

**GOVERNMENT COLLEGE, ISRANA**  
**LESSON PLAN, EVEN SEMESTER, SESSION 2021-22**  
**Department of Chemistry**

**Name of Assistant Professor: Sh. KULBIR KADYAN, Ms. POOJA JAGLAN**

**B.Sc-I**

Month	Syllabus to be covered
April	<p><b>Hydrogen Bonding and Van der Waals forces</b></p> <p><b>Hydrogen Bonding</b>  Definition, types, effects of hydrogen bonding on properties of substances, application Brief discussion of various types of Van der Waals forces. Metallic Bond and semiconductors</p> <p><b>Metallic bond</b>  Qualitative idea of valence bond and Band theories of metallic bond (conductors, semiconductors, insulators). Semiconductors Introduction, types and applications.</p> <p><b>Kinetics</b>  Rate of reaction, rate equation and its types, factors influencing the rate of a reaction – concentration, temperature, pressure, solvent, light, catalyst. Order of a reaction, integrated rate expression for zero order, first order, second and third order reactions. Half life period of a reaction. Effect of temperature on the rate of reaction – Arrhenius equation. Theories of reaction rate – Simple collision theory for unimolecular collision. Transition state theory of bimolecular reactions.</p> <p><b>Alkenes</b>  Nomenclature of alkenes, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halide. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes. mechanisms involved in—Chemical reactions of alkenes hydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration–oxidation, oxymercurationreduction, ozonolysis, hydration, hydroxylation and oxidation with <math>\text{KMnO}_4</math>.</p>
May	<p><b>s-Block elements</b>  Comparative study of the elements including diagonal relationship, Anomalous behaviour of Lithium and Beryllium compared to other elements in the same group, salient features of hydrides, oxides, halides, hydroxides ( methods of preparation excluded), behaviour of solution in liquid <math>\text{NH}_3</math>.</p> <p><b>Chemistry of Noble Gases</b>  General physical properties, low chemical reactivity, chemistry of xenon, structure and bonding in fluorides, oxides and oxyfluorides of xenon.</p> <p><b>Arenes and Aromaticity</b>  Nomenclature of benzene derivatives: Aromatic nucleus and side chain. Aromaticity: the Huckel rule, aromatic ions, annulenes up to 10 carbon atoms, aromatic, anti-aromatic and non-aromatic compounds. general pattern of</p>

	<p>the—Aromatic electrophilic substitution mechanism, mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts reaction. Energy profile diagrams. Activating, deactivating substituents and orientation.</p> <p><b>Electrochemistry</b></p> <p>Electrolytic conduction, factors affecting electrolytic conduction, specific conductance, molar conductance, equivalent conductance and relation among them, their variation with concentration. Arrhenius theory of ionization, Ostwald's Dilution Law. Debye-Huckel – Onsager's equation for strong electrolytes (elementary treatment only), Application of Kohlrausch's Law in calculation of conductance of weak electrolytes at infinite dilution.</p>
June	<p><b>p-Block elements</b></p> <p>Electronic configuration, atomic and ionic size, metallic character, melting point, ionization energy, electron affinity, electronegativity, inert pair effect and diagonal relationship.</p> <p>Boron family (13th group): Diborane: Preparation, properties and structure (as an example of electron deficient compound and multicenter bonding), Borazine chemical properties and structure, relative strength of trihalide of Boron as Lewis acids, structure of aluminium(III) chloride.</p> <p>Carbon family and Nitrogen family (14th and 15th group): Catenation, Carbides, fluoro carbons, silicates (structural aspects). Oxides: Structure of oxides of nitrogen and phosphorus, Oxyacids: Structure and relative acid strength of oxy acids of nitrogen and phosphorus, structure of white and Red phosphorus.</p> <p>Oxygen family (16th group): Oxy acids of sulphur – structure and acidic strength, Hydrogen Peroxide – properties and uses.</p> <p><b>Electrochemistry</b></p> <p>Applications of conductivity measurements: determination of degree of dissociation, determination of <math>K_a</math> of acids, determination of solubility product of sparingly soluble salts, conductometric titrations. Concepts of pH and <math>pK_a</math>, Buffer solution, Buffer action, Henderson – Hasselbalch equation, Buffer mechanism of buffer action.</p> <p><b>Dienes and Alkynes</b></p> <p>Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of butadiene. Chemical reactions 1,2 and 1,4 additions (Electrophilic &amp; free radical mechanism), Diels-Alder reaction, Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation of alkynes.</p>

July	<p><b>p-Block elements</b></p> <p>Halogen family ( 17th group): Interhalogen compounds (their properties and structures), Hydra and oxy acids of chlorine – structure and comparison of acid strength, cationic nature of Iodine.</p> <p><b>Alkyl and Aryl Halides</b></p> <p>Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms and stereochemistry of nucleophilic substitution reactions of alkyl halides, S<sub>N</sub>2 and S<sub>N</sub>1 reactions with energy profile diagrams. Methods of formation and reactions of aryl halides, The addition-elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions. Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides.</p>
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## B.Sc.-II

