

## **C-1 INORGANIC CHEMISTRY**

### **UNIT I – Atomic Structure**

Bohr's theory of atom and its failure with the theory of de-Broglie and Heisenberg's uncertainty principle, Schrödinger's wave function with shape of orbitals.

### **Unit –II Periodicity of Elements**

Periodicity of elements : s, p, dp block elements, the long form of periodic table.

Detailed discussion of the following properties of the elements i) Effective nuclear charge shielding or screening effect. Slater rules, variation of effective nuclear charge in periodic table etc.

### **Unit – III Chemical Bonding - I**

Ionic bond : General characteristics, valence bond theory, molecular orbital theory, Faján's rule.

### **Unit-IV Chemical bonding II**

Metallic band, semiconductors and insulators, hydrogen bonding, Redox reactions.

## **C-2 PHYSICAL CHEMISTRY**

### **Unit- I Gaseous State**

Kinetic molecular model of a gas, postulates and derivation of the kinetic gas equation collision frequently: collision i) diameter etc. maxwell distribution ii) and its use in evaluating molecular velocities

### **Unit-II Liquid State**

Qualitative treatment of the structure of liquid state of physical properties of liquids vapour pressure surface Tension, coefficient of viscosity etc.

### **Ionic Equilibria-I**

Strong, moderate and weak electrolytes, degree of ionization factors affecting degree of ionization

### **Unit- III : Solid state**

Nature of the solid state ; law of constancy of interfacial angles, law of rational indices, miller indices, elementary ideas of symmetry x-ray diffractions; Braggs law

### **Unit -IV : Ionic equilibria- II**

Salt hydrolysis -calculation of hydrolysis constant, degree of hydrolysis and  $P_H$  for different- salts. Buffer solutions; derivation of Henderson equation and its applications. Theory of acid base indicators; selection of indicators and their limitations.

## **C-3 Organic Chemistry**

## **Unit- I Basics of organic chemistry**

Electronic displacements : Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications Dipole moment; organic acids and bases; their relative strength, stability of carbocations, carbanions. Introduction to types of organic reactions and their mechanism.

### **Carbon –carbon sigma Bonds**

Chemistry of alkenes, Formation of alkenes, Halogenation relative reactivity and selectivity.

## **Unit- II Stereochemistry**

Fischer projection; Newmann and saw horse projection formulae; Geometrical isomerism? Cis and trans and syn-anti isomerism. E/Z notations with C.I.P rules. Enantiomers Diastereoisomers Relative and absolute configuration: D/L and R/S designations.

## **Unit – III: Chemistry of Aliphatic Hydrocarbons:**

### **A. carbonyl bonds:**

Formation of alkenes and alkenes by elimination reaction, mechanism of  $E_1$ ,  $E_2$ ,  $E_{1cB}$  reactions, Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms Nucleophilic additions Hydration to form carbonyl compounds.

### **B. Cycloalkenes and conformational analysis :**

Types of cycloalkenes and their relative stability energy diagrams of cyclohexane:

## **Unit - IV Aromatic hydrocarbons**

Aromaticity: Huckel rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples.

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## **Physical Chemistry - II**

### **Unit-I Chemical thermodynamics:**

Intensive and extensive variables, state and path functions isolated, closed and open systems, Zeroth law of thermodynamics. First law: concept of heat,  $q$ , work,  $w$ , internal energy,  $U$ , and statement of first law enthalpy,  $H$ , relation between heat capacities, calculations of  $q$ ,  $w$ ,  $u$  and  $H$  for reversible, irreversible and free expansion of gases. Thermochemistry: Heats of reactions : Standard states; enthalpy of formation of molecules and ions and enthalpy of combination and its applications.

### **Unit- II : Second Law:**

Concept of entropy, thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible process. Third Law : statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Gibbs and Helmholtz energy, Gibbs- Helmholtz equation.

### **Unit- III Systems of variables composition**

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal

mixtures, change in thermodynamic functions in mixing of ideal gases. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration free energy of mixture and spontaneity.

#### **Unit- IV Solutions and Colligative properties:**

Dilute solutions, lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between four colligative properties and amount of solute.

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### **Inorganic Chemistry**

#### **Unit-I General Principles of Metallurgy :**

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic reduction, Hydrometallurgy.

#### **Acids and Bases**

Bronsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions ; Lewis acid-base concept.

Unit -II Chemistry of s and p Block elements -I Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous Allotropy and catenation.

#### **Unit- III :Chemistry of s and p Block elements - II**

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides, carboranes and graphitic compounds, silanes.

#### **Unit – IV: Noble Gases**

Occurrence and uses, rationalization of interhalogen compounds of noble gases,  $\text{XeF}_2$ ,  $\text{XeF}_4$  and  $\text{XeF}_6$ .

#### **Inorganic Polymers**

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes.

