B.Sc. Chemistry: Semester - I
Basic Chemistry - I
Paper No. – I

Unit I. Atomic Structure & Periodic Properties

Idea of de Broglie matter waves, Heisenberg uncertainty principle, Atomic orbitals, Schrodinger wave equation, significance of ψ and ψ^2, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d orbitals, Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configurations of the elements, effective nuclear charge. Atomic and ionic radii, ionization energy, electron affinity and electronegativity – definition, methods of determination or evaluation, trends in periodic table and applications in predicting and explaining the chemicals behavior.

Unit II. Chemical Bonding

Definition and explanation of ionic bond, factors affecting the formation of ionic bond, Lattice energy and Born-Haber cycle. Polarizing power of ions, Fajan's rule. Covalent bond, Sigma and pi-bond, Valence bond theory of covalent bonding and its limitations, percentage ionic character in covalent bond from dipole moment and electronegativity difference. Weak Interactions-Hydrogen bonding, van der Waals forces. Concept of hybridization in inorganic compounds: Definition and explanation of sp, sp^2, sp^3, dsp^2, hybridization by taking example of $[Ni(CN)_4]^{-2}$, d^2sp^3 hybridization by taking example PCl_5, d^3sp^3 hybridization by taking example IF_7.

MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy.

VSEPR Theory: Postulates, applications in explaining geometry and bond angle in molecules such as CH_4, NH_3, and H_2O. limitations of VSEPR theory.

Unit III: Reaction Mechanism of Organic Molecules

Localised and delocalised bonds, Vander Walls interactions , Inductive & field effects, Charge transfer complexes, Resonance, Hyper-conjugation, Hydrogen bonding Aromaticity.

Curved arrow notation, drawing 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, energy considerations. Reactive intermediated (carbocations, carbanions, free radicals, carbenes with example). Methods of determination of reaction mechanism (product analysis, intermediates).

Unit IV: Gaseous and Liquid states

Gaseous State :Gas Laws, Ideal Gas Equation, Dalton's Law of Partial Pressure, Graham's Law of Diffusion, Postulates of Kinetic Theory of Gases, Kinetic Gas Equation. Deviation from Ideal Behavior: Effect of Temperature and Pressure.

Molecular Velocities: Root Mean Square, Average and Most Probable Velocities. Qualitative Discussion on Maxwell's Distribution of Molecular Velocities. Collision Properties: Collision Number, Mean Free Path, Collision Diameter and Collision Frequency. Liquefaction of Gases (based on Joule - Thomson effect).

Critical Phenomena: PV Isotherms of Real Gases, Continuity of States, van der Walls Equation, Isotherms of van der Waals Equation, Relationship between Critical Constants and van der Waals Constants.

Liquid State: Structure of Liquids (a qualitative description), Intermolecular Forces, Structural Differences between Solids, Liquids and Gases. Vapour pressure-Temperature Diagrams

Books suggested:

1. Inorganic Chemistry by A. G. Sharp.
2. Concise Inorganic Chemistry - J.D.Lee
3. A Guidebook to Mechanism in Organic Chemistry, 6th Edition Peter Sykes
4. Advanced Organic Chemistry – Bahl & Bahl.
5. Essentials of Physical Chemistry, B.S. Bahl, G.D.Tuli and Arun Bahl, S. Chand & Company Ltd.
6. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.

B.Sc. Chemistry: Semester - I
Inorganic Chemistry - I
Paper No. - II

Unit I: Elements of Group I & II

Chemical properties of the metals: reaction with water, air, nitrogen; Compounds of alkali metals: oxides, hydroxides, peroxides, superoxides-preparation and properties; oxo salts-carbonates, bicarbonates, nitrates; halides and polyhalides; anomalous behavior of Li.

Alkaline earth metals: Comparative study of these elements with special reference to their d-hydrides, oxides, hydroxide and halides. Diagonal relationship, salvation and complexation tendencies, crown ethers.

Complexes of *s*-block metals, complexes with crown ethers, uses of *s*-block metals and their compounds, biological importance. organometallic compounds of Be.

Unit II: Group III (13) Elements

Comparative study of physical and chemical properties of these elements with special refrence to their oxides, hydrides, halides and nitirides. Preparation and properties of boric acids (ortho & meta boric acids) and borax, borax bead test. Study of hydrides formed by boron, structure and bonding in diboranes, an idea of three center-two electron bon in the light of molecular orbital theory, borazine, borohydrides.

Unit III: Group IV (14) Elements

Comparative study of physical and chemicals properties of these elements with special references to their oxides, hydrides, nitrides, sulphides and carbides, fluorocarbons, study of silicates (structural aspects only) organosilicon compounds and silicones. Allotropy, inert pair effect, metallic and non-metallic character, catenation.

Unit IV: Group V (15) Elements

Comparative study of the physical and chemical properties of these elements with special reference to their hydrides, oxides, halodes, oxyhalides and sulphides, Oxoacids of nitrogen: nitrous acid, nitric acid, hyponitrous acid, hydrazoic acid, pernitric acid; oxoacids of phosphorus-orthophosphorous acid, metaphosphorous acid, hypophosphorous acid; orthophosphoric acid, di-, tri-, and tetrapolyphosphoric acids.

