

# Chemistry Paper-I

## INORGANIC CHEMISTRY

Maximum Marks 50

Duration -3 hrs.

### UNIT-I

#### Atomic Structure

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger wave equation, significance of  $\psi$  and  $\psi^2$ , quantum numbers, radial and angular wave functions and probability distribution curves, shape of s, p and d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configuration of the elements, effective nuclear charge.

### UNIT-II

#### Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electro-negativity. Definition, methods of determination or evaluation, trends in periodic table and application in predicting and explaining the chemical behaviour.

#### Chemical Bonding

**Covalent Bond** – Valence bond theory and its limitations, directional characteristic of covalent bond, various types of hybridization and shapes of inorganic molecules and ions, Valence shell electron pair repulsion (VSEPR) theory and its applications to  $\text{NH}_3$ ,  $\text{H}_3\text{O}^+$ ,  $\text{SF}_4$ ,  $\text{ClF}_3$ ,  $\text{ICl}_2^-$  and  $\text{H}_2\text{O}$ . Molecular orbital theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

### UNIT-III

**Ionic Solids** – Ionic structures, radius ratio effects and coordination number, limitations of radius ratio rule, lattice defects, semiconductor, lattice energy and Born - Haber cycles, solvation energy and solubility of ionic solids, polarizing power and polarizability of ions, Fajan's rule, Metallic bond - free electron, valence bond and bond theories.

**Weak Interactions**- Hydrogen bonding, van der Waals forces.

### UNIT-IV

#### s- Block Elements

Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems. An introduction to alkyls and aryls.

#### p- Block Elements :

Chemical properties of the noble gases, chemistry of Xenon, structure and bonding in xenon compounds.

### UNIT-V

Comparative study (including diagonal relationship) of groups 13 - 17 elements, compounds like hydrides. Oxides, oxyacids and halides of group 13 - 16, Hydrides of Boron's, diborane and higher boranes, borazine, borohydride and fullerenes.

### Books Suggested

1. Concise Inorganic Chemistry: *J D Lee*
2. Essentials of Inorganic Chemistry: *D M P Mingose (Oxford Publication)*
3. Inorganic Chemistry: *D F Shriver and P W Atkins (ELBS, London)*
4. Inorganic Chemistry: *Puri, Sharma and Kalia*
5. Inorganic Chemistry: *K K Bhasin (Vol. I)*
6. Inorganic Chemistry: *Madan, Tuli and Srivastava*

# Chemistry Paper-II

## ORGANIC CHEMISTRY

Maximum Marks-50

Duration -3 hrs

### UNIT-I

**Nomenclature:** Nomenclature of Aliphatic compounds having one and more functional groups.

**Structure and Bonding:** Hybridization, Inductive, Electromeric, Resonance, Hyperconjugation.

**Mechanism of Organic reactions:** Curved arrow notation, drawing of electron movements with arrows, half headed and double headed arrows, Homolytic and heterolytic bond breaking, types of reagents (Electrophiles and Nucleophiles) types of organic reactions. Reactive intermediates (structure and stability of Carbocations, Carbanions, Free-radicals, Carbenes).

### UNIT-II

**Stereochemistry of Organic compounds** - Concept of Stereo-isomerism. Optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic centres, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, meso compounds, resolution of enantiomers, racemization (simple idea), relative and absolute configuration, sequence rules, D – L and R – S systems of nomenclature, Geometrical isomerism, Determination of Configuration of geometrical isomers. E and Z systems of nomenclature, Difference between Configuration and Conformation, Conformational Isomerism- Conformational analysis of Ethane and n-Butane. Fischer projection formulae, Newmann projection and Sawhorse formulae.

### UNIT-III

**Alkanes-** Methods of formation with special reference to Wurtz reaction, Kolbe's reaction, Corey-House reaction and de-carboxylation of carboxylic acids. Mechanism of free radical, halogenation of alkanes, orientation, reactivity and selectivity.

**Alkenes, Dienes and Alkynes-** Methods of formation. Mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides. The saytzeff rule, Hoffmann elimination. Chemical reaction of Alkenes-Mechanism involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule, Hydroboration- oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with  $\text{KMnO}_4$ . Polymerization of alkenes. Substitution of the allylic and vinylic positions of alkenes. Industrial application of ethylene and propene, Isolated, conjugated and cumulated dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions- 1,2 and 1,4 additions, Diels-Alder reaction. Methods of formation, chemical reactions of Alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration- oxidation, metal-ammonia reactions, oxidation and polymerization.

