

UNIT- I

Structure of atom-discovery of electron, determination of e/m ratio, determination of charge of electron. Rutherford's experiment and atomic model, Bohr's atomic model. Black body radiation-failure of Wien and Raleigh-Jeans laws in explaining black body radiation. Planck's quantum theory. Bohr's explanation of atomic absorption spectrum of hydrogen. Einstein's theory of photoelectric effect. de Broglie equation- derivation. Heisenberg's uncertainty principle.

UNIT-II

Atomic orbitals, quantum numbers- principal, azimuthal, magnetic and spin quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, aufbau principle, $(n + l)$ rule, stability of half-filled and completely filled orbitals.

Classification of s, p, d & f block elements, atomic volume, atomic and ionic radii, ionization potential, electron affinity and electronegativity - variation along periods and groups. Factors influencing periodic properties.

UNIT- III

Chemical bonding- Ionic bonding- factors influencing the formation of ionic bond-characteristics of ionic compounds-Born-Haber cycle. Covalent bond - factors influencing the formation covalent bond-partial ionic character in covalent bond-Fajan's rule and coordinate bond.

UNIT- IV

Classification of organic compounds, functional group, homologous series. IUPAC system of nomenclature of alkanes, alkenes, alkynes, alcohols, aldehydes, ketones, carboxylic acids. Priority rules for multifunctional groups. Polar, non-polar molecules, electron donating and withdrawing groups. Polar effects-inductive, mesomeric, electromeric and hyperconjugation. Homolytic and heterolytic fission- free radicals, carbocations, carbanions and their stabilities. Electrophiles and nucleophiles.

UNIT- V

Alkanes-general methods of preparation of alkanes, Hybridisation in methane. Chemical properties of alkanes-halogenation, nitration, sulphonation, oxidation, thermal decomposition, isomerisation and aromatization.

Alkenes-general methods of preparation of alkenes. Hybridisation in ethylene. Chemical properties of alkenes-hydrogenation, halogenation, hydrohalogenation (Markovnikoff's rule and peroxide effect), hydration, hydroboration, oxidation by KMnO_4 and ozonolysis.

Text Books

1. B. S. Bahl and Arun Bahl, Advanced Organic Chemistry, S.Chand & Company, Edn. (2010).
2. B. R. Puri and L. R. Sharma, Principles of Inorganic Chemistry, Milestone Publication, Edn.31 (2011).
3. B. R. Puri and L. R. Sharma, Principles of Physical Chemistry, Vishal Publication, Edn. 44 (2011).

UNIT-I

Chemical bonding- Valence Bond theory-formation of H₂ molecule- concept of resonance-resonance energy- resonance structures of CO₃²⁻ ion, O₃ and CO molecules. **Molecular Orbital theory (MOT)-bonding and antibonding molecular orbitals. M.O. diagram** and bond order calculations for H₂, He₂, N₂ and O₂. Valence Shell Electron Pair Repulsion (VSEPR) theory-geometry of BeF₂, BF₃, CH₄, NH₃, H₂O and PCl₅ only. Hydrogen bonding-intermolecular, intramolecular-consequences.

UNIT- II

General methods of preparation of alkynes, properties of alkynes-acidity of alkynes, hydration, hydroboration, oxidation with KMnO₄, ozonolysis and polymerization. Alkadienes-preparation-stability of conjugated dienes-1,2 and 1,4 addition. Diels- Alder reaction.

Alkyl halides-preparation by direct halogenations of alkenes, hydrohalogenation of alkenes and alkynes. Aliphatic nucleophilic substitution-S_N1 and S_N2 mechanisms. Grignard reagent preparation. Synthesis of alcohols, ketones, carboxylic acids and ethers from Grignard reagents.

UNIT- III

Cycloalkanes-synthesis by internal Wurtz reaction and Dieckmann reaction-ring opening reaction of cyclopropane and cyclobutane. Baeyer's strain theory, Sachse-Mohr theory. Aromaticity - Huckle's rule and its applications to benzene, naphthalene, pyridine, pyrrole, cyclopropenyl cation and cyclopentadienyl anion. Aromatic hydrocarbons - mechanism of aromatic electrophilic substitution reactions- nitration, sulphonation, Friedel-Crafts alkylation and acylation of benzene.

UNIT- IV

Gaseous state-postulates of kinetic theory of gases-derivation of kinetic gas equation-derivation of Boyle's law, Charles' law, Avogadro's law, ideal gas equation, Graham's law of diffusion and Dalton's law of partial pressures from kinetic gas equation. Maxwell's distribution of molecular velocities (derivation not necessary). Root mean square velocity, average velocity and most probable velocity (derivation of equations not necessary). Collision diameter, collision frequency and mean free path (definition only).

UNIT- V

Colloids-classification, preparation and purification of colloids. Properties of colloids-optical, kinetic and electrical properties. Origin of charge of colloidal particles. Emulsions and gels-elementary treatment only. Solid: state-crystalline and amorphous solids-difference between them. Crystal systems- definitions of space lattice, Unit cell, Bravais lattice. **Weiss and Miller indices**

Text Books

1. B. S. Bahl and Arun Bahl, Advanced Organic Chemistry, S.Chand & Company, Edn. (2010).
2. B. R. Puri and L. R. Sharma, Principles of Inorganic Chemistry, Milestone Publication, Edn.31 (2011).
3. B. R. Puri and L. R. Sharma, Principles of Physical Chemistry, Vishal Publication, Edn. 44 (2011).

A. Qualitative Inorganic analysis

1. Semi micro method of analysis of a mixture containing two cations and two anions of which one may be an interfering acid radical requiring elimination during the analysis of basic radical.