Books suggested:

1. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson & P.L. Gaus.
2. Concise Inorganic Chemistry by J.D. Lee.

3. Inorganic Chemistry by W.W. Portfield.
4. Inorganic Chemistry by D.E. Shriuer, P.W. Atkins and C.H. Longford.
5. Inorganic Chemistry by A.G. Sharpe.

B.Sc. Chemistry: Semester - I
Inorganic Chemistry Practical

Qualitative Analysis:

Semi micro qualitative analysis of inorganic salt mixtures containing:

Anions: (including interfering radical)
Acetate, sulphite, Nitrate, chloride, bromide and phosphate

Cations:
Group 0 cation: Ammonium
Group I cations: Lead, silver, mercurous.
Group II cations: Lead, mercuric, copper, cadmium, bismuth, antimony, tin.

Book suggested:

1. Vogel's Text Book of Inorganic Qualitative Analysis, 4 th edition, ELBS, London, 1974. .

2. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd edition, The National Publishing Company, Chennai, 1974.

B.Sc. Chemistry: Semester - I
Organic Chemistry Practical

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
   a. Water
   b. Alcohol
   c. Alcohol-Water
3. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100° C by distillation and capillary method)
6. Chromatography
   a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
   b. Separation of a mixture of two sugars by ascending paper chromatography
   c. Separation of a mixture of o- and p-nitrophenol or o- and p-aminophenol by thin layer chromatography (TLC).

B.Sc. Chemistry: Semester - I
Physical Chemistry Practicals

1. Determination of the viscosity of pure liquids and binary mixtures.
2. Determination of the surface tension of pure liquids and binary mixtures.
3. Refractive index measurement of pure liquids.
4. Determination of Molecular weight of pure liquids by Victor Meyer method.
5. Solubility curve of benzoic acid in water.

BOOKS SUGGESTED:

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.
2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

B.Sc. Chemistry: Semester – II
Basic Chemistry - II
Paper No. - III

Unit I: Acid-Base Theory and Oxidation-Reduction reactions

Introduction: Definition of acids and bases according to Arrhenius, Bronsted and Lowery and Lewis
Other theories: Solvents system concept for acids and bases, Lux-Flood concept for acids and bases and their limitations.

Hard and soft acids and bases: Definition (Pearson's Concept), Bonding in hard-hard and soft-soft combination, HSAB principle.

Oxidation and reduction: Oxidation-reduction reactions, oxidation state, rules for the determination of oxidation states.

Unit II: Stereochemistry of organic compounds

Concept of isomerism, types of isomerism.
Optical isomers, elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diasteriomers, threo and erythro diasteriomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

Absolute configuration of molecules, sequence rules, D and L, R and S systems of nomenclature. Geometrical isomerism- determination of geometric isomers, E and Z systems of nomenclature.

Conformational isomerism- Conformational analysis of ethane and n- butane, conformation of cyclohexane, axial and equatorial bonds, conformation of Monosubstituted cyclohexane derivatives. Newmann projection and saw horse formulae, Fischer and flying wedge formula. Difference between configuration and conformation.

Unit III: Chemical Kinetics

Chemical Kinetics and its Scope, Rate of a Reaction, Rate Laws, Factors Influencing the Rate of Reaction: Concentration, Temperature, Pressure, Catalyst. Rate Constant, Elementary and Complex Reactions, Molecularity, Order of Reactions, Concentration and Temperature Dependence of Rates, Mathematical Characteristics of Simple Chemical Reactions - Zero Order, First Order, Second Order, Pseudo Order, and their Half-life Expressions. Determination of Order of Reaction - Differential Method, Method of Integration, Half-life Method and Isolation Method. Theories of Reaction Rates: Collision Theory of Reaction Rates, Arrhenius Equation, Absolute Reaction Rate Theory, Lindemann Theory of Unimolecular Reactions.

Unit IV: Solid State

Crystalline and Amorphous Solid, Symmetry of Crystal Systems, Space Lattice and Unit Cell, Summary of Crystal Systems, Packing Fraction, Density of Crystalline Solid, Coordination Number, Number of Atoms in Unit Cell. Reciprocal Lattice and Law of Rational of Indices, Inter-planer Spacing in a Crystal System. X-ray Diffraction, Bragg's Equation. Powder Method, Determination of Grain size/Crystallite size using X-ray Line Broadening Studies (Scherrer's Formula),The Rotating Crystal Method. Determination of Crystal Structure of NaCl and KCI (The Laue Method and Powder Method).

Books Recommended:

1. Inorganic Chemistry by A. G. Sharp.
3. Concise Inorganic Chemistry - J.D.Lee
4. A Guidebook to Mechanism in Organic Chemistry, 6th Edition Peter Sykes
5. Advanced Organic Chemistry – Bahl & Bahl.
6. Essentials of Physical Chemistry, B.S. Bahl, G.D.Tuli and Arun Bahl, S. Chand & Company Ltd.
7. A Text Book of Physical Chemistry, A.S. Negi and S.C. Anand, New Age International Publishers.

