

B.Sc. 1st Year Chemistry

Max. Marks: 75

Internal Max: 25

Total Duration: (150 hours)

Min. Marks: 27

Internal Min: 09

Section-A

Unit-I: Inorganic Chemistry-I

(25 hours)

Atomic Structure: Wave Mechanical concept of Atomic Structure: de-Broglie's wave equation; derivation and experimental verification. Confirmation of quantization of angular momentum and its significance. Heisenberg's Uncertainty Principle: Illustration and significance.

Reasons for abnormal electronic configurations of some elements. Shapes of s, p & d orbitals. Effective nuclear charge and its calculation by Slater rules.

Periodic Properties: Trends in Atomic, Ionic, Metallic and Vander Waal radii.

Successive ionization energies and factors affecting ionization energy.

Electronegativity and Electron Affinity :- Trends, methods of determination; Applications in predicting and explaining the chemical behavior of elements.

Qualitative Analysis: General Safety rules: Maintenance of equipments; Storage of chemicals & solvents; Prevention and protection from explosions and hazards. Electrical Safety and UV-radiations. Safe disposal of hazardous / radioactive chemicals. First aid.

Qualitative Analysis: Underlying principles – Common-ion effect and Solubility product.

Effect of acids, temperature and solvent upon the solubility of precipitate. Salt effect. Relation between solubility and solubility product.

Scales of Qualitative Analysis: Macro, Semi-micro, Micro and Ultramicro Analysis. Spot test analysis.

Analysis of Inorganic Mixtures: Analytical groups and group reagents; Selective precipitation of cations; Reactions involved in separation and identification of cations from different analytical groups. Identification of anions.

Unit-II: Inorganic Chemistry-II

(25 hours)

Chemical Bonding-I

Ionic Bond: Lattice energy and Born Haber Cycle. Factors affecting the structure of ionic solids; Radius ratio effect; Coordination number and limitations of radius ratio rule. Defects in ionic solids and their applications. Fajan's rules and its applications.

Solvation energy and solubility of ionic solids. Factors affecting the solubility of ionic solids.

Metallic bond: Characteristics, comparison with ionic and covalent bonds. Theories (Free electron, VB and MO). Concept of Semiconductors.

Chemical Bonding-II

Valence bond theory: Directional characteristics of covalent bond and types of hybridizations. Limitations of VB theory. Percent ionic character from dipole moment and electronegativity difference.

VSEPR theory: Assumptions; Shapes of some molecules (BF₃, NH₃, H₂O, SF₄, ClF₃ and XeF₂)

Molecular Orbital Theory: Energy level diagrams, Bond order with its significance and Magnetic properties of homo & hetero nuclear diatomic molecules (N₂, O₂, F₂, HCl, CO & NO).

Multicenter bonding in electron deficient molecules.

Weak interactions: Hydrogen bonding, Types, Effects on properties and Theories. Pi-Hydrogen bonding. Van der Waal forces.

Section-B

Unit-III: Organic Chemistry-I

(25 hours)

Localised and delocalised chemical bonds: Recapitulation and applications of Inductive, electromeric, resonance and hyperconjugative effects.

Aromaticity: Requirements of aromaticity. Huckel's rule and its significance. Explanation using molecular orbital diagram of benzene. Aromaticity of non-benzenoid compounds like pyrrole, thiophene, furan and aromatic ions (3,5 and 7-membered rings).

Dipole-dipole interactions: Hydrogen bond, Vander-wall's and London forces and their significance with respect to organic compounds.

Reactive intermediates: Structure, generation and stability of Carbocations, carbanions, free radicals, carbenes, benzyne and nitrenes.

Reaction mechanism: Methods of determination of reaction mechanism.

Stereochemistry: Concept and types of stereoisomerism. **Geometrical Isomerism:** Determination of configuration of geometrical isomers. **E** and **Z** systems of nomenclature. Geometrical isomerism in oximes and alicyclic compounds. **Optical Isomerism:** Elements of symmetry, molecular chirality, chiral and achiral molecules with two stereogenic centers. Enantiomers, diastereoisomers and meso compounds. Resolution of enantiomers. Inversion, retention and racemisation. Relative and absolute configurations. **D**, **L** and **R**, **S** systems of nomenclature.

Conformational Analysis: Conformational analysis of *n*-butane and 1,2-dibromoethane using Newman, Sawhorse and Fischer projection formulae. Conformations of cyclohexane and methylcyclohexane.

