Shiksha Mandal's

Jankidevi Bajaj College of Science, Wardha

Department of Chemistry

Revised Syllabus of B. Sc. (Semester I to VI)

for Academic Autonomy

(Approved in BOS Meeting 28-July-2018)

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)
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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, KCl 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.
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- *Principles of Inorganic Chemistry*, Puri, Sharma, Kalia

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- 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.
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- Puri, Sharma and Pathania. *Principles of Physical Chemistry*,
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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).
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Jankidevi Bajaj College of Science, Wardha

Syllabus under Academic Autonomy

SUBJECT CHEMISTRY

B.Sc. II Semester III

CY-III Elements of Inorganic, Organic & Physical Chemistry **(60 Hrs)**

Course Objectives:-

19. To analyze and integrate concepts relevant to inorganic chemistry required to understand compound formations with special reference to Molecular Orbital theory
20. To understand the need of concept of MOT
21. To know LCAO principal and its approximation
22. To understand and show the formation of bonding and antibonding MO's
23. To draw combinations of s-s, s-p, p-p and d-d orbital to form σ and π molecular orbitals.
24. 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
25. 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
26. To draw the shapes of molecular orbitals.
27. To give the calculations of bond order, energy and explanation on stability of the above molecule and ions
28. To draw the MO energy level diagrams for heteronuclear diatomic molecules
29. To learn the calculations of bond order, energy and explain the stability of the molecules.
30. To explain the magnetic properties of various compounds using MOT
31. To understand the bonding in tetrasulphur tetranitride
32. To learn the preparation and properties of tetrasulphur tetranitride
33. To understand the bonding in interhalogen compounds
34. To learn the preparation and properties of interhalogen compounds
35. To know position of d-block elements in periodic table.
36. To know the general electronic configuration & electronic configuration of elements of first transition series.
37. 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.
38. To know the general electronic configuration & electronic configuration of elements of second and third transition series.

39. To compare magnetic behavior of 4d and 5d elements with 3d elements.
40. To study non-aqueous solvents with reference to liquid ammonia and liquid sulphur dioxide.
41. To learn structure, nomenclature, preparation and reactions of alkyl halides, aryl halides, organometallic compounds, alcohols, phenols and amines.
42. To understand mechanisms of characteristic reactions of each functional group which can be used to identify and distinguish that compound from other compounds.
43. To predict the conversion of one functional group into other functional group involving one or more number of steps.
44. To learn conversion of the given compound into other compound containing more or less number of carbon atoms.
45. 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.
46. To suggest the possible reagents to bring about the given conversion.
47. To learn Concept of reaction rate, factors affecting the rate of a reaction
48. To differentiate between Order and molecularity
49. To learn mathematical expression for rate constant of zero, first and second order reactions
50. To understand concept of Pseudo order reactions
51. To understand concept of half life and mean life of reactions with examples.
52. To learn methods of determination of order of reaction
53. To understand effect of temperature on rate of reaction. Arrhenius equation and activation energy
54. To study collision theory of bimolecular reactions and Transition state theory
55. To recapitulate the ideas related to ionc equilibria
56. 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
57. To learn buffer solutions and Henderson's equation
58. To understand various colligative properties and their relationships with the molar mass of solutes.

Unit I **(10 Hrs)**

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: **(10 Hrs)**

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 Nonaqueous solvents with reference to i) Liquid Ammonia and ii) Liquid Sulphur dioxide.

Unit III: **(10 Hrs)**

A. Alkyl Halides

Preparation: from alkenes and alcohols. Reactions: Nucleophilic substitution reactions of alkyl halides (alcohol, ester, nitrile & isonitrile formation, Williamson's ether synthesis), mechanism and stereochemistry of nucleophilic substitution reactions (SN_1 and SN_2), factors affecting SN_1 and SN_2 reactions.

B. Aryl Halides

Chlorobenzene: Preparation by aromatic halogenation and 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.

C. Organometallic compounds :

Organomagnesium compound: Grignard reagent, formation (from alkyl and aryl bromide) and chemical reactions with carbonyl compounds, esters, alkyne and dry ice.

Organozinc compounds: Formation (from ethyl bromide) and Reformatsky reaction.

Organolithium compounds: Formation of methyl and n-butyl Lithium and its use as base.

Unit IV: **(10 Hrs)**

A. Alcohols: Classification and nomenclature of primary alcohol.

Dihydric alcohols: Nomenclature, methods of formation of ethylene glycol (from ethylene, epoxide, ethylene dibromide and ethylene diamine). Chemical reactions of vicinal glycols: with carbonyl compounds, dehydration, oxidative cleavage with $Pb(OAc)_4$ and HIO_4 and Pinacol–Pinacolone rearrangement (with mechanism).

