Anekant Education Society's
Tuljaram Chaturchand College, Baramati 413102 (Dist –Pune)
(Autonomous)

Department of Chemistry
S.Y.B.Sc Chemistry Semester III
Syllabus 2022 Pattern with effect from June 2023
Paper I

USCH231: Physical and Analytical Chemistry-I (48 L, 3 Credits)

A. Learning Objective:

1. To introduce the basic concepts of chemical kinetics in terms of molecularity, rate of reaction, order of reaction etc.
2. To provide the details of energetics regarding free energy and entropy of the process.
3. To learn the basic principles of chemical equilibrium and its applications.
4. To adequate the student about the basic analytical tools used in chemical analysis.
5. To obtain the qualitative and quantitative parameter by performing different types of titrimetric analysis.

B. Learning Outcome:

1. Students will be able to apply the knowledge of chemical kinetics to represent the mechanism of chemical reaction.
2. Students will be able to learn concepts in energetics and free energy to study the applications in chemical equilibrium.
3. Students will learn to understand concepts utilized in volumetric analysis by learning different types of titrations.

Section I: Physical Chemistry

1. Chemical Kinetics (10 L)

Introduction, The concept of reaction rate. Effects of various factors like temperature, pressure, presence of catalyst on the reaction rate. Order and Molecularity of a chemical reaction. Derivation of integrated reaction rate equation for zero, first, second order (both for equal and unequal initial concentrations of reactants) reactions and third order reaction (no derivation). Half-life period of reaction. General methods for determination of order of reaction. Concept of activation energy and its determination from Arrhenius equation. Numerical problems.

2. Chemical Thermodynamics (6 L)

Second Law of Thermodynamics: Concept of entropy; statement of the second law of thermodynamics; Calculation of entropy change (Δ S) forreversible and irreversible processes under different conditions. Numerical problems.

Third Law of Thermodynamics: Concept of absolute entropy. Statement of third law.

3. Free energy and Chemical Equilibrium (8 L)

Introduction, Helmholtz free energy, variation of it with volume and temperature, Gibbs free energy, variation of it with pressure and temperature,

Gibbs free energy change for chemical reaction, Free energy change for an ideal gas. Free Energy and equilibrium - Concept, Definition and significance

The reaction Gibbs energy. The perfect gas equilibrium, the general case of equilibrium, the relation between equilibrium constants, molecular interpretation of equilibrium constant.

Van't Haff equation, Value of K at different temperature, Problems

Reference books:

1. Principles of Physical Chemistry, S. H. Marron and C. F. Pruton, 6th edn.
2. Essentials of Physical Chemistry, Bahl, Tuli, Revised multicolour edn. 2009
3. Physical Chemistry, G. M. Barrow, Tata McGraw-Hill (2007)
4. University Chemistry, B. H. Mahan, 3rd edn. Narosa (1998)
5. Chemical Thermodynamics, R. P. Rastogi and R.P. Misera

Section II: Analytical Chemistry

1. Analytical Chemistry and Essentials (10 L)

A brief introduction of analytical chemistry, the analytical perspectives, Common analytical problems.

Solution and their concentrations- Molar concentrations, Molar analytical Concentrations, Molar equilibrium concentration, percent Concentration, Preparation of ppm level solutions from source materials (salts), conversion factors, density and specific gravity of solutions, Numerical problems

Chemical Stoichiometry – empirical and molecular formulas, Stoichiometriccalculations, Numerical problems.

2. Volumetric Analysis (14 L)

Introduction to volumetric analysis Calibration of apparatus, Standard solutions, Equivalent weights in different type of reactions, Classification of volumetric analysis,

I. Neutralization titration: Acid base indicators, Ostwald's theory of indicators, neutralization curves for strong acid- strong base, weak acid- strong base, weak base- strong acid, Determination of equivalence point and calculations. Problems.

II. Complexometric titration: Principle, Mg- EDTA titration, metal ion indicators, choice of indicators. Applications,

III. Redox titration: Principle, detection of equivalence point using suitable indicators. Titration between oxalic acid and $KMnO_4$. Applications.

IV. Precipitation titration: Principle, titration between $AgNO_3$ and halide ions by Volhard's method and Fajan's method. Detection of end point of the titration. Applications.

V. Iodometric titration: Principle, detection of end point, difference between iodometry and iodimetry, standardization of $Na_2S_2O_3$ solution using $K_2Cr_2O_7$ and estimation of iodine. Applications.

