Shiksha Mandal's

Jankidevi Bajaj College of Science, Wardha

Department of Chemistry

Syllabus of B. Sc. (Semester I to IV)

(Approved in BOS Meeting Dec-2017)

Shiksha Mandal's

Jankidevi Bajaj College of Science, Wardha

Syllabus of B.Sc. I / Semester I

SUBJECT - CHEMISTRY

CY I: (Fundamentals of Inorganic, Organic & Physical Chemistry) (72 Hrs)

Course Objectives:-

1. To reinforce the basics of Inorganic Chemistry with special reference to atomic structure, periodic table and periodicity of properties
2. To understand the structure of most important basic unit of matter i.e. atom
3. To elaborate important principles regarding behavior and arrangement of electrons in an atom i.e. wave particle duality, uncertainty principle, Aufbau principle, Pauli's exclusion principles and Hund's rule of maximum multiplicity
4. To study the concept of quantum numbers and to learn the electronic configuration of elements
5. To study the covalent bonding in various molecules
6. To learn various periodic properties and their trends in periodic table
7. To understand Slater's rules and to learn the calculation of Screening constant and EAN
8. To understand various bond theories especially VSEPR and Valence Bond Theory
9. To understand ionic bonding with respect to various physical properties
10. To understand fundamental concepts in organic chemistry inductive effect, electromeric effect, resonance, hyperconjugation, homolysis, heterolysis, nucleophiles and electrophiles
11. To learn to classify reaction types and intermediates
12. To differentiate between various types of stereoisomerism – geometrical and optical isomerism
13. To understand fundamentals of optical, geometrical and conformational isomerism
14. To understand the behavior of gases, ideal gas as a model system, its extension to real gases and the dependence of physical state on pressure, volume and temperature
15. To understand different physical properties of liquids
16. To study and understand the tenets of thermodynamics pertaining to First Law of thermodynamics
17. To correlate between and calculate change in enthalpy of various reactions

Unit I: Atomic Structure and Periodic Properties (12 Hrs)

A. **Atomic structure**: Recapitulation of atomic models, Failure of classical mechanics and Foundation of Quantum mechanics: Explanation on the basis of Black body radiation, Photoelectric effect and heat capacity of solids, Hydrogen atom spectra, Bohr's model of Hydrogen atom (No derivation), Plank's quantum theory, De Broglie's hypothesis (Explanation and Derivation). Heisenberg's uncertainty principle (Explanation), Quantum numbers, shapes of s, p, and d orbitals, Aufbau principle, Pauli's exclusion principles and Hund's rule of maximum multiplicity. Electronic Configuration of elements and ions (Z = 1 to 30)

B. **Periodic Properties**: Atomic and ionic radii, (Covalent radii, Vander Waals radii & metallic radii), ionization Potential (Definition, Factors affecting & trends in Periodic table), Electron gain enthalpy and electronegativity (Definition & trends in Periodic table. Pauling's and

Muliken's scale of electronegativity. Effective nuclear charge and Slater's rule with some exercises.

Unit II: Chemical Bonding **(12 Hrs)**

A. Covalent Bond: Recapitulation of Bond Theories, Valence shell electron pair repulsion (VSEPR) theory to NH_3, SF_4, ClF_3, and H_2O, Limitations of VSEPR, Valance bond theory, Formation of Hydrogen molecule, directional characteristics of covalent bond, types of covalent bond, overlap criterion and bond strength. Bond energy, bond length, Bond order & Bond angle. Limitations of VBT. Need of concept of hybridization, Hybridization and its types (sp, sp^2, sp^3, sp^3d, sp^3d^2, sp^3d^3).

B. Ionic bond: Introduction, Lattice energy and its calculation by using Born- Haber cycle. Solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajans rule.

Unit III: Basics of Organic Chemistry **(12 Hrs)**

A. Structure & bonding of alkanes, alkenes & alkynes. Brief Idea of Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis, Nucleophiles and electrophiles.

B. Reactive Intermediates: Carbocations, Carbanions and free radicals (Methods of Preparation & Reactions). Types of organic reactions — addition, substitution, elimination, rearrangement.

Unit IV: Stereochemistry **(12 Hrs)**

Concept of isomerism. Types of isomerism with suitable examples

A. Optical isomerism-elements of symmetry, molecular chirality, enantiomers, stereogenic centre (lactic acid as example). Optical activity, chiral and achiral molecules with two stereogenic centres (Tartaric acid) diastereo-isomers, mesocompound. Relative and absolute configuration, sequence rules, D & L and R & S system of nomenclature, resolutions of racemic mixture and its types, inversion, retention and racemization, asymmetric synthesis.

B. Geometrical isomerism: E & Z system of nomenclature, geometric isomerism in maleic acid and fumaric acid and 2-butene. **Conformational isomerism:** Conformational analysis of ethane and n-butane. Newman's projection and sawhorse formulae. Difference between configuration and conformation.

