

B.Sc. (Subs.) Chemistry: Semester - I
General Chemistry - I
Paper No. – I

Unit I: Chemical Bonding

Overlapping of orbital, homo and heterodiatomic molecules, types of bonds: ionic, covalent, coordinate, Metallic and hydrogen bonding, Valence bond theory of covalent bonding and its limitations, Hybridization and hybrid orbitals, resonance, Shapes of molecular orbitals, Born-Haber cycle and lattice energy.

Unit II: Synthetic Polymers

Classification of polymers, addition and condensation polymerization, natural and synthetic polymers, physical and chemical properties of thermosetting and thermoplastic polymers, synthesis and properties of PVC, Nylon, Bakelite and Rubber.

Unit III: Ionic Solids

Crystalline and Amorphous Solid, Symmetry of Crystal Systems, Space Lattice and Unit Cell, Summary of Crystal Systems, Structures of ionic solid crystals, radius ratio rule, closed packing, ionic compounds of type AX (NaCl, CsCl, ZnS), AX₂ Calcium fluorite, antiferite and rutile structure, Stoichiometric defects- Schottky and Frankel defects.

Unit IV: Solutions

Types of solutions, normality molarity, molality, mole fraction, Raoult's law, ideal, non-ideal and colloidal solutions, phase rule, phase diagrams of one component systems (water and sulphur); *two component systems*: partially miscible liquids, consolute solution temperature-UCST and LCST.

Books recommended

1. Concise Inorganic Chemistry by J. D. Lee
2. Inorganic Chemistry by Puri and Sharma
3. Modern ceramic engineering by David W. Richerson
4. Principle of Physical Chemistry by Puri, Sharma and Pathania.
5. Textbook of Polymer Science, Fred W. Billmeyer Jr.

B.Sc. (Subs.) Chemistry: Semester - I
Organic Chemistry - I
Paper No. II

Unit I: Isomerism

Isomerism and its types, Stereoisomerism of maleic and fumaric acid. Criteria of geometrical isomerism. Effects of geometrical isomerism of physical and chemical properties of molecules. Chirality and optical isomerism. Criteria for optical isomerism. Optical isomerism of lactic and tartaric acids. Enantiomers and diastereomers. Resolution, racemization and Walden inversion.

Unit II: Reaction mechanism

Some basic concepts; inductive effect, electromeric effect, resonance and hyperconjugation. Reaction intermediates; electrophiles, nucleophiles, carbocations, carbanions and free radicals. Mechanism of electrophilic addition to $>C=C<$ (Markovnikov's addition and Kharasch effect) and nucleophilic substitution to saturated carbon atom. Elimination reactions of alcohols and alkyl halides (Saytzeff's rule). Mechanism of electrophilic substitution of aromatic compounds.

Unit III: Synthetic reagents

Grignard reagent; Preparation, structure and synthetic applications. Acetoacetic ester: Preparation, structure and synthetic applications. Preparation, structure and synthetic applications of malonic ester and diazonium chloride.

Unit IV: Alkenes, Alkynes and Alkyl Halides

Nomenclature of alkenes, methods of formation of, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hoffman elimination, physical properties and relative stabilities of alkenes.

Chemical reactions of alkenes- mechanisms involved in hydrogenation, electrophilic and free radicals, Markovnikov's rule, hydroboration-oxidation, oxymercuration-reduction, Epoxidation, Ozonolysis, hydration, hydroxylation, oxidation with $KMnO_4$. Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene.

Methods of formation, conformation and chemical reactions of cycloalkenes.

Nomenclature, structure and bonding in alkynes. Method of formation. Chemical reactions of alkynes, Acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization.

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nucleophilic substitution reactions of alkyl halides, SN_2 and SN_1 reactions with energy profile diagrams.

Polyhalogen compounds: chloroform, carbon tetrachloride.

Methods of formation of aryl halides, nuclear and side chain reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions.

Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC

Books Recommended:

1. Organic chemistry (Vol.I)- S M Mukherji, S P Sing & R P Kapoor, New Age publishers, New Delhi.
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi
3. Organic Chemistry, Solomons & Fryhle, Wiley Student Edition, New Delhi.
4. Organic chemistry, Morrison & Boyd, Pearson Education, New Delhi.