B.Sc. Chemistry: Semester - II
Inorganic Chemistry-II
Paper No. - IV

Unit I: Group VI (16) Elements

Comparative study of physical and chemical properties of these elements with special reference to their hydrides, oxides, halides and oxyhalides. Detailed study of oxyacids, peroxyacids and thio-oxyacids of sulphur (with special emphasis on their structure). oxoacids of sulphur-thionic acid series, peroxoacid series, (with special emphasis on their structure and methods of preparation) and allotropy of elements, ozone.

Unit II: Group VII (17) Elements

Comparative study of physical and chemical properties of these elements with special reference to their electron affinity, electronegativity, bond dissociation energy, oxidation number, oxidizing power, reactivity of the elements, hydrides, oxides and oxyacids.

Unit III: Oxyacids and Compounds of Halogens

Detailed study of oxyacids, hypohalous acid HOX, halous acid HXO2, halic oxide HXO3, perhalic acid HXO4, peroxyacids, strength of oxoacids.

Interhalogens, polyhalides ions (with special emphasis on their structures): ClF, ICl; ClF3, BrF3, IF3; ClF5, BrF5, IF5.,oxyhalides

Unit IV: Zero Group-Noble Gases

Position of zero group in the periodic table, history of discovery of noble gases isolation of noble gases, detailed study of the compounds of xenon with fluorine (with special emphasis on their structures and bonding), clathrates.

Books suggested:

1. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson & P.L. Gaus.
2. Concise Inorganic Chemistry by J.D. Lee.
3. Inorganic Chemistry by W.W. Porterfield.
4. Inorganic Chemistry by D.E. Shriuer, P.W. Atkins and C.H. Longford.
5. Inorganic Chemistry by A.G. Sharpe.

B.Sc. Chemistry: Semester - II
Inorganic Chemistry Practical

Qualitative Analysis:

Semi micro qualitative analysis of inorganic salt mixtures containing:

Anions: (including interfering radical)
Sulphide, nitrite, oxalate, iodide and sulphate

Cations:
Group III cations: Aluminium, ferrous, ferric, chromium.
Group IV cations: Cobalt, nickel, manganese, zinc.
Group V cations: Barium, strontium, calcium
Group VI cations: Magnesium,

Book suggested:

1. Vogel's Text Book of Inorganic Qualitative Analysis, 4 th edition, ELBS, London, 1974.

2. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd edition, The National Publishing Company, Chennai, 1974.

B.Sc. Chemistry: Semester-II
Organic Chemistry Practicals

Preparation of the organic compounds based on single stage reaction of the type –Esterification, nitration, reduction, oxidation, acetylation. Suggested compounds: acetanilide, amylacetate, m-dinitrobenzene, aniline.

B.Sc. Chemistry: Semester-II
Physical Chemistry Practicals

Chemical Kinetics

1. To determine the specific reaction rate of the hydrolysis of methyl acetate / ethyl acetate catalysed by hydrogen ions at room temperature..

2. To study the effect of acid strength on the hydrolysis of an ester.

3. To compare the strengths of HCl and H_2SO_4 by studyng the kinetics of hydrolysis of ethylacetate..

4. To study the kinetics of the reaction between Iodide and persulphate by inial rate method.

5. To study the kinetics of the saponification of ethylacetate by integrated rate method.

Colloids

1. To prepare arsenious sulphide sol and compare the precipitating power of mono- , bi- and trivalent ions.

2. Use of computational tools to plot and analyze data.

3. Any other experiment(s) introduced during the year.

BOOKS SUGGESTED

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.

2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

B.Sc. Chemistry: Semester-III
PHYSICAL CHEMISTRY
Paper No. - V

Unit I: Thermodynamics – I

Definitions: system, surroundings, intensive and extensive properties, thermodynamic processes, state and path functions.

First law of thermodynamics: statement, internal energy, reversible work of expansion, heat change at constant volume and constant pressure, enthalpy, energy as a function of T and V, enthalpy as a function of T and P, Joule experiment, Joule- Thomson experiment and coefficient, heat capacities, relation between Cp and Cv, important thermodynamic relations, isothermal adiabatic expansion of ideal gas, calculation of ΔE, ΔH, q , and w, comparison of w_{rev} and w_{irrev}, Carnot theorem and Carnot cycle and its efficiency.

Unit II: Thermochemistry

Exothermic and endothermic reactions, standard states, relation between heat of reaction at contant volume (q_v) and at contant pressure (q_p), laws of thermochemistry, enthalpy of formation, integral heat of solution and dilution, bond dissociation energy, bond energy and its calculation, Kirchhoff's equation

Unit III: Thermodynamics - II

Spontaneous process, statements of second law of thermodynamics, concept of entropy, mathematical treatment, energy as a function of S and V, enthalpy as a function of S and P, entropy change for isolated systems, thermodynamic equation of states, entropy change in phase transitions, entropy change for reversible expansion of ideal gas, entropy change on heating or cooling of a substance, reversible adiabatic changes, entropy as a criteria of spontaneity and equilibrium, third law of thermodynamics, Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data.