### UNIT-IV

#### **Arenes and Aromaticity**

Nomenclature of benzene derivatives. The Aryl group, Aromatic nucleus and side-chain, Structure of benzene, Molecular formula and Kekule structure. Stability and carbon-carbon bond length of benzene, Resonance structures, molecular orbital picture, Aromaticity. The Huckle rule, Aromatic ions, Aromatic electrophilic substitution-general pattern of the mechanism, role of sigma and pi-complexes. Mechanism of nitration, halogenations, sulphonation and friedel-Craft reaction. Activating and deactivating groups.

## UNIT-V

### Alkyl and Aryl halides

Mechanism of Nucleophilic substitution reactions of Alkyl halides ( $SN^1$  and  $SN^2$  reaction with energy profile diagrams) Method of formation of Aryl halides, Nuclear and side chain reactions. The addition-elimination and elimination addition mechanism of nucleophilic aromatic substitution reactions. Relative reactivity of Alkyl halides versus Vinyl, Allyl, Aryl halides synthesis and uses of DDT and BHC.

### Books Suggested:

1. Organic Chemistry: *I L Finar, Vol. 1 & 2*
2. Organic Chemistry: *Morrison & Boyd*
3. Organic Chemistry: *P Y Bruice, (Pearson Education)*
4. Organic Chemistry: *S.N.Dhawan Vol. 1.*
5. Undergraduate Organic Chemistry: *Jagdamba Singh and L.D.S.Yadava Vol. 1*
6. Organic Reactions & their Mechanism: *P S Kalsi, New Age International Publishers*
7. Organic Chemistry: *M K.Jain and S.C.Sharma Vol. 1*
8. Advance Organic Chemistry: *Bahl and Bahl*

# Chemistry Paper-III

## PHYSICAL CHEMISTRY

Maximum Marks-50

Duration -3 hrs.

### UNIT-I

#### Mathematical Concepts and Computers

**Mathematical Concepts :** Differentiation of functions like  $kx$ ,  $e^x$ ,  $x^n$ ,  $\sin x$ ,  $\log x$  ; Integration of some useful/relevant functions.

**Computers:** General introduction to computers, different components of a computer, hardware and software, input-output devices, binary numbers and arithmetic, introduction to computer languages, Operating systems.

#### Liquid state

Intermolecular forces, structure of liquids (a qualitative description) Structural differences between solid, liquid and gases.

**Liquid Crystals:** Difference between liquid crystals , solid and liquid. Surface tension, viscosity- definition, measurement, effect of temperature.

### UNIT-II

#### Gaseous States

Postulates of kinetic theory of gases, derivation from ideal behaviour, Van der Waals equation of state.

**Critical Phenomena:** PV isotherms of real gases, continuity of states, the isotherms of Van der Waals equation, relationship between critical constants and Van der Waals constant, the law of corresponding states, reduced equation of state.

**Molecular Velocities. :** Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter. Liquification of gases (based on joule-Thomson effect).

### UNIT-III

#### Solid State

Definition of space lattice, unit cell.

Laws of crystallography- Law of constancy of interfacial angles, Law of rationality of indices, Law of symmetry, Symmetry elements in crystals. X-ray diffraction by crystals. Derivation of Bragg's equation, determination of crystal structure of NaCl, KCl and CsCl , X-ray Spectrometer Method).

### UNIT-IV

#### Colloidal State

Definition of colloids, Classification of colloids.

Solid in liquid (sols) properties- Kinetic, optical and electrical; Stability of colloids and protective action, Hardy-Schulz law and Gold Number.

Liquid in liquid (emulsions) - Types of emulsions, preparation, emulsifiers liquid in solids (gels) Classification, preparation and properties, inhibition, general application of colloids.

### UNIT-V

#### Chemical Kinetics and Catalysis

Chemical kinetics and its scope, rate of reaction, factors influencing the rate of a reaction - concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates - mathematical characteristics of simple chemical reaction-Zero order, first order second order, pseudo order, half life and mean life. Determination of the order of reaction - differential

method. Method of integration, method of half life period and isolation period. Radioactive decay as first order phenomena.

Theories of chemical kinetics, effect of temperature on rate of reaction Arrhenius equation concept of activation energy. Simple Collision theory based on hard sphere model, transition state theory (equilibrium hypothesis) Catalysis, Characterization of catalyzed reactions, classification of catalysis, miscellaneous examples.

**Books Suggested:**

1. Physical Chemistry: *Singh, Das and Singh Vol.1 (New Age)*
2. Physical Chemistry: *S.C.Kheterpal Vol. 1*
3. Physical Chemistry: *Kushwaha Vol. 1*
4. Physical Chemistry: *Puri and Sharma*
5. Physical Chemistry: *Rastogi, Singh and Nath*
6. Physical Chemistry: *P.W. Atkins.*
7. Physical Chemistry: *G.M.Barrow*
8. Physical Chemistry: *Castellon.*
9. Physical Chemistry: *Gurdeep Raj*
10. *Physical Chemistry : S.N.Singh,S.N.Lal*

# Chemistry Practical

**Maximum Marks-50**

**Duration -6 hrs.**

**1. Inorganic mixture analysis**

(Marks 20)

Qualitative analysis of inorganic mixture containing five radicals (including insoluble substances, interfering anions and combination of anions).