Trihydric alcohols: Nomenclature and methods of formation (from hydrolysis of fats and oils, propene and acrolein), chemical reactions of glycerol (with PCl_5, HI, oxidation and dehydration).

B. Phenols

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

C. Amines

Structure and stereochemistry of amines, basicity of amines, preparation of alkyl &aryl amines: reduction of nitro compounds and nitriles, reductive amination of aldehydic and ketonic compounds, Gabriel phthalimide reaction, Hofmann bromamide reaction. Reactions of amines: Preparation and synthetic transformations of aryl diazonium salts (Coupling with β-naphthol and Sandmeyer).

Unit V: Chemical Kinetics **10 Hrs**

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. 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.

Unit VI: Ionic Equilibria and Colligative Properties **10 Hrs**

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. Numericals.

B) Colligative Properties

Types of 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. Numericals.

References:-

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- 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.
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- Tadashi Okuyama and Haward Maskill, Oxford organic chemistry, a mechanistic approach (oxford)
- Hashmat Ali, Reaction mechanism in organic chemistry (S-chand publications)
- Gautam Bramhachari, Organic chemistry through solved problems (Narosa publications)
- Gautam Bramhachari , Organic name reactions, a united approach (Narosa publications)

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)
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- 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, TMH Publishing Co. Ltd. New Delhi.

- Puri, Sharma, Pathania, *Principles of Physical Chemistry,* Vishal Publishing Co.
- P. L. Sony, O. R. Dharma *Textbook of Physical Chemistry.*
- B.S. Bahl, G.D.Tuli and Arun Bahl, *Essentials of Physical Chemistry,* S. Chand and Company Ltd.
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- http://ocw.mit.edu

CHEMISTRY LAB: Practical Course **(60 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 and to improve analytical skills
6. To correlate the theory and experiments and understand their importance
7. To learn to detect two acidic radicals of different group and two basic radicals of same groups from given mixture of inorganic salts
8. To identify the given organic compound
9. To study rate and to determine rate constant and actvation energy of certain reactions
10. To determine molecular mass of a non-volatile solute by Rast method
11. 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 analyzed)

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 azo dye from aniline

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 pk_a 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).
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Jankidevi Bajaj College of Science, Wardha

Syllabus under Academic Autonomy

SUBJECT CHEMISTRY

B.Sc. II Semester IV

CY-IV Concise of Inorganic, Organic & Physical Chemistry **(60 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 important basic concepts in statistical analysis of the data.
4. To understand Werner's Coordination theory and its experimental verification and Sidgwicks electronic interpretation
5. To understand Chelates, their classification and application,
6. To learn valence bond theory of transition metal complexes
7. To study isomerism in coordination compounds.
8. To understand the use of redox potential data, Latimer diagram, Frost diagram and Porbaix diagram.
9. To learn structure, nomenclature, preparation and reactions of aldehydes, ketones, carboxylic acids and derivatives of carboxylic acids.
10. To understand the characteristic reactions of each functional group which can be used to identify and distinguish that compound from other compounds.
11. To predict the conversion of one functional group into other functional group involving one or more number of steps.
12. To learn conversion of the given compound into other compound containing more or less number of carbon atoms.
13. 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.
14. To suggest the possible reagents to bring about the given conversion.
15. To understand the mechanisms of some named reactions.
16. To study important topics of surface chemistry i.e. adsorption and catalysis.
17. To understand thermodynamics of adsorption, to study various isotherms of adsorption and applications of adsorption.
18. To learn Ohm's law and meaning of specific resistance, specific conductance, equivalent conductance, molar conductance, cell constant and their units.

19. To know experimental determination of conductance.
20. To understand variation of specific and equivalent conductance of strong and weak electrolyte with dilution
21. To understand the meaning of infinitely dilute solution.

22. 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.
23. To know the concept of Transport number of an ion and its experimental determination by moving boundary method.
24. To understand drawbacks of Arrhenius theory and study Debye-Huckel-Onsager Interionic Attraction theory with reference to Asymmetry / Relaxation effect and Electrophoretic effect
25. To understand migration of ions & change in concentration around electrode
26. To understand transport number concept, relation between transport number & ionic conductance, factors affecting transport number of ions & to learn its determination by moving boundary method.
27. To study Kohlrausch's law and various application of Kohlrausch's law & conductance measurement.
28. To study Conductometric titrations curves in the different acid-base and precipitation titrations.

Unit I **(10 Hrs)**

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).

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

B) 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: **(10 Hrs)**

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.