Books Suggested:

1. An Introduction to Chemical Thermodynamics
   R.P. Rastogi and R. R. Mishra

2. Principles of Physical Chemistry
   S. H. Maron and C. F. Prutton

B.Sc. Chemistry: Semester – III
ORGANIC CHEMISTRY
PAPER-VI

Unit-I: Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, Classification of carbon atoms in alkanes. Isomerism in alkanes, sources,methods of formation (with special reference to wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids, physical properties and chemical reactions of alkanes.

Mechanism of free radical halogenations of alkanes: orientation, reactivity and selectivity. Cycloalkanes- nomenclature, methods of formation, chemical reactions,Baeyer's strain theory and its limitations. Ring strain in small rings(cyclopropane and cyclobutane) , theory of strainless rings. The case of cyclopropane ring: banana bonds.

Unit-II : Alkenes, Alkynes and Conjugated unsaturated systems

Nomenclature of alkenes, Methods of formation- Mechanism of dehydration of alcohols and dehydrogenation of alkyl halides, regioselectivity in alcohol dehydration. Saytzeff rule, Hoffmann elimination, physical properties and relative stability of alkenes. Chemical reactions of alkenes- mechanism involved in hydrogenation, electrophillic and free radical additions. Markonikoff's rule, hydroboration- oxidation, oxymercuration- reduction, epoxidation, ozonolysis, hydration, hydroxylation and oxidation with $KMnO_4$. Polymerization of alkenes. Substitution at the allylic and vinylic position of alkenes.

Nomenclature, structure and bonding in alkynes. Methods of formation, chemical reactions, acidity of alkynes. Mechanisms of electrophillic and nucleophillic addition reactions, hydroboration oxidation, metal- ammonia reductions, oxidation and polymerization.

Unit-III: Arenes and Aromaticity

Nomenclature of benzene derivatives, aromatic nuclear and side chain reactions of benzene. Molecular formula and Kekule structure. Stability and C-C bond lengths of benzene, resonance structure, MO picture.

Aromaticity: The Huckle's rule, aromatic ions.

Aromatic electrophillic substitution – general pattern of the mechanism, role of sigma and π complexes.

Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel craft reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/ para ratio. Side chain reaction of benzene derivatives. Birch reuction.

Unit-IV: Alcohols & Phenols

Classification and nomenclature

Dihydric alcohols-Nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAC)_4$ + HIO_4] and pinacol-pinacolone rearrangement.

Trihydric alcohols- Nomenclature and methods of formation, chemical reactions of glycol.

Nomenclature, structure and bonding of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenol-Electrophilic aromatic substitution, acylation and carboxylation, mechanism of fries rearrangement, claisen rearrangement, Gatterman synthesis, Hauben-Hoesch reaction, Reimer Tiemann reaction.

Books Suggested:

1. Organic Chemistry by Morrison and Boyd.
2. Organic Chemistry by IL Finar, Vol. I and II.
3. Organic Chemistry by Jerry March**.**

B.Sc. Chemistry: Semester - III
Inorganic Chemistry Practical

VOLUMECTRIC ANALYSIS

1. To determine the strength of sodium carbonate and sodium bicarbonate in a solution (use of multiple indicator) using 0.1 N HCl.
2. To determine the percentage of ammonia in a sample of ammonium salt by indirect method using 0.1N- NaOH and 0.1N HCl.
3. To determine the strength of $BaCl_2$ in the given solution provided 1N Na_2CO_3 and using 0.1N HCl.
4. To determine the strength of a given solution of $KMnO_4$ using 0.1N oxalic acid.
5. To determine the strength of a given solution of $FeSO_4$ using 0.1N $KMnO_4$.
6. To determine the strength of ferrous and ferric ions in a solution constraining both, using 0.1 $KMnO_4$.

B.Sc. Chemistry: Semester-III
Organic Chemistry Practical

1. Benzolyation of one of the following compounds: amines (aniline, o-,m-,p- toluidines and o-,m-,p- anisidine) and phenols (β-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction

2. Hydrolysis of amides and esters to obtain benzoic acid

3. Derivatives of the carbonyl compounds:
   - 2,4-DNP of one the following compounds- acetone, ethyl methyl ketone, di-ethylketone, cyclohexanone
   - semicarbazone of one the following compounds- acetone, ethyl methyl ketone, di-ethyl ketone, cyclohexanone
   - oxime of one the following compounds- di-ethyl ketone, cyclohexanone

B.Sc. Chemistry: Semester-III
Physical Chemistry Practical

Thermochemistry

1. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.

2. To determine the enthalpy of neutralization of a weak acid / weal base versus strong base/ strong acid and determine the enthalpy of ionisation of the weak acid / weak base.

3. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born Haber Cycle.

4. Determination of basicity/acidity of a polybasic acid / polyacidic base.

5. Any other experiment(s) introduced during the year.

BOOKS SUGGESTED

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.