**2. Volumetric Analysis**

(Marks 15)

**Redox Titration-** Titration of Ferrous ions with dichromate using internal and external indicators.

**Iodometric titration-** Iodometric estimation of potassium dichromate and copper sulphate.

**3. Chemical Kinetics**

( Marks 05)

Study of hydrolysis of methyl acetate in presence of  $H^+$  at room temperature.

To study the kinetics of dissolution of magnesium metal in mineral acid (Dil. HCl)

**4. Viva – voce**

(Marks 05)

**5. Record**

(Marks 05)

***Books Suggested***

1. Modern Approach to Practical Chemistry (Vol.1): *K.K.Singh and Subhra Singh.*
2. Practical Chemistry: *Bahal, Dubey and Nath.*
3. Practical Chemistry: *Giri, Bajpai and Pandey*
4. Practical Chemistry: *S. N. Srivastava and M.M.N.Tandon*

# Chemistry Paper-I

## INORGANIC CHEMISTRY

Maximum Marks-50

Duration -3 hrs.

### UNIT-I

#### **Chemistry of Elements of First Transition Series:**

Characteristic properties of d-block elements. Properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry.

#### **Chemistry of Elements of Second and Third Transition Series:**

General characteristics, comparative treatments with their 3d analogues in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.

### UNIT-II

#### **Oxidation and Reduction**

Use of redox potential data-analysis of redox cycle, redox stability in water-frost, Latmer and Pourbaix diagrams, principles involved in the extraction of the elements.

### UNIT-III

#### **Coordination Compounds**

Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

### UNIT-IV

#### **Chemistry of Lanthanide Elements.**

Electronic structure, oxidation states, ionic radii, lanthanide contraction, complex formation, occurrence and isolation of lanthanide compounds. Magnetic and spectral properties.

#### **Chemistry of Actinides.**

General features and chemistry of actinides, chemistry of separation of Np, Pu, and Am from U. Similarities between the later actinides and the later lanthanides. Extension of periodic table.

### UNIT-V

#### **Acids and Bases.**

Arrhenius, Bronsted-Lowry, the Lux-flood. Solvent system and Lewis concepts of acids and bases.

#### **Non-aqueous Solvents**

Physical properties of a solvent, types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid NH<sub>3</sub> and liquid SO<sub>2</sub>.

### **Books Suggested**

- 1 Concise Inorganic Chemistry: *J D Lee*
- 2 Essentials of Inorganic Chemistry: *D M P Mingose (Oxford Publication)*
- 3 Inorganic Chemistry: *D F Shriver and P W Atkins (ELBS, London)*
- 4 Inorganic Chemistry: *Puri Sharma and Kalia*
- 5 Inorganic Chemistry: *K K Bhasin (Vol. II)*
- 6 Inorganic Chemistry: *Madan, Tuli and Srivastava*
- 7 *Inorganic Chemistry: R.C.Saraswat, A.K.Goswami*

# Chemistry Paper-II

## ORGANIC CHEMISTRY

Maximum Marks-50

Duration -3 hrs.

### UNIT-I

#### Organometallic Compounds:

- (i) Definition with suitable examples, organomagnesium halides (Grignard- reagent); preparation, structure and synthetic applications.
- (ii) Organo-lithium compounds: preparation and synthetic applications.

### UNIT-II

#### Alcohols, Ethers and Epoxides:

- (i) Distinction between 1<sup>o</sup>-, 2<sup>o</sup>- and 3<sup>o</sup> – Alcohols.  
Interconversion of primary, secondary and tertiary alcohols, Hydrogen bonding in alcohols,

#### Mechanism of dehydration of alcohols.

- (ii) Williamson synthesis, Auto-oxidation, oxonium salt and cleavage.
- (iii) Synthesis of epoxide, acid and base catalyzed ring opening of epoxides, Reaction of Grignard and organo-lithium reagents with epoxides.

#### Phenols :

Structure and bonding, General methods of preparation and reactions of phenol, Acidic character of phenol, Resonance stabilization of phenoxide ion, Relative acidity of phenol, alcohol and acids. Mechanism of Reimer- Tiemann, Kolbe and Gattermann reactions.

