



**Shiksha Mandal's
Bajaj College of Science, Wardha
Department of Chemistry**

**Revised Syllabus of B. Sc. Chemistry
(Semester I to II)
for Academic Autonomy**

**(Approved in BOS Meeting 06-April-2021 to be
implemented from Academic Session 2021-22)**

Structure for Revised Syllabus for BSc Chemistry Semester I to Semester VI

Semester	Course Codes	Course Names
Semester I	UG –CHEM(02)-S1-T	Fundamentals of Inorganic, Organic & Physical Chemistry
	UG-CHEM(02)-S1-P	Fundamentals of Practical Chemistry
Semester II	UG –CHEM(02)-S2-T	Concepts of Inorganic, Organic & Physical Chemistry
	UG-CHEM(02)-S2-P	Concepts of Practical Chemistry
Semester III	UG –CHEM(02)-S3-T	Elements of Inorganic, Organic & Physical Chemistry
	UG-CHEM(02)-S3-P	Elements of Practical Chemistry
Semester IV	UG –CHEM(02)-S4-T	Concise Inorganic, Organic & Physical Chemistry
	UG-CHEM(02)-S4-P	Concise Practical Chemistry
Semester V	UG –CHEM(02)-S5-T	Principles of Inorganic, Organic & Physical Chemistry
	UG-CHEM(02)-S5-P	Principles of Practical Chemistry
Semester VI	UG –CHEM(02)-S6-T	Advanced Inorganic, Organic & Physical Chemistry
	UG-CHEM(02)-S6-P	Advanced Practical Chemistry

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

UG –CHEM(02)-S1-T: (Fundamentals of Inorganic, Organic & Physical Chemistry) (60 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 various covalent bond theories especially VSEPR and Valence Bond Theory and to understand ionic bonding with respect to various physical properties.
3. To understand fundamental concepts in organic chemistry like electronic displacements, bond fissions, classification of reagents, reactive intermediates and types of reactions.
4. To differentiate between various types of stereoisomerism and to understand fundamentals of optical, geometrical and conformational isomerism.
5. To understand the behavior of gases, ideal gas as a model system, its extension to real gases and different physical properties of liquids.
6. To study and understand the tenets of thermodynamics pertaining to First Law of thermodynamics and to correlate between change in enthalpy of various reactions.

Unit I: Atomic Structure and Periodic Properties (10 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), Planck'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, van der 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 Mulliken's scale of electronegativity. Effective nuclear charge and Slater's rule with some exercises.

Unit II: Chemical Bonding (10 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, Valence 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 (10 Hrs)

- A. Bonding of carbon atom in alkanes, alkenes & alkynes. Types of electronic displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation (definition and**

examples). Bond Fission: Homolytic fission and Heterolytic fission. Nucleophiles and electrophiles (definition and examples).

- B. Reactive Intermediates:** Carbocation, Carbanion, free radical, carbene and nitrene, (Definition, formation, geometry, stability and one reaction each). Types of organic reactions — addition, substitution, elimination, rearrangement (definition and examples).

Unit IV: Stereochemistry

(10 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

(10 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, Avogadro'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, their expressions and numericals. 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 Waal's equation of state, Critical phenomenon, Andrew's isotherm of a real gas (CO_2) and its comparison with van der Waal's isotherm.
- 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, Method of determination by Ostwald viscometer. (Numericals)

Unit-VI Thermodynamics

(10 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, Zeroth law of thermodynamics, First law of thermodynamics, concept of heat capacity, heat capacity at constant volume and at constant pressure, their relationship. Calculations of w , q , ΔE & ΔH for reversible expansion of ideal gases under isothermal and adiabatic conditions (Numericals).
- B.** Thermochemistry: Standard states, Heat of reaction, enthalpy of formation, enthalpy of combustion, enthalpy of solution, enthalpy of neutralisation, relation between heat of reaction at constant volume and constant pressure. Hess's law of constant heat of summation & its applications (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.
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- 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 Publishing House
- <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 University Press 2011.
- 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
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Course Objectives:-

1. To understand fundamentals of volumetric analysis and to perform and apply volumetric titrations.
2. To learn to identify extra element and functional group in given organic compound.
3. To learn to determine thermodynamic properties like heat capacity of calorimeter and enthalpy of a reaction, solubility and heat of solubility and surface tension and 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 dilution 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 & CH₃COOH 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. (-COOH, Phenolic -OH, -CHO, Aromatic -NH₂, -CONH₂).