### **C<sub>6</sub> ORGANIC CHEMISTRY II**

#### **Unit – I Chemistry of Halogenated Hydrocarbons :**

Alkyl halides : Methods of preparation, nucleophilic substitution reactions  $\text{S}_{\text{N}}1$ ,  $\text{S}_{\text{N}}2$  and  $\text{S}_{\text{N}}3$  mechanism with stereochemical aspects and effect of solvent etc. nucleophilic substitution vs elimination Aryl Halides preparation, including preparation from diazonium salts, nucleophilic aromatic substitutions.

#### **Unit – II Alcohols, phenols, Ethers and Epoxides :**

Alcohols: preparation, properties and relative reactivity of 1, 2, 3 alcohols,  $\text{C}_6\text{H}_5\text{MgBr}$ - Grignard reaction; preparation and properties of glycols: oxidation by periodic acid and lead tetracetate, pinacol-pinacolone rearrangement Phenols : preparation and properties.

#### **Unit – III Carbonyl Compounds**

Structure reactivity and preparation, Nucleophilic additions, Nucleophilic addition- elimination reactions with ammonia derivatives with mechanism. Mechanism of Aldol and Benzoin condensation, Knoevenagel condensation, Perkin and Cannizzaro and Wittig reaction etc.

#### **Unit- IV Carboxylic Acids and their derivatives :**

Preparation, physical properties and reactions of monocarboxylic acids, Typical reactions of dicarboxylic acids hydroxyl acids and unsaturated acids: succinic, lactic, malic tartaric, citric, maleic and fumaric acids, preparation and reactions of acid chlorides, anhydrides esters and amides etc.

Sulphur-containing compounds

Preparation of thiolsthoethers and reactions.

### **C<sub>7</sub> Physical Chemistry III**

#### **Unit - I Phase Equilibria- I**

Concept of phases, components and degrees of freedom derivation of Gibbs Phase Rule for non reactive and reactive systems, Clausius-Clapeyron equation and its applications to solid liquid, liquid - vapour and solid-vapour equilibria, phase diagram for one component system.

#### **Unit -II Phase Equilibria- II**

Three component systems, water- chloroform acetic acid system, triangular plots, Binary solutions,, Nearest distribution etc.

#### **Unit- III Chemical kinetics**

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to the second order reactions, experimental methods of the determinations of orders, kinetics of complex reactions, Arrhenius equation, activation energy. Collision theory of reaction rates.

#### **Unit- IV Catalysis**

Types of catalyst, specificity and selectivity, mechanism of catalyzed reactions at solid surfaces effect of particle size.

Surface chemistry

Physical adsorption, chemisorptions, adsorption isotherms

**INORGANIC CHEMISTRY III****Unit- I Co- ordination chemistry**

Werner theory, valence bond theory, electro neutrality principle and back bonding, crystal field theory, measurement of CFSE weak and strong fields pairing energies, factors affecting the magnitude of  $10 Dq$  in octahedral vs tetrahedral Co-ordination, tetragonal distortions from octahedral geometry

**Unit- II Transition Elements - I**

General group trends with special reference to electronic configuration, colour variable valency, magnetic and catalytic properties, ability to form complexes.

**Unit -III Transition Elements -II**

Chemistry of Ti, V, Cr, Mn Fe and Co in various oxidation states.

**Unit - IV Lanthanoids and Actinoids**

Electronic configuration, oxidation states, colour spectral and magnetic properties lanthanide contraction, separation of lanthanides.

Bioorganic chemistry

Metal ions present in biological systems, clarification of elements according to their action in biological system. Na/K pump, carbonic anhydrase and carboxy peptidase.

**Organic chemistry - III****Unit- I Nitrogen Containing functional groups :**

Preparation and important reactions of nitro and compounds nitriles. Amines: Effect of substituent and solvent on basicity; preparation and properties Gabriel phthalimide synthesis, carbylamines reaction, Mannich reaction.

## **Unit- II Diazoniumsalts:**

Preparation and their synthetic applications

PolynuclearHydrocarbons :

Reactions of naphthalene and anthracene structure preparation and structure elucidation and important derivatives of naphthalene and anthracene.

## **Unit- III Heterocyclic compounds**

Classification and nomenclature, structure, aromaticity in 5-membered and 6-member rings containing pyrrole, Thiophene, pyridine (Hantzsch Synthesis), indole, synthesis and isolation.

## **Unit- IV Alkaloids:**

Natural occurrence, General structural features Isolation and their physiological action, Hoffmann exhaustive methylation, Emde modification, structure elucidation and synthesis of Hydrastine and Nicotine.

## **C – 10: Physical Chemistry**

### **Unit- I Conductance – I**

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions.

### **Unit – II Conductance – II**

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and moving boundary methods. Applications of conductance measurement (i) Degree of dissociation of weak electrolytes.

### **Unit-III Electrochemistry - I**

Quantitative aspects of faradays laws of electrolysis, rules of oxidation/ reduction of ions based on half cell potentials, applications of electrolysis in metallurgy and industry chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement.