2. Radicals for the reactions

- a. **Basic radicals:-** Lead , copper, zinc, bismuth, cadmium, tin, iron, aluminium, Manganese, magnesium, cobalt, nickel, calcium, barium, strontium, ammonium
- b. **Acidic radicals:-** Sulphate, carbonate, nitrate, chloride, bromide, iodide, oxalate, arsenite, arsenate, phosphate, borate and chromate

B. PREPARATION OF INORGANIC COMPLEXES

Preparation of any four of the following complexes:

Prussian Blue, Tetramminecopper(II)sulphate tetrahydrate,

Tris(thiourea)copper(II)sulphate dehydrate, Potassium trioxalatochromate(III),

Potassium trioxalato ferrate(III), Hexamminecobalt(III)chloride and

Ammonium hexachloro stannate(III)

Text Book:

V. Venkateswaran, R. Veeraswamy and A. R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand &sons (2006)

UNIT I

Classification of oxides based on their chemical behaviour-acidic, basic, amphoteric and neutral. Classification based on oxygen content-normal oxides, peroxides, super oxides, dioxides and mixed oxides. Hydrogen peroxide-preparation, properties structure and uses. Preparation, properties, structure and uses of oxy acids of sulphur- H_2SO_3 , H_2SO_5 , H_2SO_4 , $\text{H}_2\text{S}_2\text{O}_7$ and $\text{H}_2\text{S}_2\text{O}_8$.

UNIT II

Metallurgy-concentration of ores-gravity separation, froth flotation, magnetic separation, chemical separation. Extraction-roasting-calcinations-smelting, purification of metals-electrolysis, zone refining, vapour phase refining-van- Arkel method.

Position of alkali metals in periodic table. Anomalous behaviour of lithium. Diagonal relationship between Li and Mg. Occurrence, extraction, properties and uses of Li and Na.

UNIT III

Transition elements-general characteristics-position in the periodic table, trends in physical and chemical properties. Occurrence, extraction, properties and uses of titanium, vanadium, molybdenum and tungsten. Chemistry of titanium dioxide, titanium tetrachloride, vanadium pentoxide, ammonium metavanadate and ammonium molybdate.

UNIT IV

Alcohols-general methods of preparation-industrial preparation of methanol and ethanol, properties of alcohols-hydrogen bonding in alcohols- distinction among primary, secondary and tertiary alcohols. Preparation, properties and uses of ethylene glycol and glycerol - Preparation, reactions and uses of methyl mercaptan.

UNIT V

Preparation of formaldehyde, acetaldehyde, benzaldehyde, cinnamaldehyde, acetone, acetophenone and benzophenone, addition reactions with Grignard reagent, HCN, NaHSO_3 and NH_3 . Reduction reactions with LiAlH_4 , Wolf-Kishner and Clemmenson reductions, mechanisms of aldol, Cannizaro, Perkin, Knoevenagel, Claisen and Haloform reactions. Tests for aldehydes and ketones, differences between aldehydes and ketones.

Text Books

1. B. S. Bahl and Arun Bahl, Advanced Organic Chemistry, S.Chand & Company (2010).
2. B. R. Puri and L. R. Sharma, Principles of Physical Chemistry, Vishal Publication (2011).
3. R. D. Madan, Modern Inorganic chemistry, S .Chand & Company (2004).

UNIT I

Definition of terms-system, surrounding and boundary, types of systems, state of a system, properties of a system, extensive and intensive properties, thermodynamic processes, thermodynamic equilibrium, nature of work and heat. First law of thermodynamics-statement and significance, internal energy and enthalpy, reversible and irreversible processes. Heat capacity-correlation between C_p and C_v . Thermochemistry-Hess's law and its applications, relation between heat and energy, determination of heat of a reaction and bond energy, temperature dependence of heat of a reaction-Kirchoff's equations.

UNIT II

Need for the second law of thermodynamics-various statements, cyclic process, Carnot's cycle. Efficiency of a heat engine, thermodynamic scale of temperature. Entropy – definition, physical significance, and entropy changes in reversible and irreversible processes. Work and free energy functions, variation of free energy changes with temperature and pressure. Maxwell's relations. Gibbs – Helmholtz equations. Third law of thermodynamics – statement and need for the third law.

UNIT III

The concept of chemical potential and its significance. Equilibrium constants K_p and K_c -relation between them. Temperature dependence of equilibrium constants. van't-Hoff equation, Le Chatelier's principle-statement and applications. Colligative properties-thermodynamic derivations of molar depression in freezing point, elevation of boiling point, their usefulness in determining molar masses. Osmotic pressure and its measurement-principle of reverse osmosis.

UNIT IV

f-block elements-position in the periodic table, general characteristics of lanthanides and actinides- lanthanide contraction and its consequences-occurrence, oxidation states, magnetic properties and colour. Separation of lanthanides by fractional crystallization method and ion exchange method. Extraction and uses of thorium and uranium.

UNIT V

Composition of nucleus, nuclear forces (meson theory)-nuclear stability- mass defect, binding energy, packing fraction, n/p ratio and magic numbers. Isotopes, isobars, isotones and isomers-basic idea only-detection of isotopes by Aston's mass spectrograph method. Radioactive disintegration-modes of decay-rate of disintegration. Half-life period and average life. Nuclear fission-atom bomb and nuclear fusion-hydrogen bomb and stellar energy, uses of radioactive isotopes in medicine, analytical chemistry and carbon dating.

Text Books

1. B. R. Puri and L. R. Sharma, Principles of Inorganic Chemistry , Milestone Publication (2011).
2. B. R. Puri and L. R. Sharma, Principles of Physical Chemistry, Vishal Publication(2011).
3. R. D. Madan, Modern Inorganic chemistry, S.Chand & Company (2004).

A. VOLUMETRIC ANALYSIS

Acidimetry and Alkalimetry

1. Estimation of sodium carbonate using link hydrochloric acid and standard sodium carbonate.
2. Estimation of hydrochloric acid using link sodium hydroxide and standard oxalic acid.
3. Estimation of carbonate and bicarbonate in a mixture by Warder's method.