2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

B.Sc. Chemistry: Semester - IV
PHYSICAL CHEMISTRY
PAPER - VII

Unit I: Free Energy Functions:

Purpose of new functions, Helmholtz free energy, A, variation of A with T at constant V, Gibbs free energy, G, variation of G with P at constant T, relation between A and G, temperature-dependence of G (Gibbs – Helmholtz equation), ΔA and ΔG of the system and ΔS of universe, criteria for equilibrium at constant T and V, and at constant T and P, spontaneity and relative values of ΔH and $T\Delta S$, coupled reactions.

Unit II: Electrochemistry- I:

Electrical transport - conduction in metals and in electrolyte solutions, electrolysis, conductance of solutions (conductance, G, conductivity/specific conductance, κ) equivalent and molar conductivities, measurement of conductance, variation of conductivity and and molar conductivity with concentration, Kohlrausch law, Arrhenius theory of electrolyte dissociation and its limitations, Ostwald`s dilution law, its uses and limitations, Debye – Huckel – Onsager equation for strong electrolytes (only introductory treatment), transport number, its determination by Hittorf and moving boundary methods, applications of conductivity measurements: determination of degree of dissociation, K_0 of acids, solubility product of a sparingly soluble salt, conductometric titrations.

Unit III: Electrochemistry – II:

Electrolytic and Galvanic cells, reversible and irreversible cells, conventional representation of electrochemical cells, electromotive force and its measurement, electrical and electrochemical potentials, Nernst equation, types of half-cells and their reactions (gas-ion half cells, metal-metal ion half cells, metal- insoluble salt – anion half-cell, oxidation reduction half-cell, electrochemical series, calculation of cell e.m.f., thermodynamic quatities of cell reactions (ΔG, ΔH, and ΔS), reference electrodes, glass electrode, calomel electrode, determination of equilibrium constant, determination of pH of a solution, potentiometric titration.

Concentration cells: Electrode concentration cells without transference, electrolyte concentration cells without transference, concentration cells with transference, liquid junction potential.

Books Suggested:

1. An Introduction to Chemical Thermodynamics, R.P.Rastogi and R.R. Mishra.
2. Principles of Physical Chemistry, S.H. Maron and C.F. Prutton.
3. A Textbook of Physical Chemistry, K.L.Kapoor, Vol. I and III.

B.Sc. Chemistry: Semester – IV
ORGANIC CHEMISTRY
Paper No. -VIII

Unit I: Ethers & Epoxides

Nomenclature of ethers and methods of their formation, physical properties. Chemical reactions-Cleavage and autoxidation, Ziesal's method.

Synthesis of epoxides. Acid and base catalysed ring opening of epoxides, orientation of epoxide ring opening, reactions of grignards and organolithium reagents with epoxides.

Unit II: Aldehydes and ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes from acid chlorodes, synthesis of aldehyde and ketones using 1,3-dithiones, synthesis of ketones from nitriles and from carboxylic acids. Physical properties, Mechanism of nucleophilic addition to carbonyl group with spectral emphasis on Benzoin, Aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives.

Use of acetals as protective group. Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizaro reaction, Clemmensen, Wolff Kishner, $LiAlH_4$ and $NaBH_4$ reduction. Halogenation of enolizable ketones. An introduction of α,β unsaturated aldehydes and ketones.

Unit III: Carboxylic acids

Nomenclature, structure and bonding, physical properties, acidity, effects of substituents on acidic strength. Preparation and reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation. Preparation and reactions of halocarboxylic acids, malic, tartaric and citric acids.

Unit IV: Organic compounds of nitrogen

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophillic substitution in nitroarenes and their reduction in acidic, neutral and alkaline media. Picric acid.

Structure and nomenclature of amines, stereochemistry of amines, separation of a mixture of primary, secondary and tertiary amines and structural features effecting basicity of amines, preparation of alkyl and aryl amines by reduction of nitrocompounds and nitriles, reductive amination of aldehydes and ketones, Gabreil phthalimide reaction, Hoffmann bromamide reaction.

Reaction of amines, electrophillic aromatic substitution in aryl amines. Reactions of amines with nitrous acid, synthetic transformations of aryl diazzonium salts, azocoupling.

Books Suggested:

1. Organic Chemistry by Morrison and Boyd.
2. Organic Chemistry by IL Finar, Vol I and II.
3. Organic Chemistry by FA Carry.
4. Organic Chemistry by LG Wade Jr.

B.Sc. Chemistry: Semester IV
Inorganic Chemistry Practical

VOLUMECTRIC ANALYSIS

1. To determine the strength of hydrogen peroxide in aqueous solution using 0.1N $KMnO_4$.
2. To determine the strength of a given solution of ferrous ammonium sulphate using 0.1N $K_2Cr_2O_7$.
3. To standardize a given hypo solution with 0.1N $K_2Cr_2O_7$.
4. To determine the strength of a given solution of $CuSO_4$ using 0.1N hypo solution.
5. To determine the percentage of available chlorine in bleaching powder using 0.1N hypo solution.
6. To determine the strength of given solution of I_2 using arsenious oxide solution.