Unit V: States of Matter **(12 Hrs)**

A. Gaseous State

Kinetic theory of gases (Postulates), derivation of kinetic gas equation, deduction of various gas laws from kinetic gas equation (Boyle's, Charles', Graham's, Avagadro's laws). Maxwell's distribution of velocities (graph and qualitative discussion), Effect of temperature on molecular velocities. Different types of molecular velocities - most probable, R.M.S. and average and expressions for them, their inter relationships. Concepts of Mean free path, collision diameter and collision number. Explanation of deviation of real gases from ideal behavior, Compressibility factor and Boyle temperature. Van der Wall's equation of state, Critical phenomenon, Andrew's isotherm of a real gas (CO_2) and its comparison with van der Waal's isotherm, Relationship between critical constants and van der Waal's constants, Law of corresponding states.

B. Liquid State: Important interactions in liquid state – dipole- dipole, dipole-induced dipole, induced dipole- induced dipole; Properties of liquids i) Surface tension: Explanation, Drop number method of determination, (Numericals) ii) Viscosity: Explanation, coefficient of

viscosity, Effect of temperature on Viscosity, Method of determination by Ostwald viscometer. (Numericals)

Unit-VI Thermodynamics **(12 Hrs)**

A. Basic concept of thermodynamics: system, surrounding, types of system (closed, open & isolated), thermodynamic variables, intensive & extensive properties, thermodynamic processes isothermal, adiabatic, isobaric, isochoric, cyclic, reversible & irreversible. State function & path functions, Concept of heat, work, internal energy & enthalpy. Zeroth law of thermodynamics Heat of reaction, relation between heat of reaction at constant volume and constant pressure. Hess`s law of constant heat of summation & its applications (Numericals).

B. First law of thermodynamics, concept of heat capacity, heat capacity at constant volume and at constant pressure, their relationship. E as a function of V & T and H as a function of P & T. Joule-Thomson experiment, Joule-Thomson coefficient & inversion temperature, calculations of w, q ΔE & ΔH for reversible expansion of ideal gases under isothermal and adiabatic conditions (Numericals).

Reference Books:

Inorganic Chemistry

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

Organic Chemistry

- Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry,* John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New
- Delhi (1988).
- Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
- Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.
- P. S. Kalsi *Organic Stereochemistry, narosa*
- http://nsdl.niscair.res.in
- http://ocw.mit.edu

Physical Chemistry

- S.H. Marron and C.F.Pruton. *Principles of Physical Chemistry*,4th edition
- Samuel Glasstone. *Textbook of Physical Chemistry*,
- Ira Levine, *Physical Chemistry*, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd.
- G.M. Barrow, *Physical Chemistry*, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- Atkins, P. W. & Paula, J. de Atkins *Physical Chemistry* 9th Ed.,Oxford UniversityPress2011.
- Puri, Sharma and Pathania. *Principles of Physical Chemistry*,
- Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa 2004.

- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall 2012.
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi 2004.
- Skoog, West, Holler and Crouch *Fundamentals of analytical chemistry*, 8th edition.
- Ball, D. W. *Physical Chemistry*, 3rd Ed., Cengage India.2012.
- Rogers, D. W. *Concise Physical Chemistry* Wiley 2010
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY 2011
- http://nsdl.niscair.res.in
- http://ocw.mit.edu

CHEMISTRY LAB: Practical Course **(72 Hrs)**

Course Objectives:-

1. To learn to perform experiments those have specific aims with correct techniques.
2. To develop skills of observation, recording and analyzing data.
3. To learn to present the experimental work in a systematic manner.
4. To understand mole concept, concentration calculations and stoichiometric relations.
5. To apply inter – conversions to relate various concentration units.
6. To differentiate between primary and secondary standards.
7. To understand role of indicators and to study types of volumetric titrations.
8. To learn to identify extra element in given organic compound.
9. To learn to identify functional group in given organic compound.
10. To learn to determine
    a. heat capacity of calorimeter
    b. enthalpy of ionization of a weak acid
    c. integral enthalpy of solution of KNO_3
    d. solubility of benzoic acid in water and heat of solubility
    e. surface tension of a liquid
    f. coefficient of viscosity of a liquid

Inorganic Chemistry

1. Calibration of pipette.
2. Preparation of standard solution of an acid (oxalic acid) & a base (sodium bicarbonate) by weighing and calculation of concentrations in terms of strength, normality, molarity, molality, formality, % by weight, % by volume , ppm, ppb and mole fraction.
3. Preparation of standard solution of hydrochloric acid by diluton and calculation of concentrations in terms of strength, normality, molarity, molality, formality, % by weight, % by volume , ppm, ppb and mole fraction.
4. Determination of strength of HCl & CH_3COOH using NaOH volumetrically (Discussion of acid-base indicator theories is expected).
5. Determination of acetic acid in commercial vinegar using NaOH.
6. Determination of alkali content in antacid tablet using HCl.

Organic Chemistry

1. Detection of elements (N, S, Cl, Br, I) in organic compounds.
2. Detection of functional groups.

Physical Chemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of ionization of acetic acid.
3. Determination of integral enthalpy of solution of KNO_3

4. Study of the solubility of benzoic acid in water and determination of heat of solubility
5. To determine co-efficient of viscosity of organic liquids.
6. Determination of surface tension of organic liquids.