Permanganometry

4. Estimation of ferrous iron using link potassium permanganate and standard oxalic acid.
5. Estimation of oxalic acid using link potassium permanganate and standard ferrous ammonium sulphate.
6. Estimation of calcium using link potassium permanganate and standard oxalic acid.

Dichrometry

7. Estimation of ferric iron using standard potassium dichromate and external indicator potassium ferricyanide.
8. Estimation of ferric iron using standard potassium dichromate and internal indicator diphenylamine
9. Estimation of potassium dichromate using link sodium thiosulphate and standard potassium dichromate.

Iodometry and iodimetry

10. Estimation of copper using link sodium thiosulphate and standard potassium dichromate.
11. Estimation of arseneous oxide using link iodine and standard arseneous oxide.

Argentometry(demonstration)

12. Estimation of chloride using link silver nitrate and standard sodium chloride.
13. Estimation of hardness of water by EDTA method.

B. ORGANIC CHEMISTRY PRACTICALS

Qualitative analysis of monofunctional groups

Organic compounds containing any one of the following functional groups/compounds given for analysis:

Acids, esters, aldehydes, ketones, nitrocompounds, anilides, amines, carbohydrates, amides, phenols, naphthols, dihydric phenols, aromatic nuclear halogen compounds and aromatic side chain halogen compounds, urea and thiourea.

C. ORGANIC PREPARATIONS

Preparation of acetanilide from aniline, benzanilide from aniline, benzoic acid from ethylbenzoate, parabromoacetanilide from acetanilide, aspirin, nitrobenzene, glucosazone and salicylic acid from methyl salicylate.

REFERENCE BOOKS

1. V. Venkateswaran, R. Veeraswamy and A. R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand &sons (2006)
2. A. Thomas, Practical Chemistry Scientific Book Centre, Cannanore.

UNIT- I

Coordination chemistry - terminology, classification of ligands, chelation, nomenclature of complexes, Werner's theory and Effective Atomic Number (EAN) concept. Isomerism in complexes-structural isomerism-coordination, ionisation, hydrate, ligand and linkage isomerism. Stereoisomerism-geometrical isomerism in 4 coordinated complexes - Ma_2b_2 , Ma_2bc , $M(ab)_2$ and 6 coordinated complexes - Ma_4b_2 , Ma_3b_3 , $M(aa)_2b_2$. Optical isomerism and conditions for optical isomerism- optical isomerism in 6 coordinated complexes - $M(aa)_3$ and $M(aa)_2b_2$.

UNIT - II

Theories of metal - ligand bonding in complexes - valence bond theory (VBT), formation of outer orbital and inner orbital complexes, magnetic behaviour of the complexes and limitations of VBT. Crystal field theory (CFT) - crystal field splitting in octahedral and tetrahedral complexes. Strong and weak ligands, factors affecting Δ_o values, spectrochemical series, high spin and low spin complexes. Application of CFT to magnetic properties and colour of complexes, crystal field stabilisation energy (CFSE) and its uses. Limitations of CFT. Comparison between VBT and CFT.

UNIT - III

Applications of coordination compounds in quantitative analysis - gravimetric estimation of nickel using DMG and aluminum using oxine, estimation of hardness of water using EDTA. Structures and functions of chlorophyll and hemoglobin. Metal carbonyls-general methods of preparation, nature of M-CO bond, structure of $Ni(CO)_4$, $Fe(CO)_5$, $Fe_2(CO)_9$, $Mn_2(CO)_{10}$ and $Co_2(CO)_8$.

UNIT - IV

Calculation of number of atoms in simple cubic (SC), face centered cubic (FCC) and body centered cubic (BCC) unit cells. Symmetry in crystals - symmetry operations and symmetry elements - plane of symmetry, axis of symmetry and centre of symmetry. Symmetry elements of a cubic crystal. **Semiconductors - intrinsic and extrinsic - n-type and p-type. Electron gas theory and band theory of metals.**

UNIT - V

Alloys - simple mixtures, solid solutions, substitutional and interstitial alloys. Hume - Rothery ratios and their applications. Structure of the ionic crystals - AX type - NaCl, CsCl and ZnS -(zinc blende and wurtzite structures), AX_2 type - CaF_2 and TiO_2 . Limiting radius ratio rule- coordination number and shape of the ionic crystals. **Defects in crystal structures: stoichiometric defects - Schottky and Frenkel defects. Non - stoichiometric defects-metal excess and metal deficiency defects.**

Textbooks

1. B. R. Puri and L. R. Sharma, Principles of Inorganic Chemistry, Milestone Publication.
2. R. D. Madan, Modern Inorganic Chemistry, S. Chand & Company.
3. W. U. Malik, G. D. Tuli and R. D. Madan, Selected Topics in Inorganic Chemistry, S. Chand & company.

UNIT I

Preparation and properties of benzene sulphonic acid and sulphanic acid. Phenol - preparation, resonance structures, bromination, nitration, oxidation, reduction, Schotten-Baumann, phthalein fusion and coupling reactions. Mechanisms of Reimer-Tiemann and Kolbe-Schmidt reactions. Tests for phenol. Preparation and properties of o-cresol, catechol, resorcinol and pyrogallol.

UNIT II

Preparation and properties of formic and acetic, benzoic, oxalic and malonic acids. Action of heat on formic, acetic, oxalic, malonic and succinic acids – Blancs rule - Mechanism of hydrolysis of esters by B_{AC2} and A_{AC2} . Diethyl malonate - preparation and synthesis of acetic acid, adipic acid, cinnamic acid, glycine and malonyl urea from diethyl malonate. Ethylacetoacetate -preparation and synthesis of succinic acid, crotonic acid, butanone, 4-methyl uracil and antipyrine from ethylacetoacetate.