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: **(10 Hrs)**

Aldehydes and ketones:

Nomenclature and structure of the carbonyl group, synthesis of aldehydes (from alcohol and acid chloride) and ketones (from alcohol and nitriles). Acidity of alpha hydrogens and formation of enolate, Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Wittig reaction and Mannich reaction (without mechanism), Baeyer-Villiger oxidation of Ketones, Cannizaro reaction, (with mechanism), MPV reaction, Clemmensen, Wolf-Kishner, $LiAlH_4$ and $NaBH_4$ reductions. Concept of reactive methylene group, Keto-enol tautomerism in Acetoacetic ester.

Unit IV: **(10 Hrs)**

A) Carboxylic Acids : Nomenclature, structure, physical properties and acidity of carboxylic acids, effect of substituent's on acid strengths, preparation of carboxylic acids (from G.R., cyanides and acetoacetic ester), Chemical Reactions of carboxylic acids: Hell-Volhard-Zelinsky reaction (with mechanism), reduction with $LiAlH_4$, decarboxylation with mechanism.

Unsaturated monocarboxylic acids: (i) Crotonic acid (synthesis from malonic ester and chemical reaction: addition of Br_2 & HX, with NBS) (ii) Cinnamic acid (synthesis by perkin reaction and chemical reaction: oxidation with $KMnO_4$ and reduction with $LiAlH_4$ & Na-Hg)
Dicarboxylic acids: Succinic acid: preparation from malonic & acetoacetic ester. Phthalic acid: synthesis from *o*-xylene. Effect of heat/dehydrating agents on succinic & phthalic acid.

B) Carboxylic acid derivatives: Interconversion of acid derivatives by nucleophilic acyl substitution. Preparation of carboxylic acid derivatives (acetyl chloride-from acetic acid, ethyl acetate-from ethanol & acetyl chloride, acetamide-from acyl chloride and acetic anhydride-from acetic acid), Chemical reactions (acetyl chloride: rosenmund reduction & Friedel-Craft reaction, ethyl acetate: hydrolysis & claisen condensation, acetamide: reduction with LAH & Hoffmann reaction and acetic anhydride: acylation of alcohol and amine).

Unit V: Adsorption and Catalysis **(10 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 **(10 Hrs)**

A) Electrical transport : electronic and electrolytic conductors, resistivity, conductance, specific resistivity, specific conductance, molar conductance and equivalent conductance, measurement of conductance of solutions, conductometer, conductivity cell, cell constant, 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. Numericals.

B) Migration of ions & change in concentration around electrode, transport number concept, relation between transport number & ionic conductance, factors affecting transport number of ions & its determination by moving boundary method. Kohlrausch's law, application of Kohlrausch's law & conductance measurement for the determination of degree of dissociation & dissociation constant of acids, solubility of sparingly soluble salt, numerical. 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. Numericals.

References:-

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- 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.
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Physical Chemistry

- 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.
- R. C. Mukherjee, *Modern Approach to Physical Chemistry*
- S.H. Marron and C.F.Pruton. *Principles of Physical Chemistry*,4th edition
- Puri, Sharma, Pathania, *Principles of Physical Chemistry,* Vishal Publishing Co.
- P. L. Sony, O. R. Dharma *Textbook of Physical Chemistry.*
- B.S. Bahl, G.D.Tuli and Arun Bahl, *Essentials of Physical Chemistry*, S. Chand and Company Ltd.

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CHEMISTRY LAB: Practical Course **(60 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 gven 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:

I. Preliminary examination
II. Detection of elements
III. Detection of functional group
IV. Determination of M.P.
V. Preparation of derivative.
VI. 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, Succinic acid.
b) β-Naphthol, α-naphthol, Resorcinol.
c) p-Toluidine, α-naphthylamine.
d) Napthalene, Thiourea, Urea, m-Dinitrobenzene, Diphenyl, Glucose, Lactose and Benzamide.

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 conductometrically using standard alkali solution.
4. To determine the strength of the given weak acid 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.
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Jankidevi Bajaj College of Science, Wardha