B.Sc. (Subs.) Chemistry: Semester - I
Chemistry Practicals

1. To prepare standard solution of sodium carbonate and determine the percentage of given NaOH and KOH mixture solution (2.5 g/liter) by using HCl solution.
2. To prepare standard solution of potassium dichromate and find out the strength of given potassium dichromate solution using sodium thiosulphate (Hypo solution) as an intermediate.
3. To prepare standard solution of potassium permanganate and find out the strength of given potassium permanganate solution using sodium thiosulphate (Hypo solution) as an intermediate.
4. To prepare standard solution of copper(II) sulphate and find out the strength of given copper(II) sulphate solution using sodium thiosulphate (Hypo solution) as an intermediate.
5. To determine the viscosity of pure liquids and binary mixtures by Ostwald viscometer.
6. Determination of the surface tension of pure liquids and binary mixtures.
7. Determination of partition coefficient of iodine between water and carbon tetrachloride or toluene or chloroform.
8. Determination of partition coefficient of Benzoic acid between water and toluene.

BOOKS SUGGESTED:

1. Practical Chemistry, OP Pandey, DN Bajpai, S. Giri, S. Chand & Company Ltd., 2008.
2. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.
3. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd edition, The National Publishing Company, Chennai, 1974.

B.Sc. (Subs.) Chemistry: Semester - II
General Chemistry - II
Paper No. III

Unit I: Electrochemistry

Electrochemical cells, western standard Cadmium cell, electromotive force (EMF), Nernst equation, electrochemical series, Batteries; Primary, Alkaline, Ni-Cd, Solar batteries, Fuel cells, Lead Acid Storage cell, electrochemical sensors.

Unit II: Corrosion and its control

Corrosion, Rusting, Chemical and electrochemical corrosion, methods for corrosion control, surface treatment, protective coatings and their applications, primers, commercial paints, Failure of paints and coatings, Enamels.

Unit III: Nuclear chemistry

Introduction, isotopes, isobars, isotones, isoelectrons, modes of decay, nuclear fission and nuclear fusion, nuclear reactions- artificial transmutation, radioactive disintegrations, half life period, rock dating and carbon dating.

Unit IV: Ceramic materials

Introduction, Physical properties of ceramics: porosity, density, melting Temperature thermal conductivity. Mechanical properties; elasticity and strength. Time, temperature and environmental effects on properties. Raw material selection criteria. Powder sizing techniques. Additives in ceramics and their functions. Shape forming process.

Books recommended

1. Concise Inorganic Chemistry by J. D. Lee.
2. Inorganic Chemistry by Puri and Sharma.
3. Modern ceramic engineering by David W. Richerson.
4. Principle of Physical Chemistry by Puri, Sharma and Pathania.

B.Sc. (Subs.) Chemistry: Semester – II
Organic Chemistry - II
Paper No. IV

Unit I: Arenes and Aromatic Electrophilic Substitution

Aromatic electrophilic substitution –general pattern of mechanism, role of sigma and pi complexes. Mechanism of nitration, halogenations, Sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of Benzene derivatives. Birch reduction.

Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

Unit II: Phenols

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.

Unit III: Ethers and Epoxides

A. Nomenclature of ethers and methods of their formation, Physical properties. Chemical reactions- Cleavage and autoxidation, Ziesel's method.

B. Synthesis of epoxides. Acids and base catalysed ring opening, reaction of Grignards and organolithium reagents with epoxides.

Unit IV: Introduction to Spectroscopy (UV-Vis and IR)

Beer-Lambert law. Working of UV-Vis spectrophotometer, principle of absorption of UV-Vis light by organic molecules. Basic terms: Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. Types of electronic transitions. Effect of solvent polarity on electronic transitions. Applications of UV-Vis spectroscopy.

Hook's law, types of molecular vibrations, Degrees of freedom, Working of UV-Vis spectrophotometer. Absorption frequencies of common functional groups, fingerprint region. Identification of molecules on the basis of IR-spectroscopy.

Books Suggested:

1. Organic Chemistry (Vol. I) - S M Mukherji, S P Sing & R P Kapoor, New Age Publishers, New Delhi.
2. Organic Chemistry, I L Finar, Pearson Education, New Delhi.
3. Organic Chemistry, Solomons & Fryhle, Wiley Student Edition, New Delhi.
4. Organic Chemistry, Morrison & Boyd, Pearson Education, New Delhi.
5. Understanding Organic Chemistry, Brown & Foote, Cengage Learning.