UNIT III

Preparation of nitrobenzene. Reduction of nitrobenzene in acid, neutral and alkaline media. Electrolytic reduction of nitrobenzene. Preparation and properties of aliphatic primary, secondary and tertiary amines. Separation of amines by Hinsberg and Hofmann methods. Aniline - preparation and reactions. Basicity of aliphatic and aromatic amines. **Preparation of benzene diazonium chloride, coupling reaction with aniline. Synthesis of phenol, benzene, benzoic acid, halo benzenes and nitrobenzene from benzene diazonium chloride.**

UNIT IV

Heterocyclic compounds- preparation and reactions of pyrrole and pyridine. Comparison of basicities of pyridine and pyrrole. Synthesis and reactions of quinoline, isoquinoline and indole. Vitamins - classification, sources and deficiency diseases. **Terpenoids-isolation and isoprene rule. Structural elucidation and synthesis of geraniol and α -terpeniol. Alkaloids - structural elucidation and synthesis of coniine and nicotine.**

UNIT V

Molecular rearrangements-mechanisms of Pinacol-pinacolone, Beckmann, benzidine, Hoffmann, Curtius, Schmidt, benzil - benzilic acid, Claisen, Cope, Fries and Wolf rearrangements. (Applications not required)

Textbooks

1. B. S. Bahl and Arun Bahl, Advanced Organic Chemistry, S. Chand & Company Ltd.
2. O. P. Agarwal, Reactions and Reagents, Krishna Prakashan Media (P) Ltd.
3. M. K. Jain, Modern Organic Chemistry, Vishal Publishing Co.

UNIT - I

Ohm's law and electrical units. Electrolysis – Faraday's law of electrolysis. Conductance of electrolytes - specific conductance, equivalent conductance and molar conductance - experimental determination of molar conductance. Types of electrolytes. Variation of specific and molar conductance with dilution. Transport number and ionic mobilities - determination of transport number - Hittorf's and moving boundary methods. Kohlrausch's law and its applications. Abnormal mobilities of hydrogen and hydroxyl ions.

UNIT - II

Arrhenius theory of electrolytic dissociation and its limitations. A qualitative discussion of interionic forces and their influence on conductance. Applications of conductance measurements - determination of solubility product, degree of dissociation, ionic product of water and conductometric titrations – acid-base and precipitation. Activity and activity coefficient of strong electrolytes (definition only).

UNIT - III

Dissociation of weak acids and bases – relative strengths. pH - definition, common ion effect and solubility product - applications of solubility product principle. Buffer solutions - types of buffers and buffer action - Henderson's equation. Hydrolysis of salts - hydrolysis constant and degree of hydrolysis of salts - weak bases and strong acids, weak acids and strong bases and weak acids and weak bases.

UNIT - IV

Electromotive force - electrochemical cells - galvanic cells - cell terminology - representation of cell - calculation of EMF of the cell. Reversible and irreversible cells - Weston standard cell. Experimental determination of EMF of a cell. Single electrode potential - determination. Electrochemical series - applications. Thermodynamic significance of electrode potential. Relation between EMF and thermodynamic quantities ΔG , ΔH , ΔS and their significance. Nernst equation for electrode and cell potentials. Types of electrodes - metal ion electrode, amalgam electrode, metal insoluble salt electrode (calomel and Ag/AgCl), oxidation-reduction electrode, gas electrode (standard hydrogen electrode).

UNIT - V

Concentration cells - types - derivation of EMF of concentration cells with and without transference. Liquid Junction potential - definition (derivation not necessary) and its elimination. Application of EMF measurements - potentiometric titrations - acid base, precipitation and redox titrations – determination of solubility of a sparingly soluble salt, determination of pH using glass, quinhydrone and hydrogen electrodes. Commercial cells – Acid storage battery. Rechargeable cells – nickel cadmium and lithium ion cells. Fuel cells. Electrochemical principle of rusting of iron.

Textbooks

1. B. R. Puri and L. R. Sharma, Principles of Physical Chemistry, Vishal Publication.
2. Arun Bahl, B.S. Bahl and G.D. Tuli, Essentials of Physical Chemistry, S. Chand and Company Ltd.
3. P.L. Soni and O. P. Dharmarha, Text Book of Physical Chemistry, Sultan Chand & Sons.

UNIT-1

Atomic and molecular spectroscopy-absorption and emission spectra. Spectroscopy, spectrometry and spectrum. Electromagnetic radiation, wavelength, wave number, frequency and energy. Regions of electromagnetic spectrum and absorption of radiation by organic molecules. Different types of molecular energies. Different types of molecular spectroscopy. **Microwave spectroscopy**-principle and theory. Diatomic molecule as a rigid rotor-selection rule-instrumentation. Applications of rotational spectroscopy-structures of xenon oxyfluoride and benzonitrile.

UNIT-II

IR Spectroscopy -theory-molecular vibrations-vibrational frequency-force constant and vibrational energy-zero point energy- vibrational degrees of freedom for liner and non-liner molecules and selection rules. Factors affecting vibrational frequencies-coupled vibration, Fermic resonance and electronic effects. Instrumentation (block diagram only). Finger print region, overtones, combination and difference frequencies. **Applications of IR spectroscopy-qualitative analysis** (determination of functional groups)-inorganic complexes, geometrical isomerism, study of keto-enol tautomerism and distinction between two types of hydrogen bonding.

UNIT III

Electronic Spectroscopy- Beer's and Lambert's law. Theory of electronic spectroscopy-types of electronic transitions. Franck- Condon principle, Chromophores and auxochormes. Absorption and intensity shifts- bathochromic, hypsochromic, hyperchromic, and hypochromic shifts. Types of absorption bands. Instrumentation (block diagram only). Woodward-Fieser rules for calculating λ_{\max} in conjugated and extended conjugated dienes and dienones. Applications to geometrical isomers.

