

B.Sc. (Chemistry)



B. Sc. FIRST YEAR

SUBJECT : CHEMISTRY
PAPER NUMBER : FIRST
NAME OF PAPER : INORGANIC CHEMISTRY

Max. Marks: 33

UNIT-I

A. ATOMIC STRUCTURE

Bohr's theory, its limitation and atomic spectrum of Hydrogen. General idea of de-Broglie matter-waves, Heisenberg Uncertainty principle, Schrodinger wave equation, significance of Ψ and Ψ^2 , radial & angular wave functions and probability distribution curves, quantum numbers, Atomic orbital and shapes of s, p, d orbital's, Aufbau and Pauli exclusion principles, Hund's Multiplicity rule, electronic configuration of the elements.

B. PERIODIC PROPERTIES

Detailed discussion of the following periodic properties of the elements, with reference to s and p-block. Trends in periodic table and applications in predicting and explaining the chemical behaviour (a) Atomic and ionic radii, (b) Ionization enthalpy, (c) Electron gain enthalpy, (d) Electronegativity, Pauling's, Mulliken's, Allred Rochow's scales, (e) Effective nuclear Charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

UNIT-II CHEMICAL BONDING - I

Ionic bond: Ionic Solids- Ionic structures, radius ratio & co-ordination number, limitation of radius, ratio rule, lattice defects, semiconductors, lattice energy Born- Haber cycle, Solvation energy and solubility of ionic solids, polarising power & polarisability of ions, Fajans rule. Ionic character in covalent compounds: Bond moment and dipole moment, Percentage ionic character from dipole moment and electronegativity difference, Metallic bond-free electron, Valence bond & band theories.

UNIT-III CHEMICAL BONDING - II

Covalent Bond: Lewis structure, Valence bond theory and its limitations, concept of hybridization, Energetics of hybridization, equivalent and non-equivalent hybrid orbitals, Valence shell electron pair repulsion (VSEPR) theory, shapes of the following simple molecules and ions containing lone pairs and bond pairs of electrons: H_2O , NH_3 , PCl_3 , PCl_5 , SF_6 , H_3O^+ , SF_4 , ClF_3 , and ICl_2^- . Molecular orbital theory, Bond order and bond strength, Molecular orbital diagram of diatomic and simple polyatomic molecules N_2 , O_2 , F_2 , CO , NO .

UNIT-IV

A. s-BLOCK ELEMENTS

General concepts on group relationships and gradation properties, Comparative study, salient features of hydrides, solvation & complexation tendencies including their function in biosystems and introduction to alkyl & aryls, Derivatives of alkali and alkaline earth metals.

B. p-BLOCK ELEMENTS

General concepts on group relationships and gradation properties, Halides, hydrides, oxides and oxyacids of Boron, Aluminium. Nitrogen and Phosphorus, boranes, borazines, fullerenes, graphene and silicates, interhalogens and pseudohalogens.

UNIT-V

A. CHEMISTRY OF NOBLE GASES

Chemical properties of the noble gases, chemistry of Xenon, structure binding in Xenon compounds.

B. THEORETICAL PRINCIPLES IN QUALITATIVE ANALYSIS (H_2S SCHEME)

Basic principles involved in the analysis of cation and anions and solubility products, common ion effect. Principle involved in separation of cation into groups and choice of the group reagents. Interfering anions (fluoride, borate, oxalate, and phosphate) and need to remove them after group II.

REFERENCE BOOKS:

1. Basic Inorganic Chemistry, F.A Cotton, G. Wilkinson and P.L. Gaus, Wley
2. Concise Inorganic Chemistry, J.D. Lee, ELBS
3. Concepts of models of Inorganic Chemistry, B. Douglas, D. Mc Daniel and J Alexander, John Wiley.
4. Inorganic Chemistry, D.E. Shriver, P.W. Atkins and C.H.L. angford, Oxford.
5. Inorganic Chemistry, G.L. Micssels and D.A. Tarr, Prentice Hall.
6. Advanced Inorganic Chemistry, Satya Prakash
7. Advanced Inorganic Chemistry, Agarwal & Agarwal
8. Advanced Inorganic Chemistry, Puri & Sharma, S. Naginchand
9. Inorganic Chemistry, Madan, S. Chand Publishing
10. Inorganic Chemistry, Catherine E. Housecroft, Edwin C. Constable, Prentice Hall.
11. Aadhunik Akarbnc Rasayan, R.K. Shrivastav & P.S. Jain, Goel Publication.

