

Lesson plan (2022-2023)

B.Sc. I Sem.

Chemistry

September

Inorganic

1. Atomic Structure Idea of de Broglie matter waves, Heisenberg's uncertainty principle, atomic orbitals, quantum numbers, radial and angular wave functions, normal and orthogonal wave functions, significance of Ψ and Ψ^2 , probability distribution curves, shapes of s, p, d, f orbitals, Aufbau and Pauli exclusion principles, Hund's multiplicity rules, Electronic configuration of elements, effective nuclear charge, Slater's rules.

Organic

1. Structure and Bonding Localized and delocalized chemical bond, Van der Waal's interactions, resonance: conditions, resonance effect and its applications, hyperconjugation, inductive effect, Electromeric effect & their comparison.

2. Stereochemistry of Organic Compounds Concept of isomerism. Types of isomerism. Optical isomerism — elements of symmetry, molecular chirality, enantiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

Physical

1. Gaseous States Kinetic Molecular Theory of Gases, Maxwell's distribution of velocities and energies (derivation excluded) Calculation of root mean square velocity, average velocity and most probable velocity. Collision diameter, collision number, collision frequency and mean free path (Derivations excluded), Deviation of Real gases from ideal behavior, Derivation of Van der Waal's Equation of State, its application in the calculation of Boyle's temperature (compression factor)

October

Inorganic

2. Periodic table and atomic properties Classification of periodic table into s, p, d, f blocks, atomic and ionic radii, ionisation energy, electron affinity and electronegativity definition, methods of determination or evaluation, trend in periodic table (in s and p-block elements), Pauling, Mulliken, Allred Rachow and Mulliken Jaffe's electronegativity scale, Sanderson's electron density ratio.
3. Covalent Bond Valence bond theory (Heitler-London and Pauling approach) and its limitation, directional characteristics of covalent bond, various type of hybridisation and shapes of simple inorganic molecules and ions (BeF_2 , BF_3 , CH_4 , PF_5 , SF_6 , IF_7 , SO_4^{2-} , ClO_4^- , NO_3^-) valence shell electron pair repulsion (VSEPR) theory to NH_3 , H_3O^+ , SF_4 , ClF_3 , H_2O , SnCl_2 , ClO_3^- and ICl_2^- .

Organic

2. Relative and absolute configuration, sequence rules, R & S systems of nomenclature. Geometric isomerism — determination of configuration of geometric isomers. E & Z system of nomenclature, Conformational isomerism — conformational analysis of ethane and n-butane, conformations of cyclohexane, axial and equatorial bonds. Newman projection and Sawhorse formulae, Difference between configuration and conformation.

3. Mechanism of Organic Reactions Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents – electrophiles and nucleophiles. Types of organic reactions. Reactive intermediates — carbocations, carbanions, free radicals, carbenes, (formation, structure & stability).

Physical

2. Critical Phenomenon Critical temperature, critical pressure, critical volume and their determination. PV isotherms of real gases, continuity of states, the isotherms of Van der Waal's equation, relationship between critical constants and Van der Waal's constants. Critical compressibility factor. The Law of corresponding states.

3.Liquid States Structure of liquids, Properties of liquids – surface tension, refractive index, viscosity, vapour pressure and optical rotation.

November

Inorganic

3.Molecular orbital theory of homonuclear (N₂, O₂) heteronuclear (CO and NO) diatomic molecules and ions, bond energy, bond angle, bond length and dipole moments, percentage ionic character from dipole moment and electronegativity difference.

4. Ionic Solids Ionic structures (NaCl, CsCl, ZnS (Zinc blende), CaF₂) size effects, radius ratio rule and its limitations, Madelung constant, Stoichiometric and Non stoichiometric defects in crystals

Organic

3.Alkanes and Cycloalkanes IUPAC nomenclature of branched and unbranched alkanes, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation: Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids, physical properties. Mechanism of free radical halogenation of alkanes: reactivity and selectivity.

Physical

4.Solid State Classification of solids, Law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry and symmetry elements, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of Laue method, rotating crystal method and powder pattern method.

December

Inorganic

4. Ionic Solids Ionic structures (NaCl, CsCl, ZnS (Zinc blende), CaF₂) size effects, radius ratio rule and its limitations, Madelung constant, Stoichiometric and Non stoichiometric defects in crystals, Lattice energy (mathematical derivation excluded) and BornHaber cycle, Solvation energy and its relation with solubility of Ionic solids, Polarizing power and Polarisability of ions, Fajan's rule and revision of all the chapters.

Organic

4. Cycloalkanes — nomenclature, synthesis of cycloalkanes and their derivatives – photochemical (2+2) cycloaddition reactions, , dehalogenation of α,ω -dihalides, , pyrolysis of calcium or barium salts of dicarboxylic acids, Baeyer's strain theory and its limitations., theory of strainless rings and revision of all the chapters.

Physical

Revision

B.Sc. III Sem. Chemistry

September

Inorganic

1. Chemistry of d-Block elements Definition of transition elements, position in the periodic table, General characteristic properties of d-Block elements, Comparison of properties of 3d elements with 4d and 5d elements with reference only to ionic radii, oxidation state, magnetic and spectral properties and stereochemistry. Stability of various oxidation states and e.m.f (Latimer and Frost diagrams), Structure and properties of some compounds of transition elements- TiO_2 , VOCl_2 , FeCl_3 , CuCl_2 and $\text{Ni}(\text{CO})_4$

Organic

1. Alcohols Monohydric alcohols — nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding. Acidic nature. Reactions of alcohols. Dihydric alcohols — nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$\text{Pb}(\text{OAc})_4$ and HIO_4] and pinacol-pinacolone rearrangement.