### UNIT-III

#### Aldehydes and Ketones:

- (i) Structure of carbonyl group, preparation of aldehydes and Ketones from acid chlorides, 1,3 dithianes and nitriles.
- (ii) Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin , aldol, perkin, cannizzaro and knoevenagel condensation.
- (iii) Condensation with ammonia and its derivatives.
- (iv) Reduction of aldehydes and ketones with LiAlH<sub>4</sub>, NaBH<sub>4</sub>, aluminium isopropoxide (MPV reduction), Wolff-Kishner and Clemmensen reduction.
- (v) Oxidation of aldehydes and Ketones with K<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>, KMnO<sub>4</sub> oxidation of aldehydes with mild oxidizing agents like Tollen's, Fehling and Benedict Solution, oxidation of Ketones (Haloform reaction, Baeyer - Villiger oxidation.)

### UNIT-IV

#### Carboxylic acids and their derivatives

- (i) Structure of Carboxylic group, Acidity of Carboxylic acids, effect of substituents (like halo and alkyl group) upon the acidity of aliphatic acids.
- (ii) Comparative acidity of benzoic, salicylic, p-toluic and p-nitrobenzoic acid.
- (iii) Preparation and reactions of benzoic, cinnamic and salicylic acid.
- (iv) Derivatives of salicylic acid of medicinal interest (Salol, Methylsalicylate, Aspirin and PAS).
- (v) Mechanism of Esterification and Hydrolysis of esters ( BAC<sup>2</sup> and AAC<sup>2</sup>)
- (vi) Hell-Volhard -Zelinsky (HVZ) reaction.

### UNIT-V

#### Organic compounds of Nitrogen :

- (i) Reactions of Nitroalkanes and alkylnitrites.
- (ii) Nitroarenes and their reduction in acidic, neutral and alkaline media.

- (iii) Mechanism of nucleophilic substitution in nitroarenes.
- (iv) Relative basic strength of methyl, dimethyl-, and trimethylamines, comparative basicity of aromatic and aliphatic amines, relative basicity of aniline, p-toluidine and p-nitroaniline.
- (v) Preparation of alkyl and arylamines (Reduction of nitro compounds and nitriles, Reductive amination of aldehydic and ketonic compounds, Gabriel's phthalimide reaction). Reactions of amines, Electrophilic aromatic substitution in arylamines.
- (vi) Reactions of amines with nitrous acid (mechanism of diazotization), synthetic transformation of aryldiazonium salts, Azo-coupling,
- (vii) Separation of a mixture of primary, secondary and tertiary amines.

**Organo-Sulphur and Organo-Phosphorous Compounds.**

- (i) Sulphur ylides sulphonic acids, Chloramint-T, Dichloramine-T, Saccharin suphonamide and sulfaguanidine.
- (ii) Phosphorous-ylides, Wittig Reaction.

**Books Suggested:**

1. Organic Chemistry: *I L Finar, Vol. 1 & 2*
2. Organic Chemistry: *Morrison & Boyd*
3. Organic Chemistry: *P Y Bruice, (Pearson Education)*
4. Organic Chemistry: *S.N.Dhawan Vol.2.*
5. Undergraduate Organic Chemistry: *Jagdamba Singh and L.D.S.Yadava, Vol. 2*
6. Organic Chemistry: *M K.Jain and S.C.Sharma vol. 2*
7. Advance Organic Chemistry: *Bahal and Bahal*

# Chemistry Paper-III

## PHYSICAL CHEMISTRY

Maximum Marks-50

Duration -3 hrs.

### UNIT-I

#### Thermodynamics

Definition of thermodynamic terms, system, surroundings.

Types of systems. Intensive and extensive properties, state and path functions. Thermodynamic processes. Concept of heat and work.

First Law of Thermodynamics

Statement, definition of internal energy and enthalpy, Heat capacity, heat capacities at constant volume and pressure and their relationship, Joules law, Joule Thomson effect and coefficient, coefficient inversion temperature, calculation of  $w$ ,  $q$ ,  $\Delta E$  and  $\Delta H$  for the expansion of ideal gases under isothermal conditions for reversible process.

#### Thermo Chemistry

Standard state, standard enthalpy of formation. Hess's law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume Enthalpy of neutralization, Bond dissociation energy and its calculation from thermochemical data. Temperature dependence of enthalpy, Kirchoff's equation.

### UNIT-II

#### Thermodynamics

Second law of thermodynamics need for the second law, different statement of the law. Concept of entropy. Entropy as a state function, entropy as a function of volume and temperature and as a function of  $P$  and  $T$ . Entropy change in physical process. Entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases. Work function and Gibb's free energy. Variation of work function with temperature and volume, variation of Gibb's free energy with temperature and pressure. criteria for thermodynamic equilibrium and spontaneity.

### UNIT-III

#### Third law of thermodynamics

Nernst heat theorem, importance of third law in the evaluation of absolute entropies Concept of residual entropies.

#### Chemical Equilibrium

Equilibrium constant, Thermodynamic derivation of chemical equilibrium, Le chateliers principle and its applications Classius Clapeyron equation and its applications.

