POST GRADUATE DEPARTMENT OF CHEMISTRY, UNIVERSITY OF JAMMU, JAMMU.

Ph.D Entrance Examination Syllabus-2023

Section-I (Inorganic Chemistry)

1. Chemical periodicity
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules
3. Concepts of acid and bases
4. Chemistry of main group elements and their compounds. Allotropy, synthesis and bonding
5. Chemistry of transition elements and coordination compounds- bonding theories, spectral and magnetic properties, reaction mechanism
6. Inner transition elements - spectral and magnetic properties, analytical applications
7. Organometallic compounds – synthesis, bonding, structure and reactivity of organometallics in homogeneous catalysts.
8. Cages and clusters.
9. Analytical chemistry – separation techniques, spectroscopic, electro- and thermoanalytical methods.
10. Bioinorganic chemistry – photosynthesis, porphyrines, metalloenzymes, oxygen transport, electron-transfer reactions, nitrogen fixation.
11. Physical characterstics of inorganic compounds by IR, Raman, NMR, EPR, Mossbaur, UV, electron spectroscopy and microscopic techniques.
12. Environment chemistry

Section-II (Organic Chemistry)

1. Aromaticity – Benzenoid, Non-benzenoid and Homoaromatic compounds, Crown ethers, Cryptands, Inclusion compounds.
2. Substitution reactions- nucleophilic and electrophilic (aromatic and aliphatic). Addition reactions (olefins, ketones)
   Elimination reactions (E2, E1 and E1cb), pyrolytic eliminations.
   Free radical reactions: Hunsdicker reaction, Wohl Zeigler reaction, Gomberg Synthesis, Sandmeyer reaction.
3. Pericylic reactions: Electrocyclic, cycloaddition, Sigmatropic rearrangements and Group transfer reactions.
4. Name reactions and their applications in organic syntheses: Knoevenagel condensation, Aldol condensation, Stobbe condensation, Perkin, Mannich reaction, Hydroboration reaction, Pinacol-Pinacolone rearrangement, Robinson annulations, Stevens reaction, Wolf rearrangement, Schmidt, Cutius, Hoffmann bromoamide reaction, Favoroski rearrangement.
5. Use of reagents in organic syntheses: Gilman reagent, LDA, $LiAlH_4$, $NaAlH_4$, $NaBH_4$, $KMnO_4$, $K_2Cr_2O_7$, $Pb(OAc)_4$, DMSO, SeO_2, H_2 (over Pd, Pt, Rh), OsO_4, Jones reagent, PCC, PDC, MnO_2, CAN, RuO_4, peroxides, peracids, Aluminum isopropoxide, Aluminum ^{t}butoxide, Thalium nitrate, DIBAL, DCC, DDQ

Organometallic reagents of Zn, Mg, Titanium, Lithium
Wilkinson catalyst, Prevost and Woodward reagent.
Coupling reactions catalysed by Pd and Cu (C-C, C-N, C-O bond formation)

6. Heterocyclic chemistry: Hantzsch Widmann and Replacement nomenclature, Reactivities of Furan, Thiophene, Pyrrole, Quinoline and Isoquinoline. Skraup synthesis for quinoline and Fischer Indole Synthesis for Isoquinoline.
Chemical reactivities of three membered, 4 membered and large sized ring compounds.
7. Bio-organic and Medicinal Chemistry: Fischer Key and Lock mechanism, Fit Induced Hypothesis, Lead compounds, Bio-isosteric replacement, Factors affecting bio-isosteric replacement, Rigid analogs. Role and mechanism of NAD^+, $NADP^+$ in organic reactions, Haemoglobin, chlorophyll. Use of lipases in resolution.
8. Stereochemistry and applications in organic reactions: Absolute configuration of biphenyls, spirans, allenes and carbon compounds. Sharpless asymmetric epoxidation, E_2-Syn- and anti-elimination, Addition of organometallic to carbonyl compounds, Asymmetric Synthesis.
9. Spectroscopy: Applications of various spectral techniques in structural elucidation of organic compounds : UV, IR, ^{1}H-NMR, ^{13}C-NMR, Mass, 2D-NMR, NOESY, COSY, DEPT, INEPT, CD & ORD.

