

SYLLABUS

PHYSICS

DYNAMICS

Newton's Laws of Motion: First law of motion - force and inertia with examples - momentum - second law of motion, derivation of $F=ma$, mention of spring force $F=kx$, mention of basic forces in nature - impulse and impulsive forces with examples - second law as applied to variable mass situation - third law of motion - Identifying action and reaction forces with examples - derivation of law of conservation of momentum with examples in daily life - principle of rocket propulsion - inertial and non-inertial frames - apparent weight in a lift and rocket/satellite - problems.

Fluid Dynamics: Explanation of streamline and turbulent motion - mention of equation of continuity - mention of expressions for PE, KE and pressure energy of an element of a liquid flowing through a pipe - statement and explanation of Bernoulli's Theorem and its application to uplift of an aircraft sprayer.

Surface Tension: Concept of adhesive and cohesive forces - definition of Surface energy and surface tension and angle of contact - explanation of capillary rise and mention of its expression - mention of application of surface tension to (i) formation of drops and bubbles (ii) capillary action in wick of a lamp (iii) action of detergents.

Work - Power - Energy: Work done by a force - F.S - unit of work - graphical representation of work done by a constant and variable force - power - units of power - energy - derivation of expression for gravitation potential energy and kinetic energy of a moving body - statement of work - energy theorem - mention of expression for potential energy of a spring - statement and explanation of law of conservation of energy - illustration in the case of a body sliding down on an inclined plane - discussion of special case = 90 degree, for a freely falling body - explanation of conservative and non conservative forces with examples - explanation of elastic and inelastic collisions with examples - coefficient of restitution - problems.

Gravitation: Statement and explanation of Law of Gravitation - definition of G - derivation of relation between g and G - mention of expression for variation of g with altitude, depth and latitude - statement and explanation of Kepler's Laws of planetary motion - definition of orbital velocity and escape velocity and mention of their expressions - satellites - basic concepts of geo-stationary satellites, launching of satellites - IRS and communication satellites - brief explanation of Inertial mass and gravitational mass - weightlessness - remote sensing and essentials of space communication - problems.

Concurrent Co-planar forces: Definition of resultant and equilibrant - statement of law of parallelogram of forces - derivation of expression for magnitude and direction of two concurrent

coplanar forces - law of triangle of forces and its converse – Lamia's Theorem - problems.

HEAT

Gas Laws: Statement and explanation of Boyle's Law and Charles's Law - definition of Pressure and Volume Coefficient of a gas - absolute zero - Kelvin scale of temperature - mention of perfect gas equation - explanation of isothermal and adiabatic changes - mention of Van-der-Waal's equation of state for real gases.

Mode of heat transfer: Conduction of heat - steady state - temperature gradient - definition of coefficient of thermal conductivity - basic concepts of convection of heat - radiation - properties of thermal radiation - radiant energy - definition of emissivity and absorptivity - perfect black body - statement and explanation of Kirchhoff's Law. Newton's Law of cooling - Stefan's Law - Wien's Displacement and Planck's Law - qualitative explanation of Solar Constant and surface temperature of sun - principle and working of total radiation pyrometer - problems.

GEOMETRICAL OPTICS

Waves: Waves around us - brief note on light waves, sound waves, radio waves, micro waves, seismic waves - wave as a carrier of energy - classification of waves. (i) based on medium - mechanical and electromagnetic waves (ii) based on vibration of particles in the medium - Longitudinal & Transverse waves - one, two & three dimensional waves with example - definition of wave amplitude, wave frequency, wave period, wavelength and wave velocity - concept to establish the relation between path of phase of a wave - derivation $v=f\lambda$ difference and phase difference - definition of a progressive wave - and its characteristics - derivation of equation of a progressive wave - different forms of a progressive wave equation - definition of wave intensity - mention of expression of wave intensity and its unit - statement and explanation of principles of superposition of waves with examples - problems.