Reference Books:-

- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education, 2012.
- Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson, 2009.
- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011)
- http://nsdl.niscair.res.in
- http://ocw.mit.edu

Shiksha Mandal's
Jankidevi Bajaj College of Science, Wardha
Syllabus of B.Sc. I /Semester II
SUBJECT – CHEMISTRY

CY II Concepts of Inorganic, Organic & Physical Chemistry **(72 Hrs)**

Course Objectives:-

1. To learn name, symbol, electronic configuration, trends and properties of s – block elements.
2. To study the applications of s-block elements: Industrial, biological and agricultural field.
3. To learn chemical properties of the noble gases.
4. To learn name, symbol, electronic configuration, trends and properties of p – block elements.
5. To know the exact position p-block elements in the long form of the periodic table.
6. To understand reasons for anomalous behavior of first element of IIIA to VII A groups with other elements in the same group.
7. To study basic compounds of boron, nitrogen, phosphorous
8. To understand the concept of oxyanions, oxyacids of phosphorous & sulphur.
9. To learn the common and IUPAC names of alkanes, alkenes, alkynes, aromatic hydrocarbons, alkyl and aryl halides.
10. To understand the Methods of preparation and chemical reactions of alkanes, alkenes, alkynes, aromatic hydrocarbons, alkyl and aryl halides.
11. To learn how to apply Huckel's rule to different organic compounds to find out aromatic /non aromatic characters.
12. To understand the natural changes with the help of second law of thermodynamics.
13. To present second law of thermodynamics with the help of state function entropy
14. To understand entropy changes in various processes and under various conditions..
15. To study various laws of crystallography and elaborate crystal structures of some compounds
16. To understand the meaning of phase, component and degree of freedom and explanation of one and two component systems.
17. To know ideal and non ideal solutions and laws governing these solutions and partially immiscible liquids.
18. To learn concept of distribution of solute amongst pair of immiscible solvents and its application in Solvent extraction.

Unit I: s-block elements & Noble Gases **(12 Hrs)**

A. s-block elements- Comparative study: Electronic configuration, atomic and ionic radii, hydrogen bonding and its consequences, Ionisation potential, Reducing properties. Diagonal Relationships (Li-Mg). Applications of s-block elements.

B. Chemistry of Noble Gases: Chemical properties of the noble gases, Chemistry of Xenon, Structure and bonding in xenon fluorides (XeF_2, XeF_4 and XeF_6) and oxyfluorides ($XeOF_2$ and $XeOF_4$).

Unit- II: p-block elements **(12 Hrs)**

A. **Comparative study of groups 13 to 17:** Atomic and ionic radii, Ionisation potential, electron affinity, electronegativity, redox properties. Diagonal relationship (B-Si). Hydrogen bonding .Classification and effect of Hydrogen bonding on viscosity, solubility, M.pt. and B.pt.

B. **Hydrides :**Comparative study with respect to structure of NH_3, PH_3, AsH_3 and SbH_3.
Oxides: Structure of P_2O_3 .P_2O_5 and Oxyacids of Phosphorous (H_3PO_3 and H_3PO_4) & Applications.
Peroxyacids of sulphur: Preparation and structure of Caro's and Marshall's acids & Applications
Hydrides of boron: Structure and bonding of diborane , structure of borazine . Applications of p- block elements.

Unit III: Aliphatic Hydrocarbons (I) **(12 Hrs)**

A. **Alkanes:** Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

B. **Alkenes:** Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides, Saytzeff's & Hoffman rule); Stereospecific reductions of alkynes (H_2/Pd, $BaSO_4$ & Na/liq NH_3): cis-addition (alk. KMnO4) and trans-addition (bromine), Addition of HX (Markovnikoff's and anti-Markownikoff's addition), Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

C. **Alkynes:** Nomenclature, Methods of formation of acetylene from - calcium carbide, dehydrohalogenation of dihalides Chemical reaction - hydroboration, oxidation metal ammonia reduction & polymerization. Oxyacetylene flame. Acidity of alkynes.

Unit IV: Aliphatic Hydrocarbons (II) and Aromatic hydrocarbons **(12 Hrs)**

A. **Dienes:** Nomenclature and classification of dienes Methods of formation of 1, 3 - butadiene. Chemical reactions of butadiene - 1, 2 and 1, 4 additions Diels-Alder reaction.

B. **Aromatic compounds and Aromaticity:** Nomenclature of benzene derivatives, structure of benzene, Molecular formula and Kekule structure. Resonance structure, MO picture, Preparation of benzene from phenol and acetylene. Aromaticity: Huckel's rule (ex: benzene, naphthalene, cyclopropylium cation, cyclopentadeienyl anion and cycloheptatrienyl cation). Orientation & reactivity activating & deactivating groups (CH_3, OH, NH_2, NO_2, CHO, COOH & Cl), Electrophilic substitution.: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation)

Unit V: Thermodynamics II **(12 Hrs)**

A. **Second law of thermodynamics** : Need for second law of thermodynamics, statements of second law of thermodynamics, Carnot's cycle and its efficiency,concept of entropy, entropy as a state function of V & T, P & T, entropy change in phase change for ideal gas, entropy as criteria of spontaneity & equilibrium.

B. **Free energy functions:** Gibb's free energy (G) & Helmholtz free energy (A) and their properties, variation of Gibb's free energy with T & P, Variation of A with T & V, Gibb's – Helmholtz equation & its applications, Spontaneity of reaction in terms of A & G .
Systems of variable composition: Partial molar quantities, chemical potential, Van't-Hoffs reaction isotherm, relation between standard free energy change & equilibrium

constant (thermodynamic derivation of law of mass action), effect of temperature on equilibrium constant (reaction isochore).

