JAM 2026
Chemistry (CY)

Section 1: Basic Mathematical Concepts (10+2 Level):

Functions; maxima and minima; integrals; ordinary differential equations; vectors and matrices; determinants; elementary statistics.

Section 2: Physical Chemistry

2.1: Atomic and Molecular Structure: Planck's black body radiation, Photoelectric effect, Bohr's theory, de Broglie postulate, Heisenberg's Uncertainty Principle; Schrödinger's wave equation (including mathematical treatment), postulates of quantum mechanics, normalized and orthogonal wave functions, its complex conjugate (idea of complex numbers) and significance of Ψ^2; Operators; Particle in one- dimension box, radial and angular wave functions for hydrogen atom, radial probability distribution; Finding maxima of distribution functions (idea of maxima and minima), energy spectrum of hydrogen atom; Shapes of s, p, d and f orbitals; Pauli's Exclusion Principle; Hund's rule of maximum multiplicity.

2.2: Gaseous State: Kinetic molecular model of a gas: collision frequency; collision diameter; mean free path and viscosity of gases; Maxwell-Boltzmann distribution: molecular velocities, law of equipartition of energy, molecular basis of heat capacities; Ideal gases, and deviations from ideal gas behaviour, van der Waals equation of state; critical state, law of corresponding states.

2.3: Liquid State: Physical properties of Liquid, vapour pressure, surface tension and co-efficient of viscosity and their applications; effect of concentration of solutes on surface tension and viscosity; effect of temperature on viscosity of liquids.

2.4: Solid State: Unit Cells, Miller indices, crystal systems and Bravais Lattices, elementary applications of vectors to crystal systems; X-ray diffraction, Bragg's Law, Structure of NaCl, CsCl, and KCl, diamond, and graphite; Close packing in metals and metal compounds, semiconductors, insulators; Defects in crystals, lattice energy; isomorphism; heat capacity of solids.

2.5: Chemical Thermodynamics: Mathematical treatment: Exact and in-exact differentials, partial derivatives, Euler's reciprocity, cyclic rule; Reversible and irreversible processes; Laws of thermodynamics, thermochemistry, thermodynamic functions, such as enthalpy, entropy, and Gibbs free energy, their properties and applications; Partial molar quantities, dependence of thermodynamic parameters on composition, Gibbs Duhem equation, chemical potential and its applications.

2.6: Chemical and Phase Equilibria: Law of mass action; K_p, K_c, K_x and K_n; Effect of temperature on K; Le-Chatelier principle; Ionic equilibria in solutions; pH and buffer solutions; Salt hydrolysis; Solubility and solubility product; Acid – base titration curves; Indicators; Dilute solutions; Raoult's and Henry's Laws and their applications; Colligative properties; Gibbs phase rule; Phase equilibria; single and two- component phase diagrams.

2.7: Electrochemistry: Conductivity, equivalent and molar conductivity and their properties; Kohlrausch law; DebyeHückel-Onsager equation; Ionic velocities, mobilities, transference numbers; Applications of conductance measurement; Quantitative aspects of Faraday's laws of electrolysis, applications of electrolysis in metallurgy and industry; Electromotive force of a cell, Nernst equation; Standard electrode potential, Electrochemical series; Concentration cells with and without transference; Applications of EMF measurements including potentiometric titrations.

2.8: Chemical Kinetics: Order and molecularity of a reaction, differential and integrated form of rate expressions; Kinetics of opposing, parallel, and consecutive reactions; Steady state approximation in reaction mechanisms; Chain reactions; Uni-molecular reaction (Lindemann mechanism); Temperature dependence of reaction rates, Arrhenius equation; activation energy; Collision theory of reaction rates; Types of catalysts, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; Enzyme catalysis (Michaelis-Menten mechanism, Double reciprocal plot), Acid-base catalysis.

2.9: Adsorption: Gibbs adsorption equation; adsorption isotherm; types of adsorption; surface area of adsorbents; surface films on liquids.

2.10: Spectroscopy: Beer-Lambert's law; fundamental concepts of rotational, vibrational, electronic and magnetic resonance spectroscopy.

Section 3: Organic Chemistry

3.1: Basic Concepts in Organic Chemistry and Stereochemistry: Electronic effects (resonance, inductive, hyperconjugation) and steric effects and its applications (acid/base property); optical isomerism in compounds with and without any stereocenters (allenes, biphenyls); conformation of acyclic systems (substituted ethane/n-propane/n-butane) and cyclic systems, substituted cyclohexanes, and polycyclic (*cis* and *trans* decalins) systems.