Physical Chemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of integral enthalpy of solution of KNO₃
3. Determination of enthalpy of ionization of acetic acid.
4. Study of the solubility of benzoic acid in water and determination of heat of solution.
5. To determine co-efficient of viscosity of organic liquids by using Ostwald's viscometer.
6. Determination of surface tension of organic liquids by using stalagmometer.

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)
- Das R. C., Behra B., *Experimental Physical Chemistry*, Tata McGraw Hill.
- Yadav J. B., *Advanced Practical Physical Chemistry*, Goel Publishing House.
- Alexander Findlay, Levitt B. P., *Findlay's Practical Physical Chemistry*, Longman, London
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Shiksha Mandal's
Bajaj College of Science, Wardha
Syllabus of B.Sc. I Semester II
SUBJECT – CHEMISTRY

UG –CHEM(02)-S2-T Concepts of Inorganic, Organic & Physical Chemistry (60 Hrs)

Course Objectives:-

1. To learn name, symbol, electronic configuration, trends, properties and important applications of s – block elements and to learn chemical properties of the noble gases.
2. To learn name, symbol, electronic configuration, trends and properties of p – block elements and to understand the structure of some of their compounds
3. To understand the chemistry of alkanes, alkenes and alkynes with respect to their methods of preparation and chemical reactions.
4. To learn the chemistry of dienes and aromatic hydrocarbons with respect to their structure, methods of preparation and chemical reactions.
5. To understand second law of thermodynamics with the help of state function entropy, free energy and to learn the basics of systems of variable composition.
6. To study various laws of crystallography and elaborate crystal structures of some compounds

Unit I: s-block elements & Noble Gases (10 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). Hydrogen bonding. Classification and effect of Hydrogen bonding on viscosity, solubility, melting point and boiling point. 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 (10 Hrs)

- A. Comparative study of groups 13 to 17:** Atomic and ionic radii, Ionisation potential, electron affinity, electronegativity, redox properties. Diagonal relationship (B-Si).
- B. Hydrides:** Comparative study with respect to structure of NH_3 , PH_3 , AsH_3 and SbH_3 .
- Oxides and Oxyacids of Phosphorous:** Structure of P_2O_3 , P_2O_5 , H_3PO_3 and H_3PO_4 with their 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) (10 Hrs)

- A. Alkanes:** Preparation: Catalytic hydrogenation, Wurtz reaction, from Grignard reagent. Reactions: Free radical Substitution i.e. Halogenation with mechanism.
- Cycloalkanes:** Introduction, Baeyer's strain theory. Theory of strainless rings. Ring strain in small rings. Introduction to conformations of cyclohexane: Boat and Chair, axial and equatorial bonds.

- 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. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markovnikoff's and anti-Markovnikoff's addition), Ozonolysis, Hydroboration-oxidation.
- C. Alkynes:** Nomenclature, Methods of formation of acetylene from - calcium carbide, dehydrohalogenation of dihalides. Chemical reaction - hydroboration, & polymerization. Oxyacetylene flame. Acidity of alkynes.

Unit IV: Aliphatic Hydrocarbons (II) and Aromatic hydrocarbons (10 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, cyclopropenium cation, cyclopentadienyl 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 (10 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, 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-Hoff's reaction isotherm.

Unit VI: Solid State (10 Hrs)

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 plane - Miller indices and Numericals. Bravais lattices, crystal systems, X-ray diffraction of crystal, derivation of Bragg's equation. Determination of crystal structure of NaCl, KCl and CsCl by powder method.

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- 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).

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Course Objectives:-

1. To perform quantitative estimation through the redox and complexometric titrations.
2. To learn to purify solid and liquid organic compounds and to study the criteria of their purity.
3. To determine critical solution temperature of given system and to study the distribution of given solute between pair of immiscible solvents.

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, permanent and temporary hardness of water by EDTA
4. Estimation of sodium carbonate content of washing soda

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

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

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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

Physical Chemistry

1. To determine the critical solution temperature of two partially miscible liquids(phenol-water systems).
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INCHARGE
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WARDHA



**Shiksha Mandal's
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Department of Chemistry**

**Revised Syllabus of B. Sc. Chemistry
(Semester III and Semester IV)
for Academic Autonomy**

**(Approved in BOS Meeting 8-September-2021 to be
implemented from Academic Session 2022-23)**

Shiksha Mandal's
Bajaj College of Science, Wardha

Syllabus of B.Sc. II Semester III

SUBJECT - CHEMISTRY

UG–CHEM (02)-S3-T

Elements of Inorganic, Organic & Physical Chemistry

60 Hrs (10 Hrs per unit)

100 Marks

Course Objectives:-

1. To understand the principles and importance of Molecular Orbital theory in chemical bonding.
2. To study important aspects of compounds like sulfur tetranitride, poly- and interhalogens.
3. To extend the study of periodic table to transition elements and to gain the knowledge of nonaqueous solvents.
4. To study important organic compounds like alkyl and aryl halides, organometallic compounds, with respective of their synthesis, properties and reactivities.
5. To gain the knowledge about synthesis, properties and reactivities alcohols, phenols and amines
6. To study the fundamentals of chemical kinetics and extend the study to the theories of reaction rates.
7. To understand the important aspects of ionic equilibrium.
8. To reinforce the basics of phase equilibrium and to understand related concepts.