B. Sc. FIRST YEAR

SUBJECT : CHEMISTRY
PAPER NUMBER : SECOND
NAME OF PAPER : ORGANIC CHEMISTRY

Max. Marks: 33

UNIT-I BASICS OF ORGANIC CHEMISTRY

Hybridization, Shape of molecules, Influence of hybridization on bond properties, Electronic displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation, and their applications; Dipole moment. Electrophiles and Nucleophiles; Nucleophilicity and basicity; Homolytic & heterolytic bond cleavage. Generation, shape and relative stability of Carbocation, Carbanions, free radicals, carbenes and nitrenes. Introduction to types of organic reactions: Addition, Elimination and Substitution reactions.

UNIT-II INTRODUCTION TO STEREOCHEMISTRY

Optical. Isomerism: Optical activity, Specific rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres. Diastereomers, meso compound, Relative and absolute configuration: Fischer, Newmann and Sawhorse Projection formulae and their interconversions; Erythrose and threose, D/L, d/l system of nomenclature, Cahn-Ingold-Prelog system of nomenclature (C.I.P rules), R/S nomenclature, Geometrical isomerism: cis-trans, syn-anti and E/Z notations.

UNIT-III CONFORMATIONAL ANALYSIS OF ALKANES

Conformational analysis of alkanes, ethane, butane, cyclohexane and sugars. Relative stability and Energy diagrams. Types of cycloalkanes and their relative stability, Baeyer strain theory: Theory of stainless rings, Chair, Boat and Twist boat conformation of cyclohexane with energy diagrams; Relative stability of mono-substituted cycloalkanes and disubstituted cycloalkanes.

UNIT-IV CHEMISTRY OF ALIPHATIC HYDROCARBONS

A. Carbon-Carbon sigma (σ) bonds:

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reaction, Free radical substitution: Halogenation-relative reactivity and selectivity.

B. Carbon-Carbon sigma (π) bonds:

Formation of alkenes and alkynes by elimination reaction, Mechanism of E1, E2, E1cb reactions, Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic addition and mechanisms (Markownikoff/Anti-Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reaction in conjugated dienes and Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.

Reaction of alkynes: Acidity, Electrophilic and nucleophilic addition. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

UNIT-V AROMATIC HYDROCARBONS

Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism, Directive effects of the groups.

REFERENCE BOOK:

1. Organic Chemistry, Morrison and Boyd, Prentice-Hall
2. Organic Chemistry, L.G. Wade Jr, Prentice-Hall
3. Fundamentals of Organic Chemistry, Solomons, John Wiley
4. Organic Chemistry, Vol. I, II, III, S.M. Mukherjee, S.P. Singh and R.P. Kapoor, Wiley Eastern, (New-Age).
5. Organic Chemistry, F.A. Carey, MC Graw Hill
6. Introduction to Organic Chemistry, Struikweisser, Heathcock and Kosover, Macmillan.
7. Organic Chemistry, P.L. Soni.
8. Organic Chemistry, Bahi & Bahl
9. Organic Chemistry, Joginder Singh.
10. Carbanic Rasayan, Bashi & Bahi
11. Carbanic Rasayan, R.N. Singh, S.M.I. Gupta, M.M. Bakodia & S.K. Wadhwa.
12. Carbanic Rasayan, Joginder Singh.
13. Carbanic Rasayan, P.L. Soni.
14. Carbanic Rasayan, Bhagchandani, Sahitya Bhawan Publication.

B. Sc. FIRST YEAR

SUBJECT : CHEMISTRY
PAPER NUMBER : THIRD
NAME OF PAPER : PHYSICAL CHEMISTRY

Max. Marks: 34

UNIT-I MATHEMATICAL CONCEPTS FOR CHEMIST

Basic Mathematical Concepts: Logarithmic relations, curve sketching, linear graphs. Properties of straight line, slope and intercept. Differentiation of functions, Maxima and minima, integrals; ordinary differential equations; vectors and matrices; Permutation and combination, and Probability theory, Significant figures and their applications.

UNIT-II GASEOUS STATE CHEMISTRY

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path; Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degree freedom and molecular basis of heat capacities, Joule Thompson effect, Liquification of Gases.

Behaviour of real gases: Deviation from ideal gas behaviour, compressibility factor (Z) and its variation with pressure and temperature for different gases. Causes of deviation from ideal behaviour. Van der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of state, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

UNIT-III

A. LIQUID STATE CHEMISTRY

Intermolecular forces, magnitude of intermolecular force, structure of liquids. Properties of liquids, viscosity and surface tension.

