereby leading to  $d^2sp^3$  hybridisation.



112. (b)  $[\text{Ni}(\text{CO})_4] \rightarrow$  tetrahedral

$[\text{PtCl}_4]^{2-} \rightarrow$  square planar

113. (c)  $[\text{Mn}(\text{CN})_6]^{3-}$  and  $[\text{Fe}(\text{CN})_6]^{3-}$  are inner orbital complexes and paramagnetic while  $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$  is diamagnetic in nature.

114. (d)

115. (a)  $\text{Cl}^-$  is a weak field ligand.

116. (c) Higher the oxidation state of the metal, greater the crystal field splitting energy. In options (a), (b) and (d), Co is present in +2 oxidation state and in (c) it is present in +3 oxidation state and hence has a higher value of CFSE.

117. (a) In octahedral complex the magnitude of  $\Delta_o$  will be highest in a complex having strongest ligand. Out of the given ligands  $\text{CN}^-$  is strongest. So,  $\Delta_o$  will be highest for  $[\text{Co}(\text{CN})_6]^{3-}$ . Thus option (a) is correct.

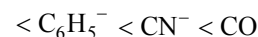
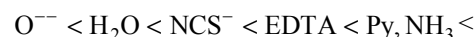
118. (a) Ligands can be arranged in a series in the orders of increasing field strength as given below:

Weak field ligands:



< Urea,  $\text{OH}^-$  < oxalate

Strong field ligands



Such a series is termed as spectrochemical series. It is an experimentally determined series based on the absorption of light by complexes with different ligands.

119. (b) Due to  $d^5$  configuration CFSE is zero.

120. (b) The crystal field splitting in tetrahedral complexes is lower than that in octahedral complexes, and

$$\Delta_t = -\frac{4}{9} \Delta_o.$$

121. (a) 122. (c)

123. (d)  $\text{CN}^-$  is a strong field ligand and form low spin complexes thus  $\Delta_o > P$ .

124. (b) According to spectrochemical series  $\text{C}_2\text{O}_4^{2-} > \text{F}^-$ .

125. (c) CO is a strong field ligand and for strong field ligands  $\Delta_o > P$ .

126. (b) In the absence of ligand, crystal field splitting does not occur and hence the substance is colourless.

127. (a)

128. (d) Magnetic moment can be calculated by using the relation  $\sqrt{n(n+2)}\text{B.M.}$ . Where  $n$  = number of electrons and B.M. is Bohr magneton.

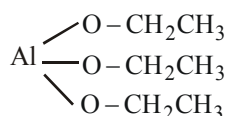
$$\therefore 5.9 = \sqrt{n(n+2)}$$

$$\therefore n = 5$$

129. (c) Energy for excitation ( $\Delta$ ) =  $hc/\text{wavelength}$ . Therefore lower the wavelength of light higher will be the energy for excitation, ( $\Delta$ ) i.e crystal field splitting energy.

$$\therefore \text{correct order will be } b < a < c < d$$

130. (a) Triethoxyaluminium has no Al – C linkage



131. (d) Due to some backbonding by sidewise overlapping between  $d$ -orbitals of metal and  $p$ -orbital of carbon, the Fe–C bond in  $\text{Fe}(\text{CO})_5$  has both  $\sigma$  and  $\pi$  character.

132. (c) In case of  $[\text{Ni}(\text{CO})_4]$ , the ligand CO, is neutral thus the charge on Ni is zero.

133. (a)  $\text{Ni}(\text{CO})_4$ . The O. S. of Ni is Zero. Electronic configuration is  $[\text{Ar}] 3d^8 4s^2 4p^0$ . In presence of strong ligand CO the pairing of electrons take place and electronic configuration will be  $[\text{Ar}] 3d^{10} 4s^0 4p^0$ . Hence unpaired electrons is zero.

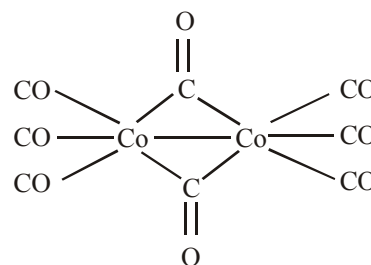
134. (d)  $\text{Fe}(\text{CO})_5$  ( $Z=26$ ) O. S. of Fe is zero. Electronic configuration is  $[\text{Ar}] 3d^6 4s^2 4p^0$ . After pairing of electrons of  $d$  and  $s$  orbitals, we have one  $d$  atomic orbital empty. C. N. is 5 so hybridisation is  $\text{dsp}^3$  which is trigonal bipyramidal.

135. (b) For the reaction of the type  $\text{M} + 4\text{L} \rightleftharpoons \text{ML}_4$ , larger the stability constant, the higher the proportion of  $\text{ML}_4$  that exists in solution.

136. (c) The chlorophyll molecule plays an important role in photosynthesis, contain porphyrin ring and the metal Mg not Ca.

137. (d)

138. (a) Structure of  $[\text{Co}_2(\text{CO})_8]$



Total M – C bonds = 10, Total M – M bonds = 1

139. (a) Overall stability constant =  $\frac{1}{K_1 K_2 K_3} = \frac{[\text{X}][\text{Y}]^3}{[\text{XY}_3]}$

140. (b)  $\beta = K_1 K_2 K_3 K_4$

$$\log \beta = \log (K_1 K_2 K_3 K_4)$$

$$\log \beta = \log K_1 + \log K_2 + \log K_3 + \log K_4$$

$$\log K_3 = 11.9 - (3.20 + 2.0 + 4.0)$$

$$\log K_3 = 2.7$$

### STATEMENT TYPE QUESTIONS

141. (a)

142. (a) Macromolecules like proteins can acts as ligand.  $[\text{EDTA}]^{4-}$  can bind through two nitrogen and four oxygen atoms.

143. (d)

144. (b) Complexes of  $\text{Ma}_3\text{B}_3$  type shows fac– meridional isomerism.

Solvate isomerism is referred to as a hydrate isomerism when solvent is water.

145. (b)  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  gives violet colour if light corresponding to the energy of blue-green region of wavelength 498 nm is absorbed by it.

Irrespective of prediction of crystal field theory on the basis of experimental observation shows that anionic ligands are found at the low end of the spectrochemical series.

146. (d)

### MATCHING TYPE QUESTIONS

147. (c)

148. (d) A – (p), B – (r), C – (s), D – (q)

149. (a)  $[\text{NiCl}_4]^{2-}$  is  $\text{sp}^3$  hybridised and paramagnetic in nature  $[\text{Ni}(\text{CN})_4]^{2-}$  is square planar and diamagnetic. Chlorophyll contains  $\text{Mg}^{2+}$  Ziegler – Natta catalyst contains  $\text{Ti}^{4+}$  Deoxyhaemoglobin is nonplanar and oxyhaemoglobin planar.



150. (d) Crystal field splitting energy increases with increase in ligand field strength i.e., with increase in no. of 'en' groups and wavelength of absorbed light decrease with increase in ligand field strength  
 $\therefore [\text{Ni}(\text{H}_2\text{O})_4(\text{en})]^{2+}(\text{aq})$  will absorb light of higher wavelength i.e., Red.  
 $[\text{Ni}(\text{en})_3]^{2+}$  will absorb light of lower wavelength i.e., blue-green and  $[\text{Ni}(\text{H}_2\text{O})_4(\text{en})_2]^{2+}$  will absorb yellow orange light.

151. (a) 152. (a)

### ASSERTION-REASON TYPE QUESTIONS

153. (c) It is correct statement that  $\text{NF}_3$  is a weaker ligand than  $\text{N}(\text{CH}_3)_3$ , the reason is that fluorine is highly electronegative therefore, it will draw electrons from nitrogen atom. Hence, the lone pair of nitrogen atom cannot be ligated. While  $\text{N}(\text{CH}_3)_3$  is a strong ligand because  $\text{CH}_3$  is electron releasing group.
154. (b) Both Assertion and Reason are true but Reason is not the correct explanation of statement-1.  $[\text{Fe}(\text{CN})_6]^{3-}$  is weakly paramagnetic as it has unpaired electrons while  $[\text{Fe}(\text{CN})_6]^{2-}$  has no unpaired electron.  
 $\therefore$  It is diamagnetic.
155. (a) Both Assertion and Reason are true and Reason is the correct explanation of statement-1.  $[\text{Sc}(\text{H}_2\text{O})_6]^{3+}$  has no unpaired electron in its  $d$  subshell and thus  $d-d$  transition is not possible whereas  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  has one unpaired electron in its  $d$  subshell which gives rise to  $d-d$  transition to impart colour.

### CRITICAL THINKING TYPE QUESTIONS

156. (c) As it forms two moles of silver chloride thus it has two moles of ionisable Cl.  
 $[\text{Co}(\text{NH}_3)_5\text{NO}_2]\text{Cl}_2 \rightarrow [\text{Co}(\text{NH}_3)_5\text{NO}_2]^{++} + 2\text{Cl}^-$   
 $2\text{Cl}^- + 2\text{AgNO}_3 \rightarrow 2\text{AgCl} + 2\text{NO}_3^-$
157. (b)  $\text{PtCl}_2 \cdot 2\text{NH}_3 = [\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$   
 $\text{CoCl}_3 \cdot 4\text{NH}_3 = [\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$   
 $\text{NiCl}_2 \cdot 6\text{H}_2\text{O} = [\text{Ni}(\text{H}_2\text{O})_6]\text{Cl}_2$
158. (b)  $\text{CN}^-$  is coordinated to cobalt as the ligand and coordinated compounds have different properties than the individual species.
159. (b) Since complex compound gives 2 moles of  $\text{AgCl}$  on treatment with  $\text{AgNO}_3$ .  
 $\therefore$  most probable structure is (b).
160. (a) Total number of electron count in  $\text{Ni}(\text{CO})_4$   
 $= \text{Atomic number} - \text{oxidation state} + 2 \times \text{no. of ligands}$   
 $= 28 - 0 + 2 \times 4 = 36$   
 Similarly for  $\text{Fe}(\text{CO})_5$ ,  
 $= 26 - 0 + 10 = 36$

161. (c)  $[\text{CuCl}_2\{(\text{O}=\text{C}(\text{NH}_2)_2\}_2]$
162. (a) IUPAC name of sodium nitroprusside  $\text{Na}_2[\text{Fe}(\text{CN})_5\text{NO}]$  is sodium pentacyanonitrosylferrate (III) because in it NO is neutral ligand. Hence  
 $2 \times \text{O.N. of Na} + \text{O.N. of Fe} + 5 \times \text{O.N. of CN}$   
 $1 \times \text{O.N. of NO} = 0$   
 $2 \times (+1) + \text{O.N. of Fe} + 5 \times (-1) + 1 \times 0 = 0$   
 $\text{O.N. of Fe} = 5 - 2 = +3$ , Hence ferrate (III)
163. (d) The total number of isomers for the complex compound

$[\text{Cu}^{\text{II}}(\text{NH}_3)_4][\text{Pt}^{\text{II}}\text{Cl}_4]$  is four.

These four isomers are

$[\text{Cu}(\text{NH}_3)_3\text{Cl}][\text{Pt}(\text{NH}_3)\text{Cl}_3]$ ,

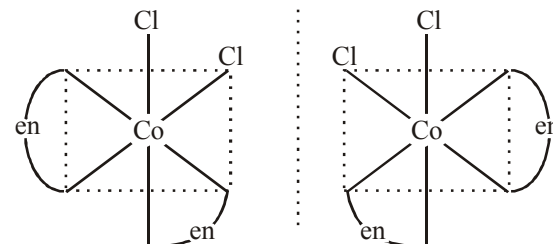
$[\text{Cu}(\text{NH}_3)\text{Cl}_3][\text{Pt}(\text{NH}_3)_3\text{Cl}]$ ,

$[\text{CuCl}_4][\text{Pt}(\text{NH}_3)_4]$

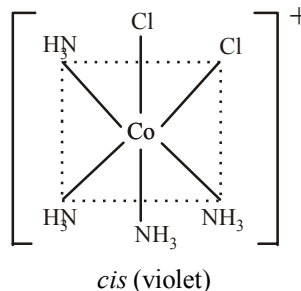
and  $[\text{Cu}(\text{NH}_3)_4][\text{PtCl}_4]$ .

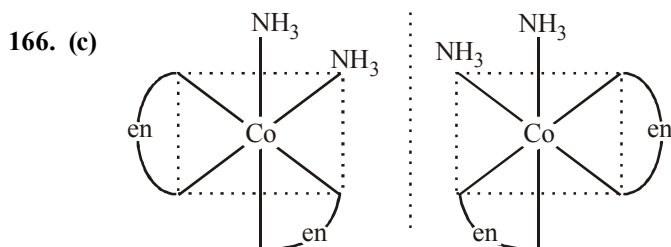
The isomer  $[\text{Cu}(\text{NH}_3)_2\text{Cl}_2][\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$  does not exist due to both parts being neutral.

164. (b) Non superimposable mirror images are called optical isomers and may be described as 'chiral'. They are also called enantiomers and rotate plane polarised light in opposite directions.



165. (b)  $\left[ \begin{array}{c} \text{Cl} \\ \diagup \quad \diagdown \\ \text{H}_3\text{N} \quad \text{NH}_3 \\ | \\ \text{Co} \\ | \\ \text{H}_3\text{N} \quad \text{NH}_3 \\ \diagdown \quad \diagup \\ \text{Cl} \end{array} \right]^+$   
*trans (green)*



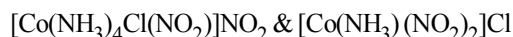


Enantiomers of  $cis-[Co(en)_2(NH_3)_2]^{3+}$

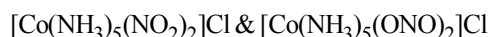
167. (b) It is optically active.

168. (a) The given compound may have linkage isomerism due to presence of  $NO_2$  group which may be in the form  $-NO_2$  or  $-ONO$ .

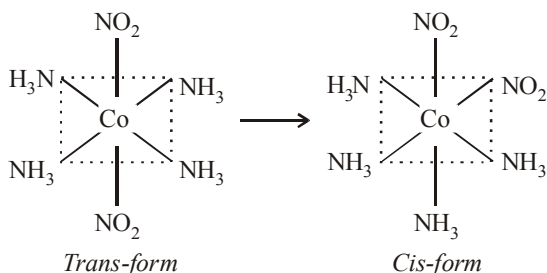
It may have ionisation isomerism due to presence of two ionisable group  $-NO_2$  &  $-Cl$ . It may have geometrical isomerism in the form of  $cis-trans$  form as follows :



— Ionisation isomers.

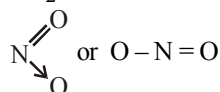


— Linkage isomers



Geometrical isomers

169. (c) The complex compound  $[Co(en)_2NO_2Cl]Br$  can have  $NO_2$  group differently linked to central metal atom –

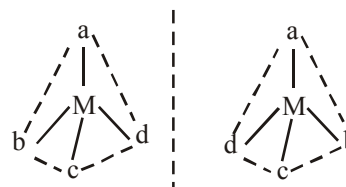
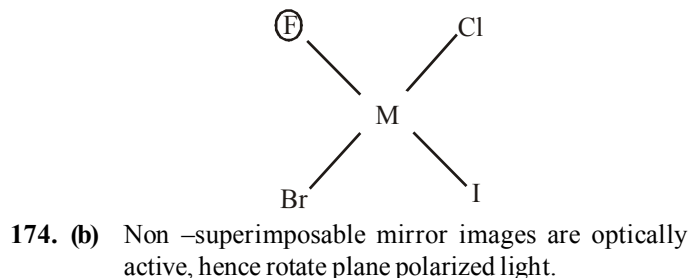
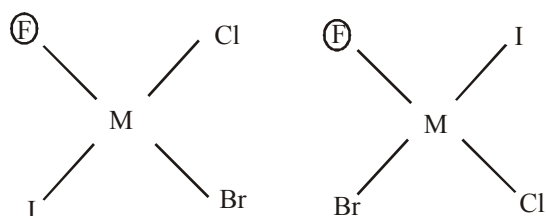


170. (a) Geometrical isomerism is possible only in square planar complexes of the type  $MA_2B_2$  and  $MA_2BC$  and for octahedral complexes of the type  $MA_4B_2$  and  $MA_4BC$ . Hence only (ii) will show geometrical isomerism.

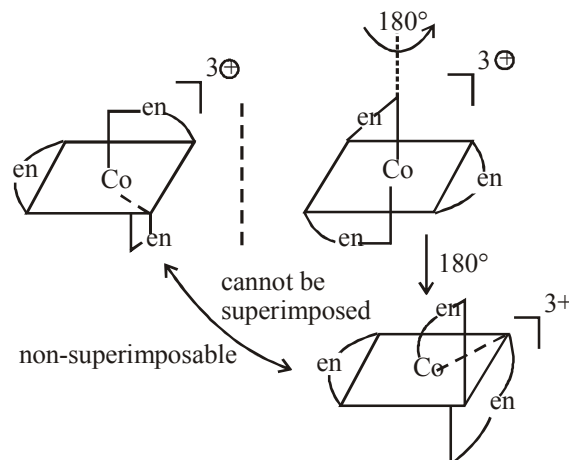
171. (a)

172. (b) Geometrical isomers of following type of square planar complexes is possible.  $Ma_2b_2$  type,  $Ma_2bc$  type and  $Mabcd$  type.

173. (b) Three isomer are possible.

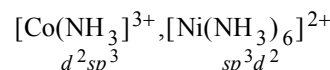
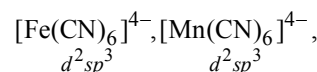


175. (c) Complex is not superimposable on its mirror image hence optically active i.e., rotate plane polarized light.

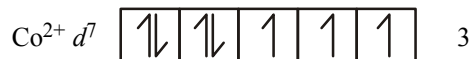
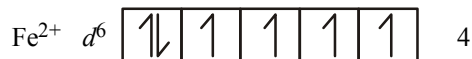
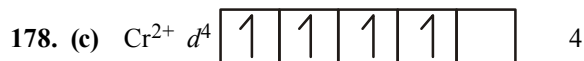


176. (d) Nickel in  $Ni(CO)_4$  is  $sp^3$  hybridised therefore geometry of  $Ni(CO)_4$  is tetrahedral whereas in  $[Ni(CN)_4]^{2-}$  nickel is  $dsp^2$  hybridised therefore geometry of  $[Ni(CN)_4]^{2-}$  is square planar.

177. (d) Hybridisation



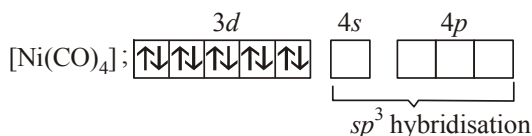
Hence  $[Ni(NH_3)_6]^{2+}$  is outer orbital complex.



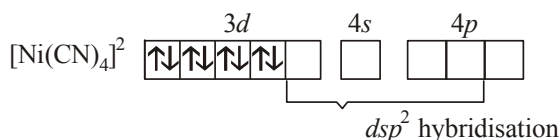
Minimum paramagnetic behaviour =  $[Co(H_2O)_6]^{2+}$

179. (b) In carbonyls O.S. of metal is zero

In  $[\text{Ni}(\text{CO})_4]$ , the oxidation state of nickel is zero. Its configuration in  $\text{Ni}(\text{CO})_4$  is



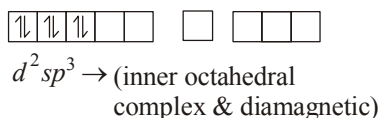
In  $[\text{Ni}(\text{CN})_4]^{2-}$  the oxidation state of Ni is  $2+$  and its configuration is



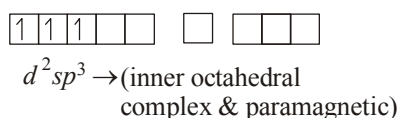
Thus the hybridisations of nickel in these compounds are  $sp^3$  and  $dsp^2$  respectively.

Hence (b) is the correct answer.

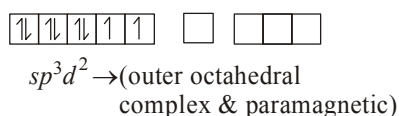
180. (c)  $[\text{Co}(\text{NH}_3)_6]^{3+}$ ,  $\text{Co}^{3+}$  ( $27 - 3 = 24$ )



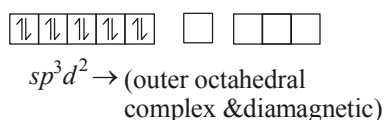
$[\text{Cr}(\text{NH}_3)_6]^{3+}$ ,  $\text{Cr}^{3+}$  ( $24 - 3 = 21$ )



$[\text{Ni}(\text{NH}_3)_6]^{2+}$ ,  $\text{Ni}^{2+}$  ( $28 - 2 = 26$ )



$[\text{Zn}(\text{NH}_3)_6]^{2+}$ ,  $\text{Zn}^{2+}$  ( $30 - 2 = 28$ )



181. (d)  $d^5$  — strong ligand field



$t_{2g}$   $e_g$

$$\mu = \sqrt{n(n+2)} = \sqrt{3} = 1.73 \text{ BM}$$

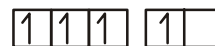
$d^3$  — in weak as well as in strong field



$t_{2g}$   $e_g$

$$\mu = \sqrt{3(5)} = \sqrt{15} = 3.87 \text{ B.M.}$$

$d^4$  — in weak ligand field



$t_{2g}$   $e_g$

$$\mu = \sqrt{4(4+2)} = \sqrt{24} = 4.89$$

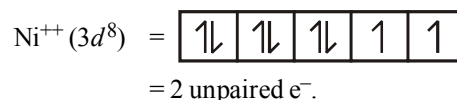
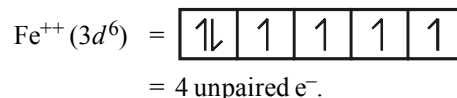
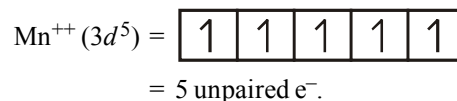
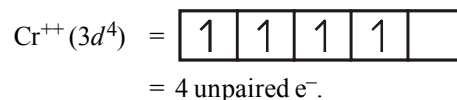
$d^4$  — in strong ligand field



$t_{2g}$   $e_g$

$$\mu = \sqrt{2(4)} = \sqrt{8} = 2.82.$$

182. (b) Lesser is the number of unpaired electrons smaller will be the paramagnetic behaviour. As  $\text{Cr}^{++}$ ,  $\text{Mn}^{++}$ ,  $\text{Fe}^{++}$  and  $\text{Ni}^{++}$  contains.



As  $\text{Ni}^{++}$  has minimum no. of unpaired  $e^-$  thus this is least paramagnetic.

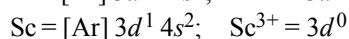
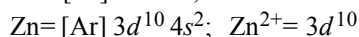
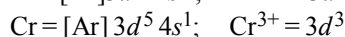
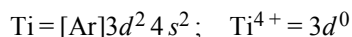
183. (d) In case of diamagnetic complexes the electrons are paired. In case of  $\text{Ni}(\text{CO})_4$   $3d$  orbital is fully filled give rise to  $sp^3$  hybridisation while in case of  $[\text{Ni}(\text{CN})_4]^{2-}$  nickel is in  $+2$  oxidation state, so one  $d$ -orbital is vacant give rise to  $dsp^2$  hybridization which is square planar in nature.
184. (d) Number of unpaired electrons in  $[\text{MnCl}_6]^{3-}$  and  $[\text{Mn}(\text{CN})_6]^{3-}$  respectively are 4 and 2  
 $\therefore$  Magnetic moment will respectively be 4.8 and 2.8  
 $[\text{MnCl}_6]^{3-}$  is  $sp^3 d^2$  hybridised and  $[\text{Mn}(\text{CN})_6]^{3-}$  will be  $d^2 sp^3$  hybridised.

185. (c) In octahedral field the crystal field splitting of  $d$ -orbitals of a metal ion depends upon the field produced by the ligands. In general ligands can be arranged in a series in the order of increasing fields and splittings which they produce around a central metal ion. A portion of the series is given below.

cyanide > ethylene - diamine > ammonia > pyridine > thiocyanate > water > oxalate > hydroxide > fluoride > chloride > bromide > iodide.

Out of the given ligands water, ammonia, cyanide and oxalate, we can find from the above series of ligands that the maximum splitting will occur in case of cyanide ( $\text{CN}^-$ ) i.e. the magnitude of  $\Delta_0$  will be maximum in case of  $[\text{Co}(\text{CN})_6]^{3+}$ .

186. (b) Since  $\text{Cr}^{3+}$  in the complex has unpaired electrons in the d orbital, hence it will absorb visible light and will be coloured



187. (d)  $d^4$  in high spin octahedral complex



$$\text{CFSE} = (-0.4x + 0.6y)\Delta_0$$

Where,  $x \rightarrow$  electrons in  $t_{2g}$  orbital

$y \rightarrow$  electrons in  $e_g$  orbital

$$\text{CFSE} = [0.6 \times 1] + [-0.4 \times 3] = -0.6 \Delta_0$$

188. (b)  $d^6 - t_{2g}^{2,2,2} e_g^{0,0}$  (in low spin)

$$\text{C.F.S.E} = -0.4 \times 6\Delta_0 + 3P$$

$$= -\frac{12}{5} \Delta_0 + 3P$$

189. (a) As positive charge on the central metal atom increases, the less readily the metal can donate electron density into the  $\pi^*$  orbitals of CO ligand (donation of electron density into  $\pi^*$  orbitals of CO result in weakening of C – O bond). Hence, the C – O bond would be strongest in  $[\text{Mn}(\text{CO})_6]^+$ .

190. (b) 191. (b)



### FACT/DEFINITION TYPE QUESTIONS

- Which of the following is a primary halide?
  - Isopropyl iodide
  - Secondary butyl iodide
  - Tertiary butyl bromide
  - Neohexyl chloride
- When two halogen atoms are attached to same carbon atom then it is :
  - vic*-dihalide
  - gem*-dihalide
  - $\alpha, \omega$ -halide
  - $\alpha, \beta$ -halide
- Gem-dibromide is
  - $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2(\text{Br})$
  - $\text{CH}_3\text{CBr}_2\text{CH}_3$
  - $\text{CH}_2(\text{Br})\text{CH}_2\text{CH}_2$
  - $\text{CH}_2\text{BrCH}_2\text{Br}$
- How many structural isomers are possible for a compound with molecular formula  $\text{C}_3\text{H}_7\text{Cl}$ ?
  - 2
  - 5
  - 7
  - 9
- The compound which contains all the four  $1^\circ, 2^\circ, 3^\circ$  and  $4^\circ$  carbon atoms is
  - 2, 3-dimethyl pentane
  - 3-chloro-2, 3-dimethylpentane
  - 2, 3, 4-trimethylpentane
  - 3, 3-dimethylpentane
- IUPAC name of  $(\text{CH}_3)_3\text{CCl}$ 
  - 3-Chlorobutane
  - 2-Chloro-2-methylpropane
  - t*-butyl chloride
  - n*-butyl chloride
- IUPAC name of  $\text{CH}_3\text{CH}_2\text{C}(\text{Br})=\text{CH}-\text{Cl}$  is
  - 2-bromo-1-chloro butene
  - 1-chloro-2-bromo butene
  - 3-chloro-2-bromo butene
  - None of the above
- The IUPAC name of  $\text{CH}_2=\text{CH}-\text{CH}_2\text{Cl}$  is
  - Allyl chloride
  - 1-chloro-3-propene
  - Vinyl chloride
  - 3-chloro-1-propene
- Which of the following halide is  $2^\circ$ ?
  - Isopropyl chloride
  - Isobutyl chloride
  - n*-propyl chloride
  - n*-butyl chloride
- Benzene hexachloride is
  - 1, 2, 3, 4, 5, 6 - hexachlorocyclohexane
  - 1, 1, 1, 6, 6, 6 - hexachlorocyclohexane
  - 1, 6 - phenyl - 1, 6 - chlorohexane
  - 1, 1 - phenyl - 6, 6 - chlorohexane
- Phosgene is a common name for
  - phosphoryl chloride
  - thionyl chloride
  - carbon dioxide and phosphine
  - carbonyl chloride
- C - X bond is strongest in
  - $\text{CH}_3\text{Cl}$
  - $\text{CH}_3\text{Br}$
  - $\text{CH}_3\text{F}$
  - $\text{CH}_3\text{I}$
- Which of the following will have the maximum dipole moment?
  - $\text{CH}_3\text{F}$
  - $\text{CH}_3\text{Cl}$
  - $\text{CH}_3\text{Br}$
  - $\text{CH}_3\text{I}$
- The decreasing order of boiling points of alkyl halides is
  - $\text{RF} > \text{RCl} > \text{RBr} > \text{RI}$
  - $\text{RBr} > \text{RCl} > \text{RI} > \text{RF}$
  - $\text{RI} > \text{RBr} > \text{RCl} > \text{RF}$
  - $\text{RCl} > \text{RF} > \text{RI} > \text{RBr}$
- $\text{C}_3\text{H}_8 + \text{Cl}_2 \xrightarrow{\text{Light}} \text{C}_3\text{H}_7\text{Cl} + \text{HCl}$  is an example of
  - substitution
  - elimination
  - addition
  - rearrangement reaction
- The reaction conditions leading to the best yields of  $\text{C}_2\text{H}_5\text{Cl}$  are :
  - $\text{C}_2\text{H}_6 (\text{excess}) + \text{Cl}_2 \xrightarrow{\text{UV light}}$
  - $\text{C}_2\text{H}_6 + \text{Cl}_2 \xrightarrow[\text{room temperature}]{\text{dark}}$
  - $\text{C}_2\text{H}_6 + \text{Cl}_2 (\text{excess}) \xrightarrow{\text{UV light}}$
  - $\text{C}_2\text{H}_6 + \text{Cl}_2 \xrightarrow{\text{UV light}}$

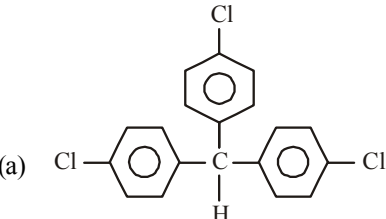
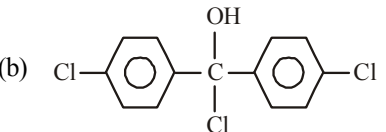
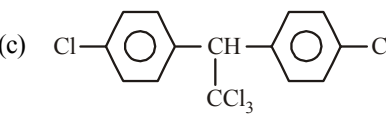
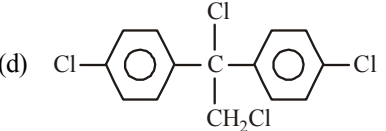
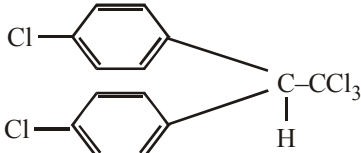


17. Halogenation of alkanes is  
(a) a reductive process (b) an oxidative process  
(c) an isothermal process (d) an endothermal process
18. Ethylene dichloride can be prepared by adding HCl to  
(a) Ethane (b) Ethylene  
(c) Acetylene (d) Ethylene glycol
19. In which of the following conversions, phosphorus pentachloride is used as the reagent?  
(a)  $\text{H}_2\text{C} = \text{CH}_2 \longrightarrow \text{CH}_3\text{CH}_2\text{Cl}$   
(b)  $\text{CH}_3\text{CH}_2\text{OH} \longrightarrow \text{CH}_3\text{CH}_2\text{Cl}$   
(c)  $\text{H}_3\text{C} - \text{O} - \text{CH}_3 \longrightarrow \text{CH}_3\text{Cl}$   
(d)  $\text{CH} \equiv \text{CH} \longrightarrow \text{CH}_2 = \text{CHCl}$
20. The best method for the conversion of an alcohol into an alkyl chloride is by treating the alcohol with  
(a)  $\text{PCl}_5$   
(b) dry HCl in the presence of anhydrous  $\text{ZnCl}_2$   
(c)  $\text{SOCl}_2$  in presence of pyridine  
(d) None of these
21. Which of the following is liquid at room temperature (b.p. is shown against it) ?  
(a)  $\text{CH}_3\text{I}$  42°C  
(b)  $\text{CH}_3\text{Br}$  3°C  
(c)  $\text{C}_2\text{H}_5\text{Cl}$  12°C  
(d)  $\text{CH}_3\text{F}$  -78°C
22. The catalyst used in the preparation of an alkyl chloride by the action of dry HCl on an alcohol is  
(a) anhydrous  $\text{AlCl}_3$  (b)  $\text{FeCl}_3$   
(c) anhydrous  $\text{ZnCl}_2$  (d) Cu
23. Chlorobenzene is prepared commercially by  
(a) Raschig process  
(b) Wurtz Fittig reaction  
(c) Friedel-Craft's reaction  
(d) Grignard reaction
24. In the preparation of chlorobenzene from aniline, the most suitable reagent is  
(a) Chlorine in the presence of ultraviolet light  
(b) Chlorine in the presence of  $\text{AlCl}_3$   
(c) Nitrous acid followed by heating with  $\text{Cu}_2\text{Cl}_2$   
(d) HCl and  $\text{Cu}_2\text{Cl}_2$
25. Which of the following possesses highest melting point?  
(a) Chlorobenzene (b) m-dichlorobenzene  
(c) o-dichlorobenzene (d) p-dichlorobenzene
26. Conant Finkelstein reaction for the preparation of alkyl iodide is based upon the fact that  
(a) Sodium iodide is soluble in methanol, while sodium chloride is insoluble in methanol  
(b) Sodium iodide is soluble in methanol, while NaCl and NaBr are insoluble in methanol  
(c) Sodium iodide is insoluble in methanol, while NaCl and NaBr are soluble  
(d) The three halogens differ considerably in their electronegativity
27. Silver acetate +  $\text{Br}_2 \xrightarrow{\text{CS}_2}$ . The main product of this reaction is  
(a)  $\text{CH}_3 - \text{Br}$  (b)  $\text{CH}_3\text{COI}$   
(c)  $\text{CH}_3\text{COOH}$  (d) None of these
28. Which of the following reactions is an example of nucleophilic substitution reaction?  
(a)  $2\text{RX} + 2\text{Na} \rightarrow \text{R}-\text{R} + 2\text{NaX}$   
(b)  $\text{RX} + \text{H}_2 \rightarrow \text{RH} + \text{HX}$   
(c)  $\text{RX} + \text{Mg} \rightarrow \text{RMgX}$   
(d)  $\text{RX} + \text{KOH} \rightarrow \text{ROH} + \text{KX}$
29. Which one is most reactive towards  $\text{S}_{\text{N}}1$  reaction ?  
(a)  $\text{C}_6\text{H}_5\text{CH}(\text{C}_6\text{H}_5)\text{Br}$   
(b)  $\text{C}_6\text{H}_5\text{CH}(\text{CH}_3)\text{Br}$   
(c)  $\text{C}_6\text{H}_5\text{C}(\text{CH}_3)(\text{C}_6\text{H}_5)\text{Br}$   
(d)  $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$
30. A Grignard reagent may be made by reacting magnesium with  
(a) Methyl amine (b) Diethyl ether  
(c) Ethyl iodide (d) Ethyl alcohol
31. Which one of the following halogen compounds is difficult to be hydrolysed by  $\text{S}_{\text{N}}1$  mechanism?  
(a) Tertiary butyl chloride (b) Isopropyl chloride  
(c) Benzyl chloride (d) Chlorobenzene
32. The order of reactivity of the given haloalkanes towards nucleophile is :  
(a)  $\text{RI} > \text{RBr} > \text{KCl}$  (b)  $\text{RCl} > \text{RBr} > \text{RI}$   
(c)  $\text{RBr} > \text{RCl} > \text{RI}$  (d)  $\text{RBr} > \text{RI} > \text{RCl}$
33. Most reactive halide towards  $\text{S}_{\text{N}}1$  reaction is  
(a) n-Butyl chloride (b) sec-Butyl chloride  
(c) tert-Butyl chloride (d) Allyl chloride
34. In  $\text{S}_{\text{N}}1$  reaction, the racemization takes place. It is due to  
(a) inversion of configuration  
(b) retention of configuration  
(c) conversion of configuration  
(d) Both (a) and (b)
35. The order of reactivities of the following alkyl halides for a  $\text{S}_{\text{N}}2$  reaction is  
(a)  $\text{RF} > \text{RCl} > \text{RBr} > \text{RI}$  (b)  $\text{RF} > \text{RBr} > \text{RCl} > \text{RI}$   
(c)  $\text{RCl} > \text{RBr} > \text{RF} > \text{RI}$  (d)  $\text{RI} > \text{RBr} > \text{RCl} > \text{RF}$
36. Which of the following is an example of  $\text{S}_{\text{N}}2$  reaction?  
(a)  $\text{CH}_3\text{Br} + \text{OH}^- \longrightarrow \text{CH}_3\text{OH} + \text{Br}^-$   
(b)  $\text{CH}_3 - \underset{\text{Br}}{\text{CH}} - \text{CH}_3 + \text{OH}^- \longrightarrow \text{CH}_3 - \underset{\text{OH}}{\text{CH}} - \text{CH}_3$   
(c)  $\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{-\text{H}_2\text{O}} \text{CH}_2 = \text{CH}_2$   
(d)  $(\text{CH}_3)_3\text{C} - \text{Br} + \text{OH}^- \longrightarrow (\text{CH}_3)_3\text{COH} + \text{Br}^-$
37.  $\text{S}_{\text{N}}2$  mechanism proceeds through intervention of  
(a) carbonium ion (b) transition state  
(c) free radical (d) carbanion
38. Which among  $\text{MeX}$ ,  $\text{RCH}_2\text{X}$ ,  $\text{R}_2\text{CHX}$  and  $\text{R}_3\text{CX}$  is most reactive towards  $\text{S}_{\text{N}}2$  reaction?  
(a)  $\text{MeX}$  (b)  $\text{RCH}_2\text{X}$   
(c)  $\text{R}_2\text{CHX}$  (d)  $\text{R}_3\text{CX}$

39. Isopropyl chloride undergoes hydrolysis by  
 (a)  $S_N1$  mechanism  
 (b)  $S_N2$  mechanism  
 (c)  $S_N1$  and  $S_N2$  mechanisms  
 (d) Neither  $S_N1$  nor  $S_N2$  mechanism
40. Tertiary alkyl halides are practically inert to substitution by  $S_N2$  mechanism because of  
 (a) steric hindrance (b) inductive effect  
 (c) instability (d) insolubility
41. Which of the following is the correct order of decreasing  $S_N2$  reactivity?  
 (a)  $R_2CHX > R_3CX > RCH_2X$   
 (b)  $RCHX > R_3CX > R_2CHX$   
 (c)  $RCH_2X > R_2CHX > R_3CX$   
 (d)  $R_3CX > R_2CHX > RCH_2X$ .  
 (X is a halogen)
42. The reaction is described as  

$$\begin{array}{c} \text{CH}_3(\text{CH}_2)_5 \\ \diagup \\ \text{C}-\text{Br} \\ \diagdown \\ \text{H} \quad \text{CH}_3 \end{array} \xrightarrow{\text{OH}^-} \begin{array}{c} (\text{CH}_2)_5\text{CH}_3 \\ \diagup \\ \text{HO}-\text{C} \\ \diagdown \\ \text{H} \quad \text{CH}_3 \end{array}$$
  
 (a)  $S_E2$  (b)  $S_N1$   
 (c)  $S_N2$  (d)  $S_N0$
43. Which of the following is an optically active compound ?  
 (a) 1-Butanol (b) 1-Propanol  
 (c) 2-Chlorobutane (d) 4-Hydroxyheptane
44. An important chemical method to resolve a racemic mixture makes use of the formation of  
 (a) a meso compound (b) enantiomers  
 (c) diastereomers (d) racemates
45. The process of separation of a racemic modification into *d* and *l* -enantiomers is called  
 (a) Resolution (b) Dehydration  
 (c) Revolution (d) Dehydrohalogenation
46. Which of the following pairs of compounds are enantiomers?  
 (a)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{HO}-\text{C}-\text{H} \\ | \\ \text{H}-\text{C}-\text{OH} \\ | \\ \text{CH}_3 \end{array}$  and  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{HO}-\text{C}-\text{H} \\ | \\ \text{HO}-\text{C}-\text{H} \\ | \\ \text{CH}_3 \end{array}$   
 (b)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}-\text{C}-\text{OH} \\ | \\ \text{HO}-\text{C}-\text{H} \\ | \\ \text{CH}_3 \end{array}$  and  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{HO}-\text{C}-\text{H} \\ | \\ \text{H}-\text{C}-\text{HO} \\ | \\ \text{CH}_3 \end{array}$   
 (c)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}-\text{C}-\text{OH} \\ | \\ \text{HO}-\text{C}-\text{H} \\ | \\ \text{CH}_3 \end{array}$  and  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{HO}-\text{C}-\text{H} \\ | \\ \text{HO}-\text{C}-\text{H} \\ | \\ \text{CH}_3 \end{array}$   
 (d)  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}-\text{C}-\text{OH} \\ | \\ \text{HO}-\text{C}-\text{H} \\ | \\ \text{CH}_3 \end{array}$  and  $\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}-\text{C}-\text{OH} \\ | \\ \text{H}-\text{C}-\text{OH} \\ | \\ \text{CH}_3 \end{array}$
47. Which of the following will have a mesoisomer also?  
 (a) 2, 3- Dichloropentane  
 (b) 2, 3-Dichlorobutane  
 (c) 2-Chlorobutane  
 (d) 2-Hydroxypropanoic acid
48. Which of the following compounds is optically active ?  
 (a)  $\text{CH}_3\text{CHClCOOH}$  (b)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$   
 (c)  $(\text{CH}_3)_2\text{CHOH}$  (d)  $(\text{CH}_3)_3\text{CCl}$
49. Racemic compound has  
 (a) equimolar mixture of enantiomers  
 (b) 1 : 1 mixture of enantiomer and diastereomer  
 (c) 1 : 1 mixture of diastereomers  
 (d) 1 : 2 mixture of enantiomers
50. An organic molecule necessarily shows optical activity if it  
 (a) contains asymmetric carbon atoms  
 (b) is non-polar  
 (c) is non-superimposable on its mirror image  
 (d) is superimposable on its mirror image
51. Optically active isomers but not mirror images are called  
 (a) enantiomers (b) mesomers  
 (c) tautomers (d) diastereomers
52. Which of the following alkyl halides is used as a methylating agent?  
 (a)  $\text{C}_2\text{H}_5\text{Br}$  (b)  $\text{C}_6\text{H}_5\text{Cl}$   
 (c)  $\text{CH}_3\text{I}$  (d)  $\text{C}_2\text{H}_5\text{Cl}$
53. Mg reacts with RBr best in  
 (a)  $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$  (b)  $\text{C}_6\text{H}_5\text{OCH}_3$   
 (c)  $\text{C}_6\text{H}_5\text{N}(\text{CH}_3)_2$  (d) Equally in all the three
54. 2-Bromopentane is heated with potassium ethoxide in ethanol. The major product obtained is  
 (a) 2-ethoxypentane (b) pentene-1  
 (c) trans-2-pentene (d) cis-pentene-2
55. An alkyl halide reacts with metallic sodium in dry ether. The reaction is known as :  
 (a) Frankland's reaction (b) Sandmeyer's reaction  
 (c) Wurtz reaction (d) Kolbe's reaction
56. When 2-bromobutane reacts with alcoholic KOH, the reaction is called  
 (a) halogenation (b) chlorination  
 (c) hydrogenation (d) dehydrohalogenation
57. An alkyl halide by formation of its Grignard reagent and heating with water yields propane. What is the original alkyl halide?  
 (a) Methyl iodide (b) Ethyl iodide  
 (c) Ethyl bromide (d) Propyl bromide
58. An organic compound A ( $\text{C}_4\text{H}_9\text{Cl}$ ) on reaction with Na/diethyl ether gives a hydrocarbon which on monochlorination gives only one chloro derivative, then A is  
 (a) tert-butyl chloride (b) sec-butyl chloride  
 (c) isobutyl chloride (d) n-butyl chloride

59. Elimination of bromine from 2-bromobutane results in the formation of –  
 (a) predominantly 2-butyne  
 (b) predominantly 1-butene  
 (c) predominantly 2-butene  
 (d) equimolar mixture of 1 and 2-butene
60. Isobutyl magnesium bromide with dry ether and ethyl alcohol gives :  
 (a)  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$  and  $\text{CH}_3\text{CH}_2\text{MgBr}$   
 (b)  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$  and  $\text{MgBr}(\text{OC}_2\text{H}_5)$   
 (c)  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}=\text{CH}_2$  and  $\text{Mg}(\text{OH})\text{Br}$   
 (d)  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_3$  and  $\text{CH}_3\text{CH}_2\text{OMgBr}$
61. Reactivity order of halides for dehydrohalogenation is  
 (a)  $\text{R-F} > \text{R-Cl} > \text{R-Br} > \text{R-I}$   
 (b)  $\text{R-I} > \text{R-Br} > \text{R-Cl} > \text{R-F}$   
 (c)  $\text{R-I} > \text{R-Cl} > \text{R-Br} > \text{R-F}$   
 (d)  $\text{R-F} > \text{R-I} > \text{R-Br} > \text{R-Cl}$
62. Arrange the following alcohols in increasing order of their reactivity towards the reaction with HCl.  
 $(\text{CH}_3)_2\text{CH-OH}$  (1),  $(\text{CH}_3)_3\text{C-OH}$  (2),  $(\text{C}_6\text{H}_5)_3\text{C-OH}$  (3)  
 (a)  $1 < 2 < 3$  (b)  $2 < 1 < 3$   
 (c)  $3 < 1 < 2$  (d)  $2 < 3 < 1$
63. Which of following can be used as solvent for grignard reagent ?  
 (a)  $\text{H}_2\text{O}$  (b)  $\text{C}_2\text{H}_5\text{OH}$   
 (c)  $\text{CH}_3\text{OH}$  (d)  $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
64. Benzene reacts with  $\text{CH}_3\text{Cl}$  in the presence of anhydrous  $\text{AlCl}_3$  to form :  
 (a) chlorobenzene (b) benzylchloride  
 (c) xylene (d) toluene
65. Chlorobenzene reacts with Mg in dry ether to give a compound (A) which further reacts with ethanol to yield  
 (a) Phenol (b) Benzene  
 (c) Ethylbenzene (d) Phenyl ether
66. Benzene reacts with n-propyl chloride in the presence of anhydrous  $\text{AlCl}_3$  to give  
 (a) 3-Propyl-1-chlorobenzene  
 (b) n-Propylbenzene  
 (c) No reaction  
 (d) Isopropylbenzene
67. Which of the following is the example of Friedal Craft reaction?  
 (a)  $\text{C}_6\text{H}_6 + \text{CH}_3\text{CH}_2\text{Cl} \xrightarrow{\text{AlCl}_3} \text{C}_6\text{H}_5\text{CH}_2\text{CH}_3 + \text{HCl}$   
 (b)  $\text{C}_6\text{H}_5\text{OH} + \text{CH}_3\text{CH}_2\text{Cl} \xrightarrow{\text{AlCl}_3} \text{C}_6\text{H}_5\text{CH}_2\text{CH}_3 + \text{HOCl}$   
 (c)  $\text{C}_6\text{H}_5\text{Cl} + \text{CH}_3\text{CH}_2\text{Cl} \xrightarrow{\text{AlCl}_3} \text{C}_6\text{H}_5\text{CH}_2\text{CH}_3 + \text{Cl}_2$   
 (d)  $\text{C}_6\text{H}_5\text{CH}_3 + \text{CH}_3\text{CH}_2\text{Cl} \xrightarrow{\text{AlCl}_3} \text{C}_6\text{H}_5\text{CH}_2\text{CH}_3 + \text{CH}_3\text{Cl}$
68. On sulphonation of  $\text{C}_6\text{H}_5\text{Cl}$   
 (a) benzene sulphonic acid is formed  
 (b) metachlorobenzene sulphonic acid is formed  
 (c) orthochlorobenzene sulphonic acid is formed  
 (d) ortho and para chlorobenzene sulphonic acids are formed
69. C-Cl bond of chlorobenzene in comparison to C-Cl bond in methyl chloride is  
 (a) Longer and weaker (b) Shorter and weaker  
 (c) Shorter and stronger (d) Longer and stronger
70. Which of the following is not used in Friedel-Crafts reaction?  
 (a) N-Phenyl acetanilide (b) Bromobenzene  
 (c) Benzene (d) Chlorobenzene
71. Which one of the following is most reactive towards nucleophilic substitution reaction?  
 (a)  $\text{CH}_2=\text{CH}-\text{Cl}$  (b)  $\text{C}_6\text{H}_5\text{Cl}$   
 (c)  $\text{CH}_3\text{CH}=\text{CH}-\text{Cl}$  (d)  $\text{ClCH}_2-\text{CH}=\text{CH}_2$
72. Which one is most reactive towards  $\text{S}_{\text{N}}1$  reaction ?  
 (a)  $\text{C}_6\text{H}_5\text{CH}(\text{C}_6\text{H}_5)\text{Br}$   
 (b)  $\text{C}_6\text{H}_5\text{CH}(\text{CH}_3)\text{Br}$   
 (c)  $\text{C}_6\text{H}_5\text{C}(\text{CH}_3)(\text{C}_6\text{H}_5)\text{Br}$   
 (d)  $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$
73. Chlorobenzene can be prepared by reacting aniline with :  
 (a) hydrochloric acid  
 (b) cuprous chloride  
 (c) chlorine in presence of anhydrous aluminium chloride  
 (d) nitrous acid followed by heating with cuprous chloride
74. Aryl halides can not be prepared by the reaction of aryl alcohols with  $\text{PCl}_3$ ,  $\text{PCl}_5$  or  $\text{SOCl}_2$  because  
 (a) phenols are highly stable compounds.  
 (b) carbon-oxygen bond in phenols has a partial double bond character.  
 (c) carbon-oxygen bond is highly polar  
 (d) all of these
75. Haloarenes are ortho and para directing due to  
 (a) Resonance in aryl halide  
 (b) -I effect of halogen atom  
 (c) +I effect of halogen atom  
 (d) Both (a) and (b)
76. Chloropicrin is obtained by the reaction of  
 (a) steam on carbon tetrachloride  
 (b) nitric acid on chlorobenzene  
 (c) chlorine on picric acid  
 (d) nitric acid on chloroform
77. Which of these can be used as moth repellent  
 (a) Benzene hexachloride (b) Benzal chloride  
 (c) Hexachloroethane (d) Tetrachloroethane

78.  $\text{CF}_x\text{Cl}_y$  [where  $x + y = 4$ ]. These compounds are not used because  
 (a) these are fluorocarbons  
 (b) these are difficult to synthesise  
 (c) they deplete ozone layer  
 (d) None of the these
79. Freon (dichlorodifluoro methane) is used  
 (a) as local anaesthetic  
 (b) for dissolving impurities in metallurgical process  
 (c) in refrigerator  
 (d) in printing industry
80. Use of chlorofluorocarbons is not encouraged because  
 (a) They are harmful to the eyes of people that use it  
 (b) They damage the refrigerators and air conditioners  
 (c) They eat away the ozone in the atmosphere  
 (d) They destroy the oxygen layer
81. Which of the following is used in fire extinguishers  
 (a)  $\text{CH}_4$  (b)  $\text{CHCl}_3$   
 (c)  $\text{CH}_2\text{Cl}_2$  (d)  $\text{CCl}_4$
82. Solvent which is used in the synthesis of chlorofluorocarbons  
 (a) iodoform (b) chloroform  
 (c) carbon tetrachloride (d) methylene chloride
83. Uses of dichloromethane is  
 (a) paint remover  
 (b) solvent in drugs manufacturing  
 (c) metal cleansing and finishing solvent  
 (d) All of the above
84. Trichloroacetaldehyde,  $\text{CCl}_3\text{CHO}$  reacts with chlorobenzene in presence of sulphuric acid and produces:
- (a) 
- (b) 
- (c) 
- (d) 
85. Chloroform on treatment with conc.  $\text{HNO}_3$  gives  
 (a) Chloropicrin (b) Nitromethane  
 (c) Picric acid (d) Acetylene
86. Which of the following is responsible for depletion of the ozone layer in the upper strata of the atmosphere?  
 (a) Polyhalogens (b) Ferrocene  
 (c) Fullerenes (d) Freons
87. Haloforms are trihalogen derivatives of  
 (a) Ethane (b) Methane  
 (c) Propane (d) Benzene
88. Which of the following compounds is used as a refrigerant?  
 (a) Acetone (b)  $\text{CCl}_4$   
 (c)  $\text{CF}_4$  (d)  $\text{CCl}_2\text{F}_2$
89. Chloroform is used as :  
 (a) Fire extinguisher (b) Industrial solvent  
 (c) Refrigerant (d) Insecticide
90.  $\text{AgNO}_3$  does not give precipitate with  $\text{CHCl}_3$  because  
 (a)  $\text{CHCl}_3$  does not ionise in water  
 (b)  $\text{CHCl}_3$  does not react with  $\text{AgNO}_3$   
 (c)  $\text{CHCl}_3$  is chemically inert  
 (d) None of these
91. When chloroform is exposed to light and air, it forms  
 (a) chlorine gas (b) methyl chloride  
 (c) phosgene gas (d) carbon tetrachloride
92. 
- The above structural formula refers to  
 (a) BHC (b) DNA  
 (c) DDT (d) RNA
93. If chloroform is left open in air in the presence of sunlight, it gives  
 (a) carbon tetrachloride (b) carbonyl chloride  
 (c) mustard gas (d) lewisite
94. Full name of DDT is  
 (a) 1, 1, 1-trichloro-2, 2-bis(p-chlorophenyl) ethane  
 (b) 1, 1-dichloro-2, 2-diphenyl trimethylethane  
 (c) 1, 1-dichloro-2, 2-diphenyl trichloroethane  
 (d) None of these
95. Freon(s) is/are :  
 (a)  $\text{CClF}_3$  (b)  $\text{CFCl}_3$   
 (c)  $\text{CCl}_2\text{F}_2$  (d) All of these
96. Freon-12 is commonly used as  
 (a) insecticide (b) refrigerant  
 (c) a solvent (d) a fire extinguisher
97. Freon used as refrigerant is  
 (a)  $\text{CF}_2=\text{CF}_2$  (b)  $\text{CH}_2\text{F}_2$   
 (c)  $\text{CCl}_2\text{F}_2$  (d)  $\text{CF}_4$
98. Methylene chloride can be used as  
 (a) paint remover  
 (b) propellant in aerosols  
 (c) solvent in manufacturing of drugs  
 (d) All of these

99. Which of the following are the harmful effects of methylene chloride?
- Impaired hearing and vision
  - Dizziness, nausea and tingling
  - Skin burning
  - All of these

### STATEMENT TYPE QUESTIONS

100. Read the following statements and choose the correct option.

- The general formula of alkyl halides is  $C_nH_{2n+1}X$
  - The general formula of aryl halides is  $C_nH_{n-1}X$
  - In alkyl halides halogen atom(s) is attached to  $sp^2$  hybridised carbon atom
  - In aryl halides halogen atom(s) is attached to  $sp^2$  hybridised carbon atom.
- (i), (ii) and (iii) are correct
  - (i), (ii) and (iv) are correct
  - (ii), (iii) and (iv) are correct
  - (i), (ii), (iii) and (iv) are correct

101. Following statements are given regarding the preparation of aryl halides from toluene. Read the following statements and choose the correct option.

- Aryl chlorides and bromides can be easily prepared by this method.
  - The ortho and para isomers formed in the reaction can not be separated easily due to small difference in their melting point.
  - Reactions with iodine are reversible in nature and require the presence of an oxidising agent.
  - Fluoro compounds are not prepared by this method due to low reactivity of fluorine.
- (i) and (iii) are correct
  - (ii) and (iv) are correct
  - (i), (ii), and (iii) are correct
  - All statements are correct

102. Read the following statements and choose the correct option.

- For the same alkyl group, the boiling points of alkyl halides decreases in the order.  
 $RI > RBr > RCl > RF$
  - With the increases in size and mass of halogen atom, the magnitude of van der Waal's forces increases.
- Both statements (i) and (ii) are correct
  - Statement (i) is correct and (ii) is incorrect
  - Statement (ii) is correct and (i) is incorrect
  - Both statement (i) and (ii) are incorrect

103. Read the following statements and choose the correct answer

- The boiling points of isomeric haloalkanes decrease with increase in branching.

- Among isomeric dihalobenzenes the para-isomers have higher melting point than their ortho and meta-isomers.
  - The isomeric dihalobenzene have large difference in their boiling and melting points
  - The isomeric dihalobenzene have nearly same boiling point.
- (i), (ii) and (iii) are correct
  - (i) and (iii) are correct
  - (ii) and (iv) are correct
  - (i), (ii) and (iv) are correct

104. Read the following statements and choose the correct code

- $S_N2$  reactions follows a second order kinetics whereas  $S_N1$  reactions follows the first order kinetics
  - $S_N1$  reactions follows the second order kinetics whereas  $S_N2$  follows the first order kinetics
  - $S_N2$  reactions take place in a single step whereas  $S_N1$  reactions take place in a two steps
  - Tertiary alkyl halides are least reactive towards  $S_N2$  reactions but we show high reactivity towards  $S_N1$  reaction.
- (ii) and (iv) are correct
  - (i) and (iii) are correct
  - (i), (ii) and are correct
  - (ii), (iii) and (iv) are correct

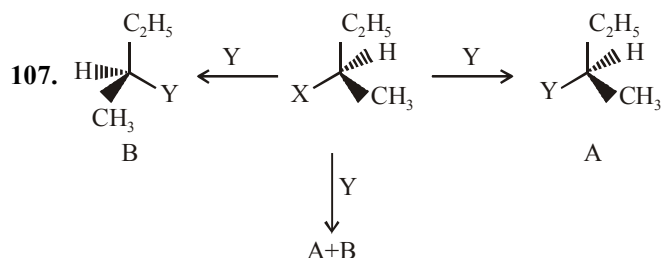
105. Read the following statements and choose the correct option.

- $S_N1$  reactions are carried out through formation of carbocation as an intermediate.
  - $S_N1$  reactions are two step reactions in which step 1 is fast and irreversible.
  - Step 1 involves breaking of C-Br bond which obtain energy through solvation of halide.
  - $S_N1$  reactions are two step reactions in which step 2 is slow and reversible.
  - Allylic and benzylic halides show high reactivity toward  $S_N1$  reactions.
- (i), (iii) and (v) are correct
  - (ii), (iii) and (v) are correct
  - (i), (iii) and (iv) are correct
  - (i), (ii) and (iv) are correct

106. Read the following statements and choose the correct code

- $S_N2$  reaction proceed with complete stereochemical inversion.
  - $S_N1$  reaction proceed with racemisation.
  - A dextrorotatory compound rotate the plane polarised light to the left.
  - A laevorotatory compound rotate the plane polarised light to the right
- |          |          |
|----------|----------|
| (a) TFFT | (b) TTFF |
| (c) FFTT | (d) TTFF |

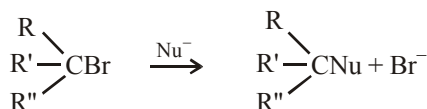




For the reaction scheme given above some statements are given. Read the statements and choose the correct option.

- If (A) is the only compound obtained, the process is called retention of configuration.
  - If (B) is the only compound obtained, the process is called inversion of configuration.
  - If a 50 : 50 mixture of the above two is obtained then the process is called racemisation
  - The product A + B is optically active
- (a) TTTF (b) TFTF  
(c) TTFF (d) TFFT

108. Which of the statement(s) is/are true, regarding following reaction?



- The reaction involves the formation of transition state.
  - Higher the nucleophilic character of the nucleophile, faster will be the reaction.
  - The product is always optically inactive.
- (a) (ii) only (b) (ii) and (iii)  
(c) (i), (ii) and (iii) (d) Neither (i), (ii) nor (iii)

### MATCHING TYPE QUESTIONS

109. Match the columns

Column - I	Column - II
(A) $\text{CH}_2=\text{CH}-\text{CH}_2\text{Cl}$	(p) Gem-dichloride
(B) $\text{CH}_2=\text{CHX}$	(q) Vinylic halide
(C) $\text{CH}_3\text{CHCl}_2$	(r) Dichloride
(D) $\text{CH}_2\text{ClCH}_2\text{Cl}$	(s) Allylic halide
(a) A – (r), B – (q), C – (p), D – (s)	
(b) A – (q), B – (p), C – (s), D – (r)	
(c) A – (s), B – (q), C – (p), D – (r)	
(d) A – (r), B – (p), C – (s), D – (q)	

110. Match the columns

Column - I	Column - II
(A) $\text{C}_2\text{H}_6 \xrightarrow{\text{Cl}_2/\text{UV light}}$	(p) Finkelstein reaction
(B) $\text{C}_6\text{H}_5\text{NH}_2 \xrightarrow[273-278\text{K}]{\text{NaNO}_2+\text{HCl}/\text{Cu}_2\text{Cl}_2}$	(q) Free radical substitution
(C) $\text{CH}_3\text{Cl} + \text{NaI} \longrightarrow$	(r) Swarts reaction
(D) $\text{CH}_3-\text{Br} + \text{AgF} \longrightarrow$	(s) Sandmeyer's reaction
	$\text{CH}_3\text{F} + \text{AgBr}$
(a) A – (q), B – (s), C – (p), D – (r)	
(b) A – (q), B – (r), C – (p), D – (s)	
(c) A – (r), B – (p), C – (s), D – (q)	
(d) A – (s), B – (r), C – (p), D – (q)	

111. Match the columns

Column - I	Column - II
(A) Chloroform	(p) Antiseptic
(B) Iodoform	(q) Insecticide
(C) Trichloromethane	(r) Anesthetic
(D) DDT	(s) Propellant
(a) A – (s), B – (p), C – (r), D – (q)	
(b) A – (r), B – (p), C – (s), D – (q)	
(c) A – (q), B – (s), C – (p), D – (q)	
(d) A – (r), B – (s), C – (p), D – (q)	

112. Match the columns.

Column - I (Haloalkane/arene)	Column - II (Applications)
(A) Iodoform	(p) $\text{CF}_4$
(B) BHC	(q) Antiseptic
(C) Freon - 14	(r) Moth repellent
(D) Halothanes	(s) Inhalative anesthetic
(E) p-dichlorobenzene	(t) Termite pesticide
(a) A – (q), B – (s), C – (t), D – (r), E – (p)	
(b) A – (q), B – (t), C – (p), D – (s), E – (r)	
(c) A – (r), B – (s), C – (q), D – (p), E – (t)	
(d) A – (p), B – (r), C – (t), D – (q), E – (s)	

113. Match the columns

Column - I	Column - II
(A) Chloramphenicol	(p) Goiter
(B) Thyroxine	(q) Surgery
(C) Chloroquine	(r) Typhoid
(D) Halothane	(s) Malaria
(a) A – (q), B – (p), C – (s), D – (r)	
(b) A – (r), B – (p), C – (s), D – (q)	
(c) A – (s), B – (r), C – (q), D – (p)	
(d) A – (p), B – (s), C – (q), D – (r)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

**114. Assertion :**  $S_N2$  reaction of an optically active aryl halide with an aqueous solution of KOH always gives an alcohol with opposite sign of rotation.

**Reason :**  $S_N2$  reactions always proceed with inversion of configuration.

**115. Assertion :** Alkylbenzene is not prepared by Friedel-Crafts alkylation of benzene.

**Reason :** Alkyl halides are less reactive than acyl halides.

**116. Assertion :** Exposure of ultraviolet rays to human causes the skin cancer, disorder and disrupt the immune system.

**Reason :** Carbon tetrachloride is released into air it rises to atmosphere and depletes the ozone layer.

**117. Assertion :**  $\text{CHCl}_3$  is stored in dark bottles.

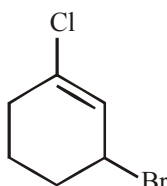
**Reason :**  $\text{CHCl}_3$  is oxidised in dark.

**118. Assertion :**  $\text{CCl}_4$  is not a fire extinguisher.

**Reason :**  $\text{CCl}_4$  is insoluble in water.

### CRITICAL THINKING TYPE QUESTIONS

**119.** The IUPAC name of the compound shown below is



- (a) 2-bromo-6-chlorocyclohex-1-ene  
 (b) 6-bromo-2-chlorocyclohexene  
 (c) 3-bromo-1-chlorocyclohexene  
 (d) 1-bromo-3-chlorocyclohexene
- 120.** A compound is formed by substitution of two chlorine for two hydrogens in propane. The number of possible isomeric compounds is
- (a) 4 (b) 3  
 (c) 5 (d) 2
- 121.** Which one of the following is not an allylic halide?
- (a) 4-Bromopent-2-ene  
 (b) 3-Bromo-2-methylbut-1-ene  
 (c) 1-Bromobut-2-ene  
 (d) 4-Bromobut-1-ene

**122.** The catalyst used in the preparation of an alkyl chloride by the action of dry HCl on an alcohol is

- (a) Anhydrous  $\text{AlCl}_3$  (b)  $\text{FeCl}_3$   
 (c) Anhydrous  $\text{ZnCl}_2$  (d) Cu

**123.**  $\text{CH}_3 - \text{CH}_2 - \underset{\text{Cl}}{\text{CH}} - \text{CH}_3$  obtained by chlorination of n-butane, will be

- (a) *l*-form (b) *d*-form  
 (c) Meso form (d) Racemic mixture

**124.** The number of possible enantiomeric pairs that can be produced during monochlorination of 2-methylbutane is

- (a) 2 (b) 3  
 (c) 4 (d) 1

**125.** The number of structural and configurational isomers of a bromo compound,  $\text{C}_5\text{H}_9\text{Br}$ , formed by the addition of HBr to 2-pentyne respectively are

- (a) 1 and 2 (b) 2 and 4  
 (c) 4 and 2 (d) 2 and 1

**126.** Which of the following reagent produces pure alkyl halides when heated with alcohols?

- (a)  $\text{PCl}_5$  (b)  $\text{PCl}_3$   
 (c)  $\text{SOCl}_2$  (d) dry HCl

**127.** If  $\text{C}_5\text{H}_{12}$  undergoes reaction with chlorine in the presence of sunlight, only one product is formed, than reactant is

- (a) 3,3-dimethylpropane (b) 2,3-dimethylpropane  
 (c) 1,3-dimethylpropane (d) 2,2-dimethylpropane

**128.** Hydrocarbon  $(\text{CH}_3)_3\text{CH}$  undergoes reaction with  $\text{Br}_2$  and  $\text{Cl}_2$  in the presence of sunlight, if the reaction with Cl is highly reactive and that with Br is highly selective so no. of possible products respectively is (are)

- (a) 2, 2 (b) 2, 1  
 (c) 1, 2 (d) 1, 1

**129.** Possible major product formed in the reaction of neopentylalcohol with HCl is

- (a) 2-chloro-2-methylbutane  
 (b) 2,2-dimethyl 1-chloropropane  
 (c) 2-chloro -3-methylbutane  
 (d) 3, chloro -3-methylbutane

**130.** Fluorobenzene ( $\text{C}_6\text{H}_5\text{F}$ ) can be synthesized in the laboratory

- (a) by direct fluorination of benzene with  $\text{F}_2$  gas  
 (b) by reacting bromobenzene with NaF solution  
 (c) by heating phenol with HF and KF  
 (d) from aniline by diazotisation followed by heating the diazonium salt with  $\text{HBF}_4$

**131.** Which chloride is least reactive with the hydrolysis point of view?

- (a)  $\text{CH}_3\text{Cl}$  (b)  $\text{CH}_3\text{CH}_2\text{Cl}$   
 (c)  $(\text{CH}_3)_3\text{CCl}$  (d)  $\text{CH}_2 = \text{CH} - \text{Cl}$

132. In a  $S_N2$  substitution reaction of the type



which one of the following has the highest relative rate ?

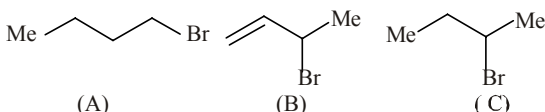
- (a)  $CH_3-CH_2-CH_2Br$  (b)  $CH_3-\underset{\begin{array}{c} | \\ CH_3 \end{array}}{CH}-CH_2Br$

- (c)  $CH_3-\underset{\begin{array}{c} | \\ CH_3 \end{array}}{C}-CH_2Br$  (d)  $CH_3CH_2Br$

133. Which will undergo  $S_N2$  reaction fastest among the following halogen compounds?

- (a)  $CH_3CH_2F$  (b)  $CH_3CH_2Cl$   
(c)  $CH_3CH_2Br$  (d)  $CH_3CH_2I$

134. Consider the following bromides :



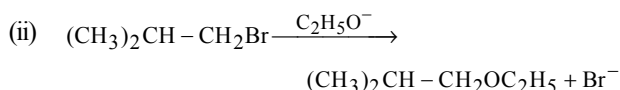
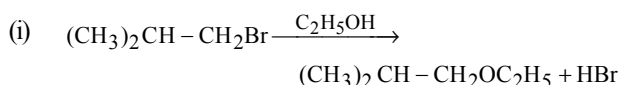
The correct order of  $S_N1$  reactivity is

- (a)  $B > C > A$  (b)  $B > A > C$   
(c)  $C > B > A$  (d)  $A > B > C$

135. Which one is most reactive towards  $S_N1$  reaction ?

- (a)  $C_6H_5CH(C_6H_5)Br$   
(b)  $C_6H_5CH(CH_3)Br$   
(c)  $C_6H_5C(CH_3)(C_6H_5)Br$   
(d)  $C_6H_5CH_2Br$

136. Consider the reactions :



The mechanisms of reactions (i) and (ii) are respectively :

- (a)  $S_N1$  and  $S_N2$  (b)  $S_N1$  and  $S_N1$   
(c)  $S_N2$  and  $S_N2$  (d)  $S_N2$  and  $S_N1$

137. The organic chloro compound, which shows complete stereochemical inversion during a  $S_N2$  reaction, is

- (a)  $(C_2H_5)_2CHCl$  (b)  $(CH_3)_3CCl$   
(c)  $(CH_3)_2CHCl$  (d)  $CH_3Cl$

138. Under certain conditions an alkyl halide reacts with base to give an alkene and  $HCl$  [Elimination Reaction] for example  $R-CH_2-CH_2-Cl \rightarrow R-CH=CH_2 + HCl$

The extent of these reactions depends on the structure of alkyl halides (e.g. primary, secondary or tertiary). The relative extent to which such reactions take place is in the order (of haloalkanes) :

- (a) Primary < secondary < Tertiary  
(b) Primary > Secondary > Tertiary  
(c) Primary > Secondary < Tertiary  
(d) Primary < Secondary > Tertiary

139. The correct order of reactivity of the halides, ethyl chloride (I) *iso*-propyl chloride (II) and benzyl chloride (III) in  $S_N1$  reaction is

- (a)  $I > II > III$  (b)  $III > II > I$   
(c)  $II > I > III$  (d)  $I > III > II$

140. Which of the following represents correct set of ambident nucleophiles?

- (a)  $CN^-$  and  $NH_3$  (b)  $CN^-$ ,  $NO_2^-$   
(c)  $OH^-$ ,  $RO^-$  (d)  $CN^-$ ,  $OH^-$

141. Which of the following statements is correct?

- (a)  $S_N2$  reactions of optically active halides are accompanied by inversion of configuration.  
(b)  $S_N1$  reactions of optically active halides are accompanied by racemisation.  
(c) Carbocation formed in  $S_N1$  reaction is  $sp^2$  hybridized.  
(d) All of the above.

142. The replacement of chlorine of chlorobenzene to give phenol requires drastic conditions, but the chlorine of 2, 4-dinitrochlorobenzene is readily replaced since,

- (a) nitro groups make the aromatic ring electron rich at ortho/para positions  
(b) nitro groups withdraw electrons from the meta position of the aromatic ring  
(c) nitro groups donate electrons at meta position  
(d) nitro groups withdraw electrons from ortho/para positions of the aromatic ring

143. A set of compounds in which the reactivity of halogen atom in the ascending order is

- (a) chlorobenzene, vinyl chloride, chloroethane  
(b) chloroethane, chlorobenzene, vinyl chloride  
(c) vinyl chloride, chlorobenzene, chloroethane  
(d) vinyl chloride, chloroethane, chlorobenzene

144. Aryl halides are extremely less reactive towards nucleophilic substitution than alkylhalides. Which of the following accounts for this ?

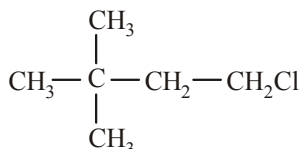
- (i) Due to resonance in aryl halides.  
(ii) In alkyl halides carbon atom in  $C-X$  bond is  $sp^2$  hybridised whereas in aryl halides carbon atom in  $C-X$  bond is  $sp^3$  hybridized.  
(iii) Due to stability of phenyl cation.  
(iv) Due to possible repulsion there are less chances of nucleophile to approach electron rich arenes.  
(a) (i), (ii) and (iv) (b) (i), (ii) and (iii)  
(c) (i) and (iv) (d) (ii), (iii) and (iv)

- 145.** The organic compound used as feedstock in the synthesis of chlorofluorocarbons is  
 (a)  $\text{CH}_2\text{Cl}_2$  (b)  $\text{CHCl}_3$   
 (c)  $\text{CH}_3\text{Cl}$  (d)  $\text{CCl}_4$
- 146.**  $\text{CCl}_4$  is well known fire extinguisher. However after using it to extinguish fire, the room should be well ventilated. This is because  
 (a) It is flammable at higher temperatures  
 (b) It is toxic  
 (c) It produces phosgene by reaction with water vapour at higher temperatures  
 (d) It is corrosive
- 147.** In which part of the atmosphere, does the freon remain unchanged ?  
 (a) Stratosphere (b) Troposphere  
 (c) Mesosphere (d) Thermosphere
- 148.** Natural ozone layer is unbalanced due to  
 (a) cloudiness of poisonous gases  
 (b) presence of rain in the atmosphere  
 (c) initiation of radical chain by freon  
 (d) All of the above
- 149.** Exposure of  $\text{CCl}_4$  causes  
 (a) Liver cancer in human  
 (b) Damage to nerve cells  
 (c) Coma, unconsciousness  
 (d) All of these
- 150.** Chloroform cannot be prepared from which of the following?  
 (a)  $\text{CH}_3\text{OH}$  (b)  $\text{C}_2\text{H}_5\text{OH}$   
 (c)  $\text{CH}_3\text{CHO}$  (d)  $(\text{CH}_3)_2\text{CO}$
- 151.** Which one of the following has antiseptic property?  
 (a) Dichloromethane (b) Trifluoromethane  
 (c) Triiodomethane (d) Tetrachloromethane
- 152.** Chronic chloroform exposure may cause damage to liver and kidney, due to the formation of  
 (a) phosgene (b) methylene chloride  
 (c) methyl chloride (d) carbon tetrachloride
- 153.** The spatial arrangement of four groups around a central carbon atom is tetrahedral and if all the substituents attached to that a carbon are different. Such a carbon is called \_\_\_\_\_.  
 (a) asymmetric carbon (b) stereocentre  
 (c) chiral (d) All of these

# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

1. (d) Neohexyl chloride is a primary halide as in it Cl-atom is attached to a primary carbon.



2. (b)  $\begin{array}{cc} \text{CHCl}_2 & \text{CH}_2\text{Cl} \\ | & | \\ \text{CH}_3 & \text{CH}_2\text{Cl} \end{array}$   
(gem-dihalide) (vic-dihalide)

3. (b) Gem-dihalides are those in which two halogen atoms are attached on the same carbon atom.

4. (a)

5. (b)  $\begin{array}{ccccccc} & 1^\circ\text{CH}_3 & & 1^\circ\text{CH}_3 & & & \\ & | & & | & & 2^\circ & \\ 1^\circ & \text{CH}_3 - \text{CH} & - & \text{C} - \text{CH}_2 & - & \text{CH}_3 & \\ & 3^\circ & & 4^\circ & & & \\ & & & | & & & \\ & & & \text{Cl} & & & \end{array}$   
3-chloro-2,3-dimethylpentane

6. (b)  $\begin{array}{c} 1^\circ\text{CH}_3 \\ | \\ \text{H}_3\text{C} - \text{C} - \text{Cl} \\ | \\ 3^\circ\text{CH}_3 \end{array}$

IUPAC name : 2-Chloro-2-methylpropane.

7. (a)  $\begin{array}{ccccccc} & & \text{Br} & & & & \\ & & | & & & & \\ \text{CH}_3 & \text{CH}_2 & \text{C} = \text{CH} - \text{Cl} \\ 4 & 3 & 2 & & & & \end{array}$   
2-bromo-1-chlorobut-1-ene

8. (d)  $\text{CH}_2 = \text{CH} - \text{CH}_2\text{Cl}$   
(3-chloro-1-propene)

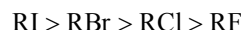
9. (a) Isopropyl chloride  $\text{CH}_3 - \text{CH}(\text{Cl}) - \text{CH}_3$  chlorine atom is attached to  $2^\circ$  carbon atom.

10. (a) 11. (d)

12. (c) Because of the small size of F, the C-F bond is strongest in  $\text{CH}_3\text{F}$ .

13. (b)  $\text{CH}_3\text{Cl}$  has higher dipole moment than  $\text{CH}_3\text{F}$  due to much longer C-Cl bond length than the C-F bond. The much longer bond length of the C-Cl bond outweighs the effect produced by lower electronegativity of Cl than that of F.

14. (c) For the same alkyl group, the boiling points of alkyl halides decrease in the order :



This is because with the increase in size and mass of halogen atom, the magnitude of van der Waal's forces increases.

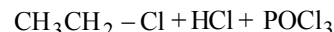
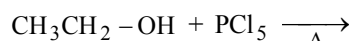
15. (a)

16. (a)  $\text{C}_2\text{H}_6 + \text{Cl}_2 \xrightarrow{\text{UV light}} \text{C}_2\text{H}_5\text{Cl} + \text{HCl}$

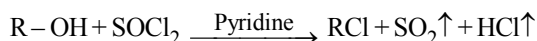
17. (b)

18. (d) Ethylene dichloride can be prepared by adding HCl to ethylene glycol ( $\text{CH}_2\text{OH} \cdot \text{CH}_2\text{OH}$ ).

19. (b) When ethyl alcohol is treated with  $\text{PCl}_5$ , then ethyl chloride is formed.



20. (c) The best method for the conversion of an alcohol into an alkyl chloride is reaction of the alcohol with thionyl chloride ( $\text{SOCl}_2$ ) in the presence of pyridine.



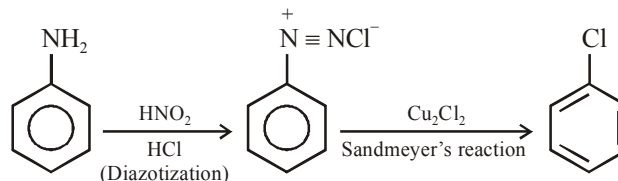
$\text{SO}_2$  and HCl being gases escape leaving behind pure alkyl halide.

21. (a) Boiling point of  $\text{CH}_3\text{I}$  is  $42^\circ\text{C}$  which indicates that it is liquid at room temperature.  $\text{CH}_3\text{I}$  is larger molecule so it has stronger van der Waal's force of attraction than others.

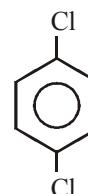
22. (c) In preparation of an alkyl chloride by the action of dry HCl, the catalyst generally used is anhydrous  $\text{ZnCl}_2$ .

23. (a)

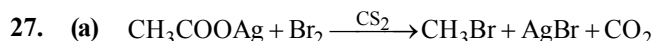
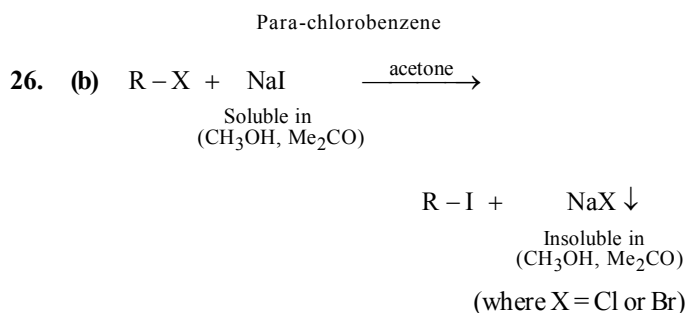
24. (c)



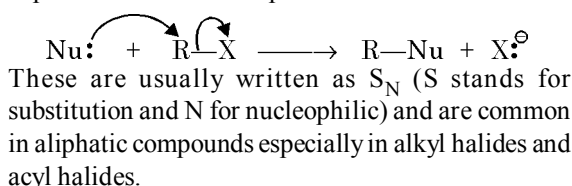
25. (d) Para-di-chlorobenzene has most symmetrical structure than others. It is found as crystalline lattice form, therefore, it has highest melting point ( $52^\circ\text{C}$ ) due to symmetrical structure.



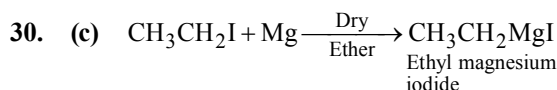




28. (d) In **nucleophilic substitution**, a nucleophile provides an electron pair to the substrate and the leaving group departs with an electron pair.

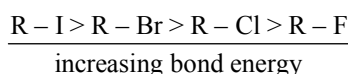


29. (c)  $\text{S}_\text{N}1$  reactions involve the formation of carbocations, hence higher the stability of carbocation, more will be reactivity of the parent alkyl halide. Thus tertiary carbocation formed from (c) is stabilized by two phenyl groups and one methyl group, hence most stable.



31. (d) Chlorobenzene does not undergo hydrolysis by  $\text{S}_\text{N}1$  mechanism because in this halogen is present on  $\text{sp}^2$  hybridised carbon atom, such halogens are relatively inert.

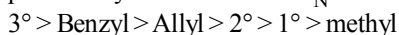
32. (a) For a given alkyl group, the order of reactivity is



decreasing halogen reactivity.

This order depends on the carbon-halogen bond energy; the carbon-fluorine bond energy is maximum and thus fluorides are least reactive while carbon-iodine bond energy is minimum hence iodides are most reactive.

33. (c) More stable the carbocation, more reactive will be the parent alkyl halide towards  $\text{S}_\text{N}1$  reaction.



34. (d)  $\text{S}_\text{N}1$  reaction involves carbocation which are planar ( $\text{sp}^2$  hybridised) and thus can be attacked on either face of the carbon.

35. (d) Weaker the C-X bond, greater is the reactivity.

36. (a) Only  $1^\circ$  alkyl halides (i.e.  $\text{CH}_3\text{Br}$ ) undergo  $\text{S}_\text{N}2$  reaction.

37. (b)

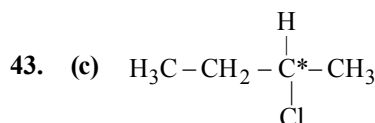
38. (a)  $1^\circ$  Alkyl halides (having least steric hindrance at  $\alpha$ -carbon atom) are most reactive towards  $\text{S}_\text{N}2$  reaction.

39. (c) Isopropyl chloride, being  $2^\circ$  alkyl halides, can undergo  $\text{S}_\text{N}1$  as well as  $\text{S}_\text{N}2$  mechanism.

40. (b) Due to steric hindrance tertiary alkyl halide do not react by  $\text{S}_\text{N}2$  mechanism they react by  $\text{S}_\text{N}1$  mechanism.  $\text{S}_\text{N}2$  mechanism is followed in case of primary and secondary alkyl halides of  $\text{CH}_3\text{-X} > \text{CH}_3\text{-CH}_2\text{X} > (\text{CH}_3)_2\text{-CH.X} > (\text{CH}_3)_3\text{-C-X}$

41. (c) In  $\text{S}_\text{N}2$  mechanism transition state is pentavalent. Thus bulky alkyl group will be sterically hindered and smaller alkyl group will favour the  $\text{S}_\text{N}2$  mechanism. So the decreasing order of reactivity of alkyl halides is  $\text{RCH}_2\text{X} > \text{R}_2\text{CHX} > \text{R}_3\text{CX}$

42. (c) Inversion in configuration occurs in  $\text{S}_\text{N}2$  reactions.



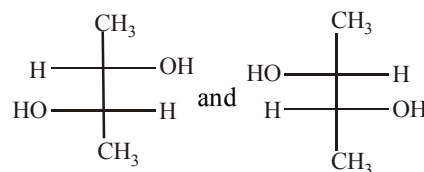
The compound containing a chiral carbon atom i.e., (a carbon atom which is attached to four different atoms is known as a chiral carbon atom) is optically active.

A 2-chlorobutane contains a chiral  $\text{C}^*$  atom hence it is optically active.

44. (c) Diastereomers since they have different melting points, boiling points, solubilities etc.

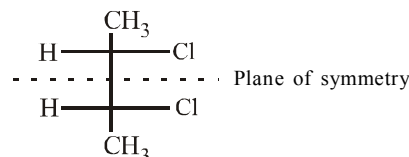
45. (a)

46. (b) Compound which are mirror image of each other and are non superimposable are termed as enantiomers.



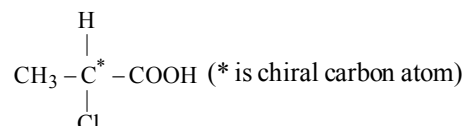
These are enantiomers

47. (b) The compound has two similar asymmetric C-atoms. It has plane of symmetry and exist in meso form.



Meso - 2, 3 dichlorobutane

48. (a) Compounds having chiral carbon atom are optically active.

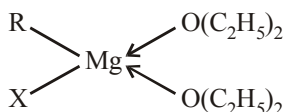


49. (a) A mixture of equal amounts of the two enantiomers is called a racemic mixture.

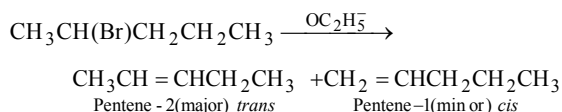
50. (c) 51. (d)

52. (c)  $C_2H_5Br$  and  $C_2H_5Cl$  are ethylating agents, while  $C_6H_5Cl$  is inert.

53. (a) Although all the three compounds can be used for preparing Grignard reagents, diethyl ether is considered as the best because it provides electron pairs to Mg of the reagent fully for coordination, in case of  $C_6H_5OCH_3$  and  $C_6H_5N(CH_3)_2$  electron pair on O and N are partially delocalised over the benzene and hence are less available for coordination with Mg.

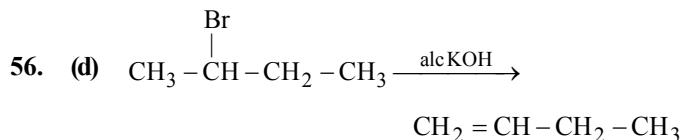
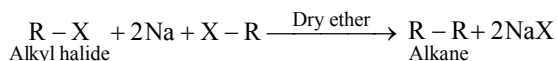


54. (c) Potassium ethoxide is a strong base, and 2-bromopentane is a 2° bromide, so elimination reaction predominates

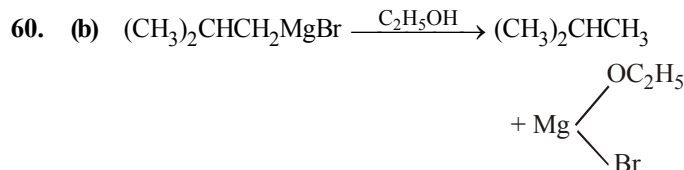
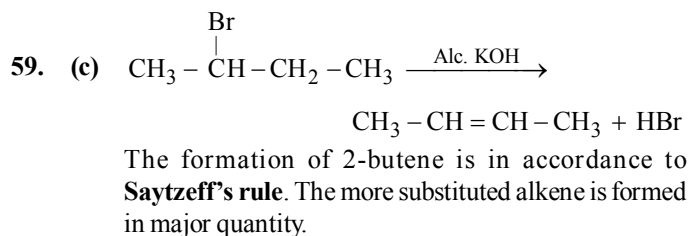
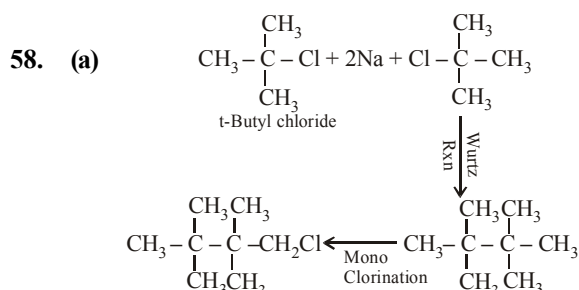
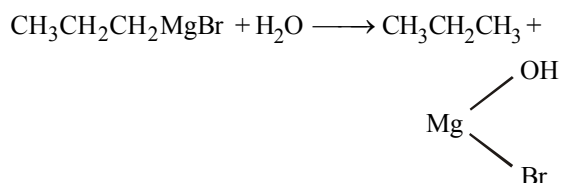
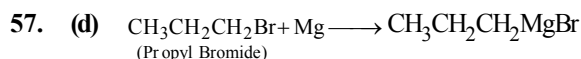


Since *trans*-alkene is more stable than *cis*. Thus *trans*-pentene-2 is the main product.