Course Outcomes:-

1. By completing this theory course students will-
2. Understand the principles and importance of Molecular Orbital theory in understanding of bonding.
3. Learn important aspects of compounds like sulfur tetranitride, poly- and interhalogens.
4. Gain knowledge about important aspects of transition elements and nonaqueous solvents.
5. Acquire the knowledge about synthesis, properties and reactivities of important organic compounds like alkyl and aryl halides, organometallic compounds, alcohols, phenols and amines.
6. Know the fundamentals of chemical kinetics and reaction dynamics.
7. Understand the principles of ionic equilibrium.
8. Gain the knowledge about phase equilibrium and understand various phase diagrams.

Contents:-

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 non-bonding 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^- 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 $\text{Pb}(\text{OAc})_4$ 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 aldehydes and ketones, 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 Phase Equilibrium

10 Hrs

A. Ionic Equilibria

Strong, moderate and weak electrolytes, 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 and degree of hydrolysis for salt of strong acid and weak base, weak acid and strong base and Numericals. Buffer solutions – Introduction, Henderson's equations, buffer solution of weak acid and its salt, buffer solution of weak base and its salt (Derivation is not expected). Numericals.

B. Phase Equilibrium

Phases, components and degrees of freedom of a system, Gibbs Phase Rule (Derivation is not expected). Phase diagrams of one-component systems (phase diagram of water) and two component systems involving eutectics (phase diagram of lead-silver).

C. Liquid-Liquid mixtures:

Ideal liquid mixtures, Raoult's law of ideal solutions, Henry's law, Partial miscible liquids: phenol-water system, trimethylamine-water, nicotine-water system, lower & upper consolute temperature, Nernst distribution law, limitations and applications (association and dissociation).

References:-

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.
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- 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.
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- Tadashi Okuyama and Howard Maskill, *Oxford organic chemistry, a mechanistic approach* (oxford)
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- Gautam Bramhachari, *Organic chemistry through solved problems* (Narosa publications)
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- 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* MacMillan 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, TMH Publishing Co. Ltd. New Delhi.
- Puri, Sharma, Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co., 2020
- Soni P. L., Dharmarha O. P., Dash U. N., *Textbook of Physical Chemistry*, Sultan Chand and Sons, 2016.

- B.S. Bahl, G.D.Tuli and Arun Bahl, *Essentials of Physical Chemistry*, S. Chand and Company Ltd.

e References

- [e-PGPathshala \(inlibnet.ac.in\)](http://inlibnet.ac.in)
- <http://nsdl.niscair.res.in>
- <http://ocw.mit.edu>

Syllabus of B.Sc. II Semester III
SUBJECT - CHEMISTRY
UG-CHEM (02)-S3-P
Elements of Practical Chemistry

60 Hrs

30 Marks

Course Objectives:-

The primary objective of the practical course is to learn to perform experiments those have specific aims with correct techniques.

1. To learn to detect two acidic radicals of different group and two basic radicals of same groups from given mixture of inorganic salts.
2. To prepare an organic compound (single step synthesis).
3. To study rate and to determine rate constant and activation energy of certain reactions
4. To determine the critical solution temperature of phenol-water system in absence and presence of impurities.
5. To apply pH metry in determination of degree of hydrolysis of a salt, pK_a and dissociation constant of a weak acid

Course Outcomes:-

On completion of the practical course students will-

1. Understand qualitative analysis of inorganic salt mixtures.
2. Acquire skill in synthetic organic chemistry. This will also help them understand the concepts of atom economy, percent yield which are important for any synthetic process.
3. Gain an understanding of methods to determine kinetic parameters of reactions like rate of reaction, rate constant, energy of activation.
4. Learn to determine molecular weights of given compounds from colligative properties.

