

**RULES AND GUIDELINES FOR ENTRANCE EXAMINATIONS FOR M.Sc. PHYSICS,
M.Sc. CHEMISTRY and M.Sc. MATHEMATICS**

1. The Entrance Examination is meant to assess the candidates' suitability for the Programme to which she is seeking admission.
2. The question papers for various Entrance Examinations will consist of objective type multiple choice questions only.
3. The duration of Entrance Test will be 90 minutes (1½ hr.). There shall be 100 objectives multiple choice type questions of 1 mark each. The candidates will be awarded 1 (one) mark for every correct answer.
4. There will be no negative marking.
5. Medium of Entrance Examination will be English.
6. There will be absolutely no weightage of any kind for admissions to the above Programme and admission will be made on the basis of marks obtained in the Entrance Test.

Syllabus for the Entrance Examination for admissions in M.Sc. Physics

MECHANICS (7 Marks)

Mechanics of single and system of particles, conservation of laws of linear momentum, angular momentum and mechanical energy, Centre of mass and equation of motion, constrained motion, degrees of freedom. Generalised coordinates, displacement, velocity, acceleration, momentum, force and potential. Hamilton's variational principle, Lagrange's equation of motion from Hamilton's Principle. Linear Harmonic oscillator, simple pendulum, Atwood's machine.

Rotation of Rigid body, moment of inertia, torque, angular momentum, kinetic energy of rotation. Theorems of perpendicular and parallel axes with proof. Moment of inertia of solid sphere, hollow sphere, spherical shell, solid cylinder, hollow cylinder and solid bar of rectangular cross-section. Acceleration of a body rolling down on an inclined plane.

ELECTRICITY AND MAGNETISM (7 Marks)

Mathematical Background: Scalars and Vectors, dot and cross product, Triple vector product, Scalar and Vector fields, Differentiation of a vector, Gradient of a scalar and its physical significance, Integration of a vector (line, surface and volume integral and their physical significance), Gauss's divergence theorem and Stokes theorem.

Magnetostatics: Magnetic Induction, magnetic flux, solenoidal nature of Vector field of induction. Properties of \mathbf{B} (i) $\nabla \cdot \mathbf{B} = 0$ (ii) $\nabla \times \mathbf{B} = \mu_0 \mathbf{J}$. Electronic theory of dia and para magnetism (Langevin's theory). Domain theory of ferromagnetism. Cycle of Magnetisation - Hysteresis (Energy dissipation, Hysteresis loss and importance of Hysteresis curve).

Electromagnetic Theory: Maxwell equation and their derivations, Displacement Current. Vector and scalar potentials, boundary conditions at interface between two different media, Propagation of electromagnetic wave (Basic idea, no derivation). Poynting vector and Poynting theorem.

PROPERTIES OF MATTER, KINETIC THEORY AND RELATIVITY (8 Marks)

Properties of Matter (Elasticity): Elasticity, Hooke's law, Elastic constants and their relations, Poisson's ratio, torsion of cylinder and twisting couple. Bending of beam (bending moment and its magnitude) cantilevers, Centrally loaded beam.

Kinetic Theory of Gases: Assumptions of Kinetic Theory of gases, Law of equipartition of energy and its applications for specific heats of gases. Maxwell distribution of speeds

and velocities (derivation required), Experimental verification of Maxwell's Law of speed distribution : most probable speed, average and r.m.s. speed, mean free path. Transport of energy and momentum, diffusion of gases. Brownian motion (qualitative), Real gases, Van der Waal's equation.

Theory of Relativity : Reference systems, inertial frames, Galilean invariance and

Conservation laws, Newtonian relativity principle, Michelson - Morley experiment :Search for ether. Lorentz transformations length contraction, time dilation, velocity addition theorem, variation of mass with velocity and mass energy equivalence.

ELECTRO MAGNETIC INDUCTION AND ELECTRONIC DEVICES (8 Marks)

Electromagnetic Induction: Growth and decay of current in a circuit with (a) Capacitance and resistance (b) resistance and inductance (c) Capacitance and inductance (d) Capacitance resistance and inductance. AC circuit analysis using complex variables with (a) capacitance and resistance, (b) resistance and inductance (c) capacitance and inductance (d) capacitance, inductance and resistance Series and parallel resonant circuit. Quality factor (Sharpness of resonance).

Semiconductor Diodes: Energy bands in solids. Intrinsic and extrinsic semiconductor, Hall effect, P-N junction diode and their V-I characteristics. Zener and avalanche breakdown.

Resistance of a diode, Light Emitting diodes (LED). Photo conduction in semiconductors, photodiode, Solar Cell.

Diode Rectifiers: P-N junction half wave and full wave rectifier. Zener diode as voltage regulator, simple regulated power supply.