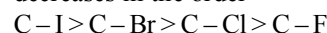
55. (c) Wurtz reaction : It involves the interaction of two molecules of an alkyl halide (preferably bromide or iodide) with metallic sodium in presence of dry ether to form symmetrical alkanes containing double the number of carbon atoms present in the alkyl halide. For example,



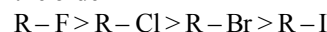
In this reaction both hydrogen and halogen atom has been removed so it is known as dehydro halogenation reaction.



61. (b) The order of atomic size of halogens decrease in the order  $I > Br > Cl > F$ . On moving down a group atomic size increases. Further the bond length of C-X bond decreases in the order



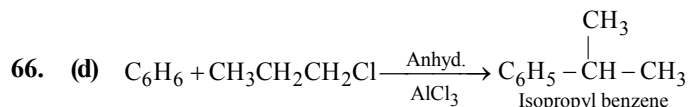
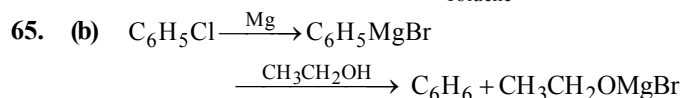
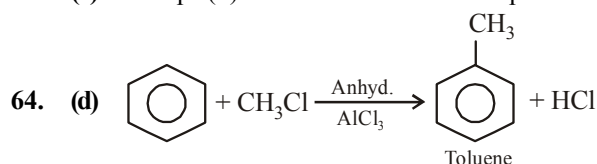
and hence the bond dissociation energy decreases in the order



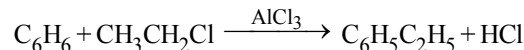
hence R-I being a weakest bond break most easily. hence R-I is most reactive.

62. (a) Alkylhalide formation in the reaction of alcohol with HCl undergoes  $S_N1$  reaction in which formation of the carbocation as intermediate occurs. Stability of carbocation is greatest for  $(C_6H_5)_3C^+$  due to resonance effect, and stability of tertiary carbocation is greater than the secondary carbocation hence the option (a) shows the correct order.

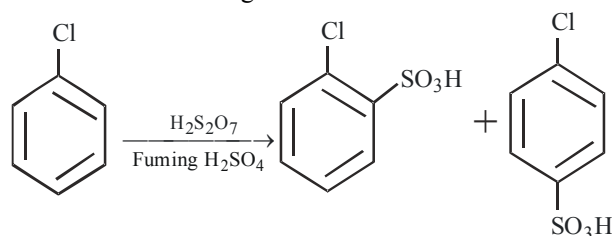
63. (d) Except (d) all contain abstractable proton



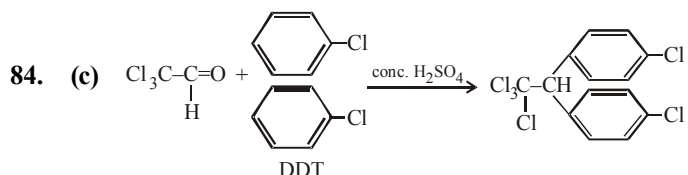
67. (a) Friedel-Craft's reaction is mainly applied on benzene.



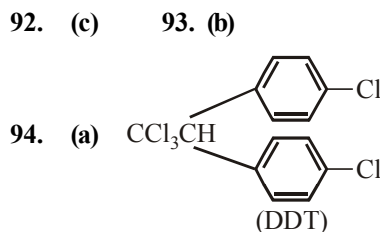
68. (d) On sulphonation of chlorobenzene, ortho and para chlorobenzene is formed because -Cl group is para and ortho directing.



69. (c) Due to resonance in chlorobenzene.
70. (a) N-Phenylacetanilide,  $C_6H_5N(C_6H_5)COCH_3$ , precipitates out to a complex with anhydrous  $AlCl_3$ .
71. (d) More the stability of the carbocation, higher will be the reactivity of the parent chloride. Allyl chloride > Vinyl chloride > Chlorobenzene
72. (c)  $S_N1$  reactions involve the formation of carbocations, hence higher the stability of carbocation, more will be reactivity of the parent alkyl halide. Thus tertiary carbocation formed from (c) is stabilized by two phenyl groups and one methyl group, hence most stable.
73. (d)  $C_6H_5NH_2 \xrightarrow[HCl]{HONO} C_6H_5N_2Cl \xrightarrow{CuCl} C_6H_5Cl$
74. (b) This method is not applicable for the preparation of aryl halides because the C–O bond in phenol has a partial double bond character and is difficult to break being stronger than a single bond.
75. (d) Due to resonance, the electron density increases more at ortho- and para-positions than at meta-positions. Further, the halogen atom because of its –I effect has some tendency to withdraw electrons from the benzene ring. As a result, the ring gets somewhat deactivated as compared to benzene and hence the electrophilic substitution reactions in haloarenes occur slowly and require more drastic conditions as compared to those in benzene.
76. (d) Chloropicrin is nitrochloroform. It is obtained by the nitration of chloroform with  $HNO_3$ .
- $$HCCl_3 \xrightarrow[HCl]{HNO_3} O_2NCCl_3$$
- Chloroform                      Chloropicrin
- Chloropicrin is a liquids, poisonous and used as an insecticide and a war gas
77. (c)      78. (c)
79. (c) Freon ( $CCl_2F_2$ ) is an odourless, non-corrosive, non toxic gas which is stable even at high temperatures and pressures. It has low b.p. low specific heat and can be easily liquified by applying pressure at room temperature. It is therefore, widely used as refrigerant (cooling agent) in refrigerators and air conditioners.
80. (c) Chlorofluorocarbon is used in air-conditioners and in domestic refrigerators for cooling purposes. Its main drawback is this, it is responsible for ozone depletion.
81. (d) Its vapours are non-inflammable (*i.e.* do not catch fire). Hence used as fire extinguishers under the name pyrene.
82. (c) Tetrachloromethane (carbon tetrachloride) is also used as feedstock in the synthesis of chlorofluorocarbon and other pharmaceutical manufacturing and general solvents etc.
83. (d) Dichloromethane is widely used as solvent as a paint remover, as a propellant in aerosols and as a process solvent in the manufacture of drugs. It is also used as a metal cleaning and finishing solvent.



85. (a)  $Cl_3C-\boxed{H+HO}-NO_2 \longrightarrow Cl_3C-NO_2$   
Chloropicrin (used as an insecticide)
86. (d) Chlorofluorocarbons, e.g.  $CF_2Cl_2$ ,  $CHF_2Cl$ ,  $HCF_2CHCl_2$ . These are non-inflammable colourless and stable upto  $550^\circ C$ . These are emitted as propellants in aerosol spray, cans refrigerators, fire fighting reagents etc. They are chemically inert and hence do not react with any substance with which they come in contact and therefore float through the atmosphere and as a result enter the stratosphere. There they absorb UV-rays and due to this they produce free atomic chlorine which results decomposition of ozone which cause depletion of ozone layer.
87. (b) Haloform compounds with the formula  $CHX_3$ , where X is a halogen atom.  
Haloforms are trihalogen derivatives of methane.  
Example: Chloroform  $CHCl_3$ .
88. (d) Under ordinary conditions freon is a gas. Its boiling point is  $-29.8^\circ C$ . It can easily be liquified. It is chemically inert. It is used in air-conditioning and in domestic refrigerators for cooling purposes (as refrigerant)
89. (b) Chloroform ( $CHCl_3$ ) is used as industrial solvent.
90. (a) Chloroform is an organic compound which does not ionise in water. Since it can not provide  $Cl^-$ , therefore, it is not precipitated with  $AgNO_3$ .
91. (c) When chloroform is exposed to light it is oxidised to a poisonous gas known as phosgene.  
 $2CHCl_3 + 2O_2 \longrightarrow 2COCl_2 + Cl_2$



95. (d) Freons are chlorofluorocarbons.  
 $\therefore CClF_3$ ,  $CFCl_3$  and  $CCl_2F_2$ , all are freons.
96. (b)
97. (c) Freons are chlorofluorocarbon.
98. (d)      99. (d)

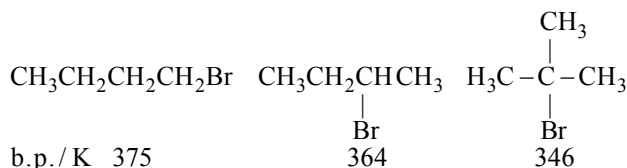
### STATEMENT TYPE QUESTIONS

100. (b) In alkyl halides halogen atom(s) is attached to  $sp^3$  hybridised carbon atom.

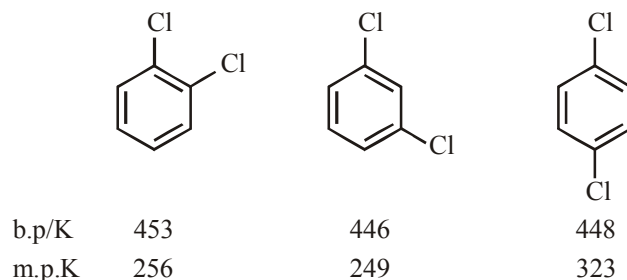
- 101. (a)** Aryl chlorides and bromides can be easily prepared by electrophilic substitution of arenes with chlorine and bromine respectively in the presence of Lewis acid catalysis like iron or iron (III) chloride. The ortho and para isomers can be easily separated due to large difference in their melting points. Reactions with iodine are reversible in nature and require the presence of an oxidising agent ( $\text{HNO}_3$ ,  $\text{HIO}_4$ ) to oxidise the HI formed during iodination. Fluoro compounds are not prepared by this method due to high reactivity of fluorine.

**102. (a)**

- 103. (d)** The boiling points of isomeric haloalkanes decrease with increase in branching. For example, 2-bromo-2-methylpropane has the lowest boiling point among the three isomers.



Boiling points of isomeric dihalobenzenes are very nearly the same. However, the para-isomers are high melting as compared to their ortho and meta-isomers. It is due to symmetry of para-isomers that fits in crystal lattice better as compared to ortho- and meta-isomers.

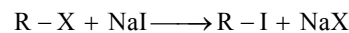


- 104. (b)**  $\text{S}_\text{N}2$  reaction follow a 2nd order kinetic i.e. the rate depends upon the concentration of both the reactants, where in  $\text{S}_\text{N}1$  reactions rate depends only upon the concentration of only one reactants. The order of reactivity order of alkyl halides for  $\text{S}_\text{N}2$  reaction  $3^\circ > 2^\circ > 1^\circ$  and for  $\text{S}_\text{N}1$  reactions  $3^\circ < 2^\circ < 1^\circ$
- 105. (a)** In  $\text{S}_\text{N}1$  reactions step 1 is slow and reversible and the slowest step is the rate determining step
- 106. (b)** If the compound rotates the plane polarised light to the right, i.e., clockwise direction, it is called dextrorotatory (Greek for right rotating) or the d-form and is indicated by placing a positive(+) sign before the degree of rotation. If the light is rotated towards left (anticlockwise direction), the compound is said to be laevorotatory or the l-form and a negative (-) sign is placed before the degree of rotation.
- 107. (a)** If a 50 : 50 mixture of the (A) and (B) is obtained then the process is called racemisation and the product is optically inactive, as one isomer will rotate light in the direction opposite to another.

- 108. (d)** *tert*-Alkyl halides undergo  $\text{S}_\text{N}1$  reactions, hence they involve the formation of quite stable carbocations, and not the transition state. In  $\text{S}_\text{N}1$  reactions, the nucleophile is not involved in rate determining (first) step, hence its stronger or weaker nature does not influence the reaction rate. In  $\text{S}_\text{N}1$ , the product has more percentage of the inverted configuration than the retained configuration, i.e. only partial racemization takes place, hence the product will be having some optical activity.

### MATCHING TYPE QUESTIONS

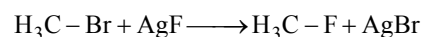
- 109. (c)** In allylic halides hydrogen atom is bonded to  $\text{sp}^3$  hybridized carbon atom. Whereas in vinylic halide, hydrogen atom is bonded to  $\text{sp}^2$  hybridized carbon atom.
- |                            |  |
|----------------------------|--|
| $\text{CH}_3\text{CHCl}_2$ | $\begin{array}{c} \text{CH}_2 - \text{CH}_2 \\   \quad   \\ \text{Cl} \quad \text{Cl} \end{array}$ |
| Ethylidene chloride        | Ethylene dichloride (vic-dihalide)   |
| (gem-dihalide)             |  |
- 110. (a)** Alkyl iodides are often prepared by the reaction of alkyl chlorides/bromides with NaI in dry acetone. This reaction is known as Finkelstein reaction.



$\text{X} = \text{Cl}, \text{Br}$

NaCl or NaBr thus formed is precipitated in dry acetone.

It facilitates the forward reaction according to le chatelier's principle. The synthesis of alkyl fluorides is best accomplished by heating an alkyl chloride/bromide in the presence of a metallic fluoride such as AgF,  $\text{Hg}_2\text{F}_2$ ,  $\text{CoF}_2$  or  $\text{SbF}_3$ . The reaction is termed as Swarts reaction.



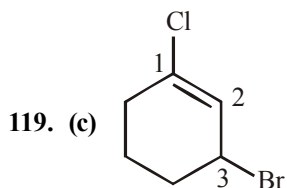
- 111. (b)** **112. (b)**
- 113. (b)** Chloramphenicol, produced by soil microorganism is very effective for the treatment of typhoid fever. Our body produces iodine containing hormone thyroxine, the deficiency of which causes a disease called goiter. Synthetic halogen compounds, viz chloroquine is used for the treatment of malaria; halothane is used as an anaesthetic during surgery. Certain fully fluorinated compounds are being considered as potential blood substitutes in surgery.

### ASSERTION-REASON TYPE QUESTIONS

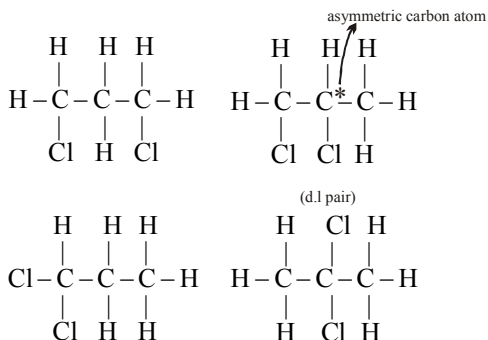
- 114. (d)** **Assertion** is false, because aryl halides do not undergo nucleophilic substitution under ordinary conditions. This is due to resonance, because of which the carbon-chlorine bond acquires partial double bond character, hence it becomes shorter and stronger and thus cannot be replaced by nucleophiles. However **Reason** is true.
- 115. (c)** Alkyl halides give polyalkylation products.

116. (b) Carbon tetrachloride rises to atmosphere and deplete the ozone layer. This depletion of ozone layer increases exposure of UV rays to human being which lead to increase of skin cancer, eye diseases and disorder with disruption of the immune system.
117. (c)  $\text{CHCl}_3$  is stored in dark bottles to prevent oxidation of  $\text{CHCl}_3$  in presence of sunlight.
118. (d)  $\text{CCl}_4$  is used as a fire extinguisher. The dense, non combustible vapours cover the burning substance and prevents the availability of oxygen around burning material.

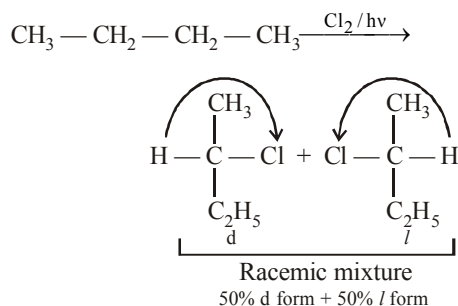
### CRITICAL THINKING TYPE QUESTIONS



120. (c) The compound is  $\text{C}_3\text{H}_6\text{Cl}_2$  and the number of possible isomeric compounds is 5

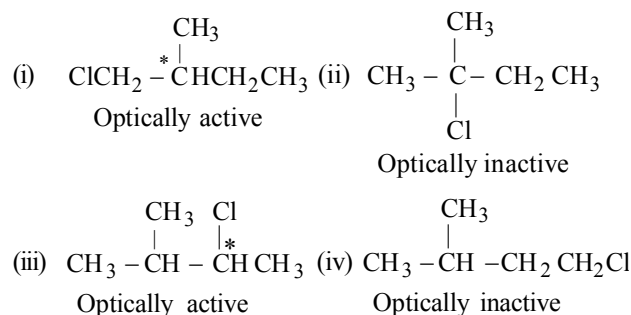


121. (d) 4-Bromobut-1-ene is not an allylic halide  
 $\text{BrH}_2\text{C}-\text{CH}_2-\text{CH}=\text{CH}_2$   
 4-Bromobut-1-ene
122. (c) Primary and secondary alkyl chlorides are prepared from the respective alcohols by using  $\text{HCl}$  gas and anhydrous  $\text{ZnCl}_2$  (Groove's process).
123. (d) Chlorination of n-butane taken place via free radical formation i.e.,  $\text{Cl}_2 \xrightarrow{h\nu} \text{Cl}^\bullet + \text{Cl}^\bullet$



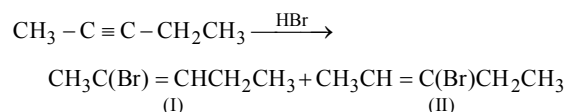
$\text{Cl}^\bullet$  may attack on either side and give a racemic mixture of 2 chloro butane which contain 50% d form and 50% l-form.

124. (d) First draw possible different structures obtained on monochlorination of 2-methylbutane,  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{CH}_3$ .



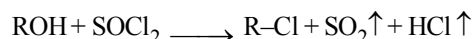
Thus structures (i) and (iii) are optically active, each has one chiral carbon; so each structure will give one enantiomeric pair; thus total enantiomeric pairs will be two.

125. (b) Addition of  $\text{HBr}$  of 2-pentyne gives two structural isomers (I) and (II)

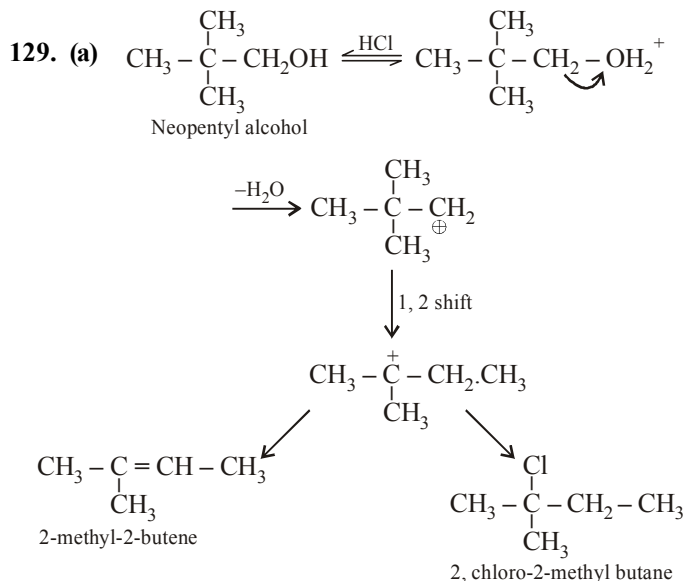


Each one of these will exist as a pair of geometrical isomers. Thus, there are two structural and four configurational isomers.

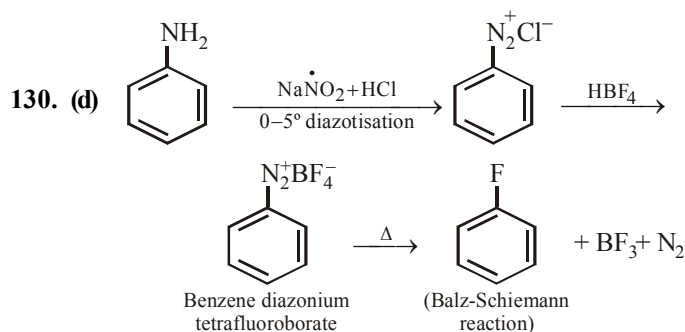
126. (c) Thionyl chloride is preferred because the other two products formed in the reaction are escapable gases. Hence the reaction gives pure alkyl halides



127. (d) This compound have only one type of hydrogen available.
128. (b) Chlorine atom is highly reactive so it will react with all type of hydrogen available while the Br atom is highly selective so it will react with that hydrogen which give the highly stabilize tertiary alkyl radical so only one product is formed.

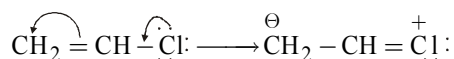




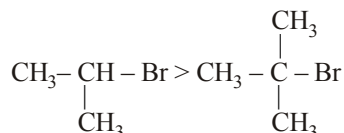


131. (d)  $\text{CH}_2 = \text{CH} - \text{Cl}$   
(Vinyl Chloride)

The halogen atom in vinyl chloride is not reactive as in other alkyl halides. The non-reactivity of chlorine atom is due to resonance stabilisation. The *l.p.* on Cl-atom can participate in delocalisation (Resonance) to give two canonical structure.

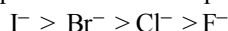


132. (d) The rate of  $\text{S}_{\text{N}}2$  substitution reaction is maximum in case of  $\text{CH}_3\text{CH}_2\text{Br}$  because  $\text{S}_{\text{N}}2$  mechanism is followed in case of primary and secondary halides i.e.,  $\text{S}_{\text{N}}2$  reaction is favoured by small groups on the carbon atom attached to halogens so  
 $\text{CH}_3\text{CH}_2\text{Br} > \text{CH}_3\text{CH}_2\text{CH}_2\text{Br} >$



133. (d) Smaller the R group reactivity will be higher towards  $\text{S}_{\text{N}}2$  reaction. For alkyl halides containing similar alkyl group better will be the leaving group, more facile is the nucleophilic substitution reaction.

Amongst the halide ions, the order in which the leaving groups depart follows the sequence :



It is because of this reason that the order of reactivity of haloalkanes follows the sequence :

*iodoalkanes* > *bromoalkanes* > *chloroalkanes* > *fluoroalkanes*

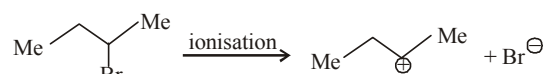
134. (a)



(A)



(B)



(C)

Since  $\text{S}_{\text{N}}1$  reactions involve the formation of carbocation as intermediate in the rate determining step, more is the stability of carbocation higher will be the reactivity of alkyl halides towards  $\text{S}_{\text{N}}1$  route. Now we know that stability of carbocations follows the order :  $3^\circ > 2^\circ > 1^\circ$ , so  $\text{S}_{\text{N}}1$  reactivity should also follow the same order.

$3^\circ > 2^\circ > 1^\circ > \text{Methyl}$  ( $\text{S}_{\text{N}}1$  reactivity)

135. (c)  $\text{S}_{\text{N}}1$  reactions involve the formation of carbocations, order of stability of carbocation is  $3^\circ > 2^\circ > 1^\circ$  hence higher the stability of carbocation, more will be the reactivity of the parent alkyl halide. Moreover the tertiary carbocation formed from (c) is stabilized by two phenyl groups.

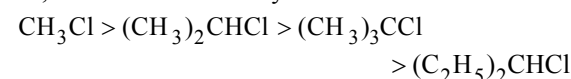
136. (a) A strong nucleophile favours the  $\text{S}_{\text{N}}2$  reaction and a weak nucleophile favours the  $\text{S}_{\text{N}}1$  reaction.

First reaction is  $\text{S}_{\text{N}}1$  reaction because  $\text{C}_2\text{H}_5\text{OH}$  is used as solvent which is a weak nucleophile.

Second reaction is  $\text{S}_{\text{N}}2$  reaction because  $\text{C}_2\text{H}_5\text{O}^-$  is strong nucleophile.

137. (d)  $\text{S}_{\text{N}}2$  reaction is favoured by small groups on the carbon atom attached to halogen.

So, the order of reactivity is



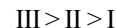
$\text{S}_{\text{N}}2$  reaction is shown to maximum extent by primary halides. The only primary halides given is  $\text{CH}_3\text{Cl}$  so the correct answer is (d).

138. (a) Primary halide < Secondary halide < Tertiary halide.

139. (b) Since  $\text{S}_{\text{N}}1$  reaction involve the formation of carbocation as intermediate in the rate determining step. More stable the carbocation, more is the reactivity of the halide toward  $\text{S}_{\text{N}}1$  route. As we know that the stability of the carbocations decreases in the order :

Benzyl  $2^\circ > 1^\circ$ .

Hence the correct order of stability is



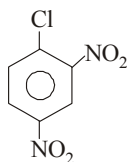
140. (b) Cyanides and nitrites possess two nucleophilic centres and are called ambident nucleophiles. Actually cyanide group is a nucleophile in two different ways

$[\text{C} \equiv \text{N} \leftrightarrow \text{C} = \text{N}^\ominus]$ . Similarly nitrite ion also represents an ambident nucleophile with two different

points of linkage  $[\text{O} = \ddot{\text{N}} - \text{O}]$ . The linkage through oxygen results in alkyl nitrites while through nitrogen atom, it leads to nitroalkanes.

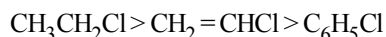
141. (d) In case of optically active alkyl halides, the product formed as a result of  $\text{S}_{\text{N}}2$  mechanism has the inverted configuration as compared to the reactant. This is because the nucleophile attaches itself on the side opposite to the one where the halogen atom is present. In case of optically active alkyl halides,  $\text{S}_{\text{N}}1$  reactions are accompanied by racemisation. The carbocation formed in the slow step being  $\text{sp}^2$  hybridised is planar (achiral).

142. (d)  $-\text{NO}_2$  group is electron attractive group, so it is able to deactivate the benzene ring.

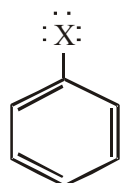


hence withdrawal of electrons from ortho and para position cause easy removal of  $-\text{Cl}$  atom due to development of +ve charge on o- and p positions.

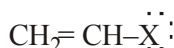
143. (a) On the same basis as above



144. (c) The carbon-halogen bonds of aryl halides are both shorter and stronger (due to possibility of resonance) than the carbon-halogen bonds of  $\text{R}-\text{X}$  and in this respect as well as in their chemical behaviour, they resemble vinyl halides ( $\text{CH}_2=\text{CHX}$ ) more than alkyl halides.

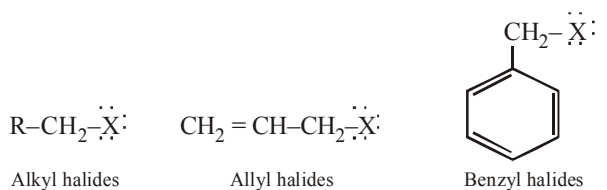


Aryl halides



Vinyl halides

Halogen attached to C is  $\text{sp}^2$  hybridised C, C-X bond is shorter and stronger because of partial double bond character due to delocalisation of electrons on halogens



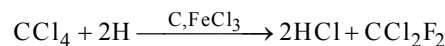
Alkyl halides

Allyl halides

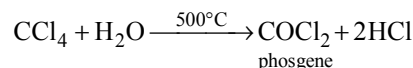
Benzyl halides

Halogen attached to  $\text{sp}^3$  hybridised C. Delocalisation of electrons on halogen is not possible, hence C-X bond does not acquire double bond character, hence it is weaker and reactive.

145. (d)  $3\text{CCl}_4 + 2\text{SbF}_5 \xrightarrow{\text{SbCl}_5} 2\text{SbCl}_3 + 3\text{CCl}_2\text{F}_2$   
freon-12

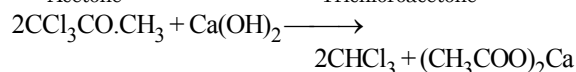
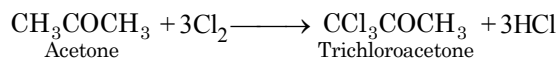
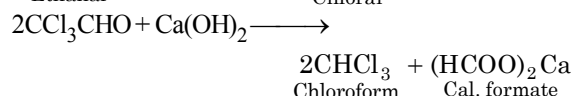
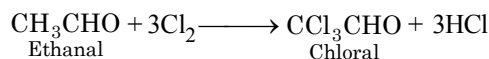


146. (c) Carbon tetrachloride vapours react with steam above  $500^\circ\text{C}$  to form phosgene, a poisonous gas.

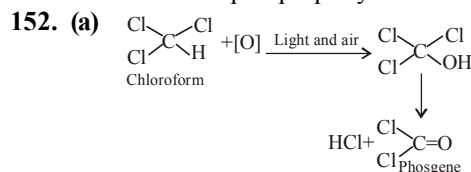


147. (a) In stratosphere, freon is able to initiate radical chain reaction that can upset the natural ozone balance.  
148. (c) In stratosphere freon is able, to initiate radical chain reactions that can upset the natural ozone balance.  
149. (d) Exposure of carbon tetrachloride causes liver cancer in humans. The most common effects are dizziness, light headedness, nausea and vomiting which cause permanent damage to nerve cells. In severe cases, these effects can lead rapidly to stupor, coma, unconsciousness or death.

150. (a)  $\text{CH}_3\text{CH}_2\text{OH} + \text{Cl}_2 \xrightarrow{\text{oxidation}} \text{CH}_3\text{CHO} + 2\text{HCl}$   
Ethanol Ethanal



151. (c) Triiodomethane ( $\text{CHI}_3$ ) when comes in contact with organic matter decomposes easily to free iodine which has antiseptic property.



Phosgene is an extremely poisonous gas.

153. (d)

# ALCOHOLS, PHENOLS AND ETHERS

## FACT/DEFINITION TYPE QUESTIONS

1. The characteristic grouping of secondary alcohols is

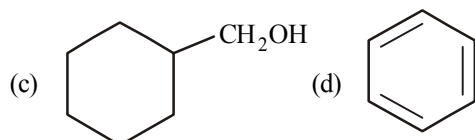
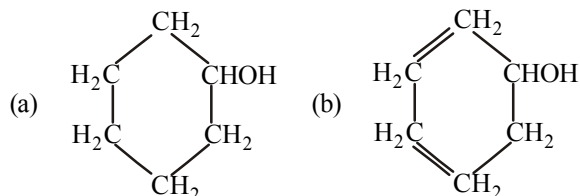
- (a)  $-\text{CH}_2\text{OH}$  (b)  $\text{>CHOH}$

- (c)  $-\text{C}-\text{OH}$  (d)  $\text{>C}(\text{OH})_2$

2. The compound  $\text{HOCH}_2-\text{CH}_2\text{OH}$  is

- (a) ethane glycol (b) ethylene glycol  
(c) ethylidene alcohol (d) dimethyl alcohol

3. The structural formula of cyclohexanol is



4. Which of the following is dihydric alcohol ?

- (a) Glycerol (b) Ethylene glycol  
(c) Catechol (d) Resorcinol

5. An example of a compound with functional group  $-\text{O}-$  is :

- (a) acetic acid (b) methyl alcohol  
(c) diethyl ether (d) acetone

6. Butane-2-ol is

- (a) primary alcohol (b) secondary alcohol  
(c) tertiary alcohol (d) aldehyde

7. Cresol has

- (a) Alcoholic  $-\text{OH}$  (b) Phenolic  $-\text{OH}$   
(c)  $-\text{COOH}$  (d)  $-\text{CHO}$

8. How many isomers of  $\text{C}_5\text{H}_{11}\text{OH}$  will be primary alcohols ?

- (a) 5 (b) 4  
(c) 2 (d) 3

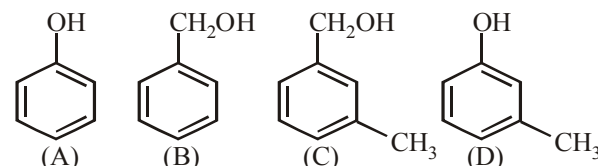
9. The IUPAC name of  $\text{CH}_3-\underset{\text{OH}}{\text{CH}}-\text{CH}_2-\overset{\text{CH}_3}{\underset{\text{OH}}{\text{C}}}-\text{CH}_3$  is

- (a) 1, 1-dimethyl-1, 3-butanediol  
(b) 2-methyl-2, 4-pentanediol  
(c) 4-methyl-2, 4-pentanediol  
(d) 1, 3, 3-trimethyl-1, 3-propanediol

10. Number of metamers represented by molecular formula  $\text{C}_4\text{H}_{10}\text{O}$  is

- (a) 4 (b) 3  
(c) 2 (d) 1

11. Which of the following compounds is aromatic alcohol?

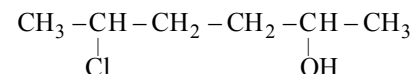


- (a) A, B, C, D (b) A, D  
(c) B, C (d) A

12. How many alcohol(s) with molecular formula  $\text{C}_4\text{H}_{10}\text{O}$  are chiral in nature?

- (a) 1 (b) 2  
(c) 3 (d) 4

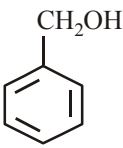
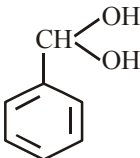
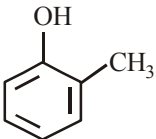
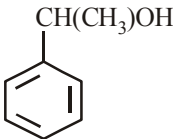
13. Give IUPAC name of the compound given below

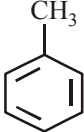
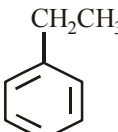
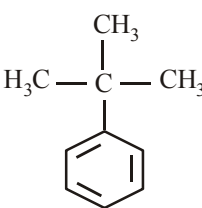
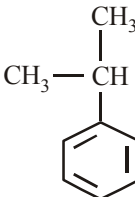

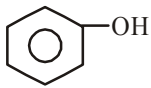
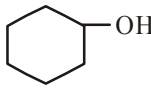
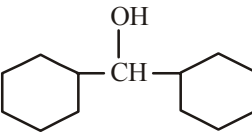


- (a) 2-Chloro-5-hydroxyhexane  
(b) 2-Hydroxy-5-chlorohexane  
(c) 5-Chlorohexane-2-ol  
(d) 2-Chlorohexan-5-ol

14. IUPAC name of *m*-cresol is \_\_\_\_\_

- (a) 2-methylphenol (b) 3-chlorophenol  
(c) 3-methoxyphenol (d) benzene-1, 3-diol

15. IUPAC name of the compound  $\text{CH}_3 - \underset{\text{CH}_3}{\text{CH}} - \text{OCH}_3$  is \_\_\_\_\_.
- 1-methoxy-1-methylethane
  - 2-methoxy-2-methylethane
  - 2-methoxypropane
  - isopropylmethyl ether
16. Which of the following are benzylic alcohols?
- $\text{C}_6\text{H}_5 - \text{CH}_2 - \text{CH}_2\text{OH}$
  - $\text{C}_6\text{H}_5 - \text{CH}_2\text{OH}$
  - $\text{C}_6\text{H}_5 - \underset{\text{CH}_3}{\text{CH}} - \text{OH}$
  - $\text{C}_6\text{H}_5 - \text{CH}_2 - \underset{\text{CH}_3}{\text{CH}} - \text{OH}$
- (i) and (ii)
  - (ii) and (iii)
  - (i), (ii) and (iv)
  - (i) and (iv)
17. In which of the following structures hydroxyl group is attached to  $sp^2$  carbon atom?
- 
  - 
  - 
  - 
18. Which of the following is an example of unsymmetrical ether?
- $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
  - $\text{C}_6\text{H}_5\text{OC}_6\text{H}_5$
  - $\text{C}_6\text{H}_5\text{OC}_2\text{H}_5$
  - $\text{CH}_3\text{OCH}_3$
19. Which of the following will not form phenol or phenoxide?
- $\text{C}_6\text{H}_5\text{N}_2\text{Cl}$
  - $\text{C}_6\text{H}_5\text{SO}_3\text{Na}$
  - $\text{C}_6\text{H}_5\text{Cl}$
  - $\text{C}_6\text{H}_5\text{CO}_2\text{H}$
20. Benzyl alcohol is obtained from benzaldehyde by
- Fittig's reaction
  - Cannizzaro's reaction
  - Kolbe's reaction
  - Wurtz's reaction
21. In the reduction  
 $\text{R} - \text{CHO} + \text{H}_2 \longrightarrow \text{RCH}_2\text{OH}$   
 the catalyst used is :
- Ni
  - Pd
  - Pt
  - Any of these
22. Ethylene reacts with Baeyer's reagent to give
- ethane
  - ethyl alcohol
  - ethylene glycol
  - None of these
23. Ethyl alcohol is industrially prepared from ethylene by
- Permanganate oxidation
  - Catalytic reduction
  - Absorbing in  $\text{H}_2\text{SO}_4$  followed by hydrolysis
  - All the three
24. Sodium salt of benzene sulphonic acid on fusion with caustic soda gives
- Benzene
  - Phenol
  - Thiophenol
  - Benzoic acid
25. Acid catalyzed hydration of alkenes except ethene leads to the formation of
- primary alcohol
  - secondary or tertiary alcohol
  - mixture of primary and secondary alcohols
  - mixture of secondary and tertiary alcohols
26. Ethyl alcohol can be prepared from Grignard reagent by the reaction of :
- HCHO
  - $\text{R}_2\text{CO}$
  - RCN
  - $\text{RCOCl}$
27. Isopropyl alcohol is obtained by reacting which of the following alkenes with concentrated  $\text{H}_2\text{SO}_4$  followed by boiling with  $\text{H}_2\text{O}$ ?
- Ethylene
  - Propylene
  - 2-Methylpropene
  - Isoprene
28. Alkenes convert into alcohols by
- hydrolysis by dil.  $\text{H}_2\text{SO}_4$
  - hydration of alkene by alkaline  $\text{KMnO}_4$
  - hydrolysis by water vapours and conc.  $\text{HNO}_3$
  - hydration of alkene by aqueous KOH
29. Which of the following reacts with NaOH to give an alcohol?
- Propene
  - Butene
  - Ethanal
  - Methanal
30. By which of the following methods alcohol can be prepared in excellent yield?
- From alkenes
  - By hydroboration-oxidation
  - From carbonyl compounds
  - From Grignard reagent
31. Which of the following are used to convert  $\text{RCHO}$  into  $\text{RCH}_2\text{OH}$ ?
- $\text{H}_2/\text{Pd}$
  - $\text{LiAlH}_4$
  - $\text{NaBH}_4$
  - Reaction with  $\text{RMgX}$  followed by hydrolysis
- (i) and (ii)
  - (i), (ii) and (iii)
  - (ii), (iii) and (iv)
  - (i) and (iii)
32. Commercially carboxylic acids are reduced to alcohols by converting them to the \_\_\_\_\_.
- esters
  - aldehydes
  - ketones
  - amines

33. The hydrocarbon which produce phenol and acetone as a by product in the large quantity is
- (a)  (b) 
- (c)  (d) 
34. In the reaction,  $\text{RNH}_2 \xrightarrow[273-278\text{K}]{\text{HNO}_2} \text{ROH} + \text{H}_2\text{O} + \text{C} \uparrow$ ; C is (where R = C<sub>6</sub>H<sub>5</sub>)
- (a) NH<sub>3</sub> (b) N<sub>2</sub>  
(c) O<sub>2</sub> (d) CO<sub>2</sub>
35. The correct order of boiling points for primary (1°), secondary (2°) and tertiary alcohol (3°) is
- (a) 1° > 2° > 3° (b) 3° > 2° > 1°  
(c) 2° > 1° > 3° (d) 2° > 3° > 1°
36. Alcohols of low molecular weight are
- (a) soluble in water  
(b) soluble in water on heating  
(c) insoluble in water  
(d) insoluble in all solvents
37. Which of the following has lowest boiling point ?
- (a) *p*-Nitrophenol (b) *m*-Nitrophenol  
(c) *o*-Nitrophenol (d) Phenol
38. Which statement is not correct about alcohol?
- (a) Molecular weight of alcohol is higher than water  
(b) Alcohol of less no. of carbon atoms is less soluble in water than alcohol of more no. of carbon atoms  
(c) Alcohol evaporates quickly  
(d) All of the above
39. Which one of the following alcohols is least soluble in water?
- (a) CH<sub>3</sub>OH (b) C<sub>3</sub>H<sub>7</sub>OH  
(c) C<sub>4</sub>H<sub>9</sub>OH (d) C<sub>10</sub>H<sub>21</sub>OH
40. Methanol and ethanol are miscible in water due to
- (a) covalent character  
(b) hydrogen bonding character  
(c) oxygen bonding character  
(d) None of these
41. If ethanol dissolves in water, then which of the following would be observed
- (a) absorption of heat and contraction in volume  
(b) emission of heat and contraction in volume  
(c) absorption of heat and increase in volume  
(d) emission of heat and increase in volume
42. Which of the following is correct ?
- (a) On reduction of any aldehyde, secondary alcohol is formed  
(b) Reaction of vegetable oil with H<sub>2</sub>SO<sub>4</sub> gives glycerine  
(c) Sucrose on reaction with NaCl gives invert sugar  
(d) Alcoholic iodine gives iodoform with NaOH
43. Which of the following is not true in case of reaction with heated copper at 300°C?
- (a) Phenol  $\longrightarrow$  Benzyl alcohol  
(b) Secondary alcohol  $\longrightarrow$  Ketone  
(c) Primary alcohol  $\longrightarrow$  Aldehyde  
(d) Tertiary alcohol  $\longrightarrow$  Olefin
44. Phenol is more acidic than alcohol because
- (a) phenol is more stable than water  
(b) phenol is aromatic and alcohol is aliphatic  
(c) phenoxide ion is resonance stabilised  
(d) None of these
45. Acidity of phenol is due to
- (a) hydrogen bonding  
(b) phenolic group  
(c) benzene ring  
(d) resonance stabilisation of its anion
46. Which one of the following compounds has the most acidic nature?
- (a)  (b) 
- (c)  (d) 
47. The ionization constant of phenol is higher than that of ethanol because :
- (a) phenoxide ion is bulkier than ethoxide  
(b) phenoxide ion is stronger base than ethoxide  
(c) phenoxide ion is stabilized through delocalization  
(d) phenoxide ion is less stable than ethoxide
48. Which one of the following on oxidation gives a ketone ?
- (a) Primary alcohol (b) Secondary alcohol  
(c) Tertiary alcohol (d) All of these
49. Primary and secondary alcohols on action of reduced copper give
- (a) Aldehydes and ketones respectively  
(b) Ketones and aldehydes respectively  
(c) Only aldehydes  
(d) Only ketones
50. When ethyl alcohol reacts with acetic acid, the products formed are
- (a) Sodium ethoxide + hydrogen  
(b) Ethyl acetate + water  
(c) Ethyl acetate + soap  
(d) Ethyl alcohol + water



51. Which of the following compounds is oxidised to prepare methyl ethyl ketone?  
 (a) 2-Propanol (b) 1-Butanol  
 (c) 2-Butanol (d) t-Butyl alcohol
52. HBr reacts fastest with  
 (a) 2-Methylpropan-1-ol  
 (b) 2-Methylpropene-2-ol  
 (c) propan-2-ol  
 (d) propan-1-ol
53. *n*-Propyl alcohol and isopropyl alcohol can be chemically distinguished by which reagent?  
 (a)  $\text{PCl}_5$   
 (b) Reduction  
 (c) Oxidation with potassium dichromate  
 (d) Ozonolysis
54. Lucas reagent is  
 (a) Conc. HCl and anhydrous  $\text{ZnCl}_2$   
 (b) Conc.  $\text{HNO}_3$  and hydrous  $\text{ZnCl}_2$   
 (c) Conc. HCl and hydrous  $\text{ZnCl}_2$   
 (d) Conc.  $\text{HNO}_3$  and anhydrous  $\text{ZnCl}_2$
55. The compound which reacts fastest with Lucas reagent at room temperature is  
 (a) Butan-1-ol (b) Butan-2-ol  
 (c) 2-Methylpropan-1-ol (d) 2-Methylpropan-2-ol
56. When phenol is treated with excess bromine water, it gives:  
 (a) *m*-Bromophenol (b) *o*- and *p*-Bromophenol  
 (c) 2, 4-Dibromophenol (d) 2, 4, 6-Tribromophenol
57. When phenol is heated with  $\text{CHCl}_3$  and alcoholic KOH when salicylaldehyde is produced. This reaction is known as  
 (a) Rosenmund's reaction (b) Reimer-Tiemann reaction  
 (c) Friedel-Crafts reaction (d) Sommelet reaction
58. On distilling phenol with Zn dust, one gets :  
 (a) Toluene (b) Benzaldehyde + ZnO  
 (c) ZnO + benzene (d) Benzoic acid
59. Phenols do not react with one of the following :  
 (a) Alkali metals (b) Sodium hydroxide  
 (c) Potassium hydroxide (d) Sodium bi-carbonate
60. In the reaction  

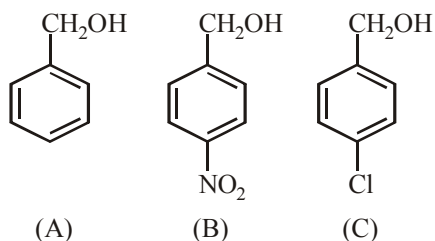
$$\text{Phenol} \xrightarrow{\text{NaOH}} (\text{A}) \xrightarrow[140^\circ]{\text{CO}_2 + \text{HCl}} (\text{B}), \text{ here B is}$$
  
 (a) benzaldehyde (b) chlorobenzene  
 (c) benzoic acid (d) salicylic acid
61. Dehydration of 2-butanol yields  
 (a) 1-butene (b) 2-butene  
 (c) 2-butyne (d) Both (a) and (b)
62. Lucas test is done to differentiate between  
 (a) alcohol and ketone  
 (b) alcohol and aromatic ketones  
 (c)  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  alcohols  
 (d) None of these
63. To distinguish between salicylic acid and phenol, one can use  
 (a)  $\text{NaHCO}_3$  solution (b) 5% NaOH solution  
 (c) neutral  $\text{FeCl}_3$  (d) bromine water
64. Ethyl alcohol exhibits acidic character on reacting it with  
 (a) acetic acid (b) sodium metal  
 (c) hydrogen chloride (d) acidic  $\text{K}_2\text{Cr}_2\text{O}_7$
65. For the reaction,  

$$\text{C}_2\text{H}_5\text{OH} + \text{HX} \xrightarrow{\text{ZnCl}_2} \text{C}_2\text{H}_5\text{X} + \text{H}_2\text{O}$$
  
 the order of reactivity is  
 (a)  $\text{HBr} > \text{HI} > \text{HCl}$  (b)  $\text{HI} > \text{HCl} > \text{HBr}$   
 (c)  $\text{HI} > \text{HBr} > \text{HCl}$  (d)  $\text{HCl} > \text{HBr} > \text{HI}$
66. In the following reaction,  

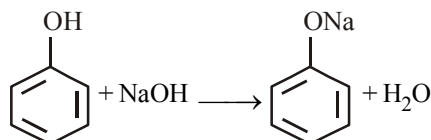
$$\text{C}_2\text{H}_5\text{OH} \xrightarrow[443\text{K}]{\text{Conc. H}_2\text{SO}_4} \text{Z} \text{ identify Z:}$$
  
 (a)  $\text{CH}_2 = \text{CH}_2$  (b)  $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$   
 (c)  $\text{CH}_3\text{CH}_2\text{HSO}_4$  (d)  $(\text{CH}_3\text{CH}_2)_2\text{SO}_4$
67. Chemical name of salol is  
 (a) acetylsalicylic acid (b) sodium salicylate  
 (c) phenyl salicylate (d) methyl salicylate
68. Aspirin is an acetylation product of  
 (a) *p*-Dihydroxybenzene (b) *o*-Hydroxybenzoic acid  
 (c) *o*-Dihydroxybenzene (d) *m*-Hydroxybenzoic acid
69. Phenol, when it first reacts with concentrated sulphuric acid and then with concentrated nitric acid, gives  
 (a) 2, 4, 6-trinitrobenzene (b) *o*-nitrophenol  
 (c) *p*-nitrophenol (d) nitrobenzene
70. 3 moles of ethanol react with one mole of phosphorus tribromide to form 3 moles of bromoethane and one mole of X. Which of the following is X?  
 (a)  $\text{H}_3\text{PO}_4$  (b)  $\text{H}_3\text{PO}_2$   
 (c)  $\text{HPO}_3$  (d)  $\text{H}_3\text{PO}_3$
71. Methanol and ethanol can be distinguished by the following:  
 (a) By reaction with metallic sodium  
 (b) By reaction with caustic soda  
 (c) By heating with iodine and washing soda  
 (d) By heating with zinc and inorganic mineral acid
72. Monochlorination of toluene in sunlight followed by hydrolysis with aq. NaOH yields.  
 (a) *o*-Cresol (b) *m*-Cresol  
 (c) 2, 4-Dihydroxytoluene (d) Benzyl alcohol
73. What is the correct order of reactivity of alcohols in the following reaction?  

$$\text{R}-\text{OH} + \text{HCl} \xrightarrow{\text{ZnCl}_2} \text{R}-\text{Cl} + \text{H}_2\text{O}$$
  
 (a)  $1^\circ > 2^\circ > 3^\circ$  (b)  $1^\circ < 2^\circ > 3^\circ$   
 (c)  $3^\circ > 2^\circ > 1^\circ$  (d)  $3^\circ > 1^\circ > 2^\circ$
74.  $\text{CH}_3\text{CH}_2\text{OH}$  can be converted into  $\text{CH}_3\text{CHO}$  by \_\_\_\_\_  
 (a) catalytic hydrogenation  
 (b) treatment with  $\text{LiAlH}_4$   
 (c) treatment with pyridinium chlorochromate  
 (d) treatment with  $\text{KMnO}_4$
75. Which of the following compounds will react with sodium hydroxide solution in water?  
 (a)  $\text{C}_6\text{H}_5\text{OH}$  (b)  $\text{C}_6\text{H}_5\text{CH}_2\text{OH}$   
 (c)  $(\text{CH}_3)_3\text{COH}$  (d)  $\text{C}_2\text{H}_5\text{OH}$

76. Phenol is less acidic than \_\_\_\_\_ .  
 (a) ethanol (b) *o*-nitrophenol  
 (c) *o*-methylphenol (d) *o*-methoxyphenol
77. Which of the following is most acidic?  
 (a) Benzyl alcohol (b) Cyclohexanol  
 (c) Phenol (d) *m*-Chlorophenol
78. Mark the correct increasing order of reactivity of the following compounds with HBr/HCl

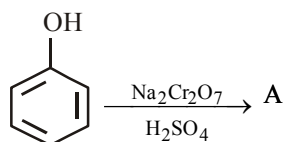


- (a)  $A < B < C$  (b)  $B < A < C$   
 (c)  $B < C < A$  (d)  $C < B < A$
79. Arrange the following in increasing order of their acidity?  
*o*-cresol(a), salicylic acid(b), phenol(c)  
 (a)  $c < a < b$  (b)  $b < c < a$   
 (c)  $a < b < c$  (d)  $a < c < b$
80. In the reaction

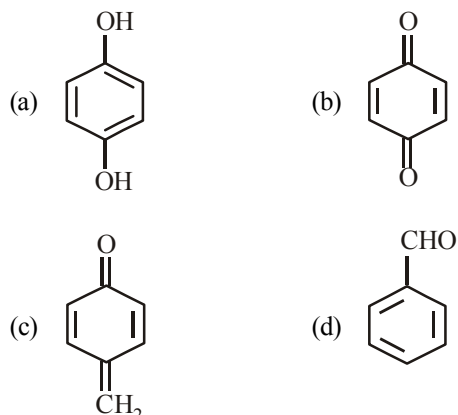


Phenol behaves as

- (a) Bronsted base (b) Bronsted acid  
 (c) Lewis acid (d) Lewis base
81. In the given reaction



A is



82. Which enzyme converts glucose and fructose both into ethanol ?  
 (a) Diastase (b) Invertase  
 (c) Zymase (d) Maltase
83. An industrial method of preparation of methanol is :  
 (a) catalytic reduction of carbon monoxide in presence of  $\text{ZnO-Cr}_2\text{O}_3$   
 (b) by reacting methane with steam at  $900^\circ\text{C}$  with a nickel catalyst  
 (c) by reducing formaldehyde with lithium aluminium hydride  
 (d) by reacting formaldehyde with aqueous sodium hydroxide solution
84. Ethyl alcohol is industrially prepared from ethylene by  
 (a) Permanganate oxidation  
 (b) Catalytic reduction  
 (c) Absorbing in  $\text{H}_2\text{SO}_4$  followed by hydrolysis  
 (d) All the three
85. 'Drinking alcohol' is very harmful and it ruins the health. 'Drinking alcohol' stands for  
 (a) drinking methyl alcohol  
 (b) drinking ethyl alcohol  
 (c) drinking propyl alcohol  
 (d) drinking isopropyl alcohol
86. The fermentation reactions are carried out in temperature range of  
 (a)  $20-30^\circ\text{C}$  (b)  $30-40^\circ\text{C}$   
 (c)  $40-50^\circ\text{C}$  (d)  $50-60^\circ\text{C}$
87. Ethanol is prepared industrially by  
 (a) hydration of ethylene (b) fermentation of sugar  
 (c) Both the above (d) None of these
88. The fermentation of starch to give alcohol occurs mainly with the help of  
 (a)  $\text{O}_2$  (b) air  
 (c)  $\text{CO}_2$  (d) enzymes
89. In the commercial manufacture of ethyl alcohol from starchy substances by fermentation method. Which enzymes slipwise complete the fermentation reaction  
 (a) Diastase, maltase and zymase  
 (b) Maltase, zymase and invertase  
 (c) Diastase, zymase and lactase  
 (d) Diastase, invertase and zymase
90. Methyl alcohol is toxic. The reason assigned is  
 (a) it stops respiratory track  
 (b) it reacts with nitrogen and forms  $\text{CN}^-$  in the lungs  
 (c) it increses  $\text{CO}_2$  content in the blood  
 (d) it is a reduction product of formaldehyde
91. In order to make alcohol undrinkable pyridine and methanol are added to it. The resulting alcohol is called  
 (a) Power alcohol (b) Proof spirit  
 (c) Denatured spirit (d) Poison alcohol
92. Wine (alcoholic beverages) contains  
 (a)  $\text{CH}_3\text{OH}$  (b) Glycerol  
 (c)  $\text{C}_2\text{H}_5\text{OH}$  (d) 2-propanol

93. Tonics in general contain  
(a) Ether (b) Methanol  
(c) Ethanol (d) Rectified spirit
94. Widespread deaths due to liquor poisoning occurs due to  
(a) presence of carbonic acid in liquor  
(b) presence of ethyl alcohol in liquor  
(c) presence of methyl alcohol in liquor  
(d) presence of lead compounds in liquor
95. Select the incorrect statement about the fermentation.  
(a) When grapes are crushed, sugar and the enzyme come in contact and fermentation starts  
(b) Fermentation takes place in anaerobic conditions  
(c) Carbon monoxide is released during fermentation  
(d) If air gets into fermentation mixture, the oxygen of air oxidises ethanol to ethanoic acid which in turn destroys the taste of alcoholic drinks
96. Denaturation of alcohol is the  
(a) mixing of  $\text{CuSO}_4$  (a foul smelling solid) and pyridine (to give the colour) to make the commercial alcohol unfit for drinking  
(b) mixing of  $\text{CuSO}_4$  (to give the colour) and pyridine (a foul smelling solid) to make the commercial alcohol unfit for drinking  
(c) mixing of  $\text{Cu}(\text{OAc})_2$  and ammonia to make the commercial alcohol unfit for drinking  
(d) mixing of  $\text{Cu}(\text{OAc})_2$  and pyridine to make the commercial alcohol unfit for drinking
97. Which one is formed when sodium phenoxide is heated with ethyl iodide?  
(a) Phenetole (b) Ethyl phenyl alcohol  
(c) Phenol (d) None of these
98. Williamson's synthesis is used to prepare  
(a) acetone (b) diethyl ether  
(c) P.V.C. (d) bakelite
99. The reaction of sodium ethoxide with ethyl iodide to form diethyl ether is termed  
(a) electrophilic substitution  
(b) nucleophilic substitution  
(c) electrophilic addition  
(d) radical substitution
100. Which of the following cannot be made by using Williamson's synthesis?  
(a) Methoxybenzene  
(b) Benzyl p-nitrophenyl ether  
(c) Methyl tertiary butyl ether  
(d) Di-tert-butyl ether
101. The reaction given below is known as  
 $\text{C}_2\text{H}_5\text{ONa} + \text{IC}_2\text{H}_5 \longrightarrow \text{C}_2\text{H}_5\text{OC}_2\text{H}_5 + \text{NaI}$   
(a) Kolbe's synthesis  
(b) Wurtz synthesis  
(c) Williamson's synthesis  
(d) Grignard's synthesis
102. Ethanol and dimethyl ether form a pair of functional isomers. The boiling point of ethanol is higher than that of dimethyl ether, due to the presence of  
(a) H-bonding in ethanol  
(b) H-bonding in dimethyl ether  
(c)  $\text{CH}_3$  group in ethanol  
(d)  $\text{CH}_3$  group in dimethyl ether
103. Ether which is liquid at room temperature is  
(a)  $\text{C}_2\text{H}_5\text{OCH}_3$  (b)  $\text{CH}_3\text{OCH}_3$   
(c)  $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$  (d) None of these
104. Ether can be used  
(a) as a general anaesthetic  
(b) as a refrigerant  
(c) in perfumery  
(d) all of the above
105. Which of the following compound is soluble in ether?  
(a) Oils and fats (b) Water  
(c)  $\text{NaCl}$  (d)  $\text{PCl}_5$
106. An ether is more volatile than an alcohol having the same molecular formula. This is due to  
(a) dipolar character of ethers  
(b) alcohols having resonance structures  
(c) inter-molecular hydrogen bonding in ethers  
(d) inter-molecular hydrogen bonding in alcohols
107. Which of the following has strongest hydrogen bonding?  
(a) Ethyl amine (b) Ethanal  
(c) Ethyl alcohol (d) Diethyl ether
108. Oxygen atom in ether is  
(a) very active (b) replaceable  
(c) comparatively inert (d) active
109. The ether that undergoes electrophilic substitution reactions is  
(a)  $\text{CH}_3\text{OC}_2\text{H}_5$  (b)  $\text{C}_6\text{H}_5\text{OCH}_3$   
(c)  $\text{CH}_3\text{OCH}_3$  (d)  $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
110. Diethyl ether on heating with conc. HI gives two moles of  
(a) ethanol (b) iodoform  
(c) ethyl iodide (d) methyl iodide
111. Methylphenyl ether can be obtained by reacting  
(a) phenolate ions and methyl iodide  
(b) methoxide ions and bromobenzene  
(c) methanol and phenol  
(d) bromo benzene and methyl bromide
112. Diethyl ether can be decomposed by heating with  
(a) HI (b) NaOH  
(c) Water (d)  $\text{KMnO}_4$
113. The major organic product in the reaction,  
 $\text{CH}_3 - \text{O} - \text{CH}(\text{CH}_3)_2 + \text{HI} \rightarrow \text{Product}$  is  
(a)  $\text{ICH}_2\text{OCH}(\text{CH}_3)_2$  (b)  $\text{CH}_3\text{OC}(\text{CH}_3)_2$   
(c)  $\text{CH}_3\text{I} + (\text{CH}_3)_2\text{CHOH}$  (d)  $\text{CH}_3\text{OH} + (\text{CH}_3)_2\text{CHI}$
114. An aromatic ether is not cleaved by HI even at 525 K. The compound is  
(a)  $\text{C}_6\text{H}_5\text{OCH}_3$  (b)  $\text{C}_6\text{H}_5\text{OC}_6\text{H}_5$   
(c)  $\text{C}_6\text{H}_5\text{OC}_3\text{H}_7$  (d) Tetrahydrofuran

115. When 2-methoxypropane is heated with HI, in the mole ratio 1 : 1, the major products formed are  
 (a) methanol and 2-iodopropane  
 (b) methyl iodide and 2-propanol  
 (c) methyl iodide and 2-iodopropane  
 (d) methanol and 2-propanol
116. Formation of diethyl ether from ethanol is based on a  
 (a) dehydration reaction  
 (b) dehydrogenation reaction  
 (c) hydrogenation reaction  
 (d) heterolytic fission reaction
117. The cleavage of an aryl-alkyl ether with cold HI gives :  
 (a) alkyl iodide and water  
 (b) aryl iodide and water  
 (c) alkyl iodide, aryl iodide and water  
 (d) phenol and alkyl iodide
118. Which of the following compounds is resistant to nucleophilic attack by hydroxyl ions?  
 (a) Methyl acetate (b) Acetonitrile  
 (c) Acetamide (d) Diethyl ether

### STATEMENT TYPE QUESTIONS

119. When an alcohol is prepared by reaction of ethylmagnesium-bromide with 2-pentanone, product formed does not rotate plane polarised light. For this reaction which of the following statement(s) is/are correct ?  
 (i). Product formed is achiral.  
 (ii). Racemic mixture is formed.  
 (a) Both statements (i) and (ii) are correct.  
 (b) Statement (i) is correct only.  
 (c) Statement (ii) is correct only.  
 (d) Both statements (i) and (ii) are incorrect.
120. Which of the following statements are correct ?  
 (i) Alcohols react as nucleophiles in the reactions involving cleavage of O-H bond.  
 (ii) Alcohols react as electrophiles in the reactions involving cleavage of O-H bond.  
 (iii) Alcohols react as nucleophile in the reaction involving cleavage of C-O bond.  
 (iv) Alcohols react as electrophiles in the reactions involving C-O bond.  
 (a) (i) only (b) (i) and (iv)  
 (c) (ii) and (iii) (d) (ii) only
121. Which of the following are correct statement(s) ?  
 (i) Polar nature of O-H bond is responsible for acidic character of alcohols.  
 (ii) Acidic strength of alcohols follow the order  $1^\circ > 2^\circ > 3^\circ$ .  
 (iii) Alcohols are stronger acids than water.  
 (iv) Alcohols also react as Bronsted base.  
 (a) (i), (ii) and (iii) (b) (i), (ii) and (iv)  
 (c) (ii), (iii) and (iv) (d) (i), (iii) and (iv)
122. Read the following statements and choose the correct option.  
 (i) Ethanol on dehydration at 443 K gives ethene  
 (ii) Ethanol on dehydration at 413 K gives diethyl ether

- (iii) Only primary alcohols on dehydration give ethers.  
 (iv) Secondary and tertiary alcohols on dehydration give ethers having  $2^\circ$  and  $3^\circ$  carbon attached with O atom.

- (a) TTFF (b) TFTF  
 (c) TTTF (d) FTTF

123. Which of the following statements are correct ?

- (i) In phenols, the —OH group is attached to  $sp^2$  hybridised carbon of an aromatic ring  
 (ii) The carbon – oxygen bond length (136 pm) in phenol is slightly more than that in methanol  
 (iii) Partial double bond character is due to the conjugation of unshared electron pair of oxygen with the aromatic ring.  
 (iv)  $sp^2$  hybridised state of carbon to which oxygen is attached.

- (a) (i), (ii) and (v) (b) (i), (ii) and (iii)  
 (c) (i), (iii) and (iv) (d) (i) and (iv)

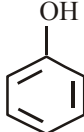
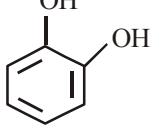
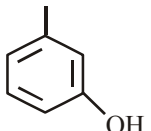
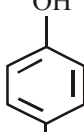
124. Which of the following statements are correct ?

- (i) Ethanol mixed with methanol is called denatured alcohol.  
 (ii) Excess of methanol in body may cause blindness.  
 (iii) In the body methanol is oxidised to methanoic acid.  
 (iv) A methanol poisoned patient is treated by giving intravenous injections of ethanoic acid.

- (a) (i), (ii) and (iii) (b) (ii), (iii) and (iv)  
 (c) (i) and (v) (d) (i), (iii) and (iv)

### MATCHING TYPE QUESTIONS

125. Match the columns

Column-I	Column-II
(A) 	(p) Quinol
(B) 	(q) Phenol
(C) 	(r) Catechol
(D) 	(s) Resorcinol
(a) A – (q), B – (p), C – (s), D – (r)	
(b) A – (r), B – (p), C – (s), D – (q)	
(c) A – (s), B – (q), C – (p), D – (r)	
(d) A – (q), B – (r), C – (s), D – (p)	

126. Match the columns

Column-I	Column-II
(A) Methanol	(p) Conversion of phenol to <i>o</i> -hydroxysalicylic acid
(B) Kolbe's reaction	(q) Wood spirit
(C) Williamson's synthesis	(r) Heated copper at 573 K
(D) Conversion of 2° alcohol to ketone	(s) Reaction of alkyl halide with sodium alkoxide
(a) A – (s), B – (r), C – (q), D – (p)	
(b) A – (q), B – (s), C – (p), D – (r)	
(c) A – (q), B – (p), C – (s), D – (r)	
(d) A – (r), B – (q), C – (p), D – (s)	

127. Match the columns

Column-I	Column-II
(A) Antifreeze used in car engine	(p) Methanol
(B) Solvent used in perfumes	(q) Phenol
(C) Starting material for picric acid	(r) Ethleneglycol
(D) Wood spirit	(s) Ethanol
(a) A – (s), B – (q), C – (p), D – (r)	
(b) A – (r), B – (s), C – (q), D – (p)	
(c) A – (s), B – (q), C – (r), D – (p)	
(d) A – (p), B – (r), C – (q), D – (s)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion.  
 (c) Assertion is correct, reason is incorrect.  
 (d) Assertion is incorrect, reason is correct.

128. **Assertion :** The bond angle in alcohols is slightly less than the tetrahedral angle.

**Reason :** In alcohols, the oxygen of –OH group is attached to  $sp^3$  hybridized carbon atom.

129. **Assertion :** In Lucas test, 3° alcohols react immediately.

**Reason :** An equimolar mixture of anhyd.  $ZnCl_2$  and conc. HCl is called Lucas reagent.

130. **Assertion :** Reimer-Tiemann reaction of phenol with  $CCl_4$  in NaOH at 340 K gives salicylic acid as the major product.

**Reason :** The reaction occurs through intermediate formation of dichlorocarbene.

131. **Assertion :** Phenol is more reactive than benzene towards electrophilic substitution reaction.

**Reason :** In the case of phenol, the intermediate carbocation is more resonance stabilized.

132. **Assertion :** In case of phenol, bromination takes place even in absence of Lewis acid whereas bromination of benzene takes place in presence of Lewis acid like  $FeBr_3$ .

**Reason :** –OH group attached to benzene ring is highly deactivating.

133. **Assertion :** *ter*-Butyl methyl ether is not prepared by the reaction of *ter*-butyl bromide with sodium methoxide.

**Reason :** Sodium methoxide is a strong nucleophile.

134. **Assertion :** Ethers behave as bases in the presence of mineral acids.

**Reason :** Due to the presence of lone pairs of electrons on oxygen.

135. **Assertion :** With HI, anisole gives iodobenzene and methyl alcohol.

**Reason :** Iodide ion combines with smaller group to avoid steric hindrance.

136. **Assertion :** With HI at 373 K, *ter*-butyl methyl ether gives *ter*-butyl iodide and methanol.

**Reason :** The reaction occurs by  $S_N2$  mechanism.

137. **Assertion :** Ethyl phenyl ether on reaction with HBr form phenol and ethyl bromide.

**Reason :** Cleavage of C–O bond takes place on ethyl-oxygen bond due to the more stable phenyl-oxygen bond.

### CRITICAL THINKING TYPE QUESTIONS

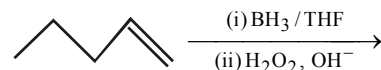
138. Vinyl carbinol is

- (a)  $HO-CH_2-CH=CH_2$   
 (b)  $CH_3C(OH)=CH_2$   
 (c)  $CH_3-CH=CH-OH$   
 (d)  $CH_3-C(CH_2OH)=CH_2$

139. Propene,  $CH_3CH=CH_2$  can be converted into 1-propanol by oxidation. Indicate which set of reagents amongst the following is ideal to effect the above conversion ?

- (a)  $KMnO_4$  (alkaline)  
 (b) Osmium tetroxide ( $OsO_4/CH_2Cl_2$ )  
 (c)  $B_6H_6$  and alk.  $H_2O_2$   
 (d)  $O_3/Zn$

140. The product of the following reaction is



- (a) 1-Pentanol  
 (b) 2-Pentanol  
 (c) Pentane  
 (d) 1,2-Pentanediol

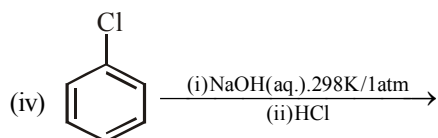
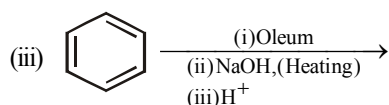
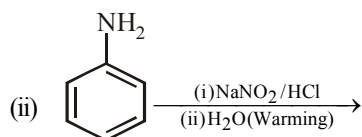
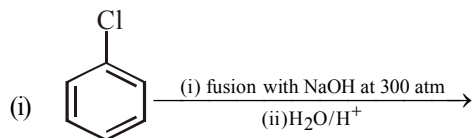
141.  $C_6H_5-CH=CHCHO \xrightarrow{X} C_6H_5CH=CHCH_2OH$ .

In the above sequence X can be

- (a)  $H_2/Ni$   
 (b)  $NaBH_4$   
 (c)  $K_2Cr_2O_7/H^+$   
 (d) Both (a) and (b)



142. Which of the following reactions will yield phenol?



- (a) (i), (ii) and (iii) (b) (i) and (iii)  
(c) (i), (iii) and (iv) (d) (ii), (iii) and (iv)

143. Hydration of styrene is carried out in presence of acid as catalyst. The major product is.

- (a) 1-hydroxy-2-phenylethane.  
(b) 1-hydroxy-1-phenylethane.  
(c) 2-hydroxy-1-phenylethane.  
(d) 2-hydroxy-2-phenylethane.

144. Which of the following reagents can be used for preparation of cumene ?

- (i)  $C_6H_6$ ,  $Cl_2$ , hv; Mg, THF; acetone.  
(ii)  $C_6H_6$ ,  $CH_3CH_2CH_2Cl$ ,  $AlCl_3$ .  
(iii)  $C_6H_6$ ,  $CH_3CHClCH_3$ ,  $AlCl_3$ .  
(iv)  $C_6H_6$ ,  $CH_3CH_2Cl$ ,  $AlCl_3$ .  
(a) (i) and (ii) (b) (ii) and (iii)  
(c) (i), (ii) and (iii) (d) (ii) and (iv)

145. The hydroboration of an alkene is carried out, then on oxidation with hydrogen peroxide, the alcohol so obtained is achiral. Possible structure of alkene is (are) :

- (i) 2, 3- dimethylbut-2-ene.  
(ii) 3, 4- dimethylbut -3-ene.  
(iii) 2-methyl-but-2-ene.  
(iv) 2-methylpropene.  
(a) (i) and (iv) (b) (ii) and (iii)  
(c) (iii) and (iv) (d) (i) and (iii)

146. Which of the following shows structure of allylic alcohol?

- (i)  $CH_2=CH-CH_2OH$   
(ii)  $CH_2=CH-OH$   
(iii)  $CH_2=CH-CH(CH_3)OH$   
(iv)  $CH_2=CH-C(CH_3)_2OH$   
(a) (i), (iii) and (iv) (b) (i), (ii) and (iv)  
(c) (ii), (iii) and (iv) (d) (i), (ii), (iii) and (iv)

147. Mechanism of acid catalysed hydration reaction involves

- (i) Protonation of alkene to form carbocation by electrophilic attack of  $H_3O^+$   
(ii) Nucleophilic attack of water on carbocation.  
(iii) Deprotonation to form alcohol.  
(a) (i) and (ii) (b) (i) and (iii)  
(c) (i), (ii) and (iii) (d) (ii) and (iii)

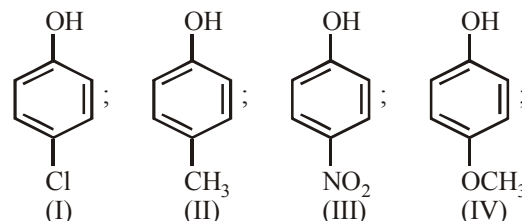
148. Phenol is less acidic than

- (a) acetic acid (b) *p*-methoxyphenol  
(c) acetylene (d) ethanol

149. The correct order of acid strength of the following compounds :

- (A) Phenol (B) *p*-Cresol  
(C) *m*-Nitrophenol (D) *p*-Nitrophenol  
(a)  $D > C > A > B$  (b)  $B > D > A > C$   
(c)  $A > B > D > C$  (d)  $C > B > A > D$

150. Arrange the following compounds in order of decreasing acidity :



- (a)  $II > IV > I > III$  (b)  $I > II > III > IV$   
(c)  $III > I > II > IV$  (d)  $IV > III > I > II$

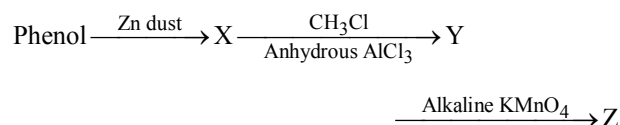
151.  $ClCH_2CH_2OH$  is stronger acid than  $CH_3CH_2OH$  because of:

- (a) -I effect of Cl increases negative charge on O atom of alcohol  
(b) -I effect of Cl disperses negative charge on O atom to produce more stable cation  
(c) -I effect of Cl disperses negative charge on O atom to produce more stable anion  
(d) None of these

152. Which one of the following compounds will be most readily attacked by an electrophile ?

- (a) Chlorobenzene (b) Benzene  
(c) Phenol (d) Toluene

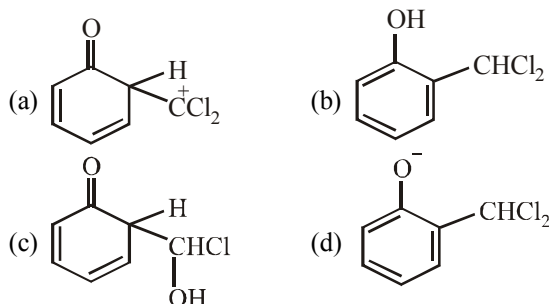
153. Consider the following reaction:



The product Z is

- (a) benzaldehyde (b) benzoic acid  
(c) benzene (d) toluene

154. When phenol is reacted with  $\text{CHCl}_3$  and  $\text{NaOH}$  followed by acidification, salicylaldehyde is obtained. Which of the following species are involved in the above mentioned reaction as intermediate?



155. The reagent used for dehydration of an alcohol is  
 (a) phosphorus pentachloride  
 (b) calcium chloride  
 (c) aluminium oxide  
 (d) sodium chloride
156. The alcohol which does not give a stable compound on dehydration is  
 (a) ethyl alcohol  
 (b) methyl alcohol  
 (c) n-Propyl alcohol  
 (d) n-Butyl alcohol
157. A compound of the formula  $\text{C}_4\text{H}_{10}\text{O}$  reacts with sodium and undergoes oxidation to give a carbonyl compound which does not reduce Tollen's reagent, the original compound is  
 (a) Diethyl ether  
 (b) n-Butyl alcohol  
 (c) Isobutyl alcohol  
 (d) sec-Butyl alcohol
158. Which of the following fact(s) explain as to why p-nitrophenol is more acidic than phenol?  
 I. -I Effect of nitro group.  
 II. Greater resonance effect of p-nitrophenoxy group  
 III. Steric effect of bulky nitro group  
 (a) I and II  
 (b) I and III  
 (c) II and III  
 (d) II alone

159. In the following sequence of reactions,  

$$\text{CH}_3\text{CH}_2\text{OH} \xrightarrow{\text{P}+\text{I}_2} \text{A} \xrightarrow[\text{ether}]{\text{Mg}} \text{B} \xrightarrow{\text{HCHO}} \text{C} \xrightarrow{\text{H}_2\text{O}} \text{D}$$

the compound D is

- (a) propanal  
 (b) butanal  
 (c) n-butyl alcohol  
 (d) n-propyl alcohol.
160. Which of the following species can act as the strongest base?  
 (a)  $^-\text{OH}$   
 (b)  $^-\text{OR}$   
 (c)  $^-\text{OC}_6\text{H}_5$   
 (d)
161. Which of the following reagents can be used to oxidise primary alcohols to aldehydes?  
 (i)  $\text{CrO}_3$  in anhydrous medium.  
 (ii)  $\text{KMnO}_4$  in acidic medium.  
 (iii) Pyridinium chlorochromate.  
 (iv) Heat in the presence of  $\text{Cu}$  at 573K.  
 (a) (i) and (iii)  
 (b) (ii), (iii) and (iv)  
 (c) (i), (iii) and (iv)  
 (d) (i), (iii) and (iv)

162. Which one of the following will show the highest pH value?  
 (a) m-nitrophenol.  
 (b) p-nitrophenol.  
 (c) o-nitrophenol.  
 (d) Both (b) and (c).

163. Which of the following is most reactive towards aqueous  $\text{HBr}$ ?

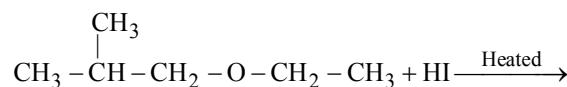
- (a) 1-Phenyl-1-propanol  
 (b) 1-Phenyl-2-propanol  
 (c) 3-Phenyl-1-propanol  
 (d) All are equally reactive

164. The major product of the reaction between tert-butyl chloride and sodium ethoxide is

- (a) 2-methylprop-1-ene  
 (b) 1-butene  
 (c) 2-butene  
 (d) ethene

165. In Williamson synthesis if tertiary alkyl halide is used than  
 (a) ether is obtained in good yield  
 (b) ether is obtained in poor yield  
 (c) alkene is the only reaction product  
 (d) a mixture of alkene as a major product and ether as a minor product forms.

166. In the reaction:



Which of the following compounds will be formed?

- (a)  $\text{CH}_3 - \overset{\text{CH}_3}{\underset{|}{\text{CH}}} - \text{CH}_3 + \text{CH}_3\text{CH}_2\text{OH}$   
 (b)  $\text{CH}_3 - \overset{\text{CH}_3}{\underset{|}{\text{CH}}} - \text{CH}_2\text{OH} + \text{CH}_3\text{CH}_3$   
 (c)  $\text{CH}_3 - \overset{\text{CH}_3}{\underset{|}{\text{CH}}} - \text{CH}_2\text{OH} + \text{CH}_3 - \text{CH}_2 - \text{I}$   
 (d)  $\text{CH}_3 - \overset{\text{CH}_3}{\underset{|}{\text{CH}}} - \text{CH}_2 - \text{I} + \text{CH}_3\text{CH}_2\text{OH}$

167. In the reaction  $\xrightarrow{\text{HBr}}$  the products are

- (a) and  $\text{CH}_4$   
 (b) and  $\text{CH}_3\text{Br}$   
 (c) and  $\text{CH}_3\text{OH}$   
 (d) and  $\text{CH}_3\text{Br}$

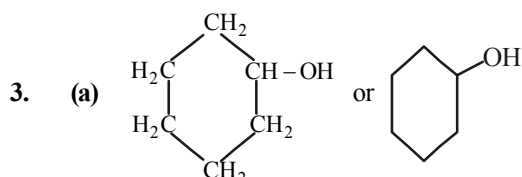
168. An aromatic ether is not cleaved by  $\text{HI}$  even at 525 K. The compound is

- (a)  $\text{C}_6\text{H}_5\text{OCH}_3$   
 (b)  $\text{C}_6\text{H}_5\text{OC}_6\text{H}_5$   
 (c)  $\text{C}_6\text{H}_5\text{OC}_3\text{H}_7$   
 (d) Tetrahydrofuran

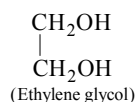
# HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

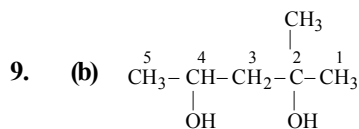
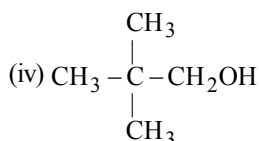
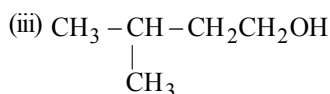
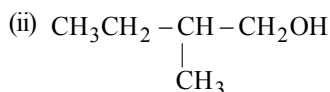
1. (b) 2. (b)



4. (b) Glycols are dihydric alcohols (having two hydroxyl groups). Ethylene glycol is the first member of this series.



5. (c) Ethers contain the functional group – O –  
6. (b)  $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$  – a secondary alcohol  
7. (b) Cresol has phenolic group – OH  
8. (b) Four primary alcohols of  $\text{C}_5\text{H}_{11}\text{OH}$  are possible. These are:



2-methyl- 2, 4-pentanediol.

10. (b)  $\text{C}_4\text{H}_{10}\text{O}$ : (i)  $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$  (ii)  $\text{CH}_3\text{OC}_3\text{H}_7$   
(iii)  $\text{CH}_3\text{OCH}(\text{CH}_3)_2$

11. (c) 12. (a) 13. (c) 14. (a) 15. (c)

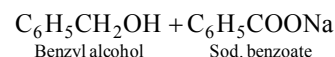
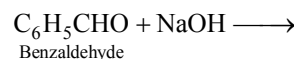
16. (b)

17. (c) In this structure –OH group is directly attached to double bonded carbon atom i.e.  $sp^2$  hybridized carbon atom.

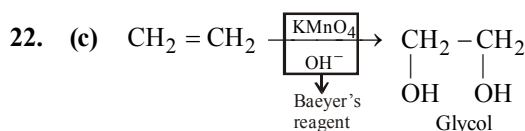
18. (c) If two groups attached to the oxygen atom are different then ethers are known as unsymmetrical or mixed ethers.

19. (d) Benzoic acid ( $\text{C}_6\text{H}_5\text{COOH}$ ) will not form phenol or phenoxide.

20. (b) By heating benzaldehyde with conc. NaOH or KOH (Cannizzaro reaction).

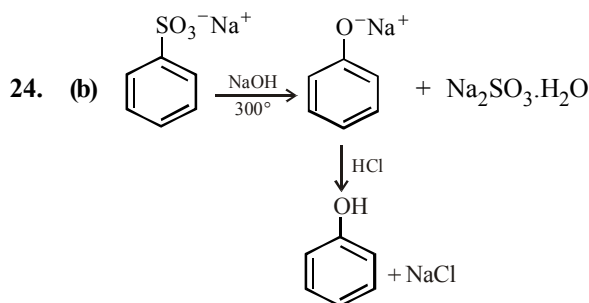
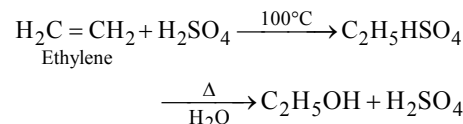


21. (d) Any one of Ni, Pt or Pd can be used in the reduction of aldehydes.

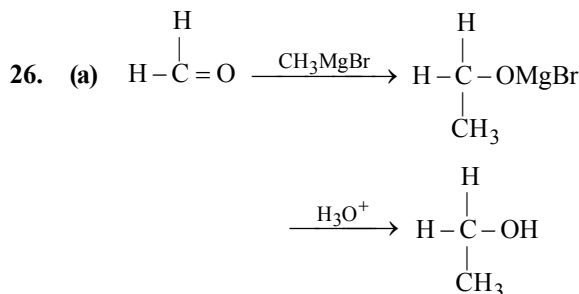


This reaction is known as Baeyer's test for unsaturation.

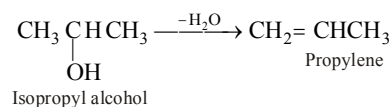
23. (c) Ethylene is passed into concentrated sulphuric acid at  $75-80^\circ\text{C}$  under pressure when a mixture of ethyl hydrogen sulphate and diethyl sulphate is formed.

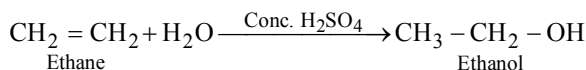
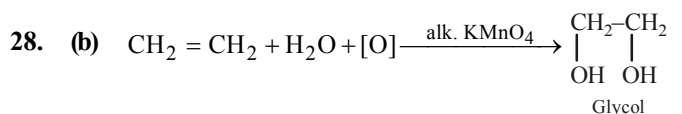


25. (b)

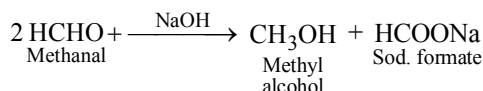


27. (b) Since the compound is formed by hydration of an alkene, to get the structure of alkene remove a molecule of water from the alcohol.



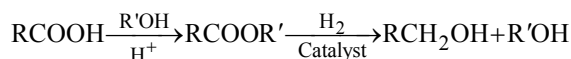


29. (d) The aldehydes which do not have  $\alpha$ -hydrogen atom react with NaOH when half of molecules are reduced to alcohol and other half of molecules are oxidised to acid (Cannizzaro reaction).



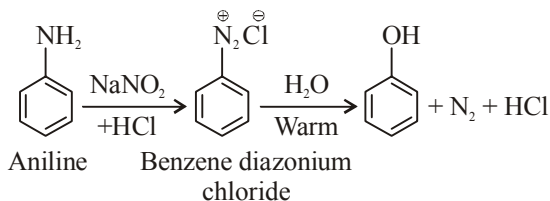
30. (b) 31. (b)

32. (a) Commercially, acids are reduced to alcohols by converting them to the esters, followed by their reduction using hydrogen in the presence of catalyst (catalytic hydrogenation).

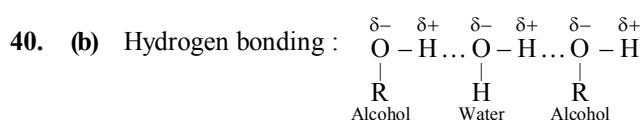


33. (d)

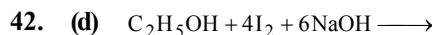
34. (b) A diazonium salt is formed by treating an aromatic primary amine with nitrous acid ( $\text{NaNO}_2 + \text{HCl}$ ) at 273-278 K. Diazonium salts are hydrolysed to phenols by warming with water or by treating with dilute acids.



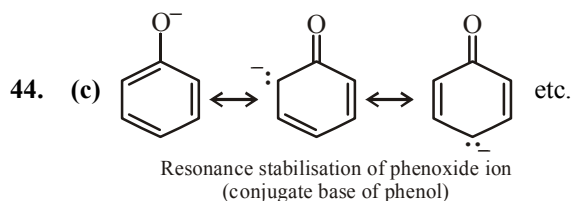
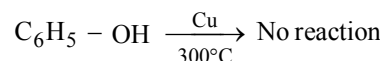
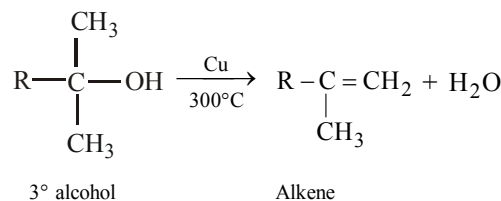
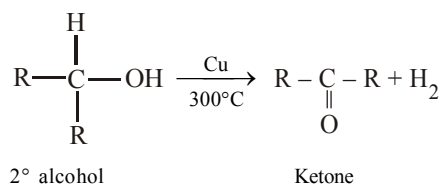
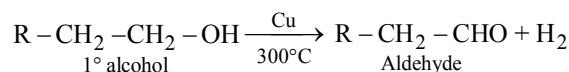
35. (a) Among isomeric alcohols surface area decreases from 1° to 2° to 3° alcohols and hence the boiling point.
36. (a) The lower alcohols are readily soluble in water and the solubility decreases with the increase in molecular weight. The solubility of alcohols in water can be explained due to the formation of hydrogen bond between the highly polarised —OH groups present both in alcohol and water.
37. (c) *o*-Nitrophenol has intramolecular H-bonding.
38. (b) The solubility of alcohols depend on number of C-atoms of alcohols. The solubility of alcohols in water is decreased by increasing number of C-atoms of alcohol. As resulting molecular weight increases, the polar nature of O — H bond decreases and hence strength of hydrogen bond decreases.
39. (d) Solubility of alcohol in water decreases with increase in molecular mass due to increase in water repelling alkyl part in alcohol.