Unit VI: Solid State and Phase Equilibra **(12 Hrs)**

A. Solid State Laws of crystallography i) Law of constancy of interfacial angles ii) Law of rationality of indices iii) Law of symmetry, symmetry elements in crystals. Unit cell, space lattice, orientation of lattice place (Miller indices).Bravais lattices, crystal systems, X-ray diffraction by crystal, derivation of Braggs' equation. Determination of crystal structure of NaCl, KCI and CsCl Laue's method and powder method.

B. Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics (lead-silver). **Liquid-Liquid mixtures :** Ideal liquid mixtures. Raoults law of ideal solutions, Henry's law, non- ideal systems, azeotropes : HCl-H_2O & ethanol- water system. Partial miscible liquids : phenol-water system, trimethylamine-water, nicotine-water system, lower & upper consolute temperature, effect of impurity on consolute temperature, Nernst distribution law, limitations and applications(association and dissociation).

Reference:-

Inorganic Chemistry

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

Organic Chemistry

- Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry,* 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry,* Orient Longman, New Delhi (1988).
- Finar, I.L. *Organic Chemistry (Vol. I & II)*, E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. & Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry 5th Ed.* Macmillan Publishing Co.: New York (1985).

Physical Chemistry

- S.H. Marron and C.F.Pruton. *Principles of Physical Chemistry*,4th edition
- Samuel Glasstone. *Textbook of Physical Chemistry,*
- Ira Levine, *Physical Chemistry,* 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd.

- G.M. Barrow, *Physical Chemistry*, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- Atkins, P. W. & Paula, J. de Atkins *Physical Chemistry* 9th Ed.,Oxford UniversityPress2011.
- Puri, Sharma and Pathania. *Principles of Physical Chemistry*,
- Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa 2004.
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall 2012.
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi 2004.
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY 2011
- http://nsdl.niscair.res.in
- http://ocw.mit.edu

CHEMISTRY LAB: Practical Course **(72 Hrs)**

Course Objectives:-

1. To learn to perform experiments those have specific aims with correct techniques.
2. To develop skills of observation, recording and analyzing data.
3. To learn to present the experimental work in a systematic manner.

Inorganic Chemistry

1. Estimation of Fe(II) by dichromate using internal indicator.
2. Determination of Zn by complexometric titration with EDTA
3. Determination of total Hardness of water (permanent and Temporary) by EDTA
4. Estimation of sodium carbonate content of washing soda

Physical Chemistry

1. To determine the critical solution temperature of two partially miscible liquids(phenol-water systems).
2. To study the critical solution temperature of phenol-water system in presence of 1% NaCl
3. To study the critical solution temperature of phenol-water system in presence of 1% succinic acid
4. To study the distribution of iodine between water and kerosene

Organic Chemistry

1. Purification of solid compounds by crystallization (from water)
2. Purification of liquids by distillation.
3. Calibration of thermometer
4. Criteria of Purity: Determination of melting points
5. Criteria of Purity: Determination of boiling points

Reference Books

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- http://nsdl.niscair.res.in

- http://ocw.mit.edu

Shiksha Mandal's
Jankidevi Bajaj College of Science, Wardha
Syllabus of B.Sc. II /Semester III
SUBJECT – CHEMISTRY

CY-III Elements of Inorganic, Organic & Physical Chemistry (72Hrs)

Course Objectives:-

1. To analyze and integrate concepts relevant to inorganic chemistry required to understand compound formations with special reference to Molecular Orbital theory
2. To understand the need of concept of MOT
3. To know LCAO principal and its approximation
4. To understand and show the formation of bonding and antibonding MO's
5. To draw combinations of s-s, s-p, p-p and d-d orbital to form σ and π molecular orbitals.
6. To give the comparison of a) Atomic orbital and molecular orbital
   b) BMO, ABMO and NBMO
   c) Sigma and pi MO's
   d) VBT and MOT
7. To draw the MO energy level diagrams for homonuclear diatomic molecules having interactions between 2s and 2p orbitals and having no interactions between 2s and 2p orbitals
8. To draw the shapes of molecular orbitals.
9. To give the calculations of bond order, energy and explanation on stability of the above molecule and ions
10. To draw the MO energy level diagrams for heteronuclear diatomic molecules
11. To learn the calculations of bond order, energy and explain the stability of the molecules.
12. To explain the magnetic properties of various compounds using MOT
13. To understand the bonding in tetrasulphur tetranitride
14. To learn the preparation and properties of tetrasulphur tetranitride
15. To understand the bonding in interhalogen compounds
16. To learn the preparation and properties of interhalogen compounds
17. To know position of d-block elements in periodic table.
18. To know the general electronic configuration & electronic configuration of elements of first transition series.
19. To know trends in periodic properties of the first transition series elements with reference to atomic and ionic radii, ionization potential, variable oxidation states, magnetic properties, colour, complex formation tendency and catalytic activity.
20. To know the general electronic configuration & electronic configuration of elements of second and third transition series.
21. To compare magnetic behavior of 4d and 5d elements with 3d elements.
22. To study non-aqueous solvents with reference to liquid ammonia and liquid sulphur dioxide.
23. To learn structure, nomenclature, preparation and reactions of alkyl halides, aryl halides, alcohols and phenols.

