

# **RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER**

## **SYLLABUS FOR SCREENING TEST FOR THE POST OF SENIOR SCIENTIFIC OFFICER PHYSICS DIVISION (M.Sc. PHYSICS) (STATE FORENSIC SCIENCE LABORATORY, RAJASTHAN, JAIPUR)**

### **Unit-I**

Frame of reference, inertial and non inertial frames, Rotating frame of reference, Coriolis force conservation Laws. Collisions, impact parameter, centre of mass frame and analysis of collision in centre of mass frame and lab systems., rotational motion of rigid bodies, moment of inertia, products of inertia, conservation of angular momentum. Central forces, motion under inverse square law forces, Special Theory of Relativity, Michelson-Morely experiment, Lorentz Transformations-addition of velocities, Time dilation and length contraction, variation of mass with velocity, mass-energy equivalence.

### **Unit-II**

Oscillations, simple harmonic motion, damped harmonic motion, forced oscillation and resonance. Wave equation, harmonic solutions, plane and spherical waves, superposition of waves, beats, stationary waves Doppler's Effect, phase and group velocities. Conditions of interference, Newton's rings and Michelson's interferometer. Diffraction-Fresnel and Fraunhofer, diffraction by plain transmission grating, Rayleigh criterion, resolving power of grating and telescope.

### **Unit-III**

Electric field and potential, Gauss's law. Poisson's and Laplace equations, dielectrics and polarization, Electromagnetic induction, transformer. Transient behaviour of R-C, and R-L, circuits, time constant. Response of an L-C-R circuit for alternating voltages; series and parallel resonance, band-width and Q-factor.

Maxwell's equations and their application to plane electromagnetic wave. Poynting vector. Vector and scalar potentials; Wave equations in isotropic dielectrics, reflection and refraction at the boundary of two dielectrics; Fresnel's relations; Total internal reflection; Normal and anomalous dispersion; Lasers, He-Ne and Ruby lasers, spatial and temporal coherence.

## **Unit-IV**

De Broglie waves. Photo-electric effect, Compton effect, wave-particle duality, Uncertainty principle and its applications (like - size of H-atom, zero point energy, wave packet, finite width of energy levels). Schrodinger wave equation with applications for free particle potential step or particle in a one dimensional box, extension of results to three dimensional case, Hydrogen spectrum, electron spin, Stern-Gerlach experiment, space-quantisation, characteristic and continuous x-rays.

## **Unit-V**

Band theory of solids - conductors, insulators and semiconductors; Bloch Theorem, effective mass, Electric conduction in metals, Sommerfeld theory of electrical conductivity, specific heat of solids - Einstein and Debye theories. Electronic specific heat, Wiedemann Franz law, Hall effect. Magnetic properties of materials: para, diaferro, anti-ferro and ferrimagnetism. Curie and Curie-Weiss Laws. Elements of superconductivity, Meissner effect, Josephson junctions and applications; Elementary ideas about high temperature superconductivity.

## **Unit-VI**

Kirchhoff's law, Thevenin, Norton and maximum power-transfer theorems. p-n junction diode, ideal diode equation, use of diode for rectification, zener diode and its use in voltage regulation. Transistor, its biasing, common emitter amplifier. Digital electronics-Boolean identities, De Morgan's laws, logic gates and truth tables; Simple logic circuits.

## **UNIT -VII**

Forensic Physics: Introduction and scope, tools and techniques, examination of vehicle in case of road traffic accident, skid marks evaluation. Physical Evidences: types and importance. Forensic Statistics: Types of data, measure of central tendency, dispersion of data, correlations and probability and proof.

Glass: Types of glass and their composition-soda-lime, boro-silicate, safety glass, laminated, light-sensitive, tampered/ toughened, wire glass, coloured glass. Matching and comparison. Forensic examinations of glass fractures-concentric and radial fractures. Colour, fluorescence, physical measurements, specific gravity examination and elemental analysis of glass evidence.

