

INDIAN INSTITUTE OF TECHNOLOGY MADRAS, CHENNAI-600036.

Advertisement No. IITM/R/2/2024 dated 02.03.2024

Syllabus & Scheme of Examination

Post: Junior Technician

Stream: Physics

LEVEL-1 Multiple Choice Question Test

(100 Marks)

PART – A

(30 Marks)

1. **Quantitative aptitude:** Number systems, simplification, decimals, fractions, LCM, HCF, ratio & proportion, percentage, log and trigonometric functions, solutions of simple equations (linear and quadratic), basic statistics – mean and standard deviation, profit & loss, discount, simple & compound interest, mensuration, time & work, time & distance, tables & graphs.
2. **Logical reasoning aptitude:** Analogies, similarities, differences, space visualization, analysis, judgment, decision making, visual memory, discrimination, observation, relationship concepts, arithmetical reasoning, verbal and figure classification
3. **Computer-related aptitude:** Hardware, software, operating systems, basic operations in MS Office® - Word, Excel, Powerpoint
4. **Language aptitude:** Comprehension, vocabulary, basic grammar in English.
5. **General awareness aptitude:** Current events, general knowledge, Indian history, Indian constitution, basic geography.

PART – B

(70 Marks)

1. **Mechanics and Properties of Matter:** Gradient, divergence, and curl - physical significance and applications. Gauss and Stokes theorems and applications. Laws of motion, motion of variable mass system, Conservation of energy and momentum, Collisions in one, two and three dimensions - impact parameter, scattering cross-section. Rigid body, rotational kinematic relations, equation of motion for a rotating body, angular momentum, Euler equations and its applications, precession of a top, gyroscope. Compound pendulum – theory – equivalent simple pendulum. Centre of mass – velocity and acceleration of centre of mass; centre of gravity of solid and hollow tetrahedron. Elastic constants of isotropic solids and their relations, Poisson's ratio. Central forces, definition and examples, Kepler's laws. Viscosity and flow through a capillary tube
2. **WAVES AND OSCILLATIONS:** Simple harmonic oscillator and the governing differential equation - physical characteristics of simple harmonic motion, torsion pendulum - measurements of rigidity modulus, compound pendulum- principle of superposition, beats, Lissajous figures. damped harmonic oscillator and solution, differential equation of forced oscillator and its solution, amplitude resonance and velocity resonance. Fourier theorem and evaluation of the Fourier coefficients, analysis of periodic wave functions-square wave, triangular wave, saw tooth wave, simple problems evaluating Fourier coefficients. One dimensional transverse wave propagation along a stretched string, general solution of wave equation and its significance, modes of vibration of stretched string clamped at ends, overtones, and harmonics.

- 3. OPTICS AND SPECTROSCOPY:** Analytical treatment of interference - expression for intensity - condition for maxima and minima in terms of phase and path difference - air-wedge - determination of diameter of thin wire - test for optical flatness. Fresnel diffraction - diffraction at a circular aperture and narrow wire. Fraunhofer diffraction - single slit - double slit. Plane diffraction grating - Determination of wavelengths using grating - normal incidence - oblique incidence. Dispersive power of a grating. Rayleigh's criterion for resolution - limit of resolution of the eye - resolving powers of telescope, microscope, prism and grating. Difference between resolving power and Dispersive power. Double refraction - polarizer and analyzer - Dichroism - polaroids and their uses - Quarter wave plate and Half Wave plate - plane, elliptically and circularly polarized light - production and detection. Electromagnetic spectrum - characterization of electromagnetic radiation - quantization of energy - microwave spectroscopy – rigid rotator - vibrational spectroscopy – Raman effect - experimental set up - Characteristics of Raman lines. Lasers - Ruby laser - He-Ne laser and applications.
- 4. THERMODYNAMICS AND RADIATION PHYSICS: Kinetic Theory of gases** – Maxwell's distribution of molecular speeds, mean free path. Isothermal and adiabatic process - reversible and irreversible processes - Carnot's engine and its efficiency - the Second law of thermodynamics. Kelvin's and Clausius statements - entropy, physical significance – change in entropy in reversible and irreversible processes - Entropy and disorder, T-S diagram and its uses. Perfect gas and van der Waals gas. Thermal conductivity – rectilinear flow of heat – thermal conductivity of a good conductor – Forbe's method – thermal conductivity of a bad conductor – Lee's disc method. Blackbody radiation – Wien's law – Stefan's law – Newton's law of cooling from Stefan's law – Solar constant – Pyrometer – determination of solar constant.
Thermodynamic potentials and Maxwell relations; Joule effect; Joule-Thompson effect and applications to liquefaction of gases like CO₂
- 5. ELECTRICITY AND MAGNETISM:** Basic laws of electrostatics in integral and differential forms. Electric field intensity due to various charge distributions like linear charge, uniformly charged sphere and an infinite conducting sheet of charge. Electrical potential – equipotential surfaces - potential due to a point charge, charged spherical shell and uniformly charged sphere. Electric dipole moment and molecular polarizability- Electric displacement D, electric polarization P – dielectric constant and susceptibility. Boundary conditions at the dielectric surface. Biot-Savart's law, explanation, and calculation of B due to long straight wire, a circular current loop and solenoid – Lorentz force – Hall effect and applications. Faraday's law - Lenz's law - Self and mutual inductance. Alternating current - LR, CR and LCR circuits, Q-factor, power in ac circuits. Displacement current - Maxwell's equations (integral and differential forms), Maxwell's wave equation, Transverse nature of electromagnetic waves and Poynting theorem.
- 6. ELECTRONICS:** PN junction diode, Zener diode, Tunnel diode, I-V characteristics, PNP and NPN transistors, CB, CE and CC configurations – Relation between β , α and β - transistor (CE) characteristics -Determination of hybrid parameters, Transistor as an amplifier. Number systems - Conversion of binary to decimal system and vice versa. Binary addition and subtraction (1's and 2's complement methods). Laws of Boolean algebra - De Morgan's laws. Basic logic gates, NAND and NOR as universal gates, exclusive-OR gate, Half adder and Full adder, Parallel adder circuits. Field effect transistor (FET) - characteristics - FET amplifier - Unijunction transistor (UJT) - characteristics - saw tooth generator.
- 7. ATOMIC PHYSICS:** Laws of photoelectric emission - Einstein photo electric equation - Millikan's experiment - verification of photoelectric equation - photomultiplier. Bohr and Sommerfeld atom models - Vector atom model - Pauli's exclusion principle - various quantum numbers - angular momentum and magnetic moment - coupling schemes - LS and JJ coupling - special quantisation - Bohr magnetron – Stern and Gerlach experiments. Excitation and ionization potential – Frank and Hertz's experiment. Spectral terms and notions - selection rules - intensity rule and interval rule - fine structure of sodium D lines - alkali spectra - fine