24. To understand the characteristic reactions of each functional group which can be used to identify and distinguish that compound from other compounds.
25. To predict the conversion of one functional group into other functional group involving one or more number of steps.
26. To learn conversion of the given compound into other compound containing more or less number of carbon atoms.
27. To predict of possible products when reactants are given. In case there are more than one possible products, to identify the major and minor products.
28. To suggest the possible reagents to bring about the given conversion.
29. To learn Concept of reaction rate, factors affecting the rate of a reaction
30. To differentiate between Order and molecularity
31. To learn mathematical expression for rate constant of zero, first and second order reactions
32. To understand concept of Pseudo order reactions
33. To understand concept of half life and mean life of reactions with examples.
34. To learn methods of determination of order of reaction
35. To understand effect of temperature on rate of reaction. Arrhenius equation and activation energy
36. To study collision theory of bimolecular reactions, Transition state theory and Lindmann's theory of unimolecular reactions
37. To recapitulate the ideas related to ionc equilibria
38. To study concepts of degree of ionization. ionization constant, ionic product of water calculation of hydrolysis constant, degree of hydrolysis with the help of equations
39. To learn buffer solutions and Henderson's equation
40. To understand various colligative properties and their relationships wth the molar mass of solutes.

Unit I: **(12Hrs)**

A. MO theory

LCAO approximation, wave equation for molecular orbitals. Difference between bonding and anti bonding MO in terms of energy and electron density distribution curves, order of energy levels in MO. Molecular Orbital diagrams for homonuclear diatomic molecules of elements(with Z = 1 to 9) Concepts of nonbonding MO in HF molecule. Coulson's MO diagram of CO and NO diatomic molecule.

B. Preparation, properties and structure of tetrasulphur tetranitride (S_4N_4) and Interhalogen compounds. Polyhalides (Structure of I^{3-}, I^{5-}, and ICl^{4-}).

Unit II: **(12Hrs)**

A. Chemistry of elements of first transition series: Characteristic properties of the elements of first transition series with reference to their: Electronic configuration, Atomic and ionic radii, Ionization potential, Variable oxidation states, Magnetic properties, Colour, Complex formation tendency and catalytic activity.

B. Chemistry of elements of second and third transition series: Electronic configuration of 4d and 5d transition series. Comparative treatment with their 3d- analogous (Group Cr-Mo-W, Co-Rh-Ir) in respect of oxidation states and magnetic behavior.

C. Non-aqueous solvents:
Classification of solvents and characteristic reactions (acid base, redox & precipitation reactions) in Non-aqueous solvents with reference to i) Liquid Ammonia and ii) Liquid Sulphur dioxide.

Unit III: **(12Hrs)**

A. Alkyl Halides
Types of Nucleophilic Substitution, factors affecting SN_1 and SN_2 reactions & Stereochemistry of SN_1 and SN_2 reactions. Preparation: from alkenes and alcohols. Reactions: Nitrile & Isonitrile formation, Williamson's ether synthesis.

B. Aryl Halides
Preparation: Aromatic Halogenation, Sandmeyer Reaction. Aromatic nucleophilic substitution involving Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl and aryl/ Vinyl halides.

Unit IV: **(12Hrs)**

A. Alcohols:
Classification and nomenclature,
Dihydric alcohols: Nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage ($pb(Oac)_4$ and HIO_4) and Pinacol – pinacolone rearrangement (with mechanism).
Trihydric alcohols: Nomenclature and methods of formation, chemical reactions of glycerol.

B. Phenols
Nomenclature, structure and bonding, Preparation of phenols From cumene, chlorobenzene (Dows and Raschig process) and diazonium salts. Physical properties and acidic character, Resonance stabilization of phenoxide ion, Reactions of phenols, Electrophilic aromatic substitution, acetylation and carboxylation, Claisen rearrangement, Gatterman synthesis reaction Mechanism of i) Fries Rearrangement,ii) Reimer-Tiemann reaction.

Unit V: Chemical Kinetics **(12Hrs)**

A. Concept of reaction rate, factors affecting the rate of a reaction – concentration, temperature, pressure, surface area, light, catalyst. Order and molecularity, Zero order reactions. Mathematical expression for rate constant of first and second order reactions ($a = b$ and $a \neq b$), their characteristics. Pseudo order reactions. Half life and mean life of reactions with examples. Methods of determination of order of reaction – integration method, differential method, graphical method, method of half life period and Ostwald's isolation method. Effect of temperature on rate of reaction. Arrhenius equation and its derivation, concepts of activation energy. Numericals.

B. Collision theory of bimolecular reactions (hard sphere model). Transition state theory, expression for rate constant based on equilibrium constant and thermodynamic aspects. Lindmann's theory of unimolecular reactions

Unit VI: Ionic Equilibria and Colligative Properties **(12Hrs)**

A) Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions –Introduction, Henderson's equation, buffer solutiuon of weak acid and its salt, buffer solutiuon of weak base and its salt.

B) Colligative Properties

Raoults law of relative lowering of vapour pressure, molecular mass determination from relative lowering of vapour pressure. Osmosis, osmotic pressure and its measurement by Barkeley and Hartley method.Determination of molecular mass from osmotic pressure. Elevation of boiling point, determination of molecular mass from elevation of boiling point. Depression of freezing point. Determination of molecular mass from depression of freezing point. Van't Hoff factor, degree of dissociation and association of solute.

