

PAPER 1- PART A

PHYSICS

UNIT-1

MOTION IN ONE & TWO DIMENSIONS : Average velocity, instantaneous velocity, one dimensional motion with constant accelerations, freely falling bodies.

MEASUREMENT : Dimensional analysis and error estimation, dimensional compatibility and significant figures.

LAWS OF MOTION : Force and inertia, Newton's laws of motion and their significance. Tension in strings, system of pulleys.

MOTION IN TWO DIMENSIONS : Projectile motion, uniform circular motion, tangential and radial acceleration in curve linear motion, relative motion.

WORK, POWER AND ENERGY : Work done by constant and variable forces, kinetic and potential energy, power, conservative and non conservative forces, conservation of energy, gravitational energy, work energy theorem, potential energy stored in a spring.

LINEAR MOMENTUM & COLLISIONS : Linear momentum & impulse, conservation of linear momentum for two particle system, collisions, collision in one dimension, collision in two dimensions, rocket propulsion.

ROTATION OF A RIGID BODY ABOUT A FIXED AXIS : Angular velocity and angular acceleration, rotational kinematics, rotational motion with constant angular acceleration relationship between angular and linear quantities, rotational energy, moment of inertia for a ring, rod, spherical shell, sphere and plane lamina, torque and angular acceleration, work and energy in rotational motion, rolling motion of a solid sphere and cylinder, friction and energy dissipation.

UNIT-2

GRAVITATION : Gravitational field, Kepler's laws and motion of planets, planetary and satellite motion, geostationary satellite, escape velocity.

OSCILLATORY MOTION : Harmonic motion, motion of mass attached to a spring, motion of mass attached to system of springs, kinetic & potential energy, Time Period of a simple pendulum, comparing simple and harmonic motion with uniform circular motion, forced oscillations, damped oscillations and resonance.

MECHANICS OF SOLIDS AND FLUIDS : States of matter Young's modulus, Bulk modulus, Shear modulus of rigidity, variation of pressure with depth, Buoyant forces and Archimedes principle, Pascal's law, Bernoulli's theorem and its applications, surface energy, surface tension, angle of contact, capillary rise, coefficient of viscosity, viscous force, terminal velocity, Stoke's law, stream line motion, Reynold's numbers.

HEAT AND THERMODYNAMICS : First law of thermodynamics, specific heat of an ideal gas at constant volume and constant pressure, relation between them, Thermal processes. (reversible, irreversible, isothermal, adiabatic), second law of thermodynamics, concept of entropy and absolute scale, efficiency of a Carnot engine, thermal conductivity, Newton's law of cooling, black body radiation, Wien's displacement law, Stefan's law.

UNIT-3

WAVE : Wave motion, phase, amplitude and velocity of a wave, Newton's formula for longitudinal waves, propagation of sound waves in air, effect of temperature and pressure on velocity of sound, Laplace's correction, Principle of superposition, formation of standing waves, standing waves in strings and organ pipes, beats, Doppler's effect in sound & light.

WAVE OPTICS : Coherent and incoherent sources of light, interference, Young's double slit experiment, diffraction due to a single slit, linearly polarized light, Polaroid.

ELECTROSTATIC : Coulomb's law, electric field and potential due to point charge, dipole and its field along the axis and perpendicular to axis, electric flux, Gauss's theorem and its applications to find the field due to infinite sheet of charge and inside the hollow conducting sphere, capacitance, parallel plate Capacitor with air and dielectric medium between the plates, Series and parallel combination of capacitors, energy of a capacitor, displacement current.

CURRENT ELECTRICITY : Concept of free and bound electrons, drift velocity and mobility, electric current, Ohm's law, resistivity, conductivity, resistance in series and parallel combination, Kirchhoff's law and their application to network of resistances, principle of potentiometer, effect of temperature on resistance and its applications.

MAGNETIC EFFECT OF CURRENT : Magnetic field due to current, Biot-Savart's law, magnetic field due to solenoid, motion of charge in a magnetic field, force on current carrying conductors and torque on current loop in a magnetic field, magnetic flux, forces between two parallel current carrying conductors, moving coil galvanometer and its conversion into ammeter and voltmeter.