Contents:-

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 determine 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 and iodide
5. To determine the critical solution temperature of two partially miscible liquids (phenol-water systems).
6. To study the distribution of iodine between water and kerosene
7. To determine the degree of hydrolysis of aniline hydrochloride
8. To determine pK_a value of given weak acid by pH-metric titration with strong base.
9. To determine the dissociation constant of oxalic acid by pH-metric titration with strong base

Reference Books

- Svehla G. *Vogel's Qualitative Inorganic Analysis*, Pearson India, 7th Edition, 2002
- Gurdeep Raj, *Advanced Practical Inorganic Chemistry*, Krishna Prakashan Media (P) Ltd, 2013.
- 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.
- Yadav J. B., *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd, 2015.

Bajaj College of Science, Wardha

Syllabus under Academic Autonomy

SUBJECT CHEMISTRY

B.Sc. II Semester IV

UG –CHEM(02)-S4-T

Concise Inorganic, Organic & Physical Chemistry

60 Hrs (10 Hrs per unit)

100 Marks

Course Objectives:-

1. To extend the study of periodic table to the position, physical and chemical properties of lanthanides and actinides.
2. To learn basic concepts in statistical analysis of the data.
3. To understand important basic concepts related to coordination compounds.
4. To study important carbonyl compounds like aldehydes and ketones with respect to synthesis, properties and reactivities.
5. To study structure, preparation and chemical properties of carboxylic acids, unsaturated mono- and disubstituted carboxylic acids and their derivatives.
6. To study important topics of surface chemistry i.e. adsorption and catalysis through thermodynamics, adsorption isotherms and theories of catalysis.
7. To understand important concepts related to electrolytic conductance and to study its applications in determination of important electrochemical properties and volumetric titrations.

Course Outcomes:-

By completing this theory course students will-

1. Learn about the position and various physical and chemical properties of lanthanides actinides.
2. Get acquainted with important basic concepts in statistical analysis of the data.
3. Gain knowledge about important fundamentals of coordination compounds and their isomerism.
4. Acquire the knowledge about synthesis, properties and reactivities of important carbonyl compounds like aldehydes and ketones.
5. Learn structure, preparation and chemical properties of carboxylic acids, unsaturated mono- and disubstituted carboxylic acids and their derivatives.
6. Know the fundamentals of adsorption and its applications in catalysis.
7. Understand the principles of electrolytic conductance and its applications.

Contents:-

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. Sidgwick's electronic interpretation, EAN rule with examples, Nomenclature of Coordination compounds. Chelates: Classification and their application, Valence Bond Theory of transition metal complexes.

B. Isomerism in coordination compounds: Structural isomerism and Stereoisomerism in coordination compounds.

Unit III:

(10 Hrs)

Aldehydes and ketones:

A. 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, Concept of reactive methylene group, Keto-enol tautomerism in Acetoacetic ester. Oxidation of aldehydes by KMnO_4 , Tollen's reagent and Fehling solution, Reduction of aldehydes by LiAlH_4 and NaBH_4 .

B. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensation. Wittig and Mannich reaction (without mechanism), Baeyer-Villiger oxidation of Ketones, Cannizzaro reaction (with mechanism), MPV reaction, Clemmensen and Wolf-Kishner reaction.

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 (derivation not expected), 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. Concept of Transport number, 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:-

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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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.
- Soni P. L., Dharmarha O. P., Dash U. N., *Textbook of Physical Chemistry*, Sultan Chand and Sons, 2016.
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- <http://nsdl.niscair.res.in>
- <http://ocw.mit.edu>

SUBJECT CHEMISTRY
B.Sc. II Semester IV
UG-CHEM (02)-S4-P
Concise Practical Chemistry

60 Hrs

30 Marks

Course Objectives:-

The important objective of practical course is to develop skills of observation, recording and analyzing data and present the experimental work in a systematic manner.

1. To estimate an ion from the given solution gravimetrically.
2. To separate binary mixtures of ions by paper chromatography and to determine R_f values
3. To identify the given organic compound
4. To verify the Freundlich and Langmuir adsorption isotherm
5. 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.

Course Outcomes:-

On completion of the practical course students will-

1. Understand gravimetric analysis of barium and nickel from given samples.
2. Acquire skill in qualitative organic analysis to identify given organic compound. This skill is of great help in analysis of various samples while working in government, industrial or forensic laboratories.
3. Know the methods to determine conductance of electrolytic solutions and use the conductance values for different applications.
4. Learn to verify Freundlich and Langmuir adsorption isotherms.

Contents:-

Inorganic Chemistry

A. Gravimetric Analysis

- i) Estimation of Ba²⁺ as BaSO₄,
- ii) Estimation Ni²⁺ 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 R_f 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) Naphthalene, 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 weak 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

- Svehla G. *Vogel's Qualitative Inorganic Analysis*, Pearson India, 7th Edition, 2002
- Gurdeep Raj, *Advanced Practical Inorganic Chemistry*, Krishna Prakashan Media (P) Ltd, 2013.
- 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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- Yadav J. B., *Advanced Practical Physical Chemistry*, Krishna Prakashan Media (P) Ltd, 2015.