Referemce:-

Inorganic Chemistry

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

Organic Chemistry

- Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
- McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
- Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
- Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
- Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
- Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
- Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

Physical Chemistry

- K.J.Laidler, Chemical Kinetics, Third Edition (1987), Harper and Row, New York.
- J.Raja Ram and J.C.Kuriacose, Kinetics and Mechanism of Chemical Transformations MacMilllan Indian Ltd., New Delhi (1993)

- C. H. Bamford and C. F. H. Tipper, Comprehensive Chemical Kinetics, **Vol 1**., Elsevier Publications, New York, 1969.
- C. H. Bamford and C. F. H. Tipper, Comprehensive Chemical Kinetics, **Vol 2**., Elsevier Publications, New York, 1969.
- Santosh Kumar Upadhyay, *Chemical Kinetics and Reaction Dynamics*, Springer 2006
- P. W. Atkins'and D. Paula, *Physical Chemistry*, 8th Edition, Oxford University Press, 2010
- S.H. Marron and C.F.Pruton. *Principles of Physical Chemistry*,4th edition
- Samuel Glasstone. *Textbook of Physical Chemistry*,
- Ira Levine, *Physical Chemistry*, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd.
- G.M. Barrow, *Physical Chemistry*, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- *Principles of Physical Chemistr,* Fourth Edition by S.H. Marron and C. F. Pruton
- *Principles of Physical Chemistry,* Puri, Sharma, Pathania, Vishal Publishing Co.
- *Textbook of Physical Chemistry,* P. L. Sony, O. R. Dharma
- *Essentials of Physical Chemistry* by B.S. Bahl, G.D.Tuli and Arun Bahl Edition 2000 S. Chand and Company Ltd.
- http://nsdl.niscair.res.in
- http://ocw.mit.edu

CHEMISTRY LAB: Practical Course **(72 Hrs)**

Course Objectives:-

1. To learn to perform experiments those have specific aims with correct techniques.
2. To develop skills of observation, recording and analyzing data.
3. To learn to present the experimental work in a systematic manner.
4. To verify theoretical principles experimentally
5. To interpret the experimental data
6. To improve analytical skills
7. To correlate the theory and experiments and understand their importance
8. To learn to detect two acidic radicals of different group and two basic radicals of same groups from given mixture of inorganic salts
9. To identify the given organic compound
10. To study rate of certain reactions
11. To determine rate constant and actvation energy for a chemical reaction
12. To determine molecular mass of a non-volatile solute by Rast method
13. To apply pH metry in determination of degree of hydrolysis of a salt, pK_a and dissociation constant of a weak acid

Inorganic Chemistry

Semi micro Qualitative Analysis

Qualitative analysis of inorganic salt mixture containing two acidic radicals of different group and two basic radicals of same groups. (At least six mixtures to be analysed)

Organic Chemistry

Preparation:

i) Hydrolysis : Preparation of Benzoic acid from Benzamide
ii) Oxidation: Preparation of Benzoic acid from Benzaldehyde
iii) Nitration: P-nitroacetanilide from Acetanilide
iv) Preparation of orange azo dye from aniloine

Physical Chemistry

1. To determine the specific reaction rate of the hydrolysis of methyl acetate catalyzed by H^+ ions at room temperature.
2. To dertermine the specific reaction rate of hydrolysis of ethyl acetate catalysed by base (saponification)
3. To study the rate of acid catalysed iodination of acetone.
4. To determine the energy of activation of reaction between persulphate iodide
5. To determine molecular mass of a non-volatile solute by Rast method
6. To determine the degree of hydrolysis of aniline hydrochloride
7. To determine pka value of given weak acid by pH-metric titration with strong base.
8. To determine the dissociation constant of oxalic acid by pH-metric titration with strong base

Reference Books

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- http://nsdl.niscair.res.in
  http://ocw.mit.edu

Shiksha Mandal's
Jankidevi Bajaj College of Science, Wardha
Syllabus of B.Sc. I / Semester IV
SUBJECT - CHEMISTRY

CY-IV Concise of Inorganic, Organic & Physical Chemistry **(72 Hrs)**

Course Objectives:-

1. To study Lanthanides with respect to Position in periodic table, electronic configuration, Oxidation states, Atomic and ionic radii, Lanthanide contraction and its consequences, Complex forming tendency. Occurrence and separation
2. To study actinides with respect to Position in periodic table, electronic configuration, Oxidation states, Atomic and ionic radii.
3. To learn errors in chemical analysis.
4. To understand Accuracy and Precision, Uncertainty, Absolute and Relative errors, Mean, Median, Average and Standard deviations, Significant figures
5. To learn Statistical Test of Data: Q-test, 2.5d and 4d Rules for rejection of data
6. To understand Werner's Coordination theory and its experimental verification
7. To study Sidgwicks electronic interpretation
8. To understand Chelates, their classification and application,
9. To learn valence bond theory of transition metal complexes
10. To study isomerism in coordination compounds
11. To understand use of redox potential data, Latimer diagram, Frost diagram and Porbaix diagram
12. To learn structure, nomenclature, preparation and reactions of aldehydes, ketones, carboxylic acids and derivatives of carboxylic acids.
13. To understand the characteristic reactions of each functional group which can be used to identify and distinguish that compound from other compounds.
14. To predict the conversion of one functional group into other functional group involving one or more number of steps.
15. To learn conversion of the given compound into other compound containing more or less number of carbon atoms.
16. To predict of possible products when reactants are given. In case there are more than one possible products, to identify the major and minor products.
17. To suggest the possible reagents to bring about the given conversion.
18. To understand the mechanisms of some named reactions.
19. To study important topics of surface chemistry i.e. adsorption and catalysis.
20. To learn Ohm's law and meaning of specific resistance, specific conductance, equivalent conductance, molar conductance, cell constant and their units.
21. To know experimental determination of conductance.