3.2: Organic Reaction Mechanism and Synthetic Applications: Chemistry of reactive intermediates (carbocations, carbanions, free radicals, carbenes, nitrenes, benzynes); nucleophilic substitution, elimination reactions and mechanisms; Hofmann-Curtius- Lossen rearrangement, Wolff rearrangement, Simmons-Smith reaction, Reimer-Tiemann reaction, Michael reaction, Darzens reaction, Wittig reaction and McMurry reaction; Pinacolpinacolone, Favorskii, benzilic acid rearrangement, Baeyer-Villeger reaction; oxidation and reduction reactions in organic chemistry; Organometallic reagents in organic synthesis (Grignard, organolithium , organocopper and organozinc (Reformatsky only); Diels-Alder, electrocyclic and sigmatropic reactions; functional group inter-conversions and structural problems using chemical reactions.

3.3: Qualitative Organic Analysis: Identification of functional groups by chemical tests; elementary UV, IR and ^{1}H NMR spectroscopic techniques as tools for structural elucidation of simple organic molecules.

3.4: Natural Products Chemistry: Chemistry of alkaloids, steroids, terpenes, carbohydrates, amino acids, peptides and nucleic acids.

3.5: Aromatic and Heterocyclic Chemistry: Monocyclic, bicyclic and tricyclic aromatic hydrocarbons, and monocyclic compounds with one hetero atom: synthesis, reactivity and properties, aromaticity; Electrophilic and nucleophilic aromatic substitution reactions.

Section 4: Inorganic Chemistry

4.1: Periodic Table: Periodic classification of elements, Aufbau's principle, periodicity; Variations of orbital energy, effective nuclear charge, atomic, covalent, and ionic radii, ionization enthalpy, electron gain enthalpy, and electronegativity with atomic number, electronic configuration of diatomic molecules (first and second row elements).

4.2: Extractions of Metals: General methods of isolation and purification of elements; Principles and applications of Ellingham diagram.

4.3: Chemical Bonding and shapes of molecules: Ionic bond: Packing of ions in crystals, radius ratio rule, Born-Landé equation, Kapustinskii expression, Madelung constant, Born-Haber cycle, solvation energy, polarizing power and polarizability; Fajan's rules; Covalent bond: Lewis structure, valence bond theory. Hybridization, molecular orbital theory, molecular orbital diagrams of diatomic and simple polyatomic molecules and ions; Multiple bonding (σ and π bond approach) and bond lengths; van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, instantaneous dipole- induced dipole interactions, hydrogen bonding; Effect of intermolecular forces on melting and boiling points, solubility energetics of dissolution process; Bond dipole, dipole moment, and molecular polarizabilities; VSEPR theory and shapes of molecules; ionic solids.

4.4: Main Group Elements (s and p blocks): Reactions of alkali and alkaline earth metals with oxygen, hydrogen and water; Alkali and alkaline earth metals in liquid ammonia; Gradation in properties of main group element in a group; Inert pair effect; Synthesis, structure and properties of diborane, ammonia, silane, phosphine and hydrogen sulphide; Allotropes of carbon; Oxides of nitrogen, phosphorus and sulphur; Oxoacids of phosphorus, sulphur and chlorine; Halides of silicon and phosphorus; Synthesis and properties of borazine, silicone and phosphazene; Synthesis and reactions of xenon fluorides.

4.5: Transition Metals (d block): Characteristics of d-block elements; oxide, hydroxide and salts of first row metals; coordination complexes: structure, isomerism, reaction mechanism and electronic spectra; VB, MO and crystal field theoretical approaches for structure, color and magnetic properties of metal complexes; Organometallic compounds with metal-ligand single and multiple bonds (such as metal carbonyls, metal nitrosyls and metallocenes); Homogenous catalysis involving Wilkinson's catalyst.

4.6: Bioinorganic Chemistry: Essentials and trace elements of life; basic reactions in the biological systems and the role of metal ions, especially Fe^{2+}, and Zn^{2+}; structure and function of myoglobin, hemoglobin and carbonic anhydrase.

4.7: Instrumental Methods of Analysis: Basic principles; instrumentations and simple applications of conductometry, potentiometry and UV-vis spectrophotometry; analyses of water, air and soil samples.

4.8: Analytical Chemistry: Principles of qualitative and quantitative analysis; Acid-base, oxidation- reduction and complexometric titrations using EDTA; Precipitation reactions; Use and types of indicators; Use of organic reagents in inorganic analysis; Radioactivity, nuclear reactions, applications of isotopes; Mathematical treatment in error analysis, elementary statistics and probability theory.