



Mahatma Gandhi University, Nalgonda

Ph.D. Entrance Test 2024

Part B Syllabus of Chemistry

UNIT-I: INORGANIC CHEMISTRY

Symmetry of Molecules: Concept of Symmetry in Chemistry – Symmetry Operations – Symmetry Elements : Molecular Point Groups: Descent in Symmetry with Substitution– Symmetry and Dipole moment – Symmetry criteria for Optical activity. **Bonding in metal complexes-I:** Crystal Field Theory: Splitting of metal orbitals in various geometries. Jahn-Teller theorem and Calculation of crystal field stabilization energies (CFSE's). Types of magnetic behaviour and magnetic susceptibility, Guoy's method and applications of magnetic moment. Reaction mechanisms of transition metal complexes: Ligand substitution reactions in octahedral complexes (SE,SN,SN₁,SN₂). Acid hydrolysis, Base Hydrolysis, Conjugate Base Mechanism and evidences. Ligand Substitution reactions in Square-Planar complexes: Electron Transfer Reactions, Marcus-Hush theory. **Metal Carbonyls, Metal Nitrosyls, Metal clusters :** Molecular orbitals of CO, NO and bonding modes, 18 Valence electron rule and its application. Structural aspects of [IrCl(PPh₃)₂(CO)(NO)]⁺ and [RuCl(PPh₃)₂(NO)₂]⁺. Stereo chemical control of valence in [Co(diars)₂(NO)]₂⁺ and [Co(diars)₂(NO)(SCN)]⁺. Metal Dinitrogen Complexes: Molecular orbitals of N₂ stretching frequencies; Structures of Ru (II) and Mo(0)dinitrogen complexes. **Metal clusters:** Carbonyl clusters: Classification of Clusters. Polyhedral skeletal electron pair theory and Total Electron Count theory–Wades rules–Capping rule – Structural patterns in carbonyls. **Bioinorganic chemistry:** Photosystems, porphyrins, metalloenzymes, oxygen transport, electron transfer reactions, nitrogen fixation, metal complexes in medicine.

UNIT-II : ORGANIC CHEMISTRY

Heterocyclic Chemistry: Study and reactivities of furan, pyrrole and thiophene. Synthesis and reactivity of indole, pyridine, quinoline, isoquinolinecoumarin, pyrazoles, pyrimidines.

Synthetic organic chemistry: Synthetic applications, elimination reactions, Oxidations and Reductions, aromatic nucleophilic substitutions, neighbouring group participation, Selective organic name reactions: Mannich reaction, Michael addition, chichibabin reaction, Shapiro reaction, Barton reaction. Rearrangement reactions: Hoffmann, Curtius, Favorski, Bayer-Villiger, Beckmann, Fries, Benzil-Benzilic acid and Von Richter rearrangement reaction

Stereochemistry: Molecular representations, Symmetry operations and symmetry elements, Racemisation and resolution techniques. Conformational analysis of a cyclic compounds & Cyclic compounds.

UNIT-III : PHYSICAL CHEMISTRY

Thermodynamics:- First & Second thermodynamics- standard entropy - entropy changes in chemical reactions. Third law of thermodynamics - calculation of absolute entropies of solids, Liquids and gases - Gibb's and Helmholtz free energy, standard free energy of formation -Ideal and Non-ideal systems: Fugacity of a gas. Partial molar properties- molar free energy - chemical potential. **Electrochemistry**: Electrochemical Cells: Derivation of Nernst equation. Chemical and concentration cells(with and without transference). Liquid junction potential (LJP)-Types of electrodes. Applications of EMF measurements: Solubility product & potentiometric titrations- Concept of activity and activity coefficients in electrolytic solutions. Mean ionic activity coefficient Debye-Huckel theory of electrolytic solutions. **Kinetics**: First order rate expression for opposing and consecutive reactions. Collision theory and Activated complex theory - Thermodynamic formulation of k-Calculation of activation parameters. Lindmann's theory of unimolecular reactions. Effect of substituent on the rate of reaction - Hammett's and Taft's equations - use of σ and ρ constants. **Photochemistry**: Jablonski's Diagram- fluorescence emission, phosphorescence-Delayed Fluorescence-Quantum yield and its determination, Bimolecular processes -quenching -Stern-Volm equation. Photochemical processes- Unimolecular processes: Isomerisation and rearrangements, Photooxidation - Photoreduction-Norrish Type I and II processes. **Quantum Chemistry**: Wave particle duality and uncertainty principle-significance of microscopic entities. Wave mechanics and Schrödinger wave equation. Operators- Operator algebra. Commutation of operators, linear operators. Complex functions. Hermitian operators. Operators ∇ and ∇^2 . Eigen functions and eigen values. Degeneracy. Well behaved functions. Normalized and orthogonal functions.

UNIT-IV: SPECTROSCOPY

UV, IR, ^1H - NMR and Mass - Instrumentation Principle - Applications of UV, IR, ^1H - NMR, Mass spectroscopy-Combined applications of UV, IR Mass spectroscopy.

UNIT-V: TECHNIQUES OF CHROMATOGRAPHY

Introduction, Classification of chromatographic techniques,. Efficiency of separation-resolution, diffusion, plate theory and rate theory. Gas Chromatography: Principle, instrumentation, detectors and applications. HPLC: Principle, instrumentation, detectors and Applications.