Unit-IV: Organic Chemistry-II

(25 hours)

Cycloalkanes: Nomenclature of mono and bicyclic cycloalkanes. Methods of formation, reactions and stability of 3 to 6-membered cycloalkanes. Baeyer's strain theory and its limitations. Strains in smaller rings including cyclopropane. The banana bonds.

Alkenes: Preparation of alkenes from alcohols and alkyl halides through elimination reaction. Hoffman and Saytzev's rules. Mechanism and Stereochemical implications. Mechanistic details and stereochemical aspects (wherever applicable) of halogenation, hydrohalogenation, hydroboration, epoxidation, hydroxylation and ozonolysis. Substitution at allylic and vinylic positions of alkenes.

Dienes: Structure of isolated, conjugated and cumulative dienes. 1,2 and 1,4-additions of 1,3-butadiene. Mechanism and Stereochemistry of Diels's-Alder reaction. Mechanism of Birch reduction.

Alkynes: Structure and acidity of alkynes. Mechanisms of electrophilic and nucleophilic additions. Hydroboration, oxidation and metal-ammonia reductions of alkynes.

Alkyl halides: Classification, methods of preparation and reactions of alkyl halides. Mechanistic details of S_N1 and S_N2 reactions. Effects of structure of alkyl halides, nature of nucleophiles, leaving groups, solvent and stereochemical implications of these reactions. Substitution Vs elimination.

Aryl halides: Methods of preparation of aryl halides with mechanistic details of the reactions involved. Addition-Elimination and Elimination-Addition mechanisms of nucleophilic aromatic substitution reactions involving aryl halides.

Aromatic electrophilic substitution reactions: General mechanism of aromatic electrophilic substitution reactions. Formation of Sigma and pi-complexes with energy profile diagram. The second substitution-concept and role of activating and deactivating groups. *Ortho* and *para* ratio.

Section-C

Unit-V: Physical Chemistry-I

(25 hours)

Mathematical Concepts: Mathematical functions; Important families of functions - linear and quadratic algebraic functions; logarithmic, exponential and trigonometric functions - and their graphical representation. Calculation of slopes of linear functions. Differentiation of functions like kx , x^n , e^x , $\sin x$, $\cos x$, $\log x$, $u.v$ u/v ; rules for differentiations. Geometrical interpretation of the derivative, maxima and minima, partial differentiation.

Integration of some useful functions- x^n , $1/x$, $1/x^n$, $\ln x$, $\sin x$, $\cos x$, e^x , $1/[x(x-a)]$ – rules of integration, integration by substitution; indefinite and definite integral. Permutations and combinations.

Chemical Kinetics: Order of reaction; derivation of rate equations for second (two reactants) and third order reactions. Determination of order of reaction by differential rate, integration, half life period and isolation methods. **Techniques for kinetic investigation:** Conductometry, potentiometry, polarimetry and spectrophotometry.

Temperature dependence of reaction rates:- Arrhenius equation, concept of activation energy.

Theories of chemical kinetics: Simple collision theory based on hard sphere model, evaluation of rate constants of atomic reactions, extension to molecular reactions, limitations. Brief idea of transition state theory (equilibrium hypothesis).

Catalysis, characteristics of catalyzed reactions, Acid-Base catalysis with examples.

Unit-VI: Physical Chemistry-II

(25 hours)

Gaseous State: Deviation of gases from ideal behavior, van der Waal's equation of state.

Critical Phenomenon: PV isotherms of real gases, continuity of states, the isotherms of van der Waal's equation. Relationship between critical constants and van der Waal's 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.

Liquid State: Liquification of gases based on Joule-Thomson effect and adiabatic expansion. Intermolecular forces. Structure of liquids (a qualitative description), structural differences between solids, liquids and gases.

Liquid crystals: Differences between liquid crystal, solid and liquid. Classification of liquid crystals based on structure - nematic, smectic and cholesteric phases Thermography and seven segment cell.

Solid State: Laws of crystallography:- (i) Law of constancy of interfacial angles (ii) Law of rational indices and (iii) Law of symmetry

Symmetry elements in crystals, Lattice planes and Miller indices. X-ray diffraction by crystals, derivation of Bragg's equation and its application. Interplanar distances in terms of miller indices. Determination of crystal structure by Laue's method and powder method. Systematic absence of diffraction lines in the X-ray pattern of cubic crystals with reference to NaCl, KCl & CsCl.