Sound: Properties of sound - speed of sound in a gas - explanation of Newton's Formula for speed of sound - correction by Laplace - Newton - Laplace Formula - discussion of factors affecting speed i.e. pressure, temperature, humidity and wind - definition of sound intensity - explanation of loudness and its unit - definition of intensity level and its unit - mention of relation between intensity and loudness - distinction between noise and musical note - characteristics of a musical note - phenomenon of beats and its theory - application of beats (i) to find the frequency of a note (ii) to tune the musical instruments - Doppler Effect - derivation of expression for apparent frequency in general case and discussion to special cases - qualitative comparison of Doppler Effect in sound and light - problems.

Refraction at a plane surface: Refraction through a parallel sided glass slab - derivation of expressions for lateral shift and normal shift (object in a denser medium) - total internal reflection and its applications - optical fibers and its application in communication - problems.

Refraction through a prism: Derivation of expression for the refractive index in terms of A and D - dispersion through a prism - experimental - arrangement for pure spectrum - deviation produced by a thin prism - dispersive power - mention of condition for dispersion without deviation - problems.

Refraction at a spherical surface: Derivation of the relation - connecting n, u, v and r for refraction at a spherical surface (concave towards a point object in a denser medium) derivation of lens maker's formula - power of a lens - magnification - derivation of expression for the equivalent focal length of combination of two thin lenses in contact - mention of expression for equivalent focal length of two thin lenses separated by a distance - problems.

PHYSICAL OPTICS

Introduction to Theories of Light: A brief explanation of Newton's corpuscular theory, Huygen's wave theory and Maxwell's electromagnetic theory - mention of expression for c , qualitative explanation of Hertz's experiment - brief on speed of light $C=1/\lambda$ explanation of Planck's quantum theory of radiation - dual nature of light.

Interference: Explanation of the phenomenon theory of interference - derivation of conditions for constructive and destructive interference.

Young's Double-slit Experiment, derivation of expression for fringe width - qualitative explanation of interference at thin films and Newton's rings - problems.

Diffraction: Explanation of the phenomenon - distinction between Fresnel and Fraunhofer Diffraction - qualitative explanation of diffraction at single slit and analysis of diffraction pattern (Fraunhofer type) - qualitative explanation of plane diffraction grating at normal incidence - limit of resolution - resolving power - Rayleigh's Criterion - definition and mention of expression for resolving powers of microscope and telescope - problems.

Polarisation: Explanation of the phenomenon - representation of polarized and unpolarised light - explanation of plane of polarization and plane of vibration - methods of producing plane polarized light : by reflection - Brewster's Law, refraction, double refraction, selective absorption - construction and application of polaroids - optical activity - specific rotatory power - construction and working of Laurent's half shade polarimeter - mention of circularly and elliptically polarized light - problems.

Speed of light: Michelson's rotating mirror experiment to determine of light - importance of speed of light.

ELECTROSTATICS

Electric charges: Concept of charge - Coulomb's Law, absolute and relative permittivity - SI unit of charge.

Electrostatic Field: Concept of electric field - definition of field strength - derivation of expression for the field due to an isolated charge, concept of dipole - mention of expression for the field due to a dipole - definition of dipole moment - mention of expression for torque on a dipole - explanation of polarization of a dielectric medium - dielectric strength - concept of lines of force and their characteristics - explanation of electric flux - statement and explanation of Gauss theorem and its applications to derive expressions for electric intensity (a) near the surface of a charged conductor (b) near a spherical conductor - concept of electric potential - derivation of the relation between electric field and potential - derivation of expression for potential due to an isolated charge - explanation of potential energy of a system of charges - problems.

Capacitors: Explanation of capacity of a conductor and factors on which it depends - definition of capacitance and its unit - derivation of expression for capacity of a spherical conductor - principle of a capacitor - derivation of expression for capacitance of parallel plate capacitor - mention of expression for capacitance of spherical and cylindrical capacitors - derivation of expression for energy stored in a capacitor - derivation of expression for equivalent capacitance of capacitors in series and parallel - mention of uses of capacitors - problems.

