Mohammad Ali Jauhar University, Rampur

Department of Chemistry
Syllabus of Phd Entrance Exam

1. Inorganic Chemistry:

- Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes.
- Point symmetry group. Schoenflies symbols, representations of groups by matrices (representation for the Cn, Cnv, Cnh, Dnh, etc. groups to be worked out explicitly). Character of a representation. Character tables and their use in spectroscopy. Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, bonding and molecular orbital theory.
- Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes; tertiary phosphine as ligand.
- Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pHmetry and spectrophotometry. Isopoly and heteropoly acids of Mo and W.
- Preparation, properties and structure. Classification, Preparation, properties and structures of borides, carbides, nitrides and silicides. Silicates- classification and Structure, Silicones- preparation, properties and application.

2. Organic Chemistry:

- **Fundamental Concepts:** Localized and Delocalized chemical bond, conjugation and cross-conjugation, Bonding in Fullerenes, Bonds weaker than covalent, addition compounds, Crown ether complexes and cryptands. Inclusion compounds, Cyclodextrins, Catenanes and Rotaxanes.
- Aromaticity in benzonoid and non-benzenoid compounds, Huckel anti-aromaticity, homo-aromaticity. PMO approach for Aromaticity, Annulenes, Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding.
- Elements of symmetry, chirality, molecules with more than one chiral center, methods of resolution, optical purity, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon - Biphenyls, allenes and spiranes, chirality due to helical shape.
- Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes. Sandmeyer reaction, Free radical rearrangement and Hunsdiecker reactionThe E2, E1 and E1cB mechanisms.
- Orientation of the double bond. Reactivity, effects of substrate structures, attacking base, the leaving group and the medium,
- Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions - conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions - antrafacial and suprafacial additions, 4n and 4n+2 system, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements - suprafacial and antarafacial shifts of H, sigmatrophic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements. Claisen, Cope and Aza-Cope rearrangements. Ene reaction.
- Spectroscopy: Understanding of various spectroscopic techniques used in organic chemistry (e.g., NMR, IR, UV-Vis).

3. Physical Chemistry:

- Chemical Thermodynamics: Deals with fundamental principles, laws, and applications of thermodynamics.
- Chemical Kinetics: Covers reaction rates, mechanisms, and factors affecting them.
- Quantum Chemistry: Basic concepts and applications of quantum mechanics to chemical systems.
- Spectroscopy: Understanding various spectroscopic techniques used in physical chemistry (e.g., Raman, microwave, etc.).

4. Research Methodology:

- Defining the Research Problem: How to identify and formulate a research question.
- Research Design: Different types of research designs and their applications.
- Data Analysis and Interpretation: Methods for analyzing and interpreting research data.
- Report Writing: Structure and format of research reports and publications.
- Plagiarism and Intellectual Property Rights: Understanding ethical considerations in research.
- Publications: Knowledge about scientific publications and their impact.

5. Other Relevant Topics:

- Computer Applications: Basic knowledge of computer architecture, operating systems, and networks.
- Statistical Methods: Understanding basic statistical concepts relevant to research