Books Recommended:

1. Basic Inorganic Chemistry ; F.A. Cotton ; G Wilkinson & P.L. Gauss; Wiley, 3rd edn., 2002
2. Inorganic Chemistry ; A.G. Sharpe ; ELBS, 3rd edn, 1992
3. Concise Inorganic Chemistry ; J.D . Lee; ELBS, 5th edn., 2003
4. Inorganic Chemistry . G.L. Miessler T. A&Tarr ; Prentice Hall, 3rd edn, 2009
5. Inorganic Chemistry ; D.E. Shriver ; P.W. Atkins & C.H. Langford ; Oxford,4th edn, 2006
6. Concepts and models of Inorganic Chemistry ; B. Douglas ; D.Mc. Daniel & J. Alexander; Wiley, 3rd edn, 2001.
7. Vogel's Qualitative Inorganic Analysis ; Svehla ;. ; Orient Longman, 7th edn., 2004
8. A textbook of Organic Chemistry ., R.K. Bansal., Wiley-Eastern, 4th edn., 2003
9. Organic Chemistry, Vol I & II ., I. L. Finar .,ELBS., 6th edn, 2004.
10. Organic Chemistry., Morrison and Boyd., PHI., 6th edn., 2003.
11. Organic Chemistry Reaction Mechanism, R. K. Bansal .,TMH.,Reaction Mechanism, 3rd edn., 2003.
12. Advanced Organic Reaction Mechanism., Peter Sykes., Orient Longmann, 6th edn., 2007.
13. Reaction Mechanism in Organic Chemistry.,Mukherji and Singh.,Macmillan India, 3rd edn., 2007.
14. Chemistry of Organic Compounds ., Eliel., TMH., 2003.
15. Organic Chemistry Vol I & II., Roger Macomber .,Viva Books private Ltd, 2004
16. The elements of Physical Chemistry ; P.W. Atkins ; Oxford University Press.,2nd edn., 1996.
17. Mathematics for Chemists, D. Dogget & B. T. Sutchcliffe ; Longman, 1995
18. Mathematics for Physical Chemistry; Robert G. Mortimer, Elsevier.
19. Principles of Physical Chemistry by B. R. Puri, L. R. Sharma and M. S.Pathania ; S. Chand & Co., 44th edn., 2011.
20. A Text Book of Physical Chemistry - Vol. I & II ; K. L Kapoor; MacMillan India Ltd., 3rd edn. 2005.
21. Text Book of Physical Chemistry ; K.K Sharma; Vikas Publishing House, 2nd edn., 1980.
22. A Text Book of Physical Chemistry ; A.S .Negi & S.C Anand ; New Age International Publishers, 2nd edn., 2008.

Laboratory Course

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Min. Marks: 09
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A. Inorganic Chemistry

Qualitative analysis (macro) of inorganic mixture containing two cations and two anions, excluding insoluble and interfering radicals.

B. Organic Chemistry :

Calibration of Thermometer, determination of melting points, boiling points. Simple distillation of organic solvent-water mixture using water condenser.

Crystallization: Concept of induction of Crystallization . Crystallization of atleast two organic compounds.

Sublimation: Simple sublimation of two organic compounds e.g. camphor and phthalic acid.

Qualitative Analysis: Detection of N, S and Halogen's in given organic compounds.

Detection of functional groups (Phenols , Carboxylic acids, Carbohydrates, Carbonyl compounds, Amines and nitro groups) in simple organic compounds.

C. 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 compare the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of ethyl acetate.

Colloids

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

Viscosity and Surface Tension

1. To determine surface tension of a liquid.
2. To determine the percentage composition of a given binary mixture by surface tension method (acetone & ethyl methyl ketone).
3. To determine viscosity co-efficient of a liquid.
4. To determine the percentage composition of a given mixture (non interacting systems) by viscosity method.

Books Suggested:

1. Vogel's Qualitative Inorganic Analysis; Svehla ; Orient Longman, 7th edn., 2004
2. Advanced Practical Inorganic Chemistry ; Gurdeep Raj ; Goel Publishing House, 15th edn. 2001.
3. Vogel's book of Practical Organic Chemistry , B.S. Furniss, A.J. Hannaford , V. Rogers , P.W.G. Smih , ELBS, 5th edn., 2009.
4. Selected Experiments in Physical Chemistry, N.G. Mukherjee , J.N. Ghosh & Sons.