Syllabus under Academic Autonomy

SUBJECT CHEMISTRY

B.Sc. II Semester V

CY-V Principles of Inorganic, Organic & Physical Chemistry **(60 Hrs)**

Course Objectives:-

1. To study definition, nomenclature and classification of organometallic compounds.
2. To study Preparation, properties, reactions and application of Alkyl and Aryls of Li and Al.
3. To learn structure of metal ethylenic complexes.
4. To understand Homogeneous Hydrogenation with example of Wilkinson's Catalyst reaction.
5. To learn basic information about mononuclear carbonyls.
6. To understand silicones with respect to introduction, nomenclature, preparation, properties and uses.
7. To study phosphonitrilic halide polymers with respect to introduction, preparation, properties and uses.
8. To study Sidgwicks electronic interpretation
9. To get introduced with Bioinorganic Chemistry and study essential and trace elements in biological processes,
10. To study structure of metalloporphyrins and to understand role of Hemoglobin and Myoglobin in transport of Oxygen.
11. To study biological role of Na^+ and K^+ and Ca^{2+} metal ions.
12. To understand classification of Acids and Bases as Hard and Soft.
13. To study Pearson's HSAB Concept and its applications.
14. To study molecular orbital picture and aromaticity of heterocyclic compounds with examples of furan, thiophene, pyrrole and pyridine.
15. To learn structure, synthesis and chemical reactions of pyridine.
16. To get introduced with condensed five and six membered heterocycles.
17. To study preparation and reactions of indole, quinoline and isoquinoline.
18. To study synthetic dyes with special focus on Colour and constitution (Witt theory, electronic concept) Classification of Dyes based on chemical constitution.Synthesis and uses of Congored, Crystal violet, Phenolphthaleinand Alizarin dye.
19. To study synthetic drugs with special focus on classification, preparation , properties and uses of Aspirin, Paracetamol, Dettol, Chloroquine, Phenobarbitone, Chloramphenicol, Chloramine T.
20. To study synthetic polymers with special focus on addition or chain growth polymerisation, free radical. Vinyl polymerisation, Ionic vinyl polymerisation, Ziegler - Natta polymerisation .Condensation or step growth polymerisation. Polyesters, polyamides,

21. To get introduced with the branch of spectroscopy and hence to study electromagnetic spectrum, absorption spectra.

22. To study different types of spectroscopy with respect to fundamental principles, selection rules, schematic diagram of spectrometer, interpretation of spectra obtained and applications in determination structure and study of some physicochemical properties.
23. To study electrolytic cell and electrochemical cell (Galvanic/Voltaic cell), cell representation of galvanic cell, reversible & irreversible cells.
24. To understand concept of EMF of a cell & measurement of EMF of a cell.
25. To learn to calculate thermodynamic quantities of a cell reactions (ΔG, ΔH & ΔS & equilibrium constant),
26. To study derivation of Nernst equation for the emf of a cell and hence for a single electrode potential.
27. To study various types of reversible electrodes
28. To learn to write half cell reactions and to calculate cell emf from single electrode potential
29. To understand reference electrodes, standard electrode potential, liquid-junction potential, salt bridge & its functions.
30. To study applications of emf measurements in pH- determination using hydrogen electrode, quinhydrone electrode & glass electrode.
31. To study curves obtained for various potentiometric titration.

Unit I **(10 Hrs)**

A) Organometallic Chemistry

Definition, Nomenclature and Classification of Organometallic compounds. Preparation properties and application of Alkyl and Aryls of Li and Al. A brief account of metal ethylenic complexes (Structure only). Homogeneous Hydrogenation (Wilkinson's Catalyst reaction).

B) Metal carbonyls-Definition, preparation, properties, structure and bonding in mononuclear carbonyls-$Ni(CO)_4$, $Fe(CO)_5$ and $Cr(CO)_6$

C) Inorganic Polymers:

Silicones: Introduction, Nomenclature, preparation, properties and uses, General introduction to Silicon oils, Silicone Elastomers and Silicon Resins

Phosphonitrilic halide polymers : Introduction, Preparation, properties and uses. Structure and bonding in $(NPCl_2)_3$ and $(NPCl_2)_4$

Unit II: **(10 Hrs)**

A) Bioinorganic Chemistry: Essential and Trace elements in biological processes. Metalloporphyrins with special reference to structure and role of Hemoglobin and Myoglobin in transport of Oxygen. Biological role of Na^+ and K^+ and Ca^{2+} metal ions.

B) Hard and Soft Acids and Bases: Classification of Acids and Bases as Hard and Soft. Pearson's HSAB Concept and its applications.Symbiosis

Unit III: **(10 Hrs)**

A) Heterocyclic Compounds: Molecular orbital picture of furan and pyridine and aromaticity of furan, thiophene, pyrrole and pyridine. Hantzsch methods of synthesis of pyridine. General mechanism of electrophilic and nucleophilic substitution reaction of pyridine. Chemical reaction of pyridine (Chichibabin and hydroxylation reaction), Comparison of basicity of pyrrole and pyridine. Preparation of Indole (by Fischer Indole synthesis), Quinoline (by Skraup synthesis) and Isoquinoline (by Bischler Napieralski synthesis).

