PHYSICS

Mechanics

1. **Vector Analysis:** Scalar and vector fields, gradient of a scalar field and its physical significance. Divergence and curl of a vector field and related problems. Vector integration, line, surface and volume integrals. Stokes, Gauss and Greens theorems- simple applications

2. **Mechanics of Particles:** Laws of motion, motion of variable mass system, motion of a rocket, multi-stage rocket, conservation of energy and momentum. Collisions in two and three dimensions, concept of impact parameter, scattering cross-section,

3. **Mechanics of rigid bodies:** Definition of Rigid body, rotational kinematic relations, equation of motion for a rotating body, angular momentum and inertial tensor. Euler's equation, precession of a top, Gyroscope,

4. **Central Forces:** Central forces–definition and examples, conservative nature of central forces, conservative force as a negative gradient of potential energy, equation of motion under a central force, gravitational potential land gravitational field, motion under inverse square law, derivation of Kepler's laws, Coriolis force and its expressions.

5. **Special theory of relativity:** Galilean relativity, absolute frames, Michelson-Morley experiment, Postulates of special theory of relativity. Lorentz transformation, time dilation, length contraction, addition of velocities, mass-energy relation. Concept of four vector formalism.

Waves and Oscillations

1. **Fundamentals of vibrations:** Simple harmonic oscillator, and solution of the differential equation– Physical characteristics of SHM, torsion pendulum,-measurements of rigidity modulus, compound pendulum, measurement of 'g', combination of two mutually perpendicular simple harmonic vibrations of same frequency and different frequencies, Lissajous figures

2. **Damped and forced oscillations:** Damped harmonic oscillator, solution of the differential equation of damped oscillator. Energy considerations, comparison with undamped harmonic oscillator, logarithmic decrement, relaxation time, quality factor, differential equation of forced oscillator and its solution, amplitude resonance, velocity resonance(Coupled Oscillators).

3. **Vibrating Strings:** Transverse wave propagation along a stretched string, general solution of wave equation and its significance, modes of vibration of stretch edstringclampeda tends, overtones, energy transport, transverse impedance

4. **Vibrations of bars:** Longitudinal vibrations in bars-wave equation and its general solution. Special cases

(i) bar fixed at both ends

ii) bar fixed at the midpoint

iii) bar free at both ends

iv) bar fixed at one end. Transverse vibrations in a bar-wave equation and its general solution. Boundary conditions, clamped free bar, free-free bar, bar supported at both ends, Tuning fork.

Thermodynamics

1. **Kinetic theory of gases:** Introduction-Deduction of Maxwell'slaw of distribution of molecular speeds, Transport Phenomena-Viscosity of gases- 2 thermal conductivity-diffusion of gases.

2. **Thermodynamics:** Basics of thermo dynamics-Kelvin's and Clausius statements–Thermodynamic scale of temperature –Entropy, physical significance – Change in entropy in reversible and irreversible processes–Entropyanddisorder–Entropyofuniverse–Temperature-Entropy(T-S) diagram–Change of entropy of aperfect gas-change of entropywhenicechangesintosteam.

3. **Thermodynamic potentials and Maxwell's equations:** Thermodynamic potentials-Derivation of Maxwell's thermodynamic relations-Clausius-Clapeyron's Equation-Derivation for ratio of specific heats–Derivation for difference of two specific heats for perfect gas.Joule-Kelvineffect–expressionforJoule-KelvincoefficientforperfectandVander Waal'sgas.

4. **Low temperature Physics:** Joule Kelvin effect–liquefaction of gasusingporousplug experiment. Joule expansion – Distinction between adiabatic and Joule Thomson expansion–Expression for Joule Thomson cooling–Lique faction of helium, Kapitza's method–Adiabaticdemagnetization–Productionoflowtemperatures–Principleofrefrigeration, vapour compression type.

5. **Quantum theory of radiation**: Blackbody-Ferry's black body – distribution of energy in the spectrum of Black body – Wein's displacement law, Wein's law, Rayleigh-Jean's law –Quantum theory of radiation– Planck'slaw–deduction of Wein's distribution law, Rayleigh-Jeanslaw, Stefan's law from Planck's law. Measurement of radiation using pyrometers – Disappearing filament optical pyrometer – experimental determination – Angstrompyrhelio meter-determination of solar constant, effective temperature of sun.

6. **Statistical Mechanics:** Introduction, postulates of statistical mechanics. Phase space, concept of ensembles and some known ensembles, classical and quantum statistics and their differences, concept

of probability, Maxwell-Boltzmann's distribution law -Molecular energies in an ideal gas- Maxwell-Boltzmann's velocity distribution law, Bose-Einstein Distribution law, Fermi-Dirac Distribution law, comparison of three distribution laws, Application of B-E distribution to Photons-planks radiation formula, Application of Fermi-Dirac statistics to white dwarfs and Neutronstars.

