

Syllabus of Chemistry (Major & Minor) for 3-Year and 4-Year B.Sc. Course

Chemistry Major

Semester-I

Paper Code: **CEMMJ-T1**(Organic Chemistry - I)

(Credit: 03)

Total Lectures: 45

1. Bonding and Physical Properties:

(15L)

VBT: A Fundamental Approach

Concept of Hybridization, Shapes of Molecules, Orbital Pictures of Bonding, Bond Polarisation and Bond Polarizability, DBE and Formal Charge Calculation.

Electronic Effects: Inductive Effect, Field Effect, Mesomeric Effect, Resonance Energy; Electromeric Effect; Hyperconjugative Effect, Steric Effect, Steric Inhibition of Resonance.

Molecular Orbitals: A Fundamental Approach

Bonding and Antibonding Interactions, Types of Molecular Orbitals: σ , σ^* , π , π^* , n . Overview of Frontier MOs (FMO) - HOMO, LUMO and SOMO. Chemical Reactivity in Terms of FMO Interactions – Basic Applications. Hückel's Rules for Aromaticity. Concepts of Antiaromaticity and Homoaromaticity. Applications in context of various molecular properties. Frost Diagram.

Fundamental Physical Properties of Organic Molecules

Impact of Hybridization on Bond Dissociation Energy, Bond Energy, Bond Distances and Bond Angles. Understanding Different Types of Strains: Angle Strain, Torsional Strain, Strain Due to Non-Bonded Interaction and Dipole-Dipole, Twisting. Impact Of Covalent and Non-Covalent Intermolecular Forces On Melting Point, Boiling Point, and Solubility. Comparison of Stability Through Exp. Data: Heat of Hydrogenation, Heat of Combustion, and Heat of Formation.

2. Reaction Mechanism-I

(15L)

Mechanistic Classification of Reactions (Definition and Examples): Ionic, Radical and Pericyclic. Types Of Reactions (Definition and Examples): Addition, Elimination, Substitution, Rearrangement, Oxidation-Reduction, Tautomerization, Condensation, Polymerization.

Homolytic And Heterolytic Bond Fission, Homogenic and Heterogenic Bond Formation

Types Of Reagents. Reactive Intermediates (Generation, Structure, Stability, Electrophilic/Nucleophilic Behavior): Carbocations, Carbanions, Carbon Radicals, Carbenes, Carbenoids, Benzynes and Nitrenes. Basic Mechanistic Approach to the mechanism of Aliphatic Nucleophilic Substitution & Elimination Reaction with simple examples (Detail Discussion at Higher Semester).

3. Stereochemistry -I

(15L)

Chirality & Representation of Molecules

Concept Of Chirality -Symmetry Elements And Point Groups (C_v , D_h , C_{nh} , C_{nv} , C_n , D_{nh} , D_{nd} , D_n , S_n (C_s , C_i); Molecular Chirality And Centre Of Chirality; Asymmetric And Dissymmetric Molecules;

Enantiomers And Diastereomers; Concept of Epimers. Fischer, Sawhorse, Flying- Wedge and Newman Projection Formulae and Their Inter Translations.

Relative And Absolute Configuration:

D/L And R/S Descriptors; Erythro/Threo and Meso Nomenclature of Compounds; Syn/Anti Nomenclatures For Aldols; E/Z Descriptors For C=C, Conjugated Diene, Triene, C=N And N=N Systems; Combination Of R/S- And E/Z- Isomerisms.

Optical activity of Chiral Compounds:

Optical Rotation, Specific Rotation and Molar Rotation; Racemic Compounds, Racemisation (Through Cationic, Anionic, Radical Intermediates and Through Reversible Formation of Stable Achiral Intermediates); Resolution of Racemic Mixture, Optical Purity And Enantiomeric Excess.

Reference Books:

1. Clayden, J., Greeves, N. & Warren, S. Organic Chemistry, Second Edition, Oxford University Press, 2012. 2. Smith, J. G. Organic Chemistry, Tata Mcgraw- Hill Publishing Company Limited. 3. Nasipuri, D. Stereochemistry of Organic Compounds, Wiley Eastern Limited. 4. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education). 5. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd., (Pearson Education). 6. Fleming, I. Molecular Orbitals and Organic Chemical Reactions, Reference/Student Edition, Wiley, 2009. 7. Eames, J., Peach, J. M. Stereochemistry at A Glance, Blackwell Publishing, 2003. 8. Robinson, M. J., Stereochemistry, Oxford Chemistry Primer, Oxford University Press, 2005.

Paper Code: CEMMJ-P1(Organic Chemistry - I PRAC)

(Credit: 01)

(30 Hours)

List of Experiments

1. Determination of Boiling Point:

Determination Of Boiling Point of Common Organic Liquid Compounds E.G., Ethanol, Cyclohexane, Chloroform, Ethyl Methyl Ketone, Cyclohexanone, Acetylacetone, Anisole, Crotonaldehyde, Mesityl Oxide, Etc. [Boiling Point of The Chosen Organic Compounds Should Preferably Be Less Than 160°C]

2. Identification of A Pure Organic Compound by Chemical Test(S): Solid Compounds:

Oxalic Acid, Tartaric Acid, Citric Acid, Succinic Acid, Resorcinol, Urea, Glucose, Cane Sugar, Benzoic Acid and Salicylic Acid.

Liquid Compounds:

Formic Acid, Acetic Acid, Methyl Alcohol, Ethyl Alcohol, Acetone, Aniline, Dimethylaniline, Benzaldehyde, Chloroform and Nitrobenzene.

Paper Code: CEMMJ-T2(Physical Chemistry - I)

(Credit: 03)

Total Lectures: 45

1. Kinetic Theory and Gaseous State:

(15L)

Kinetic Theory of Gases:

Concept of Pressure and Temperature; Collision Diameter; Collision Number and Mean Free Path; Frequency of Binary Collisions. Maxwell's Distribution of Speeds in One, Two and Three Dimensions; Kinetic Energy Distribution on One, Two and Three Dimensions, Average, Root Mean Square and Most Probable Velocities. Principle of Equipartition of Energy.

Gaseous State:

Deviation of Gases from Ideal Behavior; Compressibility Factor; Boyle Temperature; Andrew's And Amagat's Plots; Van Der Waals Equation And Its Features; Its Derivation And Application In Explaining Real Gas Behaviour, Critical State, Critical Constants In Terms Of Van Der Waals Constants; Law Of Corresponding States. Virial Equation of State.

2. Thermodynamics-I:

(12L)

First Law and Zeroth Law of Thermodynamics:

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics; First law of thermodynamics; calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions; Joule's experiment and its consequence.

Thermochemistry:

Heats Of Reaction; Enthalpy of Formation; Laws of Thermochemistry; Bond Energy, Bond Dissociation Energy, Kirchhoff's Equations and Effect of Pressure On Enthalpy Of Reactions. Adiabatic Flame Temperature, Explosion Temperature

3. Chemical Kinetics I:

(18L)

Rate Law, Order and Molecularity:

Elementary and Non-Elementary Reactions, Rate law Rate constants, Order; Molecularity, First, second and nth order reactions; Pseudo first order reactions Determination of order of a reaction Opposing reactions, consecutive reactions and parallel reactions

Role of Temperature and Theories of Reaction Rate:

Temperature Dependence of Rate Constant; Arrhenius Equation, Energy of Activation; Steady-State Approximation; Theories of Reaction Rate: Collision Theory; Lindemann Theory of Unimolecular Reaction; Transition State Theory (Classical Treatment).

Reference Books:

1. Atkins, P. W. & Paula, J. de Atkins' Physical Chemistry, Oxford University Press. 2. Castellan, G. W. Physical Chemistry, Narosa. 3. McQuarrie, D. A. & Simons, J. D. Physical Chemistry: A Molecular Approach, Viva Press. 4. Engel, T. & Reid, P. Physical Chemistry, Pearson. 5. Levine, I. N. Physical Chemistry, Tata McGraw-Hill. 6. Maron, S. & Prutton Physical Chemistry. 7. Ball, D. W. Physical Chemistry, Thomson Press. 8. Mortimer, R. G. Physical Chemistry, Elsevier. 9. Laidler, K. J. Chemical Kinetics, Pearson. 10. Glasstone, S. & Lewis, G. N. Elements of Physical Chemistry. 11. Rakshit, P. C., Physical Chemistry Sarat Book House. 12. Zemansky, M. W. & Dittman, R. H. Heat and Thermodynamics, Tata- McGraw-Hill. 13. Rastogi, R. P. & Misra, R. R. An Introduction to Chemical Thermodynamics, Vikas. 14. Clauze & Rosenberg, Chemical Thermodynamics.

Paper Code: CEMMJ-P2 (Physical Chemistry - IPRAC)

(Credit: 01)

(30 Hours)

List of Experiments

1. Determination of pH of Unknown Solution (Buffer), By Colour Matching Method.
2. Study of Kinetics of Acid-Catalyzed Hydrolysis of Methyl Acetate.
3. Study of Kinetics of Decomposition of H₂O₂
4. Determination of Heat of Neutralization of A Strong Acid By A Strong Base.

Total Lectures: 45

1. Introduction

(4L)

Strategies of analytical chemistry and its interdisciplinary applicability. Protocol of sampling. Variability and validity of analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

2. Complexometry

(5L)

Complexometric titrations, chelation, chelating agents, use of indicators. Estimation of calcium and magnesium ions as calcium carbonate by complexometric titration.

3. Soil Analysis

(3L)

Composition, pH of soil samples, estimation of calcium and magnesium content.

4. Analysis of Water

(7L)

Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods. Determination of pH, acidity and alkalinity of a water sample. Determination of Biological Oxygen Demand (BOD).

5. Analysis of Food Products

(7L)

Nutritional value of foods, ideas about food processing and food preservatives and adulteration. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc. Analysis of preservatives and colouring matter.

6. Chromatography

(9L)

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc. Paper chromatographic separation of mixture of metal ions (Fe^{3+} , Al^{3+} and Ni^{2+} , Co^{2+}). To compare paint samples by TLC method.

6. Ion-exchange

(4L)

Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

7. Analysis of Cosmetics

(6L)

Major and minor constituents and their function.

Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration

Reference Books:

1. Analytical Chemistry (Skill Enhancement Course), K. Chattopadhyay, M. Mandal; CBS Publishers & Distributors Pvt. Ltd.
2. Analytical Chemistry, Gurdeep R. Chatwal, Himalaya Publishing House.
3. Quantitative Analysis, R.A. Day, A.L. Underwood, PHI Learning Private Limited.
4. Food Science (Seventh Edition), B. Srilakshmi, New Age International Publishers.
5. Dinesh Fuel Chemistry & Chemistry of Cosmetics & Perfumes, S.K. Juneja, A. Kumar, S. Dinesh & Co.