### UNIT-IV

#### Phase Equilibrium

Meaning of the terms-phase, component and degree of freedom. Derivation of Gibbs phase rule. Application of phase rule to one component-system, water, carbon dioxide and sulphur system. Study of two component systems Lead- Silver, and Bismuth-Cd systems.

#### Liquid-liquid mixtures

Ideal liquid mixtures, Raoult's and Henry's law Non ideal systems-  $\text{HCl-H}_2\text{O}$  and ethanol-water systems. Partially miscible liquids- Phenol-water system, critical solution temperature, effect of impurity on CST Immiscible liquids-steam distillation.

Nernst- Distribution law, Thermodynamic derivation and its application in solvent extraction process.

## UNIT-V

### Electro Chemistry I

Electric transport-conduction in metals and in electrolyte solutions, specific conductance, equivalent conductance, measurement of equivalent conductance, variation of conductance with dilution. Application of conductivity in conductometric titrations and determination of solubility product. Migration of ions, Transport number, definition and determination by moving boundary method. Kohlrausch law. Arrhenius theory of electrolytic dissociation. Ostwald dilution law, its uses and limitations Debye-Huckel-Onsager theory for strong electrolytes.

### Electrochemistry II

Electrolytic and galvanic cells. Reversible and irreversible cells, presentation of cells. Types of electrodes, gas-metal ion, metal-metal ion, metal-insoluble salt anion and redox- electrodes, Electrode potential - measurement of electrode potential , effect of concentration on electrode potential (Nernst- equation) EMF of cell and its measurement. Concentration cells, with and without transport, liquid junction potential.

pH and  $pK_a$  , determination of pH , Buffer solution , Henderson equation for buffers. Hydrolysis of salts. Elementary idea of corrosion.

### Books Suggested:

1. Physical Chemistry: *Singh, Das and Singh Vol.2 (New Age)*
2. Physical Chemistry: *Khetarpal Vol. 2*
3. Physical Chemistry: *Kushwaha Vol. 2*
4. Physical Chemistry: *Puri and Sharma*
5. Physical Chemistry: *Rastogi, Singh and Nath*
6. Physical Chemistry: *P.W. Atkins.*
7. Physical Chemistry: *G.M.Barrow*
8. Physical Chemistry: *Castellon.*
9. Physical Chemistry: *Gurdeep Raj*
10. Physical Chemistry: *S.N.Lal,S.N.Singh*

# Chemistry Practical

Maximum Marks-50

Duration -6 hrs

## 1. Inorganic Chemistry

(Marks 20)

### *Qualitative Analysis*

- (i) To estimate Barium as Barium sulphate in Barium chloride solution.
- (ii) To estimate Zinc as Zinc oxide from zinc chloride or zinc sulphate solution.
- (iii) To estimate copper as cupric oxide in a solution of copper sulphate.

## 2. Organic chemistry

(Marks 10)

Identification of organic compounds.

## 3. Physical Chemistry

(Marks 10)

The neutralization equivalent of a given acids.

The heat of neutralization of sodium hydroxide and hydrochloric acid.

The heat of solution of the given salts in water by calorimeter.

The heat of solution of  $\text{KNO}_3$  by solubility method.

## 4. Viva Voice

(Marks 05)

## 5. Record

(Marks 05)

### *Books Suggested*

1. Modern Approach to Practical Chemistry (Vol.II): *K.K.Singh and Subhra Singh*.
2. Practical Chemistry: *Bahal, Dubey and Nath*.
3. Practical Chemistry: *Giri, Bajpai and Pandey*
4. Practical Chemistry: *S. N. Srivastava and M.M.N.Tandon*

# Chemistry Paper-I

## Inorganic Chemistry

Max. Marks 55

Duration 3 hrs

### UNIT-I

#### Hard and Soft Acids and Bases (HSAB)

Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

#### Magnetic Properties of Transition Metal Complexes

Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only Formula, L-S coupling, correlation of  $\mu_s$ , and  $\mu_{\text{eff}}$  values, orbital contribution to magnetic moments and application of magnetic moment data for 3d-metal complexes.

### UNIT-II

#### Metal-ligand bonding in Transition Metal Complexes

Limitations of valence bond theory, an elementary idea of crystal-field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal-field parameters.

### UNIT –III

#### Electron Spectra of Transition Metal Complexes

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series. Orgel-energy level diagram for  $d^1$  and  $d^9$  states, discussion of the electronic spectrum of  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  complex ion.

#### Thermodynamic and Kinetic Aspects of Metal Complexes

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes.

### UNIT-IV

#### Organometallic Chemistry

Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti. A brief account of metal-ethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.

### UNIT-V

**Bioinorganic Chemistry** :Essential and trace elements in biological processes metalloporphyrins with special reference to hemoglobin and myoglobin Biological role of alkali and alkaline earth metal ions with special reference to  $\text{Ca}^{2+}$ . Nitrogen fixation.