UNIT IV

NMR Spectroscopy-theory- number of signals-equivalent and non-equivalent protons. Instrumentation (block diagram only). Chemical shift and TMS reference standard. Factors affecting chemical shift-shielding and deshielding-anisotropy with reference to ethylene, acetylene and benzene. Spin - Spin Coupling. Pascal's rule, Proton exchange.Rules of splitting signals-splitting of signals with reference to 1, 1, 2-tribromoethane, ethanol and acetaldehyde. Coupling constant (elementary idea only) NMR spectra of ethyl bromide, 2-chloropropane, acetamide, toluene and 1, 4-dioxane.

UNIT V

Mass Spectrometry- basic principles and theory. Instrumentation- Single focusing mass analyser-presentation of mass spectrum. Nitrogen rule-isotopic peaks, metastable ions and peak, molecular ion peak, base peak. Mc Lafferty rearrangement and Retro Diels - Alder reaction, double bond or ring equivalents Fragmentation associated with the following functional groups-ethanol, isopropyl alcohol, tert-butyl alcohol, diethyl ether, acetaldehyde, butyraldehyde, ethyl methyl ketone

Text Books

1. Elementary organic Spectroscopy, Y. R. Sharma. S. Chand & Company Pvt . Ltd, New Delhi.
2. Organic Spectroscopy Principles and Applications, Jag Mohan, Narosa Publishing House, New Delhi.
3. Instrumental methods of Chemical Analysis, Chatwal and Anand Himalalyan Publishing House.

Water Analysis:

1. Determination of pH, Conductivity using water analysis kit.
2. Estimation of Calcium, Magnesium, Chloride and dissolved oxygen using water analysis kit.
3. Estimation of total dissolved solids (TDS & Gravimetric methods).
4. Estimation of total solids.
5. Estimation of total suspended solids.
6. Estimation of permanent hardness.
7. Estimation of temporary hardness.
8. Estimation of total hardness (EDTA method).

Industrial Analysis

1. Estimation of Hydrogenperoxide.
2. Estimation of available chlorine in bleaching powder.
3. Estimation of saponification value of oil.
4. Estimation of iodine value of oil.
5. Estimation of calcium in limestone.
6. Estimation of available or free CaO in industrial lime.
7. Separation of individual organic compounds in plant extract using Thin Layer and Column chromatography. (Demonstration only).

Textbooks

1. O. P. Vermani and A. K. Narula, Applied Chemistry Theory and Practice.
2. J. Bassett, R. C. Denney, G. H. Jeffery, J. Mendham, Vogel's Text Book of Quantitative Inorganic Analysis

Programme: B.Sc., Chemistry

Course code:

Course Title: **CORE PRACTICAL: Basic concepts in Chemistry**

16UCH5CP4

PART-III Year: III Semester: V Credits: 3

Self-Study Course

Basic concepts in

Atomic structure, chemical bonding, periodic properties, s and p block elements, transition elements, coordination compounds and nuclear chemistry.

Gaseous state, solid state, thermodynamics, chemical equilibrium, chemical kinetics, catalysis, colloids and electro chemistry

Isomerism, hydrocarbons, halogen compounds, hydroxy derivatives, carbonyl compounds, ethers, carbonyl compounds, carboxylic acids, nitro compounds, amines and diazonium salts.

UNIT – I

Covalency and oxidation number, difference between oxidation number and valency. Rules for calculating oxidation number. Oxidation and reduction, common oxidising agents and reducing agents. Equivalent weight of common oxidising and reducing agents. Balancing redox equations using oxidation number method. Extraction of Mn, Co and Ni. Preparation, properties and uses of potassium permanganate, potassium dichromate and ferrous sulphate.

UNIT – II

Occurrence, extraction, chemical properties and uses of boron. Preparation, properties, structure and uses of diborane, sodium borohydride, boric acid, borax and boron nitride-borax bead test. Borazine-preparation, chemical properties and structure – comparison of borazine with benzene.

UNIT -III

Compounds of silicon-quartz, tridymite, cristobalite and carborundum. **Silicates**-types, structures and uses.

Isolation of **noble gases from liquid air-Ramsey-Rleigh's method and Dewar's method clathrate compounds**-types and properties. Preparation, properties and structures of – XeF₂, XeF₄, XeF₆, XeO₃ and XeOF₄

Inter halogen compounds: preparation, properties, uses and structures of-ICl, IBr, ICl₃, IF₅ and IF₇.

UNIT -IV

Non-aqueous solvents-classification of solvents, characteristic properties of a solvent. Physical properties, chemical reactions, advantages and limitations of liquid ammonia, liquid hydrogen fluoride and liquid sulphur dioxide.

UNIT -V

Acids and Bases - Arrhenius concept, Lowry - Bronsted concept - conjugate acid - base pairs, Lewis concept. Relative strengths of acids and bases-effect of solvent, levelling effect-polarity and dielectric constant- effect of substituents-electron releasing, electron withdrawing nature of substituents, oxidation number of central atom, resonance effect. Hard and Soft Acids and Bases (HSAB) principle and their applications.

Textbooks

1. R. D. Madan, Modern Inorganic Chemistry, S. Chand & Co.
2. B. R. Puri, L. R. Sharma and K. C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers.
3. P. L. Soni Textbook of Inorganic Chemistry, S. Chand &Co.

UNIT-I

Isomerism: structural and stereoisomerism - geometrical isomerism-Cahn – Ingold - Prelog rules for priority of groups, E-Z notation, and determination of configuration of geometrical isomers by physical and chemical methods. Optical isomerism, plane polarized light, chirality, enantiomers, diastereomers, anomers, epimers, optical isomerism in lactic acid and tartaric acid. R-S configuration.

