

Section – C: CHEMISTRY**UNIT - 1**

- 1. ATOMIC STRUCTURE:** Characteristics of Electron, Proton and Neutron, Rutherford's model of atom - Nature of electromagnetic theory - Planck's Quantum Theory, Explanation of photoelectric effect - Features of atomic Spectra - Characteristics of Hydrogen spectrum, Bohr's theory of structure of atom, Bohr's explanation of spectral lines, failure of Bohr's theory - Wave particle nature of electron - de Broglie's hypothesis, Heisenberg's uncertainty principle, Important features of the Quantum mechanical model of atom, Quantum numbers, concept of orbitals - Expressing atomic orbitals in terms of quantum numbers, shapes of s, p and d orbitals, Aufbau principle, Pauli's exclusion principle, Hund's rule of maximum multiplicity. Electronic configuration of atoms, explanation of stability of half-filled and completely filled orbitals.
- 2. NUCLEAR CHEMISTRY:** Composition of Nucleus, Isotopes, Isotones, Isobars, Isodiaphers, Factors affecting nuclear stability, mass defect, binding energy, N/P ratio. Radioactive disintegration and its rate - Half life and average life, Types of nuclear reactors - Fission and Fusion with examples one each. Radioactive isotopes and their applications - Iodine 131, Cobalt 60, Sodium 24, C14 and P30-Properties of α , β and γ rays.
- 3. CHEMICAL BONDING:** Orbital overlap and covalent bond, Ionic bond and Fajan's rules, Lattice energy, Hybridisation involving s, p and d orbitals, MOT (Homonuclear diatomic species only), H-bond, Dipole moment, VSEPR theory and shapes of molecules.

UNIT - 2

- 1. CLASSIFICATION OF ELEMENTS AND PERIODICITY OF PROPERTIES :** Concept of grouping of elements in accordance with their properties, The periodic law, The significance of atomic number and electronic configuration as the basis for periodic classification - Classification of elements into s, p, d, f blocks and their main characteristics - Classification of elements based on their properties.
- 2. HYDROGEN AND ITS COMPOUNDS :** Position of hydrogen in the periodic table. Occurrence, isotopes of hydrogen, Preparation, properties and uses (including as fuel) of hydrogen. Reactions of hydrogen with different types of elements leading to ionic, molecular and non-stoichiometric hydrides, Physical and chemical properties of water and heavy water, hydrogen peroxide - Methods of preparation, physical and chemical properties - oxidation - reduction, decomposition and disproportionation and addition reactions. Detection of hydrogen peroxide - structure and uses of Hydrogen peroxide.

- 3. ALKALI AND ALKALINE EARTH METALS:** General introduction, electronic configuration, occurrence, anomalous properties of first element in each group, diagonal relationship, trends in properties like Ionisation enthalpy, atomic and ionic radii, reactivity with oxygen, hydrogen, halogens and water. Preparation and properties and uses of the compounds sodium hydroxide, salts of oxoacids, sodium carbonate, sodium hydrogen carbonate, sodium chloride, biological importance of sodium and potassium, preparation and uses of CaO, CaCO₃ and CaSO₄, Industrial uses of lime and limestone - Biological importance of Mg and Ca.

UNIT - 3

- 1. STATES OF MATTER: GASES AND LIQUIDS:** Grahams Law of diffusion, Dalton's law of partial pressures, Avogadro's law. Ideal behavior, Empirical derivation of Gas equation, Ideal gas equation. Kinetic molecular theory of gases, Kinetic gas equation (No derivation) and deduction of gas laws from kinetic gas equation, Distribution of molecular velocities - types of molecular velocities, behavior of real gases, Deviation from ideal behavior, compressibility factor Vs pressure diagrams of real Conditions for liquefaction of gases, critical temperature, Liquid state - properties of liquids in terms of Intermolecular attractions, Vapour pressure, viscosity and surface tension (Quantitative Idea only. No mathematical derivation).
- 2. CHEMICAL THERMODYNAMICS : THERMODYNAMICS:** Concepts of system, types of systems, surroundings, work, heat, energy, extensive and intensive properties, state functions, First law of thermodynamics-internal energy and enthalpy, heat capacity and specific heat, Exothermic and endothermic reactions. Measurement of U and H, Enthalpies of bond dissociation, combustion, neutralization, formation, atomization, sublimation, phase transition, ionization and dilution, Thermo-chemical equations.

Hess's law of constant heat summation, Driving force for a spontaneous process, Thermodynamic representation of criteria of spontaneity in terms of entropy, entropy as a state function, Gibbs free energy, Gibbs free energy change for spontaneous, non spontaneous process and equilibrium process.