structure of alkali spectra - spectrum of Helium - Zeeman effect - Larmor's theorem - Debye's explanation of normal Zeeman effect. Lande's g-factor and explanation of splitting of D1 and D2 lines of sodium. Paschen-Back effect - Stark effect (qualitative study only). X-ray spectroscopy - characteristic X-ray spectra, Moseley's law - uses of X-rays – the Compton effect and experimental verification,

8. CONDENSED MATTER PHYSICS: Crystal lattice – primitive and unit cell – Bravais Lattice – Miller Indices – Structure of crystals. X ray diffraction – Bragg's law. Defects in solids - Point defects - Frenkel and Schottky defects - Equilibrium concentrations - line defects - edge dislocation and screw dislocation - surface defects - grain boundary - Effects of crystal imperfections. Interatomic forces and chemical bonds - Dielectric materials - Polarization - Local field or internal field - Clausius-Mossotti relation - Sources of polarizability – Frequency and temperature effects on polarization. Dielectric breakdown – Properties of different types of insulating materials and different types of magnetic materials.

9. RELATIVITY AND QUANTUM MECHANICS: Galilean transformation - Michelson-Morley experiment - Postulates of special theory of relativity - Lorentz transformation - length contraction – time dilation - addition of velocities - variation of mass with velocity – mass energy relation. Phase and group velocity - wave packet - expression of de Broglie's wave length - Davisson and Germer's experiment - G.P.Thompson's experiment - Electron microscope - Heisenberg's uncertainty principle and its application to simple systems. Inadequacy of classical mechanics - Basic postulates of quantum mechanics – the Schrodinger equation - Properties of wave function - expectation value - eigenvalues and eigenfunctions - commutativity and compatibility. Orbital angular momentum operators and their commutation relations - separation of three-dimensional Schrodinger equation into radial and angular parts - Elementary ideas of spin angular momentum of an electron - Pauli matrices. Free particle solution - particle in a box - potential well of finite depth (one dimension) - linear harmonic oscillator - rigid rotator and hydrogen atom.

10. NUCLEAR AND PARTICLE PHYSICS: Nuclear size, charge, mass-determination of nuclear radius; mass defect and binding energy-packing fraction - nuclear spin - magnetic dipole moment. Shell model – magic numbers and the liquid drop model. Natural radioactivity - law of disintegration - half life and mean life period - units of radioactivity-transient and secular equilibrium - radiocarbon dating - age of earth - alpha rays and - G.M.Counters. Linear accelerator – cyclotron and betatron. Conservation laws - nuclear reactions. Classification of elementary particles and fundamental interactions. Elementary particle quantum numbers - isospin and strangeness - conservation laws and symmetry - basic ideas about quarks.

Level – 2 Trade Test

- **Trade Test** - Syllabus as above under Part-B for Level-1 Multiple Choice Question Test

Scheme of Examination:

Level	Type of Test	Time	Details	Weightage for the final result
Level -1	Multiple Choice Question Test	Time: 120 Minutes	100 Objective Questions – 100 Marks	70 %
Level-2	Trade Test	Time: 90 minutes approximately	Practical Trade Test	30 %

- A minimum of 5X candidates shall be shortlisted (for X number of posts advertised) for the Level-2 Trade Test, based on their performance in the Level-1 Multiple Choice Question Test.

NOTE:

- a) The medium of examination will be ENGLISH
 - b) The questions will generally be on the minimum qualification level i.e. Graduation.
 - c) There shall be no negative marking for wrong answers.
 - d) **The Level-1 Multiple Choice Question Test is tentatively scheduled to be held on 06th February 2025 at TCS iON Centres in Chennai.**
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