UNIT-II

Conformational analysis - distinction between conformation and configuration. Conformations and potential energy diagrams of ethane and n-butane. Conformations of cyclohexane- chair, half chair, boat and twist forms. Methyl cyclohexane, conformations and stabilities of 1, 2 -dimethylcyclohexane, 1,3 -dimethylcyclohexane and 1,4 -dimethylcyclohexane, conformations in cyclohexanol, cyclohexane-1,3- diol and cyclohexane-1,4,-diol.

UNIT-III

Free radicals-classification, generation of free radicals, detection of free radicals, configuration of free radicals and relative stabilities of alkyl free radicals. Stability of triphenylmethyl free radical, reactions involving free radicals-polymerization, allylic bromination by NBS, autoxidation, Sandmeyer reaction, Gomberg and Ullmann reactions.

UNIT-IV

Addition reactions of alkenes - electrophilic, nucleophilic and free radical addition reactions. Mechanisms of addition of H₂, halogens and hydrogen halides to carbon – carbon double bond systems, Markovnikov's rule and Kharasch-peroxide effect, cis-hydroxylation and hydroboration. Synthetic uses of diazomethane and perbenzoic acid.

UNIT-V

Carbohydrates- classification - elucidation of open chain structure of glucose and fructose, mutarotation, interconversions between glucose and fructose, reducing and non-reducing sugars. **Amino acids and proteins:** Amino acids-classification and general methods of preparation and properties. **Peptide synthesis** by Bergmann method, proteins-classification, primary and secondary and tertiary structures. Colour test for proteins.

Textbooks

1. Arun Bahl and B. S. Bahl, Advanced Organic Chemistry, S. Chand & Co.
2. O.P. Agarwal, Reactions and Reagents, Goel publishing house, Meerut.
3. M. K. Jain, Modern Organic Chemistry, Vishal Publishing Co.

UNIT - I

Phase rule – Definition of phase, component and degrees of freedom. **Derivation of phase rule**. **Application of phase rule to one-component systems** – phase diagrams of H₂O, CO₂ and sulphur systems. **Application of phase rule to two component systems** – lead-silver and zinc-magnesium systems. Phase diagrams for two component liquid systems – completely miscible and partially miscible (Phenol-water, triethylamine-water and nicotine-water) systems. Principle of steam distillation. Nernst distribution law and its applications.

UNIT - II

Chemical Kinetics: Definition of rate and rate constant dimensions of rate and rate constant. Order and molecularity – differences. Derivation of rate constants for zero, first and second order reactions. Examples for fractional and higher order reactions. Various methods of determining order of a reaction. Effect of temperature on reaction rate, Arrhenius equation – **calculation of energy of activation**.

UNIT - III

Simple collision theory – its limitations and modifications. Lindemann theory of unimolecular reactions. A qualitative discussion of absolute reaction rate theory (ARRT) using HI reaction- significance of entropy of activation, comparison of collision theory with ARRT. Catalysis – definition, types, characteristics of catalytic reactions, catalytic promoter, catalytic poison, auto catalyst, negative catalyst and induced catalyst. Energy of activation and catalysis. Theories of catalysis. Enzyme catalysis, lock and key and Michaleis - Menton (Derivation not required) mechanisms.

UNIT - IV

Absorption and adsorption – definitions – physisorption and chemisorption – difference. Adsorption isotherms – theory and derivation of Freundlich and Langmuir isotherms. Ion exchange adsorption – cationic exchange and anionic exchange. Applications of ion exchange adsorption – water softening and deionization of water.

UNIT - V

Photochemical reactions. Difference between photochemical and thermochemical reactions. Laws of photochemistry – Lambert Beer's, Grotthus Draper law and Stark Einstein's law. Quantum yield – definition and experimental determination (actinometry). Photochemical reactions of low and high quantum yields. Kinetics of hydrogen-bromine and hydrogen-chlorine reactions. Photosensitization and quenching. Definition of chemiluminescence, fluorescence and phosphorescence.

Text Books

1. B. R. Puri and L. R. Sharma, Principles of Physical Chemistry, Vishal Publication.
2. Arun Bahl, B. S. Bahl and G. D. Tuli, Essentials of Physical Chemistry, S. Chand and Company Ltd.
3. P. L. Soni and D. P. Dharmarha, Text Book of Physical Chemistry, Sultan Chand & Sons.
4. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing house.

UNIT -I

Storage and handling of chemicals - corrosive, inflammable, explosive, toxic, poisonous and carcinogenic chemicals. **First aid procedures for laboratory accidents** involving toxic and poisonous chemicals, electrical shock, cuts and burns from hot objects. Laboratory cleansing methods and cleaning agents. Interchangeable glass ground joint apparatus and their advantages. Calibration and grading of pipette, burette and volumetric flask.

UNIT -II

Evaluation of analytical Data- Errors - types-determinate indeterminate and gross errors. Errors in measurements - weighing, measuring solutions, titrations and gravimetric analysis. Absolute error and relative error. Precision and accuracy, difference between precision and accuracy. Significant figures, mean, median and mode, average, deviation-standard deviation. Confidence limits, Q-test, F- test and t-test. SI and derived units.

UNIT -III

Semi-micro qualitative analysis - anions (interfering and non-interfering), reactions of some common anions (carbonate, sulphide, sulphate, nitrate, halides, oxalate, borate and phosphate), principle involved in the preparation of sodium carbonate extract and elimination of interfering anions. Classification of cations into groups, reactions of various cations, group reagents, solubility product and common ion effect.

UNIT -IV

Volumetric analysis - classification, standard solution, primary and secondary standard substances, concentration units. Acid-base titrations - choice of indicators and theory of acid base indicators. Redox titrations-self indicators and external indicators. Precipitation titrations - halides, thiocyanates, indicators of precipitation titrations. Complexometric titrations (EDTA titration only).