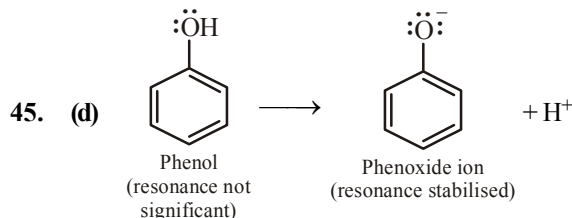
41. (b) When ethanol dissolves in water then there is emission of heat and contraction in volume.



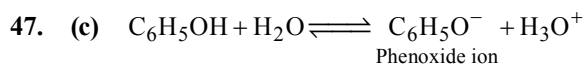
43. (a) When primary (1°) alcohols are treated with copper at 300°C, then aldehydes are obtained by dehydrogenation of alcohols. Similarly secondary (2°) alcohols form ketone and alkene is obtained by dehydration of tertiary (3°) - alcohols. But phenol does not respond to this test.



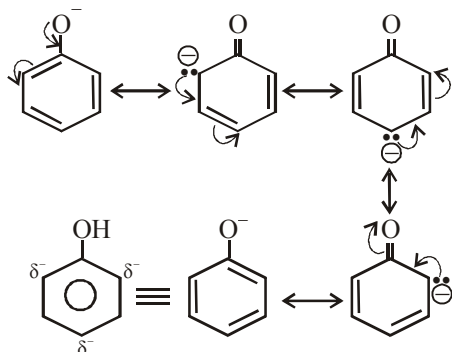
Conjugate base of ethyl alcohol, i.e.,  $\text{C}_2\text{H}_5\text{O}^-$  does not show resonance.



46. (b) Phenol is most acidic because its conjugate base is stabilised due to resonance, while the rest three compounds are alcohols, hence, their corresponding conjugate bases do not exhibit resonance.

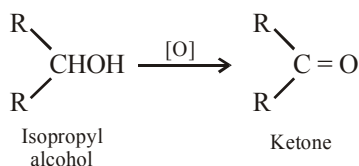


The phenoxide ion is stable due to resonance.

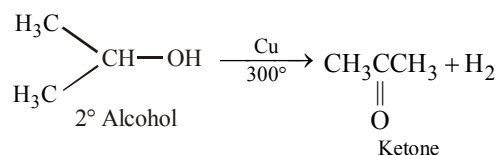
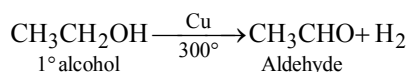


The negative charge is delocalized in the benzene ring which is a stabilizing factor in the phenoxide ion and because of this reason ionization constant of phenol is higher whereas no resonance is possible in alkoxide ions ( $\text{RO}^-$ ) derived from alcohol. The negative charge is localized on oxygen atom in case of alcohols.

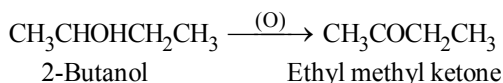
48. (b) Secondary alcohols on oxidation give ketones.  
Note : – Primary alcohols from aldehydes.



49. (a) Alcohols are oxidized by removal of  $\text{H}_2$  in presence of a heated metal catalyst (Cu)

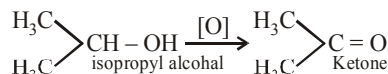
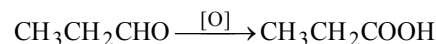
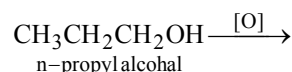


51. (c) Secondary alcohols oxidise to produce ketone.



52. (b) Greater the stability of the intermediate carbocation, more reactive is the alcohol. Since 2-methylpropan-2-ol generates  $3^\circ$  carbocation, therefore, it reacts fastest with  $\text{HBr}$ .

53. (c) Primary alcohol on oxidation give aldehyde which on further oxidation give carboxylic acid whereas secondary alcohols give ketone.

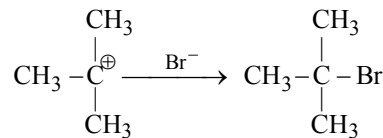
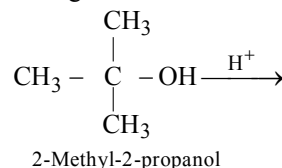


54. (a) Lucas reagent is conc.  $\text{HCl} + \text{anhyd. ZnCl}_2$ .

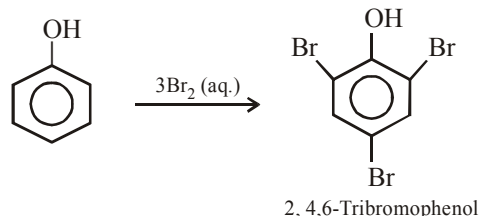
55. (d) The rates of reaction with lucas reagent follows the order.

$3^\circ \text{ alcohol} > 2^\circ \text{ alcohol} > 1^\circ \text{ alcohol}$

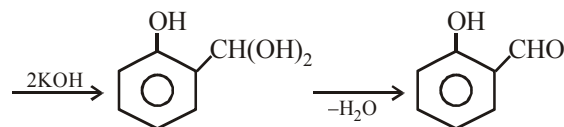
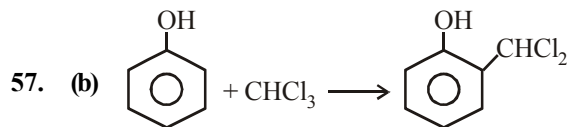
since carbocations are formed as intermediate, more stable the carbocation, higher will be the reactivity of the parent compound (alcohol). 2-Methylpropan-2-ol generates a  $3^\circ$  carbocation, so it will react fastest; other three generates either  $1^\circ$  or  $2^\circ$  carbocations.



56. (d)

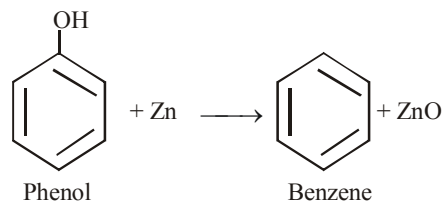


**Note :** The  $-\text{OH}$  group in phenol, being activating group, facilitates substitution in the *o*- and *p*-positions.



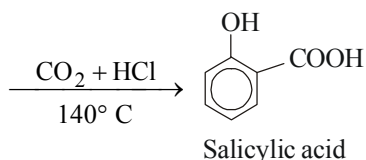
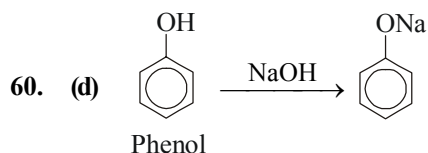
Reimer-Tiemann reaction.

58. (c) When phenol reacts with Zinc dust, then benzene and zinc oxide are formed

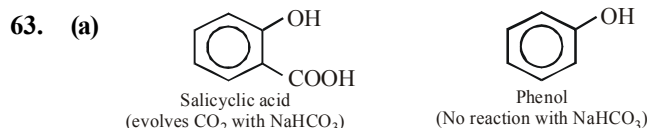




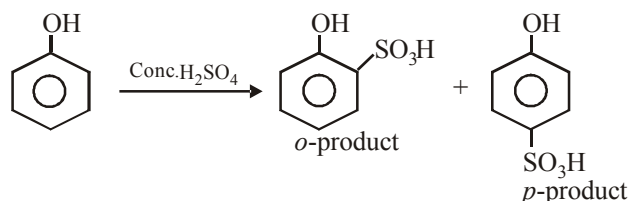
59. (d) Phenol does not react with  $\text{NaHCO}_3$ .



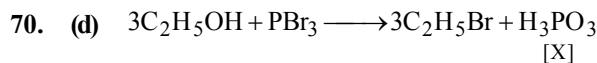
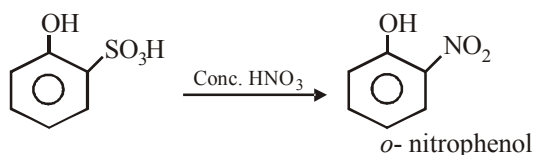
61. (d)  $\text{CH}_3\text{CH}_2\text{CHOH} \xrightarrow{-\text{H}_2\text{O}}$
- $\text{CH}_3$
- $\text{CH}_3\text{CH}=\text{CHCH}_3 + \text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$
- (Major product) (Minor product)
62. (c) Lucas test is used to distinguish between  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  alcohols. Lucas reagent is anhydrous  $\text{ZnCl}_2$  and  $\text{HCl}$ .  
 $3^\circ$  alcohol + Lucas reagent  $\longrightarrow$  turbidity immediately  
 $2^\circ$  alcohol + Lucas reagent  $\longrightarrow$  turbidity after 5 minutes  
 $1^\circ$  alcohol + Lucas reagent  $\longrightarrow$  No turbidity at room temperature.



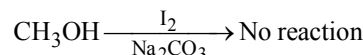
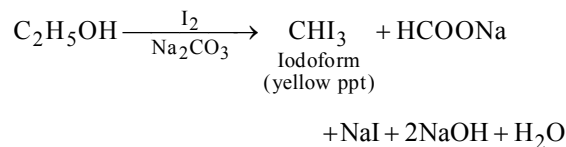
64. (b) Other options are acids, only Na metal is a base.  
 65. (c) Reactivity increases as the nucleophilicity of the halide ion increases, i.e.  $\text{I}^- > \text{Br}^- > \text{Cl}^-$ .  
 66. (a) In presence of acid, alcohols always form carbocations as intermediates.  
 67. (c) 68. (b)  
 69. (b) Phenol on reaction with conc.  $\text{H}_2\text{SO}_4$  gives a mixture of *o*- and *p*- products (i.e.,  $-\text{SO}_3\text{H}$  group, occupies *o*-, *p*- position). At room temperature *o*-product is more stable, which on treatment with conc.  $\text{HNO}_3$  will yield *o*-nitrophenol.



At room temperature *o*- product is more stable

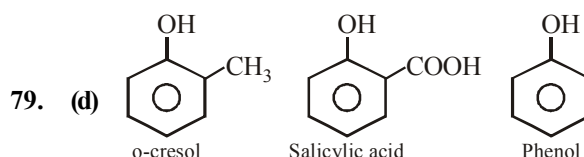


71. (c) Methanol and ethanol can be distinguished by heating with iodine and washing soda



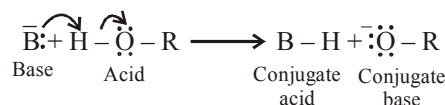
This is also called iodoform test.

72. (d) 73. (c) 74. (c) 75. (a) 76. (b)  
 77. (d) 78. (c)

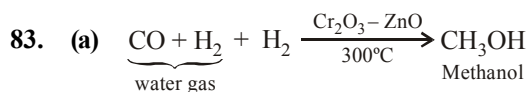
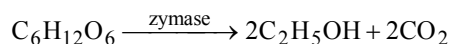


Electron releasing groups ( $-\text{CH}_3$ ,  $-\text{OCH}_3$ ,  $-\text{NCH}_3$  etc) intensify the negative charge of phenoxide ion, i.e., destabilises it hence decrease ionization of parent phenol. Therefore decreases acidity while electron donating groups ( $-\text{NO}_2$ ,  $-\text{COOH}$ ,  $-\text{CHO}$  etc.) increases acidity.

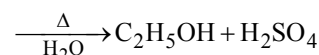
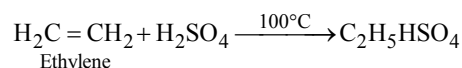
80. (b) Alcohols and phenols are acidic in nature. In fact they are Bronsted acids i.e., they can donate a proton to a stronger base ( $\text{B}:$ )



81. (b) Oxidation of phenol with chromic acid produces a conjugated diketone known as benzoquinone. In the presence of air, phenols are slowly oxidised to dark coloured mixtures containing quinones.  
 82. (c) Glucose and fructose obtained by hydrolysis of sucrose, are converted into alcohol by enzyme zymase.

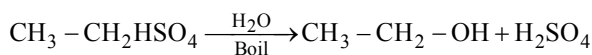
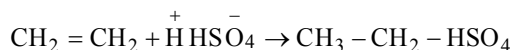


84. (c) Ethylene is passed into concentrated sulphuric acid at  $75-80^\circ\text{C}$  under pressure when a mixture of ethyl hydrogen sulphate and diethyl sulphate is formed.

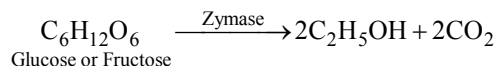
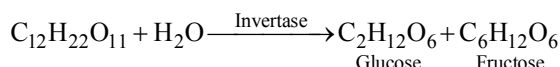


85. (b) 86. (a)

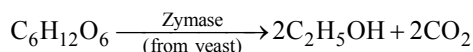
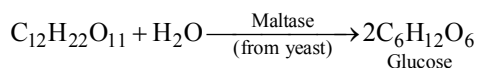
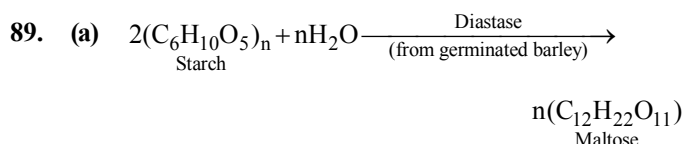
87. (c) Hydration of alkenes



Fermentation of sugar :



88. (d) Starch
- $\xrightarrow{\text{Enzymes}}$
- Alcohol



90. (b)

91. (c) Denaturing can also be done by adding 0.5% pyridine, petroleum naptha,
- $\text{CuSO}_4$
- etc.

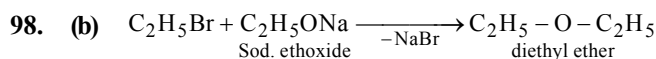
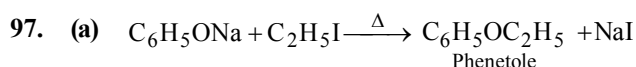
92. (c)

93. (c) Tonics contain ethyl alcohol.

94. (c) Due to presence of methyl alcohol in liquor.

95. (c) The quantity of sugar increases and yeast grows on the outer skin as grapes ripen. When grapes are crushed, sugar and the enzyme come in contact and fermentation starts. Fermentation takes place in anaerobic conditions i.e., in absence of air
- $\text{CO}_2$
- is released during fermentation. If air gets into fermentation mixture the oxygen of air oxidises ethanol to ethanoic acid which in turn destroys the taste of alcoholic drinks.

96. (b) The commercial alcohol is made unfit for drinking by mixing in it some copper sulphate (to give it colour) and pyridine (a foul smelling liquid). It is known as denaturation of alcohol.



99. (b) Reaction of sodium ethoxide with ethyl iodide to produce diethyl ether is known as Williamson synthesis.

It is a nucleophilic substitution reaction and proceeds via  $\text{S}_\text{N}2$  mechanism.

100. (d) The two components should be
- $(\text{CH}_3)_3\text{CONa} + (\text{CH}_3)_3\text{CBr}$
- . However, tert-alkyl halides tend to undergo elimination reaction rather than substitution leading to the formation of an alkene,
- $\text{Me}_2\text{C} = \text{CH}_2$

101. (c) Preparation of ethers by reacting sodium ethoxide with alkyl halide is called Williamson synthesis.

102. (a) Due to H-bonding, the boiling point of ethanol is much higher than that of the isomeric diethyl ether.

103. (c)
- $\text{CH}_3\text{OCH}_3$
- and
- $\text{C}_2\text{H}_5\text{OCH}_3$
- are gases while
- $\text{C}_2\text{H}_5\text{OC}_2\text{H}_5$
- (b. p. 308 K) is low boiling liquid.

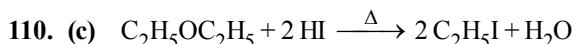
104. (d) Ether is used (i) as a general anaesthetic, (ii) as refrigerant since it produces cooling on evaporation, (iii) as solvent for oils, fats, resins etc. (iv) for providing inert medium in Wurtz reaction, (v) for preparing Grignard reagent, (vi) in perfumery.

105. (a) Like dissolves like. Oils and fats, being covalent, dissolve in ether, a non-polar solvent.

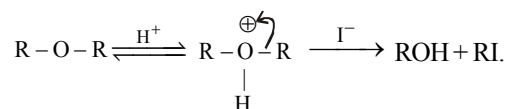
106. (d) Due to inter-molecular hydrogen bonding in alcohols boiling point of alcohols is much higher than ether.

107. (c) 108. (c)

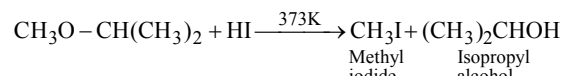
109. (b) Only alkyl aryl ethers e.g.,
- $\text{C}_6\text{H}_5\text{OCH}_3$
- undergoes electrophilic substitution reactions.



112. (a) Ethers are readily cleaved by HI as follows :

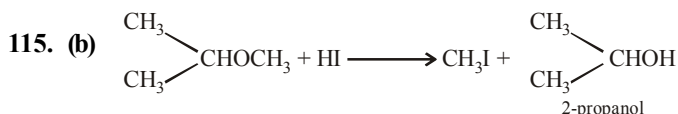


113. (c) In case of unsymmetrical ethers, the site of cleavage depends on the nature of alkyl group e.g.,

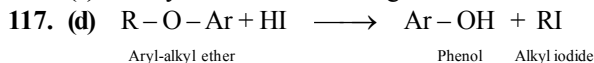


The alkyl halide is always formed from the smaller alkyl group.

114. (b) Due to greater electronegativity of
- $sp^2$
- hybridized carbon atoms of the benzene ring, diaryl ethers are not attacked by nucleophiles like
- $\text{I}^-$
- .

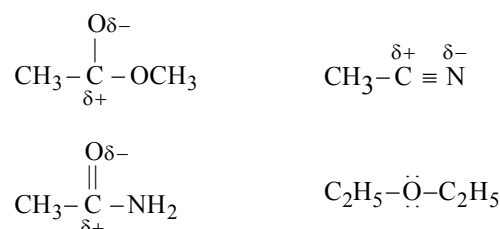


116. (a) Dehydration of alcohols gives ethers



Due to steric hinderance, smaller alkyl group is always attached to iodine.

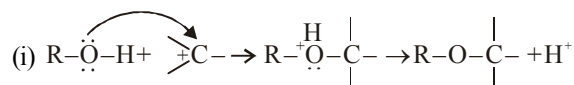
118. (d) Diethyl ether, being a Lewis base, is not attacked by nucleophiles, while all others contain electrophilic carbon, hence attacked by nucleophiles like
- $\text{OH}^-$
- ions.



### STATEMENT TYPE QUESTIONS

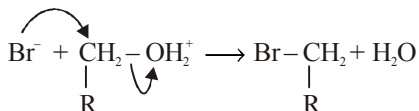
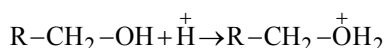
119. (c) Product formed is 2-methyl-pentan-2-ol hence carbon is attached to four different group therefore the molecule is chiral but because the carbonyl group is planar so attack of methyl group can take place either ways above and below the plane of the of molecule hence equal number of enantiomers are formed and hence the racemic mixture is formed.

120. (b) Alcohols are versatile compounds. They react both as nucleophiles and electrophiles. The bond between O—H is broken when alcohols react as nucleophiles.  
*Alcohols as nucleophiles*

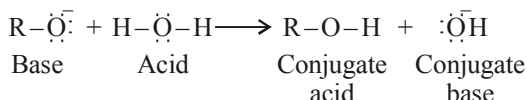


- (ii) The bond between C—O is broken when they react as electrophiles. Protonated alcohols react in this manner.

*Protonated alcohols as electrophiles*



121. (b) Alcohols are, weaker acids than water. This can be illustrated by the reaction of water with an alkoxide.



This reaction shows that water is a better proton donor (i.e., stronger acid) than alcohol. Also in the above reaction, we note that an alkoxide ion is a better proton acceptor than hydroxide ion, which suggests that alkoxide are stronger bases (sodiummethoxide is a stronger base than sodium hydroxide).

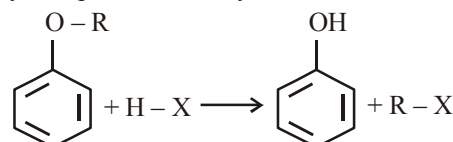
122. (c) The dehydration of secondary and tertiary alcohols to give corresponding ethers is unsuccessful as elimination competes over substitution and as a consequence, alkenes are easily formed.
123. (c) The C—O bond length (136 pm) in phenol is slightly less than that in methanol (142 pm).
124. (a) A methanol poisoned patient is treated by giving intravenous injection of ethanol.

### MATCHING TYPE QUESTIONS

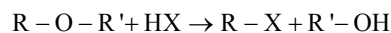
125. (d)      126. (c)      127. (b)

### ASSERTION-REASON TYPE QUESTIONS

128. (a) The bond angle  $\text{C}-\overset{\text{O}}{\text{H}}$  in alcohols is slightly less than the tetrahedral angle ( $109^\circ-28'$ ). It is due to the repulsion between the unshared electron pairs of oxygen.
129. (b) The correct explanation is : In Lucas test, tertiary alcohols react immediately because of the formation of the more stable tertiary carbocations.
130. (c) The correct reason is : Nucleophilic attack of phenolate ion through the *ortho*-carbon atom occurs on  $\text{CCl}_4$  (a neutral electrophile) to form an intermediate which on hydrolysis gives salicylic acid (ArSE reaction).
131. (a) R is the correct explanation of A. Due to +M effect of  $-\ddot{\text{O}}\text{H}$ , its intermediate carbocation is more stable than the one in benzene.
132. (c) The usual halogenation of benzene takes place in the presence of a Lewis acid, such as  $\text{FeBr}_3$ , which polarises the halogen molecule. In case of phenol, the polarisation of bromine molecule takes place even in the absence of Lewis acid. It is due to the highly activating effect of  $-\text{OH}$  group attached to the benzene ring.
133. (b) R is the correct explanation of A.
134. (a)      136. (c)
135. (d)      137. (c) Alkyl aryl ethers are cleaved at the alkyl-oxygen bond due to the more stable aryl-oxygen bond. The reaction yields phenol and alkyl halide

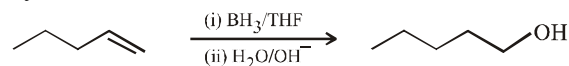


Ethers with two different alkyl groups are also cleaved in the same manner.



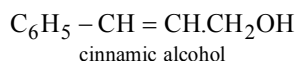
### CRITICAL THINKING TYPE QUESTIONS

138. (a) Methyl alcohol ( $\text{CH}_3\text{OH}$ ) is also known as carbinol. Hence vinyl carbinol is  $\text{CH}_2=\text{CH}-\text{CH}_2\text{OH}$ .
139. (c)  $\text{KMnO}_4$  (alkaline) and  $\text{OsO}_4 / \text{CH}_2\text{Cl}_2$  are used for hydroxylation of double bond while  $\text{O}_3 / \text{Zn}$  is used for ozonolysis. Therefore, the right option is (c), i.e.,
- $$3\text{CH}_3\text{CH}=\text{CH}_2 \xrightarrow{\text{BH}_3 \text{ in THF}} (\text{CH}_3\text{CH}_2\text{CH}_2)_3\text{B}$$
- $$\xrightarrow[\text{NaOH}]{3\text{H}_2\text{O}_2} 3\text{CH}_3\text{CH}_2\text{CH}_2\text{OH} + \text{H}_3\text{BO}_3$$
- 1-propanol
140. (a) Hydroboration-oxidation leads to *anti*-Markownikoff's hydration, thus

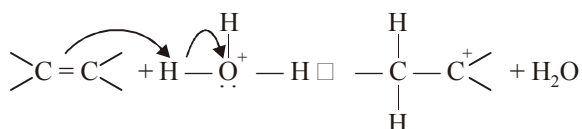
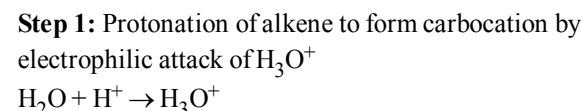


1-Pentanol

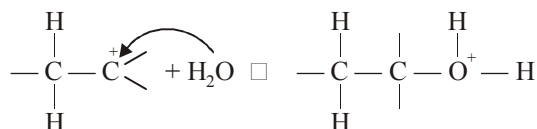
- 141. (b)**  $\text{NaBH}_4$  and  $\text{LiAlH}_4$  attacks only carbonyl group and reduce it into alcohol group.



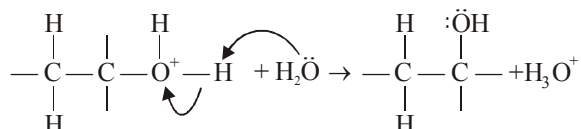
142. (a)
143. (b) Carbocation is formed as intermediate which is most stabilized when protonation occurs on terminal carbon.
144. (b) Reaction of 1-chloropropane leads to the formation of the primary carbocation which rearranges to more stable secondary carbocation, hence (ii) and (iii) give similar products.
145. (a) In case of (ii) and (iii), the alcohol so obtained contain carbon which is attached to four different groups i.e., chiral carbon while in case of (i) and (iv) achiral alcohol is obtained.
146. (a)  $\text{CH}_2 = \text{CH} - \text{OH}$  represents vinylic alcohol. In vinylic alcohols  $-\text{OH}$  group is attached to  $sp^2$  hybridized carbon whereas in allylic alcohols  $-\text{OH}$  group is attached to  $sp^3$  hybridized carbon.
147. (c) The mechanism of the reaction involves the following three steps:



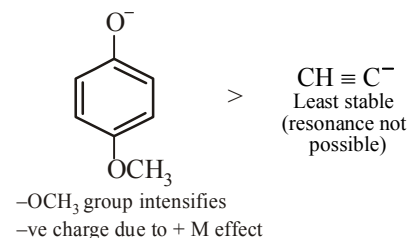
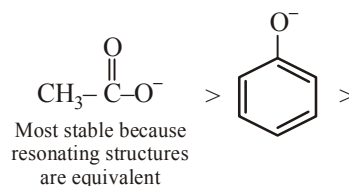
**Step 2:** Nucleophilic attack of water on carbocation.



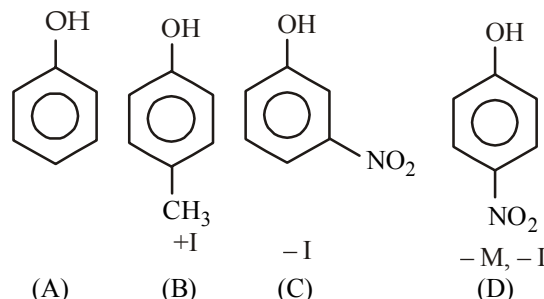
**Step 3:** Deprotonation to form an alcohol.



- 148. (a)** More the stability of the conjugate base, higher is the acidic character of the parent acid. Stability order of the four conjugate bases is arranged below.

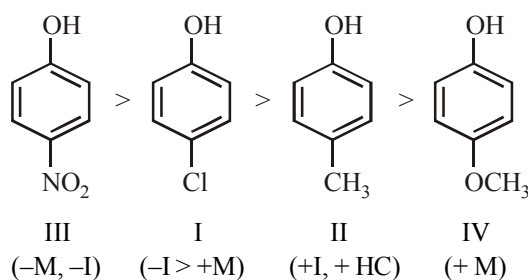


- 149. (a)**

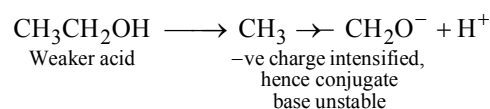
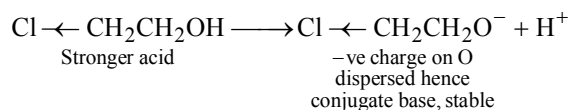


Electron withdrawing substituents increases the acidity of phenols; while electron releasing substituents decreases acidity. Further the particular effect (acidity increasing or decreasing) is more when a substituent is present in o-ortho position to phenolic group. Thus the correct order will be  $D > C > A > B$ .

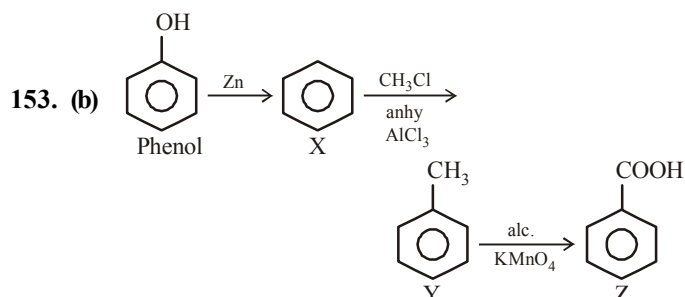
- 150. (c)** Electron withdrawing substituents like  $-\text{NO}_2$ ,  $\text{Cl}$  increase the acidity of phenol while electron releasing substituents like  $-\text{CH}_3$ ,  $-\text{OCH}_3$  decreases acidity. hence the correct order of acidity will be



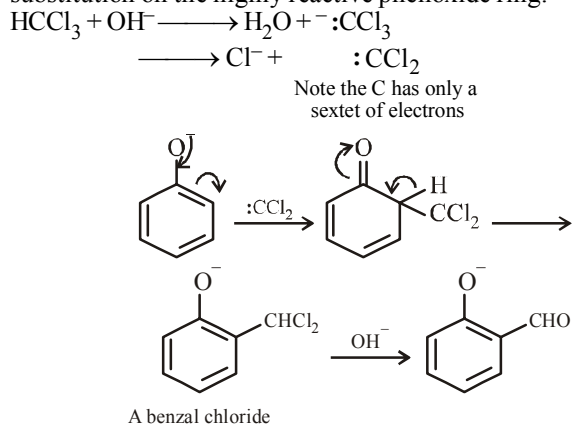
- 151. (c)**  $\text{ClCH}_2\text{CH}_2\text{OH}$  is stronger acid than  $\text{CH}_3\text{CH}_2\text{OH}$  due to  $-I$  effect of Cl.



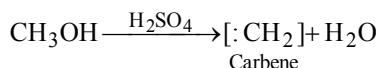
- 152. (c)** Due to strong electron-donating effect of the OH group, the electron density in phenol is much higher than that in toluene, benzene and chlorobenzene and hence phenol is readily attacked by the electrophile.



154. (d) Reimer-Tiemann reaction involves electrophilic substitution on the highly reactive phenoxide ring.

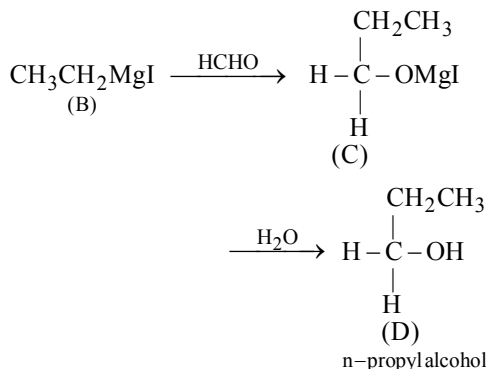
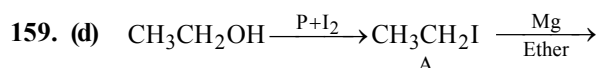


155. (c)  $\text{CH}_2 = \text{CH}_2 \xleftarrow[650\text{K}]{\text{Al}_2\text{O}_3} \text{CH}_3\text{CH}_2\text{OH} \xrightarrow[525\text{K}]{\text{Al}_2\text{O}_3} \text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$
156. (b) Dehydration of  $\text{CH}_3\text{OH}$  gives carbene (methylene), an unstable intermediate.



157. (d) Since the compound ( $\text{C}_4\text{H}_{10}\text{O}$ ) react with sodium, it must be alcohol (option *b*, *c*, or *d*). As it is oxidised to carbonyl compound which does not reduce Tollen's reagent, the carbonyl compound should be a ketone and thus  $\text{C}_4\text{H}_{10}\text{O}$  should be a secondary alcohol, i.e. *sec*-butyl alcohol; other two given alcohols are 1°.

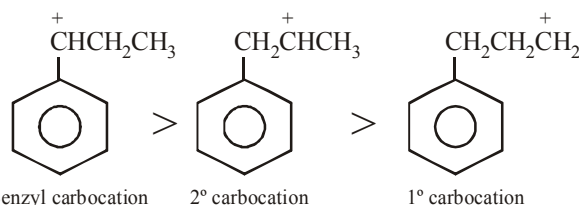
158. (a)



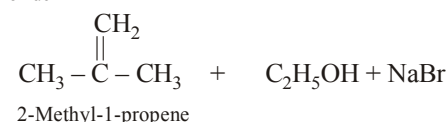
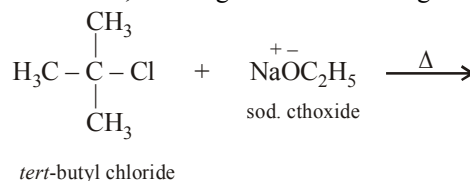
160. (b) 161. (c)

162. (a) In case of *m*-nitrophenol operational effect of nitrogroup is electron withdrawing inductive effect while in case of *b* and *c*, both  $-\text{R}$  and  $-\text{I}$  effect are operational.

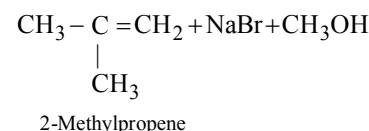
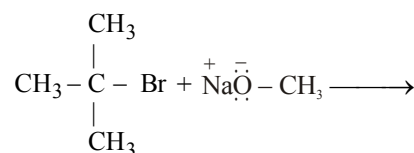
163. (a) Here also, carbocation is formed as an intermediate, hence the species capable of forming most stable carbocation will be most reactive.



164. (a) In Williamson's synthesis the reaction of alkyl halides with sodium alkoxides give ethers. However, if the alkyl halide is 3°, it undergoes elimination to give an alkene.

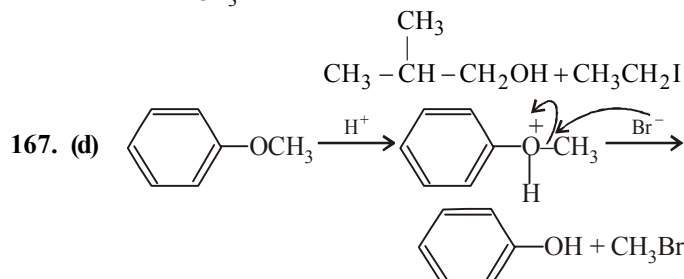
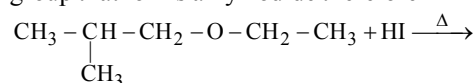


165. (c) If a tertiary alkyl halide is used, an alkene is the only reaction product and no ether is formed. For example, the reaction of  $\text{CH}_3\text{ONa}$  with  $(\text{CH}_3)_3\text{C}-\text{Br}$  gives exclusively 2-methylpropene.



It is because alkoxides are not only nucleophiles but strong bases as well. They react with alkyl halides leading to elimination reactions.

166. (c) In the cleavage of mixed ethers having two different alkyl groups, the alcohol and alkyl iodide that form depend on the nature of alkyl group. When primary or secondary alkyl groups are present, it is the lower alkyl group that forms alkyl iodide therefore



168. (b) Due to greater electronegativity of  $sp^2$ -hybridized carbon atoms of the benzene ring, diaryl ethers are not attacked by nucleophiles like  $\text{I}^-$ .



26

# ALDEHYDES, KETONES AND CARBOXYLIC ACIDS

### FACT/DEFINITION TYPE QUESTIONS

- $$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CHO} \\ | \\ \text{CH}_2-\text{CH}_3 \end{array}$$

- CC1=CC(=O)C=C(O)C=C1

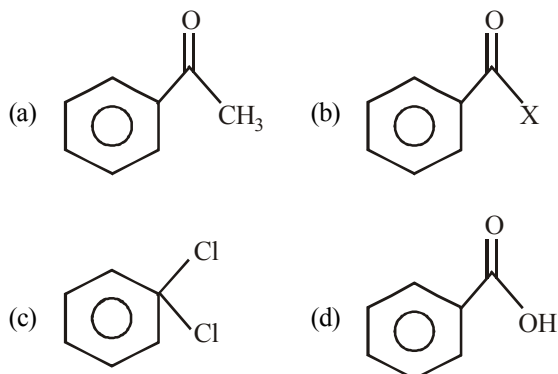
- (a) s-s-overlapping      (b) p-p-overlapping  
(c) s-p-overlapping      (d) p-d-overlapping

- (a)  $\begin{array}{c} \text{R} \\ \diagdown \\ \text{C}=\text{O} \\ \diagup \\ \text{R}' \end{array}$   $\delta^- \quad \delta^+$
- (c)  $\begin{array}{c} \delta^+ \quad \delta^- \\ \text{R}-\text{C}=\text{O} \\ | \\ \text{R}' \end{array}$

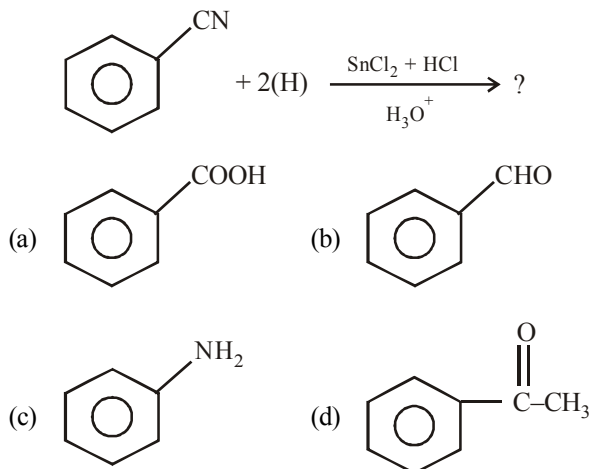
- (b)  $\begin{array}{c} \text{R} \\ \diagdown \\ \text{C}=\text{O} \\ \diagup \\ \text{R}' \end{array}$   $\delta^+ \quad \delta^-$
- (d)  $\begin{array}{c} \delta^+ \quad \delta^- \\ \text{R}-\text{C}=\text{O} \\ | \\ \text{R}' \end{array}$

- (a)  $\text{CH}_3\text{CH}_2\text{CH}=\text{C}(\text{CH}_3)_2$  (b)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_2\text{CH}_3$   
(c)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CHCH}_3$  (d)  $\text{CH}_3-\text{C}(\text{CH}_3)=\text{CHCH}_3$

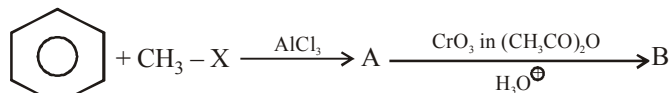
16. The catalyst used in Rosenmund's reduction is  
 (a)  $\text{HgSO}_4$  (b)  $\text{Pd/BaSO}_4$   
 (c) anhydrous  $\text{AlCl}_3$  (d) anhydrous  $\text{ZnCl}_2$
17.  $\text{C}_6\text{H}_5\text{C}\equiv\text{N} + [\text{H}] \xrightarrow{\text{SnCl}_2/\text{HCl}} \text{C}_6\text{H}_5\text{CHO} + \text{NH}_3$ .  
 The above reaction is  
 (a) Mendius reaction (b) Sandorn's reaction  
 (c) Rosenmund's reaction (d) Stephen's reaction
18. Benzaldehyde can be prepared by oxidation of toluene by  
 (a) Acidic  $\text{KMnO}_4$  (b)  $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$   
 (c)  $\text{CrO}_2\text{Cl}_2$  (d) All of these
19. The oxidation of toluene to benzaldehyde by chromyl chloride is called  
 (a) Rosenmund reaction (b) Wurtz reaction  
 (c) Etard reaction (d) Fittig reaction
20. An aldehyde group can be present  
 (a) in between carbon chain  
 (b) at any position in carbon atom  
 (c) only at the end of carbon chain  
 (d) at the second carbon atom of the carbon chain
21. Benzaldehyde is obtained from Rosenmund's reduction of

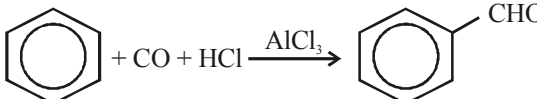


22. Which of the following is not used in the preparation of ketone?  
 (a) Oxidation of secondary alcohols  
 (b) Dehydrogenation of  $2^\circ$  alcohol  
 (c) Pyrolysis of calcium acetate  
 (d) Acid hydrolysis of alkyl cyanide
23. Product of the following reaction is



24. Find out B in the given reactions



- (a) acetophenone  
 (b) benzaldehyde  
 (c) cyclohexyl carbaldehyde  
 (d) benzoic acid
25. The reaction
- 
- (a) Rosenmund's reaction (b) Stephen's reaction  
 (c) Cannizzaro's reaction (d) Gatterman-Koch reaction
26. Which aldehyde cannot be obtained by Rosenmund's reaction?  
 (a)  $\text{CH}_3\text{CHO}$  (b)  $\text{HCHO}$   
 (c)  $\text{CH}_3\text{CH}_2\text{CHO}$  (d) All of these
27. The conversion  $\text{PhCN} \rightarrow \text{PhCOCH}_3$ , can be achieved most conveniently by reaction with  
 (a)  $\text{CH}_3\text{MgBr}$  followed by hydrolysis  
 (b)  $\text{I}_2 - \text{NaOH}$ ,  $\text{CH}_3\text{I}$   
 (c) Dil.  $\text{H}_2\text{SO}_4$  followed by reaction with  $\text{CH}_2\text{N}_2$   
 (d)  $\text{LiAlH}_4$  followed by reaction with  $\text{CH}_3\text{I}$
28. Which of the following is used to prepare ketone from acyl chloride?  
 (a)  $\text{R-MgX}$  (b)  $\text{R}_2\text{Cd}$   
 (c)  $\text{CO} + \text{HCl}$  (d)  $\text{CrO}_3$
29. Which of the following forces explain the boiling point of aldehydes and ketones?  
 (a) Hydrogen bonding (b) van der Waal's forces  
 (c) Dipole-dipole attraction (d) None of these
30. Which is highly soluble in water?  
 (a) Methanal (b) Propanal  
 (c) Propanone (d) Butanone
31. Propanal and propanone, both have same molecular formula ( $\text{C}_3\text{H}_6\text{O}$ ), what do you expect about their boiling points?  
 (a) Both have same boiling point  
 (b) Boiling point of propanal is higher than the boiling point of propanone.  
 (c) Boiling point of propanal is lower than the boiling point of propanone  
 (d) Nothing can be predicted
32. Less reactivity of ketone is due to  
 (a) + I inductive effect decrease positive charge on carbonyl carbon atom  
 (b) steric effect of two bulky alkyl groups  
 (c)  $\text{sp}^2$  hybridised carbon atom of carbonyl carbon atom  
 (d) Both (a) and (b)
33. Acetaldehyde reacts with  
 (a) Electrophiles only  
 (b) Nucleophiles only  
 (c) Free radicals only  
 (d) Both electrophiles and nucleophiles

34. Carbonyl compounds undergo nucleophilic addition because of  
 (a) electronegativity difference of carbon and oxygen atoms  
 (b) electromeric effect  
 (c) more stable anion with negative charge on oxygen atom and less stable carbonium ion  
 (d) None of the above
35. Which of the following statement is false ?  
 (a) Cannizzaro reaction is given by aldehydes in presence of alkali  
 (b) Aldol condensation is given by aldehydes in presence of alkali  
 (c) Aldol condensation is given by aldehydes and ketones in presence of acids  
 (d) None of the above
36. If formaldehyde and KOH are heated, then we get  
 (a) methane (b) methyl alcohol  
 (c) ethyl formate (d) acetylene
37. The reagent which can be used to distinguish acetophenone from benzophenone is  
 (a) 2,4-dinitrophenylhydrazine  
 (b) aqueous solution of  $\text{NaHSO}_3$   
 (c) benedict reagent  
 (d)  $\text{I}_2$  and  $\text{Na}_2\text{CO}_3$
38. Benzaldehyde reacts with ethanoic KCN to give  
 (a)  $\text{C}_6\text{H}_5\text{CHOHCN}$  (b)  $\text{C}_6\text{H}_5\text{CHOHCOC}_6\text{H}_5$   
 (c)  $\text{C}_6\text{H}_5\text{CHOHCOOH}$  (d)  $\text{C}_6\text{H}_5\text{CHOHCHOHC}_6\text{H}_5$
39. Acetone reacts with iodine ( $\text{I}_2$ ) to form iodoform in the presence of  
 (a)  $\text{CaCO}_3$  (b)  $\text{NaOH}$   
 (c)  $\text{KOH}$  (d)  $\text{MgCO}_3$
40.  $(\text{CH}_3)_3\text{C}-\text{CHO}$  does not undergo aldol condensation due to  
 (a) three electron donating methyl groups  
 (b) cleavage taking place between  $-\text{C}-\text{CHO}$  bond  
 (c) absence of alpha hydrogen atom in the molecule  
 (d) bulky  $(\text{CH}_3)_3\text{C}-$  group
41. Acetaldehyde reacts with semicarbazide and forms semicarbazone. Its structure is  
 (a)  $\text{CH}_3\text{CH}=\text{NNHCON}=\text{CHCH}_3$   
 (b)  $\text{CH}_3\text{CH}=\text{NNHCONH}_2$   
 (c)  $\text{CH}_3\text{CH}=\text{N}-\underset{\text{OH}}{\text{N}}-\text{CONH}_2$   
 (d)  $\text{CH}_3\text{CH}=\text{N}-\text{CONHNH}_2$
42. Iodoform test is not given by  
 (a) 2-Pentanone (b) Ethanol  
 (c) Ethanal (d) 3-Pentanone
43. Phenylmethyl ketone can be converted into ethylbenzene in one step by which of the following reagents?  
 (a)  $\text{LiAlH}_4$  (b)  $\text{Zn-Hg/HCl}$   
 (c)  $\text{NaBH}_4$  (d)  $\text{CH}_3\text{MgI}$
44. When acetaldehyde is heated with Fehling's solution it gives a precipitate of  
 (a) Cu (b) CuO  
 (c)  $\text{Cu}_2\text{O}$  (d)  $\text{Cu}(\text{OH})_2$
45. Aldol condensation would not occur in :  
 (a)  $\text{CH}_3\text{COCH}_3$  (b)  $\text{CH}_3\text{CH}_2\text{CHO}$   
 (c)  $\text{HCHO}$  (d)  $\text{CH}_3\text{CHO}$
46. Cannizzaro reaction occurs with  
 (a)  $\text{CH}_3-\text{CH}_2\text{OH}$  (b)  $\text{C}_6\text{H}_5\text{CHO}$   
 (c)  $\text{CH}_3\text{CHO}$  (d)  $\text{CH}_3-\text{CO}-\text{CH}_3$
47. Which of the following compound will show positive silver mirror test ?  
 (a)  $\text{HCOOH}$  (b)  $\text{CH}_3(\text{CHOH})_3\text{CHO}$   
 (c)  $\text{CH}_3\text{CO}(\text{CHOH})\text{CH}_3$  (d) Both (a) and (b)
48. Aldehydes and ketones are distinguished by which of the following test ?  
 (a) Lucas test  
 (b) Tollen's test  
 (c)  $\text{KMnO}_4$  solution (Baeyer's test)  
 (d) None of these
49. Aldehydes and ketones are generally reduced by :  
 (a) Clemmensen reduction (b)  $\text{H}_2\text{S}$   
 (c)  $\text{H}_2/\text{Ni}$  (d) None of these
50. In which reaction,  $>\text{C}=\text{O}$  can be reduced to  $>\text{CH}_2$ ?  
 (a) Wolf-Kishner reaction (b) Reimer-Tiemann reaction  
 (c) Wurtz reaction (d) None of these
51. A compound does not react with 2, 4-dinitrophenylhydrazine, the compound is :  
 (a) Acetone (b) Acetaldehyde  
 (c)  $\text{CH}_3\text{OH}$  (d)  $\text{CH}_3\text{CH}_2\text{COCH}_3$
52. Which gives lactic acid on hydrolysis after reacting with  $\text{HCN}$ ?  
 (a)  $\text{HCHO}$  (b)  $\text{CH}_3\text{CHO}$   
 (c)  $\text{C}_6\text{H}_5\text{CHO}$  (d)  $\text{CH}_3\text{COCH}_3$
53. The most appropriate reagent to distinguish between acetaldehyde and formaldehyde is :  
 (a) Fehling's solution  
 (b) Tollen's reagent  
 (c) Schiff's reagent  
 (d) Iodine in presence of base
54. Aldehydes can be oxidised by :  
 (a) Tollen's reagent (b) Fehling solution  
 (c) Benedict solution (d) All the above
55. 2-pentanone and 3-pentanone can be distinguished by :  
 (a) Cannizzaro's reaction (b) Aldol condensation  
 (c) Iodoform reaction (d) Clemmensen's reduction
56. Cross aldol condensation occurs between  
 (a) two same aldehydes  
 (b) two same ketones  
 (c) two different aldehydes and ketones  
 (d) None of these
57. Ketone upon treatment with Grignard Reagent gives  
 (a) primary alcohol (b) secondary alcohol  
 (c) tertiary alcohol (d) aldehyde

58. When acetaldehyde reacts with alcohol then produce  
 (a) Acetal (b) Ketal  
 (c) Acetone (d) None
59. The product formed in Aldol condensation is  
 (a) a beta-hydroxy aldehyde or a beta-hydroxy ketone  
 (b) an alpha-hydroxy aldehyde or ketone  
 (c) an alpha, beta unsaturated ester  
 (d) a beta-hydroxy acid
60. Clemmensen reduction of a ketone is carried out in the presence of which of the following ?  
 (a) Glycol with KOH (b) Zn-Hg with HCl  
 (c)  $\text{LiAlH}_4$  (d)  $\text{H}_2$  and Pt as catalyst
61. Which of the following products is formed when benzaldehyde is treated with  $\text{CH}_3\text{MgBr}$  and the addition product so obtained is subjected to acid hydrolysis ?  
 (a) A secondary alcohol (b) A primary alcohol  
 (c) Phenol (d) tert-Butyl alcohol
62. During reduction of aldehydes with hydrazine and potassium hydroxide, the first step is the formation of  
 (a)  $\text{R}-\text{CH}=\text{N}-\text{NH}_2$  (b)  $\text{R}-\text{C}\equiv\text{N}$   
 (c)  $\text{R}-\text{C}-\text{NH}_2$  (d)  $\text{R}-\text{CH}=\text{NH}$   
 $\text{O}$
63. A and B in the following reactions are  

$$\text{R}-\text{C}-\text{R}' \xrightarrow[\text{KCN}]{\text{HCN}} \text{A} \xrightarrow{\text{B}} \text{R}-\text{C} \begin{matrix} \text{OH} \\ \text{CH}_2\text{NH}_2 \end{matrix}$$
  
 (a)  $\text{A} = \text{RR}'\text{C} \begin{matrix} \text{CN} \\ \text{OH} \end{matrix}$ ,  $\text{B} = \text{LiAlH}_4$   
 (b)  $\text{A} = \text{RR}'\text{C} \begin{matrix} \text{OH} \\ \text{COOH} \end{matrix}$ ,  $\text{B} = \text{NH}_3$   
 (c)  $\text{A} = \text{RR}'\text{C} \begin{matrix} \text{CN} \\ \text{OH} \end{matrix}$ ,  $\text{B} = \text{H}_3\text{O}^+$   
 (d)  $\text{A} = \text{RR}'\text{CH}_2\text{CN}$ ,  $\text{B} = \text{NaOH}$
64. The product obtained by the reaction of an aldehyde and hydroxylamine is  
 (a) hydrazone (b) aldoxime  
 (c) primary amine (d) alcohol
65. Which one gives positive iodoform test ?  
 (a)  $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$   
 (b)  $\text{C}_6\text{H}_5-\text{OH}$   
 (c)  $\text{CH}_3-\text{CH}_2-\text{C} \begin{matrix} \text{H} \\ | \\ \text{OH} \end{matrix} -\text{CH}_2-\text{CH}_3$   
 (d)  $\text{CH}_3\text{CH}_2\text{OH}$
66. The compound that neither forms semicarbazone nor oxime is  
 (a)  $\text{HCHO}$  (b)  $\text{CH}_3\text{COCH}_2\text{Cl}$   
 (c)  $\text{CH}_3\text{CHO}$  (d)  $\text{CH}_3\text{CONHCH}_3$
67. Schiff's reagent gives pink colour with  
 (a) acetaldehyde (b) acetone  
 (c) acetic acid (d) methyl acetate
68. Benzophenone can be converted into benzene by using  
 (a) fused alkali  
 (b) anhydrous  $\text{AlCl}_3$   
 (c) sodium amalgam in water  
 (d) acidified dichromate
69. In the reaction of  $\text{NaHSO}_3$  with carbonyl compounds to form bisulphite product, the nucleophile is  
 (a)  $\text{HSO}_3^-$  (b)  $\text{SO}_3\text{Na}$   
 (c)  $\text{SO}_3^{--}$  (d) None of the above
70. Wolf-Kishner reduction is  
 (a) reduction of carbonyl compound into alcohol  
 (b) reduction of carbonyl compound into alkene  
 (c) reduction of carboxyl compound into alkane  
 (d) reduction of nitro compound into aniline
71. Tollen's reagent is  
 (a) ammonical  $\text{CuSO}_4$   
 (b) ammonical  $\text{AgNO}_3$   
 (c) alkaline solution containing complex of copper nitrate  
 (d) none of these
72. Compound of general formula  $\text{R}-\text{C} \begin{matrix} \text{OR} \\ \text{H} \end{matrix} \begin{matrix} \text{OR} \\ \text{OR} \end{matrix}$  are called  
 (a) diester (b) acid anhydride  
 (c) hemiacetal (d) acetal
73. Imine derivatives of aldehyde and ketone is called as  
 (a) Schiff's reagent (b) Fehling's reagent  
 (c) Schiff's base (d) Schiff's acid
74. Which reaction is used for detecting the presence of carbonyl group?  
 (a) Reaction with hydrazine  
 (b) Reaction with phenyl hydrazine  
 (c) Reaction with hydroxylamine  
 (d) All of the above
75. The difference between aldol condensation and Cannizzaro's reaction is that:  
 (a) the former takes place in the presence of  $\alpha$ -H-atom.  
 (b) the former takes place in the absence of  $\alpha$ -H-atom.  
 (c) the former takes place in the presence of  $\beta$ -H-atom.  
 (d) none of the above
76.  $\text{C}_6\text{H}_5\text{CH}=\text{CHCHO} \xrightarrow{\text{X}} \text{C}_6\text{H}_5\text{CH}=\text{CHCH}_2\text{OH}$   
 In the above sequence X can be :  
 (a)  $\text{H}_2/\text{Ni}$  (b)  $\text{NaBH}_4$   
 (c)  $\text{K}_2\text{Cr}_2\text{O}_7/\text{H}^+$  (d) Both (a) and (b)
77. Which of the following pairs of compounds will undergo aldol and Cannizzaro reaction respectively ?  
 (i) acetone; benzaldehyde  
 (ii) acetaldehyde; butan-2-one  
 (iii) propanone; formaldehyde.  
 (iv) cyclopentanone, benzaldehyde  
 (a) (i), (ii) and (iii) (b) (ii) and (iii)  
 (c) (ii), (iii) and (iv) (d) (iii) and (iv)

78. Two compounds benzyl alcohol and benzoic acid are formed from this compound, when this compound is heated in the presence of conc. NaOH, this compound is.

- (a) Benzaldehyde (b) Benzylalcohol  
(c) Acetophenone (d) Benzophenone

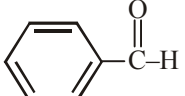
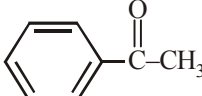
79. The reagent which does not react with both, acetone and benzaldehyde.

- (a) Sodium hydrogensulphite  
(b) Phenyl hydrazine  
(c) Fehling's solution  
(d) Grignard reagent

80. Which of the following compounds will give butanone on oxidation with alkaline  $\text{KMnO}_4$  solution?

- (a) Butan-1-ol (b) Butan-2-ol  
(c) Both of these (d) None of these

81. Which of the following compounds is most reactive towards nucleophilic addition reactions?

- (a)  $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$  (b)  $\text{CH}_3-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$   
(c)  (d) 

82. Which of the following does not represent the natural source of the corresponding acids?

- (a) Formic acid : Red ant  
(b) Acetic acid : Vinegar  
(c) Butyric acid : Rancid butter  
(d) Isobutyric acid : Automobile exhausts

83. Vinegar is a solution of acetic acid which is :

- (a) 15–20% (b) 20–25%  
(c) 6–8% (d) 2–4%

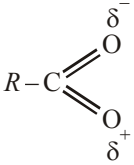
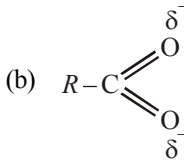
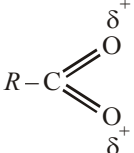
84. Methyl cyanide can be converted into acetic acid by one of the following reactions.

- (a) Reduction (b) Hydrolysis  
(c) Electrolysis (d) Decarboxylation

85. Toluene can be oxidised to benzoic acid by

- (a)  $\text{KMnO}_4$  (alk.) (b)  $\text{K}_2\text{Cr}_2\text{O}_7$  (alk.)  
(c) Both (a) and (b) (d) Neither (a) nor (b)

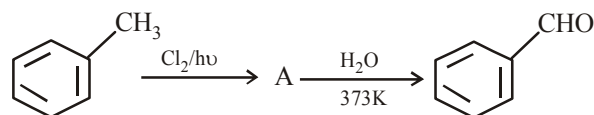
86. Which of the following does the best represent the structure of the carboxylate ion?

- (a)  (b)   
(c)  (d) None of these

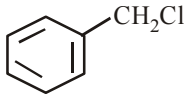
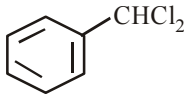
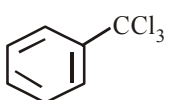
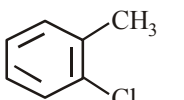
87. Select the acid(s) which cannot be prepared by Grignard reagent.

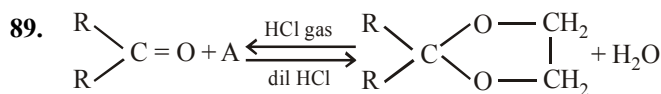
- (a) Acetic acid (b) Succinic acid  
(c) Formic acid (d) All of the above

88. In the given reaction


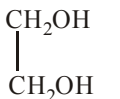


A is

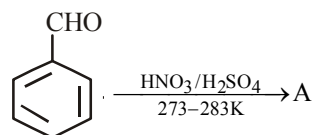
- (a)  (b)   
(c)  (d) 



A is

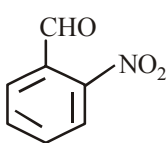
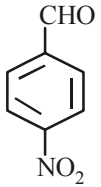
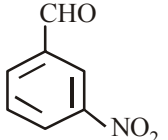
- (a)  $\text{CH}_3\text{OH}$  (b)  $\text{CH}_3\text{COOH}$   
(c)  (d) 

90. In the reaction

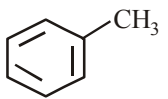
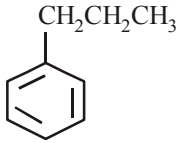
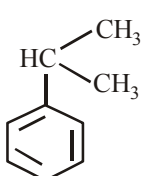
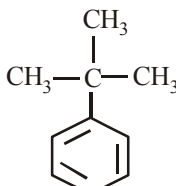


Benzaldehyde

A is

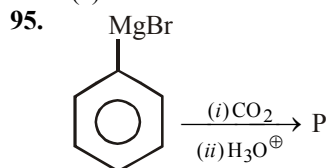
- (a)  (b)   
(c)  (d) Both (a) and (b)

91. Which of the following can not be oxidised to give carboxylic acid?

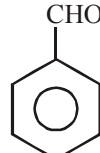
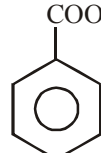
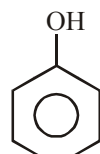
- (a)  (b)   
(c)  (d) 



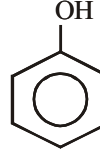
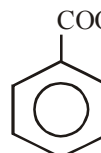
92. Lower carboxylic acids are soluble in water due to  
(a) low molecular weight (b) hydrogen bonding  
(c) dissociation into ions (d) easy hydrolysis
93. Dimerisation of carboxylic acids is due to  
(a) ionic bond  
(b) covalent bond  
(c) coordinate bond  
(d) intermolecular hydrogen bond
94. Boiling points of carboxylic acids are  
(a) lower than corresponding alcohols  
(b) higher than corresponding alcohols  
(c) equal to that of corresponding alcohols  
(d) None of the above



In the above reaction product 'P' is

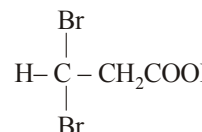
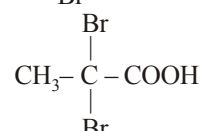
- (a)  (b) 
- (c)  (d)  $\text{C}_6\text{H}_5 - \overset{\text{O}}{\parallel} \text{C} - \text{C}_6\text{H}_5$

96. In the anion  $\text{HCOO}^-$  the two carbon-oxygen bonds are found to be of equal length. What is the reason for it?  
(a) Electronic orbitals of carbon atom are hybridised  
(b) The  $\text{C}=\text{O}$  bond is weaker than the  $\text{C}-\text{C}$  bond  
(c) The anion  $\text{HCOO}^-$  has two resonating structures  
(d) The anion is obtained by removal of a proton from the acid molecule
97. Carboxylic acids are more acidic than phenol and alcohol because of  
(a) intermolecular hydrogen bonding  
(b) formation of dimers  
(c) highly acidic hydrogen  
(d) resonance stabilization of their conjugate base
98. Which of the following has the maximum acidic strength?  
(a) o-nitrobenzoic acid (b) m-nitrobenzoic acid  
(c) p-nitrobenzoic acid (d) p-nitrophenol
99. Which of the following is the weakest acid?

- (a)  (b)  $\text{CH}_3\text{COOH}$
- (c)  $\text{HCOOH}$  (d) 

100. Which of the following acids has the smallest dissociation constant?  
(a)  $\text{CH}_3\text{CHF}\text{COOH}$  (b)  $\text{FCH}_2\text{CH}_2\text{COOH}$   
(c)  $\text{BrCH}_2\text{CH}_2\text{COOH}$  (d)  $\text{CH}_3\text{CHBr}\text{COOH}$
101. Which one of the following esters is obtained by the esterification of propan-2-ol with ethanoic acid?  
(a)  $(\text{CH}_3)_2\text{CHCOOCH}_3$  (b)  $\text{CH}_3\text{COOCH}_2\text{CH}_3$   
(c)  $\text{CH}_3\text{COOCH}(\text{CH}_3)_2$  (d)  $(\text{CH}_3)_2\text{CHCOOCH}_2\text{CH}_3$
102. The major product of nitration of benzoic acid is  
(a) 3-Nitrobenzoic acid (b) 4-Nitrobenzoic acid  
(c) 2-Nitrobenzoic acid (d) 2,4-dinitrobenzoic acid
103. Among the following acids which has the lowest  $\text{pK}_a$  value?  
(a)  $\text{CH}_3\text{CH}_2\text{COOH}$  (b)  $(\text{CH}_3)_2\text{CH}-\text{COOH}$   
(c)  $\text{HCOOH}$  (d)  $\text{CH}_3\text{COOH}$
104. The correct order of increasing acidic strength is

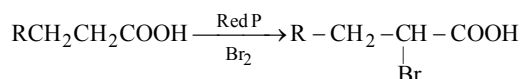
- (a) Phenol < Ethanol < Chloroacetic acid < Acetic acid  
(b) Ethanol < Phenol < Chloroacetic acid < Acetic acid  
(c) Ethanol < Phenol < Acetic acid < Chloroacetic acid  
(d) Chloroacetic acid < Acetic acid < Phenol < Ethanol
105. Which reagent can convert acetic acid into ethanol?  
(a)  $\text{Na} + \text{alcohol}$  (b)  $\text{LiAlH}_4 + \text{ether}$   
(c)  $\text{H}_2 + \text{Pt}$  (d)  $\text{Sn} + \text{HCl}$
106. Which is false in case of carboxylic acids?  
(a) They are polar molecules  
(b) They form H-bonds  
(c) They are stronger than mineral acids  
(d) They have higher b.p. than corresponding alcohols
107. The elimination of  $\text{CO}_2$  from a carboxylic acid is known as  
(a) hydration (b) dehydration  
(c) decarboxylation (d) carboxylation
108. The reaction of carboxylic acid gives effervescences of  $\text{CO}_2$  with  $\text{NaHCO}_3$ . The  $\text{CO}_2$  comes from.  
(a)  $\text{R}-\text{COOH}$  (b)  $\text{NaHCO}_3$   
(c) Both (a) and (b) (d) None of these
109. Acetic anhydride is obtained by the reaction of  
(a) sodium and acetic acid  
(b) ammonia and acetic acid  
(c) ethanol and acetic acid  
(d)  $\text{P}_2\text{O}_5$  and acetic acid
110. Benzoic acid may be converted to ethyl benzoate by reaction with  
(a) sodium ethoxide (b) ethyl chloride  
(c) dry  $\text{HCl}-\text{C}_2\text{H}_5\text{OH}$  (d) ethanol
111. Propionic acid with  $\text{Br}_2/\text{P}$  yields a dibromo product. Its structure would be:

- (a)  (b)  $\text{CH}_2\text{Br}-\text{CH}_2-\text{COBr}$
- (c)  (d)  $\text{CH}_2\text{Br}-\text{CHBr}-\text{COOH}$

112. The product obtained when acetic acid is treated with phosphorus trichloride is

- (a)  $\text{CH}_3\text{COOPCl}_3$  (b)  $\text{ClCH}_2\text{COCl}$   
(c)  $\text{CH}_3\text{COCl}$  (d)  $\text{ClCH}_2\text{COOH}$

113. The reaction



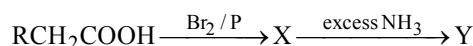
is called as

- (a) Reimer-Tiemann reaction  
(b) Hell-Volhard Zelinsky reaction  
(c) Cannizzaro reaction  
(d) Sandmeyer reaction

114. Benzoic acid reacts with conc.  $\text{HNO}_3$  and  $\text{H}_2\text{SO}_4$  to give :

- (a) 3-Nitrobenzoic acid  
(b) 4-Benzene sulphonic acid  
(c) 4-Nitrobenzoic acid  
(d) 2-Nitrobenzoic acid

115. In the following reaction



The major compounds X and Y are

- (a)  $\text{RCHBrCONH}_2$ ;  $\text{RCH}(\text{NH}_2)\text{COOH}$   
(b)  $\text{RCHBrCOOH}$ ;  $\text{RCH}(\text{NH}_2)\text{COOH}$   
(c)  $\text{RCH}_2\text{COBr}$ ;  $\text{RCH}_2\text{COONH}_4$   
(d)  $\text{RCHBrCOOH}$ ;  $\text{RCH}_2\text{CONH}_2$

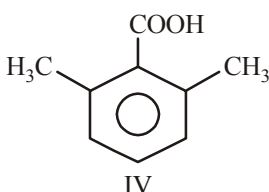
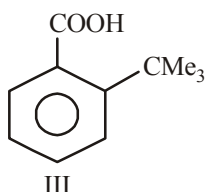
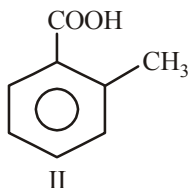
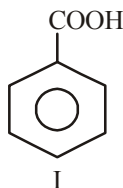
116. The yield of ester in esterification can be increased by  $\text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COOCH}_2\text{CH}_3 + \text{H}_2\text{O}$

- (a) removing water  
(b) taking ethanol in excess  
(c) taking acetic acid in excess  
(d) all the above factors

117. A carboxylic acid can best be converted into acid chloride by using

- (a)  $\text{PCl}_5$  (b)  $\text{SOCl}_2$   
(c)  $\text{HCl}$  (d)  $\text{ClCOCOCI}$

118. Arrange the following four acids in their decreasing order of acidity



- (a)  $\text{I} > \text{II} > \text{III} > \text{IV}$  (b)  $\text{IV} > \text{III} > \text{II} > \text{I}$   
(c)  $\text{II} > \text{IV} > \text{III} > \text{I}$  (d)  $\text{III} > \text{IV} > \text{II} > \text{I}$

119. The strongest acid among the following is –

- (a) Salicylic acid (b) *m*-hydroxybenzoic acid  
(c) *p*-hydroxybenzoic acid (d) Benzoic acid

120. Among the following, the most acidic is :

- (a)  $\text{CH}_3\text{COOH}$  (b)  $\text{ClCH}_2\text{COOH}$   
(c)  $\text{Cl}_2\text{CHCOOH}$  (d)  $\text{Cl}_2\text{CHCH}_2\text{COOH}$

121. Which of the following is the correct decreasing order of acidic strength of

- (i) Methanoic acid (ii) Ethanoic acid  
(iii) Propanoic acid (iv) Butanoic acid  
(a) (i) > (ii) > (iii) > (iv) (b) (ii) > (iii) > (iv) > (i)  
(c) (i) > (iv) > (iii) > (ii) (d) (iv) > (i) > (iii) > (ii)

122. Among the following the strongest acid is

- (a)  $\text{CH}_3\text{COOH}$  (b)  $\text{CH}_2\text{ClCH}_2\text{COOH}$   
(c)  $\text{CH}_2\text{ClCOOH}$  (d)  $\text{CH}_3\text{CH}_2\text{COOH}$

123. Arrange the following carboxylic acid in their decreasing acidity.

- $\begin{array}{c} \text{COOH} \\ | \\ \text{COOH} \end{array}$  Oxalic acid
  - $\text{HOOC}-\text{CH}_2-\text{COOH}$  Malonic acid
  - $\begin{array}{c} \text{CH}_2-\text{COOH} \\ | \\ \text{CH}_2-\text{COOH} \end{array}$  Succinic acid
- (a)  $3 > 2 > 1$  (b)  $1 > 2 > 3$   
(c)  $2 > 3 > 1$  (d)  $2 > 1 > 3$

### STATEMENT TYPE QUESTIONS

124. Read the following statements and choose the correct option

- (i) The carbonyl carbon atom is  $\text{sp}^2$ -hybridised  
(ii) The carbonyl carbon is an electrophilic (Lewis acid) centre  
(iii) The carbonyl oxygen is a nucleophilic (Lewis base) centre  
(iv) Carbonyl compounds are non-polar in nature.  
(a) (i), (ii) and (iv) are correct  
(b) (i), (ii) and (iii) are correct  
(c) (ii), (iii) and (iv) are correct  
(d) (ii) and (iv) are correct

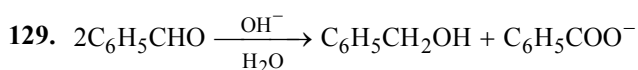
125. Which of the following statement(s) is/are true regarding preparation of aldehydes and ketones?

- (i) Both can be prepared by the oxidation of the concerned alcohol with copper at about  $250^\circ\text{C}$ .  
(ii) Both can be prepared by the oxidation of the concerned alcohol by Oppenauer oxidation.  
(iii) Both can be prepared by the oxidation of respective alcohol with acidic dichromate.  
(a) (i) only (b) (ii) and (iii)  
(c) (i) and (iii) (d) All the three

126. Which of the following statements are *false*?
- No aldehyde can be prepared by the oxidation of primary alcohol with acidic  $\text{KMnO}_4$ .
  - Aldehydes having a boiling point less than  $100^\circ\text{C}$  can be prepared by the oxidation of primary alcohol with acidic dichromate.
  - Secondary alcohols on oxidation with PCC in dichloromethane give carboxylic acids having lesser number of carbon atoms
  - Tertiary alcohols can't be oxidised at all
- (a) (ii) and (iii) (b) (ii), (iii) and (iv)  
(c) (i), (iii) and (iv) (d) (i), (ii) and (iii)

127. Read the following statements and choose the correct option
- The boiling points of aldehydes and ketones are lower than those of alcohols of similar molecular masses
  - Alcohols show intermolecular hydrogen bonding whereas aldehydes and ketones do not show intermolecular hydrogen bonding.
  - The lower members of aldehydes and ketones are miscible with water in all proportions, because they form hydrogen bond with water.
  - The solubility of aldehydes and ketones increases rapidly on increasing the length of alkyl chain
- (a) TTFB (b) TFFT  
(c) FTTT (d) TTTT

128. Aldehydes are generally more reactive than ketones in nucleophilic addition reactions. Which of the following statements accounts for this?
- Sterically, the presence of two relatively large substituents in ketones hinders the approach of nucleophile to carbonyl carbon
  - Aldehydes show resonance whereas ketones do not
  - Electronically, the presence of two alkyl groups reduce the electrophilicity of the carbonyl carbon more effectively.
  - Electronically carbonyl carbon atom in ketones is more electrophilic than in aldehydes
- (a) (i) and (iii) (b) (i) and (iv)  
(c) (ii) and (iii) (d) (ii) and (iv)



Which of the following statements are correct regarding the above reduction of benzaldehyde to benzyl alcohol?

- One hydrogen is coming from  $\text{H}_2\text{O}$  as  $\text{H}^+$  and another from  $\text{C}_6\text{H}_5\text{CHO}$  as  $\text{H}^-$
  - One hydrogen is coming from  $\text{H}_2\text{O}$  as  $\text{H}^-$  and another from  $\text{C}_6\text{H}_5\text{CHO}$  as  $\text{H}^+$
  - One hydrogen from  $\text{H}_2\text{O}$  and another from  $\text{C}_6\text{H}_5\text{CHO}$ , both in the form of  $\text{H}^-$
  - The reduction is an example of disproportionation reaction
- (a) (i), (ii) and (iii) (b) (i) and (iv)  
(c) (ii), (iii) and (iv) (d) (iii) and (iv)

130. Which of the following statement(s) is/are true regarding esterification of a carboxylic acid with an alcohol?

- It is carried out in presence of a strong acid which acts as a catalyst.
  - The strong acid makes the carbonyl carbon more electrophilic, and hence causes the alcohol, a strong nucleophile to attack on the carbonyl carbon.
  - The strong acid makes the carbonyl group more electrophilic which is thus attacked easily by an alcohol, a weak nucleophile.
  - Esterification can be done even in absence of a strong acid.
- (a) (i) and (ii) (b) (i) and (iii)  
(c) (i) only (d) (iv) only

### MATCHING TYPE QUESTIONS

131. Match the columns

Column-I (Common names)	Column-II (IUPAC names)
(A) Cinnamaldehyde	(p) Pentanal
(B) Acetophenone	(q) Prop-2-enal
(C) Valeraldehyde	(r) 4-Methylpent-3-en-2-one
(D) Acrolein	(s) 3-Phenylprop-2-enal
(E) Mesityl oxide	(t) 1-Phenylethanone
(a) A – (s), B – (t), C – (p), D – (q), E – (r)	
(b) A – (p), B – (q), C – (s), D – (t), E – (r)	
(c) A – (t), B – (s), C – (p), D – (r), E – (q)	
(d) A – (q), B – (t), C – (r), D – (s), E – (p)	

132. Match the columns

Column-I	Column-II
(A) $\text{R}-\text{CO}-\text{CH}_3 \xrightarrow{\text{Zn-Hg/HCl}} \text{R}-\text{CH}_2-\text{CH}_3$	(p) Friedel-Craft's reaction
(B) $2\text{C}_6\text{H}_5\text{CHO} \xrightarrow{\text{NaOH}} \text{C}_6\text{H}_5\text{COONa} + \text{C}_6\text{H}_5\text{CH}_2\text{OH}$	(q) Kolbe's reaction
(C) $\text{C}_6\text{H}_6 + \text{CH}_3\text{COCl} \xrightarrow[\text{AlCl}_3]{\text{Anhyd.}} \text{C}_6\text{H}_5\text{COCH}_3$	(r) Clemmensen's reaction
(D) $\text{C}_6\text{H}_5\text{OH} + \text{CO}_2 + \text{NaOH} \rightarrow \text{HOC}_6\text{H}_4\text{COONa}$	(s) Cannizzaro's reaction
(a) A – (p), B – (q), C – (r), D – (s)	
(b) A – (q), B – (p), C – (r), D – (s)	
(c) A – (r), B – (s), C – (p), D – (q)	
(d) A – (s), B – (r), C – (p), D – (q)	

133. Match the columns

Column-I	Column-II
(A) Etard reaction	(p) Alcoholic KOH
(B) Hydroxylation	(q) Anhydrous $\text{AlCl}_3$
(C) Dehydrohalogenation	(r) Chromyl chloride
(D) Friedel-Crafts reaction	(s) Dilute alkaline $\text{KMnO}_4$
(a) A – (p), B – (q), C – (r), D – (s)	
(b) A – (s), B – (r), C – (p), D – (q)	
(c) A – (r), B – (s), C – (p), D – (q)	
(d) A – (q), B – (p), C – (s), D – (r)	

134. Match the columns

Column-I (Reactions)	Column-II (Reagents)
(A) Benzophenone $\rightarrow$ Diphenylmethane	(p) $\text{LiAlH}_4$
(B) Benzaldehyde $\rightarrow$ 1-Phenylethanol	(q) DIBAL-H
(C) Cyclohexanone $\rightarrow$ Cyclohexanol	(r) $\text{Zn(Hg)/Conc HCl}$
(D) Phenyl benzoate $\rightarrow$ Benzaldehyde	(s) $\text{CH}_3\text{MgBr}$
(a) A – (p), B – (s), C – (r), D – (q)	
(b) A – (q), B – (s), C – (p), D – (r)	
(c) A – (s), B – (r), C – (q), D – (p)	
(d) A – (r), B – (s), C – (p), D – (q)	

135. Match the columns

Column-I	Column-II
(A) $\begin{array}{c} \text{R} \\ \diagdown \\ \text{C} = \text{NH} \\ \diagup \\ \text{R} \end{array}$	(p) Oxime
(B) $\begin{array}{c} \text{R} \\ \diagdown \\ \text{C} = \text{NOH} \\ \diagup \\ \text{R} \end{array}$	(q) Semicarbazone
(C) $\begin{array}{c} \text{R} \\ \diagdown \\ \text{C} = \text{N} - \text{NH}_2 \\ \diagup \\ \text{R} \end{array}$	(r) Imine
(D) $\begin{array}{c} \text{R} \\ \diagdown \\ \text{C} = \text{N} - \text{NH} - \text{C}(=\text{O}) - \text{NH}_2 \\ \diagup \\ \text{R} \end{array}$	(s) Hydrazone
(a) A – (q), B – (s), C – (p), D – (r)	
(b) A – (r), B – (p), C – (s), D – (q)	
(c) A – (r), B – (s), C – (p), D – (q)	
(d) A – (s), B – (r), C – (q), D – (p)	

136. Match the acids given in Column-I with their correct IUPAC names given in Column-II.

Column-I (Acids)	Column-II (IUPAC names)
(A) Phthalic acid	(p) Hexane-1, 6-dioic acid
(B) Oxalic acid	(q) Benzene-1, 2-dicarboxylic acid
(C) Succinic acid	(r) Pentane-1, 5-dioic acid
(D) Adipic acid	(s) Butane-1, 4-dioic acid
(E) Glutaric acid	(t) Ethane-1, 2-dioic acid
(a) A – (t), B – (q), C – (r), D – (p), E – (s)	
(b) A – (p), B – (s), C – (t), D – (q), E – (r)	
(c) A – (q), B – (t), C – (s), D – (p), E – (r)	
(d) A – (r), B – (t), C – (p), D – (s), E – (q)	

137. Match the columns

Column-I	Column-II
(A) $\begin{array}{c} \text{COOH} \\ \diagup \\ \text{CH}_2 \\ \diagdown \\ \text{COOH} \end{array}$	(p) Glutaric acid
(B) $\begin{array}{c} \text{CH}_2 - \text{COOH} \\   \\ \text{CH}_2 - \text{COOH} \end{array}$	(q) Adipic acid
(C) $\begin{array}{c} \text{CH}_2 - \text{COOH} \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 - \text{COOH} \end{array}$	(r) Succinic acid
(D) $\begin{array}{c} \text{CH}_2 - \text{COOH} \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 \\   \\ \text{CH}_2 - \text{COOH} \end{array}$	(s) Malonic acid
(a) A – (q), B – (p), C – (s), D – (r)	
(b) A – (r), B – (p), C – (s), D – (q)	
(c) A – (s), B – (r), C – (p), D – (q)	
(d) A – (r), B – (q), C – (s), D – (p)	

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

**138. Assertion :** The boiling points of aldehydes and ketones are higher than hydrocarbons and ethers of comparable molecular masses.

**Reason :** There is a weak molecular association in aldehydes and ketones arising out of the dipole-dipole interactions.

**139. Assertion :** Formaldehyde is a planar molecule.

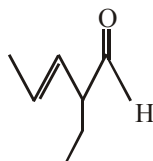
**Reason :** It contains  $\text{sp}^2$  hybridised carbon atom.

**140. Assertion :** Compounds containing  $-\text{CHO}$  group are easily oxidised to corresponding carboxylic acids.


**Reason :** Carboxylic acids can be reduced to alcohols by treatment with  $\text{LiAlH}_4$ .


**Reason :** The carboxylic acids exist as cyclic dimers in which the two molecules of the acid are held together by two strong hydrogen bonds.

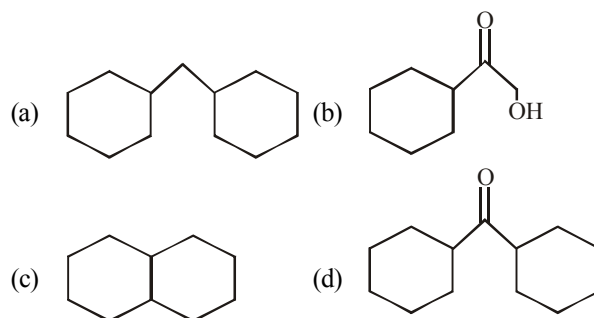
**142.** IUPAC name of the following compound is



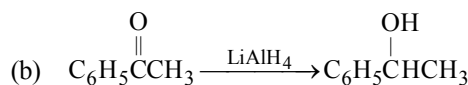
- $$\begin{array}{cc} >C=O & >C=\overset{+}{O}H \\ \text{I} & & \text{II} \end{array}$$

- contain polar   $\text{C}=\text{O}$  group and lower alcohols  
have H-bonding.

- contain polar  C = O group and held together by strong dipole-dipole attraction and lower alcohols have H-bonding, which is stronger than dipole-dipole attraction.

