CHEMISTRY

PAPER-I

1. **Atomic Structure :**
   - **Heisenberg's uncertainty principle Schrodinger wave equation (time independent); Interpretation of wave function, particle in one-dimensional box, quantum numbers, hydrogen atom wave functions; Shapes of s, p and d orbitals.**

2. **Chemical bonding :**
   - **Ionic bond, characteristics of ionic compounds, lattice energy, Born-Haber cycle; covalent bond and its general characteristics, polarities of bonds in molecules and their dipole moments;**
   - **Valence bond theory, concept of resonance and resonance energy;**
   - **Molecular orbital theory (LCAO method); bonding H2 +, H2 He2 + to Ne2, NO, CO, HF, CN–, Comparison of valence bond and molecular orbital theories, bond order, bond strength and bond length.**

3. **Solid State :**
   - Crystal systems;
   - Designation of crystal faces, lattice structures and unit cell; Bragg's law;
   - X-ray diffraction by crystals; Close packing, radius ratio rules, calculation of some limiting radius ratio values; Structures of NaCl, ZnS, CsCl, CaF2;
   - Stoichiometric and nonstoichiometric defects, impurity defects, semi-conductors.

4. **The Gaseous State and Transport Phenomenon :**
   - **Equation of state for real gases, intermolecular interactions, and critical phenomena and liquefaction of gases;**
   - **Maxwell’s distribution of speeds, intermolecular collisions, collisions on the wall and effusion;**
   - **Thermal conductivity and viscosity of ideal gases.**

5. **Liquid State :**
   - **Kelvin equation;**
   - **Surface tension and surface enercy, wetting and contact angle, interfacial tension and capillary action.**

6. **Thermodynamics :**
   - **Work, heat and internal energy;**
   - **First law of thermodynamics. Second law of thermodynamics;**
   - **Entropy as a state function, entropy changes in various processes, entropy-reversibility and irreversibility, Free energy functions;**
   - **Thermodynamic equation of state;**
   - **Maxwell relations;**
   - **Temperature, volume and pressure dependence of U, H, A, G, Cp and Cv, and ; J-T effect and inversion temperature;**
   - **criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities;**
   - **Nernst heat theorem, introductory idea of third law of thermodynamics.**

7. **Phase Equilibria and Solutions :**
   - **Clausius-Clapeyron equation;**
   - **Phase diagram for a pure substance; phase equilibria in binary systems, partially miscible liquids—upper and lower critical solution temperatures; partial molar quantities, their significance and determination; excess thermodynamic functions and their determination.**

8. **Electrochemistry :**
   - **Debye-Huckel theory of strong electrolytes and Debye-Huckel limiting Law for various equilibrium and transport properties. Galvanic cells, concentration cells;**
   - **Electrochemical series, measurement of e.m.f. of cells and its applications fuel cells and batteries. Processes at electrodes;**

- **Double layer at the interface; rate of charge transfer, current density; overpotential; electroanalytical techniques : amperometry, ion selective electrodes and their use.**

9. **Chemical Kinetics:**
   - **Differential and integral rate equations for zeroth, first, second and fractional order reactions;**
   - **Rate equations involving reverse, parallel, consecutive and chain reactions; Branching chain and explosions; effect of temperature and pressure on rate constant.**
   - **Study of fast reactions by stop-flow and relaxation methods. Collisions and transition state theories.**

10. **Photochemistry:**
    - **Absorption of light; decay of excited state by different routes; photochemical reactions between hydrogen and halogens and their quantum yields.**

11. **Surface Phenomena and Catalysis:**
    - Adsorption from gases and solutions on solid adsorbents;
    - Langmuir and B.E.T. adsorption isotherms; determination of surface area, characteristics and mechanism of reaction on heterogeneous catalysts.

12. **Bio-inorganic Chemistry:**
    - **Metal ions in biological systems and their role in ion-transport across the membranes (molecular mechanism), oxygen-uptake proteins, cytochromes and ferrodoxins.**

13. **Coordination Chemistry :**
    - Bonding in transition of metal complexes. Valence bond theory, crystal field theory and its modifications; applications of theories in the explanation of magnetism and electronic spectra of metal complexes.

