

SYLLABUS

Physics

UNIT I: Physics and Measurement

- Physics, technology and society, S I units, Fundamental and derived units. Least count, accuracy and precision of measuring instruments, Errors in measurement, Dimensions of Physical quantities, dimensional analysis and its applications.

UNIT II: Kinematics

- Frame of reference. Motion in a straight line: Position-time graph, speed and velocity. Uniform and non-uniform motion, average speed and instantaneous velocity uniformly accelerated motion, velocity-time, position-time graphs, relations for uniformly accelerated motion.
- Scalars and Vectors, Vector addition and Subtraction, Zero Vector, Scalar and Vector products, Unit Vector, Resolution of a Vector. Relative Velocity, Motion in a plane, Projectile Motion, Uniform Circular Motion.

UNIT III: Laws of Motion

- Force and Inertia, Newton's First Law of motion; Momentum, Newton's Second Law of motion; Impulse; streamline and turbulent flow, Reynolds number. Newton's Third Law of motion. 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 and its applications.

UNIT IV: Work, Energy and Power

- Work done by a constant force and a variable force; kinetic and potential energies, work energy theorem, power. Potential energy of a spring, conservation of mechanical energy, conservative and non - conservative forces; Elastic and inelastic collisions in one and two dimensions.

UNIT V: Rotational Motion

- Centre of mass of a two-particle system, Centre of mass of a rigid body; Basic concepts of rotational motion; moment of a force, torque, angular momentum, conservation of angular momentum and its applications; moment of inertia, radius of gyration. Values of moments of inertia for simple geometrical objects, parallel and perpendicular axes theorems and their applications. Rigid body rotation, equations of rotational motion.

UNIT VI: Gravitation

- The universal law of gravitation. Acceleration due to gravity and its variation with altitude and depth. Kepler's laws of planetary motion. Gravitational potential energy; gravitational potential. Escape velocity. Orbital velocity of a satellite. Geo-stationary satellites.

UNIT VII: Properties of Solids and Liquids

- Elastic behaviour, Stress-strain relationship, Hooke's Law, Young's modulus, bulk modulus, modulus of rigidity. Pressure due to a fluid column; Pascal's law and its applications. Viscosity, Stokes' law, terminal velocity.

UNIT VIII: Thermodynamics

Thermal equilibrium, zeroth law of thermodynamics, concept of temperature. Heat, work and internal energy. First law of thermodynamics. Second law of thermodynamics: reversible and irreversible processes. Carnot engine and its efficiency.

UNIT IX: Kinetic Theory of Gases

- Equation of state of a perfect gas, work done on compressing a gas. Kinetic theory of gases - assumptions, concept of pressure. Kinetic energy and temperature: rms speed of gas molecules; Degrees of freedom, Law of equipartition of energy, applications to specific heat capacities of gases; Mean free path, Avogadro's number.

UNIT X: Oscillations and Waves

- Periodic motion - period, frequency, displacement as a function of time. Periodic functions. Simple harmonic motion (S.H.M.) and its equation; phase; oscillations of a spring –restoring force and force constant; energy in S.H.M. - kinetic and potential energies; Simple pendulum - derivation of expression for its time period; Free, forced and damped oscillations, resonance. Wave motion. Longitudinal and transverse waves, speed of a 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, Doppler Effect in sound.

UNIT XI: Electrostatics

- Electric charges: Conservation of charge, Coulomb's law-forces between two point charges, forces between multiple charges; superposition principle and continuous charge distribution. Electric field: Electric field due to a point charge, Electric field lines, Electric dipole, Electric field due to a dipole, Torque on a dipole in a uniform electric field. Electric flux, Gauss's law and its applications to find field due to infinitely long uniformly charged straight wire, uniformly charged infinite plane sheet and uniformly charged thin spherical shell. Electric potential and its calculation for a point charge, electric dipole and system of charges; Equipotential surfaces, Electrical potential energy of a system of two point charges in an electrostatic field. Conductors and insulators, Dielectrics and electric polarization, capacitor, combination of capacitors in series and in parallel, capacitance of a parallel plate capacitor with and without dielectric medium between the plates, Energy stored in a capacitor.