Month	Syllabus to be covered
April	<p><b>Chemistry of f-Block elements</b></p> <p>Lanthanides: Electronic structure, oxidation states, magnetic properties, complex formation, colour, ionic radii and lanthanide contraction, occurrence, separation of lanthanides, Lanthanide compounds.</p> <p><b>Thermodynamics</b></p> <p>Second law of thermodynamics, need for the law, different statements of the law, Carnot's cycles and its efficiency, Carnot's theorem, Thermodynamics scale of temperature. Concept of entropy – entropy as a state function, entropy as a function of V &amp; T, entropy as a function of P &amp; T, entropy change in physical change, entropy as a criteria of spontaneity and equilibrium.</p> <p><b>Infrared (IR) absorption spectroscopy</b></p> <p>Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds. Applications of IR spectroscopy in structure elucidation of simple organic compounds.</p>
May	<p><b>Chemistry of f-Block elements</b></p> <p>Actinides: General characteristics of actinides, chemistry of separation of Np, Pu and Am from uranium, Transuranic elements, comparison of properties of Lanthanides and actinides with transition elements.</p> <p><b>Thermodynamics</b></p> <p>Third law of thermodynamics: Nernst heat theorem, statement of concept of residual entropy, evaluation of absolute entropy from heat capacity data. Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, G as criteria for thermodynamic equilibrium and spontaneity, its advantage over entropy change. Variation of G with P, V and T.</p> <p><b>Amines</b></p> <p>Structure and nomenclature of amines, physical properties. Separation of a mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles, reductive amination of aldehydic and ketonic compounds. Gabrielphthalimide reaction, Hofmann bromamide reaction. Electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid.</p>
June	<p><b>Theory of Qualitative and Quantitative Analysis</b></p> <p>Chemistry of analysis of various groups of basic and acidic radicals, chemistry of identification of acid radicals in typical combination, chemistry of interference of acid radicals including their removal in the analysis of basic radicals, common ion effect, solubility product, theory of precipitation, co-precipitation, post precipitation, purification of precipitates.</p> <p><b>Electrochemistry</b></p>

	<p>Electrolytic and Galvanic cells – reversible &amp; irreversible cells, conventional representation of electrochemical cells. Calculation of thermodynamic quantities of cell reaction (<math>\Delta G</math>, <math>\Delta H</math> &amp; <math>K</math>). Types of reversible electrodes – metal- metal ion, gas electrode, metal –insoluble salt- anion and redox electrodes. Electrode reactions, Nernst equations, derivation of cell EMF and single electrode potential.</p> <p><b>Diazonium Salts</b></p> <p>Mechanism of diazotisation, structure of benzene diazonium chloride, Replacement of diazo group by H, OH, F, Cl, Br, I, NO<sub>2</sub> and CN groups, reduction of diazonium salts to hydrazines, coupling reaction and its synthetic application.</p>
July	<p><b>Electrochemistry</b></p> <p>Standard Hydrogen electrode, reference electrodes, standard electrode potential, sign conventions, Concentration cells with and without transference, liquid junction potential and its measurement. Applications of EMF measurement in solubility product and potentiometric titrations using glass electrode. More stress on numerical problems.</p> <p><b>Aldehydes and Ketones</b></p> <p>Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, advantage of oxidation of alcohols with chromium trioxide (Sarett reagent) pyridinium chlorochromate (PCC) and pyridinium dichromate. Physical properties, Comparison of reactivities of aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction. Oxidation of aldehydes, Baeyer– Villiger oxidation of ketones, Cannizzaro reaction. MPV, Clemmensen, WolffKishner, LiAlH<sub>4</sub> and NaBH<sub>4</sub> reductions.</p>

### B.Sc.-III

Month	Syllabus to be covered
April	<p><b>Acids and Bases</b> Arrhenius, Bronsted-lowry, Lux-flood, solvent system and Lewis concept of acids and bases, relative strength of acids and bases, levelling solvents, hard and soft acids and bases(HSAB), Applications of HSAB principle.</p> <p><b>Introduction to statistical mechanics</b> Need for statistical thermodynamics, thermodynamic probability, Maxwell Boltzmann distribution statistics, Born oppenheimer approximation, partition function and its physical significance. Factorization of partition function.</p> <p><b>Organic Synthesis via Enolates</b> -hydrogens, alkylation of diethyl malonate and ethyl<math>\alpha</math>Acidity of acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate.</p>
May	<p><b>Organometallic chemistry</b> Definition, classification and nomenclature of organometallic compounds, preparation, properties and bonding of alkyls of Li, Al, Hg and Sn, concept of hapticity of organic ligand, Structure and bonding in metal-ethylenic complexes, Structure of Ferrocene, classification in metal carbonyls, preparation, properties and bonding in mononuclear carbonyls.</p> <p><b>Photochemistry</b> Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grotthus-Draper law, StarkEinstein law (law of photochemical equivalence), Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples).</p> <p><b>Heterocyclic Compounds</b> Introduction: Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution. Mechanism of nucleophilic substitution reactions in pyridine derivatives. Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six-membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of, quinoline and isoquinoline</p>
June	<p><b>Bio inorganic chemistry</b> Metal ions present in biological system, classification on the basis of action (essential, non essential, trace, toxic), Metalloporphyrins with special reference to</p>

	<p>haemoglobin and myoglobin. Biological role of <math>\text{Na}^+</math> , <math>\text{K}^+</math> , <math>\text{Ca}^{+2}</math>, <math>\text{Mg}^{+2}</math> , <math>\text{Fe}^{+2}</math> ions, Cooperative effect, Bohr effect.</p> <p><b>Solutions, Dilute Solutions and Colligative Properties</b></p> <p>Ideal and non-ideal solutions, methods of expressing concentrations of solutions, Dilute solutions, Raoult's law. Colligative properties: (i) relