

## PART 2 - CHEMISTRY (35 Questions)

### UNIT 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.

### UNIT 2: States of Matter

Classification of matter into solid, liquid and gaseous states.

**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.

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

**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 behaviour, compressibility factor, Van der Waals equation, liquefaction of gases, critical constants.

### UNIT 3: Chemical Families - Periodic Properties

Modern periodic law and present form of the periodic table, s&p block elements, periodic trends in properties of elements, atomic and ionic radii, ionization enthalpy, electron gain enthalpy, valence, oxidation states and chemical reactivity. Transition elements-d-block elements, inner transition elements-f-block elements. Ionization energy, lanthanides and actinides-general characteristics.

**Coordination Chemistry:** Coordination compounds, nomenclature: terminology - Werner's coordination theory. Applications of coordination compounds.

### UNIT 4: Atomic Structure

Discovery of sub-atomic particles (electron, proton and neutron); 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, various quantum numbers (principal, angular momentum and magnetic quantum numbers) and their significance; shapes of s, p and d-orbitals, electron spin and spin quantum number; rules for filling electrons in orbitals-Aufbau principle, Pauli's exclusion principle and Hund's rule, electronic configuration of elements, extra stability of half-filled and completely filled orbitals.

### UNIT 5: Chemical Bonding and Molecular Structure

**Covalent bonding:** Concept of electronegativity, 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, anti-bonding), sigma and pi-bonds, molecular orbital electronic configurations of homonuclear diatomic molecules, concept of bond order, bond length and bond energy. Elementary idea of metallic bonding. Hydrogen bonding and its applications.

**Extractive metallurgy of sodium, lithium,** properties of alkali metals, basic nature of oxides and hydroxides, compounds of alkaline earth metals, compounds of boron. Oxides, carbides, halides and sulphides of carbon group. Oxides-classification-acidic, basic, neutral, peroxide and amphoteric oxides.

### UNIT 6: Chemical Energetics

First law of thermodynamics, energy changes during a chemical reaction, internal energy and enthalpy, Hess's law of constant heat summation, numerical based on these concepts. Enthalpies of reactions (enthalpy of neutralization, enthalpy of combustion, enthalpy of fusion and vaporization).

### UNIT 7: Chemical Thermodynamics

Second law of thermodynamics - Spontaneity of processes;  $\Delta S$  of the universe and  $\Delta G$  of the system as criteria for spontaneity,  $\Delta G^\circ$  (Standard Gibbs energy change) and equilibrium constant.

## UNIT 8: 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.

## UNIT 9: Chemical Equilibrium

Meaning of equilibrium, concept of dynamic equilibrium.

Equilibria involving physical processes: Solid-liquid, liquid-gas and solid-gas equilibria, Henry's law, Equilibria involving chemical processes: Law of chemical equilibrium, equilibrium constants ( $K_p$  and  $K_c$ ) and their significance, significance of  $\Delta G$  and  $\Delta G^\circ$  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.

## UNIT 10: Electrochemistry

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; dry cell and lead accumulator; fuel cells; corrosion and its prevention.

## UNIT 11: Surface Chemistry, Chemical Kinetics and Catalysis

Adsorption-Physisorption and chemisorption and their characteristics, factors affecting adsorption of gases on solids-Freundlich and Langmuir adsorption isotherms, adsorption from solutions.

Catalysis-Homogeneous and heterogeneous, activity and selectivity of solid catalysts, enzyme catalysis and its mechanism.

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.

Rate of reaction, instantaneous rate of reaction and order of reaction. Factors affecting rates of reactions - factors affecting rate of collisions encountered between the reactant molecules, effect of temperature on the reaction rate, concept of activation energy, catalyst. Rate law expression. Order of a reaction (with suitable examples). Units of rates and specific rate constants. Order of reaction and effect of concentration (study will be confined to first order only). Theories of catalysis adsorption theory-some of important industrial process using catalysts.

Nuclear Chemistry: Radioactivity: isotopes and isobars: Properties of  $\alpha$ ,  $\beta$  and  $\gamma$  rays; Kinetics of radioactive decay (decay series excluded), carbon dating; Stability of nuclei with respect to proton-neutron ratio; brief discussion on fission and fusion reactions.

## UNIT 12: 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.

## UNIT 13: 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:  $-C=C-$ ,  $-C\equiv C-$  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.

Common types of organic reactions - Substitution, addition, elimination and rearrangement.

#### **UNIT 14: 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, oxidation, 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 monosubstituted benzene.

#### **UNIT 15: Organic Compounds Containing Oxygen**

General methods of preparation, properties, reactions and uses.

Alcohols: Distinction of primary, secondary and tertiary alcohols; mechanism of dehydration. Reactions of hydroxyl derivatives.

Phenols: Acidic nature, electrophilic substitution reactions: halogenation, nitration and sulphonation, Reimer-Tiemann reaction. Addition to  $>C=O$  group, relative reactivities of aldehydes and ketones.

Ethers: Structure.

Aldehyde and Ketones: Nature of carbonyl group; Nucleophilic addition reactions (addition of HCN,  $NH_3$  and its derivatives), Grignard reagent; oxidation; reduction (Wolff Kishner and Clemmensen); acidity of-hydrogen, aldol condensation, Cannizzaro reaction, Haloform reaction; Chemical tests to distinguish between aldehydes and Ketones.

Carboxylic acids: Reactions, Acidic strength and factors affecting it; reactions of acid derivatives.

#### **UNIT 16: 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.

#### **UNIT 17: Polymers**

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

#### **UNIT 18: Biomolecules**

Carbohydrates-Classification: aldoses and ketoses; monosaccharides (glucose and fructose), constituent monosaccharides of oligosaccharides (sucrose, lactose, maltose) and polysaccharides (starch, cellulose, glycogen).

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.

#### **UNIT 19: Chemistry in Everyday Life**

Chemicals in medicines-Analgesics, tranquilizers, antiseptics, disinfectants, antimicrobials, antifertility drugs, antibiotics, antacids.

Antihistamins-their meaning and common examples. Chemicals in food-preservatives, artificial sweetening agents-common examples.

Cleansing agents-Soaps and detergents, cleansing action.