CHEMISTRY

Scheme:

Paper	Duration	Max. Marks	Min. Pass Marks
Paper I	3 hrs.	50	18
Paper II	3 hrs.	50	18
Paper III	3 hrs.	50	18
Practical	5 hrs.	75	27
Total Marks		**225**	**81**

Note: Each theory paper is divided into three independent units. The question paper is divided into three parts Part-A, Part-B and Part-C. Part A (15 marks) is compulsory and contains 10 questions (50 words) at least two questions from each unit, each question is of 1.5 mark. Part-B (15 marks) is compulsory and contains five questions at least one from each unit. Candidate is required to attempt all five questions. Each question is of 3 marks (50 words). Part-C (20 marks) contains six questions two from each unit. Candidate is required to attempt three questions, one from each Unit. Each question is of 7+7+6=20 marks (400 words).

PAPER-I INORGANIC CHEMISTRY

Hours: Three Max. Marks: 50

Unit-I

A. Atomic Structure

De Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of φ and φ^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 configurationof the elements, effective nuclear charge.

B. Chemical Bonding

Covalent Bond- Valence bond theory and its limitations, direction of 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, CIF_3, ICI_2 and H_2O, MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicentre bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

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

Unit-II

A. Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electronegativity-definition, methods of determination and trends in periodic table, applications in predicting and explaining the chemical behaviour.

B. **s-Block Elements:** Comparative study,diagonal, relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, and introduction to alkyls and aryls.

C. p-Block Elements

Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides and halides of groups 13-16, hydrides of boron-diborane and higher boranes,borazine, properties borohydrides.

Unit-III

A. Fullerenes, carbides, fluorocarbons, silicones, silicates (Structural principle) tetrasulphurtetranitride, basic properties of halogens, interhalogens and polyhalides.

B. **Ionic Solids-** Ionic structures, radius ratio 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. Chemistry of Noble Gases

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

Paper-II ORGANIC CHEMISTRY

Hours: Three Max. Marks: 50

Unit-I

A. Structure and Bonding

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

B. 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. Energy considerations. Reactive intermediates-carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with example). Methods of determination of mechanism of organic reactions. Assigning formal charges on intermediates and other ionic species.

C. Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism. Optical isomerism-elementsof symmetry, molecular chirality, enantiomers, stereogeniccentre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogeniccentres,diastereomers, threo and erythrodiastereomersmeso compounds, resolution of enantiomers, inversion, retention and recemization.

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 formula, Difference between configuration and conformation.

Unit-II

A. Cycloalkanes

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.

B. Alkenes

Mechanism 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-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.

C. Cycloalkenes, Dienes and Alkynes

Methods of formation, conformation and chemical reactions of cycloalkenes.

Nomenclature and classification ofdienes: isolated, conjugated cumulated dienes.

Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions-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-III

A. Arenes and aromaticity

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

Aromaticity: the Huckle rule, aromatic ions.

B. **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.

C. Alkyl and Aryl Halides

Nomenclature and classes of alkyl halides. Methods of formation, chemical reaction. Mechanisms of nucleophilic substitution reactions of alkyl halides, S_N2 and S_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 vsallyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC

PAPER-III PHYSICAL CHEMISTRY

Hours: Three Max Marks: 50

Unit-I

A. 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 van der Waals equation, relationship between critical constant and van der 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 Maxwells' distribution of molecular velocities, collision number, mean free path and collision diameter. Liquefaction of gases (based on Joule-Thomson effect)

B. Solid State:

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)

Unit-II

A. Liquid State:

Intermolecular forces, sound speed of solutions, structure of liquids (a qualitative description) Structural differences between solids, liquids and gases.

Liquids crystals: Difference between liquid crystal, solid and liquid classification, structure of nematic and cholestric phases. Thermography and seven segment cell.

B. Solutions, Dilute Solutions and Colligative Properties

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

Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression in

freezing point. Experimental methods for determining, various colligative properties.

Abnormal molar mass, degree of dissociation and association of solutes.

Unit-III

A. Mathematics for Chemistry

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 and partial differentiation. Integration of some useful/relevant functions, permutations and combinations, Factorials, Probability.

B. Nuclear Chemistry

Discovery of radioactivity , radioactive emanations – type and properties, units of radioactivity, brief description of Geiger - Muller Scintillation counters for detection and measurement of radioactivity, radioactive decay – decay law, disintegration constant, half life and average life, alpha and beta disintegration reactions, group displacement law, nuclear reactions- fission, fusion, artificial radioactivity, applications of radioactivity, nuclear power, carbon dating, medical and chemical applications.

C. Collodial State

Definitionof 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.Emulsifiers

Liquids in solids (gels); classification, preparation and properties, inhibition, general applications of colloids.

PAPER IV - PRACTICALS

Time: 5 Hours Max Marks : **75**

1. **Inorganic Chemistry**
   (A) Semi-micro Analysis - Separation and Identification of two cations& two anions including interfering radicals from Groups Zero, I, II, III, IV, V and VI radicals
   (B) Calibration of pipettes, burettes and thermometer. Preparation of standard solutions and dilution of solutions for titrimetry.
2. **Organic Chemistry**
   (A) Laboratory Techniques (Any Three)
      (a) Determination of Melting Point

Naphthalene, Benzoic acid
Urea, Succinic acid
Cinnamic acid, Salicylic acid etc.
Acetanilide, m-Dinitrobenzene
P-Dichlorobenzene, Aspirin

(b) Determination of boiling points
Ethanol, Cyclohexane, Toluene, Benzene etc.

(c) Mixed melting points
Urea-Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)

(d) Distillation
Simple distillation of ethanol-water mixture or anyother mixture using water condenser. Distillation of nitrobenzene and aniline or any other mixture using air condenser

(e) Crystallization
Phthalic acid from hot water,Acetanilide from boiling ethanol
Benzoic acid from water or any other mixture

(f) Sublimation
Camphor, Naphthalene, Phthalic acid,Succinic Acid etc.

(B) Qualitative Analysis

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

3. PHYSICAL CHEMISTRY (ANY FIVE)

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 H_2SO_4 by studying the kinetics of hydrolysis of ethyl acetate.
4. To study the distribution of iodine between water and CCl_4.
5. To study the distribution of benzoic acid between benzene andwater.
6. To determine the percentage composition of a given mixture (noninteracting systems) by viscosity method.
7. To determine the viscosity of amyl alcohol in water at different concentrations and calculate the excess viscosity of these solutions.
8. To determine the percentage composition of a given binary mixture by surface tension method (acetone, ethyl methyl ketone, benzene and nitrobenzene or any other).

Scheme of Practical Examination&Distribution of Marks

1. Inorganic Chemistry.

(A) A mixture containing two cations& two anions may be given. -16
(B) Calibration and preparation of standard solution -08

2.Organic Chemistry:-

(A) At least one laboratory technique is to be performed by the candidate out of three. - 10

(B) Detection of elements and functional group of one solid and liquid.- 12

3.Physical Chemistry

Out of five, one experiment should be performed by the candidate. -14

4. **Viva** -10
5. **Record** - 5

Maximum Marks -75