

B.Sc. Ist Sem. (Subsidiary Chemistry)

Periods: 45

Mark s: 54

Internal assessment -06

Note: Examiner will set three questions from each section. The candidate will be required to attempt five questions in all, selecting not more than two questions from each section. All questions carry equal marks.

Section-A

Atomic Structure

Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, 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, Slater's rules.

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 (BeF₂, BF₃, CH₄, PF₅, SF₆, IF₇ SO₄²⁻, ClO₄⁻)Valence shell electron pair repulsion (VSEPR) theory to NH₃, H₃O⁺, SF₄, ClF₃, ICl₂⁻ and H₂O. MO theory of heteronuclear (CO and NO) diatomic molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

Section-B

Gaseous States

Maxwell's distribution of velocities and energies (derivation excluded) Calculation of root mean square velocity, average velocity and most probable velocity. Collision diameter, collision number, collision frequency and mean free path. Deviation of Real gases from ideal behaviour. Derivation of Vander Waal's Equation

of State, its application in the calculation of Boyle's temperature (compression factor) Explanation of behaviour of real gases using Vander Waal's equation.

Critical Phenomenon: Critical temperature, Critical pressure, critical volume and their determination. PV isotherms of real gases, continuity of states, the isotherms of Vander Waal's equation, relationship between critical constants and Vander Waal's constants. Critical compressibility factor. The Law of corresponding states. Lequifaction of gases.

Liquid States

Properties of liquids – surface tension, viscosity and their determination.

Solid State

Liquid crystals: Difference between solids, liquids and liquid crystals, types of liquid crystals. Applications of liquid crystals.

Section-C

Structure and Bonding

Localized and delocalized chemical bond, resonance effect and its applications,

Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism.

Optical isomerism — elements of symmetry, molecular chirality, enantiomers, , optical activity, , chiral and achiral molecules with two stereogenic centres, diastereomers,

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

Geometric isomerism — determination of configuration of geometric isomers. E & Z system of nomenclature,

Mechanism of Organic Reactions

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.

Reactive intermediates — carbocations, carbanions, free radicals,

Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atoms in alkanes. Isomerism in alkanes, , methods of formation (with special reference to Wurtz reaction, Kolbe reaction),.

Cycloalkanes — nomenclature, synthesis of cycloalkanes , dehalogenation of α,ω -dihalides, ,.

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Section-A

Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electronegativity – definition, trends in periodic table (in s & p block elements).

s-Block Elements

Comparative study of the elements including, diagonal relationships and salient features of hydrides (methods of preparation excluded).

p-Block Elements

Emphasis on comparative study of properties of p-block elements (including diagonal relationship and excluding methods of preparation).

Boron family (13th gp):-

Diborane – properties and structure (as an example of electron – deficient compound and multicentre bonding), Borazene – chemical properties and structure.

Carbon Family (14th group)

Allotropy of carbon, Catenation, $p\pi-d\pi$ bonding (an idea), carbides, fluorocarbons– general methods of preparations, properties and uses.

Nitrogen Family (15th group)

Oxides – structures of oxides of N,P. oxyacids – structure and relative acid strengths of oxyacids of Nitrogen and phosphorus. .

Oxygen Family (16th group)

Oxyacids of sulphur – structures and acidic strength

Halogen Family (17th group)

Basic properties of halogen, hydro and oxyacids of chlorine – structure and comparison of acid strength.

Section-B

Kinetics

Rate of reaction, rate equation, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, catalyst. Order of a reaction, integrated rate expression for zero order, first order, Half life period of a reaction. Methods of determination of order of reaction, effect of temperature on the rate of reaction – Arrhenius equation.

Electrochemistry

Electrolytic conduction, factors affecting electrolytic conduction, specific, conductance, molar conductance, equivalent conductance and relation among them, their variation with concentration. Arrhenius theory of ionization, Ostwald's Dilution Law. Debye-Huckel – Onsager's equation for strong electrolytes (elementary treatment only), Kohlrausch's Law, calculation of molar ionic conductance and effect of viscosity temperature & pressure on it. Application of Kohlrausch's Law in calculation of conductance of weak electrolytes at infinite dilution. Applications of conductivity measurements: determination of degree of dissociation, determination of K_a of acids determination of solubility product of sparingly soluble salts, conductometric titrations. Definition of pH and pK_a , Buffer solution, Buffer action, (elementary idea only).