CURRENT ELECTRICITY

Electric current: Microscopic view of current through conductors (random motion of electrons) - explanation of drift velocity and mobility - derivation of expression for current $I = neA$ - deduction of Ohm's Law - origin of resistance - definition of resistivity - temperature coefficient of resistance - concept of superconductivity - explanation of critical temperature, critical field and high temperature superconductors - mention of uses of superconductors - thermistors and mention of their uses - colour code for resistors - derivation of expression for effective resistance of resistances in series and parallel - derivation of expression for branch currents - definition of emf and internal resistance of a cell - Ohm's law applied to a circuit - problems.

Kirchoff's Laws: Statement and explanation of Kirchoff's Laws for electrical network - explanation of Wheatstone's network - derivation of the condition for its balance by applying Kirchoff's laws - principle of metre bridge - problems.

Magnetic effect of electric current: Magnetic field produced by electric current - statement and explanation of Biot - Savart (Laplace's) Law - derivation of expression for magnetic field at any point on the axis of a circular coil carrying current and hence expression for magnetic field at the centre - current in a circular coil as a magnetic dipole - explanation of magnetic moment of the current loop - mention of expression for the magnetic field due to (i) a straight current carrying conductor (ii) at a point on the axis of a solenoid - basic concepts of terrestrial magnetism - statement and explanation of Tangent law - construction and theory of tangent galvanometer -

problems.

Mechanical effect of electric current: Mention of expression for force on a charge moving in magnetic field - mention of expression for force on a conductor carrying current kept in a magnetic field - statement of Fleming's left hand rule - explanation of magnetic field strength in terms of flux density - derivation of expression for the force between two parallel conductors carrying currents and hence definition of ampere - mention of expression for torque on a current loop kept in a uniform magnetic field - construction and theory of moving coil galvanometer - conversion of a pointer galvanometer into an ammeter and voltmeter - problems.

Electromagnetic Induction: Statement explanation of Faraday's laws of electromagnetic induction and Lenz's Law - derivation of expression for emf induced in a rod moving in a uniform magnetic field - explanation of self induction and mutual induction - mention of expression for energy stored in a coil - explanation of eddy currents - alternating currents - derivation of expression for sinusoidal emf - definition of phase and frequency of ac - mention of the expression for instantaneous, peak, rms, and average values - derivation of expression for current in case of ac applied to a circuit containing (i) pure resistor (ii) inductor (iii) capacitor - derivation of expression for impedance and current in LCR series circuit by phasor diagram method - explanation of resonance - derivation of expression for resonant frequency - brief account of sharpness of resonance and Q-factor - mention of expression for power in ac circuits - power factor and wattless current - qualitative description of choke - basic ideas of magnetic hysteresis - construction and working of transformers - mention of sources of power loss in transformers - ac meters - principle and working of moving iron meter - qualitative explanation of transmission of electrical power - advantages of ac and dc - problems.

ATOMIC PHYSICS

Introduction to atomic physics: Mention of the types of electron emission - description and theory of Dunnington's method of finding e/m of an electron - explanation of types of spectra: emission and absorption spectra - brief account of Fraunhofer lines - qualitative explanation of electromagnetic spectrum with emphasis on frequency.

Photo electric effect: Explanation of photo electric effect - experiment to study photo electric effect - experimental observations - Einstein's photo electric equation and its explanation - principle and uses of photo cells: (i) photo emissive (ii) photo voltaic (iii) photo conductive cells - problems.

Dual nature of matter: Concept of matter waves - arriving at the expression for de Broglie Wave length - principle and working of G.P. Thomson's experiment - principle of Electron Microscope - Scanning Electron Microscope Transmission Electron Microscope and Atomic -Force Microscope.

Bohr's Atom model: Bohr's atomic model for Hydrogen like atoms - Bohr's postulates -

arriving at the expressions for radius, velocity, energy and wave number - explanation of spectral series of Hydrogen -energy level diagram - explanation of ionization and excitation energy - limitations of Bohr's theory -qualitative explanation of Sommerfeld & Vector atom models - problems.

Scattering of light: Explanation of coherent and incoherent scattering - blue of the sky and sea - red at sunrise and sunset - basic concepts and applications of Raman effect.

Lasers: Interaction between energy levels and electromagnetic radiation - laser action - population inversion - optical pumping - properties of lasers - construction and working of Ruby laser - mention of applications of lasers - brief account of photonics.