B.Sc. Chemistry: Semester-IV
Organic Chemistry Practical

1. Nitration of one the following compounds: nitrobenzene, chlorobenzene, bromobenzene

2. Oxidation of the following compounds: benzaldehyde, benzyl alcohol acetophenone to benzoic acid (by iodoform reaction)

B.Sc. Chemistry: Semester-IV
Physical Chemistry Practical

Potentiometry

1. Perform the following acid – base potentiometric titrations (at least two):

   (i) Strong acid with Strong base,
   (ii) Weak acid with strong base (also determine the pKa value of the acid)
   (iii) Dibasic acid with strong base

2. To titrate potentiometrically the given ferrous ammonium sulphate (Mohr's salt) solution using $KMnO_4/K_2Cr_2O_7$ as titrant and calculate the redox potential of Fe^{2+} / Fe^{3+} system on the hydrogen scale.

Conductance

1. To study changes in conductances during titration with strong alkali in the following systems:

   (i) Strong acid

(ii) Weak acid, and
(i) Mixture of strong acid and weak acid

2. To study the saponification of ethyl acetate conductometrically.

3. To determine the ionization constant of a weak acid conductometrically

4. Any other experiment(s) introduced during the year.

BOOKS SUGGESTED

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.

2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

B.Sc. Chemistry: Semester – V
Inorganic Chemistry
Paper No. - IX

Unit I: Chemistry of Elements of First Transition Series

Characteristics of d-block elements with special reference to electronic configuration, oxidation states, variable valency, metallic character, colour, magnetic properties, catalytic properties and ability to form complexes, their binary compounds and complexes illustrating relative stability of their oxidation states, Coordination number and Geometry.

Unit II: Chemistry of Elements of Second and Third Transition Series.

General Characteristics, Comparative treatment with their 3d analogues in respect of ionic radii, Oxidation States, Magnetic behavior, Spectral properties and Stereochemistry. Comparison of the properties of second and third transition series with first transition series.

Unit III: Coordination Compounds

Introduction, double salt and co-ordination compounds, – Werner's Co-ordination theory, Nomenclature, Isomerism, types of ligands, Werner's theory, EAN rule. Modern theories of M-L bond, valence bond theory, hybridization in tetrahedral, square planar and octahedral complexes,

Unit IV: Metal-Ligand Bonding in Transition Metal Complexes.

Valence bond theory of 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. Structural, Magnetic and Thermodynamics properties form crystal field splitting. Jahn-Teller Effect.

Books suggested:

1. F. A. Cotton, G. Wilkinson, C. Murillo and M. Bochman, Advanced Inorganic Chemistry, 6th ed., John Wiley, New York, 1999.
2. T. Moeller, Inorganic Chemistry: A Modern Introduction, Wiley, New York, 1990.
3. J. D. Lee, Concise Inorganic Chemistry, 5th ed., Blackwell Science, London, 1996

B.Sc. Chemistry: Semester - V
Organic Chemistry
Paper No. - X

Unit I: Heterocyclic Compounds

Molecular orbital picture and aromatic characteristic of pyrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions. Mechanism of nucleophillic substitution in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrole.

Unit II: Carbohydrates

Classification and nomenclature. Monosaccharides. Configuration of monosaccharides. Interconversion of glucose and fructose. Ascending and descending of aldoses. Determination of ring size of monosaccharides. Cyclic structure of D(+) glucose. Mutarotation. Disacharides (Maltose, sucrose, lactose) and polysaccharides without involving structure determination.

Unit III: Amino acids, proteins and nucleic acids

Classification, structure and stereochemistry of aminoacids. Preparation and reactions of amino acids. Structure and nomenclature of peptides and proteins.

Unit IV: Proteins and Nucleic acids

Classification of proteins, protein Denaturation and renaturation.

Nucleic acids: Introduction and constitution of nucleic acids, ribonucleosides and ribonucleotides. The double helical structure of DNA.

Books Suggested:

1. Organic Chemistry by Morrison and Boyd.
2. Organic Chemistry by IL Finar, Vol. I and II.
3. Organic Chemistry by FA Carry.
4. Spectroscopy by Dyer.
5. Organic Chemistry, Vol. I, II and III by SM Mukherji, SP Singh and RP Kapoor.
6. Polymer Chemistry: A Practical Approach by Fred J. Davis.

B.Sc. Chemistry: Semester-V
Physical Chemistry
Paper No. -XI

Unit I: Adsorption and Catalysis

Adsorption and heat of adsorption, factors effecting adsorption, physical and chemical adsorption, types of adsorption isotherms, effect of catalyst on activation energy of a reaction, homogeneous and heterogeneous catalysis, promoters, inhibitors autocatalysis, enzyme catalysis, theories of catalysis. Mechanism and kinetics of enzymn and micellar catalysed reactions. Michaelis-Menten equation. Catalysis characteristics of catalyze reactions classification of catalysis, miscellaneous examples.