Section-C

Alkenes

Nomenclature of alkenes, , mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halides,. The Saytzeff rule, Chemical reactions of alkenes — mechanisms involved in hydrogenation, electrophilic and free radical additions, Markownikoff's rule,

.Arenes and Aromaticity

Nomenclature of benzene derivatives:. Aromatic nucleus and side chain.

Aromaticity: the Huckel rule, aromatic ions, aromatic, anti - aromatic and non - aromatic compounds.

Dienes and Alkynes

Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes.,. Chemical reactions — 1,2 and 1,4 additions (Electrophilic & free radical mechanism), Diels-Alder reaction, Nomenclature, structure and bonding in alkynes., acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions,

Alkyl and Aryl Halides

Nomenclature and classes of alkyl halides, Mechanisms and stereochemistry of nucleophilic substitution reactions of alkyl halides, S_N2 and S_N1 reactions. The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions of aryl halides.

Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides.

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Section-A

Chemistry of d-Block Elements

Definition of transition elements, position in the periodic table, General characteristics & properties of d-block elements, Comparison of properties of 3d elements with 4d & 5d elements with reference only to ionic radii, oxidation state, magnetic and spectral properties.

Coordination Compounds

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

Metal-ligand Bonding in Transition Metal Complexes

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

Section-B

Thermodynamics

Definition of thermodynamic terms: system, surrounding etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

Zeroth Law of thermodynamics, First law of thermodynamics: statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Calculation of w.q. dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process, Kirchoffs equation.

Second law of thermodynamics, need for the law, different statements of the law, Carnot's cycles and its efficiency, Carnot's theorem, Thermodynamics scale of temperature. Concept of entropy – entropy as a state function, entropy as a function of P, V & T.

Section-C

.Alcohols

Monohydric alcohols — nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature.

Dihydric alcohols — nomenclature, methods of formation, chemical reactions of vicinal glycols,.

.Phenols

Nomenclature, structure and bonding. Preparation of phenols, Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Mechanisms of Fries rearrangement, Claisen rearrangement, and Schotten and Baumann reactions.

.Epoxides

Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides,

. Ultraviolet (UV) absorption spectroscopy

Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts.

.Carboxylic Acids & Acid Derivatives

Nomenclature of Carboxylic acids, structure and bonding, , acidity of carboxylic acids, effects of substituents on acid strength. Hell-Volhard-Zelinsky reaction. Mechanism of decarboxylation.

. Relative stability of acyl derivatives. interconversion of acid derivatives by nucleophilic acyl substitution.

Mechanisms of esterification and hydrolysis (acidic and basic).

B.Sc. IVth Sem. (Subsidiary Chemistry)

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Section-A

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_3 and liquid SO_2

Acids and Bases, HSAB Concept

Arrhenius, Bronsted – Lowry, the Lux – Flood, Solvent system and Lewis concepts of acids & bases, relative strength of acids & bases, Concept of Hard and Soft Acids & Bases.

Chemistry of f – block elements

Lanthanides

Occurrence, Electronic structure, oxidation states and ionic radii and lanthanide contraction and complex formation of lanthanide compounds.

Actinides

General features and chemistry of actinides, Comparison of properties of Lanthanides and Actinides and with transition elements. Elementary idea about the transuranic elements.

Section-B

Thermodynamics

Third law of thermodynamics: Nernst heat theorem,
Thermodynamic functions G, H, E, A & S. Criteria for

thermodynamic equilibrium and spontaneity of a process in terms of thermodynamic functions.

Chemical Equilibrium

Equilibrium constant and free energy, concept of chemical potential, Thermodynamic derivation of law of chemical equilibrium. Clapeyron equation and Clausius – Clapeyron equation its applications.

Electrochemistry

Electrolytic and Galvanic cells – reversible & Irreversible cells, conventional representation of electrochemical cells. EMF of cell and its measurement, Weston standard cell, activity and activity coefficients.

Calculation of thermodynamic quantities of cell reaction (ΔG , ΔH & K).

, Nernst equation, prediction of single electrode potential and EMF of cell. Reference electrodes; standard hydrogen electrode & calomel electrode standard electrode potential, sign convention, electrochemical series and its applications.

Section-C

. Infrared (IR) absorption spectroscopy

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups. **2.**

.Amines

Structure and nomenclature of amines, physical properties. Separation of a mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. . Gabriel-phthalimide reaction, Hofmann bromamide reaction.

electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid.

. Diazonium Salts

Mechanism of diazotisation, structure of benzene diazonium chloride, Replacement of diazo group by H, OH, F, Cl, Br, I, NO₂ and CN groups.