**Silicones and Phosphazenes** : Silicones and phosphazenes as examples of inorganic polymers, nature of bonding in triphosphazenes,

### Books Suggested

1. Concise Inorganic Chemistry: *J D Lee*
2. Essentials of Inorganic Chemistry: *D M P Mingose (Oxford Publication)*
3. Inorganic Chemistry: *D F Shriver and P W Atkins (ELBS, London)*
4. Inorganic Chemistry: *Puri Sharma and Kalia*
5. Inorganic Chemistry: *K K Bhasin (Vol. III)*
6. Inorganic Chemistry: *Madan, Tuli and Srivastava*
7. Inorganic Chemistry: *G L Misseler and Tarr (Printce Hall)*
8. Concepts of Models of Inorganic Chemistry: *B Douglas D McDaniel and J Alexander (John Wiley)*
9. Basic Inorganic Chemistry: *F A Cotton, G Wilkinson and P L Gaus (Wiley)*
10. Organometallic Chemistry: *R C Mahrotra and A Singh (New Age)*
11. Symmetry and Spectroscopy of Molecules: *K.Veera.Reddy (New Age)*

# Chemistry Paper- II

## Organic Chemistry

Max. Marks 55

Duration 3 hrs

### UNIT- I

#### *Spectroscopy*

- (i) **Ultra Violet-Visible**- Absorption Law, Beer's - Lambert's Law, Molar Absorptivity, Presentation and Analysis of UV spectra, Types of Electronic Transition, Effect of Conjugation, Auxochromophore, Chromophore, Bathochromic and Hypsochromic Shift, UV spectra of Enes and Enones.
- (ii) **Infra Red** - Molecular Vibrations, Hooke's law, Selection rule, Intensity and Position of IR Bands, Measurements of IR Spectrum, Finger Print Region, Characteristic Absorption of Various Functional groups.
- (iii) **Nuclear Magnetic Resonance** – Proton Magnetic Resonance, Nuclear Shielding and Deshielding, Chemical Shift and Molecular structures, Spin-Spin Splitting and Coupling Constants, Areas of Signals, Interpretation of PMR Spectra of Simple Organic Molecules (Ethyl Bromide, Ethanol, Acetaldehyde, 1,1,2-tribromoethane, Ethyl Acetate, Toluene, Acetophenone).

### UNIT - II

- (i) General Methods for Determination of Mechanism, Product Analysis, Study of Intermediates, Intermediates vs. Transition States, Cross-over Experiments, Isotopic Labeling, Kinetic Isotope Effect and Kinetic Evidences.
- (ii) Electrophilic Addition of Halogens and Halogen Acids to  $>C=C<$  Mechanism and Stereochemistry, Stereoselective and Stereospecific reactions, Epoxidation and Hydroxylation, Nucleophilic addition to  $>C=C<$  (Cyanomethylation and Michael's Addition)

### UNIT-III

#### *Carboxylic Compounds*

- (i) **Alicyclic Compounds**- Classification and Nomenclature of Alicyclic Compounds, General methods for preparation of Cycloalkanes (upto  $C_6$ ), Reactions of Small Rings Cycloalkanes (Cyclopropane and Cyclobutane), Baeyer's Strain Theory, Theory of Strainless ring, Conformational Analysis of Cyclohexane and Methylcyclohexane.
- (ii) **Polynuclear Aromatic Hydrocarbons**- Preparation, Reaction and Structure of Naphthalene, Synthesis and Reactions of Anthracene and Phenanthrene.

### UNIT- IV

#### **Heterocyclic Compounds**

Introduction- Molecular Orbital Picture and Aromatic Characteristics of Pyrrole, Furan and Thiophene and Pyridine. Methods of Synthesis and Chemical Reactions with particular emphasis on Mechanism of Electrophilic Substitution. Mechanism of Nucleophilic Substitution Reactions in Pyridine, Comparison of Basicity of Pyridine, Piperidine and Pyrrole. Introduction to Condensed 5 & 6 Membered Heterocycles. Fischer- Indole Synthesis, Skraup Synthesis, Bischler- Napieralski Synthesis, Mechanism of Electrophilic Substitution Reactions of Indole, Quinoline and Iso-quinoline.