Unit II: Solution and Colligative properties

Ideal and non-ideal solutions, methods of expressing concentrations of solutions, activity and activity coefficient.

Dilute solution, colligative properties, Raoults law, relative lowering of vapour pressure, molecular weight determination. Osmosis, Law of osmotic pressure 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. Abnormal molar mass, degree of dissociation and association of solutes.

Unit III: 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, quantum yield, photosensitized reactions – energy transfer processes. Kinetics of hydrogen-chlorine reaction.

Books Suggested:

1. Elements of Physical Chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
2. A Textbook of Physical Chemistry, K L Kapoor
3. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.

B.Sc. Chemistry: Semester - V
Inorganic Chemistry Practical

1. **SYNTHESIS AND ANALYSIS**
   a) Preparation of Ni DMG Complex [Ni(DMG)].
   b) Preparation of Cis and Trans potassium bisoxalatodiaquachromate(III).
   c) Preparation of coppertetraammine complex, $[Cu(NH_3)_4SO_4]$.
   d) Preparation of Copper(I)tetraiodomercurate(II)- determination of the transition temperature between red and black forms by melting point apparatus.

2. **GRAVIMETRIC ANALYSIS**
   a) Determination of Al as Aluminium 8–dehydroxyquinolate
   b) Determination of SO_4^{2-} ion as barium sulphate.

B.Sc. Chemistry: Semester-V
Organic Chemistry Practical

Identification of organic compounds based on functiona tests and using melting and boiling point determinations, methyl alcohol, ethyl alcohol, glycerol, formaldehyde, acetaldehyde, acetone, formic acid, succinic acid, glucose, sucrose, chloroform, chloral, urea, benzaldehyde, phenol, nitrobenzene, benzoic acid, phthalic acid, benzene.

B.Sc. Chemistry: Semester-V
Physical Chemistry Practical

1. Adsorption of acetic acid / oxalic acid on charcoal.

2. Determination of molar mass of a non-volatile solute by Rast method, Beckmann freezing point method.

3. To verify Beer-Lambert law for $KMnO_4$ / $K_2Cr_2O_7$ and determine the concentration of the given substance.

4. To determine the pK_a value of an indicator for phenopthalein or methyl red colorimetrically.

5. To determine the specific rotation of a given optically active compound using Polarimeter.

6. Any other experiment(s) introduced during the year.

BOOKS SUGGESTED

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.

2. 2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

B. Sc. Chemistry: Semester – VI
Inorganic Chemistry
Paper-XII

Unit I. Bio-Inorganic Chemistry

Metallo-proteins, biomaterials, biological roles of Cr, Fe, Co, Cu, Zn (mention of metal containing proteins and enzymes and their biological roles). Essential and Trace Elements in Biological Processes, Metalloporphyrins with special refrence to Haemoglobin and Myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{++}.

UNIT-II : Water treatment

Sources of water. Hardness of water-temporary or carbonate hardness, permanent hardness or non-carbonate hardness. Units of hardness, disadvantages of hard water – In domestic, in industry and in steam generation in boilers. Effect of iron and manganese in water. Estimation of hardness – EDTA method – Estimation of total hardness – O. Hehner's method or alkali titration method.

Unit III. Inorganic Polymers

Inorganic polymers – general properties, comparison with organic polymers, glass transition temperature. Sulphur based polymers – polymeric sulphur nitride and chalcogenic glasses (preparation, properties and uses). Silicon based polymers – silicones and silicone rubber (preparation, properties and uses).

Unit IV. Environmental Chemistry

Pollution: Air pollution - Acid rain. Green house effect (global warming), ozone layer depletion - photochemical oxidants. Control of air pollution. Water pollution – heavy metal pollutants, Chemical oxygen demand (COD), Biological oxygen demand (BOD).
*Chemical Toxicology:*Toxicity -effects, toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, Co, NO_x, SO_2 , O_3, PAN, CN, pesticides, carcinogenic substances.

Books suggested:

1. Concise Inorganic Chemistry by J.D. Lee.
2. Concepts and models of Inorganic Chemistry by B. Douglas, D. Mc Daniel and J. Alexander.
3. J. E. Huheey, E. A. Kieter and R. L. Keiter, Inorganic Chemistry, 4th ed., Harper Collins, New York, 1993.
4. Environmental chemistry 2nd ed.; Wiley eastern Ltd., 1987. by De, a. k.
5. Basic Inorganic Chemistry by F.A. Cotton, G. Wilkinson and P.L. Gauss.

B.Sc. Chemistry: Semester - VI
Organic Chemistry
Paper No. - XIII

Unit I: Fats, oils and detergents

Natural fat, edible and individual oils of vegetable origin, common fatty acids. Hydrogenation of oils, saponification value, oil value and acid value. Soaps, synthetic detergents, alkyl and aryl sulphonates.

Unit II: Synthetic dyes

Colour and constitution (electronic theory), classification of dyes. Chemistry and synthesis of methyl orange, congo red, malachite, green, crystal white, phenolphthalein, alizarin and indigo.