Paint: Types of paint and their composition, macroscopic and microscopic analysis of paint pigments, pigment distribution, micro-chemical analysis- solubility test, pyrolysis gas chromatography, TLC, colorimetric analysis, IR spectroscopy and X-ray diffraction, elemental analysis, mass spectrometer, interpretation of paint evidence.

### **UNIT -VIII**

Fibre: Types of fibres, forensic aspects of fibre examination- fluorescence, optical properties, refractive index, birefringence, dye analysis. Physical fit and chemical testing. TLC, IR-micro spectroscopy. Miscellaneous Evidences: wire, broken bangles, seals, counterfeit coins, ropes/ strings, synthetic fibers etc their introduction & forensic examination. Tool Marks: theory, types of tool marks, and their forensic examination, Restoration methods of obliterated marks.

### **UNIT-IX**

Building Materials: Cement- composition, types, Forensic Analysis- bromoform test, fineness test, ignition-loss test, Identification of adulterated cement. Mortar and concrete analysis. Soil: Types and composition of soil, sample preparation, removal of contaminants, colour, turbidity test, pH measurements, microscopic examination, density gradient analysis, ignition-loss test, elemental analysis.

### **UNIT -X**

Audio and Video Analysis and Tape Authentication: theory of voice production, theory of voice identification, acoustics of speech, the sound spectrograph, voice comparison -standards and methods of voice comparison, voice spectrograph and its significance. Speech recognition and speaker identification.

\* \* \* \* \*

## **PHYSICS DIVISION (M.Sc. PHYSICAL CHEMISTRY)**

### **UNIT-I**

Chemical kinetics: order, molecularity, methods to determine order of reaction using integrated rate equation, zero, first, second and half integral order reactions, determining the order- graphical method, half-life method, differential method, effect of temperature on reaction rate, Arrhenius equation. Basics of atomic structure: electronic configuration, shapes of orbitals, Bohr's interpretation of hydrogen spectrum. Electrolytic conductance, specific and molecular conductance, variation of molecular conductance with concentration, Kohlrausch's law and its applications. Electrochemical cells: Reversible and irreversible cells, EMF and its measurements, standard cells, cell reaction and EMF, single electrode potential and its calculation, calculation of cell EMF, thermodynamics of cell EMF, types of electrodes, Determination of pH. Acid–base and oxidation – reduction titration.

### **UNIT-II**

Zero, first, second and third law of thermodynamics- enthalpy, entropy, free energy and their dependence on pressure and temperature. Surface Chemistry: adsorption, physisorption and chemisorption, Freundlich and Langmuir adsorption isotherms, surface area determination. Phase rule: Definitions, Gibb's phase rule, one component system (moderate pressure only) for sulphur and water system, two component system for silver-lead and zinc-cadmium.

### **UNIT-III**

The structure of nucleus: classification of nuclides, nuclear stability and binding energy, discovery of radioactivity, types of radioactivity, general characteristics of radioactive decay and decay kinetics, measurements radioactivity, gas ion collection method, proportional and G.M. counter, applications of radioactivity, radiochemical principles in the use of tracers, typical applications of radioisotopes as a tracer. Crystal structure: crystallography, crystal systems SC, BCC, FCC and HCP, properties of crystals, crystal lattice and unit cell, crystal structure analysis by X ray, The Laue's method and Bragg's method, X-ray analysis of NaCl crystal system, Bragg's equation. Crystal defects : Schottky and Frenkel defect.

#### **UNIT-IV**

Photochemistry: photochemical reactions, laws of photochemistry, quantum yield, measurement of quantum yield, types of photochemical reactions, photolysis, photosensitization, photophysical processes-fluorescence, phosphorescence, quenching, chemiluminescence. Molecular Orbital Theory: Limitations of Valence Bond theory (VBT), features of MOT, formation of molecular orbitals (MO's) by LCAO principle, rules of LCAO combination, different types of combination of Atomic orbital (AO's):  $\sigma$  and  $\pi$ . Non-bonding combination of orbitals (formation of NBMO), M.O. energy level diagram for homonuclear diatomic molecules, bond order and existence of molecule from bond order.