B. COLLOIDS AND SURFACE CHEMISTRY

Classification, Optical, Kinetic, and Electrical Properties of colloids. Coagulation, Hardy Schulze law, flocculation value. Protection, Gold number, Emulsion, micelles and types. Gel. Syneresis and thixotropy. Application of colloids.

Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). Nature of adsorbed state. Qualitative discussion of BET.

UNIT-IV SOLID STATE CHEMISTRY

Nature of the solid state, Law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Crystal defects.

UNIT-V

A. CHEMICAL KINETICS

Rate of reaction, Factors influencing rate of reaction, rate law, rate constant. Order and molecularity of reactions, rate determining step, Zero, first and second order reaction, rate and rate law, methods of determining order of reaction. Chain reactions.

Temperature dependence of reaction rate, Arrhenius theory, Physical significance of Activation energy, collision theory, demerits of collision theory, non-mathematical concept of transition state theory.

B. CATALYSIS

Homogeneous and Heterogeneous Catalysis, types of catalyst, characteristics of catalyst. Enzyme Catalysed reactions. Micellar catalysed reactions. Industrial applications of Catalysis.

REFERENCE BOOKS:

1. Physical chemistry, G.M. Barrow, International student edition, MC Graw Hill
2. Basic programming with application, V.K. Jain, Tata Mc Graw-Hill
3. Computers & Common sense, R. Hunt & Shelly, Prentice-Hall
4. University general chemistry, C.N.R. Rao Macmillan.
5. Physical Chemistry, R.A. Alberty, Wiley Eastern.
6. The elements of Physical Chemistry, P.W. Atkins, Oxford.
7. Physical Chemistry thought problems, S.K. Dogra & Dogra, Wiley Eastern.
8. Physical Chemistry, B.D. Khosla
9. Physical Chemistry, Puri & Sharma
10. Bhoutic Rasayan, Puri, Sharma & Palhania, Vishal Publishing Company.

B. Sc. FIRST YEAR

SUBJECT : CHEMISTRY
PAPER NUMBER : FOURTH
NAME OF PAPER : LABORATORY COURSE

Max. Marks: 50

INORGANIC CHEMISTRY

- A. Semi-micro qualitative Analysis (using H_2S or other methods) of mixtures – not more than four ionic species (two anions and two cations, excluding interfering, insoluble salts) out of the followings:
Cations: NH_4^+ , Pb^{2+} , Bi^{3+} , Cu^{2+} , Cd^{2+} , Fe^{3+} , Al^{3+} , Co^{2+} , Ni^{2+} , Mn^{2+} , Zn^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , Sb^{3+} , Sn^{2+} , Cr^{3+} , Mg^{2+}
Anions CO_3^{2-} , S_2^{2-} , SO_3^{2-} , $\text{S}_2\text{O}_3^{2-}$, NO_2^- , CH_3COO^- , F^- , Cl^- , Br^- , I^- , NO_3^- , SO_4^{2-} , $\text{C}_2\text{O}_4^{2-}$, BO_3^{3-} .
(Spot tests may be carried out wherever feasible)

B. Acid-Base Titrations

- Standardization of sodium hydroxide by oxalic acid solution.
- Determination of strength of HCl solution using sodium hydroxide as intermediate.
- Estimation of carbonate and hydroxide present together in mixture.
- Estimation of carbonate and bicarbonate present together in a mixture.
- Estimation of free alkali present in different soaps/detergents.

C. Redox Titrations

- Standardization of KMnO_4 by oxalic acid solution.
- Estimation of Fe(II) using standardized KMnO_4 solution.
- Estimation of oxalic acid and sodium oxalate in given mixture.
- Estimation of Fe(II) with $\text{K}_2\text{Cr}_2\text{O}_7$ using internal (diphenylamine, anththranilic acid) and external indicator.

D. Iodo/Iodimetric Titrations

- Estimation of Cu(II) and $\text{K}_2\text{Cr}_2\text{O}_7$ using sodium thiosulphate solution iodimetrically.
- Estimation of (a) arsenite and (b) antimony iodimetrically.
- Estimation of available chlorine in bleaching powder iodimetrically.
- Estimation of Copper and Iron in mixture by standard solution of $\text{K}_2\text{Cr}_2\text{O}_7$ using sodium thiosulphate solution as titrants.

