SYLLABUS
FOR THE POST OF

PHOTOGRAPHER, SNATAK SAHAYAK, PRATIRUP SAHAYAK & VAGYANIK SAHAYAK

PART I
PHYSICS

I. Need for measurement, Units of measurement; Systems of units; SI units, Length, Mass and time measurement, fundamental and derived units. Accuracy and precision of measuring instruments, error in measurement and significant figures. Dimensions of physical quantities, dimensional analysis and its applications. Scalar and vector quantities; Frame of reference, Motion in a straight line, uniform and non- uniform motion, speed and velocity, uniformly accelerated motion, velocity - time and position-time graphs. Motion in a plane, Projectile motion, Newton's laws of motion; impulse; Law of conservation of linear momentum and its applications. Equilibrium of concurrent forces, Static and kinetic friction, laws of friction, rolling friction; Dynamics of uniform circular motion: Centripetal force.

II. Work done by a constant force and a variable force; kinetic energy, work- energy theorem, power, potential energy of a spring, conservative forces: non-conservative forces, elastic and inelastic collisions in one and two dimensions. Centre of mass of a two-particle system, and rigid body, torque, angular momentum, Moment of inertia (MI), MI for simple geometrical objects, radius of gyration, Kepler's laws of planetary motion, universal law of gravitation; Acceleration due to gravity and its variation with altitude and depth; Gravitational potential energy and gravitational potential, escape speed, orbital velocity of a satellite.

III. Elasticity, Stress-strain relationship, Hooke's law, Young's modulus, bulk modulus, shear modulus of rigidity, Poisson's ratio; elastic energy, Pressure, Pascal's law and its applications, hydraulic machine, Viscosity, Stokes' law, terminal velocity, streamline and turbulent flow, critical velocity, Bernoulli's theorem and its simple applications. Surface energy and surface tension, angle of contact, application of surface tension ideas to drops, bubbles and capillary rise.

IV. Heat, temperature, thermal expansion; thermal expansion of solids, liquids and gases, specific heat capacity; Cp, Cv - calorimetry; change of state - latent heat capacity and triple point, Heat transfer-conduction, convection and radiation, thermal conductivity, qualitative ideas of Blackbody radiation, Wein's displacement Law, Stefan's law, Newton's law of cooling, Definition of temperature and thermal equilibrium, zeroth, first, and second law of thermodynamics, isothermal, adiabatic, reversible, irreversible, and cyclic processes, Carnot engine and its efficiency, Kinetic theory of gases - assumptions, concept of pressure, Ideal gas, Kinetic interpretation of temperature; rms speed of gas molecules; degrees of freedom, law of equi-partition of energy and application to specific heat capacities of gases;

concept of mean free path, Avogadro's number.

V. Periodic and oscillatory motion, time period, frequency, displacement as a function of time, periodic functions and their applications, Simple harmonic motion (S.H.M) and its equations of motion, oscillations of a loaded spring- restoring force and force constant; energy in S.H.M. Kinetic and potential energies; simple pendulum derivation of expression for its time period, Transverse and longitudinal waves, speed of travelling wave, displacement relation for a progressive wave, principle of superposition of waves, reflection of waves, standing waves in strings and organ pipes, fundamental mode and harmonics, Beats.

VI. Electric charges, Coulomb's law-force between charges, superposition principle and continuous charge distribution, electric field due to a point charge, electric dipole, electric field due to a dipole, torque on a dipole in uniform electric field. Electric flux, statement of Gauss's theorem and its applications, Electric potential, electric potential due to a point charge and dipole, equipotential surfaces, electrical potential energy of a system of two-point charges and of electric dipole in an electrostatic field; Conductors and insulators; Dielectrics and electric polarization, capacitors and capacitance, combination of capacitors, capacitance of a parallel plate capacitor, energy stored in a capacitor; Electric current, drift velocity, mobility and their relation with electric current; Ohm's law, electrical energy and power, electrical resistivity and conductivity, Internal resistance of a cell, combination of cells, Kirchhoff's rules, Wheatstone bridge and meter bridge.

VII. Concept of magnetic field and magnetic forces, Lorentz force, Biot - Savart law and its application to current carrying circular loop, Ampere's circuital law and its applications, Solenoid and toroid, force between two parallel current-carrying conductors-definition of ampere, torque experienced by a current loop in uniform magnetic field, moving coil galvanometer- its current sensitivity and conversion to ammeter and voltmeter, Bar magnet and magnetic field lines, bar magnet as an equivalent solenoid, magnetic field intensity due to a magnetic dipole (bar magnet), torque on a magnetic dipole (bar magnet); Magnetic properties of materials with examples, magnetization of materials, effect of temperature on magnetic properties.

VIII. Electromagnetic induction; Faraday's laws, induced EMF and current; Lenz's Law, Self and mutual induction; Alternating currents, peak and RMS value of alternating current/voltage; reactance and impedance; LCR series circuit and resonance, power in AC circuits, power factor, AC generator; Transformer; Basic idea of displacement current, Electromagnetic waves, their characteristics, Electromagnetic spectrum and their uses.