UNIT -V

Gravimetric analysis-methods of precipitation, conditions of precipitation, choice of precipitants. Types of organic precipitants, sequestering agents, solubility product and precipitation, factors affecting the solubility of precipitates, co-precipitation and post precipitation, procedure to minimise co-precipitation and post precipitation. Precipitation from homogeneous solution, Washing and drying of precipitates.

Textbooks

1. R.Gopalan, P.S.Subramanian, Elements of Analytical Chemistry & K. Rengarajan Sultan Chand & Sons
2. A. K. Srivastava & P. C. Jain, Instrumental Approach to Chemical Analysis S. Chand Company Ltd
3. V. Venkateswaran, R. Veeraswamy, Basic Principles of Practical Chemistry & A. R. Kulandaivelu, Sultan Chand & Sons

A. Gravimetric Analysis

1. Lead as lead chromate
2. Barium as barium chromate
3. Calcium as calcium oxalate monohydrate
4. Nickel as nickel dimethyl glyoxime complex
5. Magnesium as magnesium oxinate
6. Barium as barium sulphate (by insineration)
7. Lead as lead sulphate

B. Physical Chemistry Experiments

1. Determination of transition temperature of a hydrated salt
2. Determination of partition coefficient of Iodine between CCl_4 and H_2O
3. Determination of equilibrium constant for the reaction $\text{KI} + \text{I}_2 \rightleftharpoons \text{KI}_3$
4. Determination of critical solution temperature of phenol-water system
5. Determination of effect of impurity (NaCl) on CST of phenol-water system
6. Determination of effect of impurity (Succinic acid) on CST of phenol-water system
7. Determination of molecular weight by Rast's macro method
8. Phase diagram- simple eutectic system
9. Determination of rate constant of acid catalyzed hydrolysis of an ester
10. Kinetics of persulphate- Iodide reaction

Electrochemistry Experiments

11. Determination of cell constant
12. Determination of equivalent conductance of a strong electrolyte.
13. Conductometric titration- strong acid vs strong base
14. Conductometric titration- weak acid vs strong base
15. Potentiometric titration- Redox reaction [KMnO_4 vs Fe(II)]
16. Potentiometric titration- acid-base titration [HCl vs NaOH]

C. Demonstration Experiments

1. Polarimetry- Inversion of cane sugar

Reference Books

1. V. Venkateswaran, R. Veeraswamy and A. R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand &sons.
2. A. O. Thomas, Practical Chemistry Scientific Book Centre, Cannanore.

Programme: B.Sc., Chemistry

Course code: **15UCH6CP6**

Course Title: **Fundamentals of Practical Chemistry**

PART-III Year: III Semester: VI Credits: 2

Self-Study Course

The syllabus includes objective type questions to be evaluated by online examination from the fundamental aspects of

(i) Inorganic qualitative analysis

(ii) Organic qualitative analysis

(iii) Inorganic quantitative analysis including volumetric and gravimetric analyses

(iv) Physical chemistry practicals

(v) Inorganic and organic preparations

Reference Books

1. V. Venkateswaran, R. Veeraswamy and A. R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons.
2. A. O. Thomas, Practical Chemistry Scientific Book Centre, Cannanore.

Programme: B.Sc., Chemistry

Course code: **13UCH6CPR**

Course Title: **Project Work**

PART-III Year: III Semester: V & VI Credits: 5 Total Hours: 90 hours

- ❖ Identification of research problem.
- ❖ Literature Survey of the work.
- ❖ Planning and execution of experimental studies.
- ❖ Data collection and Data analysis.
- ❖ Report writing and project submission.

Unit I:

Shapes of s and p orbitals, hybridization of carbon atom in CH_4 , C_2H_4 and C_2H_2 . Polar effects - Inductive effect, Electromeric effect, Resonance effect, Hyperconjugative effect and steric effect. Cis-Trans isomerism - inter-conversion of Maleic and Fumaric acids, Optical isomerism - Optical activity, Optical isomerism in Lactic acid and Tartaric acid.

Unit II:

Molecular orbital theory - postulates, applications of Molecular Orbital theory to H_2 , He_2 , N_2 and O_2 molecules. Interhalogen compounds - Preparation, properties, structure and uses of ICl , BrF_3 and IF_5 . Diborane- preparation, properties and structure.

Unit III:

Synthetic dyes: classification based on chemical constitution, preparation of methyl orange and malachite green. **Chemotherapy** - preparation and uses of sulpha drugs-prontosil, sulphadiazine and sulphafurazole. Structure and uses of Penicillin and Chloromycetin. **Vitamins:** Sources and deficiency diseases. Hormones: definition, classification - biological functions of oxytocin and insulin.

Unit IV:

Solutions: types, Raoult's law, deviation from ideal behaviour, binary liquid mixture, fractional distillation. Chemical Kinetics: order and molecularity, determination of order of a reaction, effect of temperature on reaction rate, activation energy. Concept of chromatography: principles and applications of thin layer, column and paper chromatography.

Unit V:

Silicones: synthesis, properties and uses. Fuel gases: natural gas, water gas, semi-water gas, producer gas, oil gas and gobar gas. Preparation and uses of fertilizers - ammonium sulphate, urea, superphosphate of lime and triple super phosphate. Pollution - air, water and soil pollutions, sources and their control - acid rain, ozone layer depletion and greenhouse effect.

Text Book:

1. V. Veeraiyan & A.N.S. Vasudevan, Allied Chemistry Paper I & II, High Mount Publishing House (2005).

Unit I:

Coordination chemistry: Nomenclature of mono-nuclear complexes, Werner's theory, Sidgwick's EAN rule, Pauling's theory applied to $K_4[Fe(CN)_6]$, $K_3[CoF_6]$, $[Ni(CO)_4]$ and $K_2[Ni(CN)_4]$. Chelation and industrial applications of EDTA. Biological role of hemoglobin and chlorophyll.