UNIT - 4

- 1. SOLUTIONS:** Classification of solutions, Molarity Normality, Molality, Mole fraction, Dilute solutions, vapour pressure, Raoult's Law, Limitations of Raoult's Law Colligative properties, relative lowering of vapour pressure, elevation of boiling point, depression in freezing point, Osmosis and osmotic pressure, theory of dilute solutions, determination of molar masses using colligative properties, abnormal molecular mass.
- 2. IONIC EQUILIBRIUM:** Lowry - Bronsted acids and bases theory, Lewis theory, limitations of Lewis theory, Ionic equilibrium, ionization of acids and

bases, strong and weak electrolytes, degree of ionization, ionic product of water. Concept of p^H , Hydrolysis of salts (elementary idea), hydrolysis constant, buffer solutions, solubility product and common ion effect with illustrative examples.

- 3. CHEMICAL EQUILIBRIUM:** Equilibrium in physical and chemical process, Dynamic nature of equilibrium, law of mass action, Equilibrium constant, Factors affecting equilibrium, Relation between K_p and K_c , Le- Chatlier's principle, applications to the industrial processes like (I) ammonia - Haber's process (2) H_2SO_4 -Contact process.

UNIT - 5

- 1. SOLID STATE:** Classification of solids based on different binding forces such as molecular, ionic, covalent solids and metallic solids, Treatment of metallic bond and metallic / solids, Amorphous and crystalline solids, Unit cell in two-dimensional and three- dimensional lattices, Seven crystal systems and Bragg's equation, X-ray study of crystal structure, Bragg's method. Calculation of density of unit cell, packing in solids, No. of atoms per cubic unit cell. Point defects - Schottky and Frenkel defects. Electrical and magnetic properties.
- 2. SURFACE CHEMISTRY:** Adsorption, physical and chemical adsorption. Adsorption of gases on solids, factors affecting the adsorption - pressure (Langmuir and Freundlich Isotherms) and temperature, Catalysis-types of catalysis, autocatalysis. Colloidal state - colloidal solutions, classification of colloidal solutions, protective colloids and Gold number emulsions - classification of emulsions, micelles, cleansing action of soap, properties of colloids -Tyndall effect, Brownian movement, Coagulation.

UNIT - 6

- 1. CHEMICAL KINETICS:** Concept of reaction rate, factors affecting reaction rates, Rate law, units of rate constant, Order and molecularity, methods of determination of order of reaction, Integrated rate equations and half lives for zero and first order reaction, Collision theory of reaction rates (elementary ideas), concepts of activation energy (Arrhenius equation).
- 2. ELECTRO CHEMISTRY:** Conductance in electrolytic solutions, Specific and molar conductances- variation of conductance with concentration, Kohlrausch's law, application to calculation of equivalent conductance of weak electrolytes. Electrolytes and non-electrolytes, redox reactions, electrolysis - some typical examples of electrolysis viz; fused NaOH, brine solution, fused $MgCl_2$, Faraday's laws of electrolysis, Galvanic and voltaic cells representation and notation of electrochemical cells with and without salt bridge, Standard hydrogen electrode and electrode potentials, electro chemical series, EMF of cell, Nernst equation and its applications, calculation of EMF of electro chemical cells, Primary cell-dry cell/Lechlanche cell, secondary cells - fuel cells - Hydrogen – Oxygen fuel cell.

UNIT - 7

- 1. GROUP 13 ELEMENTS:** General introduction, electronic configuration, occurrence, variation of properties, oxidation states, trends in chemical reactivity, Anomalous properties of first element of the group, Boron: - Physical and chemical properties, uses, some important compounds: Borax and Boric acid. Boron hydrides, aluminium - uses, reactions with acids and alkalies, Alums.
- 2. GROUP 14 ELEMENTS:** General introduction, electronic configuration, occurrence, Variation of properties, oxidation states, trends in chemical reactivity, Anomalous behavior of the first element of the group Carbon - catenation, allotropic forms, physical and chemical properties and uses. Similarities between carbon and silicon, uses of oxides of carbon, Important compounds of silicon - silicon dioxide and a few uses of silicon tetrachloride, silicones, silicates and zeolites (Elementary ideas) Fuel gases : Manufacture and uses of producer gas and water gas.
- 3. GROUP 18 ELEMENTS (ZERO GROUP ELEMENTS):** General introduction, electronic configuration, occurrence, Isolation trends in physical and chemical properties, uses, compounds of xenon oxides and xenon Fluorides (structures only).

