

B.Sc. - FIRST YEAR

CHEMISTRY

There shall be three written papers and a practical examination as follows:

		Max. Marks
Paper – I	Inorganic Chemistry	50
Paper – II	Organic Chemistry	50
Paper – III	Physical Chemistry	50
TOTAL		150
PRACTICAL		50
GRAND TOTAL		200

Candidate will be required to pass in Theory and Practical Separately.

B.Sc. – I Chemistry (Paper-I)

Inorganic Chemistry :

Unit – I

I. Atomic Structure:

Idea of de-Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrödinger 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.

II. Periodic Properties:

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 chemical behaviour.

Unit – II

III. Chemical Bonding:

- (A) Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, valence shell electron pair repulsion (VSEPR) theory to NH_3 , H_3O^+ , SF_4 , ClF_3 , ICl_2 and H_2O , MO 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 electro-negativity difference.
- (B) Ionic Solids – Ionic structures, radius ratio effect and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule, Metallic bond-free electron, valence bond and band theories.
- (C) Weak Interactions – Hydrogen bonding, Vander Waals forces.

Unit – III

IV. s-Block Elements:

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

V. Chemistry of Noble Gases:

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

Unit – IV

VI. p-Block Elements:

Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides, oxyacids and halides of group 13-16, hydrides of boron-diborane and higher boranes, borazine, borohydrides, fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetra nitride, basic properties of halogens, interhalogens and polyhalides.

B.Sc. – I Chemistry (Paper-II)

Organic Chemistry :

Unit – I

I. Structure and Bonding:

Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bonding, van der Waals interactions, inclusion compounds, clathrates, charge transfer complexes, resonances, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.

II. Mechanism of Organic Reactions:

Curved arrow notation, drawing electron movements with allows, half-headed and double-headed arrows, homolytic and heterolytic bond fission, Types of reagents – electrophiles and nucleophiles, Types of organic reactions, Energy considerations.

Reactive intermediates – Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning formal charges on intermediates and other ionic species.

Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

III. Alkanes and Cycloalkanes:

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atom 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 halogenation 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 strain less rings. The case of cyclopropane ring, banana bonds.

Unit – II

IV. Stereochemistry of Organic Compounds:

Concept of isomerism, Types of isomerism;

Optical isomerism – elements of symmetry, molecular chirality, enantiomers, stereogenic center, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centers, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomer, inversion, retention and racemization.

Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.

Geometric isomerism – determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

Conformational isomerism – conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives, Newman projection and Sawhorse

formulae, Fischer and flying wedge formulae, Difference between configuration and conformation.

Unit – III

V. Alkenes, Cycloalkenes, Dienes and Alkynes:

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

Chemical reactions 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 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 and classification of dienes : isolated, conjugated and cumulated dienes, Structure of allenes and butadiene, methods of formation, polymerization, chemical reaction – 1, 2 and 1, 4 additions, Diels-Alder reaction. Nomenclature, structure and bonding in alkynes, Methods of formation, Chemical reactions of alkynes, acidity of alkynes, Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization.

Unit – IV

VI. Arenes and Aromaticity:

Nomenclature of benzene derivatives, The aryl group, Aromatic nucleus and side chain, Structure of benzene; molecular formula and Kekulé structure, stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture.

Aromaticity: The Hückle rule, aromatic ions.

Aromatic electrophilic substitution – general pattern of the mechanism, role of σ and π complexes, Mechanism of nitration, halogenation, 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, naphthalene and Anthracene;

VII. Alkyl and Aryl Halides:

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions, Mechanisms of nucleophilic substitution reactions of alkyl halides, $\text{S}_{\text{N}}2$ and $\text{S}_{\text{N}}1$ 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.

B.Sc. – I Chemistry (Paper-III)

Physical Chemistry :

Unit – I

I. **Mathematical Concepts and Computers:**

(A) **Mathematical Concepts:**

Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like K_x , e^x , X^n , $\sin x$, $\log x$; maxima and minima, partial differentiation and reciprocity relations, Integration of some useful/relevant functions; permutations and combinations, Factorials, Probability.

(B) **Computers:**

General introduction to computers, different components of a computer, hardware and software, input-output devices; binary numbers and arithmetic's; introduction to computer languages, programming, operating systems.