ORGANIC CHEMISTRY

1. Demonstration of laboratory Glasswares and Equipments.
 2. Calibration of Thermometer. Naphthalene ($80^\circ - 82^\circ$), Acetanilide ($113.5^\circ - 114^\circ$), Urea ($132.5^\circ - 133^\circ$), Distilled Water (100°)
 3. Purification of organic compounds by crystallization using different solvents.
 - Phthalic acid from hot water (using fluted filter paper and stemless funnel).
 - Acetanilide from boiling water.
 - Naphthalene from ethanol.
 - Benzoic acid from water.
 4. Determination of Melting Point
Naphthalene ($80^\circ - 82^\circ$), Benzoic acid ($121.5^\circ - 122^\circ$), Urea ($132.5^\circ - 133^\circ$), Succinic acid ($184.5 - 185^\circ$), Cinnamic acid ($132.5 - 133^\circ$), Salicylic acid ($157.5 - 158^\circ$), Acetanilide ($113.5 - 114^\circ$), m- Dinitrobenzene (90°), p-Dichlorobenzene (52°) Aspirin (135°).
 5. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.
 - Urea- Cinnamic acid mixture of various compositions (1 : 4, 1 : 1, 4 : 1)
 6. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100°C by distillation and capillary method).
 - Ethanol (78°), Cyclohexane (81.4°), Toluene (110.6°), Benzene (80°).
- i. Distillation (Demonstration)
 - Simple distillation of ethanol- water mixture using water condenser.
 - Distillation of nitrobenzene and aniline using air condenser.
 - ii. Sublimation
 - Camphor, Naphthalene, Phthalic acid and Succinic acid
 - iii. Decolourisation and crystallisation using charcoal
 - Decolourisation of brown sugar with animal charcoal using gravity filtration, Crystallization and decolourisation of impure naphthalene (100g of naphthalene mixed with 0.3g of Congo red using 1g of decolorizing carbon) from ethanol.

7. Qualitative Analysis

Detection of elements (N, S and halogens) and functional groups (Phenolic, Carboxylic, Carbonyl, Esters, Carbohydrates, Amines, Amides, Nitro and Anilide) in simple organic compounds.

3. PHYSICAL CHEMISTRY

1. Surface tension measurements

Determine the surface tension by (i) drop number (ii) drop weight method

Surface tension composition curve for a binary liquid mixture.

2. Viscosity measurement using Ostwald's viscometer.

Determination of viscosity of aqueous solution of (i) sugar (ii) ethanol at room temperature.

Study of the variation of viscosity of sucrose solution with the concentration of solute.

Viscosity Composition curve for a binary liquid mixture.

3. Chemical Kinetics

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

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

To compare the strengths of HCl & H₂SO₄ by studying the kinetics of hydrolysis of ethyl acetate

4. Colloids

To prepare colloidal solution of silver nanoparticles (reduction method) and other metal nanoparticles using capping agents.

REFERENCE BOOK:

1. Qualitative analysis, revised Svehla, orient Longman

2. Standard methods of chemical analysis, W.W. Scott, The Technical Press

3. Experimental Organic Chemistry, Vol. I & II, P.R. Singh, D.S. Gupta & K.S. Bajpai, Tata Mc Graw Hill

4. Manual inorganic chemistry, R.K. Bansal Wiley Eastern

5. Vogel's text book of practical organic chemistry, B.S. Furnis A.J. Hannaford, V. Rogers, P.W.G. Smith & A.R. Tatchel, ELBS

6. Experiments in general chemistry, CNR Rao & U.C. Agarwal

7. Experiments in physical chemistry, R. C. Das & B. Behara Tata Mc Graw Hill

8. Advanced practical physical chemistry, J.B. Yadav, Goel publishing house

PRACTICAL EXAMINATION

Three experiments are to be performed

1. Inorganic Mixture Analysis, four radicals two basic & two acid (excluding insoluble, Interfering & combination of acid radicals) OR Two Titration (Acid-Bases, Redox and Iodo/Iodimetry)

12 Marks

2.

3. Detection of functional group in the given organic compound and determine its MPt/BPt.

8 marks

OR

Crystallization of any one compound as given in the prospectus along with the determination of mixed MPt.

OR

Decolourisation of brown sugar along with sublimation of camphor/ Naphthalene.

4. Any one physical experiment that can be completed in two hours including calculations.

14 marks

5. Viva

10 marks

6. Sessional

06 marks

In case of Ex-Students two marks will be added to each of the experiments.