OPTICS

1. **Interference:** Principle of super position–coherence–temporal coherence and spatial coherence–conditions for Interference of light

Interference by division of wave front: Fresnel's Biprism – determination of wavelength of light. Determination of thickness of a transparent material using Biprism – change of phase on reflection–Lloyd's mirror experiment.

Interferencebydivisionofamplitude:Obliqueincidenceofaplanewaveonathinfilmdueto reflected and transmitted light (Cosine law) – Colours of thin films – Non reflecting films – interference by a plane parallel film illuminated by a point source – Interference by a film with two non-parallel reflecting surfaces (Wedge shaped film) – Determination of diameter of wire-Newton's ringsin reflected light with and without contact between lens and glass plate, Newton's rings in transmitted light (Haidinger Fringes) – Determination of wavelength of monochromatic light – Michelson Interferometer – types of fringes – Determination of wave length of monochromatic light, Difference in wave length of sodium D1,D2 lines and thickness of a thin transparent plate.

2. **Diffraction**: Introduction–Distinction between Fresnel and Fraunhofer diffraction

Fraunhofer diffraction: -Diffraction due to single slit and circular aperture–Limit of resolution

–Fraunhofer diffraction due to double slit–Fraunhofer diffraction pattern with N slits(diffraction grating) Resolving Power of grating–Determination of wave length of light in normal and oblique incidence methods using diffraction grating.

Fresnel diffraction-Fresnel'shalf period zones – area of the half period zones –zone plate – Comparison of zone plate with convexlens–Phasereversalzoneplate–diffraction at a straight edge–difference between interference and diffraction.

3**. Polarization**: Polarized light : Methods of Polarization, Polarization by reflection, refraction, Double refraction, selective absorption , scattering of light – Brewsters law – Malus law – Nicolprism polarizer and analyzer – Refraction of plane wave incident on negative and positive crystals (Huygen's explanation) – Quarter wave plate, Half wave plate –Babinet's compensator – Optical activity, analysis of light by Laurent's half shadepolarimeter.

4. **Aberrations and Fiber Optics:** Introduction– Monochromatic aberrations, spherical aberration, methods of minimizing spherical aberration, coma, astigmatism and curvature of field, distortion. Chromatic aberration–the achromatic doublet–Removal of chromatic aberration of a separated doublet. Fiber Optics: Introduction–Optical fibers–Principles of fiber communication–Step and graded index fibers–Rays and modes in an optical fiber–Fibermaterial–Types of optical fibers and advantages of fiber communication.

Electromagnetism, Electrostatics:

Electric Field: - Concept of electric field lines and electric flux, Gauss's law (Integral and differential forms),application to linear, plane and spherical charge distributions. Conservative nature of electric field E, irrotational field. Electric Potential: - Concept of electricpotential, relation between electric potential and electric field, potential energy of a system of charges. Energy density in an electric field. Calculation of potential from electric field for a spherical charge distribution.

Magnetostatics

Concept of magnetic field B and magnetic flux, Biot-Savart's law, B due to a straight current carrying conductor. Force on a point charge in a magnetic field. Properties of B, curland divergence of B, solenoidal field. Integral form of Ampere's law, applications of Ampere'slaw: Magnetic field due to straight, circular and solenoidal currents. Energy stored in magnetic field. Magnetic energy in terms of current and inductance. Magnetic force between two current carrying conductors. Magnetic field intensity.

Ballistic Galvanometer: - Torque on a current loop in a uniform magnetic field, working principle of Ballistic Galvanometer, current and charge sensitivity, electromagnetic damping, critical damping resistance.

Electromagnetic Induction

Faraday's laws of induction (differential and integral form), Lenz'slaw, self and mutual Induction. Continuity equation, modification of Ampere's law, displacement current, Max well equations.

Electromagnetic waves

Maxwell's equations in vacuum and dielectric medium, boundary conditions, plane wave equation: transverse nature of EM waves, velocity of light in vacuum and in medium, polarization, reflection and transmission. Polarization of electromagnetic waves, Brewster's angle, description of linear, circular and elliptical polarization.

MODERNPHYSICS

1. **Atomic Spectra and Models Inadequacy of classical physics:**

Brief Review of Black body Radiation, Photo electric effect, Compton effect, dual nature of radiation, wave nature of particles. Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle. Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations, Bohr's model of H atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Experiment. Sommerfeld's modification of Bohr's Theory. Wave Particle Dualityde Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of de Broglie wave, wave particle duality, Complementarity. Super position of two waves, phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wave packet in time.Time development of a wave Packet; Wave Particle Duality, Complementarity. Heisenberg Uncertainty Principle, Illustration of the Principle through Experiments of Gamma ray microscope and electron diffraction through a slit. Time independent and time dependent Schrodinger wave equation. Estimation of ground state energy of harmonic oscillator and hydrogen atom, non-existence of electron in the nucleus. Uncertainty and Complementarities.

2. **Nuclear Physics:** Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. Fission and fusion-mass deficit, relativity and generation of energy; Fission-nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235;Fusion and thermo nuclear reactions driving stellar energy(brief qualitative discussions), Classification of Elementary Particles.

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