B) Synthetic Dyes: Definition and ideal characteristics of dyes, Colour and constitution (Witt theory, electronic concept), Synthesis and uses of Congored, Crystal violet, Phenolphthalein and Alizarin dye.

C) Synthetic Drugs: Definition, preparation, properties and uses of Aspirin , Paracetamol, Chloroquine.

D) Synthetic Polymers: Classifications of synthetic polymers- Addition or chain growth polymers and Condensation polymers. Ziegler-Natta polymerization (without mechanism).

Unit IV: **(10 Hrs)**

SPECTROSCOPY:

A) **UV-Visible spectroscopy:** Introduction to spectroscopy, electromagnetic spectrum, Absorption spectra, Ultraviolet absorption spectroscopy, Absorption laws (Beer-Lambert law), molar absorptivity, Presentation and analysis of UV spectra, Types of electronic transitions, Effect of conjugation(HOMO-LUMO), concept of chromophores and auxochromes, Bathochromic, hypsochromic, hyperchromic and hypochromic shifts.

applications of UV –Visible spectroscopy, analysis of UV–Visible spectra of conjugated dienes and enones.

B) Infrared (IR) absorption spectroscopy: Molecular vibrations, Hook's law, Selection rules, Intensity and position of IR bands, measurement of IR spectrum. Fingerprint region, characteristic absorptions of various functional groups and application of IR spectra.

Unit V: Spectroscopy **(10 Hrs)**

A) Rotational Spectroscopy:

Introduction to spectroscopy, Dipole moment and Rotational Spectra. Rotational spectra of diatomic molecules, Energy levels of rigid rotor. Selection rule for transition between energy levels. Expression for wave number (cm^{-1}) of spectral lines in terms of rotational constant (B) and rotational quantum number (J). Intensity of spectral lines. Application of rotational spectra for determination of bond length of diatomic molecules.

B) Vibrational Spectra :

Energy levels of simple harmonic oscillator, Energy level diagram, relative populations of energy levels. Selection rule for pure vibrational spectra (harmonic oscillations), Force constant. Anharmonic oscillator Morse equation, selection rules, idea of overtones. Degrees of freedom and normal modes of vibration for CO_2, H_2O molecules. Idea of vibrational frequencies of different functional groups.

C) Raman Spectroscopy :

Raman effect, Concept of polarizability, Pure rotational Raman spectra of diatomic molecules. Applications of rotational spectra, Numericals.

Unit VI: Electrochemistry II **(10 Hrs)**

(A) Introduction to Electrolytic cell and Electrochemical cell (Galvanic /Voltaic cell), Cell representation of galvanic cell from cell reactions and vice versa, reversible & irreversible cells, Concept of EMF of a cell & Measurement of EMF of a cell, calculation of thermodynamic quantities of a cell reactions (ΔG, ΔH & ΔS & equilibrium constant), Derivation of Nernst equation for the emf of a cell and hence for a single electrode potential. Numericals.

(B) Types of reversible electrodes : gas electrode, metal-metal ion electrode, amalgam electrode, metal insoluble salt-anion, redox electrodes, Half cell reactions, calculation of cell emf from single electrode potential, reference electrodes, standard electrode potential, liquid-junction potential, salt bridge & its functions, Applications of emf measurements in pH- determination using hydrogen electrode, quinhydrone electrode & glass electrode. Potentiometric titration curves for:(i) strong acid vs. strong base (ii) weak acid vs. strong base (iii) redox titration. Numericals.

Referemce:-

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- 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.
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- Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
- Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
- RM Silverstein, G C Bassler and TC Morril, John Wally Spectroscopic identification of organic compound-
- PS Kalsi, Spectroscopy of Organic Molecule- Wiley, Esterna, New Delhi
- Y. R. Sharma, Elementary Organic Spectroscopy
- Tadashi Okuyama and Haward Maskill, Oxford organic chemistry, a mechanistic approach (oxford)
- Hashmat Ali, Reaction mechanism in organic chemistry (S-chand publications)
- Gautam Bramhachari, Organic chemistry through solved problems (Narosa publications)
- Gautam Bramhachari , Organic name reactions, a united approach (Narosa publications)

Physical Chemistry

- 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, TMH Publishing Co. Ltd. New Delhi.
- Puri, Sharma, Pathania, *Principles of Physical Chemistry,* Vishal Publishing Co.
- P. L. Sony, O. R. Dharma, *Textbook of Physical Chemistry.*
- B.S. Bahl, G.D.Tuli and Arun Bahl, *Essentials of Physical Chemistry,* S. Chand and Company Ltd.
- CN Banwell, E. M. McCash, Fundamentals of molecular spectroscopy.
- R. C. Mukherjee, *Modern Approach to Physical Chemistry.*

