

# **RAJASTHAN PUBLIC SERVICE COMMISSION, AJMER**

## **SYLLABUS FOR SCREENING TEST FOR THE POST OF SENIOR SCIENTIFIC OFFICER BALLISTIC 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**

History and development of firearms, their classification and characteristics, various components of small arms, bore and caliber, relation between bore number of shotguns and internal cross sectional diameter of their barrels, choke- purpose, degrees and types, different automatic mechanisms used in small arms- blow back, retarded blow- back, short recoil operated, long- recoil operated and gas operated mechanisms; rifling, methods to produce rifling, trigger and firing mechanisms,

Projectile- velocity determination, determination of velocity of shot-charge, techniques of dismantling/assembling of various types of firearms, identification of origin- various marks on firearms, improvised/Country- made/imitative firearms, and their constructional features, comparative merits of different bores of shotguns, silencers, Headspace and its importance.

### **Unit-VIII**

Types of ammunition, classification and constructional features of different types of cartridges, types of primers and priming compositions. Propellants and their compositions-black, smokeless and semi-smokeless powders, various additives in propellants like stabilizers, chemicals for reducing flash, non- hygroscopic agents, chemicals for conversion of propellants into progressive burning, etc, velocity and pressure characteristics under different conditions. Identification of origin, head stamp markings on cartridges, improvised ammunition, safety aspects for handling of firearms and ammunition.

### **Unit – IX**

Principles and practice of identification of firearms, ammunition and their components how different parts of firearms acquire individual characteristics during their manufacture, types of marks produced during firing process on cartridge cases-firing-pin marks, breech- face marks, chamber marks, extractor and ejector marks, marks on bullets, striation marks of lands and grooves, various factors affecting nature of these marks, measurement of rifling details, i.e., number/ direction of lands and grooves, pitch of rifling etc, imprinted on fired bullets, determination of make/ model of the suspected firearm, techniques of obtaining test materials from various types of weapons and process of their linkage with fired ammunition, photomicrography, non- submission of photomicrographs along with report, presence of matching and non- matching characteristics on evidence and test cartridge cases and bullets, source correspondence, number of matching points, furnishing of opinion- definite positive, definite negative, no definite etc., writing of reports, automatic bullet and cartridge comparison systems, linkage of fired shots with suspected shot gun, effects of erosion, corrosion etc., effect of human decomposition on bullet striations.

## **Unit-X**

Determination of range of firing, burning scorching, blackening, tattooing, metallic fouling, GSR distribution and dispersion of pellets, factors affecting these phenomena, the stringing of shots, effect of stringing on pattern, cartwheel pattern, balling, determination of range of firing in case of country- made firearms, characteristics of contact shots, distinction between blackening and lead/dirt ring, abrasion, back scatter effect, Walker's test around gun-shot holes in clothes, tests of presence of tattooing around gun- shot holes in skin/ head, IR photography of tattooing around gun-shot holes in dark- coloured clothes, use of various instrumentation techniques for estimation of range of firing, effective, killing and extreme ranges.

Testing of barrel wash, chemical tests for testing for testing of lead/copper around gun-shot holes in clothes, skin and other objects, use of instrumentation techniques in identification of gun-shot holes. Use of instrumentation techniques for analysis of propellant particles found on hands of shooter, fired cartridge case, barrel and target.

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# BALLISTIC DIVISION (M.Sc. MATHEMATICS)

## Unit-I

**Dynamics of a particle:-** Velocity and acceleration along radial and transverse direction, tangential and normal acceleration, motion under variable forces, motion in a resisting medium, projectile, impact, work, power, energy and impulse, conservation laws, work energy theorem, systems with variable mass, central orbits, Kepler's law.

## Unit-II

**Dynamics of a Rigid Body:-** Moment and Product of inertia of a rigid body, D'Alembert principle, general equation of motion of a rigid body, motion about a fixed axis, the compound pendulum, motion of rigid body in two dimension under finite and impulsive forces, motion in three dimension with reference to Euler's dynamical and geometrical equation.

## Unit – III

**Fluid Dynamics:-** General introduction of fluid dynamics, kinematics of flow fields, conservation of momentum, irrotational motion, equation of continuity, Bernoulli's theorem, viscous fluids, streamline and turbulent flow, Poiseuille's law, Surface tension capillary tube flow, Reynold's number, Stoke's law.

## Unit-IV

**Differential Equations:-** Degree and order of a differential equations, differential equations of first order and first degree, linear differential equations with constant coefficients, complimentary function and particular integral, homogeneous linear differential equations of second order, Normal form, transformation of the equations by the changing the dependent / independent variable.

## Unit-V

**Statistics:-** Measure of dispersion, moments, central moments, skewness, kurtosis, Pearson's coefficients, probability-theory, basic terms-events, trials, mutually exclusive events, favourable events, exhaustive events etc. addition theorem, multiplication theorem, Baye's theorem of probability, Binomial distribution, normal distribution, hyper geometric distribution.

## **Unit-VI**

Correlation coefficient, rank correlation coefficient, fitting of a line and quadratic curve, simple linear regression, properties of regression coefficients, tests of significance of attributes, Z-test of significance, small sample test, t-test, paired test, chi-square test, F-test for equality of variance, large sample test, normal test, index numbers.

## **Unit-VII**

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factors affecting nature of these marks, measurement of rifling details, i.e., number/ direction of lands and grooves, pitch of rifling etc, imprinted on fired bullets, determination of make/model of the suspected firearm, techniques of obtaining test materials from various types of weapons and process of their linkage with fired ammunition, photomicrography, non- submission of photomicrographs along with report, presence of matching and non- matching characteristics on evidence and test cartridge cases and bullets, source correspondence, number of matching points, furnishing of opinion- definite positive, definite negative, no definite etc., writing of reports, automatic bullet and cartridge comparison systems, linkage of fired shots with suspected shot gun, effects of erosion, corrosion etc., effect of human decomposition on bullet striations.

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#### **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 Mathematics

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