MAGNETISM IN MATTER : The magnetization of substance due to orbital and spin motions of electrons, magnetic moment of atoms, diamagnetism, paramagnetism, ferromagnetism, earth's magnetic field and its components and their measurement.

UNIT-4

ELECTROMAGNETIC INDUCTION : Induced E.M.F., Faraday's laws, Lenz's law, electromagnetic induction, self and mutual induction, B-H curve, hysteresis loss and its importance, eddy currents.

RAY OPTICS AND OPTICAL INSTRUMENTS : Sources of light, luminous intensity, luminous flux, illuminance, photometry, wave nature of light, Huygen's theory for propagation of light and rectilinear propagation of light, reflection of light, total internal reflection, reflection and refraction at spherical surfaces, focal length of a combination of lenses, spherical and chromatic aberration and their removal, refraction and dispersion of light due to a prism, simple and compound microscope, reflecting and refracting telescope, magnifying power and resolving power.

UNIT-5

MODERN PHYSICS : Photo-electric equation, matter waves, quantization, Planck's hypothesis, Bohr's model of hydrogen atom and its spectra, ionisation potential, Rydberg constant, solar spectrum and Fraunhofer lines, fluorescence and phosphorescence, X-Rays and their productions, characteristic and continuous spectra. Moseley law, de Broglie wave length, Nuclear Instability, radioactive decay laws, Emission of α , β and γ rays, Mass - defect, Mass Energy equivalence, Nuclear Fission, Nuclear Reactors, Nuclear Fusion, Classification of conductors, Insulators and semiconductors on the basis of energy bands in solids, PN junction, PN Diode, junction Transistors, Transistor as an amplifier and Oscillator, Principles of Logic Gates (AND, OR and NOT) Analog Vs Digital communication, Difference between Radio and television, Signal propagation, Principle of LASER and MASER, Population Inversion, Spontaneous and stimulated Emission.

CHEMISTRY

UNIT-1

ATOMIC STRUCTURE : Bohr's atomic model, Electronic Configuration, Quantum number, Aufbau Principle, Hund's Rule, Pauli's Exclusion Principle, De Broglie's equation, Heisenberg Principle, Shape of Orbitals.

CHEMICAL BONDING AND MOLECULAR STRUCTURE : Electrovalent Bond, Covalent Bond, Hydrogen Bond, Hybridization involving s, p and d orbitals, Shapes of molecules, VSEPR- Theory, Molecular Orbital Theory.

SOLID STATE : Classification of solids, Seven crystal systems, Structure of simple ionic solids, space lattice and unit cell.

CHEMICAL EQUILIBRIUM : Law of mass action, Equilibrium constant, Le-Chateliers's Principle (Effect of temperature, pressure and concentration) Ionic equilibrium, Ostwald's Dilution law, Salt hydrolysis, pH and buffer solution, solubility and solubility product, Acid and Bases (Bronsted and Lewis concept).

UNIT-2

CHEMICAL KINETICS : Rate of chemical reaction, Molecularity and order of reaction, Rate constant, First and second order reactions, Half life period and its dependence on concentration in 1st and 2nd order reactions. Temperature dependence of rate constant (Arrhenius equation)

ELECTROCHEMISTRY : Specific, equivalent and molecular conductances, Effects of concentration on equivalent conductivity, Kohlrausch's law of independent migration of ions, Electrochemical Cells and cell reactions. Standard electrode potential, Nernst equation and electrochemical series.

CATALYSIS AND COLLOIDS : Types of catalysis, Kinetics of homogenous catalysis, Theories of catalysis. Colloids- Types, preparation and general properties, Emulsions, Surfactants and Micelles.

UNIT-3

ENERGETICS : First law of Thermodynamics- Internal energy, work, heat and pressure - volume, work, Enthalpy, Hess's law of constant heat summation, Fusion and vapourization. Heat of reaction, Heat of formation, Heat of combustion and Heat of neutralization, Second law of thermodynamics, Entropy, Free Energy, Criterion of spontaneity.