### Unit - V

**Organic Synthesis via Enolates:** (1) Synthesis of Ethyl Acetoacetate & Malonic Ester, (2) Synthetic Application of Acetoacetic Ester and Malonic Ester, Claisen Condensation, (3) Keto - Enol Tautomerism of Ethyl Acetoacetate, (4) Alkylation of 1,3- Dithianes, (5) Alkylation and Acylation of Enamines

**Books Suggested:**

1. Organic Chemistry: *I L Finar, Vol. 1 & 2*
2. Organic Chemistry: *Morrison & Boyd*
3. Organic Chemistry: *P Y Bruice, (Pearson Education)*
4. Organic Compounds- Spectra & Spectrum Analysis, *P S Kalsi, (New Age International Publishers)*
5. Spectrometric Identification of Organic Compounds: *Silverstein, Bassler, Morrill, John Wiley & Sons*
6. Organic Reactions & their Mechanism, *P S Kalsi, (New Age International Publishers)*
7. Organic Chemistry: *LG. Wade Jr., (Prentice Hall Publication)*
8. Fundamentals of Organic Chemistry: *Solomons, (John Wiley Publication)*
9. Organic Chemistry: *Vol. 1, 2 & 3: Mukherjee, Singh & Kapoor, (Wiley Eastern Ltd.)*
10. Organic Chemistry: *F A Carey, (Mc Graw Hills Publication)*
11. Heterocyclic Chemistry: *R K Bansal, (New Age International Publications.)*
12. Organic Stereochemistry: *Michael J T Robinson, (Oxford Chemistry Primers Indian Edition)*

# Chemistry Paper III

## Physical Chemistry

Maximum Marks 55

Duration 3 hrs.

### UNIT- I

#### Elementary Quantum Mechanics

Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton Effect. de Broglie hypothesis, the Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates of quantum mechanics, particle in a one dimensional box, Schrodinger wave equation for H-atom, separation into three equations (without derivation) quantum numbers and their importance, hydrogen like wave functions, radial wave functions and angular wave functions.

### UNIT-II

Molecular orbital theory, basic ideas - criteria for forming M.O from A.O, construction of MO's by LCAO –  $H_2^+$  ion. Calculation of energy levels from wave functions, physical picture of bonding and anti bonding wave functions. Concept of  $\sigma$ ,  $\sigma^*$ ,  $\pi$ ,  $\pi^*$  orbitals and their characteristics. Hybrid orbital - sp,  $sp^2$ ,  $sp^3$  calculation of coefficients of A.O's used In these hybrid orbitals. Introduction to valence bond order of  $H_2$ . Comparison of M.O. and V.B. models.

### UNIT-III

#### Spectroscopy

Introduction: electromagnetic radiation. regions of the spectrum, basic features of different Spectrometers. Statement of the Born-Oppenheimer approximation. Degrees of freedom.

#### *Rotational Spectrum*

Diatomic molecules. Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.

#### *Vibrational Spectrum*

Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, Idea of vibrational frequencies of different functional groups. Raman Spectrum: concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules.

#### *Electronic Spectrum*

Concept of potential energy curves for bonding and antibonding molecular orbital, qualitative description of selection rules and Franck-Condon principle. Qualitative description of  $\sigma$ ,  $\pi$  and n MO, their energy levels and the respective transitions.

### UNIT-IV

#### Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical Processes. Laws of photochemistry: Grothus - Drapper law. Stark - Einstein law, Jablonski diagram depicting various processes occurring in the excited state. Qualitative description of fluorescence, Phosphorescence. non-radiative processes (Internal conversion, Intersystem crossing). quantum yield. Photosensitized reactions – energy transfer processes (simple examples).

#### Physical Properties and Molecular Structure

Optical activity. polarization - (Clausius - Mossotti equation). Orientation of dipoles in an electric field. Dipole moment. Induced dipole moment. Measurement of dipole moment temperature method and refractivity method. dipole moment and structure of molecules, magnetic properties –paramagnetism, diamagnetism and ferromagnetism.

#### UNIT -V

##### **Solutions, Dilute Solutions and Colligative Properties**

Ideal and non-ideal solutions. Methods of expressing concentrations of solutions. Activity and activity coefficient. Dilute solution. Colligative properties, Raoult's law. Relative lowering of vapour pressure, molecular weight determination, Osmosis. Law of osmotic pressure and its measurement. Determination of molecular weight from osmotic pressure. Elevation of boiling point and depression of freezing point, Thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point. Experimental methods for determining various colligative properties. Abnormal molar mass, degree of dissociation and association of solutes.

##### **Books Suggested:**

1. Physical Chemistry: *Singh, Das and Singh Vol.2 (New Age)*
1. Physical Chemistry: *Kheterpal Vol. 3*
2. Physical Chemistry: *Kushwaha Vol. 3*
3. Physical Chemistry: *Puri and Sharma*
4. Physical Chemistry: *Rastogi, Singh and Nath*
5. Physical Chemistry: *Bahal and Bahal*
6. Physical Chemistry: *Atkin*
7. Physical Chemistry: *Laidler*
8. Physical Chemistry: *Levine*

# Chemistry Paper-IV

## Biological and Industrial Chemistry

Max. Marks – 55

Duration 3 hrs.