22. To understand variation of specific and equivalent conductance of strong and weak electrolyte with dilution
23. To understand the meaning of infinitely dilute solution.
24. To learn Kohlrausch's law of independent migration of ions and its applications such equivalent conductance of weak electrolyte at zero conc., degree of dissociation (α),ionic product of water.
25. To know the concept of Transport number of an ion and its experimental determination by moving boundary method.
26. To understand drawbacks of Arrhenius theory and study Debye-Huckel-Onsager Interionic Attraction theory with reference to Asymmetry /Relaxation effect and Electrophoretic effect

Unit I: **(12Hrs)**

A) Chemistry of Lanthanides: Position in periodic table, electronic configuration, Oxidation states, Atomic and ionic radii, Lanthanide contraction and its consequences, Complex forming tendency. Occurrence and separation of lanthanides (ion exchange and solvent extraction).

B) Chemistry of Actinides: Position in periodic table, electronic configuration, Oxidation states, Atomic and ionic radii.

C) Errors in Chemical Analysis:

Random and Systematic errors, Explanation of terms: Accuracy and Precision, Uncertainty, Absolute and Relative errors, Mean, Median, Average and Standard deviations, Significant figures, numerical problems, Statistical Test of Data: Q-test, 2.5d and 4d Rules for rejection of data. Numerical problems

Unit II: **(12Hrs)**

A) Coordination compounds:

Distinction among simple salts, double salts and coordination compounds. Werner's Coordination theory and its experimental verification. Sidgwicks electronic interpretation, EAN rule with examples, Nomenclature of Coordination compounds. Chelates: Classification and their application, Valence Bond Theory of transition metal complexes, Isomerism in coordination compounds: Structural isomerism and Stereoisomerism in coordination compounds.

B) Oxidation and reduction:

Use of redox potential data: Analysis of Redox cycle, redox stability in water, Latimer diagram of Chlorine and Oxygen, Frost diagram of Nitrogen and Oxygen, and Porbaix diagrams of Iron

Unit III: **(12Hrs)**

Aldehydes and ketones: Nomenclature and structure of the carbonyl group, synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides and ketones from nitriles. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation, Wittig reaction, Mannich reaction, oxidation of aldehydes (by $KMnO_4$, Tollens reagent and Fehlings solution), Baeyer-Villiger oxidation of Ketones, Cannizaro reaction, (with mechanism) MPV, Clemmensen, Wolf-Kishner, $LiAlH_4$ and $NaBH_4$ reductions.

Unit IV: **(12Hrs)**

A) Carboxylic Acids : Nomenclature, structure & bonding, Physical properties, acidity of carboxylic acids, effect of substituent's on acid strengths preparation of carboxylic acids(from G.R. and cyanides), Reactions of carboxylic acids, Hell-Volhard-Zelinsky reactions (with mechanism). Reduction of carboxylic acids, Mechanism of decarboxylation. Methods of formation and chemical reactions of unsaturated monocarboxylic acids (crotonic acid and cinnamic acid).

Dicarboxylic acids : Methods of formation and effect of heat and dehydrating agents. (Succinic acid, Phthalic acid).

(B) Carboxylic acid derivatives : Reactive methylene group, Interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives, Chemical reactions, Mechanism of esterification and hydrolysis (preparation of acetoacetic ester and malonic ester), Reformatsky reaction.

Unit V: Adsorption and Catalysis **12 Hrs**

(A) Adsorption- General introduction, Thermodynamics of adsorption, Types of adsorption, Factors affecting adsorption of Gases by Solids, Adsorption Isotherms: Freundlich Adsorption Isotherm, Langmuir Adsorption Isotherm, B.E.T. Equation(no derivation). Application of B.E.T. equation in the determination of Surface Area of Adsorbent (Numerical), Application of Adsorption.

(B) Catalysis:- Introduction, Homogeneous & Heterogeneous Catalysis, Auto catalysis Examples. Action of Catalytic Promoters & Inhibitors, Activation energy and catalysis, Theories of catalysis i) Intermediate compound formation theory ii) Adsorption theory, Active centre on catalyst surface, Adsorption theory and catalytic activity, Acid – Base catalysis (theoretical aspect only) and its industrial applications.

Unit VI: Electrochemistry I **12 Hrs**

A) Electrical transport : electronic and electrolytic conductors, conductance, resistivity, specific resistivity, measurement of conductance of solutions, conductometer, conductivity cell, cell constant, specific conductance, molar conductance and equivalent conductance, Numericals. Variation of equivalent & specific conductance with dilution, Arrhenius theory of electrolyte dissociation & its limitation, Debye-Huckel theory (elementary treatment).Relaxation effect, Electrophoretic effect and Onsagar equation.