Metals: Ore dressing, reduction to free metals, refining of crude metals. Furnaces - kilns, Muffle furnace, blast furnace, electric furnace and reverberatory furnace. Metallurgy of copper.

Unit II:

Aromatic compounds: Aromaticity, Aromatic electrophilic substitution reactions - halogenation, nitration, alkylation, acylation and sulphonation. Isolation, preparation, properties and structural elucidation of naphthalene. Preparation and properties of pyrrole, furan and thiophene.

Unit III:

Amino acids - classification, preparation and properties. Bergmann synthesis of polypeptides. Proteins - classification, properties and biological functions. Carbohydrates - Classification, preparation and properties of glucose and fructose.

Unit IV:

Energetics - Types of systems and processes. Statement of the first law of thermodynamics and need for the second law. Carnot cycle and efficiency of a heat engine. Joule-Thomson effect, Enthalpy and free energy relationships.

Phase equilibria-definition of phase, component and degrees of freedom. Phase rule (derivation not necessary). Phase diagrams- water system and lead-silver system.

Unit V:

Electrochemistry: conductance-definition, Kohlrausch law and its application, conductometric titrations, electroplating. Galvanic cells: EMF, standard electrode potential, hydrogen electrode, calomel electrode and glass electrode. pH definition and its determination by EMF method. Buffer solution: definition, buffer action, buffer solutions in biological systems.

Text Book:

1. Dr. V.Veeraiyan & A.N.S.Vasudevan, Allied Chemistry Paper I & II, HighMountPublishing House (2005).

A. **VOLUMETRIC ANALYSIS**

ACIDIMETRY- ALKALIMETRY

1. Estimation of Sodium Carbonate
 2. Estimation of Sodium hydroxide
 3. Estimation of Sodium Carbonate and sodium bicarbonate in a mixture – Warder’s method
 4. Estimation of Oxalic acid
 5. Estimation of Hydrochloric acid
 6. Determination of hardness of water
- PERMANGANOMETRY
7. Estimation of Mohr’s salt
 8. Estimation of Ferrous sulphate
 9. Estimation of Oxalic acid
 10. Estimation of Hydrogen peroxide
- DICHROMOMETRY
11. Estimation of Ferric iron (Internal indicator method)
 12. Estimation of Ferrous iron (Internal indicator method)
- IODOMETRY
13. Estimation of Potassium dichromate
 14. Estimation of Potassium permanganate
 15. Estimation of Copper

B. **ORGANIC ANALYSIS**

1. Detection of elements (N, S, halogens)
2. To distinguish between aliphatic or aromatic, saturated or unsaturated compounds
3. Functional groups tests for phenols, aromatic amines, aromatic acids, amides and carbohydrates

Text Book:

1. V.Venkateswaran, R. Veeraswamy and A. R. Kulandaivelu, Allied Practical Chemistry by S. Chand & Company Ltd., Ramnagar, New Delhi, (2001)

Unit – I: **Characteristics of solids-crystalline** and amorphous solids-differences-crystal lattice-unit cells-crystal systems-Bravais lattice-Weiss and Miller indices. Symmetry in crystals-elements of symmetry-symmetry elements of cubic system. Law of constancy of interfacial angles-law of rationality of indices.

Unit – II: X-ray diffraction and crystal structure-derivation of Bragg's law-**determination of crystal structure by rotating crystal method and powder method. Calculation of number of particles in a unit cell-density of solids.** Type of crystals-ionic, covalent, molecular and metallic crystals. Packing in crystals-voidtypes of three dimensional packing and hexagonal close packing - and coordination number.

Unit – III: **Lattice energy-experimental determination of lattice energy**-explanation of solubility and stability of ionic crystals based on lattice energy. Limiting radius ratio for trigonal, tetrahedral, octahedral and cubic sites-radius ratio rule and shape of ionic crystals application of radius ratio rule.

Text Books:

1. B. R. Puri and L. R. Sharma, Principles of Inorganic Chemistry, Milestone Publication (2011).
2. B. R .Puri and L. R. Sharma, Principles of Physical Chemistry, Vishal Publication (2011).
3. P. L. Soni, O. P. Dharmarha and U. N Dash. Text Book of Physical Chemistry Sultan Chand & Sons, (2009).

Programme: B.Sc., Physics

Course code: **13UPH4NM2**

Course Title: **NME: Solid state chemistry-II**

PART-IV

Year: II

Semester: IV

Credits: 2

Total Hours: 2x15 = 30

Unit – I:

Defects in Solids- Schottky defect and Frenkel defect and their Consequences, metal deficiency defects and metal excess defects and their consequences, thermal defects and impurity defects. Void space in close packed spheres- calculation of void space and occupied space in simple cubic, body centered and face centered cubic packings.

Unit – II:

Structure of solids-sodium chloride, zinc blende, wurtzite, cesium chloride and calcium fluoride (fluorite) and rutile structures. Liquid crystals-smectic, nematic and cholesteric liquid crystals-applications of liquid crystals.

Unit – III:

Electrical, magnetic and dielectric properties of crystals-ferroelectricity, pyroelectricity and antiferroelectricity- superconductivity. Intrinsic conduction and extrinsic conduction-band theory-conductors and insulators- p-type and n-type semiconductors. **Effect of temperature on the conductivity of semiconductors-applications of semiconductors.**

Text Books:

1. B. R. Puri and L. R. Sharma, Principles of Inorganic Chemistry , Milestone Publication (2011).
2. B. R. Puri and L. R. Sharma, Principles of Physical Chemistry, Vishal Publication (2011).
3. P. L. Soni, O. P. Dharmarha, and U. N Dash. Text Book of Physical Chemistry, Sultan Chand & Sons (2009)