B.Sc.(Subs.) Chemistry: Semester - II
Chemistry Practicals

1. To determine the percentage purity of NaHCO_3 in the given solution.
2. To estimate the calcium and magnesium ions in the given water sample by EDTA method.
3. To estimate the iron in the given solution of iron(II) and iron(III) using external indicator.
4. Separation of amino acids by thin layer chromatography.
5. Determination of heat of water of crystallization of BaCO_3 , MgSO_4 .
6. Determination of heat of solution of KNO_3 or NH_4Cl .
7. Determination of heat of vaporization by syringe method.
8. Determination of basicity/acidity of a polybasic acid / polyacidic base.
9. **Qualitative Analysis:**

Semi micro qualitative analysis of inorganic salt mixtures containing:

Anions:

Carbonate, sulphite, nitrate, chloride, iodide, and sulphate, Acetate, Sulphide, oxilate, bromide and sulphate.

Cations:

Ammonium, Lead, mercurous, copper, cadmium, bismuth, antimony, tin, Aluminium, ferrous, ferric, chromium, cobalt, nickel, manganese, zinc, barium, strontium, calcium, Magnesium.

Book suggested:

1. Practical Chemistry, OP Pandey, DN Bajpai, S. Giri, S. Chand & Company Ltd., 2008.
2. Senior Practical Physical Chemistry by B.D. Khosla, V.C. Garg and Adarsh Khosla – R. Chand & Co. Delhi.
3. Vogel's Text Book of Inorganic Qualitative Analysis, 4th edition, ELBS, London, 1974. .
4. V.V. Ramanujam, *Inorganic Semi Micro Qualitative Analysis*, 3rd edition, The National Publishing Company, Chennai, 1974.

B.Sc (Subs.) Chemistry: Semester - III
Inorganic Chemistry: Chemistry of Main Group Elements
Paper No. V

Unit I: Group I & II (1 and 2)

Diagonal relationship, bonding and shapes of hydride, oxides and halides of these elements, periodic trends in size of atoms/ionic, ionization energy, electronegativity, oxidation state.

Unit II: Group III (13)

Diagonal relationship, electronic configuration anomalous behavior of boron, periodic trends in the properties of these elements with respect to atomic/ionic size, ionization energy, electronegativity, oxidation states and reactivity, boric acid and borax.

Unit III: Group IV (14)

Electronic configuration, oxidation states, periodic trends of size of atoms/ions, ionization energy, electronegativity and reactivity, Comparative study of bonding and shape of their oxides, hydrides and halides. Types of silicates and their structure.

Unit IV: Group V (15)

Electronic configuration, periodic trends of size atoms/ions, ionization energy, electronegativity, oxidation states and reactivity. Comparative study of their oxides, hydrides and halides (special emphasis on structure and bonding).

Books suggested:

1. Basic Inorganic Chemistry by F.A.Cotton, G.Wilkinson, and P.L.Gaus.
2. New Concise Inorganic Chemistry by J.D. Lee.
3. Principles of Inorganic Chemistry by B.R. Puri & L.R. Sharma.

B.Sc. (Subs.) Chemistry: Semester-III
Physical Chemistry
Paper No. VI

Unit I: Thermodynamics

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, q , work, w , internal energy U and statement of first law; enthalpy, H , Heat capacity and relation between heat capacities at constant volume and pressure, Joule's law, Joule-Thomson Coefficient and inversion temperature. Calculations of q , w , U and H for reversible expansion of ideal gases under isothermal and adiabatic conditions.

Second Law: Concept of entropy; thermodynamic scale of temperature, different statements of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Free Energy Functions: Gibbs (G) and Helmholtz (A) energy; variation of S , G , A with T , V , P ; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit II: Thermochemistry

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions, Hess's law of heat summation and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Unit III: Chemical Kinetics

Chemical Kinetics and its Scope, Rate of a Reaction, Rate Laws, Rate Constant, Elementary and Complex Reactions, Molecularity, Order of Reactions. Factors Influencing the Rate of Reaction: Concentration, Temperature, Pressure, Catalyst. 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. Steady state principle. Activation Energy, Theories of Reaction Rates: Collision Theory of bimolecular reactions, Arrhenius Equation, Absolute Reaction Rate Theory.