Reference books:

1. Basic concept of Analytical Chemistry, S. M. Khopkar
2. Instrumental methods of chemical analysis, Willard, Merritt, Dean
3. Analytical Chemistry, G. D. Christian
4. Introduction to Instrumental analysis, R. D. Brown
5. Fundamentals of Analytical Chemistry, Skoog
6. Instrumental methods of chemical analysis, Chatwal and Anand

Paper II

USCH 232: ORGANIC AND INORGANIC CHEMISTRY- I (48 L, 3 Credits)

A. Learning Objective:

1. To understand basic concept of isomerism, types of isomers and their stereochemistry.
2. To introduce the Baeyer's strain theory and its applications.
3. Students should learn to optical isomerism and know about stability, energy calculation with Potential diagram and optical activity of these conformers.
4. Students should know-definition and types of aliphatic amines and analysis of primary, secondary and tertiary amines.
5. Students should provide the types of reagents, types of organic reaction and types of rearrangement.
6. Students should understand the concept MOT of Oh complex with sigma bonding.
7. To know the limitation of VBT and the assumption of CFT
8. Students should able to explain d-d transitions and colour of the complex.
9. Students should understand and the concept of acid, base theory.

B. Learning Outcome:

1. Learning stereochemistry of the mono-substituted cyclohexane with their stereoisomerism and their stability.
2. Students will be able to learn concepts of the aliphatic substitution reaction and difference between them.
3. Students will be able to apply the knowledge to represent the mechanism of organic reaction.
4. Students will be learn the VB representation of tetrahedral, square planer, trigonal bipyramidal and octahedral complex.
5. Students will be able to learn the concepts of the VBT and CFT.
6. Learning of acid, base and solvent of Arrhenius theory, Lowry-Brönsted theory, Lux-Flood concept, Lewis concept.

Section I: Organic Chemistry

1. Stereoisomerism (10 L)

i) Introduction to optical isomerism - Optical Activity and polarimetry- Ordinary light, mono chromatic light, plane polarized light, optical activity, dextro rotatory, leavo rotatory, specific rotation, causes of optical activity, chirality, asymmetric carbon atom, Enantiomerism, Diastereomerism.

ii) Stereoisomerism - Baeye'rs strain theory, heat of combustion, cycloalkanes, factors affecting the stability of conformation, Conformation of cyclohexane - equatorial and axial bonds, Mono-substituted cyclohexane stability with $-CH_3$ and-$C(CH_3)_3$ substitutes. Structures of geometrical isomers of dimethyl cyclohexane.

Ref. 2

2. Aliphatic amines (6 L)

a) Structure b) Classification c) nomenclature d) physical Properties.

e) preparation of amine from – reduction of nitro compounds, reductive amination, reduction

of nitriles, Hoffmann degradation of amides f) Reactions of amines - alkylation, conversion into amides, Analysis of amine.

Ref. 1

3. Organic reaction Mechanism (8 L)

Introduction, types of reagents–electrophile, nucleophile and free radical. Types of organic reactions: Addition, Elimination (β-elimination and Hofmann elimination), substitution (aliphatic electrophilic and nucleophilic, aromatic electrophilic) and rearrangement. Mechanism: (i) Markovnikov and anti-Markovnikov addition reaction (ii) Saytzeff and Hoffmann elimination (iii) SN^1 and SN^2 reactions (v) Pinacol-Pinacolone rearrangement (vi) Wagner-Meerwin reaction.

Ref. 1, 3 and 4

Reference Books:

1. Organic Chemistry. Morrison and Boyd, 6th Ed Prentice Hall, New Delhi-2001.
2. Stereochemistry of carbon compounds, E. L. Eliel
3. Reactions, rearrangements and reagents, S N Sanyal
4. A guide book to Mechanism in Organic Chemistry, Peter Sykes, 6th Ed

Section II: Inorganic Chemistry

1. Molecular Orbital Theory of diatomic molecules (12 L)

Limitations of Valence Bond theory(VBT), Need of Molecular orbital theory (MOT), Features of MOT, Sigma and pi bond, Molecular orbital Method, LCAO principle and method, s-s combinations of orbitals, s-p combinations of orbitals, p-p combinations of orbitals, p-d combinations of orbitals, d-d combinations, Non-bonding combinations of orbitals, Rules for linear combination of atomic orbitals.