SOLUTION : Raoult's law: molecular weight determination from lowering of vapour pressure, Elevation of boiling point, Depression of freezing point, Osmotic pressure, Vant Hoff factor.

GAS LAWS : Ideal gas equation, Kinetic molecular theory of gases deviation from ideal behavior, vander Waal's equation. Average, Root Mean Square (RMS) and most probable velocities and their relation.

UNIT-4

INORGANIC CHEMISTRY

PERIODIC TABLE : Classification of elements on the basis of electronic configuration, Ionisation potential, Electronegativity and Electron affinity.

PREPARATION AND PROPERTIES OF THE FOLLOWING :

Hydrogen Peroxide, Phosphorous, Aluminum, Iron, Copper, Silver, Lead, Cement, Glass, Copper Sulphate, Silver Nitrate, Plaster of Paris, Borax, Mohr's Salt, Alums, White and Red Lead, Micro cosmic salt and Bleaching powder, Sodium Thiosulphate, Soap.

PRINCIPLES OF QUALITATIVE ANALYSIS: Group I to V

(Ag^+ , Hg^{2+} , Cu^{2+} , Pb^{2+} , Bi^{3+} , Fe^{3+} , Cr^{3+} , Al^{3+} , Zn^{2+} , Ni^{2+} , Co^{2+} , Ca^{2+} , Ba^{2+} , Sr^{2+} .)

NUCLEAR CHEMISTRY : Radioactivity, Isotopes and Isobars. Properties of Alpha (a), Beta (b) and Gamma (g) rays, Nuclear fission and fusion, Kinetics of radioactivity.

UNIT-5

ORGANIC CHEMISTRY : Shape of organic compounds, Free radicals, Ions, Electromeric and Resonance effects, Types of organic reactions [Cannizzaro, Friedel-Craft, Perkin reaction, Aldol condensation], Isomerism [Structural, Geometrical and Optical].

General preparation and functional group properties of the following with emphasis on points noted against each of them.

(a) Alkane (Free radical substitution), Alkenes [Electrophilic addition, Markownikoff's addition. Peroxide effect] and Alkynes. Petroleum [Cracking, Octane Number, Anti knocking compounds].

(b) Alcohol, [Distinctions, Haloform reaction].

(c) Carbonyl Compound [Aldehydes, Ketones, carboxylic acids & Esters, Ether, Primary Amines [Classification, Distinction, Basic nature]. Benzene [Resonance], Toluene, Phenol, Nitrobenzene, Aniline, Benzaldehyde, Benzoic acid.

PAPER - 1 - PART B

MATHEMATICS

UNIT-1

ALGEBRA : Sets, relations & functions, De-Morgan's Law, Mapping, Inverse relations, Equivalence relations, Peano's axioms, Definition of rationals and integers through equivalence relation, Indices and Surds, solutions of simultaneous and quadratic equations, A.P., G.P. and H.P., Partial fraction, Binomial Theorem for any index, exponential series, Logarithmic Series, Determinants and their use in solving simultaneous linear equations, Matrices, algebra of matrices, inverse of a matrix, Use of matrix for solving linear equations.

TRIGONOMETRY : Identities, Trigonometric equations, properties of triangles, heights and distances, Inverse function, Complex numbers and their properties, Cube roots of unity, De-Moivre's theorem.

UNIT-2

CO-ORDINATE GEOMETRY : Cartesian system of rectangular co-ordinates in a plane, distance formula, section formula, locus and its equation, translation of axes, slope of a line, parallel and perpendicular lines, intercepts of a line on the coordinate axes.

STRAIGHT LINES : Various forms of equations of a line, intersection of lines, angles between two lines, condition for concurrence of three lines, distance of a point from a line, equations of internal and external bisectors of angles between two lines, coordinates of centroid, orthocenter and

circumcentre of a triangle, equation of family of lines passing through the point of intersection of two lines.