C1CCCCC1C#N + C1CCCCC1[Mg]X  $\xrightarrow[\text{H}_3\text{O}^+]{\text{dry ether}}$ 

- $$(a) \quad \text{C}_6\text{H}_5\overset{\text{O}}{\parallel}\text{CCH}_3 \xrightarrow{\text{NH}_2\text{NH}_2, \text{H}^+} \text{C}_6\text{H}_5\overset{\text{NNH}_2}{\parallel}\text{CCH}_3$$



- $$\begin{array}{c} \text{R} \\ \diagup \\ \text{C}=\text{O} \\ \diagdown \\ \text{H} \end{array} + \text{R}'\text{OH} \xrightleftharpoons{\text{H}^+} \begin{array}{c} \text{R} \\ \diagup \\ \text{C} \\ \diagdown \\ \text{H} \end{array} \begin{array}{c} \diagup \text{OH} \\ \diagdown \text{OR}' \end{array} \xrightleftharpoons{\text{R}'\text{OH}, \text{H}^+} \begin{array}{c} \text{R} \\ \diagup \\ \text{C} \\ \diagdown \\ \text{H} \end{array} \begin{array}{c} \diagup \text{OR}' \\ \diagdown \text{OR}' \end{array} + \text{H}_2\text{O}$$

(a) Using excess of alcohol  
(b) Using high temperature  
(c) Using dilute acid and excess of alcohol  
(d) Using dry acid and excess of alcohol

- (a) HCHO is always oxidised because of electronic effect  
(b) HCHO is always oxidised because of steric effect  
(c) both of the above statements are true  
(d) none of the above statement is true

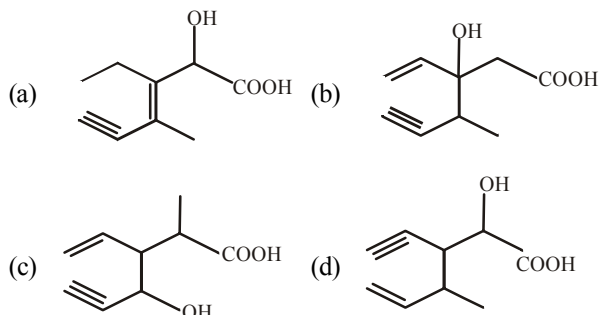
- (i)  $\text{OH}^-$  (ii)  $\text{H}_2\ddot{\text{O}}:$   
 (iii)  $^-\text{CH}_2\text{CHO}$   
 (a) Only (i) (b) (i) and (ii)  
 (c) (i) and (iii) (d) All the three



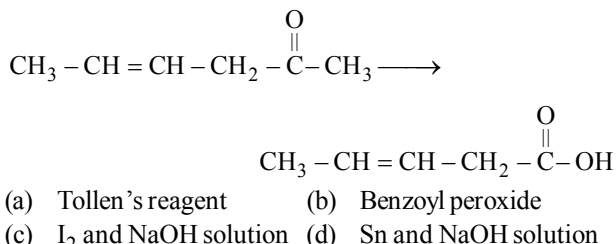
152. Which of the following acts as a nucleophile in the Cannizzaro reaction involving benzaldehyde ?  
 (i)  $\text{OH}^-$  (ii)  $\text{C}_6\text{H}_5\text{CHO}$   
 (iii)  $\text{C}_6\text{H}_5\text{CH}(\text{OH})\text{O}^-$  (iv)  $\text{H}_2\ddot{\text{O}}:$   
 (a) (i) and (iv) (b) (i) and (ii)  
 (c) (i) and (iii) (d) Only (i)
153. Which of the following undergoes haloform reaction ?  
 (i)  $\text{CH}_3\text{CH}_2\text{COCH}_2\text{Cl}$  (ii)  $\text{C}_6\text{H}_5\text{COCH}_3$   
 (iii)  $\text{C}_6\text{H}_5\text{COCHCl}_2$  (iv)  $\text{CH}_3\text{CH}_2\text{COCCL}_3$   
 (a) Only (ii) (b) (ii) and (iv)  
 (c) (i), (ii) and (iv) (d) All the four
154. When ethanal reacts with propanal in the presence of a base, the number of products formed is  
 (a) 2 (b) 3  
 (c) 4 (d) 5
155. Aldehydes and ketones will not form crystalline derivatives with  
 (a) sodium bisulphite  
 (b) phenylhydrazine  
 (c) semicarbazide hydrochloride  
 (d) dihydrogen sodium phosphate.
156. Which of the following compound will undergo self aldol condensation in the presence of cold dilute alkali ?  
 (a)  $\text{CH}_2=\text{CH}-\text{CHO}$  (b)  $\text{CH}\equiv\text{C}-\text{CHO}$   
 (c)  $\text{C}_6\text{H}_5\text{CHO}$  (d)  $\text{CH}_3\text{CH}_2\text{CHO}$ .
157. Which of the following is an example of aldol condensation?  
 (a)  $2\text{CH}_3\text{COCH}_3 \xrightarrow{\text{dil NaOH}} \text{CH}_3\text{C}(\text{OH})(\text{CH}_3)\text{CH}_2\text{COCH}_3$   
 (b)  $2\text{HCHO} \xrightarrow{\text{dil NaOH}} \text{CH}_3\text{OH}$   
 (c)  $\text{C}_6\text{H}_5\text{CHO} + \text{HCHO} \xrightarrow{\text{dil NaOH}} \text{C}_6\text{H}_5\text{CH}_2\text{OH}$   
 (d) None of the above
158. Identify X,  

$$\begin{array}{c} \text{H}_3\text{C} \\ \diagup \\ \text{C}=\text{O} \\ \diagdown \\ \text{H}_3\text{C} \end{array} \xrightarrow[\text{dry ether}]{\text{CH}_3\text{MgI}} \text{Intermediate} \xrightarrow{\text{H}_2\text{O}} \text{X}$$
  
 (a)  $\text{CH}_3\text{OH}$  (b) Ethyl alcohol  
 (c) Methyl cyanide (d) tert-Butyl alcohol
159. An organic compound of formula,  $\text{C}_3\text{H}_6\text{O}$  forms phenyl hydrazone, but gives negative Tollen's test. The compound is  
 (a)  $\text{CH}_3\text{CH}_2\text{COCH}_3$  (b)  $\text{CH}_3\text{CH}_2\text{CHO}$   
 (c)  $\text{CH}_3\text{COCH}_3$  (d) Both (a) and (c)
160. 
$$\text{R}-\text{C}(=\text{O})-\text{R} \xrightarrow{\text{HCN}} (\text{A}) \xrightarrow{\text{NH}_3} (\text{B}) \xrightarrow{\text{Hydrolysis}} (\text{C})$$
  
 Compound (C) in above reaction is  
 (a)  $\alpha$ -hydroxy acid (b)  $\alpha$ -amino acid  
 (c)  $\alpha$ -amino alkanol (d)  $\alpha$ -amino  $\beta$ -hydroxy acid
161. Cannizzaro's reaction is not given by \_\_\_\_\_  
 (a)  (b)   
 (c)  $\text{HCHO}$  (d)  $\text{CH}_3\text{CHO}$
162. Benzophenone can be obtained by \_\_\_\_\_.  
 (i) Benzoyl chloride + Benzene +  $\text{AlCl}_3$   
 (ii) Benzoyl chloride + Diphenyl cadmium  
 (iii) Benzoyl chloride + Phenyl magnesium chloride  
 (iv) Benzene + Carbon monoxide +  $\text{ZnCl}_2$   
 (a) (i), (ii) and (iii) (b) (ii) and (iii)  
 (c) (iii) and (iv) (d) (i), (ii) and (iv)
163. Which of the following conversions can be carried out by Clemmensen Reduction ?  
 (i) Benzaldehyde into benzyl alcohol  
 (ii) Cyclohexanone into cyclohexane  
 (iii) Benzoyl chloride into benzaldehyde  
 (iv) Benzophenone into diphenyl methane  
 (a) (ii) and (iv) (b) (i) and (iv)  
 (c) (i) and (iii) (d) (iii) and (iv)
164. Benzaldehyde is less reactive than propanal because  
 (i) the carbon atom of the carbonyl group of benzaldehyde is less electrophilic as in propanal.  
 (ii) the carbon atom of the carbonyl group of benzaldehyde is more electrophilic as in propanal.  
 (iii) carbonyl group in benzaldehyde is more polar due to resonance  
 (iv) carbonyl group in benzaldehyde is less polar due to resonance  
 (a) (i) and (iii) (b) (i) and (iv)  
 (c) (i) only (d) (iv) only
165. Addition of hydrogen cyanide to aldehydes and ketones occurs in presence of a base. The role of base is to  
 (i) catalyse the reaction  
 (ii) generate  $\text{CN}^-$  ion  
 (iii) slow down the reaction  
 (iv) to stabilize the cyanohydrins  
 (a) (i) and (iii) (b) (i) and (ii)  
 (c) (i) and (iv) (d) (ii) and (iv)
166. Addition of alcohols to aldehydes and ketones takes place in presence of dry  $\text{HCl}$  gas because it  
 (i) Protonates the oxygen of the carbonyl compounds  
 (ii) Increases the electrophilicity of the carbonyl carbon  
 (iii) Removes the excess moisture from the reaction  
 (iv) Helps the reaction to move in the forward direction  
 (a) (i), (ii) and (iv) (b) (i), (ii), (iii) and (iv)  
 (c) (ii), (iii), and (iv) (d) (i), (iii) and (iv)
167. When benzaldehyde and acetaldehyde undergoes reaction with the 2, 4-DNP ?  
 (a) Benzaldehyde reacts slowly than acetaldehyde  
 (b) Acetaldehyde reacts slowly than benzaldehyde  
 (c) Both reacts equally  
 (d) Both do not react with 2, 4-DNP

168. Suppose the reaction of compound containing ketone as functional group is carried in basic medium of NaOH. Which of the following will one use to protect the unwanted reaction due presence of carbonyl moiety.
- NaHSO<sub>3</sub>
  - HCN
  - ethylene glycol and HCl
  - None of these
169. A compound C<sub>5</sub>H<sub>10</sub>O forms orange-red precipitate upon reaction with 2,4-DNP, but does not give positive Tollen's test and iodoform test. Possible compound is
- 2,2-dimethylpropanal
  - 3-methylbutan-2-one
  - Pentan-3-one
  - None of the above
170. Nitration of the compound is carried out, this compound gives red-orange ppt. with 2,4-DNP, this compound undergoes Cannizzaro reaction but not aldol, than possible product due to nitration is
- 3-nitroacetophenone
  - (2-nitro)-2-phenylethanal
  - (2-nitro)-1-phenylpropan-2-one
  - 3-nitrobenzaldehyde
171. Structure of the compound whose IUPAC name is 3-ethyl-2-hydroxy-4-methylhex-3-en-5-ynoic acid is :



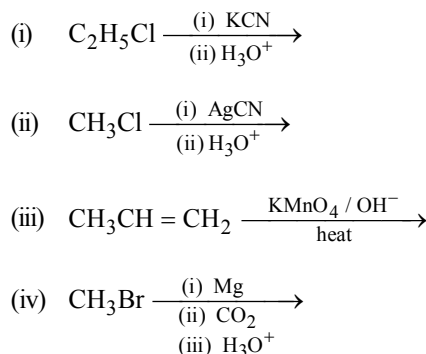
172. The end product B in the sequence of reactions,  
 $R-X \xrightarrow{CN^-} A \xrightarrow{NaOH} B$  is
- an alkane
  - a carboxylic acid
  - sodium salt of carboxylic acid
  - a ketone
173. Which is the most suitable reagent for the following conversion?



174. In the given reaction,  
 $(C_6H_5CO)_2O \xrightarrow{H_2O} I$   
 $C_6H_5COOCOCH_3 \xrightarrow{H_2O} II$

Identify the product(s) formed in the given reaction.

- | I                               | II  |
|---------------------------------|---|
| (a) 2 molecules of benzoic acid | 2 molecules of ethanoic acid                                |
| (b) 2 molecules of benzoic acid | 1 molecules of benzoic acid and 1 molecule of ethanoic acid |
| (c) 1 molecule of ethanoic acid | 1 molecule of benzoic acid                                  |
| (d) 1 molecule of benzoic acid  | 1 molecule of butanoic acid                                 |
175. Ethanoic acid can't be obtained by which of the following reaction ?



- (iii) and (iv)
  - (i) and (ii)
  - (ii) and (iii)
  - (i) and (iv)
176. Primary alcohols can be readily oxidised to carboxylic acids by.
- KMnO<sub>4</sub> in neutral medium.
  - KMnO<sub>4</sub> in acidic or alkaline medium.
  - K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> in alkaline medium.
  - K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub> in acidic medium.
- (i), (ii) and (iv)
  - (i), (ii) and (iii)
  - (ii) and (iii)
  - (i) and (iii)
177. Which of the following is correct order of acidity?
- HCOOH > CH<sub>3</sub>COOH > ClCH<sub>2</sub>COOH > C<sub>2</sub>H<sub>5</sub>COOH
  - ClCH<sub>2</sub>COOH > HCOOH > CH<sub>3</sub>COOH > C<sub>2</sub>H<sub>5</sub>COOH
  - CH<sub>3</sub>COOH > HCOOH > ClCH<sub>2</sub>COOH > C<sub>2</sub>H<sub>5</sub>COOH
  - C<sub>2</sub>H<sub>5</sub>COOH > CH<sub>3</sub>COOH > HCOOH > ClCH<sub>2</sub>COOH
178. An organic compound A upon reacting with NH<sub>3</sub> gives B. On heating B gives C. C in presence of KOH reacts with Br<sub>2</sub> to give CH<sub>3</sub>CH<sub>2</sub>NH<sub>2</sub>. A is :
- CH<sub>3</sub>COOH
  - CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH
  - CH<sub>3</sub>-CH(CH<sub>3</sub>)-COOH
  - CH<sub>3</sub>CH<sub>2</sub>COOH

179. The correct order of increasing acid strength of the compounds
- |                                       |   |
|---------------------------------------|---|
| (A) CH <sub>3</sub> CO <sub>2</sub> H | (B) MeOCH <sub>2</sub> CO <sub>2</sub> H  |
| (C) CF <sub>3</sub> CO <sub>2</sub> H | (D) $\begin{matrix} \text{Me} \\ \diagup \\ \text{C} \\ \diagdown \\ \text{Me} \end{matrix} \text{CO}_2\text{H}$ is |
| (a) D < A < B < C                     | (b) A < D < B < C   |
| (c) B < D < A < C                     | (d) D < A < C < B   |

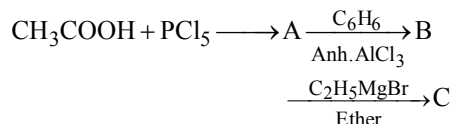
180. Through which of the following reactions number of carbon atoms can be increased in the chain?

- (i) Grignard reaction (ii) Cannizzaro's reaction  
(iii) Aldol condensation (iv) HVZ reaction

Choose the correct option.

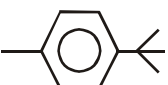
- (a) Only (iii) and (i) (b) Only (iii) and (ii)  
(c) Only (iii) and (iv) (d) (i), (ii), (iii) and (iv)

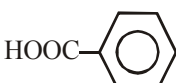
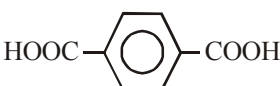
181. In a set of the given reactions, acetic acid yielded a product C.



Product C would be

- (a)  $\text{CH}_3-\overset{\text{C}_2\text{H}_5}{\underset{|}{\text{C}}}(\text{OH})\text{C}_6\text{H}_5$  (b)  $\text{CH}_3\text{CH}(\text{OH})\text{C}_2\text{H}_5$   
(c)  $\text{CH}_3\text{COC}_6\text{H}_5$  (d)  $\text{CH}_3\text{CH}(\text{OH})\text{C}_6\text{H}_5$

182.   $\xrightarrow{\text{K}_2\text{Cr}_2\text{O}_7+\text{H}_2\text{SO}_4}$  Z. Here Z is

- (a)   
(b)  $(\text{CH}_3)_3\text{CCOOH}$   
(c) Both (a) and (b)  
(d) 

183.  $\text{RCOOH}$  can be reduced to  $\text{RCH}_2\text{OH}$  by

- (i)  $\text{NaBH}_4$  (ii)  $\text{LiAlH}_4$   
(iii)  $\text{Na}/\text{C}_2\text{H}_5\text{OH}$  (iv)  $\text{H}_2/\text{Catalyst}$   
(a) (ii) and (iv) (b) (i) and (iii)  
(c) (i), (ii) and (iv) (d) (i), (iii) and (iv)

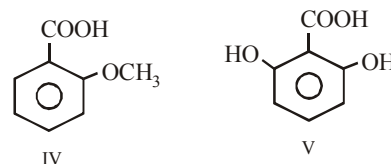
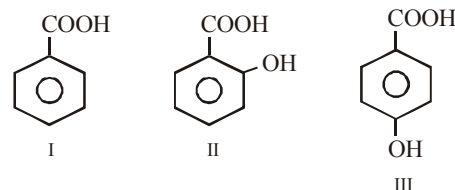
184. Kolbe's electrolytic method can be applied on

- (i)  $\begin{array}{c} \text{CH}_2\text{COONa} \\ | \\ \text{CH}_2\text{COONa} \end{array}$  (ii)  $\begin{array}{c} \text{CHCOONa} \\ || \\ \text{CHCOONa} \end{array}$   
(iii)  $\text{C}_6\text{H}_5\text{COOK}$  (iv)  $\text{CH}_3\text{COOK}$   
(a) (i), (ii) and (iv) (b) (i), (ii) and (iii)  
(c) (ii), (iii) and (iv) (d) (iii) and (iv)

185. Which of the following represents the correct order of the acidity in the given compounds?

- (a)  $\text{FCH}_2\text{COOH} > \text{CH}_3\text{COOH} > \text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH}$   
(b)  $\text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{CH}_3\text{COOH}$   
(c)  $\text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{BrCH}_2\text{COOH} > \text{CH}_3\text{COOH}$   
(d)  $\text{CH}_3\text{COOH} > \text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{FCH}_2\text{COOH}$

186. The correct order for the acidic character of the following carboxylic acids is

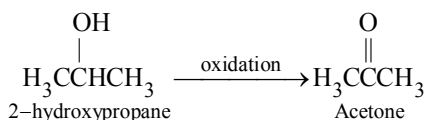


- (a)  $\text{IV} > \text{I} > \text{II} > \text{III} > \text{V}$  (b)  $\text{V} > \text{II} > \text{III} > \text{I} > \text{IV}$   
(c)  $\text{V} > \text{II} > \text{IV} > \text{III} > \text{I}$  (d)  $\text{V} > \text{II} > \text{IV} > \text{I} > \text{III}$

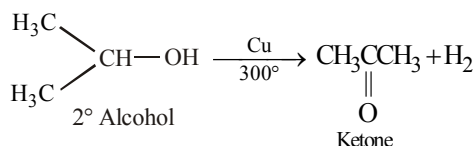
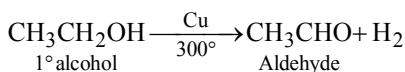
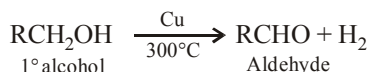
## HINTS AND SOLUTIONS

## FACT/DEFINITION TYPE QUESTIONS

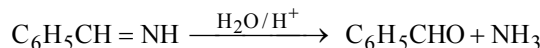
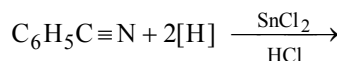
- (b)  $\text{CH}_3 - \overset{2}{\underset{\underset{\text{CH}_2 - \text{CH}_3}{|}}{\text{CH}}} - \overset{1}{\text{CHO}}$
- (a)
- (c)  $\text{CH}_3 - \overset{1}{\underset{\underset{\text{O}}{||}}{\text{C}}} - \overset{2}{\underset{\underset{\text{CH}}{|}}{\text{C}}} - \overset{3}{\underset{\underset{\text{CH}_3}{|}}{\text{CH}}} - \overset{4}{\text{CH}_3}$ ; 3-methyl-2-butanone
- (c)      5. (b)      6. (a)      7. (b)
- (b) O is more electronegative than C.
- (d) Vanillin-vanilla beans  
Salicylaldehyde - meadow sweet  
Cinnamaldehyde - from cinnamon.
- (d) The lower aldehydes have sharp pungent odours. As the size of the molecule increases, the odour becomes less pungent and more fragrant.
- (a) Carbonyl compounds (aldehydes and ketones) are obtained by the oxidation of  $1^\circ$  and  $2^\circ$  alcohols respectively. Among the given options, only (a) is  $2^\circ$  alcohol hence it can be oxidized to ketone.



- (b) Secondary alcohols on oxidation give ketones.  
Note: Primary alcohols form aldehydes.
- (a)  $1^\circ$  Alcohols on catalytic dehydrogenation give aldehydes.
- (a) Alcohols are oxidized by removal of  $\text{H}_2$  in presence of a heated metal catalyst (Cu)



- (a)  $\text{CH}_3 - \text{CH}_2 - \overset{\text{H}}{\underset{\underset{\text{O}}{||}}{\text{C}}} = \overset{\text{CH}_3}{\underset{\underset{\text{O}}{||}}{\text{C}}} \xrightarrow{\text{O}_3} \text{CH}_3 - \text{CH}_2 - \overset{\text{H}}{\underset{\underset{\text{O}}{||}}{\text{C}}} - \overset{\text{O}}{\underset{\underset{\text{O}}{||}}{\text{C}}} - \text{CH}_3$   
 $\text{CH}_3 - \overset{\text{O}}{\underset{\underset{\text{O}}{||}}{\text{C}}} - \text{CH}_3 + \text{CH}_3 - \text{CH}_2 - \text{CHO} \xleftarrow{(-\text{H}_2\text{O})}$
- (b) Catalyst used in Rosenmund reduction is  $\text{Pd}/\text{BaSO}_4$ . Rosenmund reduction is used for reduction of acid chloride.
- (d) Phenyl cyanide is reduced into benzaldehyde in the presence of  $\text{SnCl}_2/\text{HCl}$  reagent. This reaction is known as **Stephen's reaction**.

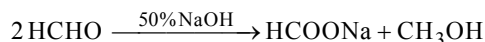


- (c)  $\text{C}_6\text{H}_5\text{COOH} \xleftarrow[\text{or KMnO}_4]{\text{acidic K}_2\text{Cr}_2\text{O}_7} \text{C}_6\text{H}_5\text{CH}_3 \xrightarrow{\text{CrO}_2\text{Cl}_2} \text{C}_6\text{H}_5\text{CHO}$   
(Etard reaction)  
Acidic  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  oxidise toluene to benzoic acid but  $\text{CrO}_2\text{Cl}_2$  oxidises it to benzaldehyde.
- (c)      20. (c)      21. (b)      22. (d)      23. (b)
- (a)      25. (d)
- (b) Formyl chloride is unstable at room temperature.
- (a) Alkanenitriles (other than methanenitrile) and benzonitrile give ketones with Grignard reagents.
- (b)

- (c)  $\text{>C=O} \longleftrightarrow \text{>C}^+ - \text{O}^-$ ; the polarity exists in carbonyl group due to resonance.
- (a) Solubility decreases with increase in mol. wt.
- (c) Propanone has symmetrical structure.
- (d)
- (b) Acetaldehyde reacts only with nucleophiles. Since the mobile p electrons of carbon-oxygen double bond are strongly pulled towards oxygen, carbonyl carbon is electron-deficient and carbonyl oxygen is electron-rich. The electron deficient (acidic) carbonyl carbon is most susceptible to attack by electron rich nucleophilic reagents, that is, by base. Hence the typical reaction of aldehydes and ketones is nucleophilic addition.
- (c)

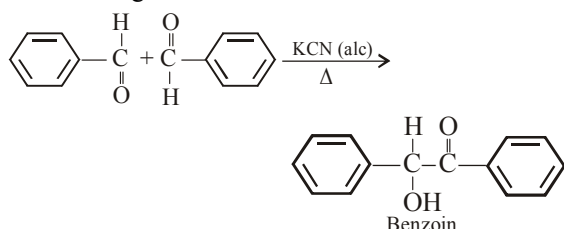
35. (d) Cannizzaro reaction is given by aldehydes having no  $\alpha$ -hydrogen atom in the presence of conc. alkali, aldol condensation is given by aldehydes and ketones having at least one  $\alpha$ -atom in presence of alkali or in presence of acids

36. (b) Aldehydes containing no  $\alpha$ -hydrogen atom on warming with 50% NaOH or KOH undergo disproportionation i.e. self oxidation - reduction known as Cannizzaro's reaction.

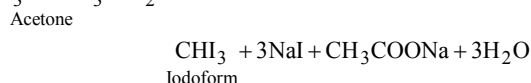


37. (d)  $\text{I}_2$  and  $\text{Na}_2\text{CO}_3$  react with acetophenone ( $\text{C}_6\text{H}_5\text{COCH}_3$ ) to give yellow ppt. of  $\text{CHI}_3$  but benzophenone ( $\text{C}_6\text{H}_5\text{COC}_6\text{H}_5$ ) does not and hence can be used to distinguish between them.

38. (b) When benzaldehyde is refluxed with aqueous alcoholic potassium cyanide, two molecules of benzaldehyde condense together to form benzoin



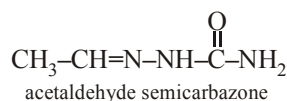
39. (b)  $\text{CH}_3\text{COCH}_3 + 3\text{I}_2 + 4\text{NaOH} \longrightarrow$



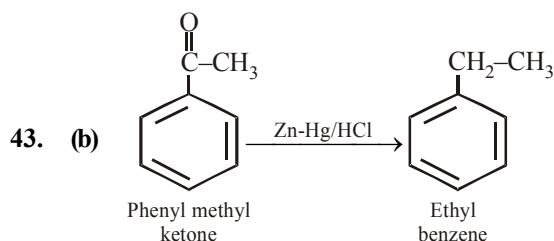
Thus acetone reacts with iodine to form iodoform in the presence of NaOH.

40. (c) Aldol condensation is given by the compounds which contain  $\alpha$  hydrogen atom. As the given compound does not contain  $\alpha$  hydrogen atom. Hence it does not undergo aldol condensation.

41. (b)  $\text{CH}_3\text{CHO} + \text{H}_2\text{N-NH-C(=O)-NH}_2 \xrightarrow{(-\text{H}_2\text{O})}$



42. (d) Iodoform test is exhibited by ethyl alcohol, acetaldehyde, acetone, methyl ketone and those alcohols which possess  $\text{CH}_3\text{CH(OH)-}$  group. As 3-pentanone does not contain  $\text{CH}_3\text{CO-}$  group therefore it does not give iodoform test.



This reaction is known as Clemmensen's reduction.

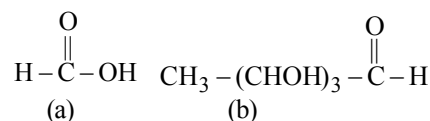
44. (c)  $\text{CH}_3\text{CHO} + 2\text{Cu}^{2+} + \text{OH}^- \rightarrow \text{CH}_3\text{COOH} + \text{Cu}_2\text{O} \downarrow$
- Fehling solution                      (red)

45. (c) Aldol condensation is given by carbonyl compounds which have  $\alpha$ -hydrogen atoms.

$\therefore$  HCHO does not have any  $\alpha$ -hydrogen atom, so it does not give aldol condensation.

46. (b) Cannizzaro reaction is given by aldehydes and ketones which do not have  $\alpha$ -hydrogen atom. Benzaldehyde ( $\text{C}_6\text{H}_5\text{CHO}$ ) does not have  $\alpha$ -H atom and hence gives Cannizzaro reaction.

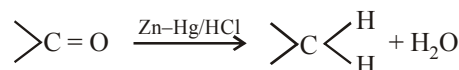
47. (d) Compounds having  $-\text{CHO}$  group reduce Tollen's reagent to silver mirror. It is called silver mirror test.



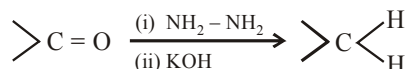
Both (a) and (b) have  $-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$  group so both of them give positive silver mirror test.

48. (b) Tollen's reagent is ammoniacal  $\text{AgNO}_3$ . Aldehydes form silver mirror with it and ketones do not show any change. So Tollen's reagent is used to distinguish between aldehydes and ketones.

49. (a) Aldehydes and ketones are reduced to alkanes by Clemmensen reduction.

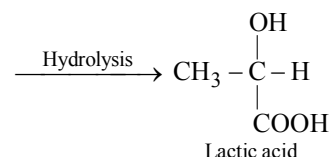


50. (a) Wolf-Kishner reduction



51. (c) Only aldehydes and ketones react with 2,4-dinitrophenylhydrazine.

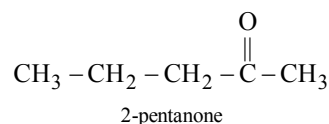
52. (b)  $\text{CH}_3\text{CHO} \xrightarrow{\text{HCN}} \text{CH}_3\text{CH(OH)CN}$
- acetaldehyde



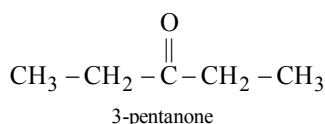
53. (d) HCHO does not undergo iodoform test, while acetaldehyde undergoes iodoform test ( $\text{I}_2$  in presence of base) to form yellow precipitate of iodoform.

54. (d) Aldehydes can be oxidised by all the three given reagents.

55. (c) Iodoform test is given by compounds which have  $\text{CH}_3\text{CO}$  group.



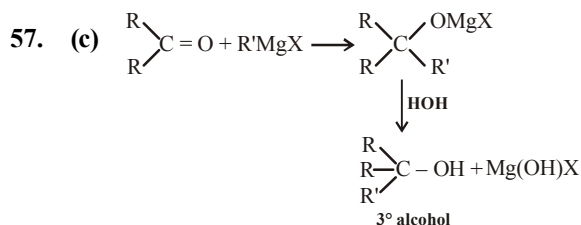
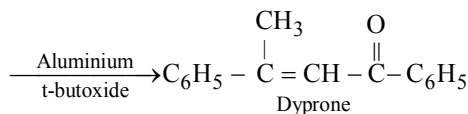
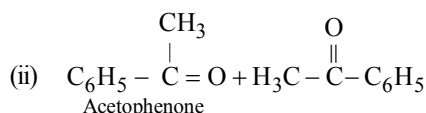
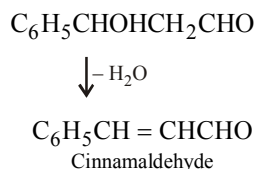
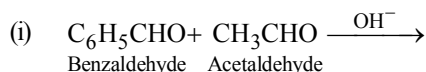




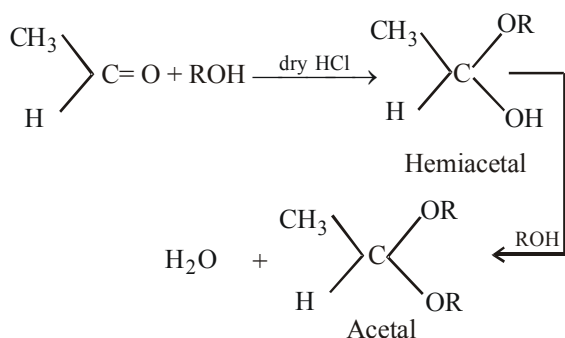
∴ 2-pentanone has  $\text{CH}_3\text{CO}$  group, so it gives iodoform test, while 3-pentanone does not have  $\text{CH}_3\text{CO}$  group, so it does not give iodoform test.

56. (c) In cross aldol condensation aromatic aldehydes or ketones (with or without  $\alpha$ -hydrogen) react with aldehydes, ketones or esters having  $\alpha$ -hydrogen atoms in the presence of dilute alkali to form a  $\beta$ -unsaturated carbonyl compound.

Example,

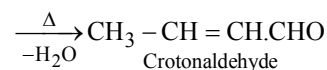
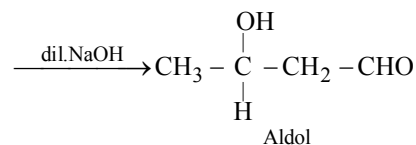
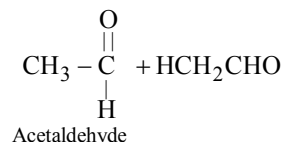


58. (a) When acetaldehyde is treated with alcohol in the presence of dry HCl, then acetal is formed

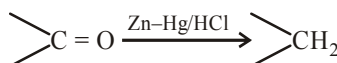


Hence, option (a) is correct.

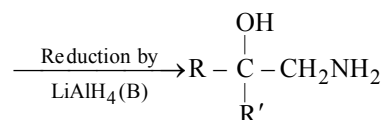
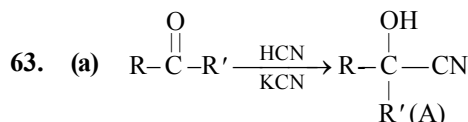
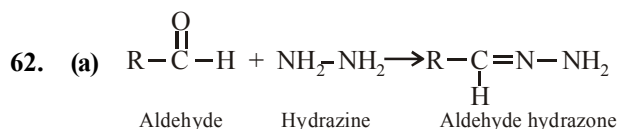
59. (a) Aldehydes and ketones having at least one  $\alpha$ -hydrogen atom in presence of dilute alkali give  $\beta$ -hydroxy aldehyde or  $\beta$ -hydroxy ketone



60. (b) Clemmensen reduction is

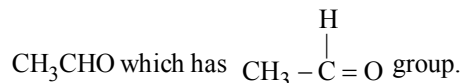


61. (a) Aldehydes, other than formaldehyde, when treated with  $\text{RMgX}$  give 2° alcohols.



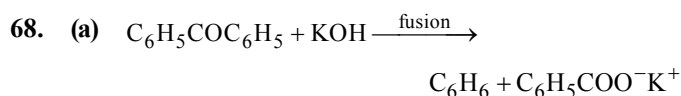
64. (b)

65. (d) Iodoform test is given by compounds having  $\text{CH}_3\text{CO}$ -group or secondary alcohols having  $\text{CH}_3$ - as one of alkyl groups, i.e.,  $\text{CH}_3\text{CHOHR}$  or  $\text{CH}_3\text{CH}_2\text{OH}$  because it is readily oxidised by halogen (present in reagent) to



66. (d)

67. (a) Aldehydes (e.g.  $\text{CH}_3\text{CHO}$ ) restore the pink colour of Schiff's reagent.



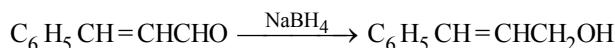
69. (c) The nucleophile is  $\text{SO}_3^{--}$  not  $\text{HSO}_3^-$ ,  $\text{SO}_3\text{Na}$

70. (c) Wolf-Kishner reduction is reduction of carboxyl compound into alkane.

71. (b) Ammonical  $\text{AgNO}_3$  is Tollen's reagent.

72. (d) 73. (c)

74. (d) These reactions lead to replacement of oxygen atom of carbonyl group to form hydrazones and oximes.

75. (a) Cannizzaro's reaction is shown by aldehydes lacking  $\alpha$ -H-atom. Aldol condensation reactions are shown by aldehydes having  $\alpha$ -H-atoms.76. (b)  $\text{NaBH}_4$  selectively reduces the aldehyde group to alcohol without affecting double bond in an organic compound. So, X is  $\text{NaBH}_4$ .77. (a) All ketones in (i), (ii) and (iii) contain abstractable  $\alpha$ -proton while all aldehydes do not contain  $\alpha$ -hydrogen.

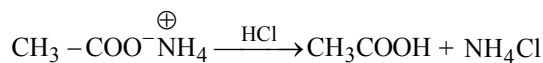
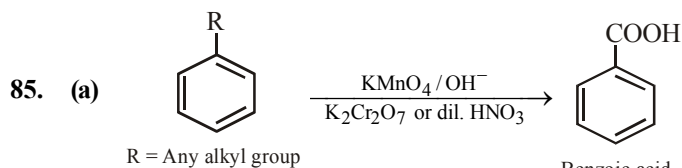
78. (a) Benzaldehyde undergoes Cannizzaro reaction, which forms benzoic acid and benzylalcohol as the product.

79. (c) 80. (b) 81. (a)

82. (d) Automobile exhausts are artificial source of isobutyric acid.

83. (c) Vinegar is 6 - 8% solution of acetic acid.

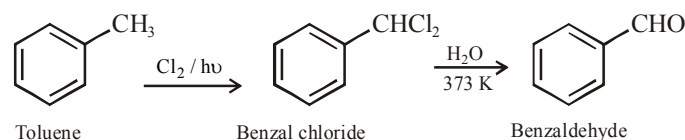
84. (b) The overall reaction involved is

On reduction cyanides yield  $1^\circ$  amines. They do not undergo decarboxylation or electrolysis.

86. (b) Both C-O bonds are identical and each O possesses partial negative charge.

87. (c) Formic acid cannot be prepared by Grignard reagent.

88. (b)



89. (d)

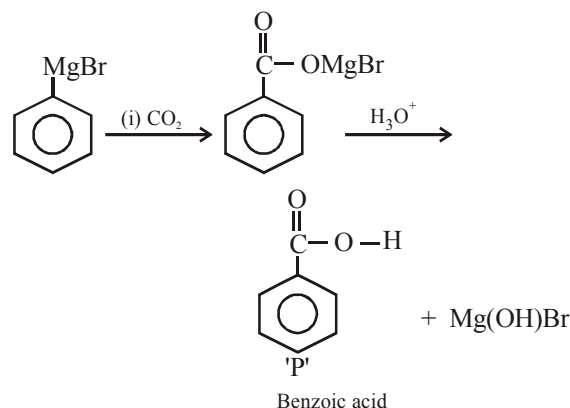
90. (c) Carbonyl group acts as a deactivating and metadirecting group.

91. (d) Primary and secondary alkyl groups oxidised to give carboxylic acid while tertiary alkyl group remain unaffected.

92. (b) 93. (d)

94. (b) Due to H-bonding.

95. (b) Grignard reagent forms addition product with bubbled carbon dioxide which on hydrolysis with HCl yields benzoic acid.

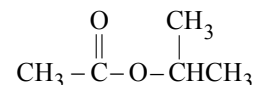
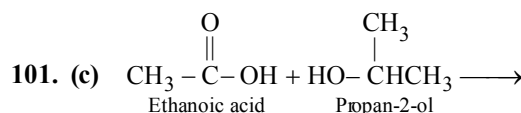


96. (c)

97. (d) In carboxylates (conjugate base of carboxylic acids), resonance is more significant because the two resonating structures are similar, while in phenoxide, the resonating structures are not equivalent, alkoxide ions do not show resonance.

98. (a)

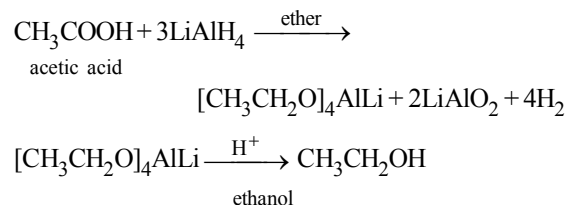
99. (a)

100. (c) Bromine is less electronegative than F, further in  $\text{BrCH}_2\text{CH}_2\text{COOH}$ , Br is more away from the  $-\text{COOH}$  group than in  $\text{CH}_3\text{CHBrCOOH}$ .

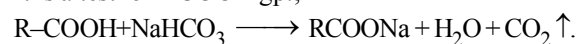
102. (a)

103. (c)  $\text{pK}_a = -\log K_a$ ;  $\text{HCOOH}$  is the strongest acid and hence it has the highest  $K_a$  or lowest  $\text{pK}_a$  value.

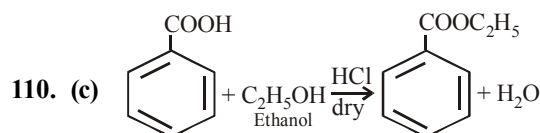
104. (c)

105. (b)  $\text{LiAlH}_4$  in presence of ether can be used to convert acetic acid into ethanol.

106. (c) Carboxylic acids are weak acids.

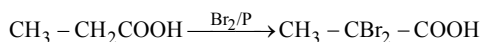
107. (c) Removal of  $\text{CO}_2$  from carboxylic acid is called decarboxylation.108. (b) It is a test for  $-\text{COOH}$  gp.;

109. (d)



This process is known as esterification.

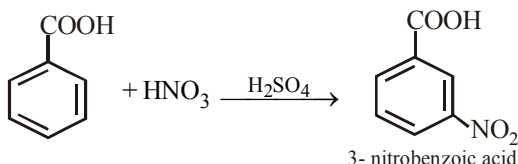
111. (c) This reaction is an example of Hell - Volhard Zelinsky reaction. In this reaction acids containing  $\alpha$  - H on treatment with  $X_2$  / P give di-halo substituted acid.



112. (c)  $3CH_3COOH + PCl_3 \longrightarrow CH_3COCl + H_3PO_3$   
Acetyl Chloride Phosphorous acid

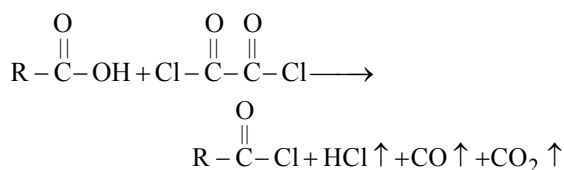
113. (b)

114. (a)  $-COOH$  group when attached to benzene ring deactivates the ring and substitution occurs at m-position. ( $HNO_3 + H_2SO_4$ ) is a source of  $^+NO_2$  (electrophile) which attacks at m-position.



115. (b)  $RCH_2COOH \xrightarrow{Br_2/P} R - \underset{\substack{| \\ Br \\ 'X'}}{CH} - COOH$   
HVZ reaction  
 $\xrightarrow{(Excess) NH_3} R - \underset{\substack{| \\ NH_2 \\ 'Y'}}{CH} - COOH$

116. (d) The yield of product in a reversible reaction can be increased by (i) removing one of the products, (ii) taking either of the reactant in excess.
117. (d) Use of  $SOCl_2$  and  $ClCOCOC$  forms gaseous by-products which can be easily removed, giving better yield of  $RCOCl$ . Further, oxalyl chloride is particularly easy to use because any excess of it can be easily evaporated due to its low b.p. ( $62^\circ C$ )

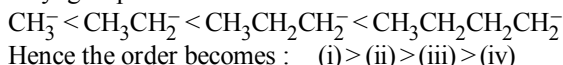


118. (b)

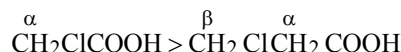
119. (a) Salicylic acid, because it stabilizes the corresponding salicylate ion by intramolecular H-bonding.

120. (c)  $Cl_2CHCOOH$  is most acidic because it has two chlorine at  $\alpha$ -position.

121. (a) An electron releasing substituent (+I) intensify the negative charge on the anion resulting in the decrease of stability and thus decreases the acidity of the acid. Hence acid character decreases as the + I-effect of the alkyl group increases as



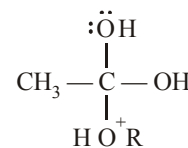
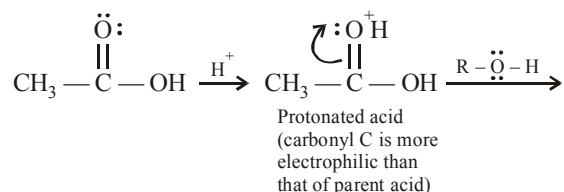
122. (c) Chlorine is electron withdrawing group. Further inductive effect is stronger at  $\alpha$  position than  $\beta$ -position. i.e.,



123. (b)

### STATEMENT TYPE QUESTIONS

124. (b) Carbonyl compounds have substantial dipole moments and are polar in nature. The high polarity of the carbonyl group is due to resonance.
125. (a) Primary alcohols on oxidation give carboxylic acids as the final product, of course through aldehydes. Oppenauer oxidation involves oxidation of  $2^\circ$  alcohols to ketones, and not for the oxidation of  $1^\circ$  alcohols.
126. (c) If the aldehyde has a boiling point less than  $100^\circ C$ , it can be prepared by the oxidation of  $1^\circ$  alcohols with regular oxidising agents like acidic permanganate or dichromate. Since the aldehyde has a lower boiling point than the alcohol, it is distilled off as soon as it is formed ; so further oxidation to a carboxylic acid is minimized.
127. (d) The solubility of aldehydes and ketones decreases rapidly on increasing the length of alkyl chain.
128. (a) Aldehydes are generally more reactive than ketones in nucleophilic addition reactions due to steric and electronic reasons. Sterically, the presence of two relatively large substituents in ketones hinders the approach of nucleophile to carbonyl carbon than in aldehydes having only one such substituent. Electronically, aldehydes are more reactive than ketones because two alkyl groups reduce the electrophilicity of the carbonyl carbon more effectively than in former.
129. (b) The hydrogen atom that is added to the carbonyl carbon of the aldehyde in the reduction is derived directly from the other aldehyde molecule as a hydride ion. The second hydrogen that is added to the negatively charged oxygen is coming from the solvent (consult mechanism of Cannizzaro reaction). Oxidation of one molecule of the compound at the expense of other molecule of the same compound is known as disproportionation.
130. (b) First two steps of the esterification make the question clear



### MATCHING TYPE QUESTIONS

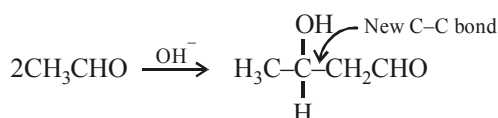
131. (a)      132. (c)      133. (b)      134. (d)      135. (b)  
136. (c)      137. (c)

### ASSERTION-REASON TYPE QUESTIONS

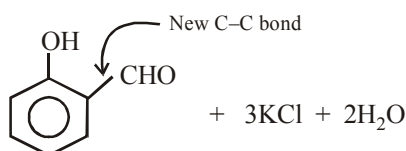
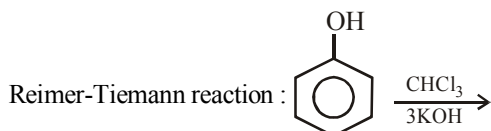
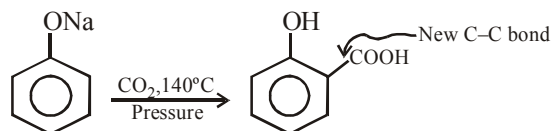
138. (a)      139. (a)      140. (b)  
141. (a) The molecular mass of acetic acid in benzene is 120 instead of 60 because the carboxylic acids exists as cyclic dimers in which two molecules of the acid are held together by two strong hydrogen bond.

### CRITICAL THINKING TYPE QUESTIONS

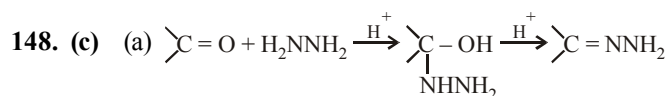
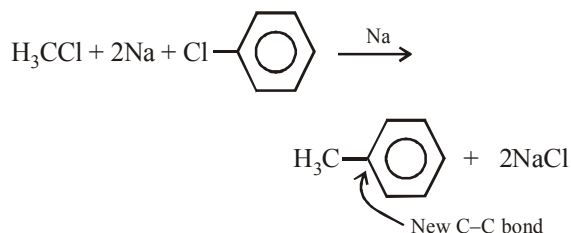
142. (d)  
143. (b) In structure II, presence of positive charge on oxygen causes the displacement of  $\pi$  electrons toward oxygen, making carbon more electron deficient than that in unprotonated carbonyl group.  
144. (c) It is the reason for the given fact.  
145. (d)  
146. (c) With ammonia, HCHO forms hexamethylenetetramine,  $\text{CH}_3\text{CHO}$  gives acetaldehydeammonia addition product, while  $\text{C}_6\text{H}_5\text{CHO}$  gives hydrobenzamide.  
147. (d) Aldol condensation :



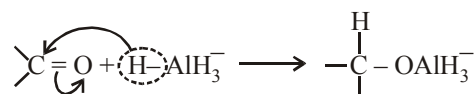
Kolbe reaction :



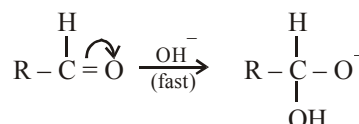
Wurtz Fittig reaction :



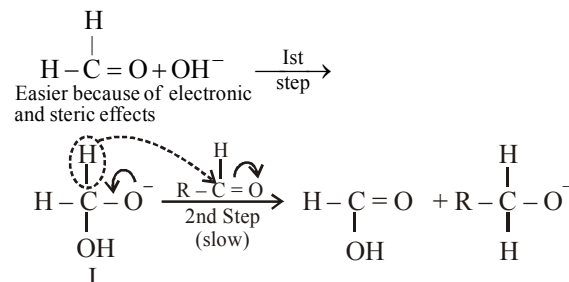
- (b) In the reduction of carbonyl group with  $\text{LiAlH}_4$  or  $\text{NaBH}_4$ , a hydride ion is transferred from the metal to the carbonyl carbon (nucleophilic addition)



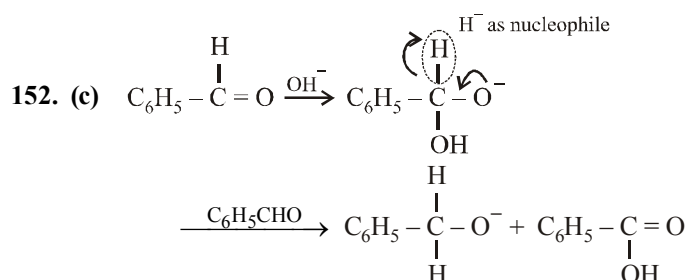
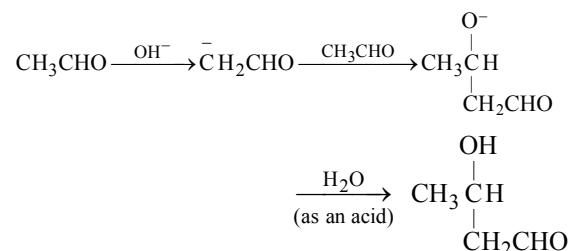
149. (d) Being reversible reaction, the backward reaction i.e. acetal-hemiacetal step can be restricted by minimizing water content, i.e. by using dry HCl. The step hemiacetal-aldehyde can be restricted by using excess of alcohol.  
150. (c) First step in Cannizzaro reaction is the nucleophilic addition of  $\text{OH}^-$  on the carbonyl carbon.



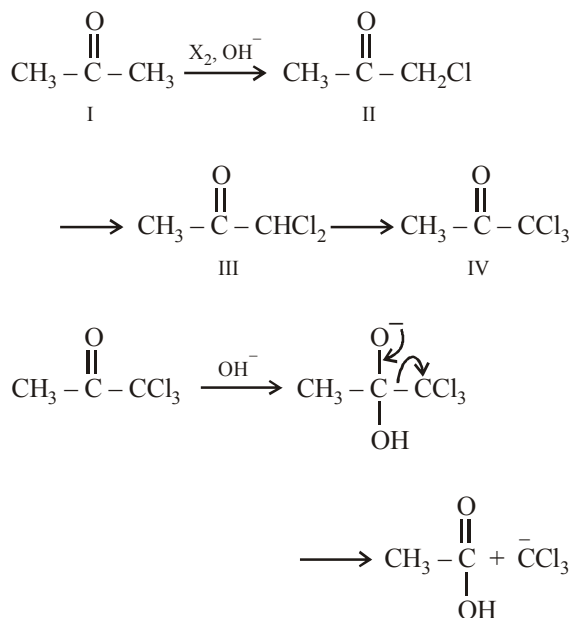
Higher the electron deficiency on carbonyl carbon, more easier will be the attack of the nucleophile ( $\text{OH}^-$ ) on its carbon. Further, the attack of  $\text{OH}^-$  on the carbonyl carbon is more easy in case of HCHO because its carbon is least hindered having two hydrogens (steric effect). Thus the intermediate I is formed very easily which donates hydride ion to another aldehyde and thus itself oxidised.



151. (c)  $\text{OH}^-$  and  $^-\text{CH}_2\text{CHO}$  act as nucleophile in the first two steps.

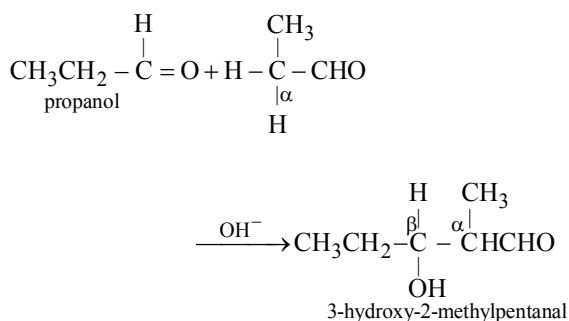


153. (d) If we observe the haloform reaction carefully, we see that  $-\text{COCH}_3$  group is first halogenated to the trihalo  $-\text{COCX}_3$  through monohalogeno and dihalogeno compound. It is the  $-\text{COCX}_3$  part which then undergoes nucleophilic addition. The product easily loses  $-\text{CX}_3$  since it is a very good leaving group.



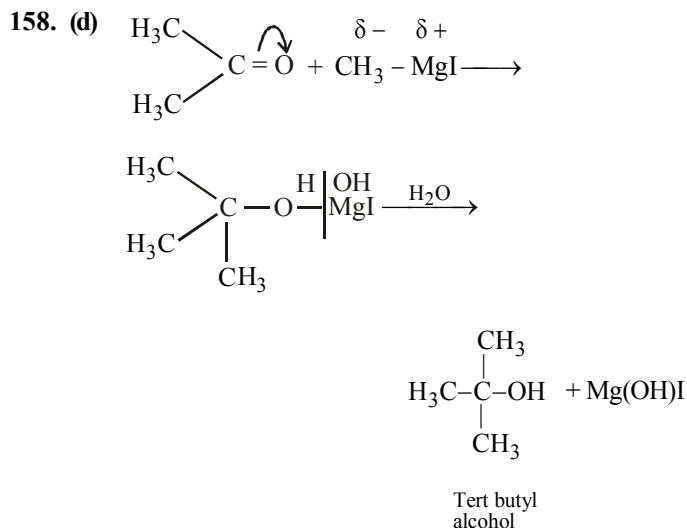
Thus all compounds (I to IV) are ultimately converted to  $\text{CHCl}_3$  (chloroform).

154. (c)  $2\text{CH}_3\text{CHO} \longrightarrow 1^{\text{st}} \text{ Product}$ ,  
 $2\text{CH}_3\text{CH}_2\text{CHO} \longrightarrow 2^{\text{nd}} \text{ Product}$   
 $\text{CH}_3\text{CH}_2\text{CHO} + \overset{\alpha}{\text{CH}_3}\text{CHO} \longrightarrow 3^{\text{rd}} \text{ Product}$ ;  
 $\text{CH}_3\overset{\alpha}{\text{CH}_2}\text{CHO} + \text{CH}_3\text{CHO} \longrightarrow 4^{\text{th}} \text{ Product}$
155. (d) Dihydrogen sodium phosphate ( $\text{NaH}_2\text{PO}_4$ ) does not have a lone pair of electrons on the P atom. As such it can not act as a nucleophile and hence does not react with aldehydes and ketones.
156. (d) Aldehydes which contain a  $\alpha$ -hydrogen on a saturated carbon, i.e.,  $\text{CH}_3\text{CH}_2\text{CHO}$  undergo aldol condensation.

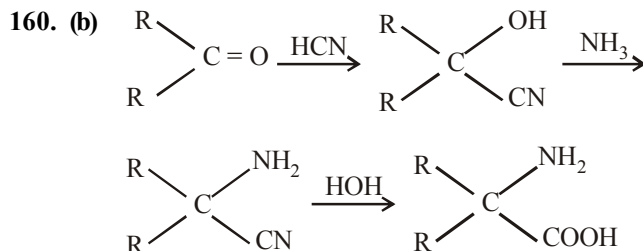


157. (a) Aldol condensation involves an aldehyde or ketone having an  $\alpha$ -hydrogen atom. This type of condensation occurs in presence of dilute base (i.e., dil NaOH).

Only  $\text{CH}_3\text{COCH}_3$  will give aldol condensation (Both  $\text{HCHO}$  and  $\text{C}_6\text{H}_5\text{CHO}$  lack  $\alpha$ -hydrogen).



159. (d) Ketones do not respond to Tollen's test. Aldehydes respond to Tollen's test.



161. (d) 162. (a) 163. (a)
164. (b) The carbon atom of the carbonyl group of benzaldehyde is less electrophilic than carbon atom of the carbonyl group present in propanal. The polarity of the carbonyl group is reduced in benzaldehyde due to resonance as shown below and hence it is less reactive than propanal.
165. (b) Aldehydes and ketones react with hydrogen cyanide (HCN) to yield cyanohydrins. This reaction occurs very slowly with pure HCN. Therefore, it is catalysed by a base and the generated cyanide ion ( $\text{CN}^-$ ) being a stronger nucleophile readily adds to carbonyl compounds to yield corresponding cyanohydrins
166. (b) Dry hydrogen chloride protonates the oxygen of the carbonyl compounds and therefore, increases the electrophilicity of the carbonyl carbon facilitating the nucleophilic attack by the alcohol molecule. Dry HCl gas also absorbs the water produced in these reactions thereby shifting the equilibrium in the forward direction.

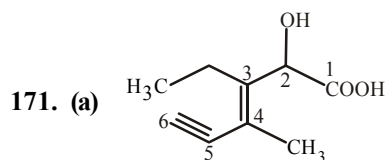


167. (a) Because of resonance in benzaldehyde which is not possible in case of acetaldehyde the positive charge on the carbonyl carbon decreases and hence there is decrease in reactivity.

168. (c) Acetal formed upon reaction of ethylene glycol and HCl, which is unaffected by base hence unwanted reaction does not occur due to presence of carbonyl group.

169. (c) 2, 2-dimethyl propanal gives Tollen's test and 3-methylbutan-2-one gives iodoform test.

170. (d)

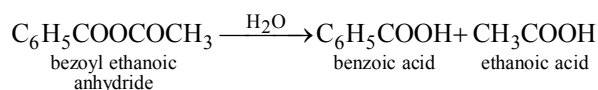


IUPAC name of the structure is 3-ethyl-2-hydroxy-4-methylhex-3-en-5-ynoic acid.

172. (c)  $R-X \xrightarrow{CN^-} R-CN \xrightarrow{NaOH} RCOONa$

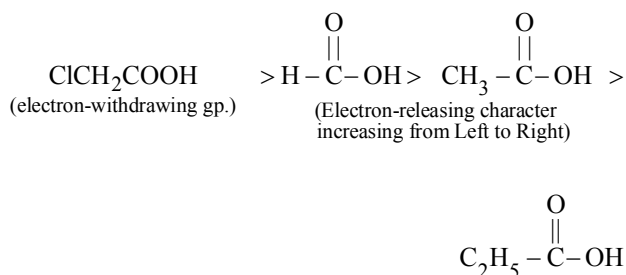
173. (c)

174. (b)  $(C_6H_5CO)_2O \xrightarrow{H_2O} 2C_6H_5COOH$   
benzoic anhydride                      benzoic acid



175. (b)      176. (a)

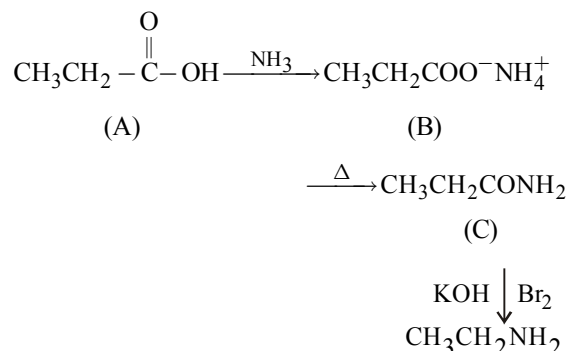
177. (b) Recall that presence of electron-withdrawing group increases, while presence of electron-releasing group decreases the acidity of carboxylic acids.



178. (d)  $A \xrightarrow[NH_3]{(I)} B \xrightarrow[\Delta]{(II)} C \xrightarrow[KOH, (III)]{Br_2} CH_3CH_2NH_2$

Reaction (III) is a Hofmann bromamide reaction. Now formation of  $CH_3CH_2NH_2$  is possible only from a compound  $CH_3CH_2CONH_2$  (C) which can be obtained from the compound  $CH_3CH_2COO^-NH_4^+$  (B).

Thus (A) should be  $CH_3CH_2COOH$

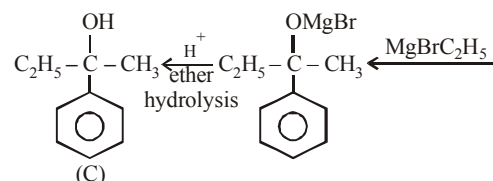
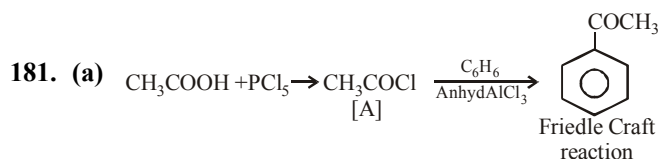


179. (a) The correct order of increasing acid strength



Electron withdrawing groups increase the acid strength and electron donating groups decrease the acid strength.

180. (a) Grignard reagents and nitriles are useful for converting alkyl halide into corresponding carboxylic acids having one carbon atom more than that present in alkyl halides.

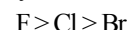


182. (c) An alkyl group attached to benzene ring can be oxidised only when it contains at least one  $\alpha$ -hydrogen atom. Thus here  $-CH_3$  group is oxidised and  $Me_3C-$  group not. However,  $Me_3C-$  group may cause oxidation of the benzene ring to  $-COOH$ .

183. (a)      184. (a)

185. (c) Electron withdrawing substituent (like halogen,  $-NO_2$ ,  $C_6H_5$  etc.) would disperse the negative charge and hence stabilise the carboxylate ion and thus increase acidity of the parent acid. On the other hand, electron-releasing substituents would intensify the negative charge, destabilise the carboxylate ion and thus decrease acidity of the parent acid.

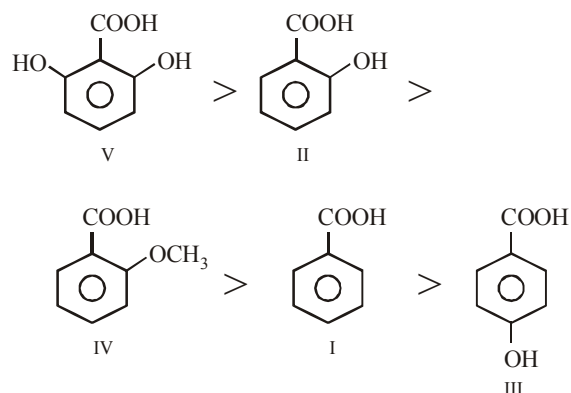
Electronegativity decreases in order



and hence  $-I$  effect also decreases in the same order, therefore the correct option is



186. (d) V is most stable because its anion is stabilized to a greater extent through H-bonding with H atom of OH present on both *ortho*-positions ; followed by II in which one OH group is present. Compound IV comes next to II because here  $-\text{OCH}_3$  group is present in *ortho* position which although is not capable of forming H-bonding yet more acidic than *p*- $\text{HOC}_6\text{H}_4\text{COOH}$  (III) due to ortho effect. Compound III is less acidic than benzoic acid because of electron-releasing group in the para position. Thus

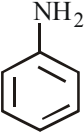




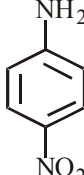
### FACT/DEFINITION TYPE QUESTIONS

- A secondary amine is
  - a compound with two carbon atoms and an  $\text{-NH}_2$  group.
  - a compound containing two  $\text{-NH}_2$  groups.
  - a compound in which hydrogens of  $\text{NH}_3$  have been replaced by two alkyl groups.
  - a compound with an  $\text{-NH}_2$  group on carbon atom in number two position.
- The general formula of quaternary ammonium compound is
  - $\text{R-NH}_2$
  - $\text{R}_3\text{N}$
  - $\text{R}_4\text{N}^+ \text{X}^-$
  - $\text{NH}_4\text{X}$
- The total number of electrons around the nitrogen atom in amines are
  - 8
  - 7
  - 4
  - 3
- The IUPAC name of the compound having formula,
 
$$\begin{array}{c} \text{O}=\text{C}-\text{CH}-\text{CH}_2 \\ | \quad | \quad | \\ \text{OH} \quad \text{NH}_2 \quad \text{OH} \end{array}$$
 is
  - 3-amino-hydroxy propine acid
  - 2-amino-propan-3-oic acid
  - amino hydroxy propanoic acid
  - 2-amino-3-hydroxy propanoic acid
- The number of primary amines of formula  $\text{C}_4\text{H}_{11}\text{N}$  is :
  - 1
  - 3
  - 4
  - 2
- What is the IUPAC name of the following compound ?
  - 2-methyl-4-hexanamine
  - 5-methyl-3-hexanamine
  - 2-methyl-4-amino hexane
  - 5-methyl-3-amino hexane
- The correct IUPAC name for  $\text{CH}_2=\text{CHCH}_2\text{NHCH}_3$  is
  - Allylmethylamine
  - 2-amino-4-pentene
  - 4-aminopent-1-ene
  - N-methylprop-2-en-1-amine
- Amines play an important role in the survival of life. Naturally they are found in
  - proteins
  - vitamins
  - alkaloids
  - All of these
- Intermediates formed during reaction of  $\text{RCONH}_2$  with  $\text{Br}_2$  and  $\text{KOH}$  are
  - $\text{RCONHBr}$  and  $\text{RNCO}$
  - $\text{RNHCOBr}$  and  $\text{RNCO}$
  - $\text{RNHBr}$  and  $\text{RCONHBr}$
  - $\text{RCONBr}_2$
- Which of the following reactions will not give a primary amine?
  - $\text{CH}_3\text{CONH}_2 \xrightarrow{\text{Br}_2 / \text{KOH}}$
  - $\text{CH}_3\text{CN} \xrightarrow{\text{LiAlH}_4}$
  - $\text{CH}_3\text{NC} \xrightarrow{\text{LiAlH}_4}$
  - $\text{CH}_3\text{CONH}_2 \xrightarrow{\text{LiAlH}_4}$
- Propionamide on Hofmann degradation gives –
  - methyl amine
  - ethyl amine
  - propyl amine
  - ethyl cyanide
- Secondary amines could be prepared by
  - reduction of nitriles
  - Hofmann bromamide reaction
  - reduction of amides
  - reduction of isonitriles
- Gabriel's phthalimide synthesis is used for the preparation of
  - Primary aromatic amines
  - Secondary amines
  - Primary aliphatic amines
  - Tertiary amines
- Ethyl amine can be obtained by the
  - Action of  $\text{NH}_3$  on ethyl iodide.
  - Action of  $\text{NH}_3$  on ethyl alcohol.
  - Both (a) and (b)
  - Neither (a) nor (b)

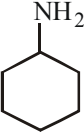
15. Treatment of ammonia with excess of ethyl iodide will yield
  - (a) diethylamine
  - (b) ethylamine
  - (c) triethylamine
  - (d) tetraethylammonium iodide
16. For alkylation of ammonia which of the following is not used?
  - (a)  $\text{CH}_3\text{-X}$
  - (b)  $\text{CH}_3\text{-CH}_2\text{-X}$
  - (c)  $(\text{CH}_3)_2\text{CH-X}$
  - (d)  $(\text{CH}_3)_3\text{C-X}$
17. Which of the following amines can be prepared by Gabriel method?
  - (i)  $\text{CH}_3\text{CH}_2\text{NH}_2$
  - (ii)  $(\text{CH}_3)_2\text{CHNH}_2$
  - (iii)  $(\text{CH}_3)_3\text{CNH}_2$
  - (iv)  $\text{C}_6\text{H}_5\text{NH}_2$
  - (a) (i) and (iii)
  - (b) (ii) and (iv)
  - (c) (i), (ii) and (iii)
  - (d) (i) and (ii)
18. Amongst the given set of reactants, the most appropriate for preparing 2° amine is \_\_\_\_\_.
  - (a)  $2^\circ\text{R-Br} + \text{NH}_3$
  - (b)  $2^\circ\text{R-Br} + \text{NaCN}$  followed by  $\text{H}_2/\text{Pt}$
  - (c)  $1^\circ\text{R-NH}_2 + \text{RCHO}$  followed by  $\text{H}_2/\text{Pt}$
  - (d)  $1^\circ\text{R-Br}$  (2 mol) + Potassium phthalimide followed by  $\text{H}_3\text{O}^+/\text{heat}$
19. The best reagent for converting 2-phenylpropanamide into 2-phenylpropanamine is \_\_\_\_\_.
  - (a) excess  $\text{H}_2$
  - (b)  $\text{Br}_2$  in aqueous  $\text{NaOH}$
  - (c) iodine in the presence of red phosphorus
  - (d)  $\text{LiAlH}_4$  in ether
20. Which of the following methods of preparation of amines will give same number of carbon atoms in the chain of amines as in the reactant?
  - (a) Reaction of nitrite with  $\text{LiAlH}_4$ .
  - (b) Reaction of amide with  $\text{LiAlH}_4$  followed by treatment with water.
  - (c) Heating alkylhalide with potassium salt of phthalimide followed by hydrolysis.
  - (d) Treatment of amide with bromine in aqueous solution of sodium hydroxide.
21. The reduction of nitro compounds is most preferred in the presence of
  - (a)  $\text{Pd/H}_2$  in ethanol
  - (b)  $\text{Sn} + \text{HCl}$
  - (c) finely divided  $\text{Ni}$
  - (d) iron scrap and  $\text{HCl}$ .
22. An alkyl or benzyl halide on reaction with an ethanolic solution of ammonia undergoes
  - (a) electrophilic substitution reaction
  - (b) nucleophilic substitution reaction.
  - (c) free radical mechanism.
  - (d) nucleophilic addition reaction.
23. In the ammonolysis of alkyl halides the halogen atom is replaced by an amino ( $-\text{NH}_2$ ) group which of the following represent the correct order of reactivity of halides with amines.
  - (a)  $\text{RBr} > \text{RI} > \text{RCl}$
  - (b)  $\text{RI} > \text{RCl} > \text{RBr}$
  - (c)  $\text{RI} > \text{RBr} > \text{RCl}$
  - (d)  $\text{RCl} > \text{RBr} > \text{RI}$
24. Which of the following will give primary amine only?
  - (i) ammonia + propylchloride
  - (ii) potassium phthalimide + ethylchloride
  - (iii) potassium phthalimide + chlorobenzene
  - (a) (i) and (ii)
  - (b) (i) and (iii)
  - (c) (ii) and (iii)
  - (d) (i), (ii) and (iii)
25. Amines have
  - (a) Garlic odour
  - (b) Fishy odour
  - (c) Jasmine odour
  - (d) Bitter almonds odour
26. Aniline is less soluble in water than ethyl amine due to
  - (a) resonance stabilization of benzene ring
  - (b) resonance stabilization of anilium ion
  - (c) more hydrophobic nature of  $\text{C}_6\text{H}_5$  group than  $\text{C}_2\text{H}_5$  group
  - (d) more hydrophobic nature of  $\text{C}_6\text{H}_5$  group than  $\text{C}_2\text{H}_5$  group
27. Which of the following should be most volatile?
  - (I)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$
  - (II)  $(\text{CH}_3)_3\text{N}$
  - (III)  $\begin{array}{c} \text{CH}_3\text{CH}_2 \\ \diagup \quad \diagdown \\ \text{CH}_3 \quad \text{NH} \end{array}$
  - (IV)  $\text{CH}_3\text{CH}_2\text{CH}_3$
  - (a) II
  - (b) IV
  - (c) I
  - (d) III
28. Amines behave as
  - (a) lewis acids
  - (b) lewis bases
  - (c) aprotic acids
  - (d) amphoteric compounds
29. The basic character of amines is due to
  - (a) presence of nitrogen atom
  - (b) lone pair of electrons on nitrogen atom
  - (c) tetrahedral structure
  - (d) high electronegativity of nitrogen
30. Aliphatic amines are.....basic than  $\text{NH}_3$  but aromatic amines are.....basic than  $\text{NH}_3$ .
  - (a) more, less
  - (b) less, more
  - (c) both (a) and (b)
  - (d) None of these
31. Substitution of one alkyl group by replacing hydrogen of primary amines
  - (a) increases the base strength
  - (b) decreases the base strength
  - (c) remains the same
  - (d) None of the above
32. Which of the following is not characteristic of amines?
  - (a) They smell like ammonia
  - (b) They are inflammable in air
  - (c) They show the property of hydrogen bonding
  - (d) They are amphoteric in nature
33. The correct order of basicity in amines
  - (i)  $\text{C}_2\text{H}_5\text{NH}_2$
  - (ii)  $\text{CH}_3\text{NH}_2$
  - (iii)  $(\text{CH}_3)_2\text{NH}$
  - (iv)  $(\text{CH}_3)_3\text{N}$
  - (a) (i) < (iv) < (ii) < (iii)
  - (b) (iv) < (ii) < (iii) < (i)
  - (c) (i) < (ii) < (iii) < (iv)
  - (d) (ii) < (iii) < (iv) < (i)
34. The conjugate base of  $(\text{CH}_3)_2\text{NH}_2^+$  is
  - (a)  $(\text{CH}_3)_2\text{NH}$
  - (b)  $(\text{CH}_3)_2\text{N}^+$
  - (c)  $(\text{CH}_3)_3\text{N}^+$
  - (d)  $(\text{CH}_3)_2\text{N}^-$


35. High basicity of  $\text{Me}_2\text{NH}$  relative to  $\text{Me}_3\text{N}$  is attributed to:  
 (a) effect of solvent (b) inductive effect of Me  
 (c) shape of  $\text{Me}_2\text{NH}$  (d) shape of  $\text{Me}_3\text{N}$
36. The correct order of basicity of the following compounds
- 

A

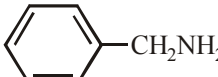


B

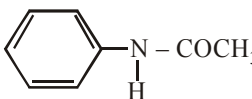


C
- (a)  $\text{B} > \text{A} > \text{C}$  (b)  $\text{A} > \text{B} > \text{C}$   
 (c)  $\text{C} > \text{A} > \text{B}$  (d)  $\text{C} > \text{B} > \text{A}$
37. Which of the following statement is correct ?  
 (a) Ammonia is more basic than methylamine.  
 (b) Methylamine is more basic than ammonia.  
 (c) Dimethylamine is less basic than methylamine.  
 (d) Dimethylamine is less basic than trimethylamine.
38. Which of the following compounds is most basic?
- 

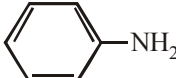
(a)

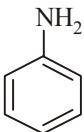


(b)

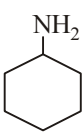


(c)

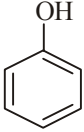


(d)
39. Which of the following compounds is the weakest Brønsted base?
- 

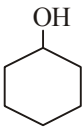
(a)



(b)



(c)



(d)
40. The correct decreasing order of basic strength of the following species is \_\_\_\_\_  $\text{H}_2\text{O}$ ,  $\text{NH}_3$ ,  $\text{OH}^-$ ,  $\text{NH}_2^-$   
 (a)  $\text{NH}_2^- > \text{OH}^- > \text{NH}_3 > \text{H}_2\text{O}$   
 (b)  $\text{OH}^- > \text{NH}_2^- > \text{H}_2\text{O} > \text{NH}_3$   
 (c)  $\text{NH}_3 > \text{H}_2\text{O} > \text{NH}_2^- > \text{OH}^-$   
 (d)  $\text{H}_2\text{O} > \text{NH}_3 > \text{OH}^- > \text{NH}_2^-$
41. Which of the following factors affect the basic strength of amine?  
 (i) Inductive effect  
 (ii) Steric hinderance  
 (iii) Solvation effect  
 (iv) Solubility in organic solvents.  
 (a) (i) and (iv) (b) (i), (ii) and (iii)  
 (c) (ii) and (iii) (d) (ii) and (iv)
42. Which statement is not true among the following?  
 (a) Amines are bases  
 (b) They turn red litmus blue  
 (c) Trimethyl amine is less basic than dimethyl amine  
 (d) Amines yield alcohols on aqueous hydrolysis.
43. Aniline is used  
 (a) in crimping of wool (b) in dyeing industry  
 (c) in making of glue (d) in fast drying vanish
44. Which of the following statements about primary amines is 'False' ?  
 (a) Alkyl amines are stronger bases than aryl amines  
 (b) Alkyl amines react with nitrous acid to produce alcohols  
 (c) Aryl amines react with nitrous acid to produce phenols  
 (d) Alkyl amines are stronger bases than ammonia
45. Mark the correct statement  
 (a) Methylamine is slightly acidic  
 (b) Methylamine is less basic than ammonia  
 (c) Methylamine is a stronger base than ammonia  
 (d) Methylamine forms salts with alkalies.
46. For carbylamine reaction, we need hot alcoholic KOH and  
 (a) any primary amine and chloroform  
 (b) chloroform and silver powder  
 (c) a primary amine and an alkyl halide  
 (d) a monoalkylamine and trichloromethane.
47. The compound obtained by heating a mixture of a primary amine and chloroform with ethanolic potassium hydroxide (KOH) is  
 (a) an alkyl cyanide (b) a nitro compound  
 (c) an alkyl isocyanide (d) an amide
48.  $\text{R}-\text{NH}_2 + \text{CH}_3\text{COCl} \xrightarrow{\text{excess}} \text{A}$   
 The product (A) will be –  
 (a)  $\text{RNHCOCH}_3$  (b)  $\text{RN}(\text{COCH}_3)_2$   
 (c)  $\text{RN}^+(\text{COCH}_3)_3 \text{Cl}^-$  (d)  $\text{R}-\text{CONH}_2$
49. Carbylamine reaction is used for the detection of  
 (a) aliphatic  $2^\circ$  amines (b) aliphatic  $1^\circ$  amines  
 (c) aromatic  $1^\circ$  amines (d) Both (b) and (c)
50. In the reaction,  
 $\text{RNH}_2 \xrightarrow{\text{HNO}_2} \text{ROH} + \text{H}_2\text{O} + \text{C} \uparrow$ ; C is  
 (a)  $\text{NH}_3$  (b)  $\text{N}_2$   
 (c)  $\text{O}_2$  (d)  $\text{CO}_2$
51. An organic amino compound reacts with aqueous nitrous acid at low temperature to produce an oily nitrosoamine. The compound is  
 (a)  $\text{CH}_3\text{NH}_2$  (b)  $\text{CH}_3\text{CH}_2\text{NH}_2$   
 (c)  $\text{CH}_3\text{CH}_2\text{NHCH}_2\text{CH}_3$  (d)  $(\text{CH}_3\text{CH}_2)_3\text{N}$
52. Ethylamine reacts with  $\text{HNO}_2$  giving :  
 (a)  $\text{C}_2\text{H}_5\text{OH}$  (b)  $\text{C}_2\text{H}_5\text{NO}_2$   
 (c)  $\text{NH}_3$  (d)  $\text{C}_2\text{H}_6$



53. Primary amines can be distinguished from secondary and tertiary amines by reacting with  
 (a) Chloroform and alcoholic KOH  
 (b) Methyl iodide  
 (c) Chloroform alone  
 (d) Zinc dust
54. Which of the following is not correct?  
 (a) Ethyl amine and aniline both have  $-\text{NH}_2$  group  
 (b) Ethyl amine and aniline dissolve in HCl  
 (c) Ethyl amine and aniline both react with  $\text{CHCl}_3$  and KOH to form unpleasant smelling compound  
 (d) Ethyl amine and aniline both react with  $\text{HNO}_2$  in cold to give hydroxy compounds
55. Hinsberg reagent is  
 (a)  $\text{C}_6\text{H}_5\text{SO}_3\text{H}$  (b)  $\text{C}_6\text{H}_5\text{NO}$   
 (c)  $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$  (d)  $\text{C}_6\text{H}_5\text{N}_2\text{Cl}$
56. Reaction of aniline with benzaldehyde is  
 (a) substitution (b) addition  
 (c) condensation (d) polymerization
57. The amine that does not react with acetyl chloride is  
 (a)  $\text{CH}_3\text{NH}_2$  (b)  $(\text{CH}_3)_2\text{NH}$   
 (c)  $(\text{CH}_3)_3\text{N}$  (d) None of these
58. Which of the following compounds cannot be identified by carbylamine test?  
 (a)  $\text{CH}_3\text{CH}_2\text{NH}_2$  (b)  $\text{CHCl}_3$   
 (c)  $\text{C}_6\text{H}_5\text{NH}_2$  (d)  $\text{C}_6\text{H}_5\text{NH}-\text{C}_6\text{H}_5$
59.  $(\text{CH}_3)_2\text{CHNH}_2$  is reacted with excess acetic anhydride, the compound formed is  
 (a)  $(\text{CH}_3)_2\text{CHNCOCH}_3$  (b)  $(\text{CH}_3)_2\text{CN}(\text{COCH}_3)_2$   
 (c)  $(\text{CH}_3)_2\text{CHOH}$  (d)  $(\text{CH}_3)_2\text{CN}(\text{COOCH}_3)_2$
60. In order to distinguish between  $\text{C}_2\text{H}_5-\text{NH}_2$  and  $\text{C}_6\text{H}_5-\text{NH}_2$ , which of the following reagent is useful  
 (a) Hinsberg's reagent (b)  $\text{HNO}_2$   
 (c)  $\text{CHCl}_3 + \text{KOH}$  (d)  $\text{NaOH}$
61. All three amines  $1^\circ$ ,  $2^\circ$ ,  $3^\circ$  react with  
 1.  $\text{H}_2\text{O}$  2.  $\text{R-X}$   
 3.  $\text{HCl}$  4.  $(\text{CH}_3\text{CO})_2\text{O}$   
 (a) 1, 2 (b) 4 only  
 (c) 1, 2, 4 (d) 1, 2, 3
62.  $-\text{NH}_2$  group in aniline is  
 (a) only *o*-directing (b) only *p*-directing  
 (c) only *m*-directing (d) *o*- and *p*-directing
63. Strong activating effect of  $-\text{NH}_2$  group is reduced by using  
 (a)  $\text{CH}_3\text{COCl}$  (b)  $\text{CH}_3\text{Cl}$   
 (c)  $\text{CH}_3\text{ONa}$  (d)  $\text{CH}_3-\text{CHO}$
64. When bromination of aniline is carried out by protecting  $-\text{NH}_2$ . The product is  
 (a) *o*-bromoaniline  
 (b) 2, 4, 6 tribromoaniline  
 (c) *p*-bromoaniline  
 (d) mixture of *o*- and *p*-bromoaniline
65. Hinsberg's method to separate amines is based on the use of  
 (a) benzene sulphonyl chloride  
 (b) benzene sulphonic acid  
 (c) ethyl oxalate  
 (d) acetyl chloride
66. The reaction,  
 $\text{C}_6\text{H}_5\text{NH}_2 + \text{ClCOC}_6\text{H}_5 \longrightarrow \text{C}_6\text{H}_5\text{NHCOC}_6\text{H}_5$  is called:  
 (a) Friedel-Crafts reaction  
 (b) Claisen condensation  
 (c) Benzoylation or Schotten Baumann reaction  
 (d) None of these
67. Which of the following statements is not correct regarding aniline?  
 (a) It is less basic than ethylamine  
 (b) It can be steam-distilled  
 (c) It reacts with sodium to give hydrogen  
 (d) It is soluble in water
68. Benzylamine may be alkylated as shown in the following equation:  
 $\text{C}_6\text{H}_5\text{CH}_2\text{NH}_2 + \text{R-X} \longrightarrow \text{C}_6\text{H}_5\text{CH}_2\text{NHR}$   
 Which of the following alkylhalides is best suited for this reaction through  $\text{S}_{\text{N}}1$  mechanism?  
 (a)  $\text{CH}_3\text{Br}$  (b)  $\text{C}_6\text{H}_5\text{Br}$   
 (c)  $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$  (d)  $\text{C}_2\text{H}_5\text{Br}$
69. The product of the following reaction is \_\_\_\_\_.
- 
- (a) (i) and (iii) (b) (i) and (ii)  
 (c) (iii) and (iv) (d) (i), (ii) and (iii)
70. Aniline and other arylamines are usually colourless but get coloured on storage due to \_\_\_\_\_.  
 (a) hydrolysis (b) dehydration  
 (c) reduction (d) atmospheric oxidation
71. The acylation reaction of amines is carried out in presence of pyridine because  
 (i) pyridine is stronger base than amine.  
 (ii) pyridine is weaker base than amine.  
 (iii) pyridine removes HCl formed and shifts the equilibrium to the right hand side.  
 (iv) pyridine removes HCl formed and shifts the equilibrium to the left hand side.  
 (a) (i) and (iii) (b) (ii) and (iv)  
 (c) (ii) and (iii) (d) (i) and (iv)

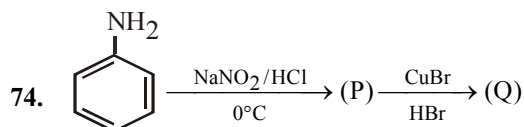
72. N-ethyl benzene sulphonyl amide is strongly acidic and soluble in alkali due to presence of

(a) strong electron donating sulphonyl group.  
(b) strong electron withdrawing sulphonyl group.  
(c) weak electron donating sulphonyl group.  
(d) weak electron withdrawing sulphonyl group.

73. Arrange the following in increasing order of their basic strength?

p-nitroaniline(1); m-nitroaniline (2); 2,6-trimethylaniline(3); 3-methylaniline(4).

(a) 1, 3, 2, 4 (b) 2, 3, 4, 1  
(c) 3, 1, 2, 4 (d) 1, 2, 4, 3



The compound Q is –

(a) bromobenzene (b) chlorobenzene  
(c) benzyl bromide (d) benzyl chloride

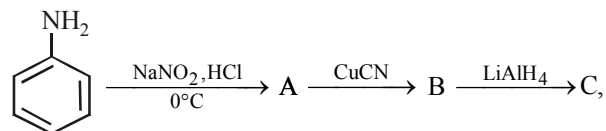
75. Diazonium salt is obtained when aniline reacts with :

(a) cold NaOH (b)  $\text{NaNO}_2$  and HCl ( $0-5^\circ\text{C}$ )  
(c)  $\text{SnCl}_2$  at  $10^\circ\text{C}$  (d)  $\text{N}_2\text{O}$  at ( $0-5^\circ\text{C}$ )

76. Azo dye is prepared by the coupling of phenol and

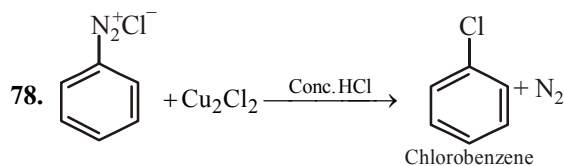
(a) diazonium chloride (b) o-nitroaniline  
(c) benzoic acid (d) chlorobenzene

77. In the reaction sequence



the product 'C' is:

(a) benzonitrile (b) benzaldehyde  
(c) benzoic acid (d) benzylamine



Above reaction is known as:

(a) Strecker's reaction (b) Sandmeyer's reaction  
(c) Wohl-Ziegler reaction (d) Stephen's reaction

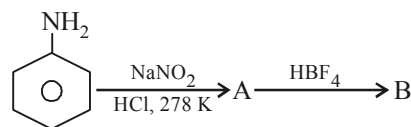
79. Which of the following reagents will convert p-methylbenzenediazonium chloride into p-cresol?

(a) Cu powder (b)  $\text{H}_2\text{O}$   
(c)  $\text{H}_3\text{PO}_2$  (d)  $\text{C}_6\text{H}_5\text{OH}$

80. When phenol and benzene diazonium chloride are coupled, the main product is :

(a) aniline (b) p-hydroxyazobenzene  
(c) azobenzene (d) chlorobenzene

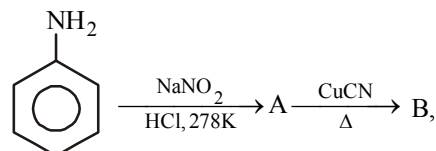
81. In the chemical reactions,



the compounds 'A' and 'B' respectively are

(a) nitrobenzene and fluorobenzene  
(b) phenol and benzene  
(c) benzene diazonium chloride and fluorobenzene  
(d) nitrobenzene and chlorobenzene

82. In the chemical reactions :



the compounds A and B respectively are :

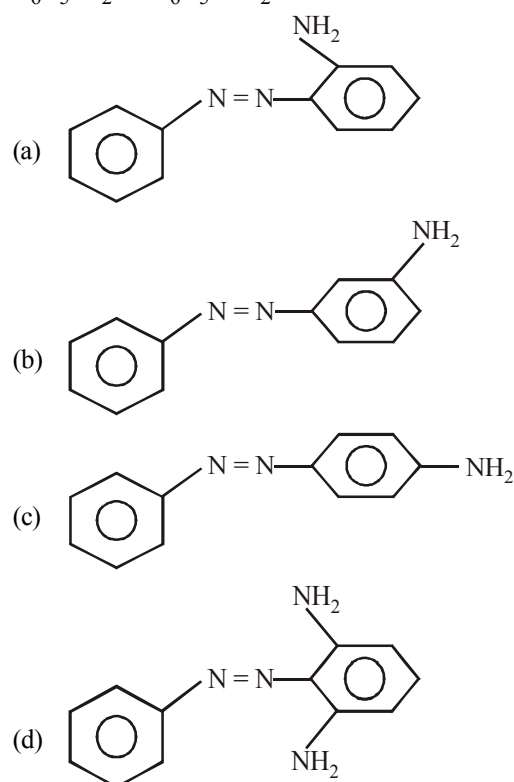
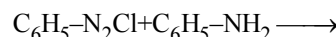
(a) benzene diazonium chloride and benzonitrile  
(b) nitrobenzene and chlorobenzene  
(c) phenol and bromobenzene  
(d) fluorobenzene and phenol

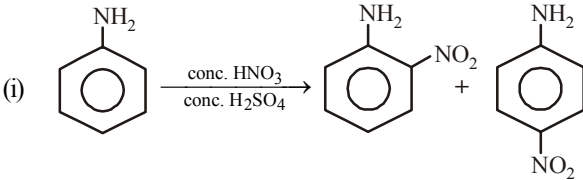
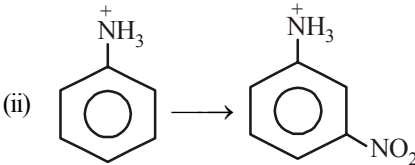
83. Replacement of  $-\text{N}_2^+\text{Cl}^-$  from benzene diazonium chloride

by iodine can be done by using

(a) HI (b) NaOI  
(c)  $\text{PI}_3$  (d) KI

84. Product of the following reaction is



85. Which of the following are intermediates in Sandmeyer reaction ?  
 (i)  $\text{C}_6\text{H}_5\text{N}^+\equiv\text{NCl}^-$  (ii)  $\text{C}_6\text{H}_5\text{N}^+\equiv\text{N}$   
 (iii)  $\dot{\text{C}}_6\text{H}_5$  (iv)  $\text{C}_6\text{H}_5\text{Cl}$   
 (a) (ii) and (iii) (b) (i) and (iv)  
 (c) (ii) and (iv) (d) (i) and (ii)
86. In the diazotization of arylamines with sodium nitrite and hydrochloric acid, an excess of hydrochloric acid is used primarily to  
 (a) Suppress the concentration of free aniline available for coupling  
 (b) Suppress hydrolysis of phenol  
 (c) Ensure a stoichiometric amount of nitrous acid  
 (d) Neutralise the base liberated
87. Which of the following reagent can be used to convert benzenediazonium chloride into benzene?  
 (a)  $\text{CH}_3\text{OH}$  (b)  $\text{H}_3\text{PO}_2$   
 (c)  $\text{Br}_2\text{-H}_2\text{O}$  (d)  $\text{LiAlH}_4$
88. When benzenediazonium chloride in hydrochloric acid reacts with cuprous chloride, then chlorobenzene is formed. The reaction is called  
 (a) Gattermann reaction (b) Perkin reaction  
 (c) Etard reaction (d) Sandmeyer reaction
89. The reaction  $\text{ArN}_2^+\text{Cl}^- \xrightarrow{\text{Cu/HCl}} \text{ArCl} + \text{N}_2 + \text{CuCl}$  is named as \_\_\_\_\_.  
 (a) Sandmeyer reaction (b) Gattermann reaction  
 (c) Claisen reaction (d) Carbylamine reaction
90. Which of the following compound will not undergo azo coupling reaction with benzene diazonium chloride.  
 (a) Aniline (b) Phenol  
 (c) Anisole (d) Nitrobenzene
91. Which of the following cannot be prepared by Sandmeyer's reaction?  
 (i) Chlorobenzene (ii) Bromobenzene  
 (iii) Iodobenzene (iv) Fluorobenzene  
 (a) (i) and (ii) (b) (ii) and (iii)  
 (c) (iii) and (iv) (d) (i) and (iv)
92. The reagents that can be used to convert benzenediazonium chloride to benzene are \_\_\_\_\_.  
 (i)  $\text{SnCl}_2/\text{HCl}$  (ii)  $\text{CH}_3\text{CH}_2\text{OH}$   
 (iii)  $\text{H}_3\text{PO}_2$  (iv)  $\text{LiAlH}_4$   
 (a) (i) and (ii) (b) (ii) and (iii)  
 (c) (iii) and (iv) (d) (i) and (iii)
- (iii) The angle C–N–C or C–N–H is slightly more than  $109.5^\circ$ .  
 (a) (i), (ii) and (iii) (b) (i) and (ii)  
 (c) (i) and (iii) (d) (ii) and (iii)
94. Which of the following statements are correct ?  
 (i) Lower aliphatic amines are soluble in water.  
 (ii) Solubility increases with decrease in molar mass of amines.  
 (iii) Higher amines are insoluble in water.  
 (iv) Amines are soluble in organic solvents.  
 (a) (i), (ii) and (iii) (b) (i), (iii) and (iv)  
 (c) (ii), (iii) and (iv) (d) (i) and (iv)
95. Which of the following statements are correct ?  
 (i) Primary amines show more intermolecular association than secondary amines.  
 (ii) Tertiary amines do not show intermolecular association.  
 (iii) Boiling points of isomeric alkenes follow the order  $3^\circ > 2^\circ > 1^\circ$   
 (a) (i) and (iii) (b) (i) and (ii)  
 (c) (i), (ii) and (iii) (d) (ii) and (iii)
96. Which of the following is/are correct regarding nitration of aniline with conc.  $\text{HNO}_3$  and conc.  $\text{H}_2\text{SO}_4$  ?
- (i) 
- (ii) 
- (iii) The substitution can be explained on the basis of inductive effect (–I)  
 (iv) The substitution can be influenced by +M and +E effects.  
 (a) (i), (ii) and (iii) (b) (ii) and (iii)  
 (c) (ii) and (iv) (d) (i) and (iii)
97. Which of the following statements are correct ?  
 (i) In Sandmeyer reaction nucleophiles like  $\text{Cl}^-$ ,  $\text{Br}^-$  and  $\text{CN}^-$  are introduced in benzene ring in the presence of  $\text{Cu}^+$  ion  
 (ii) In Gattermann reaction nucleophiles are introduced in benzene ring in the presence of copper powder and HCl.  
 (iii) The yield in Gattermann reaction is found to be better than Sandmeyer reaction.  
 (a) (i) and (ii) (b) (i), (ii) and (iii)  
 (c) (ii) and (iii) (d) (i) and (iii)

## STATEMENT TYPE QUESTIONS

93. Read the following statements and choose the correct option.  
 (i) Nitrogen atom in amines is  $\text{sp}^3$ -hybridised.  
 (ii) The geometry of amines is pyramidal.