UNIT XII: Current Electricity

- Electric current, Drift velocity, Ohm's law, Electrical resistance, Resistances of different materials, V-I characteristics of Ohmic and non-ohmic conductors, Electrical energy and power, Electrical resistivity, Colour code for resistors; Series and parallel combinations of resistors; Temperature dependence of resistance. Electric Cell and its internal resistance, potential difference and emf of a cell, combination of cells in series and in parallel. Kirchhoff's laws and their applications. Wheatstone bridge, Metre Bridge. Potentiometer - principle and its applications.

UNIT XIII: Magnetic Effects of Current and Magnetism

- Biot - Savart law and its application to current carrying circular loop. Ampere's law and its applications to infinitely long current carrying straight wire and solenoid. Force on a moving charge in uniform magnetic and electric fields. Cyclotron. Force on a current carrying conductor in a uniform magnetic field. 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. Current loop as a magnetic dipole and its magnetic dipole moment. Bar magnet as an equivalent solenoid, magnetic field lines; Earth's magnetic field and magnetic elements. Para-, dia- and ferro- magnetic substances. Magnetic susceptibility and permeability, Hysteresis, Electromagnets and permanent magnets.

UNIT XIV: Electromagnetic Induction and Alternating Currents

- Electromagnetic induction; Faraday's law, induced emf and current; Lenz's Law, Eddy currents. Self and mutual inductance. Alternating currents, peak and rms value of alternating current/ voltage; reactance and impedance; LCR series circuit, resonance; Quality factor, power in AC circuits, wattless current. AC generator and transformer.

UNIT XV: Electromagnetic Waves

- Electromagnetic waves and their characteristics. Transverse nature of electromagnetic waves. Electromagnetic spectrum (radio waves, microwaves, infrared, visible, ultraviolet, X-rays, gamma rays). Applications of e.m. waves. Reflection and refraction of light at plane and spherical surfaces, mirror formula, Total internal reflection and its applications, Deviation and Dispersion of light by a prism, Lens Formula, Magnification, Power of a Lens, Combination of thin lenses in contact, Microscope and Astronomical Telescope (reflecting and refracting) and their magnifying powers. Wave optics: wave front

and Huygens' Principle, Laws of reflection and refraction using Huygen's principle. Interference, Young's double slit experiment and expression for fringe width. Diffraction due to a single slit, width of central maximum. Resolving power of microscopes and astronomical telescopes, Polarisation, plane polarized light; Brewster's law, uses of plane polarized light and Polaroids.

UNIT XVI: Optics

- Reflection and refraction of light at plane and spherical surfaces, mirror formula, Total internal reflection and its applications, Deviation and Dispersion of light by a prism, Lens Formula, Magnification, Power of a Lens, Combination of thin lenses in contact, Microscope and Astronomical Telescope (reflecting and refracting) and their magnifying powers.
- Wave optics: wavefront and Huygen's Principle, Laws of reflection and refraction using Huygen's principle. Interference, Young's double slit experiment and expression for fringe width, coherent sources and sustained interference of light. Diffraction due to a single slit, width of central maximum. Resolving power of microscopes and astronomical telescopes, Polarisation, plane polarized light; Brewster's law, uses of plane polarized lights and Polaroids.

UNIT XVII: Dual Nature of Matter and Radiation

- Dual nature of radiation. Photoelectric effect, Hertz and Lenard's observations; Einstein's photoelectric equation; particle nature of light. Matter waves-wave nature of particle, de Broglie relation. Davisson Germer experiment.

UNIT XVIII: Atoms and Nuclei

- Alpha-particle scattering experiment; Rutherford's model of atom; Bohr model, energy levels, hydrogen spectrum. Composition and size of nucleus, atomic masses, isotopes, isobars; isotones. Radioactivity-alpha, beta and gamma particles/rays and their properties; radioactive decay law. Mass-energy relation, mass defect; binding energy per nucleon and its variation with mass number, nuclear fission and fusion.

UNIT XIX: Electronic Devices

- Semiconductors; semiconductor diode: I-V characteristics in forward and reverse bias; diode as a rectifier; I-V characteristics of LED, photodiode, solar cell and Zener diode; Zener diode as a voltage regulator. Junction transistor, transistor action, characteristics of a transistor; transistor as an amplifier (common emitter configuration) and oscillator. Logic gates (OR, AND, NOT, NAND and NOR). Transistor as a switch.