- V. Preparation of derivative.
- VI. Performance of specific test if any
- There should be at least one belonging from each type (**any four**)
- Benzoic acid, Salicylic acid, Cinnamic acid, Phthalic acid, Succinic acid.
 - β -Naphthol, α -naphthol, Resorcinol.
 - p-Toluidine, α -naphthylamine.
 - Napthalene, Thiourea, Urea, m-Dinitrobenzene, Diphenyl, Glucose, Lactose and Benzamide.

Physical Chemistry

- To verify the Freundlich adsorption isotherm of acetic acid on charcoal.
- To verify the Langmuir's adsorption isotherm of acetic acid on charcoal.
- To determine the strength of the given strong acid conductometrically using standard alkali solution.
- To determine the strength of the given weak acid conductometrically using standard alkali solution.
- To determine the strength of strong acid and a weak acid in a given mixture conductometrically by titrating it with standard alkali solution.
- To determine the solubility and solubility product of a sparingly soluble salt conductometrically.
- To determine the ionization constant of weak acid conductometrically.

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- Gurdeep Raj, *Advanced Practical Inorganic Chemistry*, Krishna Prakashan Media (P) Ltd, 2013.
- 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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INCHARGE
Department of Chemistry
Bajaj College of Science
WARDHA

Shiksha Mandal's
Bajaj College of Science, Wardha

Department of Chemistry

Revised Syllabus of B. Sc.
(Semester V to VI)
for Academic Autonomy

(Approved in BOS Meeting 28-July-2018)

Bajaj College of Science, Wardha

Syllabus under Academic Autonomy

SUBJECT CHEMISTRY

B.Sc. III 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 Sidgwick's 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 Congo red, Crystal violet, Phenolphthalein and 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 (NPCl₂)₃ and (NPCl₂)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 Ca²⁺ 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 Congo red, 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:

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.

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

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- Graham Solomon, T.W., Fryhle, C.B. & Snyder, 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.
- RM Silverstein, G C Bassler and TC Morrill, *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)*
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- 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*.
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CHEMISTRY LAB: Practical Course

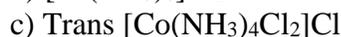
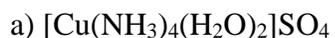
(60 Hrs)

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 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



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 as titrate and calculate the redox potential of $\text{Fe}^{2+}/\text{Fe}^{3+}$ system on hydrogen scale.

Reference Books

- Vogel A, IIIrd 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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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 stabilisation 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 $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ and $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ 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 photometry.
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 particle 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 Stabilisation 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 $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ and $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ 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) Colorimetry and Spectrophotometry:**

Principles of photometry: 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:

- Chromatography: Classification, Principle, Technique and Application of Paper and Column Chromatography. Numericals.
- Ion- Exchange: Types of ion exchange resins, Equilibria and ion exchange capacity, Application in separation of binary mixtures. Numericals.
- Solvent Extraction: Principle and Classification, Factors influencing extraction and application in chemistry. Numericals.

Unit III:**(10 Hrs)**

Nuclear Magnetic Resonance (NMR) spectroscopy (^1H NMR) : Introduction, spin active nuclei, ^1H 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 ^1H 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, 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 Particle 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, 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, chemiluminescence, 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 HCl from H_2 and Cl_2

B) Electric Properties: Electrical dipole moment, polarization of molecules (Clausius 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: Important terms in nuclear chemistry:- Isotope, Isobar, Isotone, Mass defect, nuclear binding energy, Average binding energy per nucleon, Numericals. Nuclear reactions: Fission and fusion. Nuclear models: Liquid Drop Model and Shell Model. Applications of radioisotopes in medicine, agriculture, carbon dating and structure determination.

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- Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
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- Braun, *Instrumental Methods of Chemical Analysis*: (Tata McGraw-Hill)

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- Jagdamba Singh and L. D. S. Yadav, *Organic Chemistry*, Pragati Prakashan
- Pradeep's *Organic Chemistry*, Volume 3
- RM Silverstein, G C Bassler and TC Morrill, *John Wiley Spectroscopic identification of organic compound-*
- PS Kalsi, *Spectroscopy of Organic Molecule-* Wiley, Esterna, New Delhi
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Physical Chemistry

- 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. Arnika, *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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CHEMISTRY LAB: Practical Course

(60 Hrs)

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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 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

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Bajaj College of Science
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