Unit III: Synthetic polymers

Polymers and their types. Condensation polymerization, polyesters, polyamides, phenol-formaldehyde resins, epoxy resins, urea formaldehyde resins.

Unit IV: Spectroscopy

UV absorption spectroscopy, Beer- Lambert Law. Types of electronic transitions. Effect of conjugation, concept of chromophores and auxochrome. UV spectra of conjugated polyenes.

IR- Absorption spectroscopy. Molecular vibrations, Hook's law. Intensity and position of IR bands, measurement of IR spectrum, finger print region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

Books Suggested:

1. Organic Chemistry by Morrison and Boyd.
2. Organic Chemistry by IL Finar, Vol. I and II.
3. Organic Chemistry by FA Carry.
4. Applications of absorption spectroscopy of organic compounds by John Robert DyerDyer.
5. Organic Chemistry, Vol. I, II and III by SM Mukherji, SP Singh and RP Kapoor.
6. Polymer Chemistry: A Practical Approach by Fred J. Davis.

B.Sc. Chemistry: Semester-VI
Physical Chemistry
Paper No. -XIV

Unit I: Phase Equilibrium

Statement and meaning of the terms – phase component and degree of freedom , derivation of Gibbs phase rule, phase equilibria of one component system – water, CO_2 and S systems.
Phase equilibria of two component system – solid liquid equilibriums, simple eutectic
Bi-Cd and Pb-Ag system.

Solid solutions – compound formation with congruent melting point (Mg-Zn) and incongruent melting point, (NaCl-H_2O) $FeCl_3$-H_2O) and ($CuSO_4$-H_2O) system,

Liquid- liquid mixtures – ideal liquid mixtures, Raoults and Henry's law. Non – ideal system azeotropes (HCl-H_2O) and ethanol- water systems.

Unit II: Chemical equilibria

Formulation of equilibrium law, equilibrium law for ideal gases, interpretation of ΔG^0, free energy change in a chemical reaction, chemical affinity and thermodynamic functions, equilibrium constants for ideal gas reactions, relation between Kp and Kc and Kx, change of K with the form of equaltion, calculation of K from ΔG^0 , variation of equilibrium constant with temperature and pressure, effect of inert gas on reaction equilibrium , Le – Chatelier's principle , free energy of mixing and spontaneity of reactions, equilibria between gases and solids, equilibrium constant for a system of real gases, equilibrium constant of reactions in solution.

Unit III: Ionic equilibria

Acids and Bases Arrhenius concept, Proton transfer theory, Lewis concept.

Dissociation constants of weak acids and weak bases. Ionic product of water. The pH scale, Buffer solutions Calculations of pH values of buffer mixtures, Henderson equation.

Hydrolysis of salts, Hydrolysis constant, Relation between K_h, K_a and K_b. Degree of hydrolysis. Solubility product Applications of solubility product principle.

Books Suggested:

1. Elements of Physical Chemistry by B.R. Puri, L.R. Sharma, M.S. Pathania
2. A Textbook of Physical Chemistry, K L Kapoor
3. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.

B.Sc. Chemistry: Semester VI
Inorganic Chemistry Practical

1. **INSTRUMENTAL ANALYSIS**

   a) Composition of iron(III)Salicilic acid complex ion in solution by job's method.
   b) Adultration-Food Stuffs

2. **Water analysis**- pH, alkalinity, dissolved oxygen available chlorine, Hardness of water.

3. Estimation of nitrogen in the fertilizer.

4. Estimation of phosphate in a superphosphate sample.

B.Sc. Chemistry: Semester-VI
Organic Chemistry Practical

Organic Preparations

1. Diels-Alder reaction between anthracene and maleic anhydride

2. Reduction: nitrobenzene to azobenzene (TLC of the mixture), m-dinitrobenzene to m-nitroaniline

3. S-benzylisothiuranum salts of any one water soluble and one water insoluble acid: acetic acid, phenyl acetic acid, oxalic acid, benzoic acid, phthalic acid

B.Sc. Chemistry: Semester-VI
Physical Chemistry Practical

Phase Equilibrium

1. Determination of partition coefficient of iodine between water and carbon tetrachloride or toluene or chloroform.

2. Determination of partition coefficient of Benzoic acid between water and toluene.

3. Study the equilibrium of at least one of the following reactions by distribution method:

   (i) $I_2(aq) + I^-(aq) \Leftrightarrow I_3^-(aq)$

   (ii) $Cu^{2+}(aq) + nNH_3(aq) \Leftrightarrow [Cu(NH_3)_n]^{2+}(aq)$

4. To construct the phase diagram of two component (e.g. diphenyl amine – benzophenone, Naphthalene-Benzoic Acid)) system by cooling curve method.

5. To Study the effect of a solute (e.g. NaCl, Succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system.

6. Any other experiment(s) introduced during the year.

BOOKS SUGGESTED

1. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.

2. Experiments in Physical Chemistry, R.C. Das and B. Behra – Tata McGraw Hill.

B.Sc. Chemistry Course Structure