UNIT XX: Communication Systems

- Propagation of electromagnetic waves in the atmosphere; Sky and space wave propagation, Need for modulation, Amplitude and Frequency Modulation, Bandwidth of signals, Bandwidth of Transmission medium, Basic Elements of a Communication System (Block Diagram only).
- Bernoulli's principle and its applications. Surface energy and surface tension, angle of contact, application of surface tension - drops, bubbles and capillary rise. Heat, temperature, thermal expansion; specific heat capacity, calorimetry; change of state, latent heat. Heat transfer conduction, convection and radiation, Newton's law of cooling.

Section A: Physical Chemistry

1. Some Basic Concepts in Chemistry:

• Matter and its nature, Dalton's atomic theory; Concept of atom, molecule, element and compound; Physical quantities and their measurements in Chemistry, precision and accuracy, significant figures, S.I. Units, dimensional analysis; Laws of chemical combination; Atomic and molecular masses, mole concept, molar mass, percentage composition, empirical and molecular formulae; Chemical equations and stoichiometry. rare opportunity.

2. States of Matter:

Classification of matter into solid, liquid and gaseous states

• Gaseous State:

Measurable properties of gases; Gas laws - Boyle's law, Charles's law, Graham's law of diffusion, Avogadro's law, Dalton's law of partial pressure; Concept of Absolute scale of temperature; Ideal gas equation; Kinetic theory of gases (only postulates); Concept of average, root mean square and most probable velocities; Real gases, deviation from Ideal behavior, compressibility factor and Vander Waals equation.

• Liquid State:

Properties of liquids - vapour pressure, viscosity and surface tension and effect of temperature on them (qualitative treatment only).

• Solid State

Classification of solids: molecular, ionic, covalent and metallic solids, amorphous and crystalline solids (elementary idea); Bragg's Law and its applications; Unit cell and lattices, packing in solids (fcc, bcc and hcp lattices), voids, calculations involving unit cell parameters, imperfection in solids; Electrical, magnetic and dielectric properties.

3. Atomic Structure

• Thomson and Rutherford atomic models and their limitations; Nature of electromagnetic radiation, photoelectric effect; Spectrum of hydrogen atom, Bohr model of hydrogen atom - its postulates, derivation of the relations for energy of the electron and radii of the different orbits, limitations of Bohr's model; Dual nature of matter, de-Broglie's relationship, Heisenberg uncertainty principle.

Elementary ideas of quantum mechanics, quantum mechanical model of atom, its important features, concept of atomic orbital's as one electron wave functions; Variation of ψ and ψ^2 , with r for 1s and 2s orbital's; various quantum numbers (principal, angular momentum and magnetic quantum numbers) and their significance; shapes of s, p and d - orbital's, electron spin and spin quantum number; Rules for filling electrons in orbital's – aufbau principle, Pauli's exclusion principle and Hund's rule, electronic configuration of elements, extra stability of half-filled and completely filled orbital's.

4. Chemical Bonding and Molecular Structure :

Kossel - Lewis approach to chemical bond formation, concept of ionic and covalent bonds.

- Ionic Bonding: Formation of ionic bonds, factors affecting the formation of ionic bonds; Calculation of lattice enthalpy.
- Covalent Bonding: Concept of electro negativity, Fajan's rule, dipole moment; Valence Shell Electron Pair Repulsion (VSEPR) theory and shapes of simple molecules.
- Quantum mechanical approach to covalent bonding: Valence bond theory – Its important features, concept of hybridization involving s, p and d orbitals; Resonance.
- Molecular Orbital Theory - Its important features, LCAOs, types of molecular orbitals (bonding, antibonding), sigma and pi-bonds, molecular orbital electronic configurations of homo nuclear diatomic molecules, concept of bond order, bond length and bond energy. Elementary idea of metallic bonding. Hydrogen bonding and its applications.

5. Chemical Thermodynamics :

Fundamentals of thermodynamics: System and surroundings, extensive and intensive properties, state functions, types of processes.