### Unit –I : Carbohydrates

Classification and Nomenclature of Monosaccharide, Mechanism of osazone formation, Interconversion of Glucose and Fructose, Chain Lengthening and Chain Shortening of Aldose. Configuration of Monosaccharide, Erythro - Threo Diastereomers, Conversion of Glucose into Mannose, formation of Glycosides, Ethers and Esters. Determination of Ring size of Monosaccharide. Cyclic structure of D (+) Glucose, mechanism of Mutarotation. An introduction to Disaccharides (Maltose, Sucrose and Lactose) (without involving Structure Elucidation).

**Unit-II : Amino-Acids :** Definition, Classification, Preparation and Reactions, Zwitterion, Formal Titration, Isoelectric point, Configuration (D-L Nomenclature)

#### Peptides and Proteins

- a) Peptides and Polypeptides, Geometry of Peptide-Linkage, Peptide Synthesis, Structure Determination of Polypeptides, End group Analysis
- b) Classification of Proteins, Characterization and structure of Proteins (Secondary structure)

### Unit - III

#### Nucleic Acids

- a) Basic components, b) Structure of RNA and DNA, c) Biological significance of Nucleic acid, (d) Replication of DNA

#### Enzymes and Coenzymes

- a) Introduction to Enzymes, Nomenclature, Characteristics, a general picture of Mechanism of Enzyme action.
- b) Enzyme Kinetics, Concentration of Substrates, Concentration of Enzyme. Effect of pH, effect of Temperature, Enzyme Inhibition, Michaelis-Menton equation. Coenzymes, Coenzymes derived from Niacin and Thiamine, Lipoic acid, Coenzyme A

### Unit-IV

#### Dyes

- a) Reaction between Colour and Constitution, Chromophores and Auxochrome, Valence-Bond Theory of Colour
- b) Classification and Nomenclature
- c) Preparation and uses of the following Dyes- Triarylmethane Dyes (Malachite Green, Magenta, Crystal Violet), Xanthene Dyes (Fluorescein, Eosin), Vat- Dyes (Indigo), Anthraquinone Dyes (Alizarin)

### Unit - V

#### Polymers

- a) General idea about Polymers and Polymerization, types of Polymerization
- b) Addition (Chain growth Polymerization, Free-radical Vinyl Polymerization, Ionic- Vinyl Polymerization, Ziegler- Natta Polymerization)
- c) Condensation (step growth) Polymerization, Manufacture and application of following Polymers- Natural and Synthetic Rubber, Plastics (polyolefin's and Polyurethanes), Synthetic fibers: Polyester, Polyamides, Polyacrylates

#### Books Suggested:

1. Organic Chemistry: *I L Finar, Vol. 1 & 2*
2. Organic Chemistry: *Morrison & Boyd*
3. Organic Chemistry: *LG. Wade Jr., (Prentice Hall Publication)*
4. Fundamentals of Organic Chemistry: *Solomons, (John Wiley Publication)*
5. Organic Chemistry: *Vol. 3: Mukherjee, Singh & Kapoor, (Wiley Eastern Ltd.)*
6. Organic Chemistry: *F A Carey, (Mc Graw Hills Publication)*
7. Carbohydrate Chemistry: *Davis & Fairbanks, (Oxford Chemistry Primers, Indian Edition)*

# Chemistry Practical

Maximum Marks-80

Duration -10 hrs

## 1. Inorganic Chemistry

(Marks 25)

- (a) Estimation of hardness of water by EDTA.
- (b) (i) Preparation of copper tetra amine complexes  $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$ .  
(ii) Preparation of Nickeldimethylglyoxime complex  $[\text{Ni}(\text{DMG})_2]$
- (c) Separation of metal ions of group I by paper chromatography

## 2. Organic chemistry

(Marks 30)

- (a) Separation and identification of organic mixture (using water or sodium bicarbonates as a solvent)
- (b) **Preparation**
  - (i) Preparation of acetanilide
  - (ii) Preparation of Benz anilide
  - (iii) Preparation of Metylorange and azo dye, dyeing of silk or wool.

## 3. Physical Chemistry

(Marks 10)

- (i) The relative viscosity of liquid with respect to water at room temperature by Ostwald's viscometer.
- (ii) The relative surface tension of liquid with respect to water at room temperature by Stalagnometer.

## 4. Viva Voce

(Marks 10)

## 5. Record

(Marks 05)

### *Books Suggested*

1. Modern Approach to Practical Chemistry ( Vol.III ): *K.K.Singh and Subhra Singh.*
2. Practical Chemistry: *Bahal, Dubey and Nath.*
3. Practical Chemistry: *Giri, Bajpai and Pandey*
4. Practical Chemistry: *S. N. Srivastava and M.M.N.Tandon*