Transistors: Junction Transistors, Bipolar transistors, working of NPN and PNP transistors, Transistor connections (C-B, C-E, C-C mode), constants of transistor. Transistor characteristic curves (excluding h parameter analysis), advantage of C-B configuration. C.R. O. (Principle, construction and working in detail).

Transistor Amplifiers: Transistor biasing, methods of Transistor biasing and stabilization. D.C. load line. Common- base and common-emitter transistor biasing. Common-base, common- emitter amplifiers. Classification of amplifiers. Resistance-capacitance (R-C) coupled amplifier (two stage; concept of band width, no derivation). Feed- back in amplifiers, advantage of negative feedback Emitter follower.

Oscillators : Oscillators, Principle of Oscillation, Classification of Oscillator. Condition for self sustained oscillation: Barkhausen Criterion for oscillations. Tuned collector common emitter oscillator. Hartley oscillator.

COMPUTER PROGRAMMING & THERMODYNAMICS (7 Marks)

Computer Programming : Computer organisation, Binary representation, Algorithm development, flow charts and their interpretation. Fortran Preliminaries; Integer and floating point arithmetic expression, built in functions executable and non-executable statements, input and output statements, Formats, I.F. DO and GO TO statements, Dimension arrays statement function and function subprogram.

Thermodynamics-I : Second law of thermodynamics, Carnot theorem, Absolute scale of temperature, Absolute Zero, Entropy, show that $dQ/T=0$, T-S diagram Nernst heat law, Joule's free expansion, Joule Thomson (Porous plug) experiment. Joule - Thomson effect. Liquefaction of gases. Air pollution due to internal combustion Engine.

Thermodynamics-II: Derivation of Clausius - Claperyron latent heat equation. Phase diagram and triple point of a substance. Development of Maxwell thermodynamical relations. Application of Maxwell relations in the derivation of relations between entropy, specific heats and thermodynamic variables.

Thermodynamic functions: Internal energy (U), Helmholtz function (F), Enthalpy(H), Gibbs function (G) and the relations between them.

Optics – I (7 Marks)

Fourier analysis and Fourier Transforms: Speed of transverse waves on a uniform string. Speed of longitudinal waves in a fluid, superposition of waves (physical idea), Fourier Analysis of complex waves and its application for the solution of triangular and rectangular waves, half and full wave rectifier outputs. Fourier transforms and its properties. Application of fourier transform to following function.

(I) $f(x) = e^{-x^2/2}$

(II) $f(x) = 1 \quad [x] < a$
 $= 0 \quad [x] > a$

Geometrical Optics: Matrix methods in paraxial optics, effects of translation and refraction, derivation of thin lens and thick lens formulae, unit plane, nodal planes, system of thin lenses, Chromatic, spherical coma, astigmatism and distortion aberrations and their remedies.

Physical Optics

Interference: Interference by Division of Wavefront: Fresnel's Biprism and its applications to determination of wavelength of sodium light and thickness of a mica sheet, Lloyd's mirror, phase change on reflection.

STATISTICAL MECHANICS (8 Marks)

Probability, some probability considerations, combinations possessing maximum probability, combinations possessing minimum probability, distribution of molecules in two boxes. Case with weightage (general). Phase space, microstates and macrostates, statistical fluctuations constraints and accessible States Thermodynamical probability. Postulates of Statistical Physics. Division of Phase space into cells, Condition of equilibrium between two system in thermal contact. b-Parameter. Entropy and Probability, Boltzman's distribution law. Evaluation of A and b. Bose-Einstein statistics, Application of B.E. Statistics to Planck's radiation law, B.E. gas.

Fermi-Dirac statistics, M.B. Law as limiting case of B.E. Degeneracy and B.E., Condensation. F.D. Gas, electron gas in metals. Zero point energy. Specific heat of metals and its solution.

Optics – II (8 Marks)

Interference by Division of Amplitude: Colour of thin, films, wedge shaped film, Newton's rings. Interferometers: Michelson's interferometer and its application to(I) Standardisation of a meter (II) determination of wavelength. Fresnel's Diffraction:

Fresnel's half period zones, zone plate, diffraction at a straight edge, rectangular slit and circular aperture.

Fraunhofer diffraction: One slit diffraction, Two slit diffraction N-slit diffraction, Plane transmission grating spectrum, Dispersive power of a grating, Limit of resolution, Rayleigh's criterion, resolving power of telescope and a grating.

Polarization : Polarisation and Double Refraction : Polarisation by reflection, Polarisation by scattering, Malus law, Phenomenon of double refraction, Huygen's wave theory of double refraction (Normal and oblique incidence), Analysis of Polarised light : Nicol prism, Quarter wave plate and half wave plate, production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light, Optical activity, Fresnel's theory of rotation, Specific rotation, Polarimeters (half shade and Biquartz).