- First law of thermodynamics - Concept of work, heat internal energy and enthalpy, heat capacity, molar heat capacity; Hess's law of constant heat summation; Enthalpies of bond dissociation, combustion, formation, atomization, sublimation, phase transition, hydration, ionization and solution.
- Second law of thermodynamics; Spontaneity of processes; ΔS of the universe and ΔG of the system as criteria for spontaneity, ΔG° (Standard Gibbs energy change) and equilibrium constant.

6. Solutions:

- Different methods for expressing concentration of solution - molality, molarity, mole fraction, percentage (by volume and mass both), vapour pressure of solutions and Raoult's Law – Ideal and non-ideal solutions, vapour pressure - composition, plots for ideal and non ideal solutions; Colligative properties of dilute solutions - relative lowering of vapour pressure, depression of freezing point, elevation of boiling point and osmotic pressure; Determination of molecular mass using colligative properties; Abnormal value of molar mass, van't Hoff factor and its significance.

7. Equilibrium:

Meaning of equilibrium, concept of dynamic equilibrium.

- Equilibria involving physical processes: Solid -liquid, liquid - gas and solid – gas equilibria, Henry's law, general characteristics of equilibrium involving physical processes.
- Equilibria involving chemical processes: Law of chemical equilibrium, equilibrium constants (K_p and K_c) and their significance, significance of ΔG and ΔG° in chemical equilibria, factors affecting equilibrium concentration, pressure, temperature, effect of catalyst; Le Chatelier's principle.
- Ionic equilibrium: Weak and strong electrolytes, ionization of electrolytes, various concepts of acids and bases (Arrhenius, Bronsted - Lowry and Lewis) and their ionization, acid - base equilibria (including multistage ionization) and ionization constants, ionization of water, pH scale, common ion effect, hydrolysis of salts and pH of their solutions, solubility of sparingly soluble salts and solubility products, buffer solutions.

8. Redox Reactions And Electrochemistry:

- Electronic concepts of oxidation and reduction, redox reactions, oxidation number, rules for assigning oxidation number, balancing of redox reactions. Electrolytic and metallic conduction, conductance in electrolytic solutions, specific and molar conductivities and their variation with concentration: Kohlrausch's law and its applications.
- Electrochemical cells - Electrolytic and Galvanic cells, different types of electrodes, electrode potentials including standard electrode potential, half - cell and cell reactions, emf of a Galvanic cell and its measurement; Nernst equation and its applications; Relationship between cell potential and Gibbs' energy change; Dry cell and lead accumulator; Fuel cells.

9. Chemical Kinetics:

- Rate of a chemical reaction, factors affecting the rate of reactions: concentration, temperature, pressure and catalyst; elementary and complex reactions, order and molecularity of reactions, rate law, rate constant and its units, differential and integral forms of zero and first order reactions, their characteristics and half - lives, effect of temperature on rate of reactions – Arrhenius theory, activation energy and its calculation, collision theory of bimolecular gaseous reactions (no derivation).

10. Surface Chemistry:

- Absorption- Physisorption and chemisorption and their characteristics, factors affecting absorption of gases on solids - Freundlich and Langmuir absorption isotherms, absorption from solutions.
- Colloidal state - distinction among true solutions, colloids and suspensions, classification of colloids - lyophilic, lyophobic; multi molecular, macromolecular and associated colloids (micelles), preparation and properties of colloids - Tyndall effect, Brownian movement, electrophoresis, dialysis, coagulation and flocculation; Emulsions and their characteristics.

Section – B: Inorganic Chemistry

11. Classification of Elements and

Periodicity in Properties:

- Modern periodic law and present form of the periodic table, s, p, d and f block elements, periodic trends in properties of elements atomic and ionic radii, ionization enthalpy, electron gain enthalpy, valence, oxidation states and chemical reactivity.

12. General Principles and Processes of Isolation of Metals:

- Modes of occurrence of elements in nature, minerals, ores; Steps involved in the extraction of metals - concentration, reduction (chemical and electrolytic methods) and refining with special reference to the extraction of Al, Cu, Zn and Fe; Thermodynamic and electrochemical principles involved in the extraction of metals.

13. Hydrogen:

- Position of hydrogen in periodic table, isotopes, preparation, properties and uses of hydrogen; Physical and chemical properties of water and heavy water; Structure, preparation, reactions and uses of hydrogen peroxide; Hydrogen as a fuel.