### MATCHING TYPE QUESTIONS

98. Match the columns

- | Column-I   | Column-II            |
|--|----------------------|
| (A) Gabriel phthalimide reaction                         | (p) $C_6H_5CH_2NH_2$ |
| (B) Reduction with $LiAlH_4$                             | (q) $C_6H_5NH_2$     |
| (C) Reaction with alc. $KOH + CHCl_3$                    | (r) $C_6H_5CN$       |
| (D) $1^\circ$ Amide with $Br_2 + KOH$                    | (s) $CH_3CH_2NH_2$   |
| (a) A – (p, s); B – (p, s); C – (p, q, s); D – (p, q, s) |                      |
| (b) A – (s); B – (p); C – (q); D – (p, q)                |                      |
| (c) A – (p, s); B – (r); C – (q); D – (s)                |                      |
| (d) A – (p, q); B – (p); C – (p, q); D – (s)             |                      |

99. Match the columns

- | Column-I                               | Column-II  |
|--|--|
| (A) Ammonolysis                        | (p) Amine with lesser number of carbon atoms     |
| (B) Gabriel phthalimide synthesis      | (q) Detection test for primary amines.           |
| (C) Hoffmann bromamide reaction        | (r) Reaction of Phthalimide with $KOH$ and $R-X$ |
| (D) Carbylamine reaction               | (s) Reaction of alkylhalides with $NH_3$         |
| (a) A – (s), B – (r), C – (p), D – (q) |  |
| (b) A – (r), B – (p), C – (r), D – (s) |  |
| (c) A – (q), B – (r), C – (s), D – (p) |  |
| (d) A – (s), B – (p), C – (q), D – (r) |  |

100. Match the columns

- | Column-I                               | Column-II                  |
|--|----------------------------|
| (A) Benzene sulphonyl chloride         | (p) Zwitter ion            |
| (B) Sulphanilic acid                   | (q) Hinsberg reagent       |
| (C) Alkyl diazonium salts              | (r) Dyes                   |
| (D) Aryl diazonium salts               | (s) Conversion to alcohols |
| (a) A – (s), B – (q), C – (r), D – (p) |                            |
| (b) A – (q), B – (p), C – (s), D – (r) |                            |
| (c) A – (r), B – (s), C – (p), D – (q) |                            |
| (d) A – (s), B – (p), C – (r), D – (q) |                            |

101. Match the columns

- | Column-I                                 | Column-II            |
|--|----------------------|
| (A) $ArN_2^+Cl^- \longrightarrow ArOH$   | (p) $HBF_4 / NaNO_2$ |
| (B) $ArN_2^+Cl^- \longrightarrow ArNO_2$ | (q) $H_2O$           |
| (C) $ArN_2^+Cl^- \longrightarrow ArH$    | (r) $HBF_4$          |
| (D) $ArN_2^+Cl^- \longrightarrow ArF$    | (s) $CH_3CH_2OH$     |

(a) A – (q), B – (p), C – (s), D – (r)

(b) A – (s), B – (p), C – (q), D – (r)

(c) A – (q), B – (s), C – (p), D – (r)

(d) A – (q), B – (s), C – (r), D – (p)

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.
- (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion
- (c) Assertion is correct, reason is incorrect
- (d) Assertion is incorrect, reason is correct.

102. **Assertion :** Aromatic  $1^\circ$  amines can be prepared by Gabriel phthalimide synthesis.

**Reason :** Aryl halides undergo nucleophilic substitution with anion formed by phthalimide.

103. **Assertion :** Only a small amount of  $HCl$  is required in the reduction of nitro compounds with iron scrap and  $HCl$  in the presence of steam.

**Reason :**  $FeCl_2$  formed gets hydrolysed to release  $HCl$  during the reaction.

104. **Assertion :** Amines are basic in nature.

**Reason :** Amines have lone pair of electrons on nitrogen atom.

105. **Assertion :** Acetanilide is less basic than aniline.

**Reason :** Acetylation of aniline results in decrease of electron density on nitrogen.

106. **Assertion :** Nitration of aniline can be conveniently done by protecting the amino group by acetylation.

**Reason :** Acetylation increases the electron-density in the benzene ring.

107. **Assertion :** Aniline does not undergo Friedel-Crafts reaction.

**Reason :**  $-NH_2$  group of aniline reacts with  $AlCl_3$  (Lewis acid) to give acid-base reaction.

108. **Assertion :** Acylation of amines gives a monosubstituted product whereas alkylation of amines gives polysubstituted product.

**Reason :** Acyl group sterically hinders the approach of further acyl groups

109. **Assertion :** Nitrating mixture used for carrying out nitration of benzene consists of conc.  $HNO_3 +$  conc.  $H_2SO_4$ .

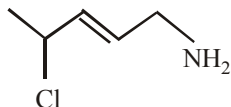
**Reason :** In presence of  $H_2SO_4$ ,  $HNO_3$  acts as a base and produces  $NO_2^+$  ions.

**CRITICAL THINKING TYPE QUESTIONS**

110. The IUPAC name of diethyl isopropyl amine is

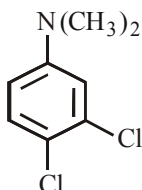
- N, N-diethylpropan-2-amine
- N, N-diethylpropan-1-amine
- N, N-diethylisopropylamine
- N, N-diethylaminopropane

111. IUPAC name of the following compound is



- 2-chloro pentanamine
- 4-chloro pentan-1-amine
- 4-chloro pent-2-en-1-amine
- 2-chloro pent-3-en-5-amine

112. Which of the following is the correct IUPAC name of the compound ?



- 1,2-dichloro-4-(N, N-dimethyl) aniline
- Dimethyl - (3, 4-dichlorophenyl) amine
- 3, 4-dichloro - N, N-dimethyl aniline
- N, N-dimethylamino - 3, 4-dichlorobenzene

113. Acetamide is treated with the following reagents separately. Which one of these would yield methylamine?

- NaOH - Br<sub>2</sub>
- Sodalime
- Hot conc. H<sub>2</sub>SO<sub>4</sub>
- PCl<sub>5</sub>

114. Amine that cannot be prepared by Gabriel phthalimide synthesis is

- aniline
- benzylamine
- methylamine
- iso-butylamine

115. A primary amine is formed by an amide on treatment with bromine and alkali. The primary amine has

- 1 carbon atom less than amide
- 1 carbon atom more than amide
- 1 hydrogen atom less than amide
- 1 hydrogen atom more than amide

116. High basicity of Me<sub>2</sub>NH relative to Me<sub>3</sub>N is attributed to:

- effect of solvent
- inductive effect of Me
- shape of Me<sub>2</sub>NH
- shape of Me<sub>3</sub>N

117. Which one of the following is the strongest base in aqueous solution ?

- Methylamine
- Trimethylamine
- Aniline
- Dimethylamine

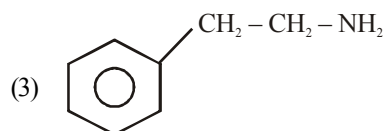
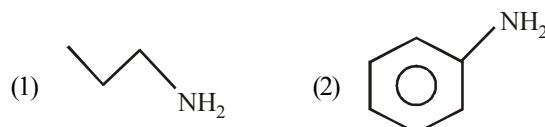
118. What is the decreasing order of basicity of primary, secondary and tertiary ethylamines and NH<sub>3</sub> ?

- NH<sub>3</sub> > C<sub>2</sub>H<sub>5</sub>NH<sub>2</sub> > (C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>NH > (C<sub>2</sub>H<sub>5</sub>)<sub>3</sub>N
- (C<sub>2</sub>H<sub>5</sub>)<sub>3</sub>N > (C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>NH > C<sub>2</sub>H<sub>5</sub>NH<sub>2</sub> > NH<sub>3</sub>
- (C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>NH > C<sub>2</sub>H<sub>5</sub>NH<sub>2</sub> > (C<sub>2</sub>H<sub>5</sub>)<sub>3</sub>N > NH<sub>3</sub>
- (C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>NH > C<sub>2</sub>H<sub>5</sub>NH<sub>2</sub> > (C<sub>2</sub>H<sub>5</sub>)<sub>3</sub>NH > NH<sub>3</sub>

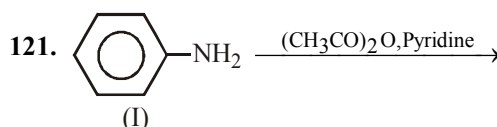
119. The correct order of the increasing basicity of methyl amine, ammonia and aniline is

- methyl amine < aniline < ammonia
- aniline < ammonia < methyl amine
- aniline < methyl amine < ammonia
- ammonia < aniline < methyl amine

120. Arrange the following amines in the decreasing order of their basicity



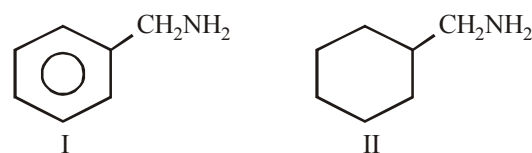
- 1 > 3 > 2
- 3 > 2 > 1
- 1 > 2 > 3
- 2 > 1 > 3



The basicity order of I, II and III is –

- III > I > II
- I > II > III
- III > II > I
- II > III > I

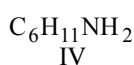
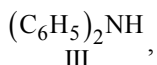
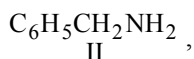
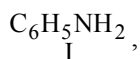
122. Which of the statement is true regarding the basicity of the following two primary amines ?



- Both are equally basic because both are 1° amines
- I > II because it is an aromatic amine
- II > I because it is an aliphatic amine
- I < II because of difference in the nature of β-carbon



123. The correct order of decreasing basic character is

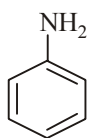


- (a)  $\text{II} > \text{I} > \text{III} > \text{IV}$  (b)  $\text{IV} > \text{II} > \text{I} > \text{III}$   
(c)  $\text{IV} > \text{III} > \text{II} > \text{I}$  (d)  $\text{IV} > \text{II} > \text{III} > \text{I}$

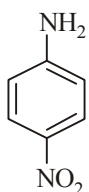
124. Aniline when treated with conc.  $\text{HNO}_3$  gives

- (a) *p*-Phenylenediamine (b) *m*-Nitroaniline  
(c) *p*-Benzoquinone (d) Nitrobenzene

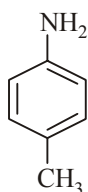
125. The correct increasing order of basic strength for the following compounds is \_\_\_\_\_.



(I)



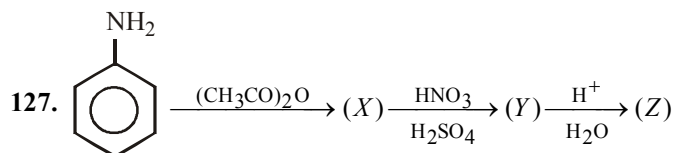
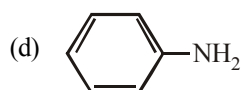
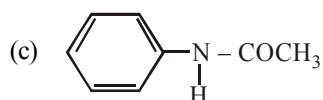
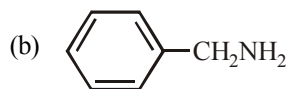
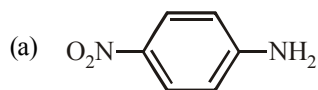
(II)



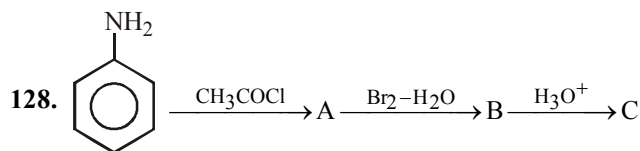
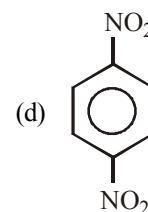
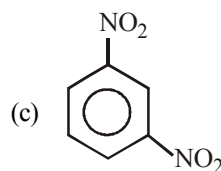
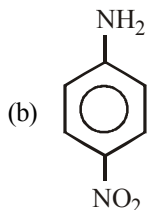
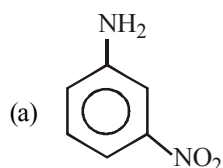
(III)

- (a)  $\text{II} < \text{III} < \text{I}$  (b)  $\text{III} < \text{I} < \text{II}$   
(c)  $\text{III} < \text{II} < \text{I}$  (d)  $\text{II} < \text{I} < \text{III}$

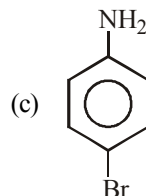
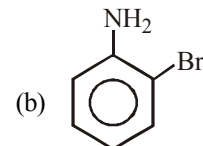
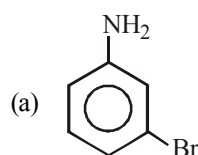
126. Which of the following compounds is most basic?



Product Z of the reaction



C (major product) is –

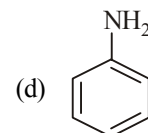
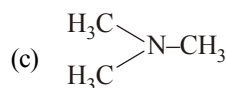


(d) None of these

129. Towards electrophilic substitution, the most reactive will be

- (a) Nitrobenzene  
(b) Aniline  
(c) Aniline hydrochloride  
(d) N-Acetylaniline

130. The most reactive amine towards dilute hydrochloric acid is \_\_\_\_\_.



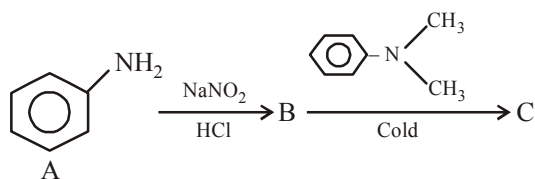
131. Nitration of nitrobenzene is carried out then the product so formed is reduced with  $\text{Fe}/\text{HCl}$ , product so formed on reaction with  $\text{HNO}_2$  and then with  $\text{H}_2\text{O}$ , forms

- (a) 1,3-dihydroxybenzene  
(b) 3-nitrophenol  
(c) 2-nitrophenol  
(d) 1,2-dihydroxybenzene

132. A compound of molecular formulae  $C_3H_6N$  shows following characteristics

- (i) Get dissolved in acidic medium.
  - (ii) Does not react with benzoylchloride
  - (iii) Does not give carbylamine test
  - (iv) Does not evolve nitrogen gas on reacting with  $HNO_2$
- than structure of the compound is
- (a) trimethylamine
  - (b) isopropylamine
  - (c) propylamine
  - (d) None of these

133. In a reaction of aniline a coloured product C was obtained.

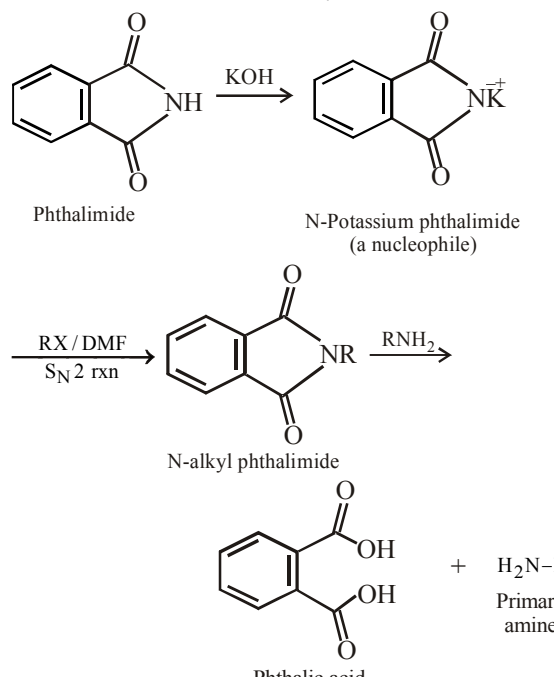


The structure of C would be :

- (a)
- (b)
- (c)
- (d)

# HINTS AND SOLUTIONS

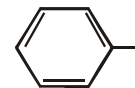
## FACT/DEFINITION TYPE QUESTIONS

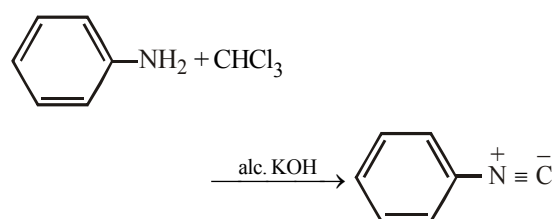
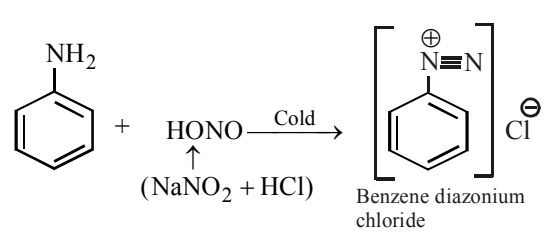
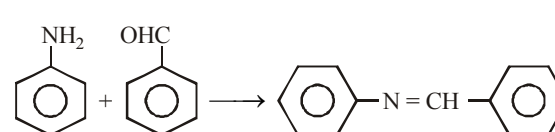
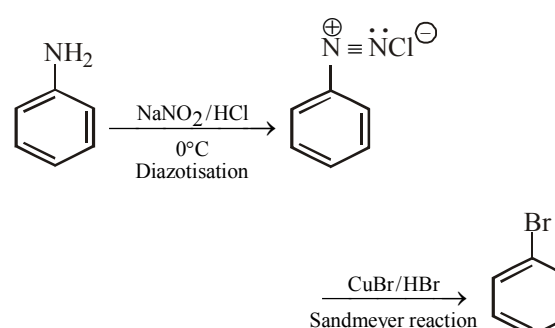
- (c)  $\text{RNH}_2$        $\text{R}_2\text{NH}$        $\text{R}_3\text{N}$   
Primary amine      Secondary amine      Tertiary amine
- (c)      3. (a)      4. (d)
- (c)  $1^\circ$  amines have  $-\text{NH}_2$  group in their structure. 4 primary amines are possible by  $\text{C}_4\text{H}_{11}\text{N}$ .  
 $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2\text{NH}_2$   
(i)  
 $\text{CH}_3 - \text{CH}_2 - \underset{\text{NH}_2}{\text{CH}} - \text{CH}_3$   
(ii)  
 $\text{CH}_3 - \underset{\text{H}}{\underset{\text{CH}_3}{\text{C}}} - \text{CH}_2 - \text{NH}_2$        $\text{CH}_3 - \underset{\text{NH}_2}{\underset{\text{CH}_3}{\text{C}}} - \text{CH}_3$   
(iii)      (iv)
- (b) The compound contains longest chain of 6C atoms and amino group. Hence it is an alkanamine.
- (d)      8. (d)      9. (a)
- (c)  $\text{CH}_3\text{NC}$  (methyl isocyanide) on reduction with  $\text{LiAlH}_4$  gives secondary amine
- (b)  $\text{CH}_3 - \text{CH}_2 - \overset{\text{O}}{\parallel}{\text{C}} - \text{NH}_2 + \text{Br}_2 + \text{KOH} \xrightarrow{\Delta} \text{CH}_3 - \text{CH}_2 - \ddot{\text{N}}\text{H}_2$
- (d)  $\text{R} - \text{N} \equiv \text{C} \xrightarrow{4[\text{H}]} \text{RNH} - \text{CH}_3$   
alkyl isocyanide      secondary amine
- (c) 

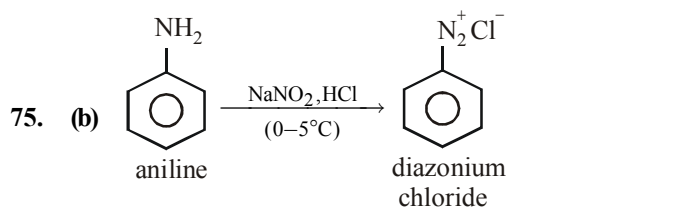
Phthalimide      N-Potassium phthalimide (a nucleophile)

N-alkyl phthalimide

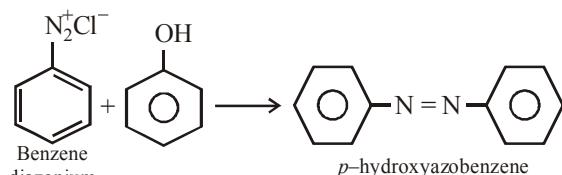
Phthalic acid      +       $\text{H}_2\text{N}-\text{R}$       Primary amine

- (c)  $\text{C}_2\text{H}_5\text{I} + \text{NH}_3 \longrightarrow \text{C}_2\text{H}_5\text{NH}_2 + \text{HI}$   
Ethyl iodide  
 $\text{C}_2\text{H}_5\text{OH} + \text{NH}_3 \longrightarrow \text{C}_2\text{H}_5\text{NH}_2 + \text{H}_2\text{O}$
- (d)      16. (d)
- (d) For the preparation of  $\text{Me}_3\text{CNH}_2$ , the required alkyl halide is  $\text{Me}_3\text{CX}$  which will react with potassium phthalimide, a strong base, to form alkene rather than substituted product. For preparing  $\text{C}_6\text{H}_5\text{NH}_2$ ,  $\text{C}_6\text{H}_5\text{Cl}$  will be the starting halide in which Cl is non-reactive.
- (c)      19. (d)      20. (c)
- (d) Reduction with iron scrap and hydrochloric acid is preferred because  $\text{FeCl}_2$  formed gets hydrolysed to release hydrochloric acid during the reaction. Thus, only a small amount of hydrochloric acid is required to initiate the reaction.
- (b)      23. (c)      24. (a)
- (b) Amines possess fishy smell.
- (c)      27. (b)      28. (b)
- (b) Basic nature of amines arises due to presence of lone pair of  $e^-$ s on the N-atom, which can be shared with an electron deficient species.
- (a)
- (a) Secondary amine is more basic than primary amine.
- (d) Amines are basic in nature
- (b)  $(\text{CH}_3)_3\text{N} < \text{CH}_3\text{NH}_2 < (\text{CH}_3)_2\text{NH} < \text{C}_2\text{H}_5\text{NH}_2$
- (a)
- (a) Secondary amines are more basic than tertiary amines due to stabilisation of  $2^\circ$  amine by hydrogen bonding with solvent molecule.
- (c) Aliphatic amines are more basic than aromatic amines. Resonance decreases the basic character due to delocalisation of shared pair of electrons on nitrogen within benzene nucleus
- (b) Basic character of amines is  $2^\circ > 1^\circ > 3^\circ > \text{NH}_3$
- (b)   $\text{CH}_2 - \text{NH}_2$  compound is most basic due to localized lone pair of electron on nitrogen atom while other compounds have delocalized lone pair of electron.
- (c)      40. (a)      41. (b)
- (d) Amines give alcohols only on reaction with  $\text{HNO}_2$  and not on hydrolysis.
- (b) Aniline gives dyes on coupling reaction with phenols and *p*-amines.
- (c) Aryl amines do not produce phenol on treatment with nitrous acid

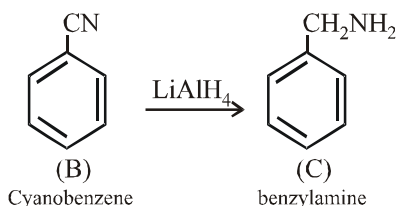
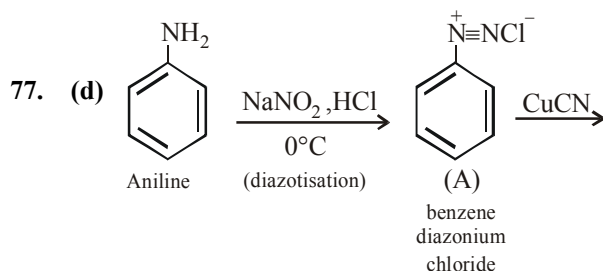
45. (c) Methyl amine is a stronger base than ammonia due to +I effect. The alkyl groups which are electron releasing groups increase the electron density around the nitrogen thereby increasing the availability of the lone pair of electrons to proton or Lewis acid and making the amine more basic
- $$\text{NH}_3 \quad \text{CH}_3\text{NH}_2$$
- $$K_b = 1.8 \times 10^{-5} \quad 44 \times 10^{-5}$$
46. (a) Any primary amine means both aliphatic as well as aromatic but monoalkylamines means only 1° aliphatic amines. Therefore, option (a) is correct while (d) is wrong.
- $$\text{RNH}_2 + \text{CHCl}_3 + 3\text{KOH} \longrightarrow \text{RNC} + 3\text{KCl} + 3\text{H}_2\text{O}$$
- alkyl  
isocyanide
47. (c) We know that
- $$\text{CH}_3\text{CH}_2\text{NH}_2 + \text{CHCl}_3 + 3\text{KOH} \longrightarrow \text{CH}_3\text{CH}_2\text{NC} + 3\text{KCl} + 3\text{H}_2\text{O}$$
- In this reaction, bad smelling compound ethyl isocyanide ( $\text{CH}_3\text{CH}_2\text{NC}$ ) is produced. This equation is known as **carbylamine reaction**.
48. (a) Acylation occurs in one step only because lone pair of nitrogen is delocalized with acyl group.
- $$\text{R}-\ddot{\text{N}}-\text{C}(=\text{O})-\text{CH}_3 \longleftrightarrow \text{R}-\text{NH}^+-\text{C}^-(=\text{O})-\text{CH}_3$$
49. (d)  $\text{R}-\text{NH}_2 + \text{CHCl}_3 \xrightarrow{\text{alc. KOH}} \text{R}-\text{N}^+ \equiv \text{C}^-$
- 
50. (b)  $\text{RNH}_2 \xrightarrow{\text{HNO}_2} \text{ROH} + \text{H}_2\text{O} + \text{N}_2 \uparrow$
- (A)      (B)      (C)
51. (c) Since the organic amino compound on reaction with nitrous acid at low temperature produces an oily nitrosoamine so the organic amino compound is a secondary aliphatic amine.
52. (a)  $\text{C}_2\text{H}_5\text{NH}_2 + \text{HNO}_2 \xrightarrow{273-278\text{K}} \text{C}_2\text{H}_5\text{OH} + \text{N}_2 + \text{H}_2\text{O}$
- Ethyl amine      Nitrous acid      Ethanol
- Note :** This reaction is used as a test for aliphatic amines since no other class of amines liberates  $\text{N}_2$  gas on treatment with  $\text{HNO}_2$ .
53. (a) 1° amines (aliphatic and aromatic) react with  $\text{CHCl}_3/\text{KOH}$  to yield isocyanide (foul smelling) This is known as carbylamine test which is not given by 2° and 3° amines.
54. (d) Nitrous acid reacts differently with aliphatic and aromatic amines in cold.
- $$\text{C}_2\text{H}_5\text{NH}_2 + \text{HONO} \longrightarrow \text{C}_2\text{H}_5\text{OH} + \text{N}_2$$
- 1° Amine      Alcohol
- 
55. (c)
56. (c) 
57. (c) The compounds containing active H-atoms (H atoms attached to N, O or S) react with  $\text{CH}_3\text{COCl}$  to form acetyl derivatives.
58. (d)      59. (b)      60. (b)      61. (d)      62. (d)
63. (a)      64. (d)
65. (a) Hinsberg's method is based on the use of benzene sulphonyl chloride.
66. (c) The inclusion of  $\text{C}_6\text{H}_5\text{CO}$  gp. in a molecule is called benzoylation
67. (d) Aniline is insoluble in water, because its  $-\text{NH}_2$  group can't form H-bond with water due to bulky phenyl group.
68. (c)      69. (b)      70. (d)
71. (a) Pyridine is a stronger base than the amine, pyridine removes  $\text{HCl}$  formed in acylation reaction of amines and shifts the equilibrium to the right hand side.
72. (b) The hydrogen attached to nitrogen in sulphonamide is strongly acidic due to the presence of strong electron withdrawing sulphonyl group. Hence, it is soluble in alkali.
73. (d) In case of substituted aniline, electron releasing groups like  $-\text{OCH}_3$ ,  $-\text{CH}_3$  increase basic strength whereas electron withdrawing groups like  $-\text{NO}_2$ ,  $-\text{SO}_3\text{H}$ ,  $-\text{COOH}$ ,  $-\text{X}$  decrease it.
74. (a) 



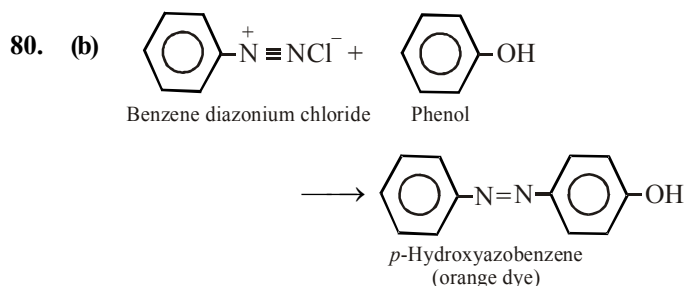
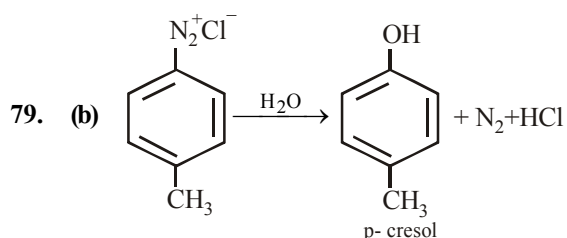
76. (a) Azo dye is prepared by diazo coupling reaction of phenol with diazonium salt.



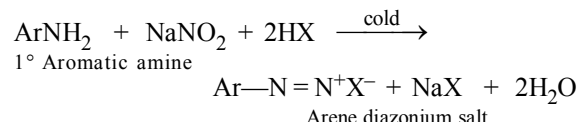
(-N=N-) group is called azo-group.



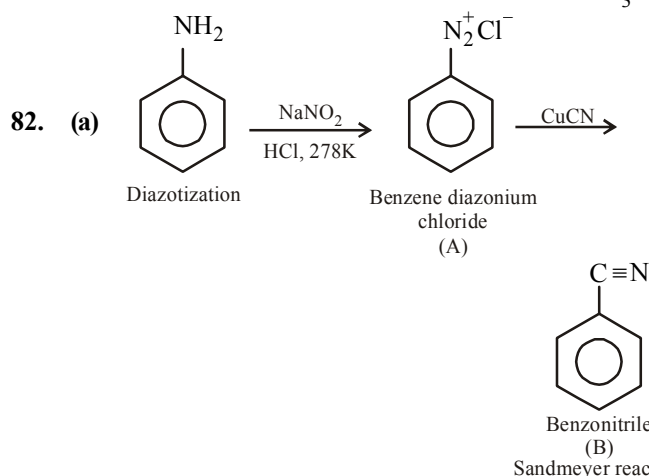
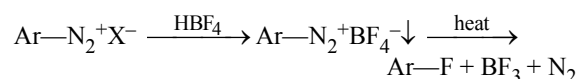
78. (b) The given reaction is known as Sandmeyer's reaction.



81. (c) Primary aromatic amines react with nitrous acid to yield arene diazonium salts.



The diazonium group can be replaced by fluorine by treating the diazonium salt with fluoroboric acid (HBF<sub>4</sub>). The precipitated diazonium fluoroborate is isolated, dried and heated until decomposition occurs to yield the aryl fluoride. This reaction is known as **Balz-Schiemann reaction**.



83. (d) 84. (c) 85. (a)  
86. (a) Excess of HCl is used to convert free aniline to aniline hydrochloride otherwise free aniline would undergo coupling reaction with benzenediazonium chloride.  
87. (b) 88. (d) 89. (b) 90. (d) 91. (b)  
92. (b)

### STATEMENT TYPE QUESTIONS

93. (b) The fourth orbital of nitrogen in all amines contains an unshared pair of electrons. Due to the presence of unshared pair of electrons, the angle C-N-E, (where E is C or H) is less than 109.5°.
94. (b) Lower aliphatic amines are soluble in water solubility decreases with increase in molar mass of amines. Higher amines are essentially insoluble in water.
95. (b) Primary and secondary amines are engaged in intermolecular association due to hydrogen bonding between nitrogen of one and hydrogen of another molecule. This intermolecular association is more in primary amines than in secondary amines as there are two hydrogen atoms available for hydrogen bond formation in it. Tertiary amines do not have intermolecular association due to the absence of hydrogen atom available for hydrogen bond formation. Therefore, the order of boiling points of isomeric amines is as follows :  
Primary > Secondary > Tertiary



96. (b)  
97. (a) The yield in Sandmeyer reaction is found to be better than Gattermann reaction.

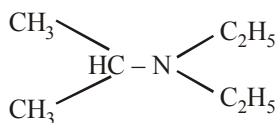
### MATCHING TYPE QUESTIONS

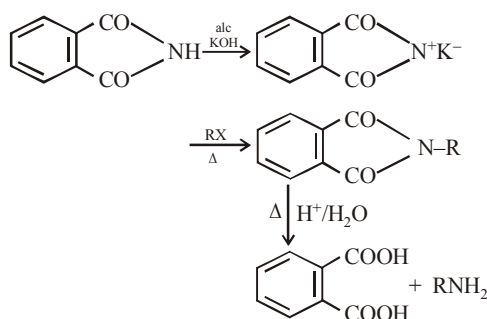
98. (a)      99. (a)      100. (b)      101. (c)

### ASSERTION-REASON TYPE QUESTIONS

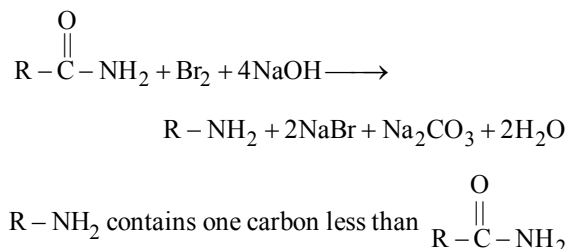
102. (a)      103. (d)  
104. (a) Amines are basic due to the presence of a lone pair of electrons on nitrogen atom. The lone pair can be easily donated.  
105. (d)  
106. (c) Acetylation decreases the electron-density in the benzene ring thereby preventing oxidation.  
107. (a)      108. (c)  
109. (a)  $\text{HNO}_3 + 2\text{H}_2\text{SO}_4 \rightleftharpoons 2\text{HSO}_4^- + \text{NO}_2^+ + \text{H}_3\text{O}^+$

### CRITICAL THINKING TYPE QUESTIONS

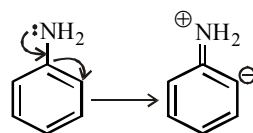
110. (a)   
N, N- diethyl propan - 2-amine  
111. (c)  
112. (c) The compound is derivative of aniline. The positions of groups are shown by numbering the nuclear C-atoms.  
113. (a)  $\text{CH}_3\text{CONH}_2 \xrightarrow[\text{Br}_2]{\text{NaOH}} \text{CH}_3\text{NH}_2$   
(Hofmann bromamide reaction)  
114. (a) Aniline cannot be prepared by this method because aryl halides do not undergo nucleophilic substitution with potassium phthalimide under ordinary conditions to give N-phenyl phthalimide (i.e., cleavage of C-X bond in haloarenes is quite difficult).



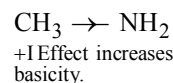
115. (a) The reaction is Hoffmann bromamide reaction



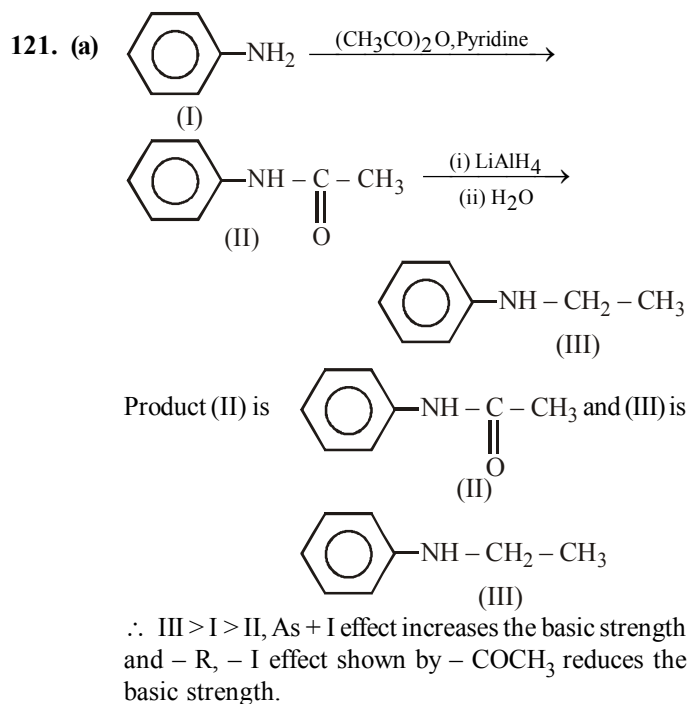
116. (a) Secondary amines are more basic than tertiary amines due to stabilisation of 2° amine by hydrogen bonding with solvent molecule.  
117. (d) Aromatic amines are less basic than aliphatic amines. Among aliphatic amines the order of basicity is 2° > 1° > 3°. The electron density is decreased in 3° amine due to crowding of alkyl group over N atom which makes the approach and bonding by a proton relatively difficult. Therefore the basicity decreases. Further Phenyl group show -I effect, thus decreases the electron density on nitrogen atom and hence the basicity.  
∴ dimethylamine (2° aliphatic amine) is strongest base among given choices.  
∴ The correct order of basic strength is  
Dimethylamine > Methyl amine > Trimethyl amine > Aniline.  
118. (d) All aliphatic amines are stronger bases than NH<sub>3</sub> and among different ethylamines order of basicity is 2° > 1° > 3°. Thus, the correct order is (d) i.e.,  
(C<sub>2</sub>H<sub>5</sub>)<sub>2</sub>NH > C<sub>2</sub>H<sub>5</sub>NH<sub>2</sub> > (C<sub>2</sub>H<sub>5</sub>)<sub>3</sub>N > NH<sub>3</sub>  
This anomalous behaviour of tertiary ethyl amine is due to steric factors i.e., crowding of alkyl groups cover nitrogen atom from all sides and thus makes the approach and bonding by a lewis acid relatively difficult which results the maximum steric strain in tertiary amines. The electrons are there but the path is blocked resulting the reduction in its basicity.  
119. (b) In aniline the lone pair on N is involved in delocalization with benzene ring and is not available for protonation. Methyl amine is a stronger base than ammonia because +I effect of methyl group increases electron density on N making it more basic than NH<sub>3</sub>.



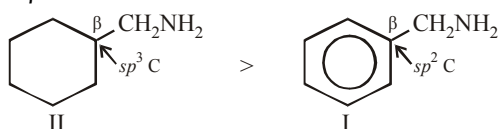
Cannot be protonated. least basic



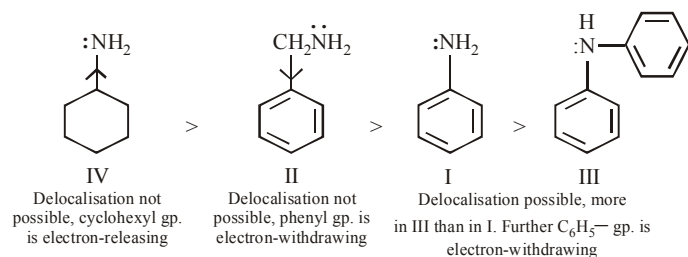
120. (a)



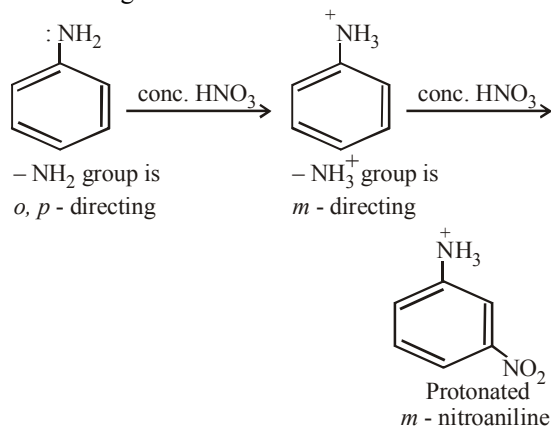
122. (d) Here again the two amines differ in the nature of  $\beta$ -carbon atom



123. (b) Greater the delocalisation of electron pair on N, lesser is its availability for protonation leading to lesser basic character.

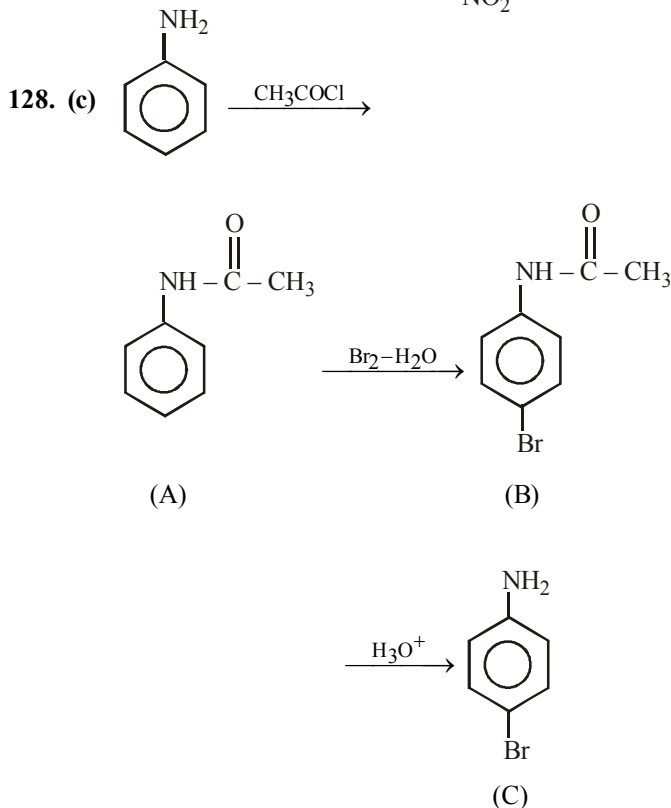
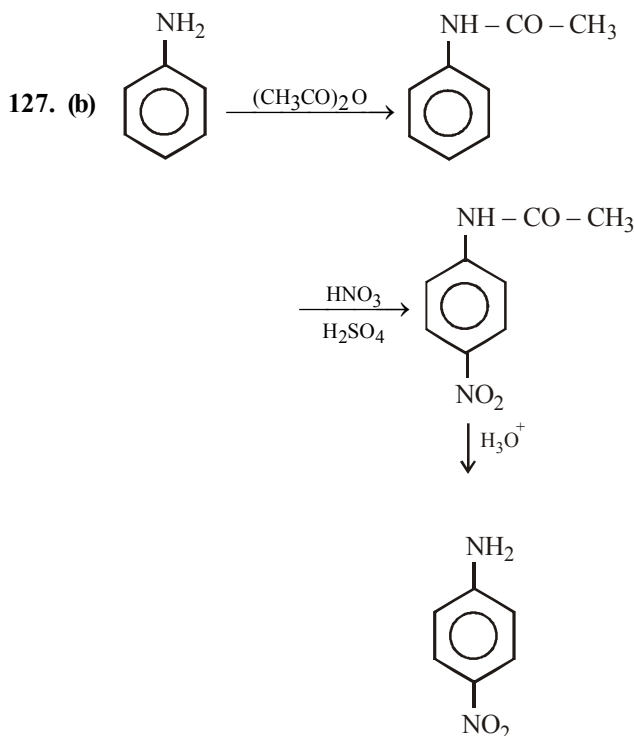


124. (b) Although -NH<sub>2</sub> group is *o,p*-directing but in presence of conc. HNO<sub>3</sub> it undergoes protonation to form -NH<sub>3</sub><sup>+</sup> which, being electron-deficient, becomes *m*-directing.

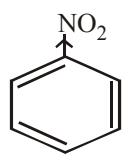


125. (d)

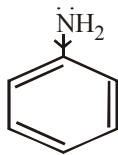
126. (b) compound is most basic due to localized lone pair of electron on nitrogen atom while other compounds have delocalized lone pair of electron.



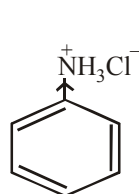
129. (b)



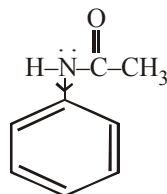
nitrobenzene



Aniline



Aniline hydrochloride

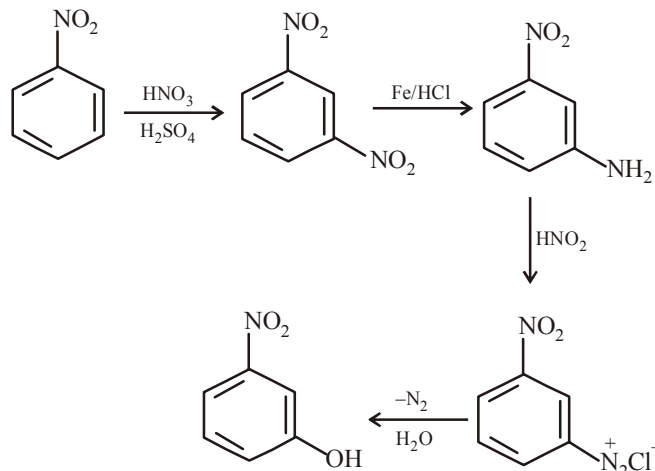


N- Acetylaniline

Nitrobenzene and aniline hydrochloride have electron-withdrawing ( $-\text{NO}_2$  and  $-\text{NH}_3^+$ ) groups, hence these will undergo electrophilic substitution with difficulty. Aniline and N- acetylaniline (acetanilide) have electron-releasing groups, however  $-\text{NHCOCH}_3$  is less electron-releasing than  $-\text{NH}_2$  due to delocalisation of lone pair of electron on N toward carbonyl group. Hence aniline (having  $-\text{NH}_2$ ) will undergo electrophilic substitution most easily.

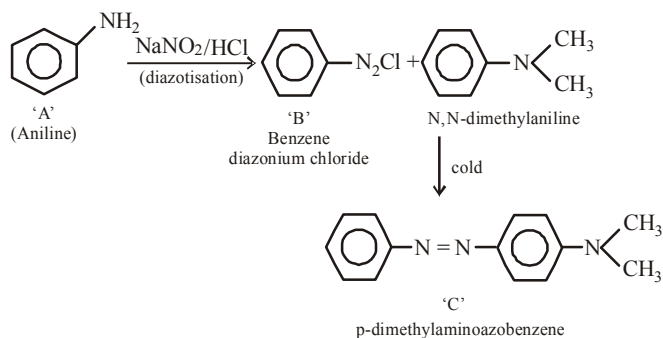
130. (b)

131. (b)



132. (a) It is a tertiary amine hence shows above observations.

133. (d) The reaction can be completed as follows:





CHAPTER

28

# BIOMOLECULES

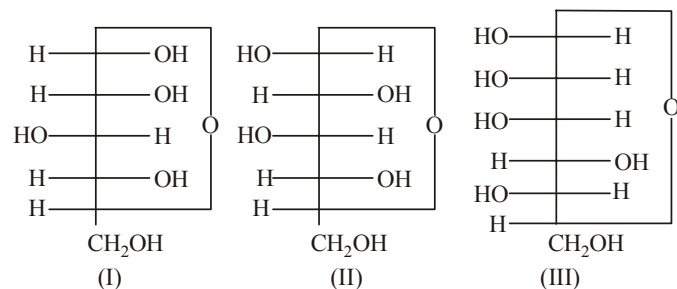
## FACT/DEFINITION TYPE QUESTIONS

- Biomolecules are
  - aldehydes and ketones
  - acids and esters
  - carbohydrates, proteins and fats
  - alcohols and phenols
- Which of the following is a disaccharide ?
  - Lactose
  - Starch
  - Cellulose
  - Fructose
- The sugar that is characteristic of milk is
  - maltose
  - ribose
  - lactose
  - galactose
- Which one is a disaccharide ?
  - Glucose
  - Fructose
  - Xylose
  - Sucrose
- Which of the following monosaccharide is pentose ?
  - Glucose
  - Fructose
  - Arabinose
  - Galactose
- The commonest disaccharide has the molecular formula
  - $C_{10}H_{18}O_9$
  - $C_{10}H_{20}O_{10}$
  - $C_{18}H_{22}O_{11}$
  - $C_{12}H_{22}O_{11}$
- Monosaccharides usually contains ... carbon atoms.
  - $C_3$  to  $C_{10}$
  - $C_1$  to  $C_6$
  - $C_4$  to  $C_{10}$
  - $C_5$  to  $C_8$
- Which one of the following compounds is found abundantly in nature?
  - Fructose
  - Starch
  - Glucose
  - Cellulose
- A carbohydrate that cannot be hydrolysed into simpler units is called
  - polysaccharides
  - trisaccharides
  - disaccharides
  - monosaccharides
- Which of the following statements is incorrect ?
  - Maltose gives two molecules of glucose only.
  - Cellulose and sucrose are polysaccharide.
  - Polysaccharides are not sweet in taste.
  - Polysaccharides are also known as non-sugars.
- Reducing sugars reduce.
  - only Fehling's solution
  - only Tollen's solution.
  - both (a) & (b)
  - neither (a) nor (b)
- Which among the following is the simplest sugar?
  - Glucose
  - Starch
  - Cellulose
  - None of these
- Glucose can't be classified as
  - hexose
  - carbohydrate
  - aldose
  - oligosaccharide
- Which of the following properties of glucose cannot be explained by its open chain structure?
  - Glucose does not form hydrogen sulphite with  $NaHSO_3$
  - On oxidation with  $HNO_3$  glucose gives saccharic acid.
  - Glucose is found to exist in two different crystalline forms which are named as  $\alpha$  and  $\beta$ .
  - (ii) only
  - (i) and (iii)
  - (ii) and (iii)
  - (i) and (ii)
- Which of the following gives positive Fehling solution test?
  - Protein
  - Sucrose
  - Glucose
  - Fats
- Which of the following statements is incorrect regarding glucose?
  - It is an aldohexose.
  - It is also known as dextrose
  - It is monomer of cellulose.
  - It is the least abundant organic compound on earth.
- Glucose gives silver mirror test with Tollen's reagent. It shows the presence of
  - acidic group
  - alcoholic group
  - ketonic group
  - aldehyde group
- The symbols D and L represents
  - the optical activity of compounds.
  - the relative configuration of a particular stereoisomer.
  - the dextrorotatory nature of molecule.
  - the levorotatory nature of molecule

19. Glucose is found to exist in two different  $\alpha$  and  $\beta$  crystalline forms. These forms can be obtained by.
  - (i) The  $\alpha$  form of glucose is obtained by crystallisation from concentrated solution of glucose at 303 K.
  - (ii) The  $\beta$  form of glucose is obtained by crystallisation from concentrated solution of glucose at 303 K.
  - (iii) The  $\beta$  form is obtained by crystallisation from hot and saturated aqueous solution at 371 K.
  - (iv) The  $\alpha$  form is obtained by crystallisation from hot and saturated aqueous solution at 371 K.
  - (a) (i) and (iii) (b) (ii) and (iv)
  - (c) (ii) and (iii) (d) (i) only
20. The function of glucose is to
  - (a) provides energy (b) promote growth
  - (c) prevent diseases (d) perform all above
21. Which one of the following compounds is different from the rest?
  - (a) Sucrose (b) Maltose
  - (c) Lactose (d) Glucose
22. The two functional groups present in a typical carbohydrate are:
  - (a)  $-\text{CHO}$  and  $-\text{COOH}$  (b)  $>\text{C}=\text{O}$  and  $-\text{OH}$
  - (c)  $-\text{OH}$  and  $-\text{CHO}$  (d)  $-\text{OH}$  and  $-\text{COOH}$
23. When glucose reacts with bromine water, the main product is
  - (a) gluconic acid (b) glyceraldehyde
  - (c) saccharic acid (d) acetic acid
24. Glucose does not react with
  - (a)  $\text{Br}_2/\text{H}_2\text{O}$  (b)  $\text{H}_2\text{NOH}$
  - (c)  $\text{HI}$  (d)  $\text{NaHSO}_3$
25. Glucose reacts with acetic anhydride to form
  - (a) monoacetate (b) tetra-acetate
  - (c) penta-acetate (d) hexa-acetate
26. Reduction of glucose by  $\text{HI}$  suggest that
  - (a) presence of  $\text{OH}$  groups
  - (b) presence of  $-\text{CHO}$  group
  - (c) cyclic structure of glucose
  - (d) six carbon atoms are arranged in straight chain
27. The reaction of glucose with red  $\text{P} + \text{HI}$  is called
  - (a) Sandmeyer's reaction (b) Reformatsky reaction
  - (c) Gattermann's reaction (d) Reduction
28. Which of the following reactions of glucose can be explained only by its cyclic structure?
  - (a) Glucose forms pentaacetate
  - (b) Glucose reacts with hydroxylamine to form an oxime
  - (c) Pentaacetate of glucose does not react with hydroxylamine
  - (d) Glucose is oxidised by nitric acid to gluconic acid
29. Which is the least stable form of glucose ?
  - (a)  $\alpha$ -D-Glucose (b)  $\beta$ -D-Glucose
  - (c) Open chain structure (d) All are equally stable
30. Isomerization of glucose produces
  - (a) galactose (b) fructose
  - (c) mannose (d) allose
31. A solution of D-glucose in water rotates the plane polarised light
  - (a) to the right (b) to the left
  - (c) to either side (d) None of these
32. The number of chiral carbon atoms present in cyclic structure  $\alpha$ -D(+) glucose
  - (a) 3 (b) 4
  - (c) 5 (d) 6
33. The  $\alpha$ -D glucose and  $\beta$ -D glucose differ from each other due to difference in carbon atom with respect to its
  - (a) conformation (b) configuration
  - (c) number of  $\text{OH}$  groups (d) size of hemiacetal ring
34. The two forms of D-glucopyranose obtained from the solution of D-glucose are called
  - (a) isomers (b) anomers
  - (c) epimers (d) enantiomers
35. Which of the following carbohydrates are branched polymer of glucose?
  - (i) Amylose (ii) Amylopectin
  - (iii) Cellulose (iv) Glycogen
  - (a) (i) and (ii) (b) (ii) and (iv)
  - (c) (iii) and (iv) (d) (i), (ii) and (iii)
36. The number of chiral carbon atoms present in cyclic structure  $\alpha$ -D(+) glucose
  - (a) 3 (b) 4
  - (c) 6 (d) 5
37. Which of the following reagent cannot distinguish between glucose and fructose?
  - (a) Fehling's solution (b) Tollen's reagent
  - (c) Benedict's solution (d) All of these
38. Maltose and glucose are
  - (a) oxidising sugar
  - (b) reducing sugar
  - (c) first is oxidising and second is reducing sugar
  - (d) both are non-reducing sugar
39. Choose the correct relationship for glucose and fructose
  - (a) these are functional isomers
  - (b) these are chain isomers
  - (c) these are position isomers
  - (d) All of these
40. The pair of compounds in which both the compounds give positive test with Tollen's reagent is
  - (a) Glucose and Sucrose
  - (b) Fructose and Sucrose
  - (c) Acetophenone and Hexanal
  - (d) Glucose and Fructose
41. The letter D and L in carbohydrates represent
  - (a) its optical rotation (b) its mutarotation
  - (c) its direct synthesis (d) its configuration
42. Which of the following statement is correct about fructose?
  - (a) It is dextrorotatory compound
  - (b) It exists in the two cyclic forms which is obtained by the addition of  $\text{OH}$  at C-5 to the  $>\text{C}=\text{O}$  group
  - (c) It exists as six membered ring
  - (d) It is named as furanose as it contain one oxygen and six carbon atom

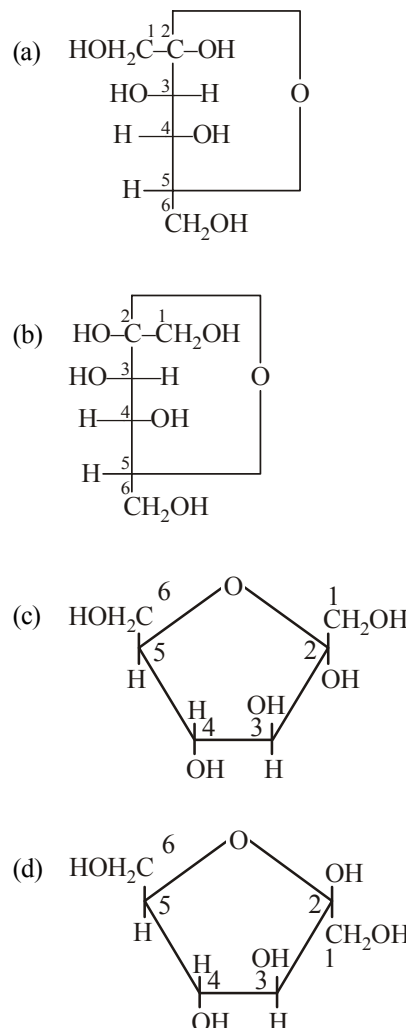


43. Fructose is  
 (a) a hemiacetal (b) an acetal  
 (c) a hemiketal (d) a ketal
44. The sugar present in fruits is  
 (a) fructose (b) glucose  
 (c) sucrose (d) galactose
45. Three cyclic structures of monosaccharides are given below which of these are anomers



- (a) I and II (b) II and III  
 (c) I and III (d) III is anomer of I and II
46. The sugar present in honey is  
 (a) sucrose (b) glucose  
 (c) fructose (d) maltose
47. Which of the following is the sweetest sugar?  
 (a) Sucrose (b) Glucose  
 (c) Fructose (d) Maltose
48. Cellulose is a polymer of  
 (a) Glucose (b) Fructose  
 (c) Ribose (d) Sucrose
49. Sucrose on hydrolysis gives  
 (a) fructose+ribose (b) glucose + fructose  
 (c) glucose+glucose (d) fructose + fructose
50. The presence or absence of hydroxyl group on which carbon atom of sugar differentiates RNA and DNA?  
 (a) 1<sup>st</sup> (b) 2<sup>nd</sup>  
 (c) 3<sup>rd</sup> (d) 4<sup>th</sup>
51. Carbohydrates are stored in the body as  
 (a) sugars (b) starch  
 (c) glucose (d) glycogen
52. A carbohydrate insoluble in water is  
 (a) glucose (b) fructose  
 (c) cellulose (d) sucrose
53. Which of the following carbohydrate does not correspond to the general formula  $C_x(H_2O)_y$ ?  
 (a) Glucose (b) 2-Deoxyribose  
 (c) Fructose (d) Arabinose
54. Lactose is made of  
 (a)  $\alpha$ -D-glucose only  
 (b)  $\alpha$ -D-glucose and  $\beta$ -D-glucose  
 (c)  $\alpha$ -D-galactose and  $\beta$ -D-glucose  
 (d)  $\beta$ -D-galactose and  $\beta$ -D-glucose
55. Which of the following monosaccharides are present as five membered cyclic structure (furanose structure)?

- (i) Ribose (ii) Glucose  
 (iii) Fructose (iv) Galactose  
 (a) (i) and (ii) (b) (i) and (iii)  
 (c) (iii) and (iv) (d) (ii) and (iii)
56. Invert sugar is  
 (a) chemically inactive form of sugar  
 (b) equimolecular mixture of glucose and fructose  
 (c) mixture of glucose and sucrose  
 (d) a variety of cane sugar
57. Which one of the following does not exhibit the phenomenon of mutarotation?  
 (a) (+) – Sucrose (b) (+) – Lactose  
 (c) (+) – Maltose (d) (–) – Fructose
58. Glycogen is a branched chain polymer of  $\alpha$ -D-glucose units in which chain is formed by C1–C4 glycosidic linkage whereas branching occurs by the formation of C1–C6 glycosidic linkage. Structure of glycogen is similar to \_\_\_\_\_  
 (a) Amylose (b) Amylopectin  
 (c) Cellulose (d) Glucose
59. Which of the following correctly represents the cyclic structure of  $\beta$ -D-(–)-fructofuranose.



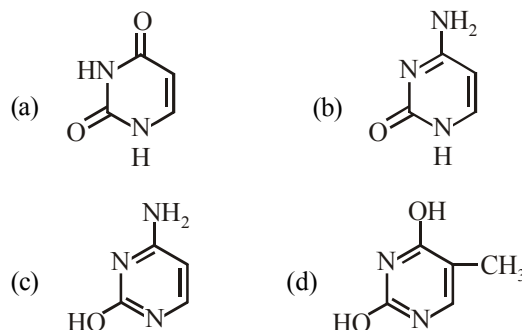
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80. Simplest proteins has one peptide linkage. It is  
(a) tripeptide (b) dipeptide  
(c) tetrapeptide (d) oligopeptide
81. A nanopptide contain how many peptide bond  
(a) 7 (b) 9  
(c) 8 (d) 10
82. Proteins are polypeptide of  
(a)  $\beta$ -amino acid (b)  $\alpha$ -hydroxy acid  
(c) D- $\alpha$ -amino acid (d) L- $\alpha$ -amino acid
83. Globular proteins are present in  
(a) blood (b) eggs  
(c) milk (d) all of these
84. In fibrous proteins, polypeptide chains are held together by  
(a) van der waals forces  
(b) electrostatic forces of attraction  
(c) hydrogen bonds  
(d) covalent bonds
85. Which of the following is not a function of proteins?  
(a) Formation of hair, wool, skin and nails  
(b) As a biological catalysts in the form of enzymes.  
(c) As food in the form of meat, eggs  
(d) As energy provider for metabolism
86. Which of the following is not a fibrous protein?  
(a) Keratin (b) Myosin  
(c) Insulin (d) Both (a) and (b)
87. A polypeptide with more than hundred amino acid residues, having molecular mass higher than 10,000 u is called \_\_\_\_\_.  
(a) nucleic acid (b) hormone  
(c) protein (d) enzyme
88. An insulin is a \_\_\_\_\_ which contains \_\_\_\_\_ amino acids.  
(a) protein, 74 (b) protein, 51  
(c) hormone, 51 (d) hormone, 74
89. Which of the following is an example of globular proteins?  
(a) Glycine (b) Albumin  
(c) Alanine (d) Both (a) and (b)
90. Which of the following is not a characteristics of fibrous proteins?  
(a) In the fibrous proteins polypeptide chains are held together by hydrogen and disulphide bonds.  
(b) These have fibre like structure.  
(c) These are generally soluble in water.  
(d) These have elongated shape.
91. Which of the following statements is true about a peptide bond (RCONHR)?  
(a) It is non planar.  
(b) It is capable of forming a hydrogen bond.  
(c) The *cis* configuration is favoured over the *trans* configuration.  
(d) Single bond rotation is permitted between nitrogen and the carbonyl group.
92. Proteins are condensation polymers of  
(a)  $\alpha$ -amino acids (b)  $\beta$ -amino acids  
(c)  $\alpha$ -hydroxy acids (d)  $\beta$ -hydroxy acids
93. Primary structure of a protein is  
(a) sequence in which  $\alpha$ -amino acid are linked to one another  
(b) sequence in which amino acids of one polypeptide chain are joined to other chain  
(c) the folding patterns of polypeptide chains  
(d) the pattern in which the polypeptide chain are arranged
94. The protein that transport oxygen in the blood stream is  
(a) haemoglobin (b) insulin  
(c) collagen (d) albumin
95. The helical structure of protein is stabilized by  
(a) dipeptide bonds (b) hydrogen bonds  
(c) ether bonds (d) peptide bonds
96. Which of the following statements is incorrect?  
(a) In  $\alpha$ -helix structure a polypeptide chain forms all possible hydrogen bonds by twisting into a right handed screw.  
(b) In  $\beta$ -structure of proteins all peptide chains are stretched out to nearly maximum extension.  
(c) During denaturation 1° and 2° structures are destroyed but 3° structure remains intact.  
(d) All the above statements are incorrect.
97. Which of the following indicates the order in which amino acids are linked together in a protein ?  
(a) Primary structure (b) Secondary structure  
(c) Tertiary structure (d) Quaternary structure
98. Which of the following statement is not true about secondary structure of protein ?  
(a) The alpha helix, beta pleated sheet and beta turns are examples of secondary structure of protein.  
(b) The ability of peptide bonds to form intramolecular hydrogen bonds is important to secondary structure.  
(c) The steric influence of amino acid residues is important to secondary structure.  
(d) The hydrophilic/ hydrophobic character of amino acid residues is important to secondary structure.
99. Which of the following terms indicates to the arrangement of different protein subunits in a multiprotein complex ?  
(a) primary structure (b) secondary structure  
(c) tertiary structure (d) quaternary structure
100. Secondary structure of protein is mainly governed by  
(a) hydrogen bonds (b) covalent bonds  
(c) ionic bonds (d) disulphide bonds
101. The secondary structure of a protein refers to  
(a) fixed configuration of the polypeptide backbone  
(b)  $\alpha$  – helical backbone  
(c) hydrophobic interactions  
(d) sequence of  $\alpha$  – amino acids
102. Tertiary structure of protein arises due to  
(a) folding of polypeptide chain  
(b) folding, coiling and bonding of polypeptide chain  
(c) linear sequence of amino acid in polypeptide chain  
(d) denatured proteins

103. Denaturation of proteins leads to loss of its biological activity by
  - (a) Formation of amino acids
  - (b) Loss of primary structure
  - (c) Loss of both primary and secondary structures
  - (d) Loss of both secondary and tertiary structures
104. Coagulation of protein is known as
  - (a) dehydration
  - (b) decay
  - (c) deamination
  - (d) denaturing
105. Which of the following terms refers to the overall three dimensional shape of a protein.
  - (a) Primary structure
  - (b) Secondary structure
  - (c) Tertiary structure
  - (d) Quaternary structure
106. Which of the following indicates to 'regions of ordered structure within a protein'.
  - (a) Primary structure
  - (b) Secondary structure
  - (c) Tertiary structure
  - (d) Quaternary structure
107. The strongest form of intermolecular bonding that could be formed involving the residue of the amino acid serine is.
  - (a) ionic bond
  - (b) hydrogen bond
  - (c) van der Waals interactions
  - (d) None of the above
108. Which of the following protein destroy the antigen when it enters in body cell?
  - (a) Antibodies
  - (b) Insulin
  - (c) Chromoprotein
  - (d) Phosphoprotein
109. Which of the following is incorrect regarding enzymes?
  - (a) Most of them are globular proteins.
  - (b) They are very specific for a particular reaction but not for a particular substrate.
  - (c) They are generally named after the compound or class of compounds upon which they work.
  - (d) All the above statements are incorrect.
110. Enzymes take part in a reaction and
  - (a) decrease the rate of a chemical reaction
  - (b) increase the rate of a chemical reaction
  - (c) both (a) and (b)
  - (d) None of these
111. Enzymes are made up of
  - (a) Edible proteins
  - (b) Proteins with specific structure
  - (c) Nitrogen containing carbohydrates
  - (d) Carbohydrates
112. The enzyme which hydrolyses triglycerides to fatty acids and glycerol is called
  - (a) Maltase
  - (b) Lipase
  - (c) Zymase
  - (d) Pepsin
113. Which one of the following, statements is incorrect about enzyme catalysis?
  - (a) Enzymes are mostly proteinous in nature.
  - (b) Enzyme action is specific.
  - (c) Enzymes are denaturated by ultraviolet rays and at high temperature.
  - (d) Enzymes are least reactive at optimum temperature.
114. Insulin production and its action in human body are responsible for the level of diabetes. This compound belongs to which of the following categories?
  - (a) An enzyme
  - (b) A hormone
  - (c) A co-enzyme
  - (d) An antibiotic
115. Enzymes are essential as biocatalysts. They function in
  - (a) aqueous medium, temp = 30–35°C; pH=7
  - (b) organic medium
  - (c) aqueous medium under extreme pH conditions
  - (d) None of these
116. Which of the following statements is incorrect?
  - (a) Enzymes are organic catalysts
  - (b) Enzymes have a very large turnover number
  - (c) Enzymes action is specific
  - (d) Enzymes always require a coenzyme in their catalytic action.
117. Among the following vitamins the one whose deficiency causes rickets (bone deficiency) is :
  - (a) Vitamin A
  - (b) Vitamin B
  - (c) Vitamin D
  - (d) Vitamin C
118. The vitamin that is not soluble in water is
  - (a) Vitamin B<sub>1</sub>
  - (b) Vitamin B<sub>2</sub>
  - (c) Vitamin B<sub>6</sub>
  - (d) Vitamin D
119. Deficiency of vitamin B<sub>1</sub> causes the disease
  - (a) Convulsions
  - (b) Beri-Beri
  - (c) Cheilosis
  - (d) Sterility
120. Anaemia is caused by the deficiency of vitamin
  - (a) B<sub>6</sub>
  - (b) B<sub>1</sub>
  - (c) B<sub>2</sub>
  - (d) B<sub>12</sub>
121. Vegetable oils like wheat gram oil, sunflower oil etc. are the good source of
  - (a) vitamin K
  - (b) vitamin E
  - (c) vitamin D
  - (d) vitamin A
122. Which is a fat soluble vitamin?
  - (a) Vitamin A
  - (b) Vitamin B<sub>6</sub>
  - (c) Vitamin C
  - (d) Vitamin B<sub>2</sub>
123. Vitamin B<sub>2</sub>, a water soluble vitamin is also known as
  - (a) ascorbic acid
  - (b) riboflavin
  - (c) thiamine
  - (d) pyridoxine
124. Which of the following statements about vitamin B<sub>12</sub> is incorrect ?
  - (a) It has a cobalt atom
  - (b) It also occurs in plants
  - (c) It is also present in rain water
  - (d) It is needed for human body in very small amounts
125. The couplings between base units of DNA is through :
  - (a) Hydrogen bonding
  - (b) Electrostatic bonding
  - (c) Covalent bonding
  - (d) van der Waals forces
126. Which of the following is correct about H-bonding in nucleotide?
  - (a) A --- A and T --- T
  - (b) G --- T and A --- C
  - (c) A --- G and T --- C
  - (d) A --- T and G --- C

127. In DNA, the complimentary bases are:  
 (a) Adenine and thymine; guanine and cytosine  
 (b) Adenine and thymine ; guanine and uracil  
 (c) Adenine and guanine; thymine and cytosine  
 (d) Uracil and adenine; cytosine and guanine
128. The segment of DNA which acts as the instrumental manual for the synthesis of the protein is:  
 (a) ribose (b) gene  
 (c) nucleoside (d) nucleotide
129. In DNA the linkages between different nitrogenous bases are :  
 (a) peptide linkage (b) phosphate linkage  
 (c) H-bonding (d) glycosidic linkage
130. DNA multiplication is called as  
 (a) translation (b) transduction  
 (c) transcription (d) replication
131. Chromosomes are made from  
 (a) proteins  
 (b) nucleic acids  
 (c) proteins and nucleic acids  
 (d) carbohydrates and nucleic acids
132. The double helical structure of DNA was proposed by  
 (a) Watson and Crick (b) Meichers  
 (c) Emil Fischer (d) Khorana
133.  $\alpha$  - Helix is found in  
 (a) DNA (b) RNA  
 (c) lipid (d) carbohydrates
134. Which of the following compounds is responsible for the transmission of heredity characters?  
 (a) RNA (b) DNA  
 (c) Glucose (d) Haemoglobin
135. The latest discovery in cytology is that of  
 (a) respiration (b) genetic code  
 (c) enzyme (d) None of these
136. Energy is stored in our body in the form of  
 (a) ATP (b) ADP  
 (c) fats (d) carbohydrates
137. The chemical change in DNA molecule that could lead to synthesis of protein with an altered amino acid sequence is called  
 (a) replication (b) lipid formation  
 (c) cellular membrane (d) mutation
138. DNA has deoxyribose, a base and the third component which is  
 (a) phosphoric acid (b) ribose  
 (c) adenine (d) thymine
139. The process by which synthesis of protein takes place based on the genetic information present in m-RNA is called  
 (a) Translation (b) Transcription  
 (c) Replication (d) Messenger hypothesis

140. Which of the following structures represents thymine ?



141. When adenine is attached to ribose sugar, it is called adenosine. To make a nucleotide from it, it would require  
 (a) oxygenation (b) addition of a base  
 (c) addition of phosphate (d) hydrogenation
142. Which of the following is not present in a nucleotide?  
 (a) Guanine (b) Cytosine  
 (c) Adenine (d) Tyrosine
143. The function of DNA in an organism is  
 (a) to assist in the synthesis of RNA molecule  
 (b) to store information of heredity characteristics  
 (c) to assist in the synthesis of proteins and polypeptides  
 (d) All of these
144. Which of the following statements regarding DNA fingerprinting is incorrect?  
 (a) It is used in forensic laboratories for identification of criminals.  
 (b) It cannot be altered by surgery.  
 (c) It is different for every cell and cannot be altered by any known treatment.  
 (d) It is used to determine paternity of an individual.

### STATEMENT TYPE QUESTIONS

145. Read the following statements and choose the correct answer?  
 (i) All monosaccharides are reducing sugars.  
 (ii) All monosaccharides are not reducing sugars.  
 (iii) In disaccharides if aldehydic or ketonic groups are bonded, these are non-reducing sugars.  
 (iv) In disaccharides if aldehydic or ketonic groups are free, these are reducing sugars.  
 (a) (i), (iii) and (iv) (b) (ii), (iii) and (iv)  
 (c) (i) and (iv) (d) (ii) and (iv)
146. Which of the following statement(s) is/are correct?  
 (i) Glucose is reducing sugar  
 (ii) Sucrose is reducing sugar  
 (iii) Maltose is non-reducing sugar  
 (iv) Lactose is reducing sugar  
 (a) (i) and (ii) only (b) (i) and (iii) only  
 (c) (i) and (iv) only (d) All of these



147. Which of the following statements regarding carbohydrates are correct?

- (i) Lactose is the carbohydrate found in milk.
  - (ii) More than 25 monosaccharides occur naturally.
  - (iii) Sucrose on hydrolysis gives one molecule each of glucose and fructose.
  - (iv) Maltose is a non-reducing sugar whereas sucrose is a reducing disaccharide sugar.
- (a) (i), (ii) and (iii)                      (b) (i) and (iii)  
(c) (ii), (iii) and (iv)                      (d) (iii) and (iv)

148. Read the following statements.

- (i) Pyran is a cyclic organic compound with one oxygen atom and five carbon atom.
- (ii) The cyclic structure of glucose is correctly represented by Haworth structure.
- (iii) Five membered cyclic structure of glucose is called pyranose structure.

Which of the following statement(s) is/are true?

- (a) (i) and (iii)                      (b) (i) and (ii)  
(c) Only (iii)                      (d) (i), (ii) and (iii)

149. Consider the following statements.

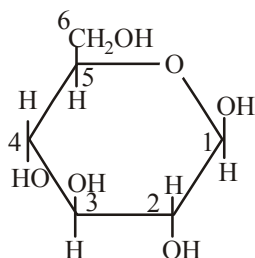
- (i) Linkage between two monosaccharide units through oxygen atom is called glycosidic linkage.
- (ii) Sucrose on hydrolysis gives an equimolar mixture of fructose and glucose which is dextrorotatory.
- (iii) Lactose consists of linkage between C<sub>1</sub> of galactose and C<sub>4</sub> of glucose.
- (iv) Out of two components of starch the component present in greater proportion is insoluble in water.
- (v) Glycogen is also known as animal starch because it is structurally similar to amylose a component of starch.

Which of the following is the correct code for statements above?

- (a) FFFTT                      (b) FTTTF  
(c) TFTFT                      (d) TTTTF

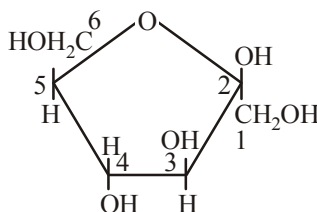
150. Read the following statements.

- (i) Haworth structure of  $\alpha$ -D-glucose will be .



- (ii) Fructose belongs to D-series and is a laevorotatory compound.

- (iii) Haworth structure for  $\beta$ -D-fructose will be.



- (iv) Fructose contains a ketonic functional group at C-2 carbon atom.

Which of the following is the correct code for the statements above?

- (a) FTTT                      (b) FFTT  
(c) TFFT                      (d) FTFT

151. Read the following statements and choose the correct option?

- (i) Starch is a polymer of  $\alpha$ -glucose.
  - (ii) Starch consists of amylose and amylopectin.
  - (iii) Amylose is insoluble in water.
  - (iv) Amylopectin is soluble in water.
- (a) (i) (iii) and (iv)                      (b) (i), (ii) and (iii)  
(c) (i) and (ii)                      (d) (iii) and (iv)

152. Which among the following statements are true for glycine?

- (i) It exists in crystalline form
  - (ii) It is optically active
  - (iii) It is soluble in water
  - (iv) It can form Zwitter ions
- (a) (i), (ii) and (iii)                      (b) (i), (ii) and (iv)  
(c) (i), (iii) and (iv)                      (d) (ii), (iii) and (iv)

153. Which of the following statements are correct?

- (i) Proteins on hydrolysis gives only  $\alpha$ -amino acids.
  - (ii) Gln stands for glutamic acid.
  - (iii) Amino acids with equal number of amino and carboxyl groups are neutral.
  - (iv) All naturally occurring  $\alpha$ -amino acids are optically active.
- (a) (i) and (iii)                      (b) (i), (ii) and (iv)  
(c) (iii) and (iv)                      (d) (ii), (iii) and (iv)

154. Which of the statements about "Denaturation" given below are correct ?

- (i) Denaturation of proteins causes loss of secondary and tertiary structures of the protein.
  - (ii) Denaturation leads to the conversion of double strand of DNA into single strand
  - (iii) Denaturation affects primary structure which gets distorted
- (a) (ii) and (iii)                      (b) (i) and (iii)  
(c) (i) and (ii)                      (d) (i), (ii) and (iii)

155. Of the following statements about enzymes which ones are true?

- (i) Enzymes lack in nucleophilic groups
  - (ii) Enzymes are highly specific both in binding chiral substrates and in catalysing their reactions
  - (iii) Enzymes catalyse chemical reactions by lowering the energy of activation
  - (iv) Pepsin is a proteolytic enzyme
- (a) (i) and (iv)                      (b) (i) and (iii)  
(c) (ii), (iii) and (iv)                      (d) (i)

156. Which of the following statements are correct ?

- (i) Vitamins A, D, E and K are insoluble in water.
  - (ii) Vitamins A, D, E and K are stored in liver and adipose tissues.
  - (iii) Vitamin B and vitamin C are water soluble.
  - (iv) Water soluble vitamins should not be supplied regularly in diet.
- (a) (i), (ii) and (iv)                      (b) (i), (ii) and (iii)  
(c) (i) and (iv)                      (d) (ii) and (iv)

157. Which of the following statement(s) is/are correct?
- Information regarding the sequence of nucleotides in the chain of a nucleic acid is called its primary structure.
  - In secondary structure of DNA adenine forms hydrogen bonds with guanine whereas cytosine forms hydrogen bonds with thymine.
  - RNA molecules are of three types m-RNA, r-RNA and t-RNA and they all perform different functions.
- (a) (ii) only (b) (i) and (iii)  
(c) (ii) and (iii) (d) (iii) only

158. Consider the following statements.

- Nucleic acids are long chain polymers of nucleotides.
- Sugar moiety in DNA molecules is  $\beta$ -D-ribose whereas in RNA molecules it is  $\beta$ -D-2-deoxyribose.
- RNA contains four bases viz. adenine (A), guanine (G), cytosine (C) and uracil (U)
- Nucleotide is a nucleoside linked to phosphoric acid at 4-position of sugar moiety.

Which of the following is the correct code for the statements above?

- (a) TFFT (b) TFTF  
(c) FFTT (d) FTFF

### MATCHING TYPE QUESTIONS

159. Match the columns.

**Column - I**  
**Reaction of glucose**

**Column - II**  
**Characteristic of glucose molecule**

- (A)  $\begin{array}{c} \text{CHO} \\ | \\ (\text{CHOH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array} \xrightarrow{\text{HI}, \Delta} \text{CH}_3-(\text{CH}_2)_4-\text{CH}_3$  (p) Presence of  $\text{>C=O}$  group
- (B)  $\begin{array}{c} \text{CHO} \\ | \\ (\text{CHOH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array} \xrightarrow[\text{(ii) HCN}]{\text{(i) NH}_2\text{OH}} \begin{array}{c} \text{H}-\text{C}-\text{CN} \\ | \\ \text{OH} \\ | \\ (\text{CHOH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array}$  (q) Presence of aldehydic group
- (C)  $\begin{array}{c} \text{CHO} \\ | \\ (\text{CHOH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array} \xrightarrow{(\text{CH}_3\text{COO})_2\text{O}} \begin{array}{c} \text{CHO} \quad \text{O} \\ | \quad || \\ (\text{CH}-\text{O}-\text{C}-\text{CH}_3)_4 \\ | \\ \text{CH}_2-\text{O}-\text{C}-\text{CH}_3 \\ || \\ \text{O} \end{array}$  (r) All six carbon atoms are linked in a straight chain.
- (D)  $\begin{array}{c} \text{CHO} \\ | \\ (\text{CHOH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array} \xrightarrow{\text{Br}_2/\text{water}} \begin{array}{c} \text{COOH} \\ | \\ (\text{CHOH})_4 \\ | \\ \text{CH}_2\text{OH} \end{array}$  (s) Presence of five  $\text{—OH}$  groups

- (a) A – (p), B – (r), C – (s), D – (q)  
(b) A – (r), B – (s), C – (p), D – (q)  
(c) A – (r), B – (p), C – (s), D – (q)  
(d) A – (r), B – (p), C – (q), D – (s)

160. Match the columns

**Column - I**  
**(Enzymes)**

**Column - II**  
**(Reactions)**

- (A) Invertase (p) Decomposition of urea into  $\text{NH}_3$  and  $\text{CO}_2$   
(B) Maltase (q) Conversion of glucose into ethyl alcohol  
(C) Pepsin (r) Hydrolysis of maltose into glucose  
(D) Urease (s) Hydrolysis of cane sugar  
(E) Zymase (t) Hydrolysis of proteins into peptides

- (a) A – (s), B – (r), C – (t), D – (p), E – (q)  
(b) A – (r), B – (q), C – (s), D – (p), E – (t)  
(c) A – (q), B – (p), C – (r), D – (s), E – (t)  
(d) A – (s), B – (p), C – (t), D – (q), E – (r)

161. Match the columns

**Column - I**

**Column - II**

- (A) Vitamin B<sub>6</sub> (p) Fat soluble  
(B) Vitamin K (q) Xerophthalmia  
(C) Vitamin D (r) Convulsions  
(D) Vitamin A (s) Delayed blood clotting
- (a) A – (p,q), B – (p,s), C – (p), D – (r)  
(b) A – (r), B – (p,s), C – (p), D – (p, q)  
(c) A – (p,s), B – (r), C – (p), D – (p,q)  
(d) A – (r), B – (p,s), C – (p,q), D – (p)

162. Match the columns

**Column - I**

**Column - II**

- (A) Vitamin A (p) Scurvy  
(B) Vitamin B<sub>12</sub> (q) Hemorrhagic condition  
(C) Vitamin C (r) Sterility  
(D) Vitamin E (s) Xerophthalmia  
(E) Vitamin K (t) Pernicious anaemia
- (a) A – (t), B – (s), C – (p), D – (r), E – (r)  
(b) A – (s), B – (t), C – (p), D – (q), E – (r)  
(c) A – (s), B – (t), C – (p), D – (r), E – (q)  
(d) A – (t), B – (s), C – (p), D – (r), E – (q)

### ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

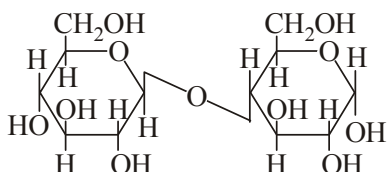
**163. Assertion :** D(+)- Glucose is dextrorotatory in nature.

**Reason :** 'D' represents its dextrorotatory nature.

**164. Assertion :** Sucrose is called an invert sugar.

**Reason :** On hydrolysis, sucrose bring the change in the sign of rotation from dextro (+) to laevo(-).

**165. Assertion :**  $\beta$ -glycosidic linkage is present in maltose,



**Reason :** Maltose is composed of two glucose units in which C-1 of one glucose unit is linked to C-4 of another glucose unit.