UNIT - 8

- 1. GROUP 15 ELEMENTS (V A GROUP ELEMENTS):** Occurrence- physical states of Nitrogen and Phosphorous; allotropy, catenation. electronic configuration, oxidation states, General characteristics of hydrides, structure of hydrides, general characteristics of oxides, general characteristics of halides, Oxyacids of nitrogen, Oxyacids of phosphorous, preparation and uses of nitric acid and ammonia, superphosphate of lime.
- 2. GROUP 16 ELEMENTS (VI GROUP ELEMENTS):** Occurrence, electronic configuration, oxidation states, physical states of Oxygen and Sulphur and their structure, allotropy, general characteristics of hydrides, oxides and halides, structural aspects of oxyacids of chalcogens, Ozone, uses of ozone, Sodium thiosulphate, Sulphuric acid - industrial process of manufacture.
- 3. GROUP 17 ELEMENTS (VII A GROUP ELEMENTS):** Occurrence, electronic configuration and oxidation states, Physical states of halogens, I.P values, electronegativity and electron affinity, bond energies, chemical reactivity, oxidizing power of fluorine, chlorine, structural aspects of oxy acids of chlorine, preparation, properties and uses of fluorine, chlorine and bleaching powder, Interhalogen compounds -structures only.

UNIT - 9

- 1. TRANSITION ELEMENTS:** General introduction, electronic configuration, Occurrence and characteristics of transition metals, general trends in properties of first row transition elements- metallic character, ionization energy, Variable oxidation states, atomic and ionic radii, color, catalytic property, magnetic property, interstitial compounds, Alloy formation. Preparation and properties of KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$, Ag_2O , AgNO_3 , $\text{Ag}_2\text{S}_2\text{O}_3$.
- 2. LANTHANIDES :** Electronic configuration, variable oxidation states, chemical reactivity and lanthanide contraction.
- 3. COORDINATION COMPOUNDS:** Introduction, ligands, coordination number, Werner's theory of coordination compounds, Shapes of coordination compounds, valence bond theory, IUPAC nomenclature of mono nuclear coordination compounds, Bonding, isomerism, EAN rule, Importance of coordination compounds in qualitative analysis, extraction of metals, Biological systems (chromo proteins, haemoglobin, chlorophyll structures only).

UNIT - 10

- 1. GENERAL PRINCIPLES OF METALURGY:** Principles and methods of extraction-concentration, reduction by chemical and electrolytic methods and refining, Occurrence and principles of extraction of copper, zinc, iron and silver. Process of molten electrolysis to extract Al, Mg and Na. Extraction of gold and lead.
- 2. PRINCIPLES OF QUALITATIVE ANALYSIS:** Group I to V (only Ag^+ , Hg^{2+} , Cu^{2+} , Pb^{2+} , Bi^{3+} , Fe^{3+} , Cr^{3+} , Al^{3+} , Ca^{2+} , Ba^{2+} , Zn^{2+} , Mn^{2+} and Mg^{2+}); nitrate, halides (excluding fluoride), sulphate and sulphide.

UNIT - 11

- 1. ORGANIC CHEMISTRY:** Some basic principles and techniques: General introduction, methods of purification, quantitative and qualitative analysis. Classification and IUPAC nomenclature of organic compounds. Electronic displacements in a covalent bond, Inductive effect, electrometric effect, resonance and hyper conjugation, Fission of a covalent bond - homolytic and heterolytic fissions, Types of reagents : Electrophiles, nucleophiles and free radicals - examples and reactive intermediates, Common types of organic reactions - substitution, addition. Elimination and rearrangement reactions with examples. Shapes of simple organic molecules. Structural and geometrical isomerism; optical isomerism of compounds containing up to two asymmetric centres (R,S and E,Z nomenclature excluded). Keto-enol tautomerism.
- 2. HYDROCARBONS :** Classification of hydrocarbons, Alkanes - Nomenclature, isomerism conformations (Ethane and butane), Methods of preparation of Ethane, physical properties, chemical reactions including free radical mechanism of halogenation, combustion and pyrolysis of ethane, Cycloalkanes: Preparation

and properties of cyclohexane, Alkenes: Nomenclature, structure of double bond (ethene), physical properties, methods of preparation of ethylene, physical properties, chemical reactions: addition of hydrogen, halogen, water, hydrogen halides (Markonikov's addition and peroxide effect), ozonolysis, oxidation, mechanism of electrophilic addition. Reaction with Baeyer's reagent. Alkynes- Preparations and properties of alkynes. Acidity of alkynes.

- 3. AROMATIC HYDROCARBONS:** Introduction - IUPAC nomenclature, Benzene, resonance, aromaticity chemical properties: mechanism of electrophilic substitution - nitration, sulphonation, halogenation, Friedel crafts alkylation and acylation, directive influence of functional group in mono substituted Benzene carcinogenicity and toxicity. Effect of O,M,P directing groups in monosubstituted benzene.