IX. Reflection of light, spherical mirrors, mirror formula, refraction of light, total internal reflection and optical fibers, refraction at spherical surfaces, lenses, thin lens formula, lens maker's formula, magnification, power of a lens, refraction of light through a prism, Microscopes and astronomical telescopes and their

magnifying powers. Wave front and Huygen's principle, reflection and refraction of plane wave using Huygen's principle, Interference, Young's double slit experiment, diffraction due to a single slit and polarization.

X. Dual nature of radiation, Photoelectric effect, Einstein's photoelectric equation, particle nature of light, the photon, wave nature of particles, de-Broglie relation, Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model of hydrogen atom, atomic spectra, hydrogen line spectra, Composition and size of nucleus, nuclear force, Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number; nuclear fission, nuclear fusion, radioactivity, Energy bands in conductors, semiconductors and insulators, p and n type semiconductors, p-n junction semiconductor diode, I-V characteristics in forward and reverse bias, application of junction diode -diode as a rectifier.

PART II
CHEMISTRY

I. Atomic, molecular and molar mass. Mole concept. Stoichiometry. Atomic number, isotopes and isobars.

II. Bohr's atomic model & it's limitation. de Broglie's equation. Heisenberg's uncertainty principle, concept of orbitals. Quantum numbers. Aufbau principle, Pauli's exclusion principle and Hund's rule. Electronic configuration of atoms.

III. Modern periodic law. Periodic table & periodic properties: atomic & ionic radii, ionization enthalpy, electron gain enthalpy and electronegativity.

IV. Ionic bond, Lattice enthalpy. Covalent bond, Valence bond theory, VSEPR theory, Concept of Hybridization, Structure & shape of simple molecules. Molecular orbital theory, Bond order. Electronic configuration of homonuclear diatomic molecules (H_2, He_2, C_2, N_2 & O_2). Hydrogen bonding.

V. d and f block elements- Electronic configuration, general trends in properties (metallic character, ionization enthalpy, oxidation state, ionic radii, catalytic property and colour. Magnetic properties, interstitial compounds, alloy formation). Preparation and properties of $KMnO_4$ and $K_2Cr_2O_7$. Lanthanoids & Actinoids: Electronic configuration and Oxidation state. Lanthanoid contraction.

VI. Coordination compounds: Difference between double salt and coordination compounds. Ligands, coordination number. IUPAC nomenclature of simple coordination compounds. Isomerism. Werner theory. Valence bond theory. Crystal Field theory, Electronic arrangement in Octahedral and Tetrahedral complexes, CFSE, Spectrochemical series. Importance of Coordination compounds (qualitative analysis, extraction of metals & biological system).

VII. General Organic Chemistry: Classification of organic compounds, IUPAC Nomenclature. Isomerism. Electronic displacement in covalent bond: Inductive effect, Electromeric effect, Hyperconjugation & Resonance. Covalent bond cleavage. Attacking reagents (Electrophile & Nucleophile). Reaction intermediates

(Carbocation, Free radical and Carbanion). Types of organic reactions. Methods of Purification of Organic Compounds. Qualitative and Quantitative analysis of Organic Compounds.

VIII. Hydrocarbons- Alkanes: Conformational analysis of Ethane. Halogenation, Combustion & Pyrolysis. Alkenes-Geometrical isomerism. Method of preparation of alkenes. Chemical reactions of alkenes (with hydrogen, halogen, water, HX, oxidation & ozonolysis). Alkynes- Acidic nature, Method of preparation of alkynes. Chemical reactions of alkynes (with hydrogen, halogen, water & HX). Aromatic Compounds- Structure of benzene, Aromaticity, Mechanism of Electrophilic Substitution reactions (Nitration, Sulphonation, Halogenation and Friedel Craft's alkylation & acylation). Directive effect of functional group in monosubsituted benzene. Carcinogenicity & toxicity.

IX. General methods of preparation, Physical, Chemical properties & uses of haloalkenes, haloarenes, alcohol, phenol, ether, aldehyde, ketones, carboxylic acid & amines. Uses and environmental effects of Dichloromethane, trichloromethane, iodoforms, freons & DDT. Importance of Diazonium salts in synthetic organic chemistry.

X. Some important name reaction (Hunsdieker reaction, Hoffmann Ammonolysis, Wurtz reaction, Sandmeyer reaction, Gattermann reaction, Esterification reaction, Reimer Teimann reaction, Aldol Condensation, Cannizaro reaction, Benzoin Condensation, Carbylamine reactions).

XI. Biomolecules: Classification, properties and importance of Carbohydrates (mono-, oligo & Polysaccharides), Proteins, Vitamins & Nucleic acid. Structure of proteins. Denaturation. Elementary idea of Enzymes & Hormones.

XII. Thermodynamics- Types of systems. Extensive and Intensive properties. State function. First law of thermodynamics. Heat capacity and specific heat capacity. Hess's law. Enthalpy of dissociation, combustion, formation, atomization, sublimation, phase transition and ionization. Concept of Entropy. Free energy, spontaneity and equilibrium. Third law of Thermodynamics (brief introduction).