Nuclear Physics: Characteristics of nucleus - qualitative explanation of liquid drop model - qualitative explanation of nuclear magnetic resonance (NMR) and its applications in medical diagnostics as MRI -nuclear forces and their characteristics - explanation of Einstein's mass - energy relation - definition of amu and eV - arriving at $1\text{amu} = 931\text{ Mev}$ - examples to show the conversion of mass into energy and vice-versa - mass defect - binding energy - specific binding energy - BE curve - packing fraction.

Nuclear fission with equations - nuclear chain reaction - critical mass - controlled and un-controlled chain reactions - types of nuclear reactors and mention of their principles - disposal of nuclear waste. Nuclear fusion - stellar energy (carbon & proton cycles) - problems.

Radioactivity: Laws of radioactivity (i) -mSoddy's group displacement laws (ii) decay law - derivation of $N=N_0e^{-\lambda t}$ - explanation of decay constant - derivation of expression for half life - mention of expression for mean life - relation between half and mean life - units of activity: Becquerel and Curie - Artificial transmutation: Artificial radioactivity - radio isotopes and mention of their uses - brief account of biological effects of radiations and safety measures - problems.

Elementary particles: Basic concepts of - decay - neutrino hypothesis leptons and hadrons - qualitative explanation of Quarks.

Solid state electronics: Qualitative explanation of Bond Theory of solids - classification of conductors, insulators and semiconductors - intrinsic and extrinsic semiconductors - p-type and n-type semiconductors - construction and action of pn-junction - forward and reverse biasing - half wave and full wave rectification -function and application of light emitting diodes - photo diode - laser diode - transistors - npn and pnp transistors - action of transistor - npn transistor as an amplifier in CE mode.

Digital Electronics: Logic gates - AND, OR, NOR & NAND symbols and truth table - applications of logic gates (Boolean equations) - half adder and full adder.

Soft condensed matter physics: Liquid crystals - classification, thermotropic (nematic, cholesteric

and smectic) and lyotropic liquid crystals - mention of applications of liquid crystals - basic concepts of emulsions, gels & foams.

CHEMISTRY

STOICHIOMETRY

Equivalent mass of elements - definition, principles involved in the determination of equivalent masses of elements by hydrogen displacement method, oxide method, chloride method and inter conversion method (experimental determination not needed). Numerical problems.

Equivalent masses of acids, bases and salts.

Atomic mass, Molecular mass, vapour density-definitions. Relationship between molecular mass and vapour density. Concept of STP conditions. Gram molar volume. Experimental determination of molecular mass of a volatile substance by Victor Meyer's method. Numerical problems.

Mole concept and Avogadro number, numerical problems involving calculation of: Number of moles when the mass of substance is given, the mass of a substance when number of moles are given and number of particles from the mass of the substance. Numerical problems involving mass-mass, mass-volume relationship in chemical reactions.

Expression of concentration of solutions-ppm, normality, molarity and mole fraction. Principles of volumetric analysis- standard solution, titrations and indicators-acid-base (phenolphthalein and methyl orange) and redox (Diphenylamine). Numerical problems.

ATOMIC STRUCTURE

Introduction- constituents of atoms, their charge and mass.

Atomic number and atomic mass.

Wave nature of light, Electromagnetic spectrum-emission spectrum of hydrogen-Lyman series, Balmer series, Paschen series, Brackett series and Pfund series. Rydberg's equation. Numerical problems involving calculation of wavelength and wave numbers of lines in the hydrogen spectrum. Atomic model- Bohr's theory, (derivation of equation for energy and radius not required). Explanation of origin of lines in hydrogen spectrum. Limitations of Bohr's theory.

Dual nature of electron- distinction between a particle and a wave. de Broglie's Theory.

Matter-wave equation (to be derived). Heisenberg's uncertainty principle (Qualitative). Quantum numbers - n , l , m and s and their significance and inter relationship. Concept of orbital-shapes of s , p and d orbitals. Pauli's Exclusion Principle and Aufbau principle. Energy level diagram and $(n+1)$ rule. Electronic configuration of elements with atomic numbers from 1 to 54.