- http://nsdl.niscair.res.in
- http://ocw.mit.edu

CHEMISTRY LAB: Practical Course **(60 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 and to interpret the experimental data
5. To improve analytical skills
6. To correlate the theory and experiments and understand their importance.
7. To prepare the complexes and comment on their VBT structure, magnetic properties and colors
8. To learn to estimate certain compounds

Inorganic Chemistry

Preparation of following complexes and Comments on its VBT structure, magnetic properties and colors

a) $[Cu(NH_3)_4(H_2O)_2]SO_4$

b) $[Ni(NH_3)_6]Cl_2$

c) Trans $[Co(NH_3)_4Cl_2]Cl$

d) $K_3[Fe(C_2O_4)_3].H_2O$

Organic Chemistry

1. Estimation of Glucose
2. Estimation of Acetamide
3. Estimation of Glycine
4. Estimation of Carboxylic group
5. Saponification value of oil

Physical Chemistry

1. To determine the specific rotation of a given optically active compound.
2. To verify Beer-Lambert law for $KMnO_4$ and determine the concentration of the given solution of $KMnO_4$.
3. To determine the strength of the given strong acid (HCl) potentiometrically using standard alkali solution.
4. To determine the strength of the given weak acid (CH_3COOH) potentiometrically using standard alkali solution.
5. To titrate potentiometrically ferrous ammonium sulphate solution using potassium dichromate solution astitrate and calculate the redox potential of Fe^{2+}/Fe^{3+} system on hydrogen scale.

Reference Books

- Vogel A, III[rd] Edition : A Textbook Of Quantitative Inorganic Analysis, Longman
- 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.
- Carl W. Garland, Joseph W. Nibler and David P. Shoemaker, Experiments in Physical Chemistry, Mc-Graw Hill, 8th Edition, 2009.
- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R.

Chand & Co.: New Delhi (2011).
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Jankidevi Bajaj College of Science, Wardha

Syllabus under Academic Autonomy

SUBJECT CHEMISTRY

B.Sc. III Semester VI

CY-VI Advanced of Inorganic, Organic & Physical Chemistry **(60 Hrs)**

Course Objectives:-

1. To study metal ligand bonding in transition metal complexes with respect to limitations of valency bond theory and crystal field theory.
2. To understand splitting of d-orbital in octahedral, tetrahedral and square planar complexes.
3. To study factors affecting the magnitude of 10dq, crystal field stabilisatation energy of octahedral and tetrahedral complexes and to learn to solve numericals.
4. To study magnetic properties of transition metal complexes.
5. To understand method of determining of magnetic susceptibility by Gouy's Method.
6. To learn spin only formula and orbital contribution to magnetic moment and to learn to solve numerical on magnetic moments.
7. To understand magnetic properties of octahedral and tetrahedral complexes with respect to CFT.
8. To study electronic spectra of transition metal complexes, Jahn Teller effect, selection rules (laporte and spin selection rules) and Hole formalism principle.
9. To understand electronic spectrum of $[Ti(H_2O)_6]^{3+}$ and $[Cu(H_2O)_6]^{2+}$ complex ions.
10. To study thermodynamic and kinetic stability of metal complexes, their relation, stepwise stability and overall stability constant and their relationship.
11. To understand factors affecting the stability of complexes.
12. To study Mole Ratio and Job's Method for determination of composition of Fe(III)-SSA complex.
13. To study principles of photometery.
14. To study types of colorimeter and spectrophotometer with schematic diagrams.
15. To understand applications of colorimeter and spectrophotometer in quantitative analysis with reference to estimation of Cu(II) as Cu - ammonia complex.
16. To study in brief the three important separation techniques a) Chromatography, b) Ion-Exchange and c) Solvent Extraction
17. To get introduced with Nuclear Magnetic Resonance (NMR) spectroscopy and Proton Magnetic Resonance spectroscopy.
18. To understand the concepts of nuclear shielding and deshielding, chemical shift, spin-spin splitting and coupling constant and areas of signals.
19. To learn to interpret NMR spectra of simple organic molecules and to elucidate the structure of simple organic molecules by NMR technique.
20. To study carbohydrates with main focus on glucose.
21. To learn structures of important carbohydrates.
22. To study amino acids, peptides, proteins & nucleic acids in brief.
23. To learn basic information about fats, oils and detergents.