Books Recommended:

1. An Introduction to Chemical Thermodynamics, R P Rastogi, R R Misra.
2. Physical Chemistry by Maron and Prutton.
3. Principle of Physical Chemistry by Puri, Sharma and Pathania.
4. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.

B.Sc. (Subs.) Chemistry: Semester - III
Chemistry Practicals

QUANTITATIVE ANALYSIS: Volumetric Analysis

1. Determination of acetic acid in commercial vinegar using NaOH.
2. Determination of alkali content-antacid tablet using HCl.
3. Estimation of Calcium content in chalk as calcium oxalate by permanganometry
4. Estimation of hardness of water by EDTA.
5. Estimation of ferrous and ferric by dichromate method.
6. Estimation of Cu using $\text{Na}_2\text{S}_2\text{O}_3$.
7. Acid-Base titration on pH meter.

B.Sc. (Subs.) Chemistry: Semester - IV
Inorganic Chemistry
Paper No. VII

Unit I: Group VI (16)

Electronic configuration, periodic trends in size of atoms/ions, ionization energy, electronegativity, oxidation state and reactivity. Comparative study of their oxides, hydrides and halides (special emphasis on structure and bonding).

Unit II: Group VII (17)

Electronic configuration, oxidation state, trends in properties of these elements with respect to size of atom/ion, ionization energy, electronegativity and reactivity. Comparative study of the hydrides and oxides of these elements (structure and bonding), oxyacids of halogens and interhalogens.

Unit III: Transition Elements

Transition Elements: Electronic structure and position in the periodic table. General properties: variable valency, colour, magnetic properties and catalytic role, important uses of transition metals and their alloys; differences between the first and the other rows, horizontal comparison with Fe, Co, Ni groups; toxicity of Cd and Hg.

Unit IV: Coordination Compounds

IUPAC Nomenclature of mononuclear complexes, Types of ligands and chelates Werner's theory of coordination compounds, isomerism (geometrical and optical) in square planar and octahedral complexes. Sidgwick's theory and EAN Principle, Use of coordination compounds in qualitative analysis ($\text{Cu}^{2+}/\text{NH}_3$) and quantitative analysis ($\text{Ni}^{2+}/\text{DMG}$), Hardness of water using EDTA.

Books suggested:

1. Basic Inorganic Chemistry by F.A.Cotton, G.Wilkinson, and P.L.Gaus.
2. New Concise Inorganic Chemistry by J.D. Lee.
3. Principles of Inorganic Chemistry by B.R. Puri & L.R. Sharma

B.Sc. (Subs.) Chemistry: Semester-IV
Physical Chemistry
Paper No. VIII

Unit I: Colloidal State

Introduction and Definition of Colloids, Classification of Colloids – Lyophilic and Lyophobic colloids.

Solids in Liquids (Sols): Preparation of Sols, Optical and Electrical Properties of Sols; electrokinetic potential, electrophoresis, electro osmosis, Stability of Colloids, Protective Action, Hardy-Schulze Rule, Flocculation value, Gold Number.

Liquids in Liquids (Emulsions): Types of Emulsions, Preparation and Properties of Emulsions, Emulsifier.

General Applications of Colloids.

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, Raoult's law, relative lowering of vapour pressure, molecular weight determination. Osmosis, Law of osmotic pressure and 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: Chemical Equilibrium

Reversible and irreversible reactions, Characteristics of chemical equilibrium, 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 K_p and K_c and K_x , variation of equilibrium constant with temperature, pressure and concentration, effect of inert gas on reaction equilibrium, Le – Chatelier's principle, free energy of mixing and spontaneity of reactions, Chemical equilibria applied to homogeneous and heterogeneous reactions.

Books Recommended:

1. Principles of Physical Chemistry by Maron and Prutton.
2. Principle of Physical Chemistry by Puri, Sharma and Pathania.
3. Physical Chemistry, G. M. Barrow, International Student Edition, McGraw Hill.

B.Sc. (Subs.) Chemistry: Semester - IV
Chemistry Practicals

QUANTITATIVE ANALYSIS: Gravimetric Analysis

1. Analysis of Cu as CuSCN.
2. Analysis of Ni as Ni(dimethylglyoxime).
3. Redox titration on potentiometer.
4. To study the kinetics of acid catalysed hydrolysis of ethyl acetate.

Books suggested:

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

B.Sc. (Subsidiary) Chemistry Course Structure

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