Examples of molecular orbital treatment for homo-nuclear diatomic molecules: (Explain each molecule with respect to MO energy level diagram, bond orderand magnetic behavior) H_2^+ molecule ion, H_2 molecule, He_2^+ molecule ion, He_2 molecule, Li_2 molecule, Be_2 molecule, B_2 molecule, C_2 molecule, N_2 molecule, O_2 molecule, O_2^+, O_2^- and O_2^{2-} molecule ion, F_2 molecule, Ne_2 molecule.

Heteronuclear diatomic molecules: Examples of molecular orbital treatment for hetero-nuclear diatomic molecules, NO molecule, CO molecule, HF molecule.

2. Chemistry of d-block (6 L)

Introduction, electronic configuration, size of atoms and ions, density, melting points and boiling points, reactivity, oxidation state, catalytic properties, colour and magnetic properties of complexes. Comparison of 1 st transition series with 2 nd & 3 rd transition series w.r.t.- a) electronic configuration b) reactivity c) Stability of oxidation state d) magnetic behavior and e) Stability of complexes (in brief)

3. Acid, base and solvents (6 L)

Properties of solvents, Arrhenius theory, Lowry-Brownsted theory, Solvent system, Lux-Flood concept, Lewis concept, Hydracids and Oxyacids.

Reference Books:

1. Concise Inorganic Chemistry, Lee, J.D. ELBS, 1991.
2. Basic Inorganic Chemistry, Cotton, F.A., Wilkinson, G. & Gaus, P.L. 3rd ed.,Wiley.
3. Concepts and Models in Inorganic Chemistry, Douglas, B.E., McDaniel, D.H. & Alexander, J.J. John Wiley & Sons.
4. Inorganic Chemistry: Principles of Structure and Reactivity, Huheey, J. E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. Pearson (2006)

Paper III

USCH233: Chemistry Practical- III (2 credit)

A. Learning Objective:

1. Students will learn the skill needed for operation and conduct the experiments from various sections of chemistry
2. Students will familiar with the experimental technique and get hands on training on sophisticated instruments.
3. Students will gain the expertise in organic chemistry practical through appropriate handling of apparatus and chemicals.

B. Learning Outcome:

1. Students should able to understand the theory and principles about the selected experiments.
2. Students should able to develop the experimental and operational skill through hands on training.
3. Students will able to analyze the organic compounds in terms of qualitative analysis and develop the skills in synthesis of various organic compound.

Section I: Physical Chemistry Practical (Any five experiments)

1. Study of variation of mutual solubility temperature with concentration for thephenol water system and determination of the critical solubility temperature.
2. Determination of solubility of Benzoic acid at different temperature and calculate ΔH of solution.
3. To determine the first order rate constant of acid catalyzed ester hydrolysis.
4. To determine the rate constant of base catalyzed ester hydrolysis.
5. To study the standardization and working of potentiometer and determine the potential and pH of two buffer solutions.
6. To study the standardization and working of pH meter and determine the equivalence point for pH metric titration between strong acid and strong base.

Reference Book:

1 A Senior Practical Physical Chemistry, Khosla, Garg & Gulati, R, Chand & Co
2. Practical Physical Chemistry, A M. Jemes, F. E. Prichard, 3rd edn, Longman.
3. Advanced Practical Physical Chemistry, J. B. Yadav, Goel Publishing house

Section II: Organic Chemistry Practical

1) Organic Qualitative Analysis (Four Single compounds).

Identification of organic compounds through –

a) Type determination b) preliminary tests c) detection of elements (Sodium fusion tests) d) detection of functional groups e) melting point / Boiling point

i) Acid (any two): benzoic, salicylic, phthalic, cinnamic, oxalic, salicylic acid

ii) Phenol (any two): α-naphthol, β-naphthol, resorcinol, o-nitrophenol, p- nitrophenol

iii) Base (any two): Aniline, p-toludine, diphenylamine, N, N-dimethylaniline, o-nitroaniline m-nitroaniline, p-nitroaniline

iv) Neutral (any two): Benzaldehyde, glucose, fructose, acetone, ethylmethyl ketone, acetophenone, methyl acetate, ethyl acetate, naphthalene, Anthracene, Nitrobenzene, mdinitrobenzene, Acetamide, Urea, Acetanilide, Chloroform, Carbon tetrachloride, Thiourea.

2) Organic Preparation (any two) (With crystallization, M. P. and TLC)

i) Aspirin from salicylic acid

ii) P-Nitro Benzoic acid from P- Nitro Toluene

iii) phthalic anhydride from phthalic acid

iv) Osazone form glucose

v) Quinone form Hydro Quinone

Reference Book:

1 Organic Qualitative Analysis – A. I. Vogel