**166. Assertion :** At isoelectric point, the amino group does not migrate under the influence of electric field.

**Reason :** At isoelectric point, amino acid exists as a zwitterion.

**167. Assertion :** Vitamin D cannot be stored in our body

**Reason :** Vitamin D is fat soluble vitamin and is excreted from the body in urine.

### CRITICAL THINKING TYPE QUESTIONS

**168.** Which one of the following is the reagent used to identify glucose?

- (a) Neutral ferric chloride  
 (b) Chloroform and alcoholic KOH  
 (c) Ammoniacal silver nitrate  
 (d) Sodium ethoxide

**169.** Glucose molecule reacts with 'X' number of molecules of phenylhydrazine to yield osazone. The value of 'X' is

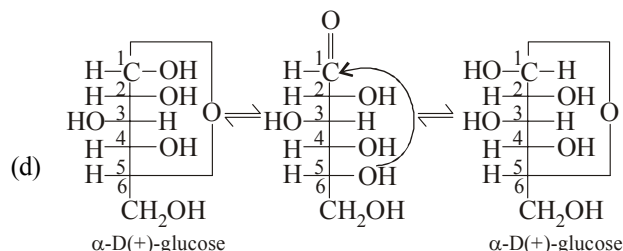
- (a) four (b) one  
 (c) two (d) three

**170.** In the acetylation of glucose, which group is involved in the reaction

- (a) CHO group (b)  $>C=O$  group  
 (c) alcoholic OH group (d) all of these

**171.** Select the false statement about the cyclic glucose.

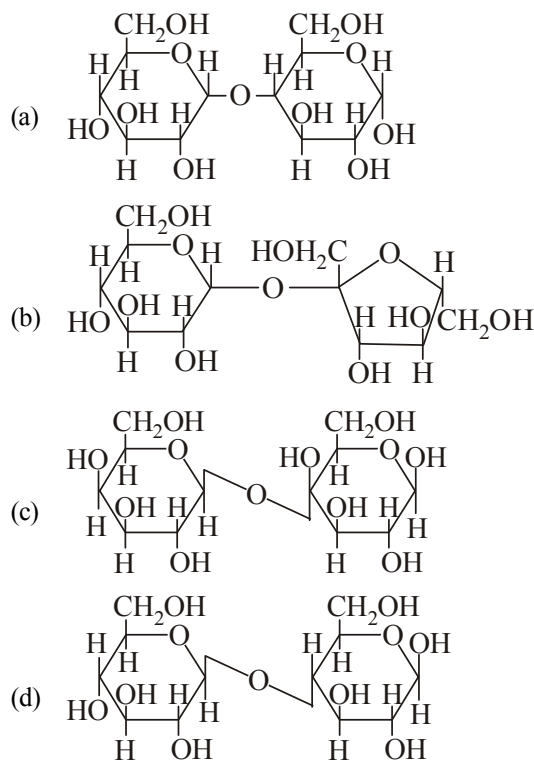
- (a) If the OH group is added to CHO group it will form cyclic hemiacetal structure  
 (b) Glucose form six-membered ring in which -OH is at C-5 position  
 (c) Melting point of  $\alpha$ -glucose is 423 K and of  $\beta$ -glucose is 419 K



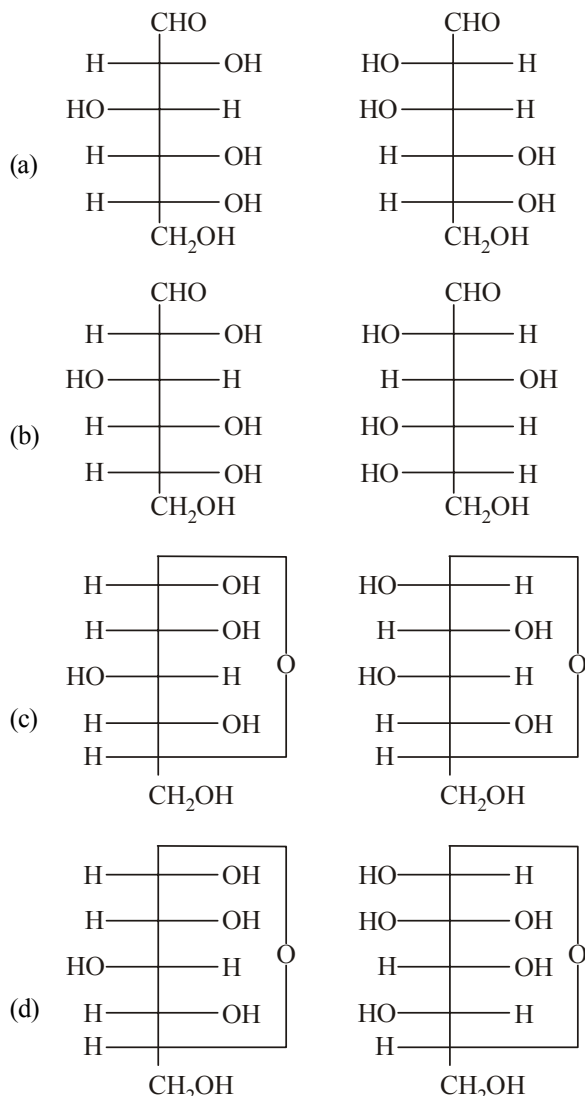
**172.** When  $\alpha$ -D-glucose and  $\beta$ -D-glucose are dissolved in water in two separate beakers I and II respectively and allowed to stand, then –

- (a) specific rotation in beaker I will decrease while in II will increase upto a constant value  
 (b) the specific rotation of equilibrium mixture in two beakers will be different  
 (c) the equilibrium mixture in both beakers will be levorotatory  
 (d) the equilibrium mixture in both beakers will contain only cyclic form of glucose

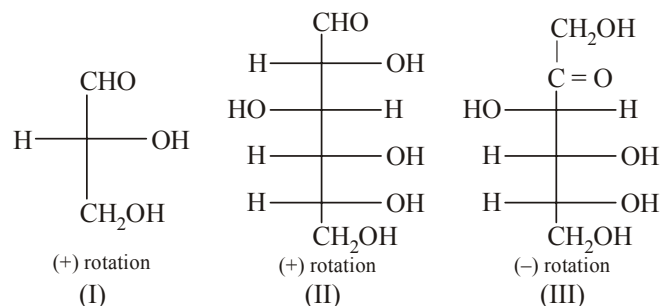
**173.** In disaccharides, if the reducing groups of monosaccharides *i.e.*, aldehydic or ketonic groups are bonded, these are non-reducing sugars. Which of the following disaccharide is a non-reducing sugar?



174. Which of the following pairs represents anomers?

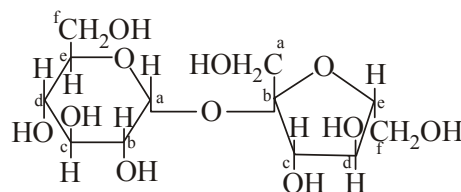


175. Optical rotation of some compound along with their structures are given below which of them have D configuration.



- (a) I, II, III                      (b) II, III  
(c) I, II                              (d) III

176. Structure of a disaccharide formed by glucose and fructose is given below. Identify anomeric carbon atoms in monosaccharide units.



- (a) 'a' carbon of glucose and 'a' carbon of fructose.  
(b) 'a' carbon of glucose and 'e' carbon of fructose.  
(c) 'a' carbon of glucose and 'b' carbon of fructose.  
(d) 'f' carbon of glucose and 'f' carbon of fructose.
177. Cyclic structure of fructose resembles with  
(a) pyran                              (b) furan  
(c) pyridine                              (d) oxiran
178. Sucrose in water is dextro-rotatory,  $[\alpha]_D = +66.4^\circ$ . When boiled with dilute HCl, the solution becomes leavo-rotatory,  $[\alpha]_D = -20^\circ$ . In this process the sucrose molecule breaks into  
(a) L-glucose + D-fructose  
(b) L-glucose + L-fructose  
(c) D-glucose + D-fructose  
(d) D-glucose + L-fructose
179. Which one of the following statements is not true regarding (+) Lactose ?  
(a) On hydrolysis (+) Lactose gives equal amount of D(+) glucose and D(+) galactose.  
(b) (+) Lactose is a  $\beta$ -glycoside formed by the union of a molecule of D(+) glucose and a molecule of D(+) galactose.  
(c) (+) Lactose is a reducing sugar and does not exhibit mutarotation.  
(d) (+) Lactose,  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$  contains 8-OH groups.
180. Which one of the following sets of monosaccharides forms sucrose?  
(a)  $\alpha$ -D-Galactopyranose and  $\alpha$ -D-Glucopyranose  
(b)  $\alpha$ -D-Glucopyranose and  $\beta$ -D-Fructofuranose  
(c)  $\beta$ -D-Glucopyranose and  $\alpha$ -D-Fructofuranose  
(d)  $\alpha$ -D-Glucopyranose and  $\beta$ -D-Fructopyranose
181. Which of the following statements is correct?  
(a) Only the compounds following general formula  $\text{C}_x(\text{H}_2\text{O})_y$  are carbohydrates.  
(b) Acetic acid ( $\text{CH}_3\text{COOH}$ ) having general formula  $\text{C}_2(\text{H}_2\text{O})_2$  falls in this category.  
(c) Rhamnose having formula  $\text{C}_6\text{H}_{12}\text{O}_5$  is a carbohydrate. Though this is not according to general formula of carbohydrates.  
(d) Chemically the carbohydrates may be defined as optically inactive polyhydroxy aldehydes or ketones.
182. The strongest form of intermolecular bonding that could be formed involving the residue of the amino acid valine is  
(a) ionic bond  
(b) hydrogen bond  
(c) van der Waals interactions  
(d) none of the above

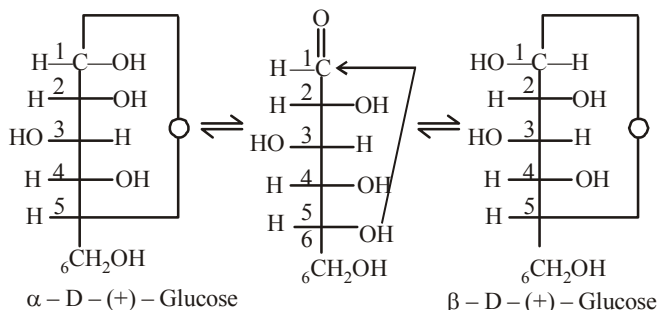
- 183.** Which functional group participates in disulphide bond formation in proteins?  
 (a) Thioester (b) Thioether  
 (c) Thiol (d) Thiolactone
- 184.** Glycosidic linkage is actually an  
 (a) Carbonyl bond (b) Ether bond  
 (c) Ester bond (d) Amide bond
- 185.** For  $\begin{array}{c} \text{O} \\ || \\ -\text{C}-\ddot{\text{N}}\text{H}- \end{array}$  (peptide bond)  
 Which statement is incorrect about peptide bond?  
 (a) C—N bond length in proteins is longer than usual bond length of the C—N bond  
 (b) Spectroscopic analysis shows planar structure of the  $\begin{array}{c} -\text{C}-\text{NH}- \\ || \\ \text{O} \end{array}$  group  
 (c) C—N bond length in proteins is smaller than usual bond length of the C—N bond  
 (d) None of the above
- 186.** The function of enzymes in the living system is to  
 (a) transport oxygen  
 (b) provide energy  
 (c) provide immunity  
 (d) catalyse biochemical reactions
- 187.** Vitamin C must be supplied regularly in diet because  
 (a) it is water soluble hence excreted in urine and can't be stored in the body  
 (b) it is fat soluble hence stored in the body and cannot be used on regular basis  
 (c) it is required in a large amount by the body hence supplied regularly  
 (d) it is water soluble hence used by the body on daily basis and is to be supplied regularly.
- 188.** In both DNA and RNA, heterocyclic base and phosphate ester linkages are at –  
 (a)  $\text{C}_5'$  and  $\text{C}_1'$  respectively of the sugar molecule  
 (b)  $\text{C}_1'$  and  $\text{C}_5'$  respectively of the sugar molecule  
 (c)  $\text{C}_2'$  and  $\text{C}_5'$  respectively of the sugar molecule  
 (d)  $\text{C}_5'$  and  $\text{C}_2'$  respectively of the sugar molecule



# HINTS AND SOLUTIONS

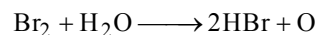
## FACT/DEFINITION TYPE QUESTIONS

- (c) Carbohydrates, proteins and fats are biomolecules.
- (a) Lactose is a disaccharide.
- (c) It is found in the milk of all animals and imparts sweetness to milk (hence named milk sugar).
- (d) The disaccharides are sugars which on hydrolysis give two moles of the same or different monosaccharides. **Sucrose, maltose and lactose** ( $C_{12}H_{22}O_{11}$ ) are the common examples.
- (c) Aldo-(keto) pentoses having 5 carbon  
Aldo-(keto) hexoses having 6 carbon  
is an example of Pentose Sugar, arabinose (aldopentose) glucose, galactose and fructose are important examples of hexose sugar.
- (d) The most common disaccharide, Lactose has the molecular formula  $C_{12}H_{22}O_{11}$ .
- (a) 8. (d)
- (d) Monosaccharides cannot be hydrolysed to simpler molecules.
- (b) Sucrose is an oligosaccharide and cellulose is a polysaccharide.
- (c) All those carbohydrates which reduce Fehling's solution and Tollens' reagent are referred to as reducing sugars.
- (a) Glucose ( $C_6H_{12}O_6$ ) is the simplest molecule which is monosaccharide while others are polysaccharides which on hydrolysis give monosaccharides. Option (a) is correct.
- (d) Glucose is aldohexose. Glucose is a monosaccharide, i.e. it can not be hydrolysed further to simple sugars. Oligosaccharides on hydrolysis give 2-10 molecules of monosaccharides.
- (b) To explain the properties which can not be explained by open chain structure of glucose it was proposed that one of the -OH groups may add to the -CHO group and form a cyclic hemiacetal structure as shown below.

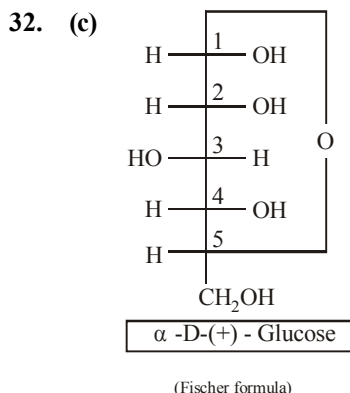


- (c) Glucose contain aldehyde group. Hence it give positive Fehling solution test.

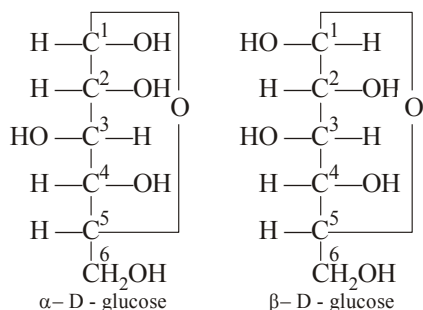
- (d) It is the most abundant organic compound on earth.
- (d) Tollen's reagent is reduced by glucose due to aldehydic group and gives grey colour as silver metal.
- (b) The letter 'D' or 'L' before the name of any compound indicate the relative configuration of a particular stereoisomer.
- (a) 20. (a)
- (d) Glucose is a monosaccharide, others are disaccharides. Sucrose is a combination of glucose and fructose. Maltose is a combination of two glucose units. Lactose (or milk sugar) is a combination of glucose and galactose (a hexose sugar).
- (c) Glucose is considered as a typical carbohydrate which contains -CHO and -OH group.
- (a) Glucose contains an aldehyde group. It is oxidised into acidic group by bromine water and gluconic acid is formed



- (d) Weak reagent like  $NaHSO_3$  is unable to open the chain and can't react with glucose. This explains the inability of glucose to form aldehyde bisulphite compound.
- (c) Glucose has 5 hydroxyl groups, hence it reacts with acetic anhydride to form a penta-acetate
- (d)
- (d) Red P + HI is reducing agent.
- (c) Pentaacetate of glucose does not react with hydroxylamine
- (c) Open chain structure is unstable and converted to cyclic.
- (b)
- (a) Natural glucose is dextrorotatory and thus, glucose is also known as dextrose.

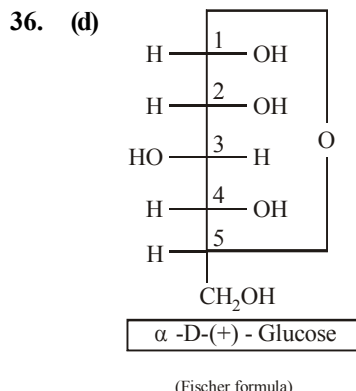


33. (b)  $\alpha$ -D glucose and  $\beta$ -D glucose are the isomers which differ in the orientation (configuration) of H and OH groups around  $C_1$  atom.



34. (b) The two isomeric forms ( $\alpha$  - and  $\beta$  -) of D-glucopyranose differ in configuration only at  $C-1$ ; hence these are called anomers.

35. (b)



37. (b) Glucose and fructose both are reduced by Fehling's solution, Tollen's reagent and Benedict's solution. Therefore, these three reagents can not be used to distinguish between glucose and fructose.

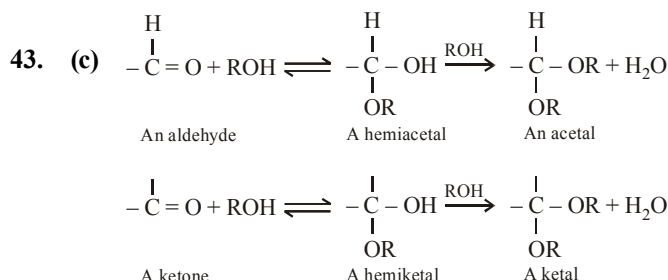
38. (b) Maltose and glucose are reducing sugars.

39. (a) Glucose contains  $-CHO$  group and fructose contains  $>C=O$  group. Hence these are functional isomers.

40. (d) Glucose being an aldose responds to Tollen's test while fructose, although a ketose, undergoes rearrangement in presence of basic medium (provided by Tollen's reagent) to form glucose, which then responds to Tollen's test.

41. (d)

42. (b) Fructose has the molecular formula  $C_6H_{12}O_6$ . It belongs to D-series and is laevorotatory compound. It also exists in two cyclic forms which are obtained by the addition of  $-OH$  at  $C-5$  to the  $>C=O$  group. The ring thus formed is a five membered ring and is named as furanose with analogy to the compound Furan. Furan is a five membered cyclic compound with one oxygen and four carbon atoms.



In cyclic structure of fructose, ketonic group has reacted with an alcoholic group, it is said to be an example of an intramolecular cyclic hemiketal.

44. (a) Sweet taste of fruits is due to fructose.

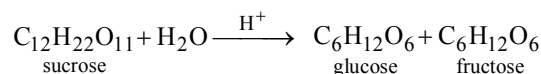
45. (a)

46. (c) Honey is collected from flowers by honey bee which contains fructose.

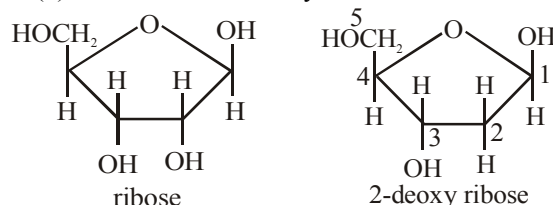
47. (c) Fructose is the sweetest sugar.

48. (a) We know that cellulose  $(C_6H_{12}O_6)_n$  is the chief constituent of cell walls of plants. It is the most abundant organic substance found in nature. It is a polymer of glucose with 3500 repeat units in a chain.

49. (b) Sucrose is a disaccharide which on hydrolysis gives one molecule of glucose (monosaccharide) and fructose (monosaccharide).



50. (b) RNA has D (-) - Ribose and the DNA has 2-Deoxy D (-) - ribose as the carbohydrate unit.



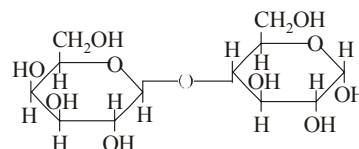
From the structures it is clear that 2<sup>nd</sup> carbon in DNA do not have OH group.

51. (d) Carbohydrates are stored in the body as glycogen.

52. (c)

53. (b)  $CH_2OHCH_2CHOHCHOHCH_2OH$  does not correspond to  $C_x(H_2O)_y$ .

54. (d) Lactose (milk sugar) is a disaccharide, it is made of  $\beta$ -D-galactose and  $\beta$ -D-glucose

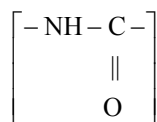


55. (b)                      56. (b)

57. (a) Sucrose does not have free  $-CHO$  or  $CO$  group, hence it does not undergo mutarotation.

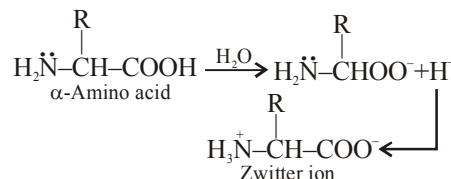
58. (b)                      59. (d)

60. (b) Sucrose is dextrorotatory but after hydrolysis gives dextrorotatory glucose and laevorotatory fructose. Since the laevorotation of fructose ( $-92.4^\circ$ ) is more than dextrorotation of glucose ( $+52.5^\circ$ ), the mixture is laevorotatory.
61. (c) Chemically amylose is a long unbranched chain with 200-1000  $\alpha$ -D-(+)-glucose units held by C1-C4 glycosidic linkage.
62. (b) It is a branched chain polymer of  $\alpha$ -D-glucose units in which chain is formed by C1-C4 glycosidic linkage whereas branching occurs by C1-C6 glycosidic linkage.
63. (b) Cellulose is a straight chain polysaccharide.
64. (b) The carbohydrates are stored in animal body as glycogen. It is also known as animal starch because its structure is similar to amylopectin and is rather more highly branched.
65. (d) Carbohydrates are essential for life in both plants and animals. Honey has been used for a long time as an instant source of energy by 'Vaid's' in ayurvedic system of medicine. Carbohydrates are used as storage molecules as starch in plants and glycogen in animals. Cell wall of bacteria and plants is made up of cellulose. We build furniture etc., from cellulose in the form of wood and cloth ourselves with cellulose in the form of cotton fibre. They provide raw materials for many important industries like textiles, paper lacquers and breweries.
66. (b) There are 20 amino acids in man out of which 10 amino acids are essential amino acids. These essential amino acids are supplied to our bodies by food which we take because they cannot be synthesised in the body. These are (1) valine (2) leucine (3) Isoleucine (4) Phenyl alanine (5) Threonine (6) Methionine (7) Lysine (8) Tryptophan (9) Arginine (10) Histidine.
67. (N) All the given options are example of neutral amino acids.
68. (b)  $\alpha$ -Amino acid is the building block unit of protein which is formed by polymerisation of amino acid through peptide linkage.

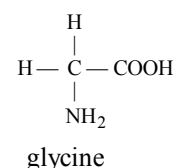


69. (a) Except alanine, all amino acids are essential amino acids which cannot be synthesised in the body and must be obtained through diet.
70. (a)
71. (c) Amino acids are the compounds having one or more amino groups and one or more carboxyl groups in the same molecule.
72. (b) Except glycine, all other naturally occurring  $\alpha$ -amino acids are optically active, since the  $\alpha$ -carbon atom is asymmetric.

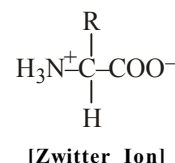
73. (d) In neutral solution, amino acids exist as dipolar ion (also known as zwitter ions or inner salts) where the proton of  $-\text{COOH}$  group is transferred to the  $-\text{NH}_2$  group to form inner salt, known as dipolar ion.



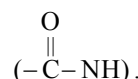
74. (c) With the exception of glycine all the 19 other common amino acids have a uniquely different functional group on the central tetrahedral alpha carbon.



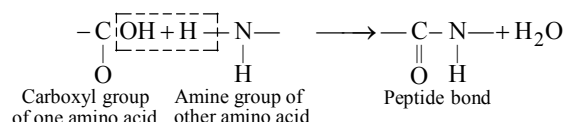
75. (d) Zwitter ion contains both +ve and -ve charge. Proton of  $-\text{COOH}$  group is transferred to the  $-\text{NH}_2$  group.  $\text{NH}_3^+$  group is acidic since it can donate a proton and  $-\text{COO}^-$  group is basic since it can accept a proton.
76. (a) Amino Acids are amphoteric in nature. So for it a special term is coined called **Zwitter ion**. They have following structure in solution



77. (d) Proline is a secondary amine
78. (a) Proteins and peptides are linked by peptide linkages



79. (c) The bond formed between two amino acids by the elimination of a water molecule is called a peptide linkage or bond. The peptide bond is simply another name for amide bond.

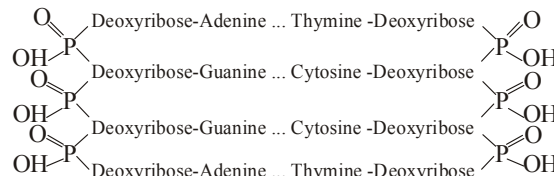


The product formed by linking amino acid molecules through peptide linkages.  $-\text{CO}-\text{NH}-$ , is called a peptide.

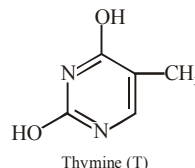
80. (b)
81. (c)
82. (d) Proteins are highly complex, natural compounds, composed of a large number of different  $\alpha$ -amino-acids joined together with peptide linkage, i.e., they are naturally occurring polypeptides.
83. (d) All these are the examples of globular proteins. These are soluble in water.

84. (c) Polypeptide chains in fibrous proteins are held together by disulphide and hydrogen bonds.
85. (d) Proteins are building blocks of the body but they do not provide energy for metabolism.
86. (c) Insulin is an example of globular protein.
87. (c) 88. (b) 89. (b)
90. (c) These are generally insoluble in water.
91. (b) The NH of the amide can act as a hydrogen bond donor and the carbonyl group can act as a hydrogen bond acceptor. Statements (a), (c) and (d) are false. The peptide bond has double bond character due to the interaction of the nitrogen lone pair with the carbonyl group. This prevents bond rotation and makes the bond planar. The *trans* isomer is favoured over the *cis* isomer.
92. (a)
93. (a) The sequence in which the  $\alpha$ -amino acids are linked to one another in a protein molecule is called its primary structure.
94. (a)
95. (b) The  $\alpha$ -helix structure is formed when the chain of  $\alpha$ -amino acids coils as a right handed screw (called  $\alpha$ -helix) because of the formation of hydrogen bonds between amide groups of the same peptide chain, i.e., NH group in one unit is linked to carbonyl oxygen of the third unit by hydrogen bonding. This hydrogen bonding between different units is responsible for holding helix in a position.
96. (c) During denaturation 2° and 3° structures are destroyed but 1° structure remains intact.
97. (a) Primary structure refers to the order of the amino acids in a protein.
98. (d) The hydrophilic/ hydrophobic character of amino acid residues is important to tertiary structure of protein rather than to secondary structure. In secondary structure, it is the steric size of the residues that is important and residues are positioned to minimise interactions between each other and the peptide chain.
99. (d) Quaternary structure refers to the overall structure of a multiprotein complex where as primary, secondary and tertiary structure refer to the different structural levels of a single protein.
100. (a) The arrangement of polypeptide chains formed as a result of hydrogen bonding is called secondary structure of proteins.  
 $\alpha$ -helix is formed by intramolecular H-bonding.  
 $\beta$ -pleated sheet is formed by intermolecular H-bonding.
101. (b) The secondary structure of a protein refers to the shape in which a long peptide chain can exist. There are two different conformations of the peptide linkage present in protein, these are  $\alpha$ -helix and  $\beta$ -conformation. The  $\alpha$ -helix always has a right handed arrangement. In  $\beta$ -conformation all peptide chains are stretched out to nearly maximum extension and then laid side by side and held together by intermolecular hydrogen bonds. The structure resembles the pleated folds of drapery and therefore is known as  $\beta$ -pleated sheet.
102. (b) In this structure of protein atoms are highly coiled and form a spherical form.
103. (d)
104. (d) When a protein, in its native form, is subjected to a physical change like change in temperature, or a chemical change like change in pH, the native conformation of the molecule is disrupted and proteins so formed are called **denatured proteins**.  
The denaturation may be reversible or irreversible. The coagulation of egg on boiling is an example of irreversible protein denaturation.  
However, it has been shown now that in some cases, the process is actually reversible. The reverse process is called **renaturation**.
105. (c) Tertiary structure indicates the overall structure of the protein.
106. (b)
107. (b) Serine contains a hydroxyl functional group on its side chain and so the strongest possible interaction will be hydrogen bonding where the hydroxyl group could act as a hydrogen bond donor or hydrogen bond acceptor.
108. (a) When antigens enter in to the body cells and destroy them, then antibodies being proteins are synthesised in the body and combine with antigens and destroy these antigens by forming inactive complexes. Therefore antibodies protein destroy antigens.
109. (b) Enzymes are highly specific for a particular reaction and also for a particular substrate.
110. (b) Enzymes being biocatalyst can increase the rate of a reaction upto 10 million times. Even very small amount can accelerate a reaction.
111. (b) Enzymes are made up of protein with specific structure.
112. (b) Triglycerides are lipids, hence these are hydrolysed by *lipases* to glycerol and fatty acids.
113. (d) Enzymes are most reactive at optimum temperature. The optimum temperature for enzyme activity lies between 40°C to 60°C.
114. (b) Insulin is a biochemically active peptide hormone secreted by pancreas.
115. (a)
116. (d) Enzymes may or may not require a coenzyme for their catalytic action.
117. (c) Deficiency of vitamin D causes rickets.
118. (d) Vitamin D is a fat soluble vitamin.
119. (b) Beri-Beri.
120. (d)
- | Vitamin         | Disease caused by deficiency |
|-----------------|------------------------------|
| B <sub>6</sub>  | Dermatitis                   |
| B <sub>1</sub>  | Beri-beri                    |
| B <sub>2</sub>  | Photophobia, glossitis       |
| B <sub>12</sub> | Pernicious anaemia           |
121. (b) Vitamin E is mainly present in vegetable oils like wheat gram oil, sunflower oil, etc.
122. (a) Vitamin A or retinol.



123. (b)
124. (c) It is found in liver, egg, milk, meat, and fish. Minute amounts are probably present in all animal cells. Peculiarly, unlike other vitamins, B<sub>12</sub> is not found in significant amounts in green plants.
125. (a) DNA consists of two polynucleotide chains, each chain forms a right handed helical spiral with ten bases in one turn of the spiral. The two chains coil to double helix and run in opposite direction held together by hydrogen bonding.
126. (d)
- 
- The hydrogen bonds are formed between the base (shown by dotted lines). Because of size and geometrics of the bases, the only possible pairing in DNA and between G(Guanine) and C(Cytosine) through three H-bonds and between A (Adenosine) and T (Thymine) through two H-bonds.
127. (a) In DNA the complimentary base are Adenine and thymine.  
Guanine and cytosine  
The genetic information for cell is contained in the sequence of bases A, T, G and C in DNA molecule.
128. (b) The DNA sequence that codes for a specific protein is called a Gene and thus every protein in a cell has a corresponding gene.
129. (c) The base pairs of the two strands of DNA are linked together through H-bonds.
130. (d) DNA has the property of self-replication. It is therefore a reproducing molecule. This unique property of DNA is at the root of all reproduction. Through its replication, **DNA acts as the key to heredity**. In the replication of DNA, the two strands of a double helix unwind and separate as a template for the formation of a new complementary strand.
131. (c) Each chromosome is made up of DNA tightly coiled many times around proteins called histones that supports its structure.
132. (a)
133. (a) DNA has double stranded  $\alpha$ -helical structure.
134. (b) DNA is responsible for transmission of heredity character.
135. (b)
136. (a) Energy is stored in our body in the form of A.T.P.
137. (d)
138. (a) Phosphoric acid is the third component in DNA.
139. (a) Synthesis of polypeptide is known as translation. For this process three type of RNA are essential.

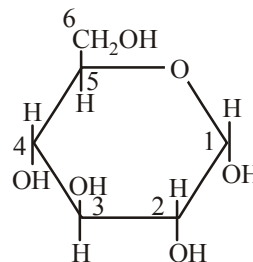
140. (d) The correct structure of thymine is



141. (c)
142. (d) Tyrosine is an  $\alpha$ -amino acid, and not a purine
143. (d)
144. (c) DNA fingerprinting is same for every cell and cannot be altered by any known treatment.

### STATEMENT TYPE QUESTIONS

145. (a)
146. (c) Sucrose is non-reducing in nature. It does not contain a free aldehydic or ketonic group. Maltose is a reducing sugar.
147. (b) Naturally occurring monosaccharides are 20 only. Sucrose is a non-reducing sugar whereas maltose is a reducing sugar.
148. (b) The six membered cyclic structure of glucose is called pyranose structure ( $\alpha$  or  $\beta$ ), in analogy with pyran. Pyran is a cyclic organic compound with one oxygen atom and five carbon atoms in the ring. The cyclic structure of glucose is correctly represented by Haworth structure.
149. (d) Sucrose is a dextrorotatory but on hydrolysis gives dextrorotatory glucose and laevorotatory fructose. Since the laevorotation of fructose ( $-92.4^\circ$ ) is more than dextrorotation of glucose ( $+52.5^\circ$ ), thus the resulting mixture is laevorotatory. Glycogen is structurally similar to amylopectin not amylose.
150. (a) For statement (i) correct Haworth structure for  $\alpha$ -D glucose will be.



151. (c) Amylose is water soluble component which constitutes about 15-20% of starch. Amylopectin is insoluble in and constitutes about 80-85% of starch.
152. (c) Glycine is optically inactive.
153. (a) Gln stands for glutamine. Except glycine, all other naturally occurring  $\alpha$ -amino acids are optically active.
154. (c) When the proteins are subjected to the action of heat, mineral acids or alkali, the water soluble form of globular protein changes to water insoluble fibrous protein. This is called denaturation of proteins. During denaturation secondary and tertiary structures of protein destroyed but primary structures remains intact.



- group, the third molecule of phenylhydrazine condenses to glucosazone. Therefore the value of X is 3

$$\begin{array}{ccc}
 \begin{array}{c} \text{CHO} + \text{H}_2\text{NNHC}_6\text{H}_5 \\ | \\ \text{CHOH} \\ | \\ (\text{CHOH})_3 \\ | \\ \text{CH}_2\text{OH} \\ \text{Glucose} \end{array} & \xrightarrow{\text{warm}} & \begin{array}{c} \text{CH} = \text{NNHC}_6\text{H}_5 \\ | \\ \text{CHOH} \\ | \\ \text{CH}(\text{OH})_3 \\ | \\ \text{CH}_2\text{OH} \\ \text{Glucose Phenylhydrazone} \end{array} \\
 & & \downarrow \text{H}_2\text{NNHC}_6\text{H}_5 \\
 \begin{array}{c} \text{CH} = \text{NNHC}_6\text{H}_5 \\ | \\ \text{C} = \text{NNHC}_6\text{H}_5 \\ | \\ \text{CH}(\text{OH})_3 \\ | \\ \text{CH}_2\text{OH} \\ \text{Glucosazone} \end{array} & \xleftarrow[\text{- H}_2\text{O}]{\text{H}_2\text{NNHC}_6\text{H}_5} & \begin{array}{c} \text{CH} = \text{NNHC}_6\text{H}_5 \\ | \\ \text{C} = \text{O} \\ | \\ (\text{CHOH})_3 \\ | \\ \text{CH}_2\text{OH} \\ \text{keto compound of glucose} \\ \text{phenyl hydrazone} \end{array}
 \end{array}$$

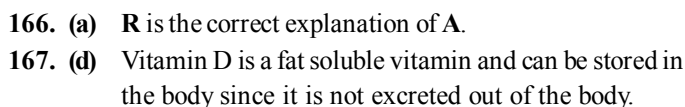
- ### ASSERTION-REASON TYPE QUESTIONS

- 170. (c)** 
$$\text{OHC} \cdot (\text{CHOH})_4 \cdot \text{CH}_2\text{OH} + 5\text{Ac}_2\text{O} \xrightarrow{\text{Au} \cdot \text{ZnCl}_2} \text{OHC} \cdot (\text{CHOAc})_4 \cdot \text{CH}_2\text{OAc}$$

Glucose

Acetic anhydride

Glucose penta-acetate  
or penta-acetyl Glucose



**171. (c)** Melting point of  $\alpha$ -glucose  $\rightarrow$  419 K and  $\beta$ -glucose is 323 K.

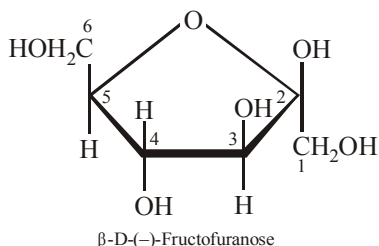
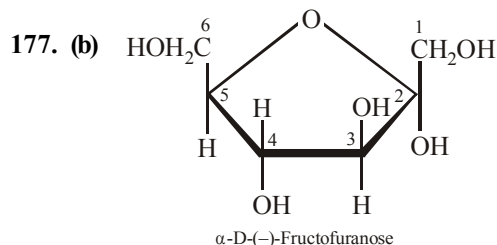
**172. (a)**  $\alpha$ -D-glucose or  $\beta$ -D-glucose when dissolved in water and allowed to stand, following equilibrium is established, which is called mutarotation.

$\alpha$ -D-glucose  $\rightleftharpoons$  Open chain form  $\rightleftharpoons$   $\beta$ -D-glucose

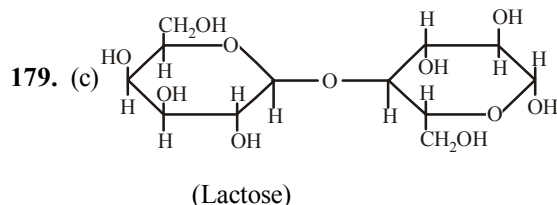
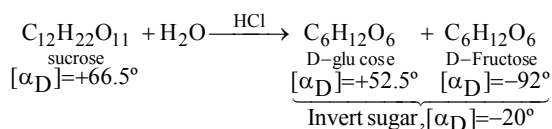
(+111°) (+19°)

- Specific rotation of  $\alpha$ -form falls until a constant value of  $+52.5^\circ$  is reached. On the other hand, specific rotation of  $\beta$  form increases. Specific rotation of equilibrium mixture is  $52.5^\circ$ .

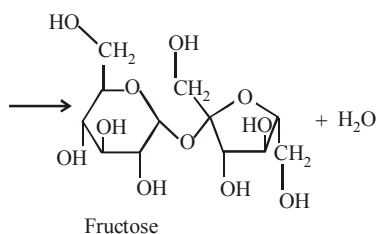
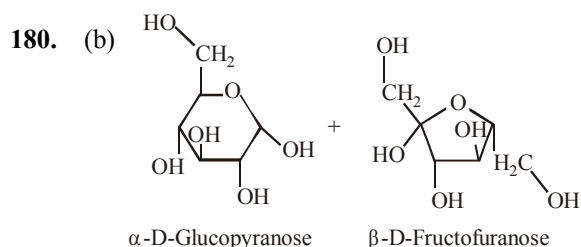
173. (b) The two monosaccharides are held together by a glycosidic linkage between C1 of  $\alpha$ -glucose and C2 of  $\beta$ -fructose. Since the reducing groups of glucose and fructose are involved in glycosidic bond formed. Sucrose is non-reducing sugar.
174. (c) Cyclic hemiacetal forms of monosaccharide which differ only in the configuration of the hydroxyl group at C1 are anomers.
175. (a)                      176. (c)



178. (c) The hydrolysis of sucrose by boiling with mineral acid or by enzyme invertase or sucrase produces a mixture of equal molecules of D(+) glucose and D(-) Fructose.

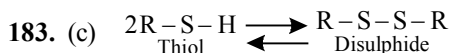


All reducing sugar shows mutarotation.

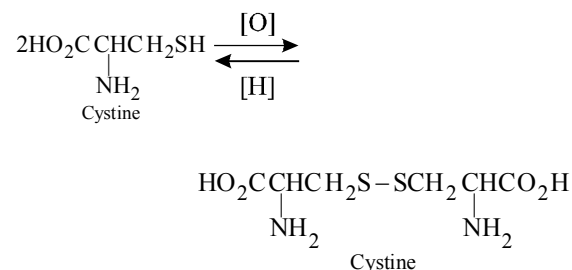


Sucrose is a disaccharide of  $\alpha$ -D-Glucopyranose and  $\beta$ -D-Fructofuranose.

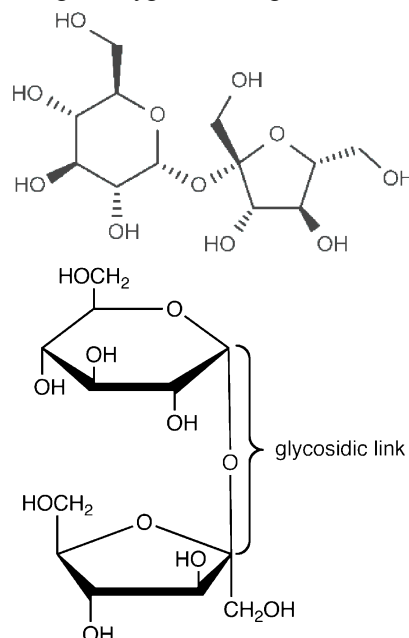
181. (c) Most of the carbohydrates have a general formula,  $\text{C}_x(\text{H}_2\text{O})_y$ , and were considered as hydrates of carbon. All the compounds which fit into this formula may not be classified as carbohydrates. Acetic acid ( $\text{CH}_3\text{COOH}$ ) fits into this general formula,  $\text{C}_2(\text{H}_2\text{O})_2$  but is not a carbohydrate. Similarly, rhamnose,  $\text{C}_6\text{H}_{12}\text{O}_5$  is a carbohydrate but does not fit in this definition. A large number of their reactions have shown that they contain specific functional groups. Chemically, the carbohydrates may be defined as optically active polyhydroxy aldehydes or ketones or the compounds which produce such units on hydrolysis.
182. (c) Valine has no functional groups on its side chain. There is only an alkyl group and so only van der Waals interactions are possible.



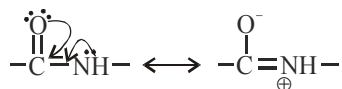
Example :



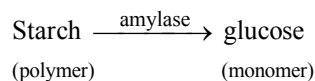
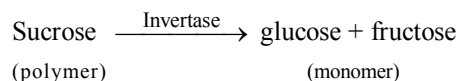
184. (b) Glycosidic linkage is actually an ether bond as the linkage forming the rings in an oligosaccharide or polysaccharide is not just one bond, but the two bonds sharing an oxygen atom e.g. sucrose



- 185. (a)** Due to resonance C — N bond in protein acquires double bond character and is smaller than usual C — N bond.

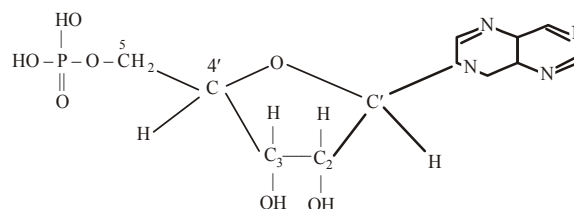


- 186. (d)** The function of enzymes in the living system is to catalyse biochemical reactions which occur in living systems. e.g. invertase, pepsin, amylase.



- 187. (a)** Vitamin C is water soluble. Therefore, it is readily excreted in urine and cannot be stored in our body and is supplied regularly in diet.

- 188. (b)** In DNA and RNA heterocyclic base and phosphate ester are at C<sub>1'</sub> and C<sub>5'</sub> respectively of the sugar molecule.





# CHAPTER 29 POLYMERS

## FACT/DEFINITION TYPE QUESTIONS

- Which is not true about polymers?
  - Polymers do not carry any charge
  - Polymers have high viscosity
  - Polymers scatter light
  - Polymers have low molecular weight
- Which of the following belongs to the class of natural polymers?
  - Proteins
  - Cellulose
  - Rubber
  - All of these
- Which of the following natural products is not a polymer?
  - DNA
  - Cellulose
  - ATP
  - Urease
- Among the following a natural polymer is
  - cellulose
  - PVC
  - teflon
  - polyethylene
- Which of the following is not a biopolymer?
  - Proteins
  - Rubber
  - Cellulose
  - RNA
- Rayon is :
  - synthetic plastic
  - natural rubber
  - natural silk
  - artificial silk
- Protein is a polymer of:
  - glucose
  - terephthalic acid
  - amino acids
  - None of these
- Natural silk is a
  - polyester
  - polyamide
  - polyacid
  - polysaccharide
- Polymers are:
  - micromolecules
  - macromolecules
  - sub-micromolecules
  - None of the above
- Which of the following is/are a semisynthetic polymers?
  - Cellulose acetate
  - Polyvinyl chloride
  - Cellulose nitrate
  - Both (a) and (c)
- Which of the following is not linear polymer?
  - Bakelite
  - Polyester
  - Cellulose
  - High density polyethene
- A polymer is formed when simple chemical units
  - combine to form long chains
  - combine to form helical chains
  - break up
  - become round
- Polymer formation from monomers starts by
  - condensation reaction between monomers
  - coordinate reaction between monomers
  - conversion of monomer to monomer ions by protons
  - hydrolysis of monomers.
- On the basis of mode of formation, polymers can be classified?
  - as addition polymers only
  - as condensation polymers only
  - as copolymers
  - both as addition and condensation polymers
- In addition polymer monomer used is
  - unsaturated compounds
  - saturated compounds
  - bifunctional saturated compounds
  - trifunctional saturated compounds
- Nylon 66 belongs to the class of
  - Addition polymer
  - Condensation polymer
  - Addition homopolymer
  - Condensation heteropolymer
- A polymer made from a polymerization reaction that produces small molecules (such as water) as well as the polymer is classified as a/an ..... polymer.
  - addition
  - natural
  - condensation
  - elimination
- In elastomer, intermolecular forces are
  - strong
  - weak
  - nil
  - None of these
- A thermoplastic among the following is
  - bakelite
  - polystyrene
  - terylene
  - urea-formaldehyde resin
- Which is an example of thermosetting polymer?
  - Polythene
  - PVC
  - Neoprene
  - Bakelite

21. Which of the following is thermoplastic ?  
(a) Bakelite (b) Polyethylene  
(c) Terylene (d) All of these
22. Thermosets are:  
(a) cross-linked polymers  
(b) don't melt or soften on heating  
(c) cross-linking is usually developed at the time of moulding where they harden reversibly  
(d) all of the above
23. Which is/are true for elastomers?  
(a) These are synthetic polymers possessing elasticity  
(b) These possess very weak intramolecular forces or attractions between polymer chains  
(c) Vulcanised rubber is an example of elastomer  
(d) All of the above
24. Among the following polymers the strongest molecular forces are present in  
(a) elastomers (b) fibres  
(c) thermoplastics (d) thermosetting polymers
25. Three dimensional molecular structure with cross links are formed in the case of a  
(a) thermoplastic (b) thermosetting plastic  
(c) Both (a) and (b) (d) None of the above
26. Which of the following polymer is an example of fibre ?  
(a) Silk (b) Dacron  
(c) Nylon-66 (d) All of these
27. Which of the following statements is not correct for fibres?  
(a) Fibres possess high tensile strength and high modulus.  
(b) Fibres impart crystalline nature.  
(c) Characteristic features of fibres are due to strong intermolecular forces like hydrogen bonding.  
(d) All are correct.
28. Which of the following is/are examples of fibres?  
(a) Polyesters (b) Polyamide  
(c) Polythene (d) Both (a) and (b)
29. Which of the following can be repeatedly soften on heating?  
(i) Polystyrene (ii) Melamine  
(iii) Polyesters (iv) Polyethylene  
(v) Neoprene  
(a) (i) and (iii) (b) (i) and (iv)  
(c) (iii), (iv) and (v) (d) (ii) and (iv)
30. Which of the following does not undergo addition polymerization?  
(a) Vinylchloride  
(b) Butadiene  
(c) Styrene  
(d) All of the above undergoes addition polymerizations
31. Which of the following is a cross linked polymer?  
(a) PVC (b) Bakelite  
(c) Polyethylene (d) Rubber
32. Fibres that have good resistance to stains, chemicals, insects and fungi is  
(a) Acrylic (b) Terylene  
(c) Nylon (d) All of these
33. Which of the following statements is not true about low density polythene?  
(a) Tough  
(b) Hard  
(c) Poor conductor of electricity  
(d) Highly branched structure
34. Low density polythene is prepared by  
(a) Free radical polymerisation  
(b) Cationic polymerisation  
(c) Anionic polymerisation  
(d) Ziegler-Natta polymerisation
35. The monomer of teflon is  
(a)  $\text{CHF}=\text{CH}_2$  (b)  $\text{CF}_2=\text{CF}_2$   
(c)  $\text{CHCl}=\text{CHCl}$  (d)  $\text{CHF}=\text{CHCl}$
36. The monomer(s) used in the preparation of Orlon, a substitute for wool is/are  
(a) caprolactam  
(b) tetrafluoroethene  
(c) styrene and 1, 3-butadiene  
(d) acrylonitrile
37. Orlon is a polymer of  
(a) styrene (b) tetrafluoroethylene  
(c) vinyl chloride (d) acrylonitrile
38. Which of the following polymer is used for manufacturing of buckets, dustbins, pipes etc ?  
(a) Low density polythene  
(b) High density polythene  
(c) Teflon  
(d) Polyacrylonitrile
39. Which of the following catalyst is used in preparation of high density polythene ?  
(a) Peroxide catalyst  
(b) Ziegler - Natta catalyst  
(c) Wilkinson's catalyst  
(d) Pd - catalyst
40. Which of the following statements is false?  
(a) Artificial silk is derived from cellulose.  
(b) Nylon-66 is an example of elastomer.  
(c) The repeat unit in natural rubber is isoprene.  
(d) Both starch and cellulose are polymers of glucose.
41. Melamine plastic crockery is a copolymer of:  
(a) HCHO and melamine (b) HCHO and ethylene  
(c) melamine and ethylene (d) None of these
42. Caprolactam polymerises to give  
(a) terylene (b) teflon  
(c) glyptal (d) nylon-6
43. Nylons, polysters and cotton, all posses strength due to:  
(a) intermolecule H-bonding  
(b) van der Waals' attraction  
(c) dipole-dipole interaction  
(d) None of the above



44. Nylon 66 is a polyamide obtained by the reaction of  
 (a)  $\text{COOH}(\text{CH}_2)_4\text{COOH} + \text{NH}_2\text{C}_6\text{H}_4\text{NH}_2$   
 (b)  $\text{COOH}(\text{CH}_2)_4\text{COOH} + \text{NH}_2(\text{CH}_2)_6\text{NH}_2$   
 (c)  $\text{COOH}(\text{CH}_2)_6\text{COOH} + \text{NH}_2(\text{CH}_2)_4\text{NH}_2$   
 (d)  $\text{COOHC}_6\text{H}_4\text{COOH}-(p) + \text{NH}_2(\text{CH}_2)_6\text{NH}_2$

45. Interparticle forces present in nylon-66 are  
 (a) van der waal's  
 (b) hydrogen bonding  
 (c) dipole-dipole interactions  
 (d) None of these

46. The plastic household crockery is prepared by using  
 (a) melamine and tetrafluoroethane  
 (b) malonic acid and hexamethyleneamine  
 (c) melamine and vinyl acetate  
 (d) melamine and formaldehyde

47. Which of the following is currently used as a tyre cord ?  
 (a) Terylene (b) Polyethylene  
 (c) Polypropylene (d) Nylon - 6

48. Of the following which one is classified as polyester polymer ?  
 (a) Terylene (b) Bakelite  
 (c) Melamine (d) Nylon-66

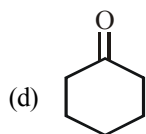
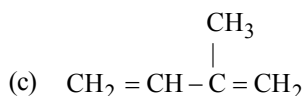
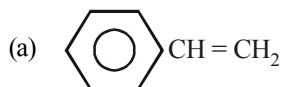
49. Which one of the following is not a condensation polymer ?  
 (a) Melamine (b) Glyptal  
 (c) Dacron (d) Neoprene

50. Bakelite is obtained from phenol by reacting with  
 (a)  $(\text{CH}_2\text{OH})_2$  (b)  $\text{CH}_3\text{CHO}$   
 (c)  $\text{CH}_3\text{COCH}_3$  (d)  $\text{HCHO}$

51. The polymer containing strong intermolecular forces e.g. hydrogen bonding, is  
 (a) teflon (b) nylon 6, 6  
 (c) polystyrene (d) natural rubber

52. Nylon threads are made of  
 (a) polyester polymer (b) polyamide polymer  
 (c) polyethylene polymer (d) polyvinyl polymer

53. Which compound/set of compounds is used in the manufacture of nylon 6?

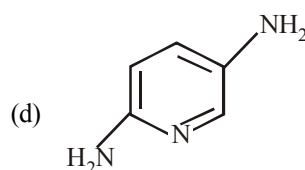
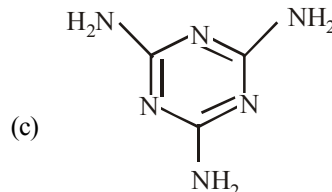
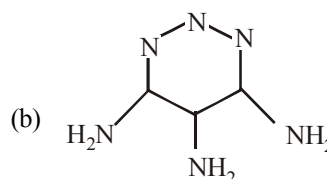
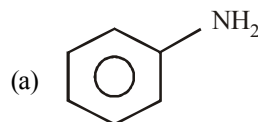


54. The repeating unit present in Nylon 6 is  
 (a)  $-\text{[NH}(\text{CH}_2)_6\text{NHCO}(\text{CH}_2)_4\text{CO]}-$   
 (b)  $-\text{[CO}(\text{CH}_2)_5\text{NH]}-$   
 (c)  $-\text{[CO}(\text{CH}_2)_6\text{NH]}-$   
 (d)  $-\text{[CO}(\text{CH}_2)_4\text{NH]}-$

55. Which of the following polymer is a polyamide ?

- (a) Terylene (b) Nylon  
 (b) Rubber (d) Vulcanised rubber

56. Which of the following compound is used for preparation of melamine formaldehyde polymer ?



57. Acetic acid is added in the preparation of Nylon-6 due to  
 (a) initiate polymerisation  
 (b) avoid polymerisation at first step  
 (c) avoid oxidation  
 (d) removal of water

58. The bakelite is made from phenol and formaldehyde. The initial reaction between the two compounds is an example of:

- (a) aromatic electrophilic substitution  
 (b) aromatic nucleophilic substitution  
 (c) free radical reaction  
 (d) aldol reaction

59. Melamine plastic crockery is a codensation polymer of

- (a)  $\text{HCHO}$  and melamine  
 (b)  $\text{HCHO}$  and ethylene  
 (c) melamine and ethylene  
 (d) None of these

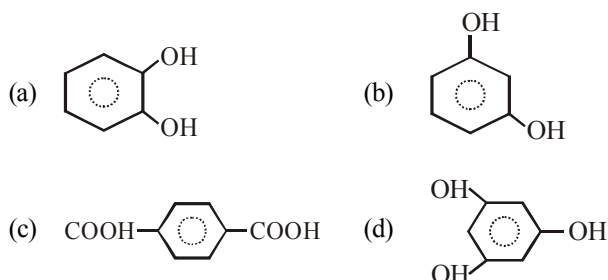
60. Which of the following polymer is used for making phonograph records ?

- (a) Bakelite (b) Dacron  
 (c) Teflon (d) PVC

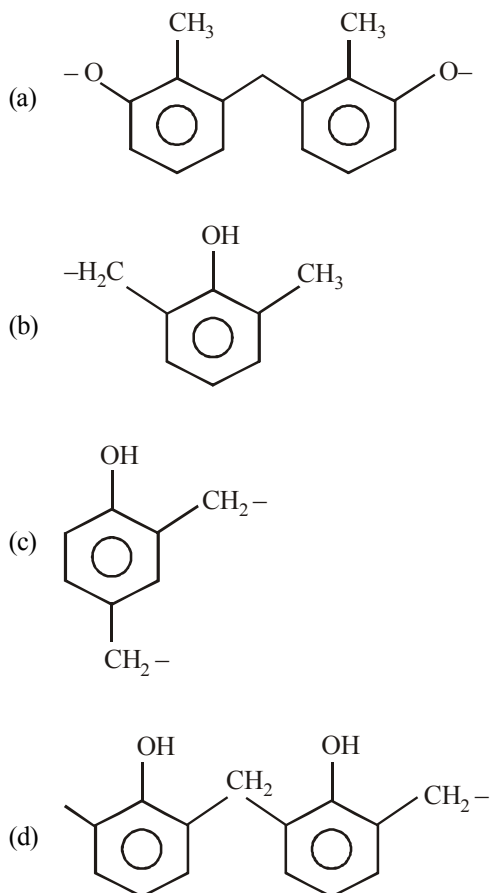
61. Novolac is

- (a) cross-linked polymer (b) linear polymer  
 (c) addition polymer (d) synthetic rubber

62. Dacron is a –  
 (a) crease resistant  
 (b) polyamide  
 (c) addition polymer  
 (d) polymer of ethylene glycol and phthalic acid
63. The monomeric units of terylene are glycol and which of the following



64. Which of the following is novolac ?



65. Soft drinks and baby feeding bottles are generally made up of  
 (a) Polystyrene (b) Polyurethane  
 (c) Polyurea (d) Polyamide
66. Which is not an example of copolymer ?  
 (a) SAN (b) ABS  
 (c) Saran (d) PVC

67. Which of the following is an use of butadiene – styrene copolymer?  
 (a) Manufacture of autotyres  
 (b) Footwear components  
 (c) Cable insulation  
 (d) All of these

68. A homopolymer is obtained by polymerisation of:  
 (a) one type of monomer units  
 (b) two types of monomer units  
 (c) either of the above  
 (d) None of the above

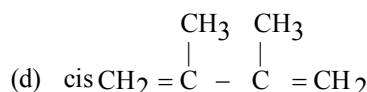
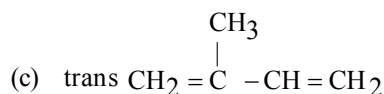
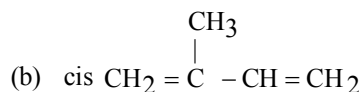
69. A copolymer of isobutylene and isoprene is called:  
 (a) align butyl rubber (b) buna-S  
 (c) buna-N (d) thiokol
70. Which one is a homopolymer?  
 (a) Bakelite (b) Nylon  
 (c) Terylene (d) Neoprene

71. Polymerisation in which two or more chemically different monomers take part is called:  
 (a) addition polymerisation  
 (b) copolymerisation  
 (c) chain polymerisation  
 (d) homo polymerisation

72. Natural rubber is a polymer of  
 (a) butadiene (b) isoprene  
 (c) 2-methylbutadiene (d) hexa-1, 3-diene
73. Which one of the following statement is *not true*?

- (a) In vulcanization the formation of sulphur bridges between different chains make rubber harder and stronger.  
 (b) Natural rubber has the *trans* -configuration at every double bond  
 (c) Buna-S is a copolymer of butadiene and styrene  
 (d) Natural rubber is a 1, 4 - polymer of isoprene

74. Natural rubber is polymer of  
 (a)  $\text{CH}_2 = \text{CH} - \text{Cl}$



75. Which of the following is not the property of natural rubber  
 (a) Low tensile strength  
 (b) High water absorption capacity  
 (c) Soft and sticky  
 (d) High elasticity

76. Natural rubber is  
 (a) all trans polyisoprene (b) all cis-polyisoprene  
 (c) chloroprene (d) Buna-N
77. The process involving heating of rubber with sulphur is called  
 (a) Galvanisation (b) Vulcanization  
 (c) Bessemerisation (d) Sulphonation
78. Isoprene is a valuable substance for making  
 (a) propene (b) liquid fuel  
 (c) synthetic rubber (d) petrol
79. Synthetic polymer which resembles natural rubber is :  
 (a) neoprene (b) chloroprene  
 (c) glyptal (d) nylon
80. Synthetic rubber is:  
 (a) polyester (b) polyamide  
 (c) polysaccharide (d) poly(halodiene)
81. Which of the following are example of synthetic rubber?  
 (i) Polychloroprene (ii) polyacrylonitrile  
 (iii) Buna-N (iv) cis-polyisoprene  
 (a) (i) and (iii) (b) (i) and (ii)  
 (c) (iii) and (iv) (d) (ii) and (iii)
82. Buna-N synthetic rubber is a copolymer of :  
 (a)  $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$  and  $\text{H}_5\text{C}_6-\text{CH}=\text{CH}_2$   
 (b)  $\text{H}_2\text{C}=\text{CH}-\text{CN}$  and  $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$   
 (c)  $\text{H}_2\text{C}=\text{CH}-\text{CN}$  and  $\text{H}_2\text{C}=\text{CH}-\underset{\text{CH}_3}{\text{C}}=\text{CH}_2$   
 (d)  $\text{H}_2\text{C}=\text{CH}-\underset{\text{Cl}}{\text{C}}=\text{CH}_2$  and  $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$
83. Which of the following structures represents neoprene polymer?  
 (a)  $\left\{ \text{CH}_2 - \underset{\text{Cl}}{\text{C}} = \text{CH} - \text{CH}_2 \right\}_n$   
 (b)  $\left\{ \text{CH}_2 - \underset{\text{CN}}{\text{CH}} \right\}_n$   
 (c)  $\left\{ \text{CH}_2 - \underset{\text{Cl}}{\text{CH}} \right\}_n$   
 (d)  $\left\{ \text{CH} - \text{CH}_2 \right\}_n$   
 $\underset{\text{C}_6\text{H}_5}{|}$
84. Which of the following is not a copolymer?  
 (a) Buna-S (b) Bakelite  
 (c) Neoprene (d) Dacron
85. In the manufacture of tyre rubber, the percentage of sulphur used as a crosslinking agent is  
 (a) 2% (b) 5%  
 (c) 10% (d) 0.5%

86. Which of the following polymer is formed on reaction of 1,3-butadiene and acrylonitrile?  
 (a) Buna-S (b) Buna-N  
 (c) Neoprene (d) Dacron
87. Which of the following monomers form biodegradable polymers?  
 (a) 3-hydroxybutanoic acid + 3-hydroxypentanoic acid  
 (b) Glycine + amino caproic acid  
 (c) Ethylene glycol + phthalic acid  
 (d) both (a) and (b)
88. The polymer which undergoes environment degradation by microorganism is known as  
 (a) chain-growth polymer  
 (b) chain step polymer  
 (c) biodegradable polymer  
 (d) non-biodegradable polymer
89. Generally, molecular mass of a polymer is over  
 (a) 100 (b) 500  
 (c) 1,000 (d) 10,000
90. For natural polymers PDI is generally  
 (a) 0 (b) 1  
 (c) 100 (d) 1000

### STATEMENT TYPE QUESTIONS

91. Which of the following statement(s) is/are correct?  
 (i) Macromolecules have high molecular mass of order  $10^3 - 10^7 \text{u}$ .  
 (ii) Monomeric units are joined together by ionic or covalent bond.  
 (a) Only (i) (b) Only (ii)  
 (c) Both (i) and (ii) (d) Neither (i) nor (ii)
92. Consider the following statements.  
 (i) Polystyrene is a homopolymer whereas Buna-N is a copolymer.  
 (ii) Condensation polymers can be obtained by condensation between two similar bi-functional monomeric units.  
 (iii) Elastomers are the polymers in which the polymeric chains are held together by the weakest intermolecular forces.  
 (iv) Buna-S and Buna-N consist of close packing of chains which impart them crystalline nature.  
 Which of the following is the correct code for the statements above?  
 (a) TFFF (b) TFTF  
 (c) FTFT (d) TFFT
93. Two condensation polymers are made  
 (1) ethylene diamine + ethane-1, 2- dicarboxylic acid  
 (2) trimethylenediamine + ethane-1, 2- dicarboxylic acid  
 if both polymers of same molecular weight are obtained then which of the following statements is/are correct ?  
 (i) Polymer (1) is found to melt at lower temperature.  
 (ii) Polymer (2) is found to melt at lower temperature.  
 (iii) H-bonding is major factor.  
 (a) (i), (ii) and (iii) (b) Only (ii)  
 (c) (i) and (iii) (d) (ii) and (iii)

94. Which of the following statements are correct?
- A polyamide nylon 6,6 prepared by the condensation polymerisation of hexamethylene diamine with adipic acid is used in the manufacture of tyre cords.
  - Terylene is crease resistant and is blended with cotton and wool fibres for various applications.
  - Condensation reaction of phenol and formaldehyde to form novolac can be catalysed either by acid or base.
  - Melamine formaldehyde polymer is mainly used in the manufacture of electrical switches
- (i), (ii) and (iii)
  - (ii), (iii) and (iv)
  - (iii) and (iv)
  - (ii) and (iii)
95. Read the following statements.
- Rubber latex is a colloidal dispersion of rubber in water.
  - Natural rubber is a cis -1, 4-polyisoprene having elastic properties due to coiled structure and weak van der Waal's forces.
  - Vulcanisation of natural rubber with sulphur and an appropriate additive is carried out above 415K.
  - In the manufacture of tyre rubber, 5% of sulphur is used as a cross-linking agent.
  - Synthetic rubbers are homopolymers.
- Which of the following is the correct code for the statements above?
- FFTFT
  - TTFTF
  - TTFFF
  - FFTTF
96. Which of the following statements are correct?
- Buna-N being resistant to the action of petrol, lubricating oil and organic solvents is used in making oil seals.
  - Biodegradable polymers are manufactured because of low chemical resistance, strength and durability of conventional polymers.
  - PHBV is a copolymer used in the manufacture of orthopaedic devices.
  - Nylon 2-nylon 6 is a biodegradable polymer.
- (i), (ii) and (iii)
  - (ii), (iii) and (iv)
  - (i), (iii) and (iv)
  - (i) and (iv)

### MATCHING TYPE QUESTIONS

97. Match the columns.

Column-I	Column-II
(A) Linear polymer	(p) Melamine
(B) Semisynthetic polymer	(q) Polyvinyl chloride
(C) Branched chain polymer	(r) LDPE
(D) Network polymer	(s) Cellulose nitrate
(a) A-(s), B-(q), C-(r), D-(p)	
(b) A-(q), B-(s), C-(r), D-(p)	
(c) A-(q), B-(r), C-(s), D-(p)	
(d) A-(q), B-(s), C-(p), D-(r)	

98. Match the columns.

Column-I	Column-II
(A) Highly branched chemically inert polymer used in the insulation of electric wires.	(p) Teflon
(B) Linear polymer prepared in presence of $\text{Al}(\text{C}_2\text{H}_5)_3$ and $\text{TiCl}_4$ .	(q) Polyacrylonitrile
(C) Corrosion resistant polymer used in manufacture of non-stick surface coated utensils.	(r) HDPE
(D) Addition polymer used as a substitute for wool.	(s) LDPE
(a) A-(s), B-(r), C-(q), D-(p)	
(b) A-(s), B-(p), C-(r), D-(q)	
(c) A-(s), B-(r), C-(p), D-(q)	
(d) A-(r), B-(s), C-(p), D-(q)	

99. Match Column-I (Monomer) with Column-II (Polymer) and select the correct answer using the codes given below the lists:

Column-I	Column-II
(A) Hexamethylenediamine	(p) Bakelite
(B) Phenol	(q) Dacron
(C) Phthalic acid	(r) Glyptal
(D) Terephthalic acid	(s) Melamine
	(t) Nylon
(a) A-(t), B-(p), C-(q), D-(r)	
(b) A-(t), B-(p), C-(r), D-(q)	
(c) A-(s), B-(r), C-(p), D-(q)	
(d) A-(s), B-(r), C-(q), D-(p)	

100. Match the columns

Column-I	Column-II
(A) Polyester of glycol and phthalic acid	(p) Novalac
(B) Copolymer of 1, 3-butadiene and styrene	(q) Glyptal
(C) Phenol and formaldehyde resin	(r) Buna-S
(E) Polyester of glycol and terephthalic acid	(s) Buna-N
(F) Copolymer of 1, 3-butadiene and acrylonitrile	(t) Dacron
(a) A-(q), B-(s), C-(p), D-(t), E-(r)	
(b) A-(q), B-(r), C-(p), D-(t), E-(s)	
(c) A-(r), B-(p), C-(t), D-(s), E-(q)	
(d) A-(p), B-(s), C-(q), D-(t), E-(r)	

101. Match the polymers given in Column-I with their chemical names given in Column-II

**Column-I**

- (A) Nylon 6  
(B) PVC  
(C) Acralin  
(D) Natural rubber  
(E) LDP

**Column-II**

- (p) Polyvinyl chloride  
(q) Polyacrylonitrile  
(r) Polycaprolactum  
(s) Low density polythene  
(t) cis-polyisoprene

- (a) A – (r), B – (p), C – (q), D – (t), E – (s)  
(b) A – (s), B – (q), C – (t), D – (r), E – (p)  
(c) A – (t), B – (s), C – (p), D – (q), E – (r)  
(d) A – (s), B – (t), C – (r), D – (q), E – (p)

102. Match the columns

**Column-I (Polymers)**

- (A) Nylon 6,6  
(B) Nylon 6  
(C) Dacron  
(D) Bakelite

**Column-II (Uses)**

- (p) Fabrics and ropes  
(q) Electrical switches  
(r) Bristles for brushes  
(s) As glass reinforcing materials in safety helmets.

- (a) A – (q), B – (s), C – (r), D – (p)  
(b) A – (r), B – (q), C – (s), D – (p)  
(c) A – (r), B – (p), C – (s), D – (q)  
(d) A – (r), B – (p), C – (q), D – (s)

103. Match the columns

**Column-I**

- (A) Polymer of styrene  
  
(B) Polymer of ethylene glycol and phthalic acid  
(C) Polymer of phenol and formaldehyde  
(D) Polymer of vinyl chloride

**Column-II**

- (p) used in making handles of utensils and computer discs  
(q) used as an insulator  
(r) used in making paints and lacquers.  
(s) used in manufacture of rain coats and flooring.

- (a) A – (q), B – (r), C – (p), D – (s)  
(b) A – (r), B – (q), C – (p), D – (s)  
(c) A – (q), B – (p), C – (r), D – (s)  
(d) A – (q), B – (r), C – (s), D – (p)

**ASSERTION-REASON TYPE QUESTIONS**

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
(c) Assertion is correct, reason is incorrect  
(d) Assertion is incorrect, reason is correct.

104. **Assertion :** Olefinic monomers undergo addition polymerisation.

**Reason :** Polymerisation of vinylchloride is initiated by peroxides/ persulphates.

105. **Assertion :** Teflon has high thermal stability and chemical inertness.

**Reason :** Teflon is a thermoplastic.

106. **Assertion :** Bakelite is a thermosetting polymer.

**Reason :** Bakelite can be melted again and again without any change.

107. **Assertion :** In vulcanisation of rubber, sulphur cross links are introduced.

**Reason :** Vulcanisation is a free radical initiated chain reaction.

108. **Assertion :** The time of vulcanisation and temperature is increased by adding accelerators.

**Reason :** By vulcanising, a material of high tensile strength can be obtained.

109. **Assertion :** Most of the Synthetic polymers are not biodegradable.

**Reason :** Polymerisation process induces toxic character in organic molecules.

**CRITICAL THINKING TYPE QUESTIONS**

110. The polymer containing strong intermolecular forces *e.g.* hydrogen bonding, is

- (a) teflon (b) nylon 6, 6  
(c) polystyrene (d) natural rubber

111. Among cellulose, poly (vinyl chloride), nylon and natural rubber, the polymer in which the intermolecular force of attraction is weakest is

- (a) nylon (b) poly(vinyl chloride)  
(c) cellulose (d) natural rubber

112. Which one of the following polymers is prepared by condensation polymerisation?

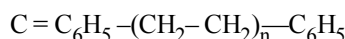
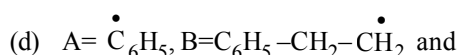
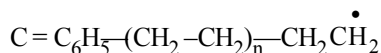
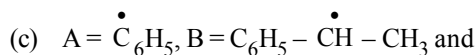
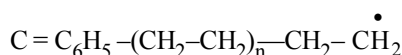
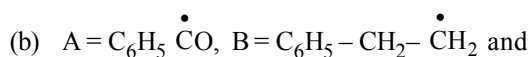
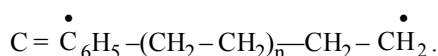
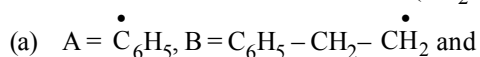
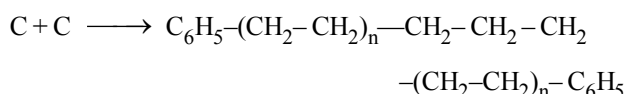
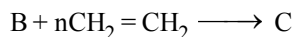
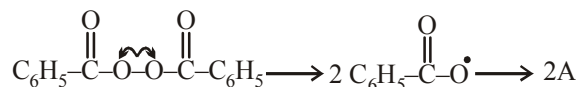
- (a) Teflon (b) Natural rubber  
(c) Styrene (d) Nylon-66

113. When condensation product of hexamethylenediamine and adipic acid is heated to 525K in an atmosphere of nitrogen for about 4-5 hours, the product obtained is

- (a) solid polymer of nylon 66  
(b) liquid polymer of nylon 66  
(c) gaseous polymer of nylon 66  
(d) liquid polymer of nylon 6



114. Identify A, B and C in the following sequence of reactions



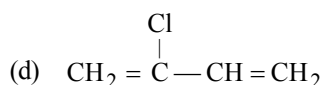
115. In which of the following the formation of radical was found to be more stable; the formation of radical of (acrylonitrile)

or  $[\text{CH}_2-\text{CH}_2]_n$  (ethene).

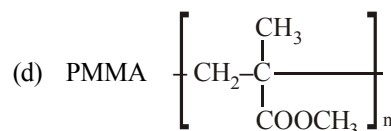
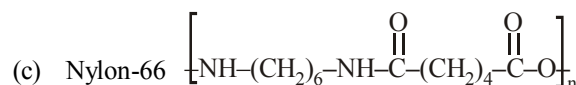
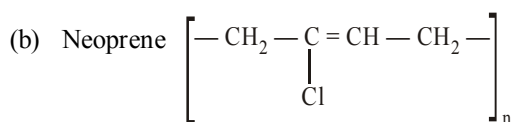
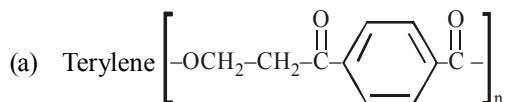
- (a) Both are equally stable (b) Acrylonitrile.  
(c) Ethene (d) Cannot say

116. Which one of the following monomers gives the polymer neoprene on polymerization ?

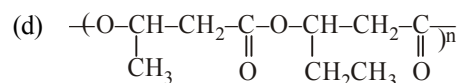
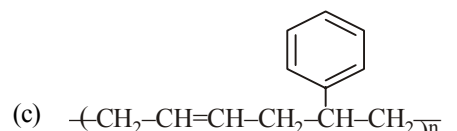
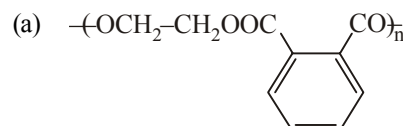
- (a)  $\text{CF}_2 = \text{CF}_2$   
(b)  $\text{CH}_2 = \text{CHCl}$   
(c)  $\text{CCl}_2 = \text{CCl}_2$



117. Which of the following is not correctly matched?



118. In which of the following polymers ethylene glycol is one of the monomer units?



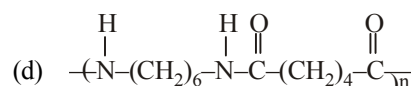
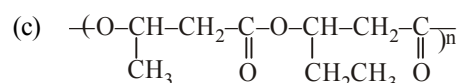
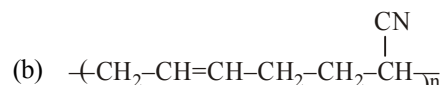
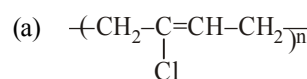
119. Arrange the following in increasing order of their melting point. Nylon 2,2 (1); Nylon 2,4 (2); Nylon 2,6 (3); Nylon 2,10(4)

- (a) 1, 2, 3, 4 (b) 3, 4, 2, 1  
(c) 2, 1, 3, 4 (d) 4, 3, 2, 1

120. Which of the following rubber is not a polydiene?

- (a) Polyisoprene (b) Polychloroprene  
(c) Thiokol rubber (d) Nitrile rubber

121. Which of the following polymer is biodegradable?



122. The mass average molecular mass & number average molecular mass of a polymer are 40,000 and 30,000 respectively. The polydispersity index of polymer will be

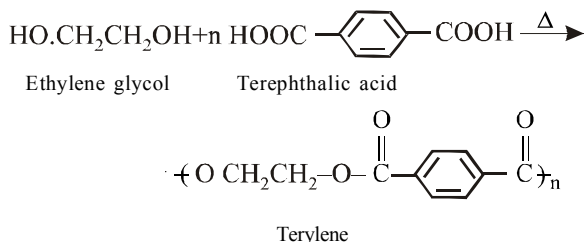
- (a) < 1 (b) > 1  
(c) 1 (d) 0

# HINTS AND SOLUTIONS

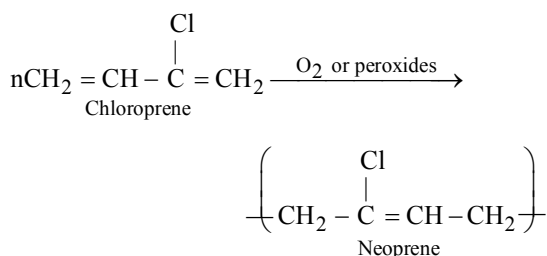
## FACT/DEFINITION TYPE QUESTIONS

1. (d)
  2. (d) All these are natural polymers and exist in nature.
  3. (c) ATP is a monomer molecule.
  4. (a) It is present in the cell wall of plant cell.
  5. (b) Since proteins, cellulose and RNA control various activities of plants and animals, they are called biopolymers.
  6. (d) Rayon is a manufactured from regenerated cellulosic fiber. Rayon is produced from naturally occurring polymers and therefore it is not a truly synthetic fiber, nor is it a natural fiber. It is known by the names *viscose rayon* and *artificial silk* in the textile industry. So, option (d) is the correct choice.
  7. (c) Protein is a natural polymer of amino acids.
  8. (b)
  9. (b) Polymers are substances of high molecular weight (usually more than a few thousand) formed by the union of small molecular weight substances by covalent bonds.
  10. (d) Cellulose acetate also known as rayon and cellulose nitrate are semisynthetic polymers.
  11. (a) 12. (a)
  13. (a) Polymerisation starts either by condensation or addition reactions between monomers. Condensation polymers are formed by the combination of monomers with the elimination of simple molecules. Whereas the addition polymers are formed by the addition together of the molecules of the monomer or monomers to form a large molecule without elimination of anything.
  14. (d) 15. (a) 16. (d) 17. (c)
  18. (b) Elastomers are the polymers having very weak intermolecular forces of attraction between the polymer chain. The weak forces permit the polymer to be stretched.
  19. (b) Those polymers in which process of heat softening and cooling can be repeated as many times as desired. Example : polystyrene PVC, teflon, etc.
  20. (c) Bakelite is a thermosetting polymer. On heating it is infusible and cannot be remoulded.
  21. (b)
  22. (d) These are characteristics of thermosets.
  23. (d) All these are characteristics of elastomers.
  24. (d) Thermosetting polymers have strongest molecular forces. These are crosslinked polymers.
  25. (b) Thermosetting plastics have three dimensional cross linked structure.
  26. (d) Silk is protein fibre. Dacron is polyester fibre and Nylon-66 is polyamide fibre.
  27. (d) All the given statements about fibres are correct.
  28. (d) Both polyesters and polyamides are examples of fibres.
  29. (b) Polystyrene and polyethylene belong to the category of thermoplastic polymers which are capable of repeatedly softening on heating and harden on cooling.
  30. (d) Vinyl chloride, butadiene and styrene being unsaturated undergoes addition polymerization.
  31. (b) 32. (a) 33. (c)
  34. (a) Ethene on free radical polymerisation gives low density polythene.
  35. (b) Monomer of teflon is to Tetrafluoro ethylene  $C_2F_4$ .
  36. (d) Acrylonitrile is the monomer used in the preparation of orlon.
  37. (d) Orlon is a trade name of polyacrylonitrile
  38. (b) High density polythene is used for manufacturing of buckets, dustbins, pipes etc.
  39. (b) High density polythene is formed when addition polymerisation of ethene takes place in a hydrocarbon solvent in presence of catalyst such as ziegler-natta catalyst.
  40. (b) Nylon-66 is an example of first synthetic fibres produced from the simple molecules. It is prepared by condensation polymer-isation of adipic acid and hexamethylene diamine.
  41. (a) Melamine plastic crockery is a copolymer of HCHO and Melamine.
  42. (d) 43. (a)
  44. (b)  $nHOOC(CH_2)_4COOH + nH_2N(CH_2)_6NH_2$   
adipic acid Hexamethylene diamine
- $$\xrightarrow[\text{Polymerisation}]{525K} \left[ -\overset{\overset{O}{||}}{C} - (CH_2)_4 - \overset{\overset{O}{||}}{C} - NH - (CH_2)_6 - NH - \right]_n$$
- Nylon 6, 6
45. (b)
  46. (d) The unbreakable plastic household crockery is made from copolymer of formaldehyde (HCHO) and melamine.
- $$\begin{array}{c} \text{H}_2\text{N} \quad \text{N} \quad \text{NH}_2 \\ \diagdown \quad \diagup \\ \text{N} \quad \text{C} \quad \text{N} \\ \diagup \quad \diagdown \\ \text{N} \quad \text{C} \quad \text{N} \\ \diagdown \quad \diagup \\ \text{NH}_2 \end{array} + \text{HCHO} \xrightarrow{\text{Polymerisation}} \text{Melamine polymer}$$
- formaldehyde
- Melamine
47. (d) Nylon tyre cord is made from high tenacity continuous filament yarn by twisting and plying.

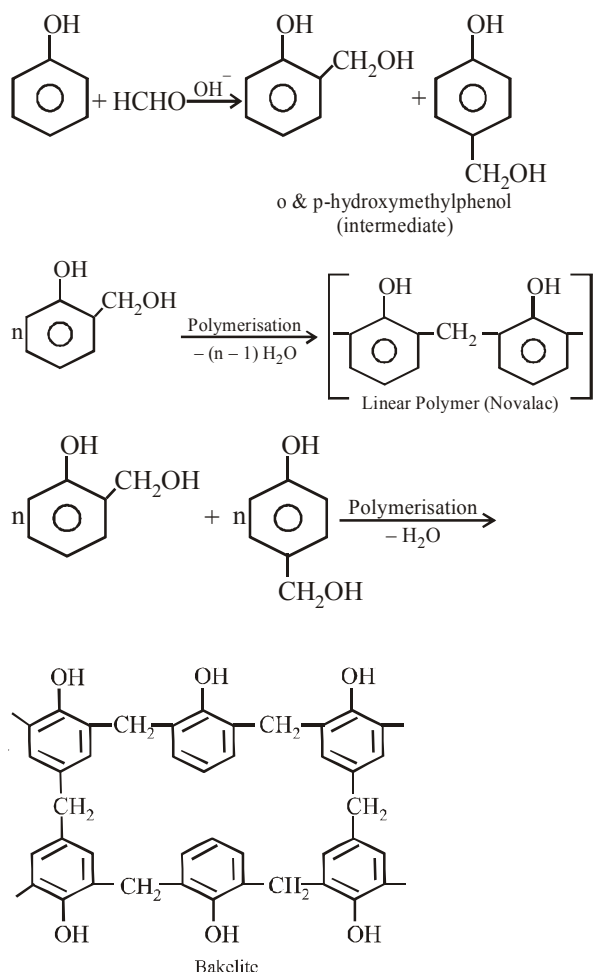
48. (a) Polyesters are condensation polymers of a dibasic acid and a diol. e.g., Terylene



49. (d) Neoprene is an addition polymer of isoprene.

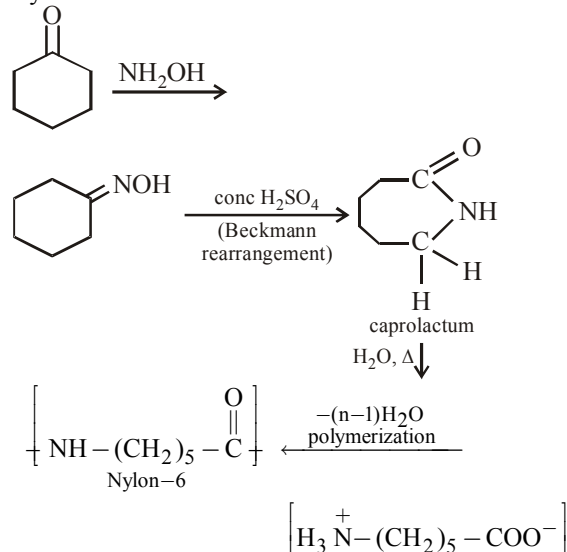


50. (d) Phenol and formaldehyde undergo condensation polymerisation under two different conditions to give a cross linked polymer called bakelite.

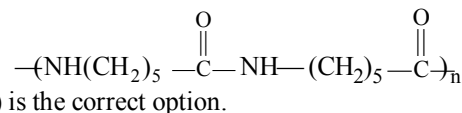


51. (b) Nylon 6, 6 has amide linkage capable of forming hydrogen bonding.  
52. (b) Nylon is a polyamide polymer.

53. (d) Nylon-6 can be manufactured from



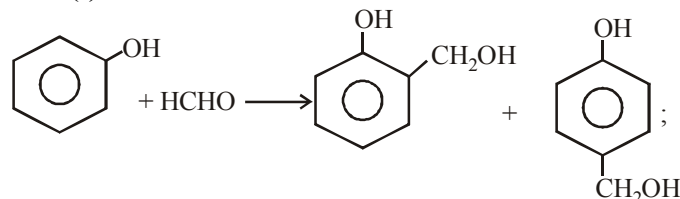
54. (b) Nylon 6 is



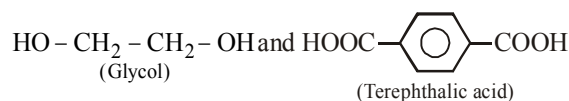
55. (b) Nylon is a polyamide fibre. It is prepared by the condensation polymerisation of adipic acid ( $\text{HOOC}(\text{CH}_2)_4\text{COOH}$ ) and hexamethylene diamine ( $\text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2$ ).

56. (c) 57. (b)

58. (a)



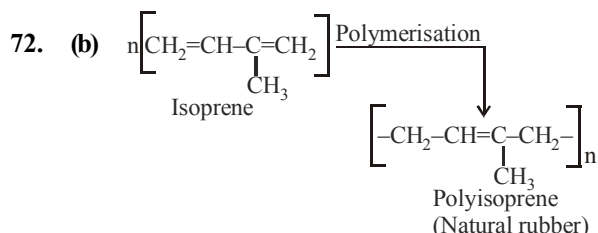
59. (a) Melamine plastic crockery is a copolymer of HCHO and Melamine.  
60. (a) Bakelite is used for making phonograph records.  
61. (b) Novolac is a linear polymer.  
62. (a) Dacron is a polyester and is the condensation polymer of ethylene glycol and terephthalic acid. It is crease resistant  
63. (c) Terylene is made from glycol and Terephthalic acid



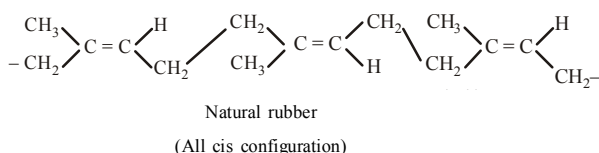
64. (d) 65. (a) 66. (d)  
67. (d) Butadiene - styrene copolymer is used for the manufacture of autotyres, floortiles, footwear components, cable insulation etc.  
68. (a) This is definition of homopolymer.  
69. (a) Butyl rubber is a copolymer of isobutylene and isoprene.

70. (d) Neoprene is a homopolymer of 2-chloro-but-1, 3-diene or chloroprene.

71. (b) It is the definition of copolymerisation.



73. (b)



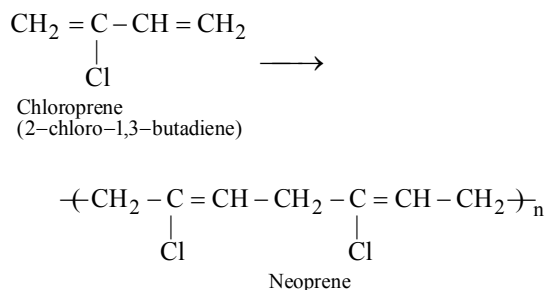
All statements except (b) are correct

74. (b) Natural rubber is a linear 1, 4-addition polymer of isoprene (2-methyl-1, 3-butadiene).

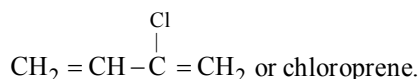
75. (d) 76. (b) 77. (b)

78. (c) Rubber is a polymer of isoprene. Its chemical formula is  $(\text{C}_5\text{H}_8)_n$ .

79. (a) Neoprene is a synthetic polymer that resembles natural rubber. Neoprene is a polymer of chloroprene which polymerises 700 times faster than the isoprene (monomer of natural rubber) and no specific catalyst is needed for this purpose.



80. (d) Synthetic rubber (neoprene) is a polymer of



81. (a)

82. (b) Buna - N is a copolymer of butadiene  $(\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2)$  and acrylonitrile  $(\text{CH}_2=\text{CHCN})$ .

83. (a) Neoprene is a polymer of chloroprene (2-chloro-1, 3-butadiene).

84. (c) Neoprene is a homopolymer of chloroprene.

85. (b) 5% of sulphur is used as a crosslinking agent in the manufacture of tyre rubber.

86. (b) Buna - N is obtained by copolymerisation of 1, 3-butadiene and acrylonitrile.

87. (d) 88. (c) 89. (d) 90. (b)

## STATEMENT TYPE QUESTIONS

91. (a) Monomeric units in polymers are joined together by covalent bonds only.

92. (b) Condensation polymers are formed by repeated condensation reaction between two different bi-functional or tri-functional monomeric units. Buna-S and Buna-N being elastomeric consists of polymeric chains held together by weak intermolecular forces thus they are elastic in nature.

93. (d) Number of hydrogen bonds is greater in polymer (1) than in (2) as the density of amide bond is greater in (1) therefore the chain links to each other strongly in (1) than in (2) hence (1) melts at higher temperature.

94. (d) Nylon-6 is used in the manufacturing of tyre cords not nylon-6,6 this is used in making sheets, bristles for brushes and in textile industry. Melamine - formaldehyde polymer is used in the manufacture of unbreakable crockery.