. Aldehydes and Ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, advantage of oxidation of alcohols with chromium trioxide (Sarett reagent) pyridinium chlorochromate (PCC) and pyridinium dichromate.,. Comparison of reactivities of aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin and aldol, condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction.

B.Sc. Ist (SEM) Practicals**Max. Marks: 40****Time: 6 Hrs.
(Spread over two days)****Section-A (Inorganic)****Volumetric Analysis**

1. **Redox titrations:** Determination of Fe^{2+} , $\text{C}_2\text{O}_4^{2-}$ (using KMnO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$)
2. **Iodometric titrations:** Determination of Cu^{2+} (using standard hypo solution).

Section-B (Physical)

1. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. To determine the specific refractivity of a given liquid

Organic

1. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point
 - (i) Iodoform from ethanol (or acetone)
2. To study the process of) sublimation of camphor and phthalic acid

Distribution of marks

1.	Section I	10 marks
2.	Section II	10 marks
3.	Section III	10 marks
4.	Viva-voce	5 marks
5.	Lab Record	5 marks

B.Sc. IInd(SEM) Practicals

Max. Marks: 40

Time: 6 Hrs.

(Spread over two days)

(Inorganic)

Volumetric analysis

Complexometric titrations: Determination of Mg^{2+} , Zn^{2+} by EDTA.

Paper Chromatography

Qualitative Analysis of the any one of the following Inorganic cations and anions by paper chromatography (Pb^{2+} , Cu^{2+} , Ca^{2+} , Ni^{2+} , Cl^- , Br^- , I^- and PO_4^{3-} and NO_3^-).

Physical

- a. To prepare arsenious sulphide sol and compare the precipitating power of mono-, bi – and trivalent anions.
2. To determine the surface tension of a given liquid by drop number method.
3. To determine the viscosity of a given liquid.

Organic

1. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point
 - (j) *m*-Dinitrobenzne from nitrobenzene (use 1:2 conc. HNO_3 - H_2SO_4 mixture if fuming HNO_3 is not available)
 - ii) *p*-Bromoacetanilide from acetanilide.
 - iii) Dibenzalacetone from acetone and benzaldehyde
 - iv) Aspirin from salicylic acid.

Distribution of marks

1.	Section I	10 marks
2.	Section II	10 marks
3.	Section III	10 marks
4.	Viva-voce	5 marks
5.	Lab Record	5 marks

B.Sc. III (SEM) Practical**Max. Marks: 40****Time: 6 Hrs.
(Spread over two days)****SECTION – I (Inorganic)**

Preparations: Preparation of Cuprous chloride, prussion blue from iron fillings, tetraammine cupric sulphate, chrome alum, potassium trioxalatochromate (III).

Section-B (Physical)

1. To determine the solubility of benzoic acid at various temperatures and to determine the ΔH of the dissolution process
2. To determine the enthalpy of neutralization of a weak acid/weak base vs. 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
4. To study the distribution of iodine between water and CCl_4 .

Distribution of marks

1.	Section I	10 marks
2.	Section II	20 marks
3.	Viva-voce	5 marks
4.	Lab Record	5 marks

B.Sc. IVth (SEM) Practical**Max. Marks: 40****Time: 6Hrs.
(Spread over two days)****Section-A****1. Gravimetric Analysis**

Quantitative estimations of, Cu^{2+} as copper thiocyanate and Ni^{2+} as Ni – dimethylglyoxime.

2. Colorimetry:

To verify Beer - Lambert law for $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ and determine the concentration of the given $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$ solution.

Section- B (Organic)

Systematic identification (detection of extra elements, functional groups, determination of melting point or boiling point and preparation of at least one pure solid derivative) of the following simple mono and bifunctional organic compounds: Naphthalene, anthracene, acenaphthene, benzyl chloride, *p*-dichlorobenzene, *m*-dinitrobenzene, *p*-nitrotoluene, resorcinol, hydroquinone, α -naphthol, β -naphthol, benzophenone, ethyl methyl ketone, benzaldehyde, vanillin, oxalic acid, succinic acid, benzoic acid, salicylic acid, aspirin, phthalic acid, cinnamic acid, benzamide, urea, acetanilide, benzanilide, aniline hydrochloride, *p*-toluidine, phenyl salicylate (salol), glucose, fructose, sucrose, *o*-, *m*-, *p*-nitroanilines, thiourea.

Distribution of marks

1.	Section I	10 marks
2.	Section II	20 marks
3.	Viva-voce	5 marks
4.	Lab Record	5 marks