14. s - Block Elements (Alkali and Alkaline Earth Metals):

Group - 1 and 2 Elements:

- General introduction, electronic configuration and general trends in physical and chemical properties of elements, anomalous properties of the first element of each group, diagonal relationships. Preparation and properties of some important compounds - sodium carbonate and sodium hydroxide; Industrial uses of lime, limestone, Plaster of Paris and cement; Biological significance of Na, K, Mg and Ca.

15. p - Block Elements:

Group - 13 to Group 18 Elements

- General Introduction: Electronic configuration and general trends in physical and chemical properties of elements across the periods and down the groups; unique behavior of the first element in each group. Groupwise study of the p – block elements

Group – 13

- Preparation, properties and uses of boron and aluminium; properties of boric acid, diborane, boron trifluoride, aluminium chloride and alums.

Group – 14

- Allotropes of carbon, tendency for catenation; Structure & properties of silicates, and zeolites.

Group – 15

- Properties and uses of nitrogen and phosphorus; Allotropic forms of phosphorus; Preparation, properties, structure and uses of ammonia, nitric acid, phosphine and phosphorus halides, (PCl_3 , PCl_5); Structures of oxides and oxoacids of phosphorus.

Group – 16

- Preparation, properties, structures and uses of ozone; Allotropic forms of sulphur; Preparation, properties, structures and uses of sulphuric acid (including its industrial preparation); Structures of oxoacids of sulphur.

Group – 17

- Preparation, properties and uses of hydrochloric acid; Trends in the acidic nature of hydrogen halides; Structures of Interhalogen compounds and oxides and oxoacids of halogens.

Group –18

- Occurrence and uses of noble gases; Structures of fluorides and oxides of xenon.

16. d – and f – Block Elements:

• Transition Elements

General introduction, electronic configuration, occurrence and characteristics, general trends in properties of the first row transition elements - physical properties, ionization enthalpy, oxidation states, atomic radii, colour, catalytic behaviour, magnetic properties, complex formation, interstitial compounds, alloy formation; Preparation, properties and uses of $\text{K}_2\text{Cr}_2\text{O}_7$ and KMnO_4 .

• Inner Transition Elements

- Lanthanoids - Electronic configuration, oxidation states and lanthanoid contraction.
- Actinoids - Electronic configuration and oxidation states.

17. Co-Ordination Compounds:

- Introduction to co-ordination compounds, Werner's theory; ligands, coordination number, denticity, chelation; IUPAC nomenclature of mononuclear coordination compounds, isomerism; Bonding-Valence bond approach and basic ideas of Crystal field theory, colour and magnetic properties; Importance of co-ordination compounds (In qualitative analysis, extraction of metals and in biological systems).

18. Environmental Chemistry:

- Environmental pollution - Atmospheric, water and soil. Atmospheric pollution - Tropospheric and Stratospheric
- Tropospheric pollutants – Gaseous pollutants: Oxides of carbon, nitrogen and sulphur, hydrocarbons; their sources, harmful effects and prevention; Green house effect and Global warming; Acid rain;
- Particulate pollutants: Smoke, dust, smog, fumes, mist; their sources, harmful effects and prevention.
- Stratospheric pollution- Formation and breakdown of ozone, depletion of ozone layer-its mechanism and effects.
- Water Pollution - Major pollutants such as, pathogens, organic wastes and chemical pollutants; their harmful effects and prevention.
- Soil pollution - Major pollutants such as: Pesticides (insecticides, herbicides and fungicides), their harmful effects and prevention. Strategies to control environmental pollution.

Section-C: Organic Chemistry

19. Purification and Characterisation of Organic Compounds:

- Purification - Crystallization, sublimation, distillation, differential extraction and chromatography - principles and their applications.
- Qualitative analysis - Detection of nitrogen, sulphur, phosphorus and halogens.
- Quantitative analysis (basic principles only) - Estimation of carbon, hydrogen, nitrogen, halogens, sulphur, phosphorus. Calculations of empirical formulae and molecular formulae; Numerical problems in organic quantitative analysis.