XIII. Solution- Method of expression of concentration. Solubility of gases in liquids and solid solutions. Raoult's law. Colligative properties. Abnormal molar mass.

XIV. Equilibrium- Law of mass action. Equilibrium constant. Le- Chatelier's principle. Ionization of acid and base. Strong and weak electrolytes. Acidic strength, pH, Buffer solutions, Solubility product, Hydrolysis of salts & Common Ion Effect.

XV. Electrochemistry-Oxidation number. Redox reactions & it's application. Conductance, Specific & Molar Conductivity and their variation with concentration. Kohlrausch's law. Electrolysis. Laws of electrolysis. Galvanic Cell, EMF of cell, Standard electrode potential, Nernst equation. Relation between Gibb's energy change & EMF of a cell. Dry cell, Pb-accumulator & Fuel cell. Corrosion.

XVI. Chemical Kinetics- Rate of reaction. Factors affecting rate of reactions (Concentration, temperature, catalyst). Order and Molecularity. Rate law and rate

constant. Integrated rate equation and half life (Zero and First order reactions). Concept of Collision theory. Activation energy and Arrhenius equation.

XVII. Laboratory methods: Volumetric analysis (Preparation of standard solution of oxalic acid, sodium carbonate; Determination of strength of NaOH & HCl). Inorganic salt analysis. Detection of N, S and Cl in Organic compounds. Determination of pH of solutions, acids, bases and salts using pH meter and universal indicator. Chromatography analysis (Paper chromatography, Rf value) of leave & flower extracts and inorganic mixture. Inorganic compound preparation (Ferrous Ammonium Sulphate, Potash Alum & Potassium Ferric Oxalate). Organic compound preparation (Acetanilide, Di-benzalacetone & p-Nitroacetanilide). Functional group determination (Unsaturation, Alcohol, Phenol, Aldehyde, Ketone, Carboxylic and Primary amine). Characteristic tests of Carbohydrates, fats and proteins.

PART III
MATHEMATICS

I. **Relations And Functions:** Sets and their Representation, Types of Sets, Venn Diagrams, Union and Intersection of Sets, Difference of Sets, Complement of a Set, Cartesian Product of Sets, Real Valued Functions, Sum, Difference, Product & Quotient of Functions, Definition of Relation, Types of Relation: Reflexive, Symmetric, Transitive and Equivalence Relations. One-To-One and Onto Functions.

II. **Algebra:** Sequences and Series, Arithmetic & Geometric Progressions, Permutations and Combinations, Binomial Theorems for Integral Indices, Algebraic Solutions of Quadratic and Cubic Equations, Relation Between Roots and Coefficients, Solution of Linear Inequalities up to Two Variables, Complex Numbers and their Properties; Determinants up to 3x3 Order and their Applications; Matrices, Types of Matrices, Consistency and Inconsistency of Systems of Equations.

III. **Calculus:**

Differential Calculus: Limit, Continuity and Differentiability, Applications of Derivatives related to Tangent and Normal, Maxima and Minima, Approximations and other Real-Life Situations.

Integral Calculus: Integration of Functions by Substitutions, By Parts, By Partial Fractions. Definite Integrals and their Properties, Applications of Definite Integrals related to Length, Area and Volumes.

Differential Equations: Order and Degree of Differential Equations, Formation and Solutions of First Order and First Degree Differential Equations.

IV. **Coordinate Geometry:**

Two-Dimensional Geometry: Distance Formula between Two Points, Straight Line and its various forms; Quadratic Curves, Circle, Parabola, Ellipse, Hyperbola and their properties.

Three Dimensional Geometry: Coordinate Axes and Coordinate Planes, Distance and Section Formulae, Centroid of a Triangle, Direction Ratio's and Direction Cosine's, Equation of a Line in Space, Angle between two Lines, Shortest Distance between two Lines, Equation of Plane, Angle between two Planes, Distance of a Point From a Plane, Angle between Line and Plane.

V. **Statistics And Probability:** Measures of Central Tendency, Measures of Dispersion, Quartiles, Percentiles and Deciles.

Probability: Concept of Probability, Conditional Probability and its Properties, Addition and Multiplication Theorems, Baye's Theorem, Random Variables, Binomial Distribution.

VI. **Trigonometry:** Trigonometric Functions, Trigonometric Ratios of Allied Angles, Trigonometric Ratios of Compound Angles, Transformation Formulae, Trigonometric Ratios of Multiple and Submultiple Angles, Sine and Cosines Formulae and their applications, Trigonometric Equations and their solutions. Inverse Trigonometric Functions and Properties.

VII. **Vector Algebra:** Scalar and Vector Quantities, Types of Vectors, Addition and Subtraction of Vectors, Dot and Cross Product of Vectors, Angles between two Vectors, Multiplication of a Vector by a Scalar.

Note: Current general knowledge of scientific advancements in all the above units is deemed to have been included.