Hund's rule of maximum multiplicity.

General electronic configurations of s , p and d block elements.

PERIODIC PROPERTIES

Periodic table with 18 groups to be used.

Atomic radii (Van der Waal and covalent) and ionic radii: Comparison of size of cation and anion with the parent atom, size of isoelectronic ions. Ionization energy, electron affinity, electronegativity- Definition with illustrations. Variation patterns in atomic radius, ionization energy, electron affinity, electronegativity down the group and along the period and their interpretation.

OXIDATION NUMBER

Oxidation and reduction-Electronic interpretation.

Oxidation number: definition, rules for computing oxidation number. Calculation of the oxidation number of an atom in a compound/ion.

Balancing redox equations using oxidation number method, calculation of equivalent masses of oxidising and reducing agents.

GASEOUS STATE

GAS LAWS: Boyle's Law, Charles's Law, Avogadro's Hypothesis, Dalton's Law of partial pressures, Graham's Law of diffusion and Gay Lussac's Law of combining volumes. Combined gas equation. Kinetic molecular theory of gases-postulates, root mean square velocity, derivation of an equation for the pressure exerted by a gas. Expressions for r.m.s velocity and kinetic energy from the kinetic gas equation. Numerical problems. Ideal and real gases, Ideal gas equation, value of R (SI units). Deviation of real gases from the ideal behaviour. PV-P curves. Causes for the deviation of real gases from ideal behavior. Derivation of Van der Waal's equation and interpretation of PV-P curves

CHEMICAL KINETICS

Introduction. Commercial importance of rate studies. Order of a reaction. Factors deciding the order of a reaction-relative concentrations of the reactants and mechanism of the reaction. Derivation of equation for the rate constant of a first order reaction. Unit for the rate constant of a first order reaction. Half-life period. Relation between half-life period and order of a reaction. Numerical problems.

Determination of the order of a reaction by the graphical and the Ostwald's isolation method. Zero order, fractional order and pseudo first order reactions with illustrations. Effect of temperature on the rate of a reaction-temperature coefficient of a reaction. Arrhenius interpretation of the energy of activation and temperature dependence of the rate of reaction. Arrhenius Equation. Influence of catalyst on energy profile. Numerical problems on energy of activation.

ORGANIC COMPOUNDS WITH OXYGEN-2, AMINES

Phenols

Uses of phenol.

Classification: Mono, di and tri-hydric Phenols

Isolation from coal tar and manufacture by Cumene Process.

Methods of preparation of phenol from - Sodium benzene sulphonate, Diazonium salts

Chemical properties: Acidity of Phenols-explanation using resonance-Effect of substituents on Acidity (methyl group and nitro group as substituents), Ring substitution reactions-Bromination, Nitration, Friedel-craft's methylation, Kolbe's reaction, Reimer-Tiemann reaction.

Aldehydes and Ketones:

Uses of methanal, benzaldehyde and acetophenone

Nomenclature

General methods of preparation of aliphatic and aromatic aldehydes and ketones from Alcohols and Calcium salts of carboxylic acids

Common Properties of aldehydes and ketones

- a) Addition reactions with - Hydrogen cyanide, sodium bisulphate
- b) Condensation reactions with-Hydroxylamine, Hydrazine, Phenyl hydrazine, Semicarbazide
- c) Oxidation.

Special reactions of aldehydes: Cannizzaro's reaction-mechanism to be discussed, Aldol condensation, Perkin's reaction, Reducing properties-with Tollen's and Fehling's reagents.

Special reaction of ketones-Clemmensen's reduction

Monocarboxylic Acids

Uses of methanoic acid and ethanoic acid.

Nomenclature and general methods of preparation of aliphatic acids

From Alcohols, Cyanoalkanes and Grignard reagent

General properties of aliphatic acids: Reactions with - Sodium bicarbonate, alcohols, Ammonia, Phosphorus pentachloride and soda lime

Strength of acids-explanation using resonance.

Effect of substituents (alkyl group and halogen as substituents)