20. Some Basic Principles of Organic Chemistry:

- Tetravalency of carbon; Shapes of simple molecules - hybridization (s and p); Classification of organic compounds based on functional groups: - C = C -, - C h C – and those containing halogens, oxygen, nitrogen and sulphur; Homologous series; Isomerism - structural and stereoisomerism.
- Nomenclature (Trivial and IUPAC) Covalent bond fission - Homolytic and heterolytic: free radicals, carbocations and carbanions; stability of carbocations and free radicals, electrophiles and nucleophiles.
- Electronic displacement in a covalent bond - Inductive effect, electromeric effect, resonance and hyperconjugation.

21. Hydrocarbons:

- Classification, isomerism, IUPAC nomenclature, general methods of preparation, properties and reactions.
- Alkanes - Conformations: Sawhorse and Newman projections (of ethane); Mechanism of halogenation of alkanes.
- Alkenes - Geometrical isomerism; Mechanism of electrophilic addition: addition of hydrogen, halogens, water, hydrogen halides (Markownikoff's and peroxide effect); Ozonolysis and polymerization.
- Alkynes - Acidic character; Addition of hydrogen, halogens, water and hydrogen halides; Polymerization.
- Aromatic hydrocarbons - Nomenclature, benzene - structure and aromaticity; Mechanism of electrophilic substitution: halogenation, nitration, Friedel – Craft's alkylation and acylation, directive influence of functional group in mono-substituted benzene.

22. Organic Compounds Containing Halogens:

- General methods of preparation, properties and reactions; Nature of C-X bond; Mechanisms of substitution reactions. Uses; Environmental effects of chloroform & iodoform.

23. Organic Compounds Containing Oxygen:

- General methods of preparation, properties, reactions and uses.
- Alcohols, Phenols and Ethers Alcohols: Identification of primary, secondary and tertiary alcohols; mechanism of dehydration.
- Phenols: Acidic nature, electrophilic substitution reactions: halogenation, nitration and sulphonation, Reimer - Tiemann reaction.
- Ethers: Structure
- Aldehyde and Ketones: Nature of carbonyl group; Nucleophilic addition to $>C=O$ group, relative reactivities of aldehydes and ketones; Important reactions such as – Nucleophilic addition reactions (addition of HCN, NH_3 and its derivatives), Grignard reagent; oxidation; reduction (Wolff Kishner and Clemmensen); acidity of α -hydrogen, aldol condensation, Cannizzaro reaction, Haloform reaction; Chemical tests to distinguish between aldehydes and Ketones.
- Carboxylic Acids: Acidic strength and factors affecting it.

24. Organic Compounds Containing Nitrogen:

- General methods of preparation, properties, reactions and uses. Amines: Nomenclature, classification, structure, basic character and identification of primary, secondary and tertiary amines and their basic character. Diazonium Salts: Importance in synthetic organic chemistry.

25. Polymers:

- General introduction and classification of polymers, general methods of polymerization addition and condensation, co polymerization; Natural and synthetic rubber and vulcanization; some important polymers with emphasis on their monomers and uses - Polythene, nylon, polyester and bakelite.

26. Biomolecules:

General introduction and importance of biomolecules.

- Carbohydrates - Classification: aldoses and ketoses; monosaccharides (glucose and fructose) and constituent monosaccharides of oligosaccharides (sucrose, lactose and maltose).
- Proteins - Elementary Idea of - amino acids, peptide bond, polypeptides; Proteins: primary, secondary, tertiary and quaternary structure (qualitative idea only), denaturation of proteins, enzymes.
- Vitamins - Classification and functions.
- Nucleic Acids - Chemical constitution of DNA and RNA. Biological functions of nucleic acids.

27. Chemistry in Everyday Life:

- Chemicals in medicines - Analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids, antihistamines – their meaning and common examples.
- Chemicals in food - Preservatives, artificial sweetening agents - common examples.
- Cleansing agents - Soaps and detergents, cleansing action.

28. Principles Related To Practical Chemistry:

Detection of extra elements (N, S, halogens) in organic compounds; Detection of the following functional groups: hydroxyl (alcoholic and phenolic), carbonyl (aldehyde and ketone), carboxyl and amino groups in organic compounds.

- Chemistry involved in the preparation of the following: Inorganic compounds: Mohr's salt, potash alum. Organic compounds: Acetanilide, p-nitroacetanilide, aniline yellow, iodoform.
- Chemistry involved in the titrimetric exercises - Acids bases and the use of indicators, oxalic-acid vs KMnO_4 , Mohr's salt vs KMnO_4
- Chemical principles involved in the qualitative salt analysis: Cations - Pb^{2+} , Cu^{2+} , Al^{3+} , Fe^{3+} , Zn^{2+} , Ni^{2+} , Ca^{2+} , Ba^{2+} , Mg^{2+} , NH_4^+ . Anions- CO_3^{2-} , S^{2-} , SO_4^{2-} , NO_2^- , NO_3^- , Cl^- , Br^- , I^- . (Insoluble salts excluded).
- Chemical principles involved in the following experiments:
 1. Enthalpy of solution of CuSO_4
 2. Enthalpy of neutralization of strong acid and strong base.
 3. Preparation of lyophilic and lyophobic sols.
 4. Kinetic study of reaction of iodide ion with hydrogen peroxide at room temperature.

1. Sets, Relations and Functions:

- Sets and their representation; Union, intersection and complement of sets and their algebraic properties; Power set; Relation, Types of relations, equivalence relations, functions;. One-one, into and onto functions, composition of functions.

2. Complex Numbers and Quadratic Equations:

- Complex numbers as ordered pairs of real, Representation of complex numbers in the form $a + ib$ and their representation in a plane, Argand diagram, algebra of complex numbers, modulus and argument (or amplitude) of a complex number, square root of a complex number, triangle inequality, Quadratic equations in real and complex number system and their solutions. Relation between roots and coefficients, nature of roots, formation of quadratic equations with given roots.

3. Matrices and Determinants:

- Matrices, algebra of matrices, types of matrices, determinants and matrices of order two and three. Properties of determinants, evaluation of determinants, area of triangles using determinants. Adjoint and evaluation of inverse of a square matrix using determinants and elementary transformations, Test of consistency and solution of simultaneous linear equations in two or three variables using determinants and matrices.

4. Mathematical Induction:

- Principle of Mathematical Induction and its simple applications.

5. Binomial Theorem and Its Simple Applications:

- Binomial theorem for a positive integral index, general term and middle term, properties of Binomial coefficients and simple applications.

6. Sequences And Series:

- Arithmetic and Geometric progressions, insertion of arithmetic, geometric means between two given numbers. Relation between A.M. and G.M. Sum up to n terms of special series: S_n , S_{2n} , S_{3n} . Arithmetic – Geometric progression.

7. Limit, Continuity And Differentiability:

- Real valued functions, algebra of functions, polynomials, rational, trigonometric, logarithmic and exponential functions, inverse functions. 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 up to two.
- Rolle's and Lagrange's mean value theorems. Applications of derivatives: Rate of change of Quantities, monotonic increasing and decreasing functions, Maxima and minima of functions of one variable, tangents and normal's.

8. Permutations And Combinations:

- Fundamental principle of counting, permutation as an arrangement and combination as selection, Meaning of $P(n, r)$ and $C(n, r)$, simple applications.

9. 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.
- 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.
- Evaluation of simple integrals of the type:

$$\int \sqrt{a^2 \pm x^2} dx, \int \sqrt{x^2 - a^2} dx, \int \frac{dx}{x^2 \pm a^2}, \int \frac{dx}{\sqrt{x^2 \pm a^2}}, \int \frac{dx}{a^2 - x^2}, \int \frac{dx}{\sqrt{a^2 - x^2}}, \int \frac{dx}{ax^2 + bx + c}, \int \frac{dx}{\sqrt{ax^2 + bx + c}}, \int \frac{(px+q)dx}{ax^2 + bx + c}, \int \frac{(px+q)dx}{\sqrt{ax^2 + bx + c}}$$

10. Differential Equations:

- Ordinary differential equations, their order and degree. Formation of differential equations. Solution of differential equations by the method of separation of variables, solution of homogeneous and linear differential equations of the type

11. Coordinate Geometry:

- Cartesian system of rectangular coordinates 10 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, conditions 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, Orthocentre and circumcentre of a triangle, equation of family of lines passing through the point of intersection of two lines.

- Circles, 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, condition for $y = mx + c$ to be a tangent and point (s) of tangency.