24. To learn important basics of quantum mechanics.

25. To study Schrodinger wave equation and its derivation from postulates of quantum mechanics.
26. To understand application of Schrodinger wave equation to partical in a one dimensional box and its extension to two- and three- dimensional box.
27. To learn basics of photochemistry with respect to interaction of radiation with matter, laws of photochemistry.
28. To understand Jablonski diagram depicting various nonradiative and radiative processes.
29. To learn the concept of quantum yield with some examples of photochemical reactions.
30. To study concept of electrical dipole moment and its application.
31. To understand essential basics of nuclear chemistry with respect to composition and stability of nucleus, nuclear reactions and nuclear models.
32. To study different applications of radioisotopes.

Unit I **(10 Hrs)**

A) Metal ligand bonding in Transition Metal Complexes:

Limitations of Valency bond theory, Crystal field theory: Splitting of d-orbital in octahedral,tetrahedral and square planar complexes. Factors affecting the Magnitude of 10Dq,Crystal field Stabilisatation Energy of Octahedral and Tetrahedral complexes (Numericals), Magnetic Properties of Transition Metal Complexes, Method of determining of Magnetic Susceptibility by Gouy's Method. Spin only formula and orbital contribution to magnetic moment. Magnetic properties of Octahedral and Tetrahedral complexes with respect to CFT. Numericals on magnetic moments

B) Electronic spectra of Transition Metal Complexes:

Jahn Teller Effect, Selection Rules (Laporte and Spin selection Rules).Hole Formalism Principle. Electronic spectrum of $[Ti(H_2O)_6]^{3+}$ and $[Cu(H_2O)_6]^{2+}$ complex ions

C) Thermodynamic and Kinetic aspect of Metal Complexes:

Thermodynamic and Kinetic stability of metal complexes, their relation. Stepwise stability and overall stability constant and their relationship, Factors affecting the Stability of complexes. Determination of composition of Fe(III)-SSA complex by Mole Ratio and Job's Method.

Unit II: **(10 Hrs)**

A) Colorimetery and Spectrophotometery:

Principles of photometery: Beer-Lamberts Law, derivation and deviation (Numericals). Types of colorimeter and spectrophotometer with simple schematic diagrams. Application of colorimeter and spectrophotometer in quantitative analysis with reference to estimation of Cu (II) as Cu-ammonia complex.

B) Separation Techniques:

a) Chromatography: Classification, Principle, Technique and Application of Paper and Column Chromatography. Numericals.

b) Ion- Exchange: Types of ion exchange resins, Equilibria and ion exchange capacity, Application in separation of binary mixtures. Numericals.

c) Solvent Extraction: Principle and Classification , Factors influencing extraction and application in chemistry. Numericals.

Unit III: **(10 Hrs)**

Nuclear Magnetic Resonance (NMR) spectroscopy (^{1}H NMR) : Introduction, spin active nuclei, ^{1}H or proton magnetic resonance, theory and principle, instrumentation, relaxation phenomenon, nuclear shielding and deshielding, chemical shift, factors affecting chemical shift, equivalent and non equivalent protons, solvents and internal standard-TMS, spin-spin splitting and coupling constant. Intensities of signals, Pascal's triangle, Interpretation of NMR spectra of organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,2 dibromoethane, ethyl acetate, toluene, acetophenone, acetyl acetone. Problem pertaining to the structure elucidation of simple organic molecules by ^{1}H NMR technique.

Unit IV: **(10 Hrs)**

A) Carbohydrates: Definition, classification and reaction of glucose. Determination of structure of glucose. Epimerisation, mutarotation, conversion of glucose into fructose and vice-versa. Chain lengthening and shortening of aldoses (Wohl's degradation). Introduction to structures of maltose, sucrose, lactose, starch, cellulose, ribose and deoxyribose without involving structure determination.

B) Amino Acids, Peptides, Proteins: Classification, structure and stereochemistry of amino acids. Acids base behavior, isoelectric point and electrophoresis. Structure and nomenclature of peptides and protein. Classification of proteins. Protein denaturation. Structure determination of proteins (primary).

C) Nucleic Acids: Introduction, constituents of nucleic acids, nucleosides and nucleotides, structures of Ribonucleic acid and Deoxyribonucleic acid.

D) Fats, Oils and Detergents: Natural fats, Glycerides, hydrogenation of unsaturated oils, Definition of Saponification value. Iodine value. Acid value, Soaps, Synthetic detergents, Alkyl and aryl sulfonates.

Unit V: **(10 Hrs)**

A) Basics of Quantum mechanics: Introduction to wave functions (Ψ), well behaved and acceptable wave functions. Interpretation of wave function (Ψ) and its square (Ψ^2), Normalized and orthogonal wave functions (only qualitative idea no problems), Introduction to operators, Linear operator, Hermitian operator. addition, subtraction and multiplication of operators, commutative and non-commutative operators, position, momentum and energy operators. Eigen function and eigen value, eigen value equation. Numericals.