Unit – II

II. **Gaseous States:**

Postulates of kinetic theory of gases, deviation from ideal behavior, Vander Waals equation of state;

Critical Phenomena : PV isotherms of real gases, continuity of states, the isotherms of vander Waals equation, relationship between critical constants and vander Waals constants, 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).

III. **Liquid State:**

Intermolecular forces, structure of liquids (a qualitative description).

Structural differences between solids, liquids and gases;

Liquid crystals: Difference between liquid crystal, solid and liquid, Classification, structure of nematic and cholestric phases, Thermography and seven segment cells.

Unit – III

IV. **Solid States:**

Definition of space lattice, unit cell;

Laws of crystallography – (i) Law of constancy of interfacial angles, (ii) Law of rationality of indices (iii) Law of symmetry, Symmetry elements in crystals.

X-ray diffraction by crystals, Derivation of Bragg equation, Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).

V. **Colloidal States:**

Definition of colloids, classification of colloids;

Solids in liquids (sols): properties – kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number.

Liquids in liquids (emulsions) : types of emulsions, preparation, Emulsifier,

Liquids in solids (gels) : classification, preparation and properties, inhibition, general application of colloids, colloidal electrolytes.

Unit – IV

VI. Chemical Kinetics and Catalysis:

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light catalyst, concentration dependence of rates, mathematical characteristics of simple chemical reactions – 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 method.

Radioactive decay as a first order phenomenon;

Experimental methods of chemical kinetics: conductometric, potentiometric, optical methods, polarimetry and spectrophotometer.

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), Expression for the rate constant based on equilibrium constant and thermodynamic aspects.

Catalysis, characteristics of catalysed reactions, classification of catalysis homogeneous and heterogeneous catalysis, enzyme catalysis, miscellaneous examples.

Inorganic Chemistry :

Semi micro Analysis – cation analysis, separation and identification of ions from Groups I, II, III, IV, V and VI, Anion analysis.

Organic Chemistry :

Laboratory techniques;

Calibration of Thermometer:

80-82⁰ (Naphthalene), 113.5-114⁰ (Acetanilide)

132.5-133⁰ (Urea), 100⁰ (Distilled Water)

Determination of melting point:

Naphthalene 80-82⁰, Benzoic acid 121.5-122⁰

Urea 132.5-133⁰, Succinic acid 184.5-185⁰

Cinnamic acid 132.5-133⁰, Salicylic acid 157.5-158⁰

Acetanilide 113.5-114⁰, m-Dinitrobenzene 90⁰

p-Dichlorobenzene 52⁰, Aspirin 135⁰

Determination of boiling point:

Ethanol 78⁰, Cyclohexane 81.4⁰, Toluene 110.6⁰, Benzene 80⁰

Mixed melting point determination:

Urea-Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)

Distillation:

Simple distillation of ethanol-water mixture using water condenser,

Distillation of nitrobenzene and aniline using air condenser

Crystallization:

Concept of induction of crystallization,

Phthalic acid from hot water (using fluted filter paper and steamless funnel)

Acetanilide from boiling water

Naphthalene from ethanol

Benzoic acid from water

Decolorisation and crystallization using charcoal:

Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.

Crystallization and decolorisation of impure naphthalene (100g of naphthalene mixes with 0.3 g of Congo Red using 1g decolorizing carbon) from ethanol.

Sublimation (Simple and Vacuum):

Camphor, Naphthalene, Phthalic acid and succinic acid.

Qualitative Analysis:

Detection of extra elements (N, S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.

Physical Chemistry :**Chemical Kinetics:**

1. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed 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 H₂SO₄ by studying the kinetics of hydrolysis of ethyl acetate.
4. To study kinetically the reaction rate of decomposition of iodide by H₂O₄.

Distribution Law:

1. To study the distribution of iodine between water and CCl₄.
2. To study the distribution of benzoic acid between benzene and water.

Colloids:

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

Viscosity, Surface Tension:

1. To determine the percentage composition of a given mixture (non interacting systems) by viscosity method.
2. To determine the viscosity of amyl alcohol in water at different concentration and calculate the excess viscosity of these solutions.
3. To determine the percentage composition of a given binary mixture by surface tension method (acetone & ethyl methyl ketone).