12. Three Dimensional Geometry:

- Coordinates of a point in space, distance between two points, section formula, direction ratios and direction cosines, angle between two intersecting lines. Skew lines, the shortest distance between them and its equation. Equations of a line and a plane in different forms, intersection of a line and a plane, coplanar lines.

13. Vector Algebra:

- Vectors and scalars, addition of vectors, components of a vector in two dimensions and three dimensional space, scalar and vector products, scalar and vector triple product.

14. Statistics and Probability

- Measures of Dispersion: Calculation of mean, median, mode of grouped and ungrouped data calculation of standard deviation, variance and mean deviation for grouped and ungrouped data.
- Probability: Probability of an event, addition and multiplication theorems of probability, Baye's theorem, probability distribution of a random variety, Bernoulli trials and Binomial distribution.

15. Trigonometry:

- Trigonometrically identities and equations. Trigonometrical functions. Inverse trigonometrical functions and their properties. Height and Distance.

16. Mathematical Reasoning:

- Statements, logical operations and, or, implies, implied by, if and only if. Understanding of tautology, contradiction, converse and contra positive.

(i) English Proficiency

This test is designed to assess the test takers general proficiency in the use of English language as a means of self-expression in real life situations and specifically to test the test takers' knowledge of basic grammar, their vocabulary, their ability to read fast and comprehend, and also their ability to apply the elements of effective writing.

1. Grammar: (1.1) Agreement, Time and Tense, Parallel construction, Relative pronouns, (1.2) Determiners, Prepositions, Modals, Adjectives, (1.3) Voice, transformation and (1.4) Question tags, Phrasal verbs .
2. Vocabulary: (2.1) Synonyms, Antonyms, Odd Word, One Word, Jumbled letters, Homophones, Spelling, (2.2) Contextual meaning and (2.3) Analogy
3. Reading Comprehension: (3.1) Content/ideas, (3.2) Vocabulary, (3.3) Referents, (3.4) Idioms/Phrases, (3.5) Reconstruction (rewording)
4. Composition: (4.1) Rearrangement, (4.2) Paragraph Unity and (4.3) Linkers/Connectives.

(ii) Logical Reasoning

The test is given to the candidates to judge their power of reasoning spread in Verbal and Nonverbal areas. The candidates should be able to think logically so that they perceive the data accurately, understand the relationships correctly, figure out the missing numbers or words, and to apply rules to new and different contexts. These indicators are measured through performance on such tasks as detecting missing links, following directions, classifying words, establishing sequences, and completing analogies.

(iii) Verbal Reasoning

1. Analogy: Analogy means correspondence. In the questions based on analogy, a particular relationship is given and another similar relationship has to be identified from the alternatives provided.
2. Classification: Classification means to assort the items of a given group on the basis of certain common quality they possess and then spot the odd option out.
3. Series Completion: Here series of numbers or letters are given and one is asked to either complete the series or find out the wrong part in the series.
4. Logical Deduction – Reading Passage: A brief passage is given and based on the passage the candidate is required to identify the correct or incorrect logical conclusions.
5. Chart Logic: Here a chart or a table is given that is partially filled in and asks to complete it in accordance with the information given either in the chart / table or in the question.
6. Nonverbal Reasoning
 - 6.1 Pattern Perception: A certain pattern will be given and generally a quarter is left blank. The candidate is required to identify the correct quarter from the given four alternatives.
 - 6.2 Figure Formation and Analysis: The candidate is required to analyse and form a figure from various given parts.
 - 6.3 Paper Cutting: It involves the analysis of a pattern that is formed when a folded piece of paper is cut into a definite design.
 - 6.4 Figure Matrix: In this more than one set of figures is given in the form of a matrix, all of them following the same rule. The candidate is required to follow the rule and identify the missing figure.
 - 6.5 Rule Detection Here a particular rule is given and it is required to select from the given sets of figures, a set a set of figures, which obeys the rule and forms the correct series.

(iv) General Awareness

7. General Awareness: (7.1) Countries of the world, (7.2) Awards and Honors, (7.3) Sports and Games, (7.4) Books and Author (7.5) International Organization, (7.6) History of India and World and (7.7) Geography of India and the World