95. (b) Vulcanisation of natural rubber with sulphur and an appropriate additive is carried out within temperature range of 373K to 415K. Synthetic rubbers are either homopolymers of 1, 3-butadiene derivatives or copolymers of 1, 3-butadiene or its derivatives with another unsaturated monomer.

96. (c) Biodegradable polymers are manufactured because conventional polymers are quite resistant to the environmental degradation which leads to accumulation of polymeric solid waste materials causing acute environmental problems.

## MATCHING TYPE QUESTIONS

97. (b) A - (q), B - (s), C - (r), D - (p)

98. (c) A - (s), B - (r), C - (p), D - (q)

99. (b) A - (t), B - (p), C - (r), D - (q)

100. (b) A - (q), B - (r), C - (p), D - (t), E - (s)

101. (a) A - (r), B - (p), C - (q), D - (t), E - (s)

102. (c) A - (r), B - (p), C - (s), D - (q)

103. (a)

(A) Polystyrene is used as insulator.

(B) Glyptal a polymer of ethylene glycol and phthalic acid is used in manufacture of paints and lacquers.

(C) Bakelite, a polymer of phenol & formaldehyde is used for making electrical switches, handles of utensils and computer discs.

(D) PVC, a polymer of vinyl chloride is used in manufacture of raincoat and flooring.

## ASSERTION-REASON TYPE QUESTIONS

104. (a)

105. (b) Due to the presence of strong C-F bonds, teflon has high thermal stability and chemical inertness.

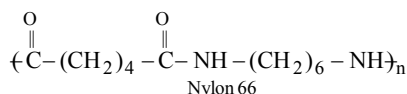
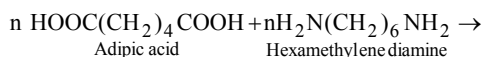
106. (c) Bakelite can be heated only once.

107. (b) Vulcanisation is a process of treating natural rubber with sulphur or some compounds of sulphur under heat so as to modify its properties. This cross-linking gives mechanical strength to the rubber.

**115. (b)** Considering the resonance structure, the radical of acrylonitrile is found to be more stable.

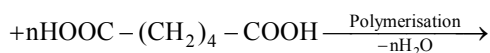
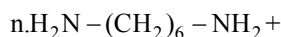
## CRITICAL THINKING TYPE QUESTIONS

110. (b) Nylon 6, 6 has amide linkage capable of forming hydrogen bonding.
111. (d) Nylon and cellulose, both have intermolecular hydrogen bonding, polyvinyl chloride has dipole-dipole interactions, while natural rubber has van der Waal forces which are weakest.
112. (d) Copolymer of adipic acid (6C) and hexamethylene diamine (6C).



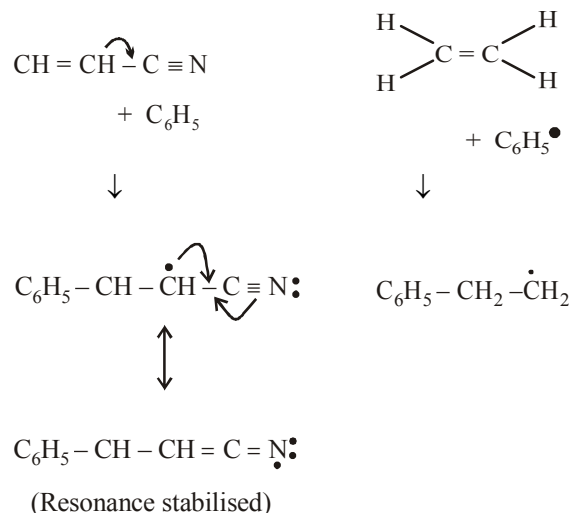
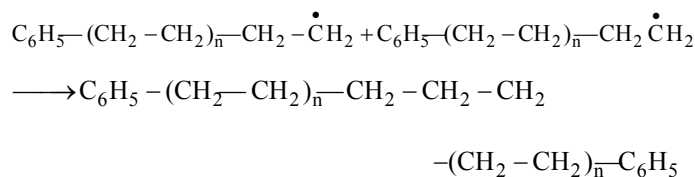
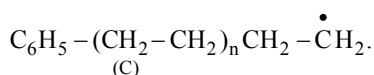
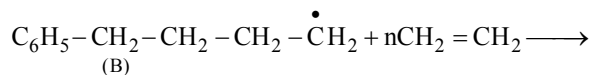
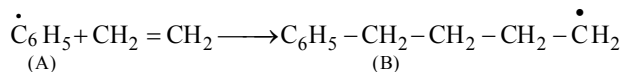
It has high tenacity and elasticity. It is resistant to abrasion and not affected by sea water. It is used for reinforcement of rubber tyres, manufacture of parachute, safety belts, carpets and fabrics.

- 113. (b)** The condensation polymerisation of hexamethylene diamine and adipic acid is done in solution form by interface technique. In this liquid nylon polymer is obtained.

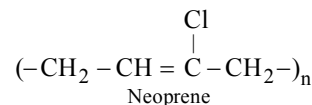


114. (a)  $\dot{\text{C}}_6\text{H}_5-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}-\text{C}_6\text{H}_5 \longrightarrow 2\text{C}_6\text{H}_5-\overset{\text{O}}{\parallel}{\text{C}}-\dot{\text{O}}$   
 $\longrightarrow 2\dot{\text{C}}_6\text{H}_5$   
 (A)

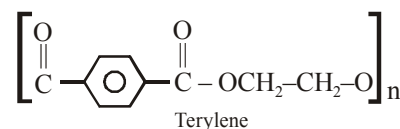
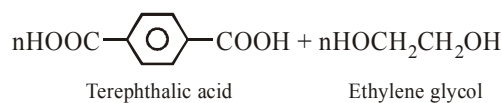
Phenyl radical



116. (d) 
$$n\text{CH}_2 = \underset{\text{Chloroprene}}{\underset{\text{Cl}}{\text{CH}}} - \text{C} = \text{CH}_2 \xrightarrow{\text{O}_2 \text{ or peroxides}}$$



- 117. (a)** Terylene is prepared by condensing terephthalic acid and ethylene glycol



118. (a)  
119. (d) As the amide density along the chain increases the melting point increases.  
120. (c) Thiokol is polymer of  $\text{CH}_2\text{ClCH}_2\text{Cl}$  and sodium polysulphide  $\text{Na-S-S-Na}$  and thus, not polydiene rubber.

- 121. (d)**

- 122. (b)** Average number molecular weight  $\overline{M}_n = 30,000$

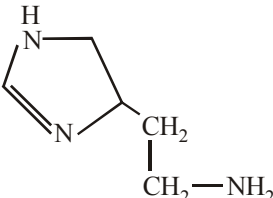
Average mass molecular weight  $\overline{M}_w = 40,000$

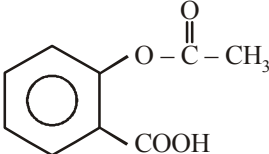
$$\text{Polydispersity index (PDI)} = \frac{\overline{M_w}}{\overline{M_n}} = \frac{40,000}{30,000} = 1.33$$



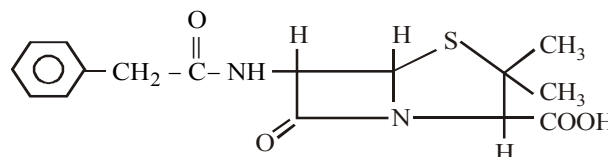


### FACT/DEFINITION TYPE QUESTIONS

- The use of chemicals for treatment of diseases is called as
  - isothermotherapy
  - angiotherapy
  - physiotherapy
  - chemotherapy
- Which of the following statements is not true about enzyme inhibitors?
  - Inhibit the catalytic activity of the enzyme.
  - Prevent the binding of substrate.
  - Generally a strong covalent bond is formed between an inhibitor and an enzyme
  - Inhibitors can be competitive or non-competitive.
- Which of the following is not a target molecule for drug function in body?
  - Carbohydrates
  - Lipids
  - Vitamins
  - Proteins
- Which of the following compounds are administered as antacids?
  - Sodium carbonate
  - Sodium hydrogencarbonate
  - Aluminium carbonate
  - Magnesium hydroxide
  - (i) and (ii)
  - (ii) and (iv)
  - (i), (ii) and (iii)
  - All of these
- The drug  is used as
  - Antacid
  - Analgesic
  - Antimicrobial
  - Antiseptic
- The function of enzymes in the living system is to
  - transport oxygen
  - provide energy
  - provide immunity
  - catalyse biochemical reactions
- Which one of the following is employed as a tranquilizer?
  - Naproxen
  - Tetracycline
  - Chlorpheniramine
  - Equanil
- Which one of the following is employed as a tranquilizer drug?
  - Promethazine
  - Valium
  - Naproxen
  - Mifepristone
- Terfenadine is commonly used as a/an
  - tranquilizer
  - antihistamine
  - antimicrobial
  - antibiotic
- Which one of the following is not a tranquilizer?
  - Equanil
  - Veronal
  - Salvarsan
  - Serotonin
- Tranquillizers are substances used for the treatment of
  - cancer
  - AIDS
  - mental diseases
  - physical disorders
- Which one of the following is employed as a tranquilizer drug?
  - Promethazine
  - Valium
  - Naproxen
  - Mifepristone
- Which of the following drugs is a tranquilizer and sedative
  - Sulphadiazine
  - Papaverine
  - Equanil
  - Mescaline
- Drug which helps to reduce anxiety and brings about calmness is
  - tranquillizer
  - diuretic
  - analgesic
  - antihistamine
- The drug used as an antidepressant is
  - Luminol
  - Tofranil
  - Mescaline
  - Sulphadiazine
- Barbituric acid and its derivatives are well known
  - antipyretics
  - analgesics
  - antiseptics
  - traquillizers
- Which of the following is a hypnotic drug?
  - luminal
  - salol
  - catechol
  - chemisol
- Which of the following is used for inducing sleep?
  - Paracetamol
  - Chloroquine
  - Bithional
  - Barbituric acid derivatives
- Aspirin is
  - antibiotic
  - antipyretic
  - sedative
  - psychedelic

20. An antipyretic is  
 (a) quinine (b) paracetamol  
 (c) luminal (d) piperazine
21. The following compound is used as
- 
- (a) an anti-inflammatory compound  
 (b) analgesic  
 (c) hypnotic  
 (d) antiseptic
22. Barbituric acid and its derivatives are well known  
 (a) antipyretics (b) analgesics  
 (c) antiseptics (d) tranquillizers
23. The drug used for prevention of heart attacks is  
 (a) aspirin (b) valium  
 (c) chloramphenicol (d) cephalosporin
24. Sulpha drugs are used for  
 (a) precipitating bacteria  
 (b) removing bacteria  
 (c) decreasing the size of bacteria  
 (d) stopping the growth of bacteria
25. Aspirin falls under which class of drugs ?  
 (a) Analgesic (b) Antibiotic  
 (c) Antifertility (d) antacid
26. Which of the following term means pain killer  
 (a) Antibiotic (b) Analgesic  
 (c) Antipyretic (d) Penicillin
27. Which one of the following can possibly be used as analgesic without causing addiction and mood modification ?  
 (a) Diazepam  
 (b) Morphine  
 (c) N-Acetyl-para-aminophenol  
 (d) Tetrahydrocannabinol
28. Aspirin is known as  
 (a) acetyl salicylic acid (b) phenyl salicylate  
 (c) acetyl salicylate (d) methyl salicylic acid
29. Which one among the following is not an analgesic?  
 (a) Ibuprofen (b) Naproxen  
 (c) Aspirin (d) Valium
30. Which of the following statements about aspirin is **not** true?  
 (a) It is effective in relieving pain.  
 (b) It is a neurologically active drug.  
 (c) It has antiblood clotting action.  
 (d) It belongs to narcotic analgesics.
31. Salol can be used as  
 (a) antiseptic (b) antipyretic  
 (c) analgesic (d) None of these
32. Various phenol derivatives, tincture of iodine (2–3%) I<sub>2</sub> in (water / alcohol) and some dyes like methylene blue are  
 (a) antiseptics (b) disinfectants  
 (c) analgesics (d) antipyretics

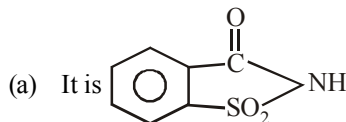
33. Sulpha drugs are used for  
 (a) precipitating bacteria  
 (b) removing bacteria  
 (c) decreasing the size of bacteria  
 (d) stopping the growth of bacteria
34. Streptomycin is effective in the treatment of  
 (a) tuberculosis (b) malaria  
 (c) typhoid (d) cholera
35. An antibiotic with a broad spectrum  
 (a) kills the antibodies  
 (b) acts on a specific antigen  
 (c) acts on different antigens  
 (d) acts on both the antigens and antibodies
36. Which of the following is not an antiseptic drug?  
 (a) Iodoform (b) Dettol  
 (c) Gammexane (d) Genation violet
37. Penicillin was first discovered by  
 (a) A. Fleming (b) Tence and Salke  
 (c) S.A. Waksna (d) Lewis Pasteur
38. Veronal, a barbiturate drug is used as  
 (a) anaesthetic (b) sedative  
 (c) antiseptic (d) None of these
39. A drug effective in the treatment of pneumonia, bronchitis, etc, is  
 (a) streptomycin (b) chloramphenicol  
 (c) penicillin (d) sulphaguanidine
40. Commonly used antiseptic 'Dettol' is a mixture of  
 (a) *o*-chlorophenoxylenol + terpeneol  
 (b) *o*-cresol + terpeneol  
 (c) phenol + terpeneol  
 (d) chloroxylenol + terpeneol
41. Chloroamphenicol is an :  
 (a) antifertility drug  
 (b) antihistaminic  
 (c) antiseptic and disinfectant  
 (d) antibiotic-broad spectrum
42. The drug which is effective in curing malaria is  
 (a) quinine (b) aspirin  
 (c) analgin (d) equanil
43. An antibiotic contains nitro group attached to aromatic nucleus. It is  
 (a) penicillin (b) streptomycin  
 (c) tetracycline (d) chloramphenicol
44. The structure given below is known as



- (a) Penicillin F (b) Penicillin G  
 (c) Penicillin K (d) Ampicillin

45. Arsenic drugs are mainly used in the treatment of  
(a) Jaundice (b) Typhoid  
(c) Syphilis (d) Cholera
46. Bithional is an example of  
(a) disinfectant (b) antiseptic  
(c) antibiotic (d) analgesic
47. Penicillin is an :  
(a) antibiotic (b) anaesthetic  
(c) antiseptic (d) antipyretic
48. Which of the following is a broad spectrum drug?  
(a) Plasmoquine (b) Chloroquine  
(c) Chloramphenicol (d) D.D.T.
49. Bithional is added to soap as an additive to function as a/an  
(a) softener (b) hardener  
(c) dryer (d) antiseptic
50. Antiseptics and disinfectants either kill or prevent growth of microorganisms. Identify which of the following statements **is not true**:  
(a) Chlorine and iodine are used as strong disinfectants.  
(b) Dilute solutions of boric acid and hydrogen Peroxide are strong antiseptics.  
(c) Disinfectants harm the living tissues.  
(d) A 0.2% solution of phenol is an antiseptic while 1% solution acts as a disinfectant.
51. Arsenic containing medicine used for the treatment of syphilis, is  
(a) erythromycin (b) ofloxacin  
(c) tetracycline (d) salvarsan
52. Novestrol is an  
(a) antibiotic (b) analgesic  
(c) antacid (d) antifertility drug
53. Which is the correct statement about birth control pills?  
(a) Contain estrogen only  
(b) Contain progesterone only  
(c) Contain a mixture of estrogen and progesterone derivatives.  
(d) Progesterone enhances ovulation.
54. Compounds with antiseptic properties are \_\_\_\_\_  
(i)  $\text{CHCl}_3$   
(ii)  $\text{CHI}_3$   
(iii) Boric acid  
(iv) 0.3 ppm aqueous solution of  $\text{Cl}_2$   
(a) (i) and (ii) (b) (ii) and (iii)  
(c) (i) and (iv) (d) (i) and (iii)
55. Which of the following is not a function of aspirin?  
(a) Relief from arthritic pain  
(b) Relief from postoperative pain.  
(c) Prevents platelet coagulation.  
(d) Prevention of heart attacks.
56. Which of the following method of classification of drugs is useful for doctors?  
(a) On the basis of drug action.  
(b) On the basis of chemical structure.  
(c) On the basis of molecular targets.  
(d) On the basis of pharmacological effect.
57. Which of the following method of classification of drugs is useful for medicinal chemists?  
(a) On the basis of molecular targets.  
(b) On the basis of chemical structure.  
(c) On the basis of drug action.  
(d) All of these.
58. Which of the following statements is true about the catalytic activity of enzyme?  
(a) Enzyme holds the substrate for a biochemical reaction.  
(b) Enzyme binds substrate through a variety of interactions such as ionic bonding, hydrogen bonding, van der Waal's interaction or dipole – dipole interaction.  
(c) Enzyme provides functional group that will attack the substrate and carry out biochemical reaction.  
(d) All of the above.
59. Drug tegamet is used as  
(a) Antacid (b) Antimalarial  
(c) Analgesic (d) Antiseptic
60. Which of the following is an essential component of sleeping pills?  
(a) Analgesics (b) Tranquilizers  
(c) Antihistamines (d) Both (b) and (c)
61. Which type of drugs inhibit the enzymes which catalyse the degradation of noradrenaline?  
(a) Narcotic analgesics (b) Antacids  
(c) Antidepressant (d) Non-narcotic analgesic.
62. Which of the following is/are example(s) of narcotic analgesics?  
(a) Morphine (b) Heroin  
(c) Codeine (d) All of these
63. Which of the following was the first effective treatment discovered for syphilis?  
(a) Penicillin (b) Arsphenamine  
(c) Chloramphenicol (d) Sulphanilamide
64. Which of the following is an example of narrow spectrum antibiotic?  
(a) Chloramphenicol (b) Penicillin G  
(c) Ampicillin (d) Ofloxacin
65. Antibiotic that can be given orally in case of typhoid, acute fever, dysentery, meningitis and pneumonia is \_\_\_\_\_.  
(a) vancomycin (b) salvarsan  
(c) ofloxacin (d) chloramphenicol
66. Veronal and luminal are derivatives of barbituric acid which are \_\_\_\_\_.  
(i) Tranquilizers  
(ii) Non-narcotic analgesic.  
(iii) Antiallergic drug  
(iv) Neurologically active drug.  
(a) (i) and (iv) (b) (i) and (iii)  
(c) (ii) and (iii) (d) (i) only

67. Which is correct about saccharin?



- (b) It is 600 times sweeter than sugar  
(c) It is used as sweetening agent  
(d) All of these

68. Which of the following acts as an antioxidant in edible oils

- (a) Vitamin B (b) Vitamin C  
(c) Vitamin D (d) Vitamin E

69. Salts of sorbic acid and propionic acid are used as

- (a) antioxidants (b) flavouring agents  
(c) food preservatives (d) nutritional supplements

70. Which of the following add nutritive value to food?

- (a) Sweeteners (b) Antioxidants  
(c) Fat emulsifiers (d) None of these

71. Arrange the following artificial sweeteners in increasing order of their sweetness value?

- (a) Sucralose < Saccharin < Alitame < Aspartame  
(b) Aspartame < Saccharin < Sucralose < Alitame  
(c) Aspartame < Sucralose < Saccharin < Alitame  
(d) Saccharin < Aspartame < Sucralose < Alitame

72. Which of the following artificial sweetener does not provide calories?

- (a) Alitame (b) Aspartame  
(c) Sucralose (d) Both (b) and (c)

73. Sodium benzoate is used as

- (a) food preservative (b) analgesic  
(c) filler in detergents (d) antiseptic

74. Structurally biodegradable detergent should contain

- (a) normal alkyl chain (b) branched alkyl chain  
(c) phenyl side chain (d) cyclohexyl side chain

75. Detergents are prepared by the action of  $\text{H}_2\text{SO}_4$  on which of the following?

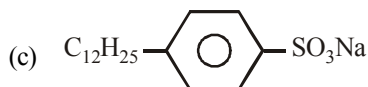
- (a) Cholesterol (b) Lauryl alcohol  
(c) Cyclohexanol (d) *p*-Nitrophenol

76. Sodium alkyl benzene sulphonate is used as

- (a) soap (b) fertilizers  
(c) pesticides (d) detergents

77. Which of the following represents a synthetic detergent?

- (a)  $\text{C}_{15}\text{H}_{31}\text{COOK}$   
(b)  $\text{CH}_3[\text{CH}_2]_{16}\text{COONa}$



- (d) None of these

78. Which of the following represents soap

- (a)  $\text{C}_{17}\text{H}_{35}\text{COOK}$  (b)  $\text{C}_{17}\text{H}_{35}\text{COOH}$   
(c)  $\text{C}_{15}\text{H}_{31}\text{COOH}$  (d)  $(\text{C}_{17}\text{H}_{35}\text{COO})_2\text{Ca}$

79. Alkaline hydrolysis of esters is known as :

- (a) Esterification (b) Saponification  
(c) dehydration (d) alkalination

80. Commercial detergent contains mainly

- (a)  $\text{RCOONa}$  (b)  $\text{RONa}$   
(c)  $\text{RSNa}$  (d)  $\text{RSO}_3\text{Na}$

81. Washing soap can be prepared by saponification with alkali of which of the following oil

- (a) Rose oil (b) Paraffin oil  
(c) Groundnut oil (d) Kerosene oil

82. Palmitic acid and stearic acid are used as :

- (a) medicine (b) soap  
(c) antiseptic cream (d) pickle

83. Soaps can be classified as :

- (a) esters (b) salts of fatty acids  
(c) alcohols (d) phenols

84. Cetyltrimethyl ammonium bromide is a popular

- (a) anionic detergent (b) cationic detergent  
(c) non-ionic detergent (d) sweetener

85. The cationic detergent that is used in hair conditioners is

- (a) sodium dodecylbenzene sulphonate  
(b) sodium lauryl sulphate  
(c) tetramethyl ammonium chloride  
(d) cetyltrimethyl ammonium bromide

86. Which of the following enhances leathering property of soap?

- (a) Sodium carbonate (b) Sodium rosinate  
(c) Sodium stearate (d) Trisodium phosphate

87. Polyethyleneglycols are used in the preparation of which type of detergents?

- (a) Cationic detergents (b) Anionic detergents  
(c) Non-ionic detergents (d) Soaps

88. Which of the following are anionic detergents?

- (i) Sodium salts of sulphonated long chain alcohol.  
(ii) Ester of stearic acid and polyethylene glycol.  
(iii) Quarternary ammonium salt of amine with acetate ion.  
(iv) Sodium salts of sulphonated long chain hydrocarbons.  
(a) (i) and (iv) (b) (ii) and (iii)  
(c) (iii) and (iv) (d) (i), (ii) and (iv)

89. Which type of detergent is formed when stearic acid reacts with polyethylene glycol?

- (a) Cationic detergent (b) Anionic detergent  
(c) Non-ionic detergent (d) None of these

90. Glycerol is added to soap. It functions \_\_\_\_\_

- (a) as a filler.  
(b) to increase leathering.  
(c) to prevent rapid drying.  
(d) to make soap granules.

### STATEMENT TYPE QUESTIONS

91. Which of the following statements are incorrect about receptor proteins?

- (i) Majority of receptor proteins are embedded in the cell membranes.  
(ii) The active site of receptor proteins opens on the inside region of the cell.  
(iii) Chemical messengers are received at the binding sites of receptor proteins.  
(iv) Shape of receptor doesn't change during attachment of messenger.  
(a) (i), (ii) and (iii) (b) (ii) and (iv)  
(c) (ii), (iii) and (iv) (d) (i) and (iv)

92. Which of the following statements are incorrect about penicillin?

- (i) An antibacterial medicine.
- (ii) Ampicillin is its synthetic modification.
- (iii) It has bacteriostatic effect.
- (iv) It is a broad spectrum antibiotic.

- (a) (i) and (ii) (b) (ii) and (iv)
- (c) (iii) and (iv) (d) (i) and (ii)

93. Which of the following statements are correct?

- (i) Before 1970 for treatment of stomach acidity  $\text{Al}(\text{OH})_3$  is a better antacid in comparison to  $\text{NaHCO}_3$ .
- (ii) Discovery of cimetidine was a major break through in the treatment of hyperacidity.
- (iii) Terfenadine is a drug which competes with histamine for binding sites of receptor.
- (iv) Antidepressant drugs like equanil inhibit the enzymes which catalyze the degradation of noradrenaline.
- (v) Veronal and luminal belongs to the class of tranquilizers called barbiturates.

- (a) (i), (ii) and (iii) (b) (i), (iii) and (v)
- (c) (ii), (iii) and (iv) (d) (ii), (iv) and (v)

94. Consider the following statements.

- (i) Antiseptics are not ingested like antibiotics.
- (ii) 1% solution of iodine in alcohol–water mixture is known as tincture of iodine.
- (iii)  $\text{SO}_2$  in low concentrations are used as antiseptics whereas in higher concentration are used as disinfectants.
- (iv) Birth control pills essentially contain a mixture of synthetic estrogen and progesterone derivatives.

Which of the following is the correct code for the statements above ?

- (a) FTFT (b) TTTF
- (c) TTFT (d) FFTT

95. Which of the following statements are correct?

- (i) Cationic detergents have germicidal properties
- (ii) Bacteria can degrade the detergents containing highly branched chains.
- (iii) Some synthetic detergents can give foam even in ice cold water.
- (iv) Synthetic detergents are not soaps.

- (a) (i), (ii) and (iii) (b) (i), (iii) and (iv)
- (c) (ii), (iii) and (iv) (d) (iii) and (iv)

96. Consider the following statements.

- (i) Potassium soaps are soft to the skin than sodium soaps.
- (ii) Shaving soaps contain ethanol to prevent rapid drying.
- (iii) Builders like  $\text{Na}_2\text{CO}_3$  and  $\text{Na}_3\text{PO}_4$  make soaps act more rapidly.
- (iv) Hard water contains  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  ions which forms insoluble  $\text{Ca}^{2+}$  and  $\text{Mg}^{2+}$  soaps separates out as scum.

Which of the following is the correct code for the statements above ?

- (a) TFFT (b) FTTT
- (c) FTFT (d) TTTT

97. Which of the following statements are correct?

- (i) Detergents give foam easily even in hard water.
- (ii) Anionic detergents are used in toothpastes.
- (iii) Cationic detergents being inexpensive are extensively used as germicide.
- (iv) Detergents with linear alkyl chains are more polluting as compared to detergents having branched alkyl chains.

Which of the following is the correct code for the statements above?

- (a) TFFT (b) TTFT
- (c) FFTT (d) TTFF

### MATCHING TYPE QUESTIONS

98. Match the columns

#### Column-I

- (A) Sodium Perborate
- (B) Chlorine
- (C) Bithional
- (D) Potassium stearate

#### Column-II

- (p) Disinfectant
- (q) Antiseptic
- (r) Milk bleaching agent
- (s) Soap

- (a) A – (p), B – (q), C – (r), D – (s)
- (b) A – (q), B – (r), C – (s), D – (p)
- (c) A – (r), B – (p), C – (q), D – (s)
- (d) A – (s), B – (p), C – (q), D – (r)

99. Match the columns

#### Column-I

- (A) Ranitidine
- (B) Furacine
- (C) Phenelzine
- (D) Chloramphenicol

#### Column-II

- (p) Tranquilizer
- (q) Antibiotic
- (r) Antihistamine
- (s) Antiseptic

- (a) A – (r), B – (s), C – (p), D – (q)
- (b) A – (s), B – (p), C – (q), D – (r)
- (c) A – (p), B – (q), C – (r), D – (s)
- (d) A – (q), B – (r), C – (s), D – (p)

100. Match the columns

#### Column – I

- (A) First antibacterial drug
- (B) Protosil
- (C) Chloramphenicol
- (D) Ofloxacin

#### Column – II

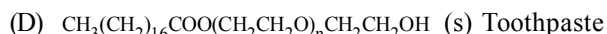
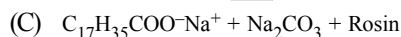
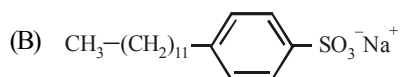
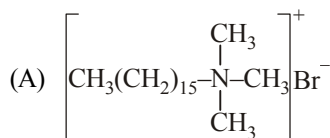
- (p) Broad spectrum antibiotic
- (q) Arsphenamine
- (r) 1932
- (s) 1947

- (a) A – (q), B – (r), C – (p, s), D – (p)
- (b) A – (r), B – (q), C – (p, s), D – (p)
- (c) A – (q), B – (p, s), C – (r), D – (p)
- (d) A – (p), B – (r), C – (p, s), D – (q)



101. Match the columns

Column-I



(a) A – (p), B – (q), C – (r), D – (s)

(b) A – (q), B – (r), C – (p), D – (s)

(c) A – (r), B – (s), C – (q), D – (p)

(d) A – (p), B – (r), C – (q), D – (s)

Column-II

(p) Dishwashing powder

(q) Laundry soap

(r) Hair conditioners

(s) Toothpaste

102. Match the columns

Column-I

(A) Toilet soap

(B) Transparent soap

(C) Shaving soaps

(D) Soaps that float in water

Column-II

(p) Made by beating tiny air bubbles before their hardening.

(q) Contain glycerol to prevent rapid drying.

(r) Prepared by using better grades of fats and oils.

(s) Made by dissolving the soap in ethanol and then evaporating excess alkali.

(a) A – (s), B – (p), C – (q), D – (r)

(b) A – (r), B – (s), C – (q), D – (p)

(c) A – (r), B – (q), C – (p), D – (s)

(d) A – (q), B – (s), C – (p), D – (r)

ASSERTION-REASON TYPE QUESTIONS

**Directions :** Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

- (a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.  
 (b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion  
 (c) Assertion is correct, reason is incorrect  
 (d) Assertion is incorrect, reason is correct.

103. **Assertion :** The drugs which act on the central nervous system and help in reducing anxiety are called antibiotics.

**Reason :** Pencillin is an antibiotic.

104. **Assertion :** Equanil is a tranquilizer.

**Reason :** Equanil is used to cure depression and hypertension.

105. **Assertion :** Tetracycline is a broad spectrum antibiotic.

**Reason :** Tetracycline is effective against a number of types of bacteria, large viruses and typhus fever.

106. **Assertion :** Antiseptics are applied to living tissues.

**Reason :** Iodine is a powerful antiseptic.

107. **Assertion :** Sedatives are given to patients who are mentally agitated and violent.

**Reason :** Sedatives are used to suppress the activities of central nervous system.

108. **Assertion :** Non-competitive inhibitor inhibits the catalytic activity of enzyme by binding with its active site.

**Reason :** Non-competitive inhibitor changes the shape of the active site in such a way that substrate can't recognise it.

109. **Assertion :** Sodium chloride is added to precipitate soap after saponification.

**Reason :** Hydrolysis of esters of long chain fatty acids by alkali produces soap in colloidal form.

CRITICAL THINKING TYPE QUESTIONS

110. Which of the following are sulpha drugs?

- (i) Sulphapyridine (ii) Prontosil  
 (iii) Salvarsan (iv) Nardil  
 (a) (i) and (ii) (b) (ii) and (iv)  
 (c) (i), (ii) and (iv) (d) (ii), (iii) and (iv)

111. Among the following antihistamines, which are antacids

- (i) Ranitidine (ii) Brompheniramine  
 (iii) Terfenadine (iv) Cimetidine  
 (a) (i) and (iii) (b) (i), (ii) and (iv)  
 (c) (i) and (iv) (d) (ii) and (iii)

112. Which one of the following is an antihistamine?

- (a) Iproniazid (b) Salvarsan  
 (c) Zantac (d) Chloramphenicol

113. Morphine is

- (a) an alkaloid (b) an enzyme  
 (c) a carbohydrate (d) a protein

114.  $H_1$  – Receptor antagonists is a term associated with :

- (a) Antiseptics (b) Antihistamins  
 (c) Antacids (d) Analgesics

115. Amoxillin is semi-synthetic modification of

- (a) penicillin (b) streptomycin  
 (c) tetracycline (d) chloroamphenicol

116. Which of the following is used as an antibiotic ?

- (a) Ciprofloxacin (b) Paracetamol  
 (c) Ibuprofen (d) Tocopherol

117. Select the incorrect statement.

- (a) Equanil is used to control depression and hypertension.  
 (b) Mifepristone is a synthetic steroid used as “morning after pill”.  
 (c) 0.2 percent solution of phenol is an antiseptic while its 1.0 percent solution is a disinfectant.  
 (d) A drug which kills the organism in the body is called bacteriostatic.

118. A large number of antibiotics have been isolated from  
 (a) Bacteria actinomycetes  
 (b) Acids  
 (c) Alkanals  
 (d) Bacteria rhizobium
119. Antiseptic chloroxylenol is  
 (a) 4-chloro-3, 5-dimethylphenol  
 (b) 3-chloro-4, 5-dimethylphenol  
 (c) 4-chloro-2, 5-dimethylphenol  
 (d) 5-chloro-3, 4-dimethylphenol
120. Which of the following is not correctly matched?  
 (i) Proteins that are – Receptors  
 crucial to body's communication process.  
 (ii) Drugs that mimic – Antagonists  
 the natural messenger by switching on the receptor.  
 (iii) Drugs that binds to – Agonists  
 the receptor site and inhibit its natural function.  
 (a) (ii) only (b) (iii) only  
 (c) (i) and (iii) (d) (ii) and (iii)
121. Which of the following drug inhibits the synthesis of chemicals known as prostaglandins which stimulate inflammation in tissue and cause pain?  
 (a) Barbiturates (b) Aspirin  
 (c) Seldane (d) Iproniazid
122. Bactericidal antibiotics are those which  
 (a) have inhibitory effect on microbes.  
 (b) have killing effect on microbes.  
 (c) have both inhibitory and killing effect on microbes.  
 (d) intervene in metabolic process of microorganism.
123. Which of the following antibiotics is not correctly classified?
- | Bactericidal        | Bacteriostatic |
|---------------------|----------------|
| (A) Penicillin      | Erythromycin   |
| (B) Aminoglycosides | Tetracycline   |
| (C) Chloramphenicol | Ofloxacin      |
| (a) A and B         | (b) C only     |
| (c) B and C         | (d) B only     |
124. Antibiotics that are effective mainly against Gram-positive or Gram-negative bacteria X. Antibiotics that are effective against a single organism or disease are Y  
 What is X and Y ?  
 (a) X = Broad spectrum antibiotics.  
 Y = Narrow spectrum antibiotics.  
 (b) X = Broad spectrum antibiotics.  
 Y = Limited spectrum antibiotics.  
 (c) X = Narrow spectrum antibiotics.  
 Y = Limited spectrum antibiotics.  
 (d) X = Narrow spectrum antibiotics.  
 Y = Broad spectrum antibiotics.
125. Which of the following is an example of synthetic progesterone derivative which is most widely used as antifertility drug?  
 (a) Norethindrone (b) Novestrol  
 (c) Ethynylestradiol (d) All of these
126. Substance used for the preservation of coloured fruit juices is  
 (a) benzene (b) benzoic acid  
 (c) phenol (d) sodium meta bisulphite
127. The artificial sweetener containing chlorine that has the appearance and taste as that of sugar and is stable at cooking temperature is  
 (a) Aspartame (b) Saccharin  
 (c) Sucrolose (d) Alitame
128. Benzalkonium chloride is a  
 (a) cationic surfactant and antiseptic  
 (b) anionic surfactant and soluble in most of organic solvents  
 (c) cationic surfactant and insoluble in most of organic solvents  
 (d) cationic surfactant and antimalarial
129. Which one of the following is not used as a filler in laundry soaps?  
 (a) Sodium silicate (b) Glycerol  
 (c) Sodium rosinate (d) Borax
130. Which of the following is an example of liquid dishwashing detergent?  
 (a)  $\text{CH}_3(\text{CH}_2)_{10}-\text{CH}_2\text{OSO}_3^-\text{Na}^+$   
 (b)  $\text{C}_9\text{H}_{19}-\text{C}_6\text{H}_4-\text{O}-(\text{CH}_2-\text{CH}_2-\text{O})_5-\text{CH}_2\text{CH}_2\text{OH}$   
 (c)  $\text{CH}_3-\text{C}_6\text{H}_4-\text{SO}_3^-\text{Na}^+$   
 (d)  $\left[ \text{CH}_3(\text{CH}_2)_{15}-\text{N}(\text{CH}_3)_3 \right]^+\text{Br}^-$
131. Which of the following statements is incorrect?  
 (a) Saccharin is about 550 times as sweet as cane sugar.  
 (b) Aspartame is used in the manufacture of baked sweets.  
 (c) Alitame is more sweet than saccharin and aspartame.  
 (d) Sodium benzoate is commonly used preservative.

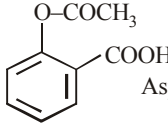
# HINTS AND SOLUTIONS

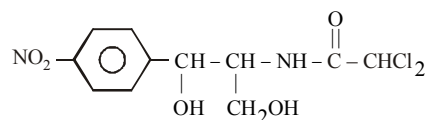
## FACT/DEFINITION TYPE QUESTIONS

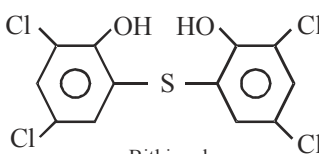
1. (d)      2. (c)      3. (c)      4. (b)
5. (a) Given drug is used as Antacid.
6. (d) The function of enzymes in the living system is to catalyse biochemical reactions which occur in living systems. e.g. invertase, pepsin, amylase.  

$$\text{Sucrose} \xrightarrow[\text{(polymer)}]{\text{Invertase}} \text{glucose} + \text{fructose} \quad \text{(monomer)}$$

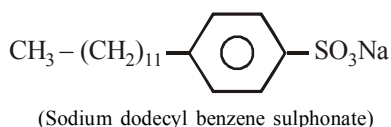
$$\text{Starch} \xrightarrow[\text{(polymer)}]{\text{amylase}} \text{glucose} \quad \text{(monomer)}$$
7. (d) Equanil is an important medicine used in depression and hypertension.
8. (b)
9. (b) Terfenadine is commonly used as antihistamine.
10. (c) Salvarsan is an organoarsenic compound, used in the treatment of syphilis. It was the first modern chemotherapeutic agent.
11. (c)      12. (b)
13. (c) Tranquilizers reduce anxiety and tension they are also called psychotropic drugs. These are two types  
 (i) Sedative the drugs used for violent and mentally agitated patient e.g., Equanil and diazepam.  
 (ii) Antidepressant- The drug are used to patients who are highly depressed and lose self confidence e.g. tofranil, imipramine, amphetamine etc.
14. (a)      15. (b)      16. (d)
17. (a) These drugs induce sleep and are habit forming common example of hypnotic drugs are Luminal and Saconal.
18. (d)
19. (b) Aspirin is antipyretic i.e., a drug which is responsible for lowering the temperature of feverish organism to normal, other antipyretic drugs are Paracetamol, Phenacetin.
20. (b) Paracetamol is an antipyretic
21. (b) It is acetyl salicylic acid i.e., aspirin, analgesic and antipyretic.
22. (d)
23. (a) Due to anti-blood clotting action of aspirin, it is used to prevent heart attack.
24. (d) Sulpha drugs (antibacterial and antibiotic) are group of drugs which are derivative of sulphanilamide.
25. (a) Analgesic are pain killers.
26. (b) Analgesic means painkiller.
27. (c) We know that N-acetyl-para-aminophenol (or paracetamol) is an antipyretic which can also be used as an analgesic to relieve pain.

28. (a)  Aspirin (Acetyl salicylic acid)
29. (d) Valium is a tranquilizer and not an analgesic. It is used for treatment of stress, fatigue, mild and severe mental diseases.
30. (d) Aspirin is a non-narcotic analgesic.
31. (a) Salol is phenyl salicylate used as antiseptic.
32. (a) Antiseptic drugs cause destruction of micro-organism that produce septic disease e.g. Dettol, Savlon, Boric acid, Phenol, Iodoform, KMnO<sub>4</sub> and some dye such as methylene blue, gentian violet.
33. (d) Sulpha drugs (antibacterial and antibiotic) are group of drugs which are derivative of sulphanilamide.
34. (a) It is the very effective antibiotic for tuberculosis.
35. (c) Broad spectrum antibiotics act on different antigens.
36. (c) It is an insecticide.
37. (a) A. Fleming discovered penicillin in 1929.
38. (b)
39. (c) Penicillin is an effective medicine for pneumonia disease.
40. (d) The mixture of chloroxylenol and terpenol is dettol which is used as antiseptic.
41. (d) Chloramphenicol is a broad spectrum antibiotic.
42. (a) Substances used for the treatment of malaria are antimalarial e.g. Quinine, chloroquine.
43. (d) Chloramphenicol is



44. (b) It is the known structure of Penicillin G
  45. (c) Arsenic drugs are poisonous for syphilis.
  46. (b) Bithional is a well known antiseptic, added in soaps to reduce odours produced by bacterial decomposition of organic matter of skin.
- 
- Bithional
47. (a) Penicillin is an antibiotic.
  48. (c) **Chloramphenicol** is a broad spectrum drug. [Broad spectrum antibiotics are medicines effective against gram positive as well as gram negative bacteria, e.g., tetracycline, chloramphenicol, etc.]

49. (d) Bithional is another well known antiseptic which is added to good quality soaps to reduce the odours produced by bacterial decomposition of organic matter on the skin.
50. (b) Dilute solutions of boric acid and hydrogen peroxide are weak antiseptics.
51. (d)
52. (d) Novestrol is an antifertility drug.
53. (c) 54. (b)
55. (b) Morphine narcotics are chiefly used for the relief of post operative pain.
56. (d) Classification of drugs on the basis of pharmacological effect is useful for doctors because it provides them the whole range of drugs available for the treatment of a particular type of problem.
57. (a) 58. (d)
59. (a) Drug tegamet was designed to prevent the interaction of histamine with the receptors present in the stomach wall. This resulted in release of lesser amount of acid.
60. (b)
61. (c) Antidepressant drugs inhibit the enzymes which catalyse the degradation of noradrenaline.
62. (d)
63. (b) Arsphenamine also known as salvarsan was the first effective treatment discovered for syphilis.
64. (b) Penicillin G has a narrow spectrum, while all other options have broad spectrum.
65. (d) Chloramphenicol is rapidly absorbed from the gastrointestinal tract and hence can be given orally in case of typhoid, acute fever, meningitis, pneumonia etc.
66. (a)
67. (d) All are characteristics of Saccharin.
68. (d) Vitamin E is an antioxidant present in edible oils.
69. (c) Salts of sorbic acid and propionic acid are used as food preservatives because these chemicals inhibit the growth of yeast bacteria or moulds.
70. (d) Neither any of the substances among given options possess nutritive value.
71. (b)
- | Artificial sweetener | Sweetness value |
|----------------------|-----------------|
| Aspartame            | 100             |
| Saccharin            | 550             |
| Sucralose            | 600             |
| Alitame              | 2000            |
72. (c) Sucralose does not provide calories.
73. (a) Sodium benzoate is used as a food preservative.
74. (b) Structurally biodegradable detergents should contain branched alkyl chain.
75. (b)
76. (d) It is used as detergent.
77. (c) The most widely used domestic detergent is the sodium dodecyl benzene sulphonate (SDS).

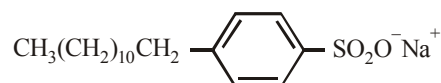


78. (a) Soaps are the sodium or potassium salt of higher fatty acids e.g.,  $\text{C}_{17}\text{H}_{37}\text{COOK}$  (Potassium stearate). These are obtained by alkaline hydrolysis of oils and fats. The reaction is called saponification.

79. (b) Alkaline hydrolysis of esters is known as saponification.



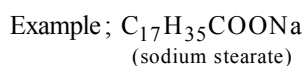
80. (d) Commercial detergent are the sodium salts of long chain (linear) alkyl substituted benzene sulphonc acids (LAB) and are most widely used. The most common is sodium dodecylbenzene sulphate.



81. (c) Any oils which are good for eating or cooking, can be used in making soap. One of the best is said to be coconut oil. Groundnut, Shea butter, Cocoa butter, Sun flower and many other vegetable oils are also used.

82. (b) Sodium or potassium salts of palmitic acid ( $\text{CH}_3(\text{CH}_2)_{14}\text{COO}^- \text{Na}^+$ ) and stearic acid ( $\text{CH}_3(\text{CH}_2)_{16}\text{COO}^- \text{Na}^+$ ) are used as soaps.

83. (b) Soaps are actually salts of higher fatty acids.



84. (b)
- $$\left[ \text{CH}_3 - (\text{CH}_2)_{15} - \overset{\text{CH}_3}{\underset{\text{CH}_3}{\text{N}^+}} - \text{CH}_3 \right] \text{Br}^-$$
- cetyl trimethyl ammonium bromide

85. (d) Cetyltrimethyl ammonium bromide possess germicidal properties. Thus it is used as a cationic detergent in hair conditioners.

86. (b) 87. (c) 88. (a)

89. (c) Non-ionic detergent is formed when stearic acid reacts with polyethylene glycol.

90. (c)

### STATEMENT TYPE QUESTIONS

91. (b) 92. (c)
93. (b) For statement (ii), drug which brings major change in the treatment of hyperacidity was histamine. For statement (iv), antidepressant drugs like iproniazid and phenelzine inhibit the enzymes which catalyse the degradation of noradrenaline when the enzyme is inhibited, this important neurotransmitter is slowly metabolised and can activate its receptor for longer periods of time, thus counteracting the effect of depression.
94. (c) For statement (ii), 2–3% solution of iodine in alcohol water mixture is known as tincture of iodine. For statement (iii),  $\text{SO}_2$  in very low concentrations are used as disinfectants.

95. (b)  
 96. (a) Shaving soaps contain glycerol to prevent rapid drying.  
 97. (d) For statement (iii), cationic detergents are expensive and thus have limited use. For statement (iv), detergents having unbranched chains can be biodegraded more easily thus are less polluting as compared to detergents having branched chains.

### MATCHING TYPE QUESTIONS

98. (c)      99. (a)      100. (a)      101. (c)      102. (b)

### ASSERTION-REASON TYPE QUESTIONS

103. (d) The drugs which act on the central nervous system and help in reducing anxiety are called tranquilizers.  
 104. (a) Tranquilizers are chemicals which are used to cure mental diseases.  
 105. (a) Broad spectrum antibiotics are those medicines which are effective against several different types of harmful micro organisms.  
 106. (b) Antiseptics are those chemical which kill or prevent the growth of micro organism. Antiseptics do not harm the living tissues and can be applied on cuts and wounds. They help to reduce odour resulting from the bacterial decomposition in the mouth and on the body.  
 107. (a) A small quantity of sedative produces a feeling of relaxation, calmness and drowsiness.  
 108. (d)      109. (b)

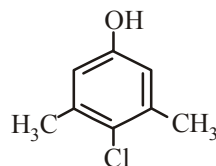
### CRITICAL THINKING TYPE QUESTIONS

110. (a)      111. (c)  
 112. (c) Iproniazid → Tranquilizer  
           Salvarsan → Antimicrobial  
           Zantac (ranitidine) → Antihistamine  
           Chloramphenicol → Antibiotic  
 113. (a) It is an alkaloid, a class of organic compound which is basic in nature and of plant origin containing atleast one nitrogen atom in a ring structure of molecule.  
 114. (b) The term “antihistamine” refers only to  $H_1$  antagonists, which is also known as  $H_1$ -receptor antagonists and  $H_1$ -antihistamine.  
 115. (a) Amoxillin is semisynthetic modification of Penicillin  
 116. (a) Ciprofloxacin is used as antibiotic while paracetamol, ibuprofen and tocopherol are respectively antipyretic, pain killer and Vit. E.

117. (d) Bacteriostatic drugs inhibit the growth of organism while bactericidal drugs kill the microorganisms.

118. (a)

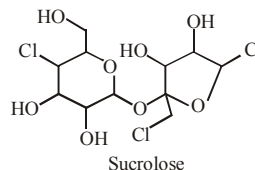
119. (a)



Chloroxylenol

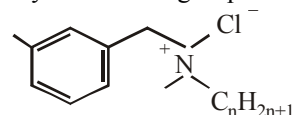
(4-chloro-3, 5-dimethylphenol)

120. (d) Drugs that mimic the natural messenger by switching on the receptor are called agonists. While drugs that binds to the receptor site and inhibit its natural function are called antagonists.  
 121. (b)  
 122. (b) Bactericidal have killing effect on microbes while bacteriostatic have inhibitory effect on microbes.  
 123. (b) Chloramphenicol is bacteriostatic antibiotic while ofloxacin is bactericidal type antibiotic.  
 124. (c) Narrow spectrum antibiotics are effective against Gram-positive or Gram-negative bacteria. Limited spectrum antibiotics are effective against a single organism or disease.  
 125. (a) Norethindrone is an example of synthetic progesterone derivative most widely used as antifertility drug.  
 126. (b) Benzoic acid used as preservative as sodium benzoate.  
 127. (c)



Sucrose

128. (a) Benzalkonium chloride, also known as alkyldimethylbenzylammonium chloride is nitrogenous cationic surface active agent belonging to the quaternary ammonium group. It is used as antiseptic.



$n = 8, 10, 12, 14, 16, 18$

129. (b) Laundry soaps contain fillers like sodium rosinate, sodium silicate, borax and sodium carbonate.  
 130. (b)  
 131. (b) Aspartame cannot be used in baked food as it is unstable at cooking temperature thus its use is limited to cold foods and soft drinks.

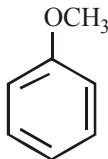


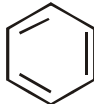
# Mock Test-1

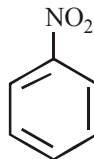
Time : 1 hr

Max. Marks -180

- An acidic solution of 'X' does not give precipitate on passing  $H_2S$  through it. 'X' gives white precipitate when  $NH_4OH$  is added to it. The white precipitate dissolves in excess of  $NaOH$  solution. Pure 'X' fumes in air and dense white fumes are obtained when a glass rod dipped in  $NH_4OH$  is put in the fumes. Compound 'X' can be  
 (a)  $ZnCl_2$  (b)  $FeCl_3$   
 (c)  $AlCl_3$  (d)  $SnCl_2$
- $CN^-$  is a strong field ligand. This is due to the fact that  
 (a) it carries negative charge  
 (b) it is a pseudohalide  
 (c) it can accept electrons from metal species  
 (d) it forms high spin complexes with metal species
- The weight of  $NaCl$  decomposed by 4.9 g of  $H_2SO_4$ , if 6 g of sodium hydrogen sulphate and 1.825 g of  $HCl$ , were produced in the reaction is:  
 (a) 6.921 g (b) 4.65 g  
 (c) 2.925 g (d) 1.4 g
- Which one of the following statement is **not** true?  
 (a) pH of drinking water should be between 5.5–9.5.  
 (b) Concentration of DO below 6 ppm is good for the growth of fish.  
 (c) Clean water would have a BOD value of less than 5 ppm.  
 (d) Oxides of sulphur, nitrogen and carbon are the most widespread air pollutant.
- Which of the following statements is not correct for nitrogen?  
 (a) Its electronegativity is very high  
 (b) d-orbitals are available for bonding  
 (c) It is a typical non-metal  
 (d) Its molecular size is small
- Which of the following statement is false?  
 (a) For 1 mole of an ideal gas,  $C_p - C_v = R$   
 (b)  $\left(\frac{\partial E}{\partial T}\right)_T = 0$  for an ideal gas  
 (c)  $\Delta q = \Delta w + p\Delta v$   
 (d) For reversible isothermal expansion of 1 mole of an ideal gas from volume  $V_1$  to  $V_2$ , work done is equal to  $RT \ln (V_2/V_1)$
- 0.4 moles of  $HCl$  and 0.2 moles of  $CaCl_2$  were dissolved in water to have 500 mL of solution, the molarity of  $Cl^-$  ion is:  
 (a) 0.8 M (b) 1.6 M  
 (c) 1.2 M (d) 10.0 M
- In sodium fusion test of organic compounds, the nitrogen of the organic compound is converted into  
 (a) Sodamide (b) Sodium cyanide  
 (c) Sodium nitrite (d) Sodium nitrate
- Specific volume of cylindrical virus particle is  $6.02 \times 10^{-2}$  cc/gm. whose radius and length 7 Å & 10 Å respectively. If  $N_A = 6.02 \times 10^{23}$ , find molecular weight of virus  
 (a)  $3.08 \times 10^3$  kg/mol (b)  $3.08 \times 10^4$  kg/mol  
 (c)  $1.54 \times 10^4$  kg/mol (d) 15.4 kg/mol
- Inductive effect involves  
 (a) displacement of  $\sigma$ -electrons  
 (b) delocalisation of  $\pi$ -electrons  
 (c) delocalisation of  $\sigma$ -electrons  
 (d) displacement of  $\pi$ -electrons
- The energy of a photon is  $3 \times 10^{-12}$  erg. What is its wavelength in nm?  
 ( $h = 6.62 \times 10^{-27}$  erg-sec;  $c = 3 \times 10^{10}$  cm/s)  
 (a) 662 (b) 1324  
 (c) 66.2 (d) 6.62
- Among the following compounds (I - III), the ease of their reaction with electrophiles is,  

  
 I

  
 II


  
 III

 (a)  $II > III > I$  (b)  $III > II > I$   
 (c)  $II > I > III$  (d)  $I > II > III$
- Aluminium vessels should not be washed with materials containing washing soda since  
 (a) washing soda is expensive  
 (b) washing soda is easily decomposed  
 (c) washing soda reacts with Al to form soluble aluminate  
 (d) washing soda reacts with Al to form insoluble aluminium oxide
- The following data are for the decomposition of ammonium nitrite in aqueous solution :  

Vol. of $N_2$ in cc	Time (min)
6.25	10
9.00	15
11.40	20
13.65	25
35.65	Infinity

 The order of reaction is :  
 (a) Zero (b) One  
 (c) Two (d) Three

15. Which of the following reagents convert propene to 1-propanol?  
 (a)  $\text{H}_2\text{O}, \text{H}_2\text{SO}_4$  (b) aqueous KOH  
 (c)  $\text{MgSO}_4, \text{NaBH}_4/\text{H}_2\text{O}$  (d)  $\text{B}_2\text{H}_6, \text{H}_2\text{O}_2, \text{OH}^-$
16. A closed container contains equal number of oxygen and hydrogen molecules at a total pressure of 740 mm. If oxygen is removed from the system then pressure will  
 (a) Become double of 740 mm  
 (b) Become half of 740 mm  
 (c) Become 1/9 of 740 mm  
 (d) Remains unchanged
17. Compound X of molecular formula  $\text{C}_4\text{H}_6$  takes up one equivalent of hydrogen in presence of Pt to form another compound Y which on ozonolysis gives only ethanoic acid. The compound X can be  
 (a)  $\text{CH}_2 = \text{CH} - \text{CH} = \text{CH}_2$   
 (b)  $\text{CH}_2 = \text{C} = \text{CHCH}_3$   
 (c)  $\text{CH}_3\text{C} \equiv \text{CCH}_3$   
 (d) All the three
18. 1 M solution of  $\text{CH}_3\text{COOH}$  should be diluted to ..... times so that pH is doubled.  
 (a) four times (b)  $5.55 \times 10^4$  times  
 (c)  $5.55 \times 10^6$  times (d)  $10^{-2}$  times
19. Which of the following statements, about the advantage of roasting of sulphide ore before reduction is not true?  
 (a) The  $\Delta G_f^\circ$  of the sulphide is greater than those for  $\text{CS}_2$  and  $\text{H}_2\text{S}$ .  
 (b) The  $\Delta G_f^\circ$  is negative for roasting of sulphide ore to oxide.  
 (c) Roasting of the sulphide to the oxide is thermodynamically feasible.  
 (d) Carbon and hydrogen are suitable reducing agents for metal sulphides.
20. Which one of the following is NOT a buffer solution?  
 (a) 0.8 M  $\text{H}_2\text{S}$  + 0.8 M KHS  
 (b)  $2\text{MC}_6\text{H}_5\text{NH}_2 + 2\text{MC}_6\text{H}_5\text{N}^+\text{H}_3\text{Br}^-$   
 (c)  $3\text{MH}_2\text{CO}_3 + 3\text{MKHCO}_3$   
 (d) 0.05 M  $\text{KClO}_4$  + 0.05 M  $\text{HClO}_4$
21. Which of the following statements is false?  
 (a) Radon is obtained from the decay of radium  
 (b) Helium is inert gas  
 (c) Xenon is the most reactive among the rare gases  
 (d) The most abundant rare gas found in the atmosphere is helium
22. Which one of the following is expected to exhibit optical isomerism?  
 (en = ethylenediamine)  
 (a)  $\text{cis} - [\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$  (b)  $\text{trans} - [\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$   
 (c)  $\text{cis} - [\text{Co}(\text{en})_2\text{Cl}_2]$  (d)  $\text{trans} - [\text{Co}(\text{en})_2\text{Cl}_2]$
23. The following equilibrium constants are given:  
 $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3; K_1$   
 $\text{N}_2 + \text{O}_2 \rightleftharpoons 2\text{NO}; K_2$   
 $\text{H}_2 + \frac{1}{2}\text{O}_2 \rightleftharpoons \text{H}_2\text{O}; K_3$   
 The equilibrium constant for the oxidation of  $\text{NH}_3$  by oxygen to give NO is  
 (a)  $\frac{K_2 K_3^2}{K_1}$  (b)  $\frac{K_2^2 K_3}{K_1}$   
 (c)  $\frac{K_1 K_2}{K_3}$  (d)  $\frac{K_2 K_3^3}{K_1}$
24. Four successive members of the first row transition elements are listed below with their atomic numbers. Which one of them is expected to have the highest third ionization enthalpy?  
 (a) Vanadium (Z = 23) (b) Chromium (Z = 24)  
 (c) Manganese (Z = 25) (d) Iron (Z = 26)
25. Which of the following organometallic compound is  $\sigma$  and  $\pi$  bonded?  
 (a)  $[\text{Fe}(\eta^5 - \text{C}_5\text{H}_5)_2]$  (b)  $\text{Fe}(\text{CH}_3)_3$   
 (c)  $\text{K}[\text{PtCl}_3(\eta^2 - \text{C}_2\text{H}_4)]$  (d)  $[\text{Co}(\text{CO})_5\text{NH}_3]^{2+}$
26. In the balanced chemical reaction  
 $\text{IO}_3^- + \text{aI}^- + \text{bH}^+ \longrightarrow \text{cH}_2\text{O} + \text{dI}_2$   
 a, b, c and d respectively corresponds to  
 (a) 5, 6, 3, 3 (b) 5, 3, 6, 3  
 (c) 3, 5, 3, 6 (d) 5, 6, 5, 5
27. Which of the following statements is true?  
 (a) Silicon exhibits 4 coordination number in its compound  
 (b) Bond energy of  $\text{F}_2$  is less than  $\text{Cl}_2$   
 (c) Mn(III) oxidation state is more stable than Mn(II) in aqueous state  
 (d) Elements of 15th group shows only +3 and +5 oxidation states
28. Which of the following compounds has the highest boiling point?  
 (a)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$   
 (b)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$   
 (c)  $\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{Cl}$   
 (d)  $(\text{CH}_3)_3\text{CCl}$
29. Which one of the following statements is not correct?  
 (a) Nickel forms  $\text{Ni}(\text{CO})_4$   
 (b) All the transition metals form monometallic carbonyls  
 (c) Carbonyls are formed by transition metals  
 (d) Transition metals form complexes
30. Hydrogen has an ionisation energy of  $1311 \text{ kJ mol}^{-1}$  and for chlorine it is  $1256 \text{ kJ mol}^{-1}$ . Hydrogen forms  $\text{H}^+$  (aq) ions but chlorine does not form  $\text{Cl}^+$  (aq) ions because  
 (a)  $\text{H}^+$  has lower hydration enthalpy  
 (b)  $\text{Cl}^+$  has lower hydration enthalpy  
 (c) Cl has high electron affinity  
 (d) Cl has high electronegativity

37. 

(a) Trioxane (b) Formose  
(c) Paraformaldehyde (d) Metaldehyde.

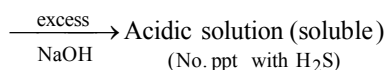
38. The correct order of atomic/ionic sizes is
- (a)  $N < Li < B$  (b)  $F^- < O^{2-} < N^{3-}$   
(c)  $Ca^{2+} < S^{2-} < Cl^-$  (d)  $Na^+ < Mg^{2+} < Cl^-$

ANSWER KEY

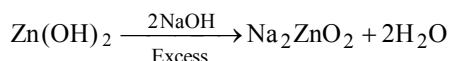
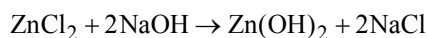
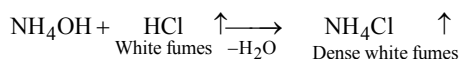
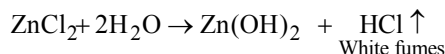
1. (a)	2. (b)	3. (c)	4. (b)	5. (b)	6. (c)	7. (b)	8. (b)	9. (d)	10. (a)
11. (a)	12. (d)	13. (d)	14. (b)	15. (d)	16. (b)	17. (d)	18. (b)	19. (d)	20. (d)
21. (d)	22. (c)	23. (d)	24. (c)	25. (d)	26. (a)	27. (b)	28. (b)	29. (b)	30. (b)
31. (c)	32. (c)	33. (a)	34. (c)	35. (a)	36. (c)	37. (a)	38. (b)	39. (c)	40. (a)
41. (b)	42. (c)	43. (a)	44. (d)	45. (d)					

HINTS & SOLUTIONS

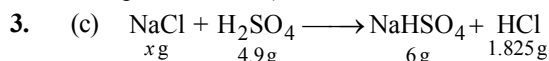
1. (a)  $X \xrightarrow{\text{NH}_4\text{OH}}$  White ppt



Given reactions (white precipitate with  $\text{H}_2\text{S}$  in presence of  $\text{NH}_4\text{OH}$ ) indicate that 'X' should be  $\text{ZnCl}_2$  which explains all given reactions.



2. (b)  $\text{CN}^-$  is a strong field ligand as it is a pseudohalide ion. These ions are strong coordinating ligands and hence have the tendency to form  $\sigma$ -bond (from the pseudo halide to the metal) and  $\pi$ -bond. (from the metal to pseudo halide)



According to law of conservation of mass "mass is neither created nor destroyed during a chemical change"

$\therefore$  Mass of the reactants = Mass of products

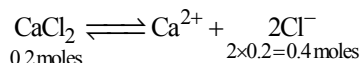
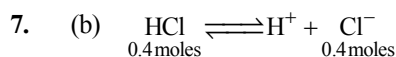
$$x + 4.9 = 6 + 1.825$$

$$\text{or } x = 2.925 \text{ g}$$

4. (b) The ideal value of D.O for growth of fishes is 8 mg/ℓ. 7mg ℓ is desirable range, below this value fishes get susceptible to disease. A value of 2 mg/ℓ or below is lethal for fishes.

5. (b) In case of nitrogen, d-orbitals are not available.

6. (c) C is incorrect ; The correct is  $\Delta E = \Delta q + \Delta w$



Total  $\text{Cl}^-$  moles = 0.4 + 0.4 = 0.8 moles

$$\text{Molarity} = \frac{\text{Moles}}{\text{Vol. in L}}$$

$$\therefore \text{Molarity of } \text{Cl}^- = \frac{0.8}{0.5} = 1.6 \text{ M.}$$

8. (b) Sodium cyanide ( $\text{Na} + \text{C} + \text{N} \rightarrow \text{NaCN}$ ). (Lassaigne's test)

9. (d) Specific volume (volume of 1 gm) of cylindrical virus particle =  $6.02 \times 10^{-2} \text{ cc/gm}$

$$\text{Radius of virus (r)} = 7 \text{ \AA} = 7 \times 10^{-8} \text{ cm}$$

$$\text{Length of virus} = 10 \times 10^{-8} \text{ cm}$$

Volume of virus

$$\pi r^2 l = \frac{22}{7} \times (7 \times 10^{-8})^2 \times 10 \times 10^{-8}$$

$$= 154 \times 10^{-23} \text{ cc}$$

$$\text{Wt. of one virus particle} = \frac{\text{volume}}{\text{specific volume}}$$

$\therefore$  Mol. wt. of virus = Wt. of  $N_A$  particle

$$= \frac{154 \times 10^{-23}}{6.02 \times 10^{-22}} \times 6.02 \times 10^{23}$$

$$= 15400 \text{ g/mol} = 15.4 \text{ kg/mole}$$

10. (a) Inductive effect involves displacement of  $\sigma$ -electrons.

11. (a) Using the relation  $\lambda = \frac{hc}{E}$

Substituting given values, we get

$$\lambda = \frac{6.62 \times 10^{-27} \text{ erg-sec} \times 3 \times 10^{10} \text{ cm s}^{-1}}{3 \times 10^{-12} \text{ erg}}$$

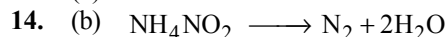
$$\lambda = 6.62 \times 10^{-5} \text{ cm}$$

$$= 6.62 \times 10^{-5} \times 10^7 \text{ nm} [1 \text{ cm} = 10^7 \text{ nm}]$$

$$= 662 \text{ nm}$$

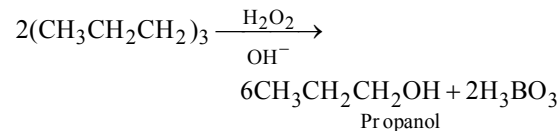
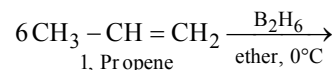
12. (d)  $-\text{OCH}_3$  activates the benzene ring.  $-\text{NO}_2$  deactivates the ring. Hence the reaction of the given compounds with electrophiles is in the order, I > II > III.

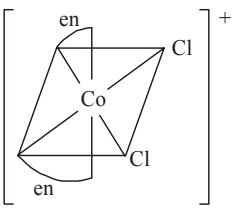
13. (d)



Volume of  $\text{N}_2$  formed in successive five minutes are 2.75 cc, 2.40 cc and 2.25 cc which is in decreasing order. So rate of reaction is dependent on concentration of  $\text{NH}_4\text{NO}_2$ . As decrease is not very fast so it will be first order reaction.

15. (d) We know that

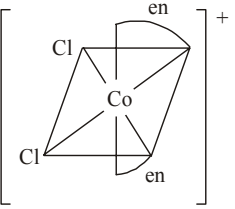


16. (b)  $p_{\text{tot}} = 740 \text{ mm}$   
 $p_{\text{tot}} = p_{\text{O}_2} + p_{\text{H}_2}$   
 Number of moles of  $\text{O}_2$  and  $\text{H}_2$  are equal  
 $\therefore p_{\text{O}_2} = p_{\text{H}_2}$   
 $\therefore p_{\text{O}_2} + p_{\text{H}_2} = 740$   
 $p_{\text{O}_2} = 370 \text{ mm} = p_{\text{H}_2}$
17. (d) Formation of only  $\text{CH}_3\text{COOH}$  by ozonolysis indicates that the compound Y should be  $\text{CH}_3\text{CH}=\text{CHCH}_3$  which can be formed by all of the three given compounds
- $$\text{CH}_2=\text{CH}-\underset{\text{X}}{\text{CH}}=\text{CH}_2 \xrightarrow{\text{IH}_2/\text{Pt}} \underset{\text{Y}}{\text{CH}_3-\text{CH}=\text{CH}-\text{CH}_3}$$
- $$\underset{\text{X}}{\text{CH}_3\text{C}\equiv\text{CCH}_3} \xrightarrow{\text{IH}_2/\text{Pt}} \underset{\text{Y}}{\text{CH}_3\text{CH}=\text{CHCH}_3}$$
- $$\underset{\text{X}}{\text{CH}_2=\text{C}=\text{CHCH}_3} \xrightarrow{\text{IH}_2/\text{Pt}} \underset{\text{Y}}{\text{CH}_3\text{CH}=\text{CHCH}_3} \xrightarrow{\text{O}_3} 2\text{CH}_3\text{COOH}$$
18. (b)  $\text{pH} = \frac{1}{2}[\text{p}K_a - \log I] = \frac{\text{p}K_a}{2}$   
 $\text{pH}' \text{ (twice of pH)} = \text{p}K_a$   
 $\therefore \text{p}K_a = \frac{1}{2}[\text{p}K_a - \log C]$   
 $-\log C = \text{p}K_a = -\log K_a$   
 $C = K_a = 1.8 \times 10^{-5} \text{ M}$   
 $\text{dilution} = \frac{1}{C} = 5.55 \times 10^4 \text{ times}$
19. (d) The sulphide ore is roasted to oxide before reduction because the  $\Delta G_f^\circ$  of most of the sulphides are greater than those of  $\text{CS}_2$  and  $\text{H}_2\text{S}$ , therefore neither C nor H can reduce metal sulphide to metal. Further, the standard free energies of formation of oxide are much less than those of  $\text{SO}_2$ . Hence oxidation of metal sulphides to metal oxide is thermodynamically favourable.
20. (d) Buffer solution contains weak base + salt of weak base with strong acid or weak acid + salt of weak acid with strong base.  
 In option (d) the acid used is  $\text{HClO}_4$  which is strong acid and  $\text{KClO}_4$  is salt of this acid with strong base. So it is not an example of buffer solution.
21. (d) The most abundant rare gas found in the atmosphere is argon and not helium.
22. (c)
- 

Cis-d-isomer

|

Mirror



Cis-l-isomer

23. (d) Given,  
 $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3; K_1 \dots \text{(i)}$   
 $\text{N}_2 + \text{O}_2 \rightleftharpoons 2\text{NO}; K_2 \dots \text{(ii)}$   
 $\text{H}_2 + \frac{1}{2}\text{O}_2 \rightleftharpoons \text{H}_2\text{O}; K_3 \dots \text{(iii)}$   
 We have to calculate  
 $4\text{NH}_3 + 5\text{O}_2 \longrightarrow 4\text{NO} + 6\text{H}_2\text{O}; K = ?$   
 or  $2\text{NH}_3 + \frac{5}{2}\text{O}_2 \longrightarrow 2\text{NO} + 3\text{H}_2\text{O}$
- For this equation,  $K = \frac{[\text{NO}]^2 [\text{H}_2\text{O}]^3}{[\text{NH}_3]^2 [\text{O}_2]^{5/2}}$
- but  $K_1 = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}, K_2 = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]}$   
 $\& K_3 = \frac{[\text{H}_2\text{O}]}{[\text{H}_2][\text{O}_2]^{1/2}} \text{ or } K_3 = \frac{[\text{H}_2\text{O}]^3}{[\text{H}_2]^3 [\text{O}_2]^{3/2}}$
- Now operate,  $\frac{K_2 \cdot K_3^3}{K_1}$
- $$= \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]} \times \frac{[\text{H}_2\text{O}]^3}{[\text{H}_2]^3 [\text{O}_2]^{3/2}} \cdot \frac{[\text{N}_2][\text{H}_2]^3}{[\text{NH}_3]^2}$$
- $$= \frac{[\text{NO}]^2 [\text{H}_2\text{O}]^3}{[\text{NH}_3]^2 [\text{O}_2]^{5/2}} = K$$
- $\therefore K = \frac{K_2 \cdot K_3^3}{K_1}$
24. (c) For third ionization enthalpy last configuration of
- |                  | 3d  | 4s   |
|------------------|---|--|
| V - $4s^0 3d^3$  | <div style="border: 1px solid black; padding: 2px; display: inline-block;">↑↑↑</div>    | <div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div> |
| Cr - $4s^0 3d^4$ | <div style="border: 1px solid black; padding: 2px; display: inline-block;">↑↑↑↑</div>   | <div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div> |
| Mn - $4s^0 3d^5$ | <div style="border: 1px solid black; padding: 2px; display: inline-block;">↑↑↑↑↑</div>  | <div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div> |
| Fe - $4s^0 3d^6$ | <div style="border: 1px solid black; padding: 2px; display: inline-block;">↑↑↑↑↑↑</div> | <div style="border: 1px solid black; padding: 2px; display: inline-block;">↑</div> |
- For third Ionization enthalpy Mn has stable configuration due to half filled d-orbital.
25. (d)  $[\text{Co}(\text{CO})_5\text{NH}_3]^{2+}$ . In this complex, Co-atom attached with  $\text{NH}_3$  through  $\sigma$  bonding with CO attached with dative  $\pi$ -bond.
26. (a) Given reaction is  
 $\text{IO}_3^- + \text{aI}^- + \text{bH}^+ \longrightarrow \text{cH}_2\text{O} + \text{dI}_2$   
 I<sup>st</sup> half reaction  
 $\text{I}^- \longrightarrow \text{I}_2 \dots \text{(i)}$   
 $-1 \quad 0 \quad \text{(oxidation)}$   
 II<sup>nd</sup> half reaction  
 $\text{IO}_3^- \longrightarrow \text{I}_2 \dots \text{(ii)}$   
 $+5 \quad 0 \quad \text{(reduction)}$   
 On balancing equation (ii) we have  
 $10\text{e}^- + 2\text{IO}_3^- + 12\text{H}^+ \longrightarrow \text{I}_2 + 6\text{H}_2\text{O} \dots \text{(iii)}$   
 Now, balance equation (i)





# Mock Test-2

Time : 1 hr

Max. Marks -180

- The angular momentum of the electron in first excited energy state of hydrogen atom is
  - $\frac{h}{\pi}$
  - $\frac{h}{2\pi}$
  - $\sqrt{2(2+1)} \frac{h}{2\pi}$
  - None of these
- When NaCl is doped with  $1.0 \times 10^{-3}$  mole of  $\text{SrCl}_2$ , the number of cation vacancy is
  - $6.023 \times 10^{18}$
  - $6.023 \times 10^{20}$
  - $2 \times 6.023 \times 10^{20}$
  - $3.011 \times 10^{20}$
- A 0.5 M NaOH solution offers a resistance of 31.6 ohm in a conductivity cell at room temperature. What shall be the approximate molar conductance of this NaOH solution if cell constant of the cell is  $0.367 \text{ cm}^{-1}$ .
  - $23.4 \text{ S cm}^2 \text{ mole}^{-1}$
  - $23.2 \text{ S cm}^2 \text{ mole}^{-1}$
  - $46.45 \text{ S cm}^2 \text{ mole}^{-1}$
  - $54.64 \text{ S cm}^2 \text{ mole}^{-1}$
- Ammonium dichromate on heating gives
  - chromic acid & ammonia
  - chromium sesquioxide & nitrogen
  - chromium sesquioxide & ammonia
  - chromic acid and  $\text{N}_2$
- Predict the relative acidic strength among the following
  - $\text{H}_2\text{O}, \text{H}_2\text{S}, \text{H}_2\text{Se}, \text{H}_2\text{Te}$
  - $\text{H}_2\text{O} < \text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$
  - $\text{H}_2\text{Te} < \text{H}_2\text{Se} < \text{H}_2\text{S} < \text{H}_2\text{O}$
  - $\text{H}_2\text{O} < \text{H}_2\text{Se} < \text{H}_2\text{S} < \text{H}_2\text{Te}$
- The catalyst used in the preparation of an alkyl chloride by the action of dry HCl on an alcohol is
  - anhydrous  $\text{AlCl}_3$
  - $\text{FeCl}_3$
  - anhydrous  $\text{ZnCl}_2$
  - Cu
- In which of the following, resonance will be possible?
  - $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CHO}$
  - $\text{CH}_2 = \text{CH} - \text{CH} = \text{O}$
  - $\text{CH}_3\text{COCH}_3$
  - $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH} = \text{CH}_2$
- The four quantum numbers that could identify the third 3p electron in sulphur are
  - $n=3, l=0, m=+1, s=+\frac{1}{2}$
  - $n=2, l=2, m=-1, s=+\frac{1}{2}$
  - $n=3, l=2, m=+1, s=-\frac{1}{2}$
  - $n=3, l=1, m=-1, s=+\frac{1}{2}$
- $\text{Sn}^{4+} + 2\text{e}^- \longrightarrow \text{Sn}^{2+} \quad E^\circ = 0.13 \text{ V}$   
 $\text{Br}_2 + 2\text{e}^- \longrightarrow 2\text{Br}^- \quad E^\circ = 1.08 \text{ V}$   
 Calculate  $K_{\text{eq}}$  for the cell at  $20^\circ\text{C}$  formed by two electrodes
  - $10^{41}$
  - $10^{32}$
  - $10^{-32}$
  - $10^{-42}$
- Calculate the pH of a solution obtained by mixing 2 ml of HCl of pH 2 and 3 ml of solution of KOH of pH = 12
  - 10.30
  - 3.70
  - 11.30
  - None of these
- Which of the following represents a correct sequence of reducing power of the following elements?
  - $\text{Li} > \text{Cs} > \text{Rb}$
  - $\text{Rb} > \text{Cs} > \text{Li}$
  - $\text{Cs} > \text{Li} > \text{Rb}$
  - $\text{Li} > \text{Rb} > \text{Cs}$
- Paramagnetism of Cr ( $Z = 24$ ),  $\text{Mn}^{2+}$  ( $Z = 25$ ) and  $\text{Fe}^{3+}$  ( $Z = 26$ ) are  $x, y$  and  $z$  respectively. They are in the order
  - $x = y = z$
  - $x > y > z$
  - $x = y > z$
  - $x > y = z$
- Formaldehyde reacts with ammonia to give urotropine is
  - $(\text{CH}_2)_6\text{N}_4$
  - $(\text{CH}_2)_4\text{N}_3$
  - $(\text{CH}_2)_6\text{N}_6$
  - $(\text{CH}_2)_3\text{N}_3$
- Indicate the wrongly named compound
  - $$\begin{array}{c} \text{CH}_3 - \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{CHO} \\ | \\ \text{CH}_3 \end{array}$$
 (4-methyl -1- pentanal)
  - $$\begin{array}{c} \text{CH}_3 - \text{CH} - \text{C} \equiv \text{C} - \text{COOH} \\ | \\ \text{CH}_3 \end{array}$$
 (4- methyl -2- pentyn -1- oic acid)
  - $$\begin{array}{c} \text{CH}_3\text{CH}_2\text{CH}_2 - \text{CH} - \text{COOH} \\ | \\ \text{CH}_3 \end{array}$$
 (2- methyl -1- pentanoic acid)
  - $$\begin{array}{c} \text{O} \\ || \\ \text{CH}_3 - \text{CH}_2 - \text{CH} = \text{CH} - \text{C} - \text{CH}_3 \end{array}$$

(3-hexen-5-one)

15. The favourable condition for a process to be spontaneous is :

- (a)  $T\Delta S > \Delta H$ ,  $\Delta H = +\text{ive}$ ,  $\Delta S = -\text{ive}$   
 (b)  $T\Delta S > \Delta H$ ,  $\Delta H = +\text{ive}$ ,  $\Delta S = +\text{ive}$   
 (c)  $T\Delta S = \Delta H$ ,  $\Delta H = -\text{ive}$ ,  $\Delta S = -\text{ive}$   
 (d)  $T\Delta S = \Delta H$ ,  $\Delta H = +\text{ive}$ ,  $\Delta S = +\text{ive}$

16. Vapour pressure (in torr) of an ideal solution of two liquids A and B is given by :  $P = 52X_A + 114$  where  $X_A$  is the mole fraction of A in the mixture. The vapour pressure (in torr) of equimolar mixture of the two liquids will be :

- (a) 166 (b) 83  
 (c) 140 (d) 280

17. The decomposition of a substance follows first order kinetics. Its concentration is reduced to 1/8th of its initial value in 24 minutes. The rate constant of the decomposition process is

- (a)  $1/24 \text{ min}^{-1}$  (b)  $\frac{0.692}{24} \text{ min}^{-1}$   
 (c)  $\frac{2.303}{24} \log \left( \frac{1}{8} \right) \text{ min}^{-1}$  (d)  $\frac{2.303}{24} \log \left( \frac{8}{1} \right) \text{ min}^{-1}$

18. Fluorine does not show highest oxidation state opposite to other halogens, because

- (a) it is most electronegative  
 (b) it has no *d*-orbital  
 (c) its atomic radius is very small  
 (d)  $\text{F}^-$  ion is stable and isoelectronic with neon

19. Glucose contains in addition to aldehyde group.

- (a) one secondary -OH and four primary -OH groups  
 (b) one primary -OH and four secondary -OH groups  
 (c) two primary -OH and three secondary -OH groups  
 (d) three primary -OH and two secondary -OH groups

20. Which of the following product is obtained by treating 1-butyne with  $\text{HgSO}_4$  and  $\text{H}_2\text{SO}_4$ ?

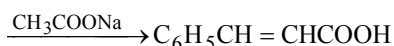
- (a)  $\text{CH}_3\text{CH}_2\text{COCH}_3$  (b)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$   
 (c)  $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$  (d)  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$

21. An example of Perkin's reaction is

- (a)  $\text{C}_6\text{H}_5\text{CHO} + \text{CH}_3\text{NO}_2$



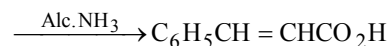
- (b)  $\text{C}_6\text{H}_5\text{CHO} + (\text{CH}_3\text{CO})_2\text{O}$



- (c)  $\text{C}_6\text{H}_5\text{CHO} + \text{CH}_3\text{CHO}$



- (d)  $\text{C}_6\text{H}_5\text{CHO} + \text{CH}_2(\text{COOH})_2$



22. The product obtained on reaction of  $\text{C}_2\text{H}_5\text{Cl}$  with hydrogen over palladium carbon is :

- (a)  $\text{C}_3\text{H}_8$  (b)  $\text{C}_4\text{H}_{10}$   
 (c)  $\text{C}_2\text{H}_6$  (d)  $\text{C}_2\text{H}_4$

23. Which of the following can be predicted from electronegativity values of elements ?

- (a) Dipole moment of a molecule  
 (b) Valency of elements  
 (c) Polarity of bonds  
 (d) Position in electrochemical series

24. The reaction  $3\text{ClO}^-(\text{aq}) \longrightarrow \text{ClO}_3^-(\text{aq}) + 2\text{Cl}^-(\text{aq})$  is an example of

- (a) oxidation reaction  
 (b) reduction reaction  
 (c) disproportionation reaction  
 (d) decomposition reaction

25. The concentration of a reactant X decreases from 0.1 M to 0.005 M in 40 min. If the reaction follows first order kinetics, the rate of the reaction when the concentration of X is 0.01 M will be

- (a)  $1.73 \times 10^{-4} \text{ M min}^{-1}$  (b)  $3.47 \times 10^{-4} \text{ M min}^{-1}$   
 (c)  $3.47 \times 10^{-5} \text{ M min}^{-1}$  (d)  $7.5 \times 10^{-4} \text{ M min}^{-1}$

26. Mark the false statement?

- (a) A salt bridge is used to eliminate liquid junction potential  
 (b) The Gibbs free energy change,  $\Delta G$  is related with electromotive force  $E$  as  $\Delta G = -nFE$   
 (c) Nernst equation for single electrode potential is  $E = E^\circ - \frac{RT}{nF} \log a_{\text{M}^{n+}}$   
 (d) The efficiency of a hydrogen-oxygen fuel cell is 23%

27. The paramagnetism of transition element compounds is due to

- (a) paired electrons spinning in opposite directions  
 (b) unpaired electrons in *d* and *f*-orbitals  
 (c) shared valance electrons  
 (d) unpaired electrons in *s* or *p*-orbitals.

28. Aniline, chloroform and alcoholic KOH react to produce a bad smelling substance which is

- (a) phenyl isocyanide  
 (b) phenyl cyanide  
 (c) chlorobenzene  
 (d) benzyl alcohol.

