PHYSICAL SCIENCES

Physical Sciences question paper will consist of multiple choice question for 100 marks.

SYLLABUS

Mechanics

Newtonian mechanics of a system of particles. Conservation of energy and momentum collisions simple harmonic motion, static equilibrium of a rigid body, rotational dynamics, angular momentum, gravitation, Kepler's laws.

Properties of Matter

Stress and strain, elastic properties of solids, elastic modulii; Hydrostatics, elements of fluid mechanics, surface, tension and viscosity.

Wave Motion

Wave propagation, phase and group velocities, standing waves, Fourier analysis, sound as elastic waves, interference and diffraction of sound waves, Doppler effect.

Thermal Physics

Kinetic theory of gases, the Maxwell-Boltzmann distribution, thermal properties of ideal and real gases, liquids and solids, laws of thermodynamics, entropy, reversible and irreversible processes, Carnot cycle, heat engines, changes of phase, low-temperature physics, superconductivity, blackbody radiation, the Stefan-Boltzmann law, Planck's law.

Electromagnetism, Electronics and Optics

Electric field and potential, Gauss law, Laplace and Poisson equations, electrostatic equilibrium, capacitance, dielectrics, electrostatic energy;

The magnetic field, magnetic forces on moving changes and current carrying wires, the Biot-Savart law, electromagnetic induction and Faraday's law, magnetic susceptibility and permeability, direct and alternating current circuits, Maxwell's equations, electromagnetic waves;

Diode, triode and cathode ray tubes, semiconductors, semiconductor devices; principles of rectification and amplification.

Reflection, refraction and polarisation of light, ray optics, thin lenses, aberrations, interference and diffraction of light, optical instruments.

Modern Physics

Frames of reference, time dilation and length contraction, simultaneity, the Lorentz transformation, relativistic energy and momentum, mass-energy relation;

The photoelectric effect, the Compton effect, atomic spectra, wave-particle dualism, the wave function and its interpretation, the complementarity principle, the unertainty principle, the Schrodinger equation.

Atomic structure, the Pauli exclusion principle, periodic classification of elements, spin of electrons, the Zeeman effect; generation and diffraction of x-rays, radioactivity, nucleus-constituents, binding, nuclear reactions, fission and fusion, nuclear reactors, particle accelerators, cosmic rays.

Experiments and Measurements

Errors in measurement, accuracy, measurements of length, mass and charge of small and large objects, fundamental constants. Basic knowledge of scientific instruments and their working.

Mathematical Physics

Theory of Systems of linear Equation, Linear algebra and matrices.

Series and their convergence.

Limits and continuity, differentiation and integration, Taylor's expansion, L'Hospital rule, maxima, minima.
Analytical geometry of curves and surfaces.
Ordinary (first and second order) differential equations.
Complex numbers, roots of complex numbers, trigonometric identities, Argand's diagram.
Vector addition and products, gradient, divergence and curl, Gauss and Stokes theorems.
Probability, basic laws of probability, mean, standard deviation.

MODEL QUESTIONS

1. A heavy ball tied to a string spins around the circle. While the ball is spinning, the length of the string is slowly halved. The angular frequency of rotatioon of the ball is
   a) halved
   b) doubled
   c) quadrupled
   d) unchanged

2. Unpolarized light passes through three polarizing filters. The axis of the second one is at an angle of $+30^0$ with respect to the first, and the axis of the third is at an angle $+30^0$ with respect to the second. The fraction of the original intensity that energes from the third polarizer is
   a) 9/32
   b) 3/8
   c) 2/9
   d) 1/8

3. Two large metal spheres, A and B are near each other. The electrostatic force between them is attractive. Of the three possibilities :
   i) the two spheres are oppositely charged
   ii) one sphere is charged and the other is uncharged
   iii) both spheres are uncharged
      a) only case i) is possible.
      b) Cases i) and ii) are possible, but not iii).
      c) All three cases are possible.
      d) It depends on the size of the spheres compared to their separation.

4. A resistor inductor, and a capacitor are connected in series to an ac voltage source $\upsilon(t) = V \cos[2\pi\nu t]$. The peak voltages across the three elements are V_R, V_L and V_C
   a) V_R, V_L and V_C must be less than V.
   b) V_R, must be less than V, *but* V_L and V_C need not.
   c) At any instant, the voltage across the resistor and the voltage from the source must have the same sign.
   d) At any instant, the voltage across the resistor must be smaller in magnitude than the voltage from the source.

5. Two spheres of radius and r1 and r2 and at temperatures T1 and T2, are placed in vacuum. The first sphere is a blockbody. The second sphere may absorb more heat from the first than it radiates out if

a) $T_1 = T_2$, but r1 is sufficiently large compared r2.

b) $T_1 = T_2$, but the second sphere is painted, with a colour matching the peak of the radilation from the first.

c) $T_1 > T_2$,.

d) Nobne of the above.