Section-III (Physical Chemistry)

Quantum Chemistry

Schrodinger wave equation for hydrogen atom, Quantum numbers and their importance, Hydrogen like wave functions, Radial and angular wave functions, Criteria for forming molecular orbital from atomic orbital, Physical picture of bonding and antibonding wave functions, Introduction to valence bond model of H_2, The variation theorem, Linear variation principle, Perturbation theory, Application of variation method and perturbation theory to He atom

Ordinary and generalized angular momentum, Eigen functions and eigen values of angular momentum, Ladder operators, Addition of angular momentum, Russell- Saunders terms and coupling schemes, Slater-condon parameters, Virial theorem, Huckel theory of conjucated systems, Applications to ethylene, butadiene, Extended Huckel theory.

Thermodynamics of Mixtures

Concepts of Free energy, chemical potential and entropy, Partial molar properties, Determination and their significance, fugacity and its determination

Gibbs Duhem Margules equation. Mean ionic activity, Mean ionic activity coefficient, Mean ionic molality of strong electrolytes, Ionic strength.

Statistical Thermodynamics

Ensembles, Statistics: Maxwell-Boltzmann: Fermi-Dirac and Bose-Einstein, Their applications, Partition function and its significance, Translational, rotational, vibrational, electronic and nuclear partition functions, Calculation of thermodynamic quantities, Equilibrium constant in terms of partition functions

Chemical Kinetics

POST GRADUATE DEPARTMENT OF CHEMISTRY, UNIVERSITY OF JAMMU, JAMMU.

Theory of reaction rates: Collision and Activated Complex, Their comparison with Arrhenius equation, Ionic reactions, Thermal and photochemical reactions ($H_2 + Br_2$; $H_2 + Cl_2$), Thermal decomposition of acetaldehyde and ethylene, Enzyme reactions, Fast reactions: flow and relaxation techniques, Unimolecular reactions; Lindemann and Hinshelwood approaches with limitations, Belousov-Zhabotinsky reaction.

Polymer Chemistry

Number and mass average molecular masses, Determination of molecular mass by sedimentation, viscosity and light scattering techniques, Morphology and order in crystalline polymers, Crystal structure of polymers, Effect of chain flexibility and other steric factors, Entropy and heat of fusion, Glass transition temperature, Effect of molecular weight, diluents, chemical structure, chain topology, branching and cross linking, Processing techniques of polymers, Properties of commercial polymers like polyethylene, poly vinyl chloride, polyamides, polysters, phenolic resins, epoxy resins and silicon polymers, electrical conducting polymers, Biomedical polymers.

Surface Chemistry

Laplace equation, Kelvin equation, Gibbs adsorption equation, BET equation and estimation of Surface Chemistry, Catalytical activity at surfaces, Langumir-Blodgett film: Properties and applications, Surface active agents and their classification, Critical micellar concentration and factors affecting on it.

Electrochemistry

Debye-Huckel theory of ion-ion interaction, Debye-Huckel-Onsager equation, Lippmann equation, Determination of surface excess, Structure of electrified interface: Helmlotz,-Perrin, Guoy-Chapman and Stern models, Theory of double layer at semiconductor-electrolyte interface, Butler-Volmer equation, Tafel plot, Polarography theory, Ilkovic equation, half wave potential and its significance.

Solid State Chemistry

Crystal systems, Various kinds of defects and their thermodynamics, color centers, Closed packed structures: Cubic close packing and hexagonal close packing, Materials that can be described as close packed structures,

Band theory of solids, Band structure of metals, insulators and semiconductors, Types of semiconductors, Super conductivity and types of super conductors, Organic metals, Organic charge transfer complexes.

Types of magnetic materials, Origin and theory of diamagnetism, Quantum and Langevin's theory, Solid state reactions, Kinetics and methods of preparation of solid state materials, Characterization of solids using advanced techniques.

Chemistry of Materials

Materials at nano scale, Physical properties of nanocrystals and bulk solids, Characterization of materials at nano scale, Carbon nanotubes,

Liquid Crystals, Classification, textures and structures, Applications

Ionic conductors: Types and mechanism, Phase transitions and mechanism of conduction of mechanism in superionic conductors, High super conductivity materials, Fullerenes as superconductors, Preparation and characterization of 1-2-3 and 2-1-4 materials, Application of high T_c materials, Non linear optical materials, Non linear optical effects.