SOLID STATE PHYSICS (10 Marks)

Crystalline and glassy forms, liquid crystals. Crystal structure, periodicity, lattice and basis, crystal translational vectors and axes. Unit cell and primitive cell, Wigner Seitz primitive Cell, symmetry operations for a two dimensional crystal, Bravais lattices in two and three dimensions. crystal planes and Miller indices, Interplanar spacing, Crystal structures of Zinc sulphide, Sodium Chloride and diamond, X-ray diffraction, Bragg's Law and experimental x-ray diffraction methods, K-space. Reciprocal lattice and its physical significance, reciprocal lattice vectors, reciprocal lattice to a simple cubic lattice, b.c.c and f.c.c. Specific heat: Specific heat of solids, Einstein's theory of specific heat, Debye model of specific heat of solids.

QUANTUM MECHANICS (10 Marks)

Failure of (Classical) E.M. Theory. quantum theory of radiation (old quantum theory), Photon, photoelectric effect and Einsteins photoelectric equation compton effect (theory and result).

Inadequacy of old quantum theory, de-Broglie hypothesis. Davisson and Germer experiment. G.P. Thomson experiment. Phase velocity group velocity, Heisenberg's uncertainty principle. Time-energy and angular momentum, position uncertainty principle from de-Broglie wave, (wave-particle duality). Gamma Ray Microscope, Electron diffraction from a slit.

Derivation of time dependent Schrodinger wave equation, eigen values, eigen functions, wave functions and its significance. Normalization of wave function, concept of observable and operator. Solution of Schrodinger equation for harmonic oscillator ground states and excited states.

Application of Schrodinger equation in the solution of the following one-dimensional problems: Free particle in one dimensional box (solution of schrodinger wave equation, eigen function, eigen values, quantization of energy and momentum, nodes and antinodes, zero point energy).

i) One-dimensional potential barrier $E > V_0$ (Reflection and Transmission coefficient).

- ii) One-dimensional potential barrier, $E > V_0$ (Reflection Coefficient, penetration of leakage coefficient, penetration depth).

ATOMIC MOLECULAR AND LASER PHYSICS (10 Marks)

Vector atom model, quantum numbers associated with vector atom model, penetrating and non-penetrating orbits (qualitative description), spectral lines in different series of alkali spectra, spin orbit interaction and doublet term separation LS or Russell-Saunders Coupling jj coupling (expressions for interaction energies for LS and jj coupling required).

Zeeman effect (normal and Anomalous) Zeeman pattern of D₁ and D₂ lines of Na-atom, Paschen Back effect of a single valence electron system. Weak field Stark effect of Hydrogen atom. Discrete set of electronic energies of molecules. Quantisation of Vibrational and rotational energies Raman effect (Quantitative description) Stokes and anti Stokes lines.

Main features of a laser: Directionality, high intensity, high degree of coherence, spatial and temporal coherence, Einstein's coefficients and possibility of amplification, momentum transfer, life time of a level, kinetics of optical absorption. Threshold condition for laser emission, Laser pumping, He-Ne laser and RUBY laser (Principle, Construction and Working). Applications of laser in the field of medicine and industry.

NUCLEAR PHYSICS (10 Marks)

Nuclear mass and binding energy, systematics nuclear binding energy, nuclear stability, Nuclear size, spin, parity, statistics magnetic dipole moment, quadrupole moment (shape concept), Determination of mass by Bain-Bridge, Bain-Bride and Jordan mass spectrograph, Determination of charge by Mosley law Determination of size of nuclei by Rutherford Back Scattering.

Interaction of heavy charged particles (Alpha particles), alpha disintegration and its theory, Energy loss of heavy charged particle (idea of Bethe formula, no derivation), Energetics of alpha -decay, Range and straggling of alpha particles. Geiger-Nuttall law.

Introduction of light charged particle (Beta-particle), Origin of continuous beta-spectrum (neutrino hypothesis) types of beta decay and energetics of beta decay, Energy loss of beta-particles (ionization), Range of electrons, absorption of beta-particles.

Interaction of Gamma Ray, Nature of gamma rays, Energetics of gamma rays, passage of Gamma radiations through matter (photoelectric, Compton and pair production effect) electron positron annihilation. Absorption of Gamma rays (Mass attenuation coefficient) and its application.

Nuclear reactions, Elastic scattering, Inelastic scattering, Nuclear disintegration, photonuclear reaction, Radiative capture, Direct reaction, heavy ion reactions and

spallation Reactions, conservation laws. Q-value and reaction threshold. Nuclear Reactors General aspects of Reactor design. Nuclear fission and fusion reactors (Principles, construction, working and use) Linear accelerator, Tandem accelerator, Cyclotron and Betatron accelerators.

Ionization chamber, proportional counter, G.M. counter detailed study, scintillation counter and semiconductor detector.