- Isomerism in coordination compounds; IUPAC nomenclature of coordination compounds; stereochemistry of complexes with 4 and 6 coordination numbers; chelate effect and polynuclear complexes; trans effect and its theories; kinetics of substitution reactions in square-planar complexes; thermodynamic and kinetic stability of complexes.
- EAN rule, Synthesis structure and reactivity of metal carbonyls; carboxylate anions, carbonyl hydrides and metal nitrosyl compounds.
- Complexes with aromatic systems, synthesis, structure and bonding in metal olefin complexes, alkyne complexes and cyclopentadienyl complexes; coordinative unsaturation, oxidative addition reactions, insertion reactions, fluxional molecules and their characterization; Compounds with metal—metal bonds and metal atom clusters.

14.Main Group Chemistry:

- **Boranes, borazines, phosphazenes and cyclic phosphazene, silicates and silicones, Interhalogen compounds;**
- **Sulphur—nitrogen compounds, noble gas compounds.**

15.**General Chemistry of 'f' Block Element:** Lanthanides and actinides: separation, oxidation states, magnetic and spectral properties; lanthanide contraction.

PAPER-II

1. **Delocalised Covalent Bonding :** Aromaticity, anti-aromaticity; annulenes, azulenes, tropolones, fulvenes, sydnones.
2. **Reactions:**
    - **Reaction mechanisms** : General methods (both kinetic and non-kinetic) of study of mechanisms or organic reactions : isotopies, mathod cross-over experiment, intermediate trapping, stereochemistry; energy of activation; thermodynamic control and kinetic control of reactions.
    - **Reactive intermediates** : Generation, geometry, stability and reactions of carboniumions and carbanions, free radicals, carbenes, benzynes and nitrenes.
    - **Substitution reactions :**—SN 1, SN 2, and SN i, mechanisms ; neighbouring group participation; electrophilic and nucleophilic reactions of aromatic compounds including heterocyclic compounds—pyrrole, furan, thiophene and indole.
    - **Elimination reactions :**—E1, E2 and E1cb mechanisms; orientation in E2 reactions—Saytzeff and Hoffmann; pyrolytic syn elimination—acetate pyrolysis, Chugaev and Cope eliminations.
    - **Addition reactions :**—Electrophilic addition to C=C and CC; nucleophilic addition to C=O, CN, conjugated olefins and carbonyls.
    - **Reactions and Rearrangements :—**
        a. Pinacol-pinacolone, Hoffmann, Beckmann, Baeyer-Villiger, Favorskii, Fries, Claisen, Cope, Stevens and Wagner—Meerwein rearrangements.
        b. Aldol condensation, Claisen condensation, Dieckmann, Perkin, Knoevenagel, Witting, Clemmensen, Wolff-Kishner, Cannizzaro and von Richter reactions; Stobbe, benzoin and acyloin condensations; Fischer indole synthesis, Skraup synthesis, Bischler-Napieralski, Sandmeyer, Reimer-Tiemann and Reformatsky reactions.

3. **Pericyclic reactions :**—Classification and examples; Woodward-Hoffmann rules—electrocyclic reactions, cycloaddition reactions [2+2 and 4+2] and sigmatropic shifts [1, 3; 3, 3 and 1, 5], FMO approach.
4. **Polymers**
    - **Preparation and Properties of Polymers:** Organic polymerspolyethylene, polystyrene, polyvinyl chloride, teflon, nylon, terylene, synthetic and natural rubber.
    - **Biopolymers**: Structure of proteins, DNA and RNA.
5. **Synthetic Uses of Reagents:** OsO_4, HIO_4, CrO_3, $Pb(OAc)_4$, SeO_2, NBS, B_2H_6, Na-Liquid NH_3, $LiAlH_4$, $NaBH_4$, n-BuLi, MCPBA.
6. **Photochemistry :—**Photochemical reactions of simple organic compounds, excited and ground states, singlet and triplet states, Norrish-Type I and Type II reactions.
7. **Spectroscopy**: Principle and applications in structure elucidation :
    - **Rotational**—Diatomic molecules; isotopic substitution and rotational constants.
    - **Vibrational**—Diatomic molecules, linear triatomic molecules, specific frequencies of functional groups in polyatomic molecules.
    - **Electronic**—Singlet and triplet states. n and transitions; application to conjugated double bonds and conjugated carbonyls Woodward-Fieser rules; Charge transfer spectra.
    - **Nuclear Magnetic Resonance (1HNMR)**: Basic principle; chemical shift and spin-spin interaction and coupling constants.
    - **Mass Spectrometry :**—Parent peak, base peak, metastable peak, McLafferty rearrangement.