B) Quantum Chemistry:-

Schrodinger wave equation, Postulates of quantum mechanics, Derivation of Schrodinger wave equation from postulates of quantum mechanics. Application of Schrodinger wave equation to Partical in a one dimensional box: derivation of energy and normalized wave function. Graphical representation of Ψ and its square (Ψ^2). Applications of particle in a one dimensional box. Extension to two and three dimensional boxes. degeneracy, Numerical problems

Unit VI: **(10 Hrs)**

A) Photochemistry :

Interaction of radiation with matter, difference between thermal and photochemical process, Beer – Lamberts, laws of photochemistry : Grothus-Draper law, Stark-Einstein law, Jablonski diagram depicting various processes (nonradiative and radiative) fluorescence, phosphorescence, chemiluminesence, quantum yield, determination of quantum yield of reactions, causes for low and high quantum yields. Some examples of photochemical reactions e.g. Photochemical decomposition of Hydrogen iodide, Photosynthesis of HBr from H_2 and Br_2 and photosynthesis of HCI from H_2 and Cl_2

B) Electric Properties

Electrical dipole moment, polarizatrion of molecules (Clasius Mosotti equation), orientation of dipoles in an electric field. Determination of dipole moment. Bond moments. Group moments for benzene derivatives. Application of dipole moment to (i) % ionic character (ii) Shape of molecules, (iii) study of geometrical isomers and (iv) substituted benzene molecules

C) Nuclear chemistry: Recapitulation and important terms in nuclear chemistry, Nuclear reactions : Fission and fusion. Nuclear models : Liquid Drop Model, Shell Model and comparison between them. Explanation of fission by liquid drop model. Applications of radioisotopes in medicine, agriculture, carbon dating and structure determination.

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.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry: Principles of Structure and Reactivity*, Pearson Education India, 2006.
- Puri, Sharma, Kalia, *Principles of Inorganic Chemistry*
- Gary D. Christian, Analytical Chemistry: (Wiley, India).
- Willard, Merrit, Dean, Settle, Instrumental Methods of Analysis: (CBS Publishers, Delhi)
- Braun, Instrumental Methods of Chemical Analysis: (Tata McGraw-Hill)

Organic Chemistry

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- Jagdamba Singh and L. D. S. Yadav, Organc Chemistry, Pragati Prakashan
- Pradeep's Organic Chemistry, Volume 3
- RM Silverstein, G C Bassler and TC Morril, John Wally Spectroscopic identification of organic compound-
- PS Kalsi, Spectroscopy of Organic Molecule- Wiley, Esterna, New Delhi
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- Donald A. McQuarrie, Quantum Chemistry
- Ira Levine, Quantum CHemistry
- 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
- K. K. Rohatagi and Mukherjee , Fundamentals of Photochemistry, Third Edition, New Age Publishers
- H. J. Arnikar, Essentials of Nuclear Chemistry Fourth Edition, New Age International Publishers
- Puri, Sharma, Pathania, *Principles of Physical Chemistry,* Vishal Publishing Co.
- P. L. Sony, O. R. Dharma, *Textbook of Physical Chemistry.*
- K. L. Kapoor, Physical Chemistry, Volume 4

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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 determine concentration of inorganic ions in given solutions using colorimeter or spectrophotometer
9. To separate and identify the components from an organic mixture containing two solid components and preparation of suitable derivatives
10. To apply principles of physical chemistry to study various physical properties of compounds.

Inorganic Chemistry

1. To estimate copper (II) in commercial copper sulphate sample as ammonia complex using colorimeter or spectrophotometer.
2. To determine composition of Fe- SSA complex by Jobs method.
3. To determine composition of Fe- SSA complex by Mole Ratio method.

Organic Chemistry

Separation of an organic mixture containing two solid components using Aq. $NaHCO_3$ or Aq. NaOH separation, identification of the components and preparation of suitable derivatives (minimum five mixtures)

Physical Chemistry

1) To determine refractive index of given liquid by Abbe's refractometer and to calculate its molar refraction.
2) To construct the phase diagram of three component system(Acetic acid-chloroform-water).
3) To determine heat of solution of solid calcium chloride and calculate lattice energy of calcium chloride from its enthalpy change data using Born-Harber cycle.
4) To determine the molecular state of Benzoic Acid by distribution method .
5) To study magnetic properties of given compound using Guoy's balance

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).
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