CIRCLE & CONIC SECTIONS : Standard form of equation of a circle, general form of the equation of a circle, its radius and centre,

equation of a circle when the end points of a diameter are given, points of intersection of a line and a circle with the centre at the origin and condition for a line to be tangent to a circle, equation of the tangent. Sections of cones, equations of conic sections (parabola, ellipse and hyperbola) in standard forms.

UNIT-3

DIFFERENTIAL CALCULUS : Limit, Continuity and Differentiability: Real valued functions, algebra of functions, polynomials, rational, trigonometric, logarithmic and exponential functions, inverse function. Graphs of simple functions. Limits, continuity and differentiability. Differentiation of the sum, difference, product and quotient of two functions. Differentiation of trigonometric, inverse trigonometric, logarithmic, exponential, composite and implicit functions; derivatives of order upto two. Rolle's and Lagrange's Mean Value theorems. Applications of derivative : Rate of change of quantities, monotonic - increasing and decreasing functions, Maxima and minima of functions of one variable, tangent and normal.

UNIT-4

INTEGRAL CALCULUS : Integral as an anti- derivative, Fundamental integrals involving algebraic, trigonometric, exponential and logarithmic functions. Integration by substitution, by parts and by partial fractions. Integration using trigonometric identities.

EVALUATION OF SIMPLE INTEGRALS : Integral as limit of a sum, Fundamental theorem of calculus, Properties of definite integrals. Evaluation of definite integrals, determining areas of the regions bounded by simple curves in standard form.

UNIT-5

VECTOR ALGEBRA : Vector and scalar quantities, addition of vectors, components of a vector in two dimensional and three dimensional space, scalar and vector double and triple product.

STATISTICS AND PROBABILITY : Mean, median, mode and standard deviation. Probability of an event, addition and multiplication theorems of probability, Baye's theorem.

BIOLOGY

Unit 1: Evolution and Biodiversity

Origin of life : Oparin's theory, Miller's experiment, Viruses structure, properties, distribution, classification and pathogenesis (eg. AIDS, Cancer, etc.), viroids & prions, biotic balance.

Organic evolution : Relationship among organisms and evidences of organic evolution- principles of evolution, Lamarckism, Darwinism and speciation.

Mechanism of organic evolution : Variations-definition, causes and types, mutations (principle of Hugo devries), role of mutation in speciation. Evolution through ages and human evolution.

Biology —its meaning and relevance to mankind. What is living; Taxonomic categories and aids (Botanical gardens, herbaria, museums, zoological parks); Systematics and Binomial system of nomenclature. Introductory classification of living organisms (Two-kingdom system, Five-kingdom system); Major groups of each kingdom alongwith their salient features (Monera, including Archaeobacteria and Cyanobacteria, Protista, Fungi, Plantae, Animalia); Viruses; Lichens

Plant kingdom —Salient features of major groups (Algae to Angiosperms);

Animal kingdom — Salient features of Nonchordates up to phylum, and Chordates up to class level.

Unit 2 : Cytology and Genetics

Cell : The Unit of Life ; Structure and Function: Cell wall; Cell membrane; Endomembrane system (ER, Golgi apparatus/Dictyosome, Lysosomes, Vacuoles); Mitochondria; Plastids; Ribosomes; Cytoskeleton; Cilia and Flagella; Centrosome and Centriole; Nucleus; Microbodies.

Structural differences between prokaryotic and eukaryotic, and between plant and animal cells. Cell cycle (various phases); Mitosis; Meiosis.

Biomolecules —Structure and function of Carbohydrates, Proteins, Lipids, and Nucleic acids.

Enzymes —Chemical nature, types, properties and mechanism of action.

Genetics : Mendelian inheritance; Chromosome theory of inheritance; Gene interaction; Incomplete dominance; Co-dominance; Complementary genes; Multiple alleles; Linkage and Crossing over; Human hereditary traits, study of twins, A, B, O blood groups and their inheritance, Rh factor, sex determination, chromosomal aberration, important human syndromes, sex-linked characters and their inheritance, applied genetics- eugenics, eugenics, eugenics & I.Q. test.