#### **UNIT-V**

Metallic bonding, band theory in metals with respect to Na along with  $n(E)$  and  $N(E)$  diagrams, Electrical conductivity of metals (Na, Mg, Al), valence electrons and conductivity. Ionic Solids: Properties of ionic solids, packing arrangements of anions in an ionic solids, voids in crystal structure, tetrahedral and octahedral, ionic radius, radius ratio effect, Lattice energy.

#### **UNIT-VI**

Spectroscopic methods in structure determination of organic compounds: Different units of measurement of wavelength frequency, different regions of electromagnetic radiations. Interaction of radiation with matter, excitation of molecules with different energy levels, such as rotational, vibrational and electronic level, types of spectroscopy and advantages of spectroscopic methods of X-ray analytical method (XRF and XRD), Spectroscopic methods: IR, RAMAN, UV and NMR, Inductive Coupled Plasma Methods, Electron Microscopy, I R, Mass spectrometry, Raman and U V Spectroscopy, AAS.

Thermal analyzing techniques: DTA and TGA Methods. Chromatography: Different techniques of chromatography. Ion chromatography TLC, GC, Paper, HPLC.

## **UNIT -VII**

Forensic Physics: Introduction and scope, tools and techniques, examination of vehicle in case of road traffic accident, skid marks evaluation. Physical Evidences: types and importance. Forensic Statistics: Types of data, measure of central tendency, dispersion of data, correlations and probability and proof.

Glass: Types of glass and their composition-soda-lime, boro-silicate, safety glass, laminated, light-sensitive, tampered/ toughened, wire glass, coloured glass. Matching and comparison. Forensic examinations of glass fractures-concentric and radial fractures. Colour, fluorescence, physical measurements, specific gravity examination and elemental analysis of glass evidence.

Paint: Types of paint and their composition, macroscopic and microscopic analysis of paint pigments, pigment distribution, micro-chemical analysis- solubility test, pyrolysis gas chromatography, TLC, colorimetric analysis, IR spectroscopy and X-ray diffraction, elemental analysis, mass spectrometer, interpretation of paint evidence.

## **UNIT -VIII**

Fibre: Types of fibres, forensic aspects of fibre examination- fluorescence, optical properties, refractive index, birefringence, dye analysis. Physical fit and chemical testing. TLC, IR-micro spectroscopy. Miscellaneous Evidences: wire, broken bangles, seals, counterfeit coins, ropes/ strings, synthetic fibers etc their introduction & forensic examination. Tool Marks: theory, types of tool marks, and their forensic examination, Restoration methods of obliterated marks.

## **UNIT-IX**

Building Materials: Cement- composition, types, Forensic Analysis- bromoform test, fineness test, ignition-loss test, Identification of adulterated cement. Mortar and concrete analysis. Soil: Types and composition of soil, sample preparation, removal of contaminants, colour, turbidity test, pH measurements, microscopic examination, density gradient analysis, ignition-loss test, elemental analysis.

## **UNIT -X**

Audio and Video Analysis and Tape Authentication: theory of voice production, theory of voice identification, acoustics of speech, the sound spectrograph, voice comparison - standards and methods of voice comparison, voice spectrograph and its significance. Speech recognition and speaker identification.

\* \* \* \* \*

### **Pattern of Question Papers:**

1. Objective Type Paper
2. Maximum Marks : 100
3. Number of Questions : 100
4. Duration of Paper : Two Hours
5. All Questions carry equal marks
6. There will be Negative Marking
7. The candidate has to choose either Physics or Physical Chemistry

\* \* \* \* \*