UNIT - 12

- 1. HALOALKANES:** Nomenclature, nature of C-X bond, Ethyl chloride and chloroform, preparation, physical and chemical properties, Mechanism of substitution reactions SN_1 & SN_2 reactions. Reactions of Grignard reagent.
- 2. HALOARENES:** Nature of C - X bond, Chlorobenzene substitution reactions (directive influence of halogen for mono substituted compounds only). Nucleophilic aromatic substitution in haloarenes.
- 3. ALCOHOLS, PHENOLS AND ETHERS:**
ALCOHOLS: Nomenclature, methods of preparation of ethyl alcohol, physical and chemical properties (of primary alcohols only), Identification of primary, secondary, tertiary alcohols, Mechanism of dehydration. Uses of some important compounds - methanol and ethanol
PHENOLS: Nomenclature, methods of preparation of phenol, Physical and chemical properties, Acidic nature of phenol, Electrophilic substitution reactions, Uses of phenols. Comparison of acidic nature of substituted phenols.
ETHERS: Nomenclature, Methods of preparation of diethyl ether, physical and chemical properties, uses.

UNIT - 13**1. ALDEHYDES, KETONES AND CARBOXYLLIC ACIDS:**

ALDEHYDES AND KETONES : Nomenclature, Nature of carbonyl group, Methods of preparation of acetaldehyde and acetone, physical and chemical properties, Mechanism of nucleophilic addition, Reactivity of alpha- hydrogen in aldehydes, uses. Distinction of Aldehydes and ketones. Reactions of Benzaldehyde.

CARBOXYLIC ACIDS: Nomenclature, acidic nature, Methods of preparation of acetic acid, Physical and chemical properties, Uses. Comparison of acidic strength of aliphatic and aromatic acids. Preparations and properties of Benzoic acid.

2. ORGANIC COMPOUNDS CONTAINING NITROGEN

Preparation and properties of Nitro compounds.

AMINES: Nomenclature, Classification, Structure, methods of preparation of aniline, physical and chemical properties, Uses, Identification of primary, secondary and tertiary amines and aromatic amine (Aniline). Comparison of basic strength of aliphatic amines and substituted anilines.

DIAZONIUM SALTS: Preparation, Chemical reactions and importance in synthetic organic chemistry, Uses of azodyes. Azo Coupling reactions of diazonium salts of aromatic amines.

3. PRACTICAL ORGANIC CHEMISTRY: Detection of elements (N, S, Halogens); detection and identification of the following functional groups: alcoholic and phenolic, aldehyde and ketone, carboxyl, amino and nitro. Chemical methods of separation of mono-functional organic compounds from binary mixtures.

UNIT - 14

1. POLYMERS: Classification of polymers, addition, condensation, copolymerization, Natural rubber, vulcanization of rubber, synthetic rubber, molecular weights of polymers – number average and weight average molecular weights (definitions only). Bio - polymers, bio-degradable polymers, Some commercially important polymers like polythene, nylon, polyesters and Bakelite.

2. BIOMOLECULES:

CARBOHYDRATES: Classification (aldoses and ketoses), Monosaccharides (glucose and fructose), Oligosaccharides (sucrose, lactose, maltose), Polysaccharides (starch, cellulose, glycogen) and Importance.

AMINOACIDS AND PROTEINS: Elementary idea of amino acids, peptide, Polypeptides, proteins Primary structure, secondary structure, tertiary structure and quaternary structures (qualitative ideas only). Denaturation of proteins, enzymes.

VITAMINS: Classification, Functions in bio systems.

NUCLEIC ACIDS: Types of nucleic acids, primary building blocks of nucleic acids, Chemical composition of DNA & RNA, Structure of D.N.A, genetic code.

UNIT – 15

1. CHEMISTRY IN EVERYDAY LIFE : Uses of chemicals in medicine: Analgesics - narcotics (morphine, codeine), Non- narcotics (Asprin, Ibuprofen); Antipyretic (analgin, Phenacetin, paracetamol), Tranquilizers (barbituric acid, luminal, secpnal, valium, serotonin), Antiseptics(chloroxylenol, bithional), disinfectants (formalin, formaldehyde), Anti-microbials (lysozyme, lactic acid, hydrochloric acid in stomach). Antifertilitydrugs, Antibiotics (pencillin, chloramphenicol, sulphadiazine), Antacids (omeprazole, lansoprazole), antihistamines (histidine), Chemicals in food preservatives (sodium benzoate, potassium metabisulphite etc.), Artificial sweetening agents (aspartame, alitane, sucralose).

2. ENVIRONMENTAL CHEMISTRY: Definition of terms: Air, water and soil pollution. Oxides of carbon - carbon monoxide, Oxides of Sulphur and Nitrogen, Chloro Fluoro Carbons, Chemical reactions in atmosphere, smogs, major atmospheric pollutants, acid rains, Ozone and its reactions, effects of depletion of ozone layer. Green house effect and global warming, Pollution due to industrial wastes, Green chemistry as an alternative tool for reducing pollution.