### **Unit- IV Electrochemistry - II**

Concentration cells with and without transference, liquid junction potential, determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric poprations (acids- base, redox, precipitation)

## **C-11**

### **Unit- I NuclicAcids**

Components of nucleic acids, Nucleosides and nucleotides, structure, synthesis and reactions of Adenine, Guanins Cytosine.

Enzymes

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action.

### **Unit II Amino Acids, Peptides and proteins**

Amino acids, Peptides and their clarification – Amino acids-Synthesis, ionic properties and reactions.Zwitterions, PKa values, isoelectric point and electrophoresis.Study of peptides determination of peptides.

### **Unit III Lipids**

Introduction to oils and fats, common fatty acids present in oils and fats. Hydrogenation of fats and oils, saponification value, acid value, iodine number.

Concept of Energy in BioSystems :

Cells obtain energy by the oxidation of foodstuff. Introduction to metabolism. Overview of catabolic pathways of fat and protein.

### **Unit IV Pharmaceutical Compounds :**

Structure and importance Classification structure and therapeutic uses of antipyretics, Paracetamol, Analgesics, Ibuprofen, Antimalarial chloroquine. An elementary treatment of Antibiotics.

## **C-12**

### **Physical Chemistry- V**

#### **Unit-I Meantime Chemistry**

Postulates of Quantum mechanics, Quantum mechanical operators, Schrodinger equation and its approach zero point energy and Heisenberg uncertainty principle, wave functions probability distribution functions nodal properties. Extension to three dimensional boxes, separation of variables, degeneracy qualitative treatment of simple harmonic oscillator model of vibrational motion.

#### **Unit II Chemical Bonding**

Covalent bonding values bond and molecular approaches LCAO-MO treatment of  $H_2^+$ . Bonding and antibonding orbitals. Qualitative extension

to H<sub>2</sub> comparison of LCAO-MO and VB treatments of (One wave functions, detailed solution not required) and their limitations.

### **Unit III Molecular Spectroscopy –I**

Interaction of electromagnetic radiation with molecular and various types of spectra Born-Oppenheimer approximation. Raman spectroscopy

#### **Molecules isotopic substitution**

Vibrational spectroscopy classical equation of vibration computation of force constant, amplitude of diatomic molecular vibration anharmonicity. Morse potential dissociation energies, fundamental frequencies.

### **Unit IV Molecular Spectroscopy II**

Electronic spectroscopy : Frank-Condon principle, Electronic transitions, Singlet and triplet states, phosphorescence.

#### **Photochemistry**

Characteristics of electromagnetic radiation Lambert Beer's law and its limitations & physical significances of absorption coefficient laws of photochemistry, quantum yield actinometry. Examples of low and high quantum yields. Photochemical equilibrium and the differential rate of photochemical reactions.

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## **INORGANIC CHEMISTRY-IV**

### **Unit-I Organometallic Compounds –I**

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls : 18 electron rule, electron count of mononuclear, Polynuclear and substituted metal carbonyls of 3<sup>rd</sup> series. General methods of preparation (direct-combination, reductive carbonylation, thermal and photochemical decomposition)

### **Unit-II Organometallic Compounds-II**

Concept of multicenter bonding Role of triethylaluminium in polymerization of ethene. Species present in the solution of Grignard reagent and their structures.

### **Unit-II Theoretical Principles in Qualitative Analysis**

Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into group reagents.

### **Unit-IV Reaction Kinetics and mechanism:**

Introduction to inorganic reaction mechanisms substitution reactions in square planar complexes, Trans effect and its applications, theories of trans effect.

## **C-14**

### **ORGANIC CHEMISTRY - IV**

#### **Unit I Organic Spectroscopy**

U.V spectroscopy : Types of electronic transitions, max, chromophores and Auxichromes, Bathochromic and Hypsochromic shifts, Intensity of absorption: Application of Woodward rules for calculation of

max for the following systems : the unsaturated aldehydes: ketones  
carboxylic acids and esters , conjugated dienes.

### **Unit - II Organic spectroscopy - II**

NMR Spectroscopy : Basic principles of proton magnetic resonance ,  
chemical shift and factors influencing it; spin-spin coupling and coupling  
constants Anisotropic effects in alkene, alkyne, aldehydes and aromatics.  
Interpretation of NMR spectra of simple compounds.

### **Unit - III Carbohydrates**

Occurrence, classification and their biological  
importance monosaccharides. Constitution and absolute configuration of  
glucose and fructose, epimers and anomers, mutarotation determination of  
ring size of glucose and fructose, Haworth projections and conformational  
structures.

Dyes

Classification, colour and constitution; mordant and vat dyes chemistry of  
dyeing synthesis and applications of AZO dyes methyl orange and Congo red  
(mechanism of Diazocoupling)

### **Unit - IV Polymers**

Introduction and classification including diblock triblock and  
amphiphilic polymers, number average molecular weight, weight average  
molecular weight degree of polymerization polydispersity index.  
Polymerization reactions- Addition and condensation- mechanism of  
cationic, anionic and free radical addition polymerization.