29. The species with a radius less than that of Ne is

- (a)  $\text{Mg}^{2+}$  (b)  $\text{F}^-$   
 (c)  $\text{O}^{2-}$  (d)  $\text{K}^+$

30. Vapour density of the equilibrium mixture of the reaction  $\text{SO}_2\text{Cl}_{2(\text{g})} \rightleftharpoons \text{SO}_{2(\text{g})} + \text{Cl}_{2(\text{g})}$  is 50.0. Percent dissociation of  $\text{SO}_2\text{Cl}_2$  is :

- (a) 33.33 (b) 35.0  
(c) 30.0 (d) 66.67
31. What will be the emf for the given cell  
 $\text{Pt} | \text{H}_2 (\text{P}_1) | \text{H}^+ (\text{aq}) | \text{H}_2 (\text{P}_2) | \text{Pt}$   
 (a)  $\frac{RT}{F} \ln \frac{P_1}{P_2}$  (b)  $\frac{RT}{2F} \ln \frac{P_1}{P_2}$   
 (c)  $\frac{RT}{F} \ln \frac{P_2}{P_1}$  (d) None of these
32.  $\text{H}_3\text{PO}_3$  is  
 (a) neutral (b) basic  
 (c) a tribasic acid (d) a dibasic acid
33. Of the following which is diamagnetic in nature?  
 (a)  $[\text{CoF}_6]^{3+}$  (b)  $[\text{NiCl}_4]^{2-}$   
 (c)  $[\text{CuCl}_4]^{2-}$  (d)  $[\text{Ni}(\text{CN})_4]^{2-}$
34. Which of the following products is formed when benzaldehyde is treated with  $\text{CH}_3\text{MgBr}$  and the addition product so obtained is subjected to acid hydrolysis?  
 (a) A secondary alcohol (b) A primary alcohol  
 (c) Phenol (d) tert-Butyl alcohol
35. Mole fraction of methanol in its aqueous solution is 0.5. The concentration of solution in terms of percent by mass of methanol is  
 (a) 36 (b) 50  
 (c) 64 (d) 72
36. The unit cell of an ionic compound is a cube in which cations (A) occupy each of the corners and anions (B) are at the centres of each face. The simplest formula of the ionic compound is  
 (a)  $\text{AB}_2$  (b)  $\text{A}_3\text{B}$   
 (c)  $\text{AB}_3$  (d)  $\text{A}_4\text{B}_3$
37. For orthorhombic system axial ratios are  $a \neq b \neq c$  and the axial angles are  
 (a)  $\alpha = \beta = \gamma \neq 90^\circ$   
 (b)  $\alpha = \beta = \gamma = 90^\circ$   
 (c)  $\alpha = \beta = \gamma = 90^\circ, \beta \neq 90^\circ$   
 (d)  $\alpha \neq \beta \neq \gamma = 90^\circ$
38. Electrolytic reduction of alumina to aluminium by Hall-Heroult process is carried out  
 (a) in the presence of NaCl  
 (b) in the presence of fluorite  
 (c) in the presence of cryolite which forms a melt with lower melting temperature  
 (d) in the presence of cryolite which forms a melt with higher melting temperature
39. Consider the following complex  
 $[\text{Co}(\text{NH}_3)_5\text{CO}_3]\text{ClO}_4$   
 The coordination number, oxidation number, number of  $d$ -electrons and number of unpaired  $d$ -electrons on the metal are respectively  
 (a) 6, 3, 6, 0 (b) 7, 2, 7, 1  
 (c) 7, 1, 6, 4 (d) 6, 2, 7, 3
40. Nylon is a :  
 (a) polysaccharide (b) polyester  
 (c) polyamide (d) all of the above
41.  $\text{OH}-\text{C}_6\text{H}_4-\text{SO}_3\text{H} \xrightarrow[\text{H}_2\text{O}]{\text{Br}_2} \text{X}$ ,  
 X is identified as  
 (a) 2, 4, 6-tribromophenol  
 (b) 2-bromo-4-hydroxybenzene sulphononic acid  
 (c) 3, 5-dibromo-4-hydroxybenzene sulphononic acid  
 (d) 2-bromophenol
42. The non-polar molecule is :  
 (a)  $\text{NF}_3$  (b)  $\text{SO}_3$   
 (c)  $\text{CHCl}_3$  (d)  $\text{ClO}_2$
43. The hybridization of P in  $\text{PO}_4^{3-}$  is the same as of  
 (a) S in  $\text{SO}_3$  (b) N in  $\text{NO}_3^-$   
 (c) S in  $\text{SO}_4^{2-}$  (d) I in  $\text{ICl}_4^-$
44. Solution of potash alum is acidic in nature. This is due to hydrolysis of  
 (a)  $\text{SO}_4^{2-}$  (b)  $\text{K}^+$   
 (c)  $\text{Al}_2(\text{SO}_4)_3$  (d)  $\text{Al}^{3+}$
45. When conc.  $\text{HNO}_3$  acts on our skin, the skin becomes yellow, because  
 (a)  $\text{HNO}_3$  acts as an oxidising agent  
 (b)  $\text{HNO}_3$  acts as a dehydrating agent  
 (c) Nitro-cellulose is formed  
 (d) The proteins are converted into xanthoproteins

ANSWER KEY

1. (a)	2. (b)	3. (b)	4. (b)	5. (a)	6. (c)	7. (b)	8. (d)	9. (b)	10. (c)
11. (a)	12. (d)	13. (a)	14. (d)	15. (b)	16. (c)	17. (d)	18. (b)	19. (b)	20. (a)
21. (b)	22. (c)	23. (c)	24. (c)	25. (d)	26. (c)	27. (b)	28. (a)	29. (a)	30. (b)
31. (b)	32. (d)	33. (d)	34. (a)	35. (c)	36. (c)	37. (b)	38. (c)	39. (a)	40. (c)
41. (c)	42. (b)	43. (c)	44. (a)	45. (d)					

HINTS&SOLUTIONS

- (a) Angular momentum,  $mvr = n \frac{h}{2\pi}$   
( $n = 2$  for first excited state)
- (b) Two  $\text{Na}^+$  ions are replaced by one  $\text{Sr}^{2+}$  ion to maintain electrical neutrality.  
Hence, number of vacancies  
= Number of  $\text{Sr}^{2+}$  ions doped  
 $= 1.0 \times 10^{-3} \times 6.02 \times 10^{23} = 6.02 \times 10^{20}$
- (b) Here,  $R = 31.6 \text{ ohm}$   
 $\therefore C = \frac{1}{R} = \frac{1}{31.6} \text{ ohm}^{-1} = 0.0316 \text{ ohm}^{-1}$   
Specific conductance = conductance  $\times$  cell constant  
 $= 0.0316 \text{ ohm}^{-1} \times 0.367 \text{ cm}^{-1}$   
 $= 0.0116 \text{ ohm}^{-1} \text{ cm}^{-1}$   
Now, molar concentration =  $0.5 \text{ M}$  (given)  
 $= 0.5 \times 10^{-3} \text{ mole cm}^{-3}$   
 $\therefore \text{Molar conductance} = \frac{K}{C} = \frac{0.0116}{0.5 \times 10^{-3}}$   
 $= 23.2 \text{ S cm}^2 \text{ mol}^{-1}$
- (b)  $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \xrightarrow{\text{heat}} \text{Cr}_2\text{O}_3 + 4\text{H}_2\text{O} + \text{N}_2$
- (a) Assume that each has lost a proton. So we get:  $\text{HO}^-$ ,  $\text{HS}^-$ ,  $\text{HSe}^-$ ,  $\text{HTe}^-$   
It can be easily seen that the volume available for the negative charge is increasing from  $\text{HO}^-$  to  $\text{HTe}^-$ , therefore  
(i) volume available for the negative charge is increasing from left to right  
(ii) charge density is decreasing from left to right  
(iii) basicity is decreasing from left to right  
(iv) acidity of conjugate acids is increasing from left to right  
 $\text{H}_2\text{O} < \text{H}_2\text{S} < \text{H}_2\text{Se} < \text{H}_2\text{Te}$
- (c) In preparation of an alkyl chloride by the action of dry  $\text{HCl}$ , the catalyst generally used is anhydrous  $\text{ZnCl}_2$ .
- (b) Only structure (b) has a conjugated system, which is necessary for resonance.
- (d)

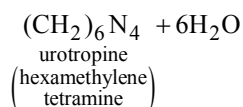
- (b)  $\text{Sn}^{4+} + 2\text{e}^- \longrightarrow \text{Sn}^{2+}$   $E^\circ = 0.13 \text{ V}$   
 $\text{Br}_2 + 2\text{e}^- \longrightarrow 2\text{Br}^-$   $E^\circ = 1.08 \text{ V}$   
 $E^\circ$  values shows  $\text{Br}_2$  has higher reduction potential.  
Hence  $E_{\text{cell}} = E_{\text{R}} - E_{\text{L}}$   
 $= E_{\text{Br}_2/\text{Br}^-} - E_{\text{Sn}^{4+}/\text{Sn}^{2+}}$   
 $= 1.08 - 0.13 = 0.95 \text{ V}$   
Now  $-\Delta G = nFE_{\text{cell}}$   
 $n = 2, F = 96500.$   
 $-\Delta G = 2 \times 96500 \times 0.95 \text{ kJ/mol}$   
Also,  $\Delta G = -2.303 RT \log K_{\text{eq}}$   
 $\log K_{\text{eq}} = -\frac{\Delta G}{2.303 \times R \times T}$   
 $= \frac{-(-2 \times 96500 \times 0.95)}{2.303 \times 8.314 \times 293} = 32.6820$   
 $K_{\text{eq}} = \text{antilog } 32.682$   
 $= 4.78 \times 10^{32} \approx 10^{32}$
- (c)  $[\text{H}^+]$  in  $\text{HCl}$  solution ( $\text{pH} = 2$ ) =  $10^{-2} \text{ M}$ ;  $[\text{OH}^-]$  in  $\text{KOH}$  solution ( $\text{pOH} = 14 - 12 = 2$ ) =  $10^{-2} \text{ M}$   
Excess m Mol of  $\text{OH}^-$  in 5 ml mixture  
 $= 3 \times 10^{-2} - 2 \times 10^{-2} = 1.0 \times 10^{-2};$   
 $[\text{OH}^-] \text{ in mixture} = \frac{1.0 \times 10^{-2}}{5}$   
 $= 2 \times 10^{-3} \text{ M};$   
 $\text{pOH} = -\log 2 \times 10^{-3} = 3 - \log 2;$   
 $\text{pH} = 14 - (3 - \log 2) = 11.30$
- (a) A reducing agent is a substance which can loose electron and hence a reducing agent should have low ionisation energy. Now since ionisation energy decreases from  $\text{Li}$  to  $\text{Cs}$ , the reducing property should increase in the opposite manner. The only exception to this is lithium. This is because the net process of converting an atom to an ion takes place in 3 steps.



- (i)  $M(s) \rightarrow M(g)$   $\Delta H$  = Sublimation energy  
 (ii)  $M(g) \rightarrow M^+(g) + e^-$   $\Delta H$  = Ionisation energy  
 (iii)  $M^+(g) + H_2O \rightarrow M^+(aq)$   $\Delta H$  = Hydration energy  
 The large amount of energy liberated in hydration of Li (because of its small size) makes the overall  $\Delta H$  negative. This accounts for the higher oxidation potential of lithium i.e., its high reducing power.

12. (d) Number of unpaired electrons in Cr,  $Mn^{2+}$  and  $Fe^{3+}$  are 6, 5 and 5 respectively.

13. (a)  $6HCHO + 4NH_3 \longrightarrow$



14. (d)  $\overset{6}{CH_3}\overset{5}{CH_2}\overset{4}{CH}=\overset{3}{CH}\overset{2}{C}\overset{1}{CH_3}$   
 (hex 3-ene-5-one)

15. (b)

16. (c) Total V.P.,

$$P = P_A^\circ X_A + P_B^\circ X_B = P_A^\circ X_A + P_B^\circ (1 - X_A)$$

$$= (P_A^\circ - P_B^\circ) X_A + P_B^\circ$$

Thus,  $P_B^\circ = 114$  torr ;  $P_A^\circ - P_B^\circ = 52$

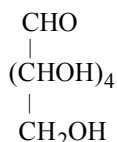
or  $P_A^\circ = 166$  torr

Hence  $P = 166 \times \frac{1}{2} + 114 \times \frac{1}{2} = 140$  torr

17. (d)  $k = \frac{2.303}{t} \log \frac{a}{a-x}$   
 $= \frac{2.303}{24} \log \frac{1}{\frac{1}{8}} = \frac{2.303}{24} \log 8$

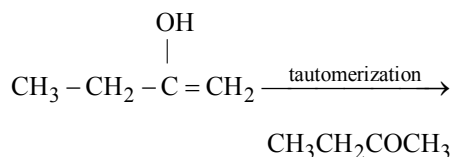
18. (b)

19. (b) Structural formula of glucose is

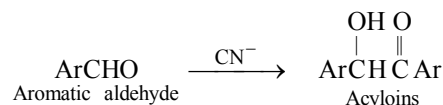


In addition to -CHO group it contains one primary and four secondary -OH groups.

20. (a)  $CH_3 - CH_2 - C \equiv CH \xrightarrow[H_3O^+]{Hg^{2+}}$



21. (b) In general,



22. (c)  $C_2H_5Cl + H_2 \xrightarrow{Pd} C_2H_6$

Reduction of alkyl halide by  $H_2$  in the presence of Pd which serves as catalyst. The accumulation of hydrogen gas occurs on the surface of active palladium so that fast reduction may be achieved.

23. (c) Greater the difference of electronegativities, more polar is the bond.

24. (c) O.N. of Cl in  $ClO^-$  changes from +1 to +5 and -1.

25. (d) For a first order reaction, we have

$$k = \frac{2.303}{t} \log \frac{N_0}{N}$$

$$\therefore k = \frac{2.303}{40 \text{ min}} \log \frac{0.1}{0.005}$$

$$= \frac{2.303}{40 \text{ min}} \times \log 20 = \frac{2.303}{40} \times 1.3010$$

Now rate =  $k \times [\text{reactant}]$

When  $[x] = 0.01$  M

$$\therefore \text{rate} = \frac{2.303}{40} \times 1.3010 \times 0.01 \text{ M min}^{-1}$$

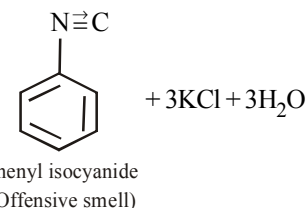
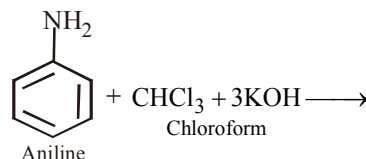
$$= 7.5 \times 10^{-4} \text{ M min}^{-1}$$

26. (c) Correct Nernst equation is

$$E = E^\circ + \frac{2.303 RT}{nF} \log a_{M^{n+}}$$

27. (b)

28. (a) This is isocyanide test



29. (a)

30. (b)  $\text{SO}_2\text{Cl}_{2(g)} \rightleftharpoons \text{SO}_{2(g)} + \text{Cl}_{2(g)}$

$$\alpha \% = \frac{D-d}{d(y-1)} \times 100 \quad (y=2)$$

$$D = \frac{\text{molar mass of SO}_2\text{Cl}_2}{2} = \frac{135}{2} = 67.5;$$

$$d = 50.0 \text{ (given)}$$

$$\alpha\% = \frac{67.5 - 50.0}{50.0(2-1)} \times 100 = 35\%$$

31. (b) LHS :  $\text{H}_2(\text{P}_1) \rightleftharpoons 2\text{H}^+ + 2\text{e}^-$  Oxidation  
RHS :  $2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{P}_2)$  Reduction  
Net reaction :

$$\text{H}_2(\text{P}_1) \rightleftharpoons \text{H}_2(\text{P}_2)$$

$$E = E^\circ - \frac{RT}{nF} \ln \frac{P_2}{P_1} = 0 + \frac{RT}{2F} \ln \frac{P_1}{P_2}$$

32. (d)  $\begin{array}{c} \text{O} \\ \uparrow \\ \text{H} - \text{P} - \text{OH} \\ | \\ \text{OH} \end{array}$ , so dibasic acid

33. (d)  $[\text{CoF}_6]^{3-}$  :  $\begin{array}{|c|c|c|c|c|c|} \hline 3d & & & & & \\ \hline \uparrow\downarrow & \uparrow & \uparrow & \uparrow & \uparrow & \uparrow \\ \hline \end{array}$   
 $\begin{array}{|c|c|c|c|c|c|c|c|c|c|} \hline 4s & 4p & & 4d & & & & & & \\ \hline \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & & & & & \\ \hline \end{array}$

$sp^3d^2$  (Paramagnetic)

$[\text{NiCl}_4]^{2-}$  :



$sp^3$  (paramagnetic)

$[\text{CuCl}_4]^{2-}$  :



$dsp^2$  (paramagnetic)

$[\text{Ni}(\text{CN})_4]^{2-}$  :



(diamagnetic)  $\begin{array}{|c|c|c|c|} \hline & & & \\ \hline \end{array} dsp^2$  :

34. (a) Aldehydes, other than formaldehyde, when treated with  $\text{RMgX}$  give 2° alcohols.

35. (c) Mass of methanol in 1 mol solution =  $0.5 \times 32 = 16 \text{ g}$

$$\text{Mass of water in solution} = 0.5 \times 18 = 9 \text{ g}$$

$$\% \text{ by mass of methanol} = \frac{16 \times 100}{16 + 9} = 64$$

36. (c) Number of A atoms per unit cell =  $\frac{1}{8} \times 8 = 1$

(An atom at corner is shared by 8 unit cells)

$$\text{Number of B atoms per unit cell} = \frac{1}{2} \times 6 = 3$$

(An atom at the face centre is shared by 2 unit cells)

Hence, formula is :  $\text{AB}_3$

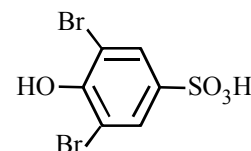
37. (b) For orthorhombic  $\alpha = \beta = \gamma = 90^\circ$

38. (c)

39. (a)  $[\text{Co}(\text{NH}_3)_5\text{CO}_3]\text{ClO}_4$ . Six monodentate ligands are attached to Co hence C. N. of Co = 6;  
O. N. =  $x + 5 \times (0) + 1 \times (-2) + 1 \times (-1) = 0$   
 $\therefore x = +3$ ; electronic configuration of  $\text{Co}^{3+}[\text{Ar}] 3d^6 4s^0$   
hence number of d electrons is 6 : All d electrons are paired due to strong ligand hence unpaired electrons zero.

40. (c) Nylon has  $\begin{array}{c} \text{O} \\ \parallel \\ -\text{C}-\text{NH}- \end{array}$  group linkage

41. (c)  $\text{HO}-\text{C}_6\text{H}_4-\text{SO}_3\text{H} \xrightarrow[\text{H}_2\text{O}]{\text{Br}_2}$



– OH group is highly activating. This is a type of electrophilic substitution reaction at ortho and para position.

42. (b)  $\text{SO}_3$  has trigonal planar geometry ( $sp^2$  hybridisation of S) which is symmetrical.

43. (c) Number of hybrid orbitals of P in  $\text{PO}_4^{3-} = \frac{1}{2} [5 + 0 + 3] = 4$  ( $sp^3$ )

No. of hybrid orbitals of N in  $\text{NO}_3^-$

$$= \frac{1}{2} [5 + 0 + 1] = 3$$
 ( $sp^2$ )

No. of hybrid orbitals of S in  $\text{SO}_4^{2-}$

$$= \frac{1}{2} [6 + 0 + 2 - 0] = 4$$
 ( $sp^3$ )

44. (a)  $\text{Al}_2(\text{SO}_4)_3$  is a salt of weak base and a strong acid hence on hydrolysis it will produce  $\text{Al}(\text{OH})_3$  and  $\text{H}_2\text{SO}_4$ . Since  $\text{H}_2\text{SO}_4$  is a strong acid and  $\text{Al}(\text{OH})_3$  is a weak base hence the solution will be acidic due to  $\text{SO}_4^{2-}$ .

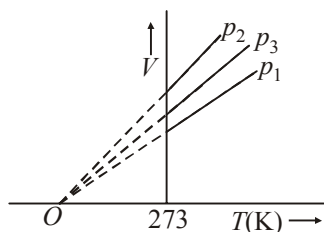
45. (d) It is the correct answer.

# Mock Test-3

Time : 1 hr

Max. Marks -180

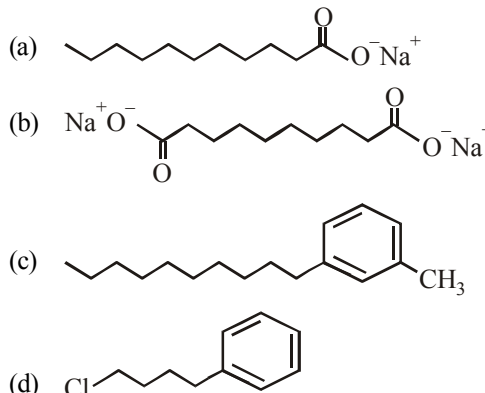
- Fluorine is more electronegative than either boron or phosphorus. What conclusion can be drawn from the fact that  $\text{BF}_3$  has no dipole moment but  $\text{PF}_3$  does ?  
 (a)  $\text{BF}_3$  is not spherically symmetrical but  $\text{PF}_3$  is spherically symmetrical.  
 (b)  $\text{BF}_3$  molecule must be linear  
 (c) The atomic radius of P is larger than that of B  
 (d) The  $\text{BF}_3$  molecule must be planar triangular
- The volume-temperature graphs of a given mass of an ideal gas at constant pressure are shown below.



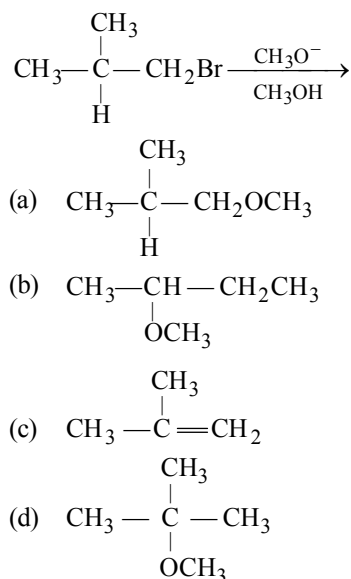
What is the correct order of pressures ?

- $p_1 > p_3 > p_2$
  - $p_1 > p_2 > p_3$
  - $p_2 > p_3 > p_1$
  - $p_2 > p_1 > p_3$
- Which is the most suitable reagent among the following to distinguish compound (3) from rest of the compounds ?  
 1.  $\text{CH}_3 - \text{C} \equiv \text{C} - \text{CH}_3$   
 2.  $\text{CH}_3 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$   
 3.  $\text{CH}_3 - \text{CH}_2\text{C} \equiv \text{CH}$   
 4.  $\text{CH}_3 - \text{CH} = \text{CH}_2$   
 (a) Bromine in carbon tetrachloride  
 (b) Bromine in acetic acid  
 (c) Alk  $\text{KMnO}_4$   
 (d) Ammonical silver nitrate.
  - In the extraction of Cu, the metal is formed in the bessemer converter due to the reaction :  
 (a)  $\text{Cu}_2\text{S} + 2\text{Cu}_2\text{O} \longrightarrow 6\text{Cu} + \text{SO}_2$   
 (b)  $\text{Cu}_2\text{S} \longrightarrow 2\text{Cu} + \text{S}$   
 (c)  $\text{Fe} + \text{Cu}_2\text{O} \longrightarrow 2\text{Cu} + \text{FeO}$   
 (d)  $2\text{Cu}_2\text{O} \longrightarrow 4\text{Cu} + \text{O}_2$
  - An example of electrophilic substitution reaction is  
 (a) Chlorination of methane  
 (b) Conversion of methyl chloride to methyl alcohol  
 (c) Nitration of benzene  
 (d) Formation of ethylene from ethyl alcohol.

- Which of the following molecules is most suitable to disperse benzene in water ?



- Ozone hole refers to  
 (a) Increase in concentration of ozone  
 (b) Hole in ozone layer  
 (c) Reduction in thickness of ozone layer in troposphere  
 (d) Reduction in thickness of ozone layer in stratosphere
- Which of the following does not represent the correct order of the properties indicated  
 (a)  $\text{Ni}^{2+} > \text{Cr}^{2+} > \text{Fe}^{2+} > \text{Mn}^{2+}$  (size)  
 (b)  $\text{Sc} > \text{Ti} > \text{Cr} > \text{Mn}$  (size)  
 (c)  $\text{Mn}^{2+} > \text{Ni}^{2+} < \text{Co}^{2+} < \text{Fe}^{2+}$  (unpaired electron)  
 (d)  $\text{Fe}^{2+} > \text{Co}^{2+} > \text{Ni}^{2+} > \text{Cu}^{2+}$  (unpaired electron)
- The major product formed in the following reaction is :



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25. A balloon has maximum capacity of 20 L. At one atmospheric pressure 10 L of air is filled in the balloon. It will burst when pressure is (assuming isothermal condition)
- (a)  $> 0.5$  atm (b)  $< 0.5$  atm  
(c)  $= 0.5$  atm (d)  $\geq 0.5$  atm
26. Which one of the following complexes will have four different isomers ?
- (a)  $[\text{Co(en)}_2\text{Cl}_2]\text{Cl}$  (b)  $[\text{Co(en)}(\text{NH}_3)\text{Cl}_2]\text{Cl}$   
(c)  $[\text{Co}(\text{PPh}_3)_2\text{Cl}_2]\text{Cl}$  (d)  $[\text{Co(en)}_3]\text{Cl}_3$
27. Solubility product of a salt AB is  $1 \times 10^{-8}$  in a solution in which the concentration of  $\text{A}^+$  ions is  $10^{-3}$  M. The salt will precipitate when the concentration of  $\text{B}^-$  ions is kept
- (a) between  $10^{-8}$  M to  $10^{-7}$  M  
(b) between  $10^{-7}$  M to  $10^{-8}$  M  
(c)  $> 10^{-5}$  M  
(d)  $< 10^{-8}$  M
28. Sucrose in water is dextro-rotatory,  $[\alpha]_D = +66.4^\circ$ . When boiled with dilute HCl, the solution becomes leavo-rotatory,  $[\alpha]_D = -20^\circ$ . In this process the sucrose molecule breaks into
- (a) L-glucose + D-fructose  
(b) L-glucose + L-fructose  
(c) D-glucose + D-fructose  
(d) D-glucose + L-fructose
29. Select correct statement(s).
- (a) Cyanamide ion ( $\text{CN}_2^{2-}$ ) is isoelectronic with  $\text{CO}_2$  and has the same linear structure  
(b)  $\text{Mg}_2\text{C}_3$  reacts with water to form propyne  
(c)  $\text{CaC}_2$  has NaCl type lattice  
(d) All of the above
30. In DNA the complementary bases are
- (a) adenine and thymine; guanine and cytosine  
(b) uracil and adenine; cytosine and guanine  
(c) adenine and guanine; thymine and cytosine  
(d) adenine and thymine; guanine and uracil
31. Vapour pressure of benzene at  $30^\circ\text{C}$  is 121.8 mm. When 15 g of a non volatile solute is dissolved in 250 g of benzene its vapour pressure decreased to 120.2 mm. The molecular weight of the solute (Mo. wt. of solvent = 78)
- (a) 356.2 (b) 456.8  
(c) 530.1 (d) 656.7
32. In nitrogen family, the H-M-H bond angle in the hydrides gradually becomes closer to  $90^\circ$  on going from N to Sb. This shows that gradually
- (a) The basic strength of the hydrides increases  
(b) Almost pure  $p$ -orbitals are used for M-H bonding  
(c) The bond energies of M-H bonds increase  
(d) The bond pairs of electrons become nearer to the central atom
33. For reaction  $a\text{A} \rightarrow x\text{P}$ , when  $[\text{A}] = 2.2$  mM, the rate was found to be  $2.4 \text{ mM s}^{-1}$ . On reducing concentration of A to half, the rate changes to  $0.6 \text{ mM s}^{-1}$ . The order of reaction with respect to A is :
- (a) 1.5 (b) 2.0  
(c) 2.5 (d) 3.0
34. Which of the following is used for making optical instruments?
- (a)  $\text{SiO}_2$  (b) Si  
(c)  $\text{SiH}_4$  (d) SiC
35. If 'a' stands for the edge length of the cubic systems : simple cubic, body centred cubic and face centred cubic, then the ratio of radii of the spheres in these systems will be respectively,
- (a)  $\frac{1}{2}a : \frac{\sqrt{3}}{4}a : \frac{1}{2\sqrt{2}}a$  (b)  $\frac{1}{2}a : \sqrt{3}a : \frac{1}{\sqrt{2}}a$   
(c)  $\frac{1}{2}a : \frac{\sqrt{3}}{2}a : \frac{\sqrt{3}}{2}a$  (d)  $1a : \sqrt{3}a : \sqrt{2}a$
36. Which of the following is correct order of acidity?
- (a)  $\text{HCOOH} > \text{CH}_3\text{COOH} > \text{ClCH}_2\text{COOH}$   
 $> \text{C}_2\text{H}_5\text{COOH}$   
(b)  $\text{ClCH}_2\text{COOH} > \text{HCOOH} > \text{CH}_3\text{COOH}$   
 $> \text{C}_2\text{H}_5\text{COOH}$   
(c)  $\text{CH}_3\text{COOH} > \text{HCOOH} > \text{ClCH}_2\text{COOH}$   
 $> \text{C}_2\text{H}_5\text{COOH}$   
(d)  $\text{C}_2\text{H}_5\text{COOH} > \text{CH}_3\text{COOH} > \text{HCOOH}$   
 $> \text{ClCH}_2\text{COOH}$
37. Penicillin is :
- (a) analgesic (b) antipyretic  
(c) antimalarial (d) antibiotic
38. The rate constant  $k$ , for the reaction
- $$\text{N}_2\text{O}_5(\text{g}) \longrightarrow 2\text{NO}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$$
- is  $1.3 \times 10^{-2} \text{ s}^{-1}$ . Which equation given below describes the change of  $[\text{N}_2\text{O}_5]$  with time ?  $[\text{N}_2\text{O}_5]_0$  and  $[\text{N}_2\text{O}_5]_t$  correspond to concentration of  $\text{N}_2\text{O}_5$  initially and at time  $t$ .
- (a)  $[\text{N}_2\text{O}_5]_t = [\text{N}_2\text{O}_5]_0 + kt$   
(b)  $[\text{N}_2\text{O}_5]_0 = [\text{N}_2\text{O}_5]_t e^{kt}$   
(c)  $\log [\text{N}_2\text{O}_5]_t = \log [\text{N}_2\text{O}_5]_0 + kt$   
(d)  $\ln \frac{[\text{N}_2\text{O}_5]_0}{[\text{N}_2\text{O}_5]_t} = kt$
39. Which of the following reactions can produce aniline as main product?
- (a)  $\text{C}_6\text{H}_5\text{NO}_2 + \text{Zn/KOH}$   
(b)  $\text{C}_6\text{H}_5\text{NO}_2 + \text{Zn/NH}_4\text{Cl}$   
(c)  $\text{C}_6\text{H}_5\text{NO}_2 + \text{LiAlH}_4$   
(d)  $\text{C}_6\text{H}_5\text{NO}_2 + \text{Zn/HCl}$



MT-16

CHEMISTRY

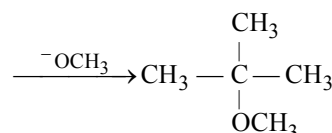
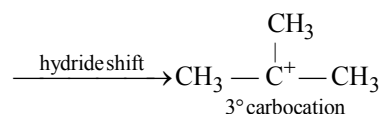
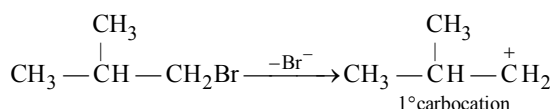
40. Which of the following reactions is used to make a fuel cell?
- (a)  $\text{Cd(s)} + 2\text{Ni(OH)}_3\text{(s)} \longrightarrow \text{CdO(s)} + 2\text{Ni(OH)}_2\text{(s)} + \text{H}_2\text{O(l)}$
- (b)  $\text{Pb(s)} + \text{PbO}_2\text{(s)} + 2\text{H}_2\text{SO}_4\text{(aq)} \longrightarrow 2\text{PbSO}_4\text{(s)} + 2\text{H}_2\text{O(l)}$
- (c)  $2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \longrightarrow 2\text{H}_2\text{O(l)}$
- (d)  $2\text{Fe(s)} + \text{O}_2\text{(g)} + 4\text{H}^+\text{(aq)} \longrightarrow 2\text{Fe}^{2+}\text{(aq)} + 2\text{H}_2\text{O(l)}$
41. Which does not exist ?
- (a)  $[\text{SiCl}_6]^{2-}$  (b)  $[\text{GeF}_6]^{2-}$   
 (c)  $[\text{CCl}_6]^{2-}$  (d)  $[\text{SnCl}_6]^{2-}$
42. In which case, van't Hoff factor  $i$  remains unchanged ?
- (a)  $\text{PtCl}_4$  reacts with aq.  $\text{KCl}$   
 (b) aq.  $\text{ZnCl}_2$  reacts with aq.  $\text{NH}_3$   
 (c) aq.  $\text{FeCl}_3$  reacts with aq.  $\text{K}_4[\text{Fe(CN)}]_6$   
 (d)  $\text{KMnO}_4$  reduced to  $\text{MnO}_2$  in alkaline medium
43. The unit of equivalent conductivity is
- (a)  $\text{S cm}^{-2}$   
 (b)  $\text{ohm cm}^2$  (g - equivalent)  
 (c)  $\text{ohm cm}$   
 (d)  $\text{ohm}^{-1}\text{cm}^2$  (g equivalent) $^{-1}$
44. Perlon is
- (a) Terylene (b) Rubber  
 (c) Nylon - 6 (d) Polyester
45. Tertiary nitro compounds do not tautomerise because
- (a) there is no double bond  
 (b) there is no  $\alpha$ -hydrogen  
 (c) oxygen is more electronegative than hydrogen  
 (d) all of the above

ANSWER KEY

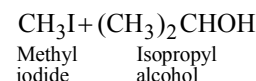
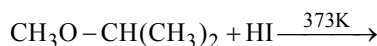
1. (d)	2. (a)	3. (d)	4. (d)	5. (c)	6. (c)	7. (d)	8. (a)	9. (d)	10. (b)
11. (b)	12. (b)	13. (c)	14. (c)	15. (d)	16. (b)	17. (a)	18. (a)	19. (c)	20. (d)
21. (d)	22. (d)	23. (d)	24. (d)	25. (b)	26. (b)	27. (c)	28. (c)	29. (d)	30. (a)
31. (a)	32. (b)	33. (b)	34. (a)	35. (a)	36. (b)	37. (d)	38. (d)	39. (d)	40. (c)
41. (c)	42. (b)	43. (d)	44. (c)	45. (b)					

HINTS&SOLUTIONS

- (d)  $\text{BF}_3$  is planar triangular while  $\text{PF}_3$  is pyramidal.
- (a) From the graph we can see the correct order of pressures  $p_1 > p_3 > p_2$
- (d)  $\text{Br}_2$  in  $\text{CCl}_4$  (a),  $\text{Br}_2$  in  $\text{CH}_3\text{COOH}$  (b) and alk.  $\text{KMnO}_4$  (c) will react with all unsaturated compounds, i.e., 1, 3 and 4 while ammonical  $\text{AgNO}_3$  (d) reacts only with terminal alkynes, i.e., 3 and hence compound 3 can be distinguished from 1, 2 and 4 by ammonical  $\text{AgNO}_3$  (d).
- (d) Decomposition of carbonates and hydrated oxides.
- (c) Chlorination of methane proceeds via free radical mechanism. Conversion of methyl chloride to methyl alcohol proceeds via nucleophilic substitution. Formation of ethylene from ethyl alcohol proceeds via dehydration reaction. Nitration of benzene is electrophilic substitution reaction.
- (c) Benzene is non-polar and hence dissolves non-polar compounds (like dissolves like). Among the given compounds, only (c) is non-polar hence it dissolves in benzene.
- (d) Ozone hole is reduction in ozone layer in stratosphere.
- (a) In a period on moving from left to right ionic radii decreases.
  - So order of cationic radii is  $\text{Cr}^{2+} > \text{Mn}^{2+} > \text{Fe}^{2+} > \text{Ni}^{2+}$  and
  - $\text{Sc} > \text{Ti} > \text{Cr} > \text{Mn}$   
(correct order of atomic radii)
  - For unpaired electrons  
 $\text{Mn}^{2+}$  (Five)  $>$   $\text{Ni}^{2+}$  (Two)  
 $<$   $\text{Co}^{2+}$  (Three)  $<$   $\text{Fe}^{2+}$  (Four)
  - For unpaired electrons  
 $\text{Fe}^{2+}$  (Four)  $>$   $\text{Co}^{2+}$  (Three)  
 $>$   $\text{Ni}^{2+}$  (Two)  $>$   $\text{Cu}^{2+}$  (One)
- (d) The reaction is an example of  $\text{S}_{\text{N}}1$  reaction



- (b) A set of question number is valid when  $l < n$  and  $m_l$  lies between  $-l$  to  $+l$ . Thus sets I, II, IV are valid, III, V invalid.
- (b) For adiabatic process,  $q = 0$
- (b)  $\text{Mn}^{2+}$  ( $3d^5$ ) is more stable than  $\text{Mn}^{3+}$  ( $3d^4$ ).
- (c) In  $\text{NH}_4\text{NO}_3$ , there are two different N-atoms ( $\text{NH}_4^+$ ,  $\text{NO}_3^-$ ) with different oxidation numbers, thus reaction is not disproportionation.
- (c) In case of unsymmetrical ethers, the site of cleavage depends on the nature of alkyl group e.g.,



The alkyl halide is always formed from the smaller alkyl group.

- (d)  $\text{H}_{2(\text{g})} + \text{Br}_{2(\text{g})} \rightleftharpoons 2\text{HBr}_{(\text{g})}$   
Rate law,  $R = k[\text{H}_2][\text{Br}_2]^{1/2}$   
Order of reaction =  $1 + 1/2 = 3/2$   
Molecularity of reaction = 2  
The unit of  $k = \frac{R}{[\text{H}_2][\text{Br}_2]^{1/2}}$   
 $= \frac{\text{mole. lit}^{-1}\text{s}^{-1}}{[\text{mole. lit}^{-1}][\text{mole. lit}^{-1}]^{1/2}}$   
 $= \text{mole}^{-1/2} \cdot \text{lit}^{1/2} \cdot \text{s}^{-1}$

- (b) As the molecular weight of noble gas atoms increases down the group its polarity increases due to which van-der-waal's force between them increases. Due to increased polarity of heavier inert gas, its solubility in

water also increases. So, most soluble gas will be Xe and least soluble will be He.

So correct order is  $\text{Xe} > \text{Kr} > \text{Ar} > \text{Ne} > \text{He}$

17. (a)  $\Delta x = \Delta v$

$$\Delta x \cdot \Delta v = \frac{h}{4\pi m}$$

$$\Delta v^2 = \frac{h}{4\pi m}$$

$$\therefore \Delta v = \sqrt{\frac{h}{4\pi m}}$$

$$\therefore \Delta p = m \cdot \Delta v = m \sqrt{\frac{h}{4\pi m}}$$

$$= \frac{1}{2} \sqrt{\frac{hm}{\pi}}$$

18. (a) It is N, N-dimethylcyclopropane-carboxamide.

19. (c) Hybridisation can be calculated by calculating the no of valence electron and dividing it by 8.

$$\text{In } \text{SO}_4^{2-} = \text{Total no. of } e^- \\ = 6 + (6 \times 4) + 2 = 32$$

$$\text{So, no. of hybrid orbitals} = \frac{32}{8} = 4$$

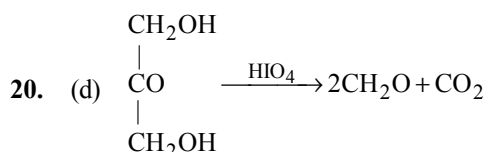
$\therefore$   $sp^3$  hybridization.

Similarly, for  $\text{PO}_4^{3-}$ ; no. of hybrid orbitals

$$= \frac{5 + 24 + 3}{8} = \frac{32}{8} = 4$$

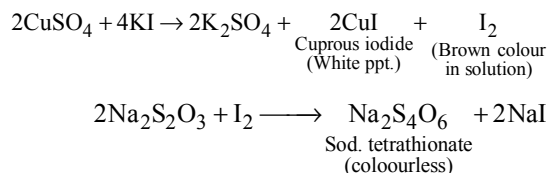
Hybridisation =  $sp^3$

Similarly, for  $\text{BF}_4^-$ , it is  $sp^3$ .



21. (d) An ion exchange resin containing R-COOH group exchange cations like  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Na}^+$ ,  $\text{Fe}^{2+}$  with  $\text{H}^+$  when hard water is passed through it. This resin is called cation exchange resin.

22. (b) KI reacts with  $\text{CuSO}_4$  solution to produce cuprous iodide (white precipitate) and  $\text{I}_2$  (which gives brown colour) Iodine reacts with hypo ( $\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$ ) solution. Decolourisation of solution shows the appearance of white precipitate.



23. (d) This reaction shows the formation of  $\text{H}_2\text{O}$ , and the  $X_2$  represents the enthalpy of formation of  $\text{H}_2\text{O}$  because as the definition suggests that the enthalpy of formation is the heat evolved or absorbed when one mole of substance is formed from its constituent atoms.

24. (d) Rotation around  $\pi$  bond is not possible. If any attempt is made to rotate one of the carbon atoms, the lobes of  $\pi$ -orbital will no longer remain coplanar i.e no parallel overlap will be possible and thus  $\pi$ -bond will break. This is known as concept of restricted rotation. In other words the presence of  $\pi$ -bonds makes the position of two carbon atom.

25. (b) The balloon would burst when  $V > 20 \text{ L}$

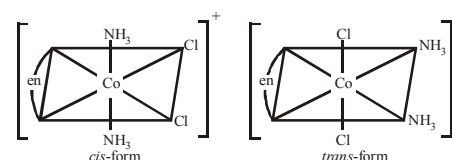
$$P_1 V_1 = P_2 V_2 \\ 1 \times 10 = P_2 \times 20$$

$$P_2 = 0.5 \text{ atm} \quad (\text{no bursting})$$

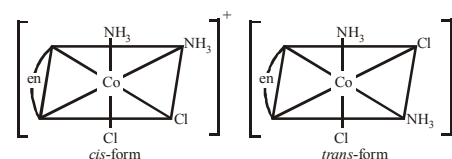
Thus, a pressure below 0.5 atm, it would burst.

26. (b) Complex  $\text{Co(en)}(\text{NH}_3)_2\text{Cl}_2$  will have four different isomers.

- (i) **Geometrical isomers**



- (ii) **Optical isomers**



27. (c)  $\text{AB} \rightleftharpoons \text{A}^+ \text{B}^-$

$$K_{sp} = \frac{[\text{A}^+][\text{B}^-]}{[\text{AB}]}$$

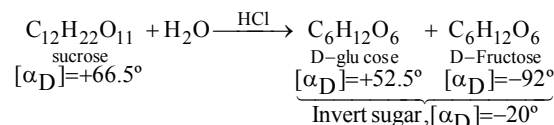
Salt will precipitate if ionic conc.  $> K_{sp}$

$$[\text{A}^+][\text{B}^-] > 1 \times 10^{-8}$$

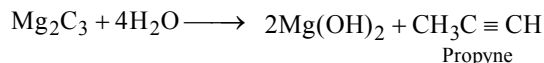
$$(1 \times 10^{-3})[\text{B}^-] > 1 \times 10^{-8}$$

$$[\text{B}^-] > \frac{1 \times 10^{-8}}{1 \times 10^{-3}} \text{ or } 1 \times 10^{-5}$$

28. (c) The hydrolysis of sucrose by boiling with mineral acid or by enzyme invertase or sucrase produces a mixture of equal molecules of D(+) glucose and D(-) Fructose.



29. (d) In  $\text{CO}_2$  we have 22 ( $6 + 8 + 8 = 22$ ) electrons. In  $(\text{CN}_2)^{2-}$ , we have 22 ( $6 + 7 + 7 + 2 = 22$ ) electrons. Both  $\text{CO}_2$  and  $(\text{CN}_2)^{2-}$  have linear structures. Thus, statement (a) is correct.



i.e., statement (b) is also correct.

The structure of  $\text{CaC}_2$  is of NaCl type

i.e., statement (c) is also correct.

30. (a) In DNA, adenine faces thymine and guanine faces cytosine.
31. (a) Given vapour pressure of pure solute

$$(P^0) = 121.8 \text{ mm; Weight of solute (w)} = 15 \text{ g}$$

Weight of solvent (W) = 250 g; Vapour pressure of pure solvent (P) = 120.2 mm and Molecular weight of solvent (M) = 78

From Raoult's law

$$\frac{P^0 - P}{P^0} = \frac{w}{m} \times \frac{M}{W} = \frac{121.8 - 120.2}{121.8} = \frac{15}{m} \times \frac{78}{250}$$

$$\text{or } m = \frac{15 \times 78}{250} \times \frac{121.8}{1.6} = 356.2$$

32. (b) With the decrease in the electronegativity of central atom the bond angle decreases
33. (b) When the concentration of reactant is reduced to half

its initial value, the rate is reduced by  $\frac{2.4}{0.6} = 4$  times

It means, rate  $\propto [\text{reactant}]^2$

So, order of reaction = 2

34. (a)  $\text{SiO}_2$  is used for this purpose.
35. (a) Following generalization can be easily derived for various types of lattice arrangements in cubic cells between the edge length (a) of the cell and r the radius of the sphere.

$$\text{For simple cubic : } a = 2r \text{ or } r = \frac{a}{2}$$

For body centred cubic :

$$a = \frac{4}{\sqrt{3}} r \text{ or } r = \frac{\sqrt{3}}{4} a$$

For face centred cubic :

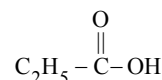
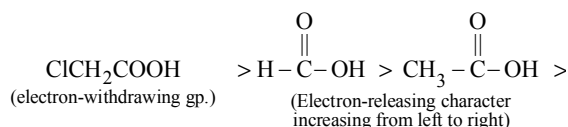
$$a = 2\sqrt{2}r \text{ or } r = \frac{1}{2\sqrt{2}} a$$

Thus the ratio of radii of spheres for these will be simple : bcc : fcc

$$= \frac{a}{2} : \frac{\sqrt{3}}{4} a : \frac{1}{2\sqrt{2}} a$$

i.e. option (a) is correct answer.

36. (b) Recall that presence of electron-withdrawing group increases, while presence of electron-releasing group decreases the acidity of carboxylic acids.

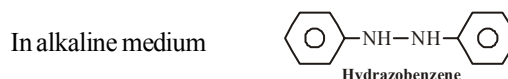
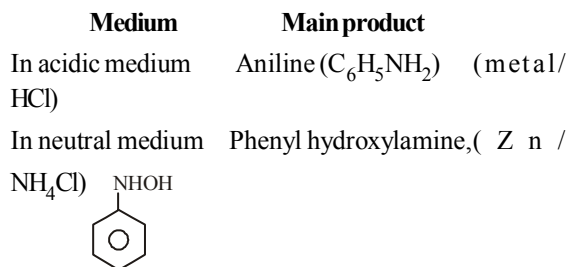


37. (d) Penicillin is an antibiotic which was first obtained from a fungus, penicillium notatum by the scientist, Flemming.

38. (d) As the unit of rate constant is  $\text{sec}^{-1}$ , so the reaction is first order reaction. Hence

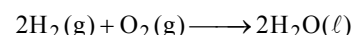
$$k = \frac{1}{t} = \log \frac{a}{(a-x)} \text{ or } kt = \log \frac{[\text{N}_2\text{O}_5]_0}{[\text{N}_2\text{O}_5]_t}$$

39. (d) Various products are formed when nitroarenes are reduced. These are given below for  $\text{C}_6\text{H}_5\text{NO}_2$ .



Thus, Aniline will be main product in case of (d).

40. (c) Reaction used in fuel cell is



At anode :  $[\text{H}_2 \longrightarrow 2\text{H}^+ + 2e] \times 2$

At cathode :  $\text{O}_2 + 2\text{H}_2\text{O} + 4e \longrightarrow 4\text{OH}^-$

41. (c) Carbon cannot expand its coordination number beyond four due to the absence of d-orbitals, hence it cannot form  $[\text{CCl}_6]^{2-}$  ion

MT-20

CHEMISTRY

42. (b)  $i$  remains unchanged when number of ions before and after complex ion remains constant.

	Solute	$y$	Complex	$y$
(a)	$\text{PtCl}_4$	5	$\text{K}_2[\text{PtCl}_6]$	3
(b)	$\text{ZnCl}_2$	3	$\text{Zn}[(\text{NH}_3)_4]\text{Cl}_2$	3

43. (d) The equivalent conductivity of a solution,

$$\Lambda_{\text{eq}} = \frac{1000}{C} \times \kappa$$

Where,

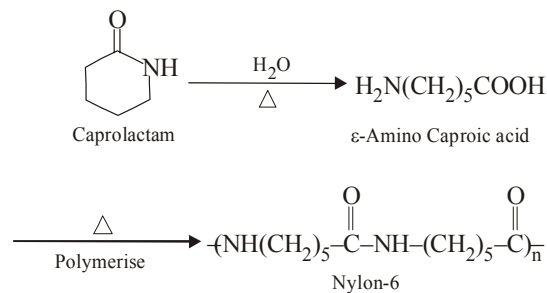
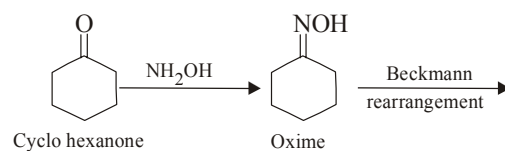
$\kappa$  = specific conductance = Unit  $\text{ohm}^{-1} \text{cm}^{-1}$

$C$  = normality of the solution unit  $\text{gm eq/cm}^3$

Hence, the unit of  $\Lambda_{\text{eq}}$  is  $\text{Ohm}^{-1} \cdot \text{cm}^2 (\text{gm equivalent})^{-1}$ .

44. (c) Nylon-6 is also called as perlon. It is a polymer of caprolactam.

45. (b)

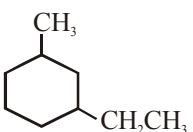


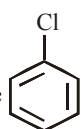


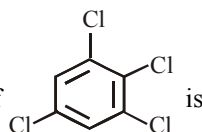
# Mock Test-4

Time : 1 hr

Max. Marks -120

1. IUPAC name of  is
- (a) 1-methyl-3 ethyl cyclohexane  
(b) 1-ethyl-3 methyl benzene  
(c) 1-ethyl-3 methyl cyclo hexane  
(d) Cyclo hexane-1-ethyl-3-methyl
2. Which of the following structures does not contain any chiral C atom but represent the chirality in the structure.  
(a) 2-Ethyl-3-hexene (b) 2,3-Pentadiene  
(c) 1,3-Butadiene (d) Pent-3-en-1-yne
3.  $N_2$  and  $O_2$  are converted to mono cations  $N_2^+$  and  $O_2^+$  respectively, which of the following is wrong?  
(a) In  $N_2^+$ , the N-N bond weakens  
(b) In  $O_2^+$ , the O-O bond order increases  
(c) In  $O_2^+$ , paramagnetism decreases  
(d)  $N_2^+$  becomes diamagnetic
4. In a compound AOH, electronegativity of 'A' is 2.1, the compound would be  
(a) Acidic  
(b) Neutral towards acid & base  
(c) Basic  
(d) Amphoteric
5. Which of the following orders is wrong?  
(a) Electron affinity-  $N < O < F < Cl$   
(b) 1st ionisation potential-  $Be < B < N < O$   
(c) Basic property-  $MgO < CaO < FeO < Fe_2O_3$   
(d) Reactivity-  $Be < Li < K < Cs$

6. The dipole moment of chlorobenzene  is 1.5 D. The

- dipole moment of  is
- (a) 2.86 D (b) 2.25 D  
(c) 1.5 D (d) 0 D

7. Following substances are in solid state :  
(A) Methane (B) Cesium chloride  
(C) Ice (D) Lithium

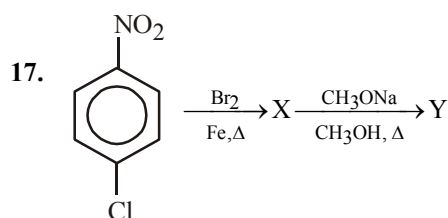
Which non-conductive solid when melts converts into conductive liquid?

- (a) C, D (b) Only C  
(c) Only B (d) A, B and C
8. On applying pressure to the equilibrium  $ice \rightleftharpoons water$ , which phenomenon will happen  
(a) More ice will be formed  
(b) More water will be formed  
(c) Equilibrium will not be disturbed  
(d) Water will evaporate
9. Let  $\nu_1$  be the frequency of the series limit of the Lyman series,  $\nu_2$  be the frequency of the first line of the Lyman series, and  $\nu_3$  be the frequency of the series limit of the Balmer series, then -  
(a)  $\nu_3 = \frac{1}{2} (\nu_1 - \nu_2)$  (b)  $\nu_2 - \nu_1 = \nu_3$   
(c)  $\nu_1 - \nu_2 = \nu_3$  (d)  $\nu_1 + \nu_2 = \nu_3$
10. Given,  $HF + H_2O \xrightarrow{K_a} H_3O^+ + F^-$ ;  
 $F^- + H_2O \xrightarrow{K_b} HF + OH^-$ .  
Which relation is correct  
(a)  $K_b = K_w$  (b)  $K_b = \frac{1}{K_w}$   
(c)  $K_a \times K_b = K_w$  (d)  $\frac{K_a}{K_b} = K_w$
11. In an amino acid, the carboxyl group ionises at  $pK_{a1} = 2.34$  and ammonium ion at  $pK_{a2} = 9.60$ . The isoelectric point of the amino acid is at pH  
(a) 5.97 (b) 2.34  
(c) 9.60 (d) 6.97
12.  $AB$ ,  $A_2$  and  $B_2$  are diatomic molecules. If the bond enthalpies of  $A_2$ ,  $AB$  and  $B_2$  are in the ratio 1:1:0.5 and enthalpy of formation of  $AB$  from  $A_2$  and  $B_2$  is  $-100 \text{ kJ mol}^{-1}$ . What is the bond energy of  $A_2$  :  
(a)  $200 \text{ kJ mol}^{-1}$  (b)  $100 \text{ kJ mol}^{-1}$   
(c)  $300 \text{ kJ mol}^{-1}$  (d)  $400 \text{ kJ mol}^{-1}$
13. Equal volume of 0.1 M urea and 0.1 M glucose are mixed. The mixture will have  
(a) Lower osmotic pressure  
(b) Same osmotic pressure  
(c) Higher osmotic pressure  
(d) None of these

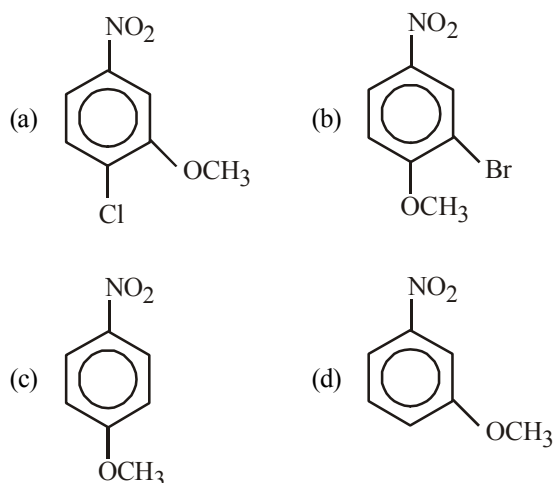
MT-22

CHEMISTRY

14. If the following half cells have the  $E^\circ$  values as  
 $\text{Fe}^{+3} + e^- \longrightarrow \text{Fe}^{+2}; E^\circ = +0.77\text{V}$  and  
 $\text{Fe}^{+2} + 2e^- \longrightarrow \text{Fe}; E^\circ = -0.44\text{V}$ . The  $E^\circ$  of the half cell  
 $\text{Fe}^{+3} + 3e^- \longrightarrow \text{Fe}$  will be  
 (a) 0.33 V (b) 1.21 V  
 (c) 0.04 V (d) 0.605 V
15. The oxidation states of sulphur in the anions  
 $\text{SO}_3^{2-}$ ,  $\text{S}_2\text{O}_4^{2-}$  and  $\text{S}_2\text{O}_6^{2-}$  follow the order  
 (a)  $\text{SO}_3^{2-} < \text{S}_2\text{O}_4^{2-} < \text{S}_2\text{O}_6^{2-}$   
 (b)  $\text{S}_2\text{O}_4^{2-} < \text{S}_2\text{O}_6^{2-} < \text{SO}_3^{2-}$   
 (c)  $\text{S}_2\text{O}_6^{2-} < \text{S}_2\text{O}_4^{2-} < \text{SO}_3^{2-}$   
 (d)  $\text{S}_2\text{O}_4^{2-} < \text{SO}_3^{2-} < \text{S}_2\text{O}_6^{2-}$
16. Which of the following statements is not correct?  
 (a) C–Cl bond in vinyl chloride is less polar than in  $\text{CH}_3\text{Cl}$   
 (b) C–Cl bond in vinyl chloride is stronger than in  $\text{CH}_3\text{Cl}$   
 (c) C–Cl bond in vinyl chloride is shorter than in  $\text{CH}_3\text{Cl}$   
 (d) Vinyl chloride undergo nucleophilic substitution more readily than  $\text{CH}_3\text{Cl}$ .



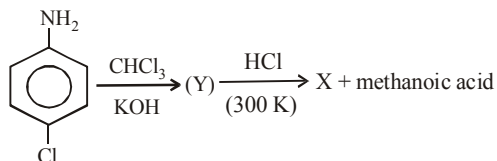
Product (Y) of this reaction is –



18. Although Al has a high oxidation potential it resists corrosion because of the formation of a tough, protective coat of  
 (a)  $\text{Al}(\text{NO}_3)_2$  (b)  $\text{AlN}$   
 (c)  $\text{Al}_2\text{O}_3$  (d)  $\text{Al}_2(\text{CO}_3)_2$

19. A metal which is not affected by conc.  $\text{H}_2\text{SO}_4$ ,  $\text{HNO}_3$  or alkalis forms a compound X. This compound X can be used to give a complex which finds its application for toning in photography? The metal is  
 (a) Au (b) Ag  
 (c) Hg (d) Cu
20. If  $\text{Cl}_2$  gas is passed into aqueous solution of KI containing some  $\text{CCl}_4$  and the mixture is shaken, then”.  
 (a) Upper layer becomes violet  
 (b) Lower layer becomes violet  
 (c) Homogenous violet layer is formed  
 (d) None
21. In Lassaigne's test, the organic compound is fused with a piece of sodium metal in order to  
 (a) increase the ionisation of the compound  
 (b) decrease the melting point of the compound  
 (c) increase the reactivity of the compound  
 (d) convert the covalent compound into a mixture of ionic compounds
22. An aqueous solution of colourless metal sulphate M gives a white precipitate with  $\text{NH}_4\text{OH}$ . This was soluble in excess of  $\text{NH}_4\text{OH}$ . On passing  $\text{H}_2\text{S}$  through this solution a white ppt. is formed. The metal M in the salt is  
 (a) Ca (b) Ba  
 (c) Al (d) Zn
23. Choose the correct order of T (True) and F (False) –  
 (1) When the pH of rain water is below 3.6, it is called acid rain.  
 (2) Ozone hole occurs over Antarctica mainly during September–October and it gets replenished in November–December.  
 (3) Methylcyclohexane is an ozone-depleting molecule.  
 (4) COD is always larger than BOD.  
 (a) TTTF (b) FTFT  
 (c) FFFF (d) FTTF
24. Which of the following compound can not used in preparation of iodoform?  
 (a)  $\text{CH}_3\text{CHO}$  (b)  $\text{CH}_3\text{COCH}_3$   
 (c)  $\text{HCHO}$  (d) 2-propanol
25. The correct priorities for the substituents shown below, according to the E-Z sequence rule is  
 I.  $-\text{CN}$  II.  $-\text{CBr}(\text{CH}_3)_2$   
 III.  $-\text{COOH}$  IV.  $-\text{CH}_2-\overset{\text{O}}{\parallel}{\text{C}}-\text{OCH}_3$   
 V.  $-\overset{\text{O}}{\parallel}{\text{C}}-\text{H}$   
 (a) II, III, V, I, IV (b) V, II, I, IV, III  
 (c) III, IV, I, II, V (d) II, V, I, IV, III

26. Identify X in the sequence given :

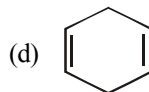
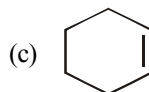


- (a) (b)
- (c) (d)

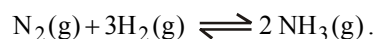
27. Select the rate law that corresponds to the data shown for the following reaction  $\text{A} + \text{B} \longrightarrow \text{C}$

Expt. No.	(1)	(2)	Initial Rate
1	0.012	0.035	0.10
2	0.024	0.070	0.80
3	0.024	0.035	0.10
4	0.012	0.070	0.80

- (a)  $\text{Rate} = k[\text{B}]^3$  (b)  $\text{Rate} = k[\text{B}]^4$   
 (c)  $\text{Rate} = k[\text{A}][\text{B}]^3$  (d)  $\text{Rate} = k[\text{A}]^2[\text{B}]^2$
28. An alkene upon ozonolysis yield  $\text{CHO} - \text{CH}_2 - \text{CH}_2 - \text{CHO}$  only. The alkene is
- (a)  $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$



29. 1 mol of  $\text{N}_2$  and 3 mol of  $\text{H}_2$  are placed in a closed container at a pressure of 4 atm. The pressure falls to 3 atm at the same temperature when the following equilibrium is attained



The  $K_p$  for the dissociation of  $\text{NH}_3$  is

- (a)  $\frac{3 \times 3}{0.5 \times (1.5)^3} \text{atm}^{-2}$  (b)  $0.5 \times (1.5)^3 \text{atm}^2$   
 (c)  $\frac{0.5 \times (1.5)^3}{3 \times 3} \text{atm}^2$  (d)  $\frac{(1.5)^3}{0.5} \text{atm}^{-2}$

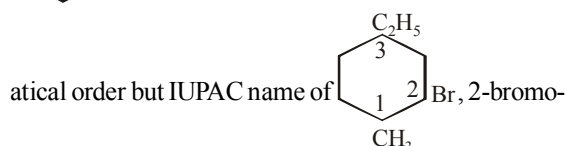
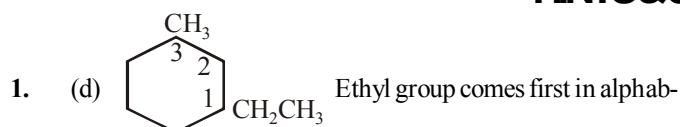
30. 0.5 g mixture of  $\text{K}_2\text{Cr}_2\text{O}_7$  and  $\text{KMnO}_4$  was treated with excess of KI in acidic medium.  $\text{I}_2$  liberated required 100  $\text{cm}^3$  of 0.15N.  $\text{Na}_2\text{S}_2\text{O}_3$  solution for titration. The percentage amount of  $\text{K}_2\text{Cr}_2\text{O}_7$  in the mixture is

(a) 85.36% (b) 14.64%  
 (c) 58.63% (d) 26.14%

ANSWER KEY

1. (d)	2. (b)	3. (d)	4. (b)	5. (b)	6. (c)	7. (c)	8. (b)	9. (c)	10. (c)
11. (a)	12. (d)	13. (b)	14. (c)	15. (d)	16. (d)	17. (b)	18. (c)	19. (a)	20. (b)
21. (d)	22. (d)	23. (b)	24. (c)	25. (a)	26. (a)	27. (a)	28. (b)	29. (b)	30. (b)

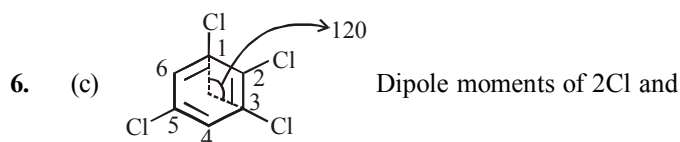
HINTS&SOLUTIONS



(i.e., lowest set of locant is preferred.)

Lowest sum of locant is = 1 + 2 + 3 = 6

2. (b) The molecule 2,3 - pentadiene does not have any chiral C but at the same time it does not have any mirror plane which makes the molecule chiral.
3. (d) In  $N_2^+$ , there is one unpaired electron hence it is paramagnetic.
4. (b) In  $A-O-H$ , if EN of 'A' is 2.1 then it will be neutral, as  $X_A - X_O = X_O - X_H$  (where X is EN)
5. (b) Correct order is  $B < Be < O < N$ .



It is due 1 Cl and 3 Cl  $\mu^2$

$$= \mu_1^2 + \mu_2^2 + 2\mu_1\mu_2 \cos \theta$$

$$= (1.5)^2 + (1.5)^2 + 2 \times 1.5 \times 1.5 \cos 120 \therefore \mu = 1.5 \text{ D}$$

7. (c) CsCl is ionic solid.
8. (b) Volume of ice > volume of water & thus increase in pressure favours forward reaction showing decrease in volume.

9. (c)  $v = RcZ^2 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$

$$v_1 = RcZ^2 \left( \frac{1}{1^2} - \frac{1}{\infty^2} \right) = RcZ^2$$

$$v_2 = RcZ^2 \left( \frac{1}{1^2} - \frac{1}{2^2} \right) = \frac{3RcZ^2}{4}$$

$$v_3 = RcZ^2 \left( \frac{1}{2^2} - \frac{1}{\infty^2} \right) = \frac{RcZ^2}{4}$$

$$\therefore v_1 - v_2 = v_3$$

10. (c)  $K_a = \frac{[H_3O^+][F^-]}{[HF][H_2O]}$  and  $K_b = \frac{[HF][OH^-]}{[F^-][H_2O]}$

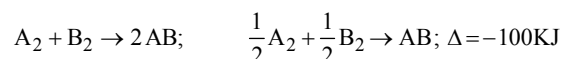
$$\text{Therefore, } K_a \times K_b = [H_3O^+][OH^-] = K_w$$

11. (a) Isoelectric point (pH)

$$= \frac{pK_{a1} + pK_{a2}}{2} = \frac{2.34 + 9.60}{2} = 5.97$$

12. (d) Let bond energy of  $A_2$  be  $x$  then bond energy of AB is also  $x$  and bond energy of  $B_2$  is  $x/2$ .

Enthalpy of formation of AB is - 100 KJ/mole:



$$\text{or } -100 = \left( \frac{x}{2} + \frac{x}{4} \right) - x \therefore -100 = \frac{2x + x - 4x}{4} \therefore x = 400 \text{ KJ}$$

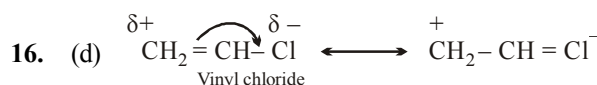
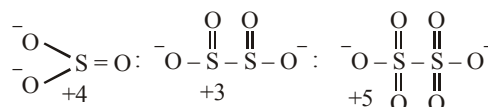
13. (b)  $M_{\text{total}} = \frac{(n_1 + n_2)}{v_1 + v_2} \text{ st}$ ,

$$n_1 = n_2 = 0.1, V_1 = V_2 = 1 \text{ litre} \Rightarrow M_{\text{total}} = 0.1 \text{ M}$$

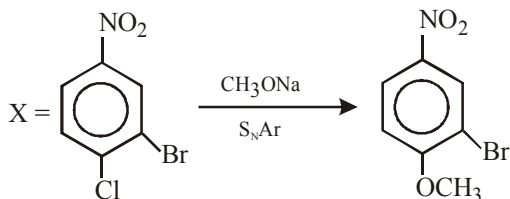
14. (c)  $E^0 = \frac{0.77 + 2(-0.44)}{3} = \frac{0.77 - 0.88}{3} = -\frac{0.11}{3}$

$$\approx -0.04$$

15. (d) The chemical bond method gives the O.N.

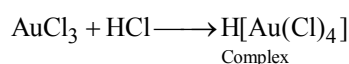


17. (b)

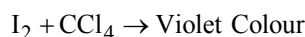


18. (c) Because the layer of  $\text{Al}_2\text{O}_3$  (oxide) is inert, insoluble and impervious.

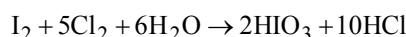
19. (a) Au, the gold is not attacked by acids and alkalis. It forms  $\text{AuCl}_3$ .  $\text{AuCl}_3$  further reacts with  $\text{HCl}$  to form  $\text{H}[\text{Au}(\text{Cl})_4]$  which is used in photography.



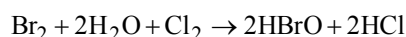
20. (b)  $2\text{KI} + \text{Cl}_2 \rightarrow 2\text{KCl} + \text{I}_2$



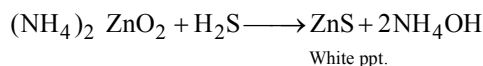
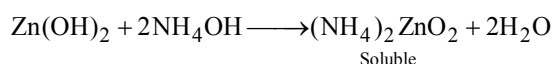
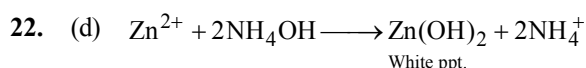
**Note:** The excess of  $\text{Cl}_2$  should be avoided. The layer may become colorless due to conversion of  $\text{I}_2$  to  $\text{HIO}_3$



In case of  $\text{Br}_2$  :



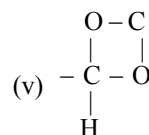
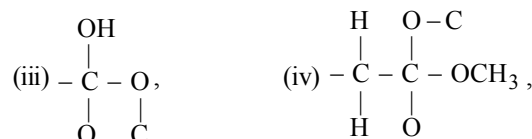
21. (d) To convert covalent compounds into ionic compounds such as  $\text{NaCN}$ ,  $\text{Na}_2\text{S}$ ,  $\text{NaX}$ , etc.



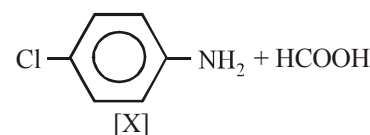
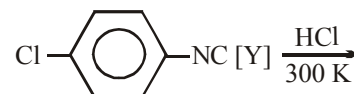
23. (b) (1) When the pH of rain water is below 5.6, it is called acid rain.  
 (2) Ozone hole occurs over Antarctica mainly during September–October and it gets replenished in November–December.  
 (3) Methylcyclohexane is not an ozone-depleting molecule.  
 (4) BOD (Biological oxygen demand) is a measure of organic pollutant present in the sample of water. Higher is the value of BOD, higher is the level of organic pollution in water. The amount of oxygen (in mg/L) consumed for oxidising all organic and oxidisable inorganic material in a sample of water is called chemical oxygen demand (COD).  
 COD is always larger than BOD.

24. (c) Formaldehyde can not produce iodoform, as only those compound which contains either  $\text{CH}_3 - \underset{\text{OH}}{\text{CH}} -$  group or  $\text{CH}_3 - \underset{\text{O}}{\underset{\text{||}}{\text{C}}} -$  group on reaction with

potassium iodide and sod. hypochlorite yield iodoform.



Arrange (NNN), (BrCC), (OOO), (CHH), (OOH) in increasing atomic number. The order is ii, iii, v, i, iv.



27. (a) Let the rate law be  $r = [\text{A}]^x[\text{B}]^y$

$$\text{Divide (3) by (1)} \quad \frac{0.10}{0.10} = \frac{[0.024]^x [0.035]^y}{[0.012]^x [0.035]^y}$$

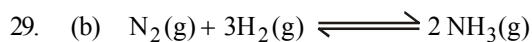
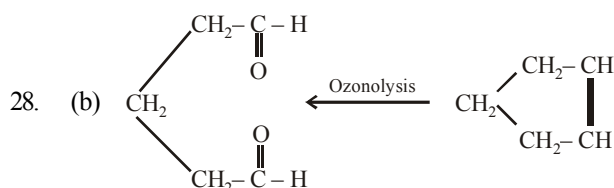
$$\therefore 1 = [2]^x, x = 0$$

$$\text{Divide (2) by (3)} \quad \frac{0.80}{0.10} = \frac{[0.024]^x [0.070]^y}{[0.024]^x [0.035]^y}$$

$$\therefore 8 = (2)^y, y = 3$$

$$\text{Hence rate equation, } R = K[\text{A}]^0[\text{B}]^3 = K[\text{B}]^3$$





1 - x      3 - 3x    2x at equilibrium

Total moles,

$$1 - x + 3 - 3x + 2x = 4 - 2x = 3 \text{ (given)}$$

(Since, 4 moles = 4 atm given)

$$\therefore x = 0.5$$

$$K_p \text{ for dissociation of } \text{NH}_3 = \frac{p_{\text{N}_2} \times p_{\text{H}_2}^3}{p_{\text{NH}_3}^2}$$

$$= \frac{\left(\frac{1-0.5}{3} \times 3\right) \times \left[\left(\frac{3-3 \times 0.5}{3}\right) \times 3\right]^3}{\left[\frac{2 \times 0.5 \times 3}{3}\right]^2}$$

$$= 0.5 \times (1.5)^3 \text{ atm}^2$$

30. (b) Let the amount of the  $\text{K}_2\text{Cr}_2\text{O}_7$  in the mixture be x g, then amount of  $\text{KMnO}_4$  will be (0.5 - x) g

$$\therefore \left(\frac{x}{49} + \frac{0.5-x}{31.6}\right) = \frac{100 \times 0.15}{1000}$$

where 49 is Eq. wt. of  $\text{K}_2\text{Cr}_2\text{O}_7$  and 31.6 is Eq. wt. of  $\text{KMnO}_4$ .

On solving, we get x = 0.073 g

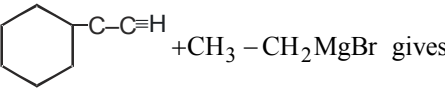
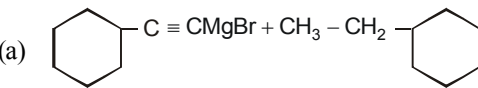
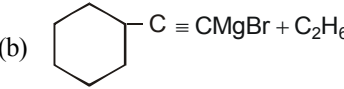
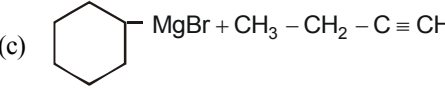
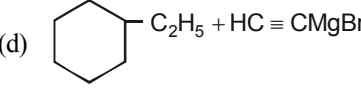
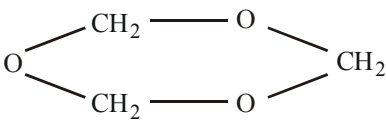
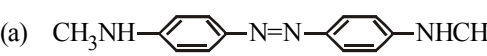
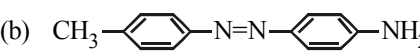

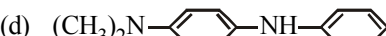
$$\% \text{ age of } \text{K}_2\text{Cr}_2\text{O}_7 = \frac{0.0732 \times 100}{0.5} = 14.64\%$$

# Mock Test-5

Time : 1 hr

Max. Marks -120

- An atom X belongs to 4<sup>th</sup> period of the periodic table and has highest number of unpaired electrons in comparison to the other elements of the period. The atomic number of X is  
 (a) 23 (b) 25  
 (c) 24 (d) 33
- In  $O_2^-$ ,  $O_2^0$  and  $O_2^{2-}$  molecular species, the total number of antibonding electrons respectively are :  
 (a) 7, 6, 8 (b) 1, 0, 2  
 (c) 6, 6, 6 (d) 8, 6, 8
- Aluminothermy used for on the spot welding of large iron structure is based on the fact that-  
 (a) As compared to iron, aluminium has greater affinity for oxygen.  
 (b) As compared to aluminium, iron has greater affinity for oxygen.  
 (c) Reaction between aluminium and oxygen is endothermic.  
 (d) Reaction between iron and oxygen is endothermic.
- Which of the following shows the tendency to form peroxide?  
 (a) Lithium (b) Magnesium  
 (c) Beryllium (d) Radium
- A 1.0 M solution with respect to each of the metal halides  $AX_3$ ,  $BX_2$ ,  $CX_3$  and  $DX_2$  is electrolysed using platinum electrodes. If  $E^\circ_{A^{3+}/A} = 1.50 \text{ V}$ ,  $E^\circ_{B^{2+}/B} = 0.3 \text{ V}$ ,  $E^\circ_{C^{3+}/C} = -0.74 \text{ V}$ ,  $E^\circ_{D^{2+}/D} = -2.37 \text{ V}$ .  
 The correct sequence in which the various metals are deposited at the cathode is  
 (a) A, B, C, D (b) A, B, C  
 (c) D, C, B, A (d) C, B, A
- Arrange hypophosphorous acid ( $H_3PO_2$ ), phosphorous acid ( $H_3PO_3$ ) and Phosphoric acid ( $H_3PO_4$ ) in the decreasing order of acidic strength  
 (a)  $H_3PO_3 > H_3PO_4 > H_3PO_2$   
 (b)  $H_3PO_4 > H_3PO_3 > H_3PO_2$   
 (c)  $H_3PO_4 > H_3PO_2 > H_3PO_3$   
 (d)  $H_3PO_4 \approx H_3PO_3 \approx H_3PO_2$
- Which of the following reactions corresponds to the definition of enthalpy of formation ?  
 (a)  $C(\text{diamond}) + O_2(g) \rightarrow CO_2(g)$   
 (b)  $C(\text{graphite}) + O_2(l) \rightarrow CO_2(g)$   
 (c)  $C(\text{graphite}) + O_2(g) \rightarrow CO_2(g)$   
 (d)  $C(g) + O_2(g) \rightarrow CO_2(g)$
- Among the reactions given below for  $B_2H_6$ , the one which does not take place is  
 (a)  $B_2H_6 + HCl \longrightarrow B_2H_5Cl + H_2$   
 (b)  $2B_2H_6 + 6NH_3 \xrightarrow{\Delta} B_3N_3H_6$  (borazine)  
 (c)  $B_2H_6 + 2N(CH_3)_3 \longrightarrow 2(CH_3)_3NBH_3$   
 (d)  $B_2H_6 + 6C_2H_4 \xrightarrow{H_3O^+} 3C_2H_5OH + 2B(OH)_3$
- The pure crystalline substance on being heated gradually first forms a turbid liquid at constant temperature and still at higher temperature turbidity completely disappears. The behaviour is a characteristic of substance forming.  
 (a) Allotropic crystals  
 (b) Liquid crystals  
 (c) Isomeric crystals  
 (d) Isomorphous crystals.
- Silver bromide when dissolve in hypo solution gives complex ..... in which oxidation state of silver is ....  
 (a)  $Na_3[Ag(S_2O_3)_2]$ , (I) (b)  $Na_3[Ag(S_2O_3)_3]$ , (III)  
 (c)  $Na_3[Ag(S_2O_3)_2]$ , (II) (d)  $Na_3[Ag(S_2O_3)_4]$ , (I)
- Which of the following can be termed as a mixed complex?  
 (a)  $K_4[Fe(CN)_6]$  (b)  $[Cu(NH_3)_4]SO_4$   
 (c)  $[Co(NH_3)_4NO_2Cl]Cl$  (d)  $K_2FeO_4$
- The relationship between the values of osmotic pressures of solutions obtained by dissolving  $6.00 \text{ g L}^{-1}$  of  $CH_3COOH$  ( $\pi_1$ ) and  $7.45 \text{ g L}^{-1}$  of  $KCl$  ( $\pi_2$ ) is  
 (a)  $\pi_1 < \pi_2$  (b)  $\pi_1 > \pi_2$   
 (c)  $\pi_1 = \pi_2$  (d)  $\frac{\pi_1}{\pi_1 + \pi_2} = \frac{\pi_2}{\pi_1 + \pi_2}$
- In the reaction of  $KMnO_4$  with an oxalate in acidic medium,  $MnO_4^-$  is reduced to  $Mn^{2+}$  and  $C_2O_4^{2-}$  is oxidised to  $CO_2$ . Hence, 50 ml of 0.02 M  $KMnO_4$  is equivalent to  
 (a) 100 ml of 0.05 M  $H_2C_2O_4$   
 (b) 50 ml of 0.05 M  $H_2C_2O_4$   
 (c) 25 ml of 0.2 M  $H_2C_2O_4$   
 (d) 50 ml of 0.10 M  $H_2C_2O_4$

14. In which reaction, there is change in oxidation number of N
- $2\text{NO}_2 \rightarrow \text{N}_2\text{O}_4$
  - $\text{NH}_4\text{OH} \rightarrow \text{NH}_4^+ + \text{OH}^-$
  - $\text{N}_2\text{O}_5 + \text{H}_2\text{O} \rightarrow 2\text{HNO}_3$
  - $2\text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3 + \text{HNO}_2$
15. Potassium permanganate acts as an oxidant in neutral, alkaline as well as acidic media. The final products obtained from it in the three conditions are, respectively
- $\text{MnO}_4^{2-}$ ,  $\text{Mn}^{3+}$  and  $\text{Mn}^{2+}$
  - $\text{MnO}_2$ ,  $\text{MnO}_2$  and  $\text{Mn}^{2+}$
  - $\text{MnO}_2$ ,  $\text{MnO}_2^+$  and  $\text{Mn}^{3+}$
  - $\text{MnO}$ ,  $\text{MnO}_2$  and  $\text{Mn}^{2+}$
16. The number of  $\pi$  electrons present in 6.4 g of calcium carbide is  $-(N_A = \text{Avagadro's number})$
- $4 N_A$
  - $0.4 N_A$
  - $0.1 N_A$
  - $0.2 N_A$
17.  gives
- 
  - 
  - 
  - 
18. The rate of  $\text{S}_{\text{N}}1$  reaction is fastest in the hydrolysis of which of the following halides ?
- $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$
  - $\text{CH}_3\text{Br}$
  - $(\text{CH}_3)_2\text{CHBr}$
  - $(\text{CH}_3)_3\text{CBr}$
19. Two elements A & B form compounds having molecular formulae  $\text{AB}_2$  and  $\text{AB}_4$ . When dissolved in 20.0 g of benzene 1.00g of  $\text{AB}_2$  lowers f.p. by  $2.3^\circ\text{C}$  whereas 1.00g of  $\text{AB}_4$  lowers f.p. by  $1.3^\circ\text{C}$ . The molal depression constant for benzene in 1000g is 5.1. The atomic masses of A and B are
- 52, 48
  - 42, 25
  - 25, 42
  - None
20. To detect iodine in presence of bromine, the sodium extract is treated with  $\text{NaNO}_2$  + glacial acetic acid +  $\text{CCl}_4$ . Iodine is detected by the appearance of
- yellow colour of  $\text{CCl}_4$  layer
  - purple colour of  $\text{CCl}_4$
  - brown colour in the organic layer of  $\text{CCl}_4$
  - deep blue colour in  $\text{CCl}_4$
21. An element (atomic mass = 100g/mol) having bcc structure has unit cell edge 400pm. The density (in  $\text{g/cm}^3$ ) of the element is
- 10.376
  - 5.19
  - 7.289
  - 2.144
22. An organic compound A ( $\text{C}_4\text{H}_{10}\text{O}$ ) has two enantiomeric forms and on dehydration it gives B (major product) and C (minor product). B and C are treated with  $\text{HBr}$ / Peroxide and the compounds so produced were subjected to alkaline hydrolysis then-
- B will give an isomer of A
  - C will give an isomer of A
  - Neither of them will give isomer of A
  - Both B and C will give isomer of A
23. A reaction is found to be second order w.r.t. one of the reactants & has rate constant of  $0.5 \text{ mol}^{-1} \text{ dm}^3 \text{ min}^{-1}$ . If initial concentration is  $0.2 \text{ mol dm}^{-3}$  then  $t_{1/2}$  of reaction is
- 5 min
  - 10 min
  - 15 min
  - 20 min
24. 
- The above shown polymer is obtained when a carbonyl compound is allowed to stand. It is a white solid. The polymer is
- trioxane
  - formose
  - paraformaldehyde
  - metaldehyde.
25. Concentration of  $\text{NH}_4\text{Cl}$  and  $\text{NH}_4\text{OH}$  in a buffer solution is in the ratio of 1 : 1,  $K_b$  for  $\text{NH}_4\text{OH}$  is  $10^{-10}$ . The pH of the buffer is
- 4
  - 5
  - 9
  - 11
26. Aniline when diazotized in cold and when treated with dimethyl aniline gives a coloured product. Its structure would be
- 
  - 
  - 
  - 

27. An organic amino compound reacts with aqueous nitrous acid at low temperature to produce an oily nitrosoamine. The compound is:

(a)  $\text{CH}_3\text{NH}_2$  (b)  $\text{CH}_3\text{CH}_2\text{NH}_2$   
(c)  $\text{CH}_3\text{CH}_2\text{NH}\cdot\text{CH}_2\text{CH}_3$  (d)  $(\text{CH}_3\text{CH}_2)_3\text{N}$

28. The standard reduction potential of

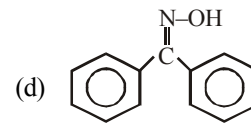
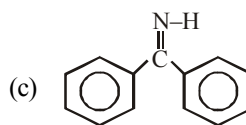
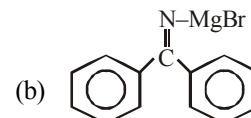
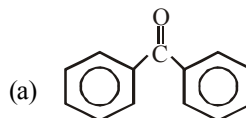
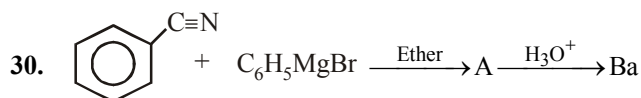
$\text{Li}^+/\text{Li}$ ,  $\text{Ba}^{2+}/\text{Ba}$ ,  $\text{Na}^+/\text{Na}$  and  $\text{Mg}^{2+}/\text{Mg}$  are  $-3.05$ ,  $-2.73$ ,  $-2.71$  and  $-2.37$  volts respectively. Which one of the following is strongest oxidising agent?

(a)  $\text{Na}^+$  (b)  $\text{Li}^+$   
(c)  $\text{Ba}^{2+}$  (d)  $\text{Mg}^{2+}$

29. Phospholipids are esters of glycerol with

(a) two carboxylic acid residues and one phosphate group

(b) one carboxylic acid residue and two phosphate groups  
(c) three phosphate groups  
(d) three carboxylic acid residues



## ANSWER KEY

1. (c)	2. (a)	3. (a)	4. (d)	5. (b)	6. (d)	7. (c)	8. (d)	9. (b)	10. (a)
11. (c)	12. (a)	13. (b)	14. (d)	15. (b)	16. (b)	17. (b)	18. (a)	19. (c)	20. (b)
21. (b)	22. (b)	23. (b)	24. (a)	25. (a)	26. (c)	27. (c)	28. (d)	29. (a)	30. (a)

## HINTS&amp;SOLUTIONS

- (c) The configuration of atom of 4<sup>th</sup> period with maximum unpaired electrons is  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$ . Hence its atomic number is 24.
- (a) The total number of electrons in the molecular species given, respectively are 17, 16 and 18. Write down the electronic configuration of the molecular species and observe the number of electrons in antibonding orbitals which are respectively are 7, 6 and 8.
- (a) Aluminium has greater affinity for oxygen and the reaction is highly exothermic.
- (d) Among alkaline earth metals, barium and radium have the tendency to form peroxides.
- (b) The more the reduction potential, the more is the deposition of metals at cathode. Cation having  $E^\circ$  value less than  $-0.83$  V (reduction potential of  $H_2O$ ) will not deposit from aqueous solution.
- (d) There is very little difference in acid strength in the series  $H_3PO_4$ ,  $H_3PO_3$  and  $H_3PO_2$  because the hydrogen in these acids are not all bonded to phosphorus.  
In the above three acids although the number of  $-OH$  groups (ionisable hydrogen increases, yet the acidity does not increase very much. This is due to the fact that *the number of unprotonated oxygen, responsible for the enhancement of acidity due to inductive effect, remains the same* with the result dissociation constant also remains nearly same.
- (c) C(graphite) is the stable state of aggregation of carbon.
- (d) Reaction between diborane and alkene are carried out in dry ether under an atmosphere of  $N_2$  because  $B_2H_6$  and the products are very reactive. The products further treated with alkaline  $H_2O_2$  to convert into alcohols.  

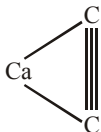
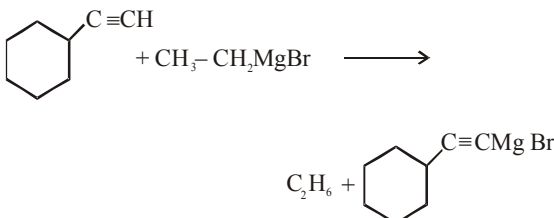
$$B_2H_6 + 6C_2H_4 \longrightarrow \underset{\text{reactive}}{B(C_2H_4)_3} \xrightarrow[H_2O_2]{\text{alkaline}}$$

$$3CH_3CH_2OH + H_3BO_3$$
- (b) Liquid crystals on heating first become turbid and then clear.
- (a)  $AgX + 2Na_2S_2O_3 \rightarrow Na_3[Ag(S_2O_3)_2] + NaX$   

Sodium argento thiosuphate  
(soluble complex)
- (c) By definition, a mixed complex contains more than one type of ligands.
- (a) Osmotic pressure,  $\pi = CRT$ ;  

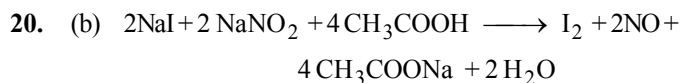
$$n_{CH_3COOH} = \frac{6}{60}, n_{KCl} = \frac{7.45}{74.5}$$
Since KCl ionises. Therefore its effective conc., in solution increases.
- (b)
- (d) In reaction (d) oxidation number changes from +4 in  $NO_2$  to +3 in  $HNO_2$  and +5 in  $HNO_3$
- (b) In neutral and alkaline medium  

$$MnO_4^- + 2H_2O + 3e^- \longrightarrow MnO_2 + 4OH^-$$
In acidic medium:  

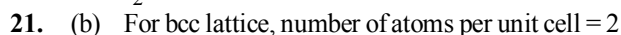
$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$$
- (b)  6.4g of  $CaC_2$  contain  $\pi$ -electron =  $4N_A$
- (b) 

$$C_6H_{11}C\equiv CH + CH_3CH_2MgBr \longrightarrow C_6H_{11}C\equiv CCH_2CH_3$$
- (a) Because of the formation of the most stable carbonium ion,  $C_6H_5 - \overset{+}{C}H_2$
- (c) Let atomic masses of A and B be a and b amu respectively  
 $\therefore$  Molar mass of  $AB_2 = (a + 2b) \text{ g mol}^{-1}$   
and Molar mass of  $AB_4 = (a + 4b) \text{ g mol}^{-1}$   
For compound  $AB_2$   
 $\Delta T_b = K_b \times W_B \times 1000 / W_A \times M_B$   
 $2.3 = 5.1 \times 1 \times 1000 / 20.0 \times (a + 2b) \dots I$   
For compound  $AB_4$   
 $1.3 = 5.1 \times 1 \times 1000 / 20.0 \times (a + 4b) \dots II$   
Solving (I) and (II),  $a = 25.49$   $b = 42.64$

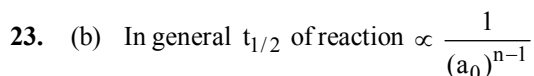
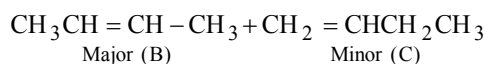
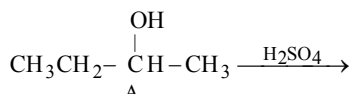
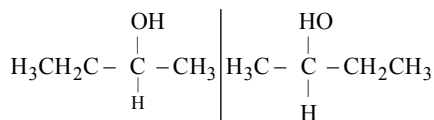
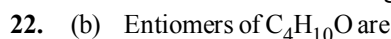




The colour of  $\text{CCl}_4$  layer turns purple due to liberated  $\text{I}_2$ .



$$\text{Now } d = \frac{n \times M}{a^3 \times N_0} = \frac{2 \times 100}{(4 \times 10^{-8} \text{ cm})^3 \times 6.02 \times 10^{23}} \\ = 200/38.528 = 5.19 \text{ g/cc}$$



For a second order reaction,

$$t_{1/2} = \frac{1}{K(a_0)^{n-1}} = \frac{1}{K(a_0)} = \frac{1}{0.5 \times 0.2} = 10 \text{ min}$$