2. Phenols Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion.

Physical

1. Thermodynamics Definition of thermodynamic terms: system, surrounding etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Thermodynamic equilibrium, Concept of heat and work. First law of thermodynamics: statement, concepts of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule–Thomson coefficient for ideal gas and real gas and inversion temperature. Calculation of w, q, dU & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process.

October

Inorganic

2. Coordination Compounds Werner's theory of coordination compounds, effective atomic number, chelates, nomenclature of coordination compounds, Isomerism in coordination compounds, valence bond theory of transition metal complexes.

Organic:

3. Reactions of phenols — electrophilic aromatic substitution, Mechanisms of Fries rearrangement, Claisen rearrangement, Reimer-Tiemann reaction, Kolbe's reaction and Schotten and Baumann reactions.
4. Epoxides Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides

Physical

2. Chemical Equilibrium Equilibrium constant and free energy, concept of chemical potential, Thermodynamic derivation of law of chemical equilibrium. Temperature dependence of equilibrium constant. Clausius-Clapeyron equation and its applications.

November

Inorganic

4. Non-aqueous solvents Physical properties of solvents, types of solvents and their general characteristics, reactions in non aqueous solvents with reference to liquid NH₃ and liquid SO₂.

Organic

Ultraviolet (UV) absorption spectroscopy Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones, Woodward-Fieser rules, calculation of λ_{max} of simple conjugated dienes and α, β -unsaturated ketones. Applications of UV Spectroscopy in structure elucidation of simple organic compounds. Carboxylic Acids & Acid Derivatives Nomenclature of Carboxylic acids, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength.

Physical

2. Distribution Law Nernst distribution law – its thermodynamic derivation, Applications of distribution law: (i) Determination of degree of hydrolysis and hydrolysis constant of aniline

hydrochloride (ii) Determination of equilibrium constant of potassium tri-iodide complex and (iii) Process of extraction. More stress on numerical problems

December

Inorganic

Revision

Organic

Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Reduction of carboxylic acids. Mechanism of decarboxylation. Relative stability of acyl derivatives. Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution. Mechanisms of esterification and hydrolysis (acidic and basic) and revision.

Physical

Revision

B.Sc. V Sem.

Chemistry

September

Inorganic

1. Metal- Ligand Bonding in Transition Metal complexes Limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planer complexes, factors affecting the crystal field parameters.

Organic

1. NMR Spectroscopy Principle of nuclear magnetic resonance, the PMR spectrum, number of signals, peak areas, equivalent and nonequivalent protons positions of signals and chemical shift, shielding and deshielding of protons, proton counting, splitting of signals and coupling constants, magnetic equivalence of protons. Discussion of PMR spectra of the molecules: ethyl bromide, n-propyl bromide, isopropyl bromide, 1,1-dibromoethane, ethanol, acetaldehyde, ethyl acetate, toluene, benzaldehyde and acetophenone.. Simple problems on PMR spectroscopy for structure determination of organic compounds.

Physical

1. Quantum Mechanics-I Black-body radiation, Planck's radiation law, photoelectric effect, postulates of quantum mechanics, quantum mechanical operators, commutation relations, Hamiltonian operator, Hermitian operator, average value of square of Hermitian as a positive quantity, Role of operators in quantum mechanics, To show quantum mechanically that position and momentum cannot be predicated simultaneously, Determination of wave function & energy of a particle in one dimensional box.

October

Inorganic

2. Thermodynamics and Kinetic Aspects of metal complexes A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, Irving William Series, substitution reactions of square planer complexes of Pt[II], Trans effect.

Organic

2. Carbohydrates Classification and nomenclature of Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erythro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, Determination of ring size of glucose and fructose. Open chain and cyclic structure of D(+)-glucose & D(-) fructose. Mechanism of mutarotation. Structures of ribose and deoxyribose. An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

Physical

2. Physical Properties and Molecular Structure Optical activity, polarization – (Clausius – Mossotti equation derivation excluded). Orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment-temperature method and refractivity method, dipole moment and structure of molecules, Magnetic permeability, magnetic susceptibility and its determination. Application of magnetic susceptibility, magnetic properties – paramagnetism, diamagnetism and ferromagnetism.

November

Inorganic

3. Magnetic properties of Transition metal complexes Types of magnetic materials, magnetic susceptibility, method of determining magnetic susceptibility, spin only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes

Organic

3. Organometallic Compounds Organomagnesium compounds: the Grignard reagents-formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions

Physical

3. Spectroscopy Introduction: Electromagnetic radiation, regions of spectrum, basic features of spectroscopy, statement of Born-oppenheimer approximation, Degrees of freedom. Rotational Spectrum Selection rules, Energy levels of rigid rotator (semi-classical principles), rotational spectra of diatomic molecules , spectral intensity distribution using population distribution (Maxwell-Boltzmann

distribution), determination of bond length and isotopic effect . Vibrational spectrum Selection rules, Energy levels of simple harmonic oscillator, pure vibrational spectrum of diatomic molecules, determination of force constant and qualitative relation of force constant and bond energy, idea of vibrational frequencies of different functional groups.

December

Inorganic

4. Electronic spectra of Transition metal complexes Selection rules for d-d transition, spectroscopic ground states, spectrochemical series, Orgel energy level diagram for d1 and d9 states, discussion of electronic spectrum of $[\text{Ti}(\text{H}_2\text{O})_6]^{+3}$ complex ion and revision

Organic

Revision

Physical

Raman Spectrum Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules, Quantum theory of Raman spectra. Give more stress on numerical problems of all spectroscopy and revision.

Submitted by:

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