

MECHANICS AND GENERAL PROPERTIES OF MATTER

Scalars and Vectors, unit vector, addition and subtraction of vectors (analytical method), product of two vectors, vector analysis, Matrices. Mechanics of single particle and a system of particles, Lagrangian and Hamiltonian formulation. Angular momentum, Conservation of angular momentum. Moment of inertia, radius of gyration. Theorem of parallel and perpendicular axes. Centripetal force and centrifugal force.

Relation between G and g , variation of g , Gravitational potential intensity at a point due to spherical and other symmetrical bodies, Kepler's laws of planetary motion.

Elastic deformations, Torsion of wire, Torsional Oscillation. Bending of uniform beam, clamped at one end supported at both ends.

Surface tension and its molecular origin, surface energy. Excess pressure on a curved liquid surface, shape of liquid drops, surface tension and evaporation.

Coefficient of viscosity. Viscous flow through a capillary tube. Poiseuille's formula. Stokes law, Reynold number.

HEAT

1. Kinetic theory of Gases --- Basic assumptions of the theory, perfect gas equation. Temperature; Degrees of freedom; classical law of distribution of energy; specific heat of gases, Ratio of specific heats at constant pressure and at constant volume. Absolute scale of temperature.
2. Deviation from perfect gas equation, van der Waals' equation of State. Critical constants.
3. Heat conduction in Solid, conductivity and diffusivity.
4. First Law of thermodynamics.
Second Law of thermodynamics, Reversible and irreversible processes. Condition of reversibility. Carnot's theorem. Kelvin temperature scale. Heat engines.
Entropy concept. Entropy of an ideal gas, Entropy of a mixture of gases. Entropy change in reversible and irreversible processes, principle of increase of entropy.
5. Throttling process, Joule Thomson effect, liquefaction of gases – critical phenomena.

SOUND (OSCILLATION AND WAVES)

1. Simple harmonic Motion. Superposition of two harmonic oscillations with constant phase, frequency and amplitude difference beat phenomenon, coupled vibration.
2. Damped harmonic oscillator, Q-factor, Forced vibration. Resonance, sharpness of resonance. An harmonic oscillation.
3. Waves in continuous medium, Elastic waves in solids, liquids and gases, phase and group velocity. Energy transport by a traveling wave. Energy flux in a sound wave. Relative and absolute intensity. Decibel and phon; standing wave.
4. Transverse vibration of strings.
5. Doppler effect in sound, ultrasonics.

OPTICS

1. Short wave-length limit and geometrical optics, Fermat's Principle and its application to reflection and refraction at plane surfaces, combination of lenses: equivalent lens. Thick lenses, Principal plane, Nodal points. Helmholtz-Lagrange law for magnification.

2. Aberrations – spherical aberration, causes and remedy. Qualitative ideas of astigmatism, distortion, chromatic aberration.
3. Ramsden and Huygens's eye pieces (Ray diagram), Angular magnification. Resolving power (no deduction).
4. Electromagnetic nature of light. Electromagnetic spectrum. Huygens's principle.
5. Interference of light, Coherent and incoherent sources. Interference by division of wave front and division of amplitude. Different types of interferometer (Principle only) Resolving power, Michelson and Fabry Perot interferometer.
6. Fresnel diffraction. Division of wave front into half period zones, zone plate. Plane diffraction grating. Resolving power, and dispersive power of a plane diffraction grating (Deduction not necessary).
7. Polarization: Biaxial and uniaxial crystals, ordinary and extra-ordinary rays. Half and quarter wave plates. Optical activity. Faraday effect, Kerr effect.

MAGNETISM, ELECTROSTATICS AND CURRENT ELECTRICITY

1. Magnetic potential and fields due to short magnet and magnetic shell.
2. Intensity of magnetization, moment of a magnet, magnetic saturation, permeability and susceptibility, Dia, Para and Ferro magnetism, Hysteresis.
3. Couple on a magnet in a uniform field, work done in deflecting a magnet, magnetic needle in two cross magnetic fields.
4. Electric potential and electric intensity. Potential and intensity at a point due to charge. Electrostatic induction, lines of forces, distribution of charge and potential on a surface. Equipotential surface, total normal induction, Gauss theorem and its applications. Coulomb's theorem and its applications. Mechanical force on a charged surface, energy per unit volume of a medium. Capacity of conductor and factors controlling it, energy of a charge; Multiple expansion.
5. Electric polarization and dipole, electric displacement, dielectric constant, Capacitance of common condenser (spherical, parallel plate and cylindrical).
6. Magnetic effect of electric current, Laplace's equation, Biot savart law, Ampere's theorem. Magnetic field on the axis of a circular coil, solenoid, field due to a current in an infinitely long wire; effect of magnetic field on current carrying conductors; Moving coil Galvanometer, ammeter and voltmeter.
7. Kirchhoff's laws and its application, Seebeck, Peltier and Thomson effect, Thermo electric power, Thermo couple.
8. Self and Mutual inductances, Varying currents, Growth and decay of currents in L-R circuit. Charging and discharging of a condenser in C-R circuit. Time constant and log decrement.
9. R.M.S. and mean values of alternating current. Reactance and impedance, phase angle. Power in a.c. circuits. LR, CR and LCR circuits series and parallel resonant circuits; Q-factor.

MODERN PHYSICS

1. X-rays, production and nature, Compton effect, Mosley's law, Rutherford model Bohr model of atoms. Pauli Principle, photo electric effect.
2. Planck hypothesis, deBroglie hypothesis, Schrodinger equation, eigenvalues and eigenstates, Orthonormalization, expectation value, commutation relation and measurement, particle in a box. Linear harmonic oscillator. Potential well and barrier problems.
3. Hydrogen atom, angular momentum, spherical harmonics, parity, atomic spectra, time independent perturbation method. Two electron atom, spin-orbit interaction, sodium D-lines, Zeeman and Stark effect.
4. Molecular spectra, vibration and rotation, Raman effect, selection rules, symmetry.

5. Crystal structure, direct and reciprocal lattice, lattice vibration, s=acoustic and optical modes, band theory, Kronig Penny model, Metal, semiconductor and insulator, Hall effect.
6. Statistical Mechanics, ensemble, canonical and grand canonical ensemble, Bose Einstein and Fermi Dirac statistics, Bose Einstein condensation.
7. Nuclear Physics, nuclear spin and nuclear magnetic moment, nuclear radium mass and binding energy, stability condition, Nuclear disintegration, short range interaction, Youkawa model, elementary particles, baryons and leptons.
8. Lasers, coherence properties, applications, He-Ne Laser, optical fiber.
9. Relativity, Lorentz transformation, four-vector, Energy-mass relations.

ELECTRONICS AND INSTRUMENTATION:

1. Diodes, p-n junction, zener diode, rectification.
2. Transistors: Bipolar junction transistor, hybrid parameters, CB, CC and CE configurations, amplifiers.
3. Boolean algebra, Logic gates, AND, OR, NOT, NAND AND NOR gates.
4. Vacuum techniques, production and measurement
5. Particle accelerators and detectors.