DNA —its organization and replication; Transcription and Translation; Gene expression and regulation; DNA fingerprinting.

Steps in recombinant DNA technology —restriction enzymes, DNA insertion by vectors and other methods, regeneration of recombinants. Applications of R-DNA technology. In human health of Insulin, Vaccines and Growth hormones, Organ transplant, Gene therapy.

Unit 3: Plant Physiology

Absorption : Absorption of water through root hairs, osmosis, translocation and root pressure, nitrogen cycle.

Nutrition : Special modes of nutrition in plants (autotrophic, heterotrophic, parasites, saprophytes, symbionts, insectivorous and their ecological relation.

Photosynthesis : Chloroplast, light, chlorophyll and carbon dioxide, mechanism of photosynthesis, formation of ATP and its functions and importance of photosynthesis.

Transpiration : Factors and importance, mechanism of opening and closing of stomata, ascent of sap.

Respiration : Aerobic, anaerobic respiration, mechanism of respiration (glycolysis, Krebs's cycle, electron transport chain).

Growth and movement : Definition of growth, region of growth and their measurements, types of movements in plants, growth hormones.

Diffusion and Osmosis : water potential, osmotic pressure, turgor pressure.

A sexual methods of reproduction; Sexual Reproduction - Development of male and female gametophytes; Pollination (Types and agents); Fertilization;

Development of embryo, endosperm, seed and fruit (including parthenocarpy and apomixis).

Growth and Movement —Growth phases; Types of growth regulators and their role in seed dormancy, germination and movement; Apical dominance; Senescence; Abscission; Photo- periodism; Vernalisation; Various types of movements.

Unit 4: Animal Physiology

Animal Nutrition : Food, balanced diet, nutritional imbalances and deficiency diseases, digestion, absorption, assimilation of food.

Animal excretion and osmoregulation : Chemical nature of excretory products in various animals, physiology of excretion, functions of liver and kidneys, formation of urine, osmoregulation by kidneys.

Respiratory system : Exchange and transport of gases (O₂ and CO₂), factors affecting their transport, cellular respiration, different lung volumes, breathing and sound production.

Nervous system : central, autonomic and peripheral nervous system, receptors, effectors, reflex action, nature and conduction of nerve impulse, synapse and sense organs- structure and working of eye and ear, biochemistry of vision and taste buds.

Endocrine system : Different endocrine glands and hormones- definition, types, characteristics and their functions (in relation to human beings), hormonal disorders and pheromones.

Circulatory system : circulation of body fluids- blood and lymph, open and closed vascular systems, structure and working physiology of heart, comparison between arteries and veins, lymphatic system.

Reproductive system : histology, structure and organizations of different systems.

Unit 5 : Environment and Applied Biotechnology

Meaning of ecology, environment, habitat and niche. Ecological levels of organization (organism to biosphere); Characteristics of Species, Population, Biotic Community and Ecosystem; Succession and Climax.

Ecosystem — Biotic and abiotic components; Ecological pyramids; Food chain and Food web; Energy flow; Major types of ecosystems including agroecosystem.

Ecological adaptations —Structural and physiological features in plants and animals of aquatic and desert habitats.

Biodiversity — Meaning, types and conservation strategies (Biosphere reserves, National parks and Sanctuaries)

Environmental Issues — Air and Water Pollution (sources and major pollutants); Global warming and Climate change; Ozone depletion; Noise pollution; Radioactive pollution; Methods of pollution control (including an idea of bioremediation); Deforestation; Extinction of species (Hot Spots).

Human population, population explosion, problems and control, test tube babies and amniocentesis.

Adolescence and drug/alcohol abuse;

Plant Breeding and Tissue Culture in crop improvement.

Biofertilisers (green manure, symbiotic and free-living nitrogen-fixing microbes, mycorrhizae); Biofuels

Microorganisms as pathogens of plant diseases with special reference to rust and smut of wheat, bacterial leaf blight of rice, late blight of potato, bean mosaic, and root - knot of vegetables. Poultry, fisheries (edible fishes).