B) Migration of ions, velocity of ions & change in concentration around electrode, transport number: concept, relation between transport number & ionic conductance factors affecting transport number of ions, numericals & determination by moving boundary method. Application of Kohlrausch's law & conductance measurement for the determination of degree of dissociation & dissociation constant of acids, solubility of sparingly soluble salt. Conductometric titrations curves in the titration of: (i) strong acid vs. strong base (ii) weak acid vs. strong base (iii) weak acid vs. weak base (iv) mixture of strong and weak acids vs. strong base (v) sodium chloride vs. silver nitrate (vi) barium hydroxide vs. magnesium sulphate. Advantages and limitations.

Referemce:-

Inorganic Chemistry

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

Organic Chemistry

- Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
- McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
- Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
- Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
- Barrow, G.M. Physical Chemistry Tata McGraw-Hill (2007).
- Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004).
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. University Chemistry 3rd Ed. Narosa (1998).
- Petrucci, R.H. General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

Physical Chemistry

- K.J.Laidler, Chemical Kinetics, Third Edition (1987), Harper and Row, New York.
- J.Raja Ram and J.C.Kuriacose, Kinetics and Mechanism of Chemical Transformations MacMilllan Indian Ltd., New Delhi (1993)
- C. H. Bamford and C. F. H. Tipper, Comprehensive Chemical Kinetics, **Vol 1**., Elsevier Publications, New York, 1969.
- C. H. Bamford and C. F. H. Tipper, Comprehensive Chemical Kinetics, **Vol 2**., Elsevier Publications, New York, 1969.
- Santosh Kumar Upadhyay, *Chemical Kinetics and Reaction Dynamics*, Springer 2006
- P. W. Atkins'and D. Paula, *Physical Chemistry*, 8th Edition, Oxford University Press, 2010
- S.H. Marron and C.F.Pruton. *Principles of Physical Chemistry*,4th edition
- Samuel Glasstone. *Textbook of Physical Chemistry*,
- Ira Levine, *Physical Chemistry*, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd.
- G.M. Barrow, *Physical Chemistry*, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
- *Principles of Physical Chemistr,* Fourth Edition by S.H. Marron and C. F. Pruton
- *Principles of Physical Chemistry,* Puri, Sharma, Pathania, Vishal Publishing Co.
- *Textbook of Physical Chemistry,* P. L. Sony, O. R. Dharma

- *Essentials of Physical Chemistry* by B.S. Bahl, G.D.Tuli and Arun Bahl Edition 2000 S. Chand and Company Ltd.
- http://nsdl.niscair.res.in
- http://ocw.mit.edu

CHEMISTRY LAB: Practical Course **(72 Hrs)**

Course Objectives:-

1. To learn to perform experiments those have specific aims with correct techniques.
2. To develop skills of observation, recording and analyzing data.
3. To learn to present the experimental work in a systematic manner.
4. To verify theoretical principles experimentally
5. To interpret the experimental data
6. To improve analytical skills
7. To correlate the theory and experiments and understand their importance
8. To estimate an ion from the given solution gravimetrically.
9. To separate binary mixtures of ions by paper chromatography and to determine Rf values
10. To identify the given organic compound
11. To verify the Freundlich and Langmuir adsorption isotherm
12. To apply principles of electrochemistry to perform conductometric titrations, to determine the solubility and solubility product of a sparingly soluble salt and to determine the ionization constant of weak acid.

Inorganic Chemistry:

A) Gravimetric Analysis

i) Estimation of Ba^{2+} as $BaSO_4$.

ii) Estimation Ni^{2+} as Ni-DMG

B) **Chromatographic separation** of binary mixtures (at least Two) containing Cu(II), Co(II) and Ni (II) ions by paper chromatography and determination of Rf values.

Organic Chemistry:

Organic qualitative analysis with respect to type, preliminary tests, elements, functional group, physical constants of single organic compound involving following steps:

1. Preliminary examination
2. Detection of elements
3. Detection of functional group
4. Determination of M.P. /B.P.
5. Preparation of derivative and its M.P./B.P.
6. Performance of specific test if any

There should be at least one belonging from each type (**any four**)

a) Benzoic acid, Salicylic acid, Cinnamic acid, Phthalic acid, oxalic acid

b) β-Naphthol, α-naphthol

c) Aniline, N,N-Dimethyl aniline

d) Napthalene, Thiourea, Urea, m-Dinitrobenzene, chloroform, ethyl methyl ketone, ethyl acetate, chlorobenzene

Physical Chemistry

1. To verify the Freundlich adsorption isotherm of acetic acid on charcoal.
2. To verify the Langmuir's adsorption isotherm of acetic acid on charcoal.
3. To determine the strength of the given strong acid (HCL) conductometrically using standard alkali solution.
4. To determine the strength of the given weak acid (CH_3COOH) conductometrically using standard alkali solution.
5. To determine the strength of strong acid and a week acid in a given mixture conductometrically by titrating it with standard alkali solution.
6. To determine the solubility and solubility product of a sparingly soluble salt conductometrically.
7. To determine the ionization constant of weak acid conductometrically.

Reference Books:

- Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall, 5th edition, 1996.
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry* Orient-Longman, 1960.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi (2011).
- http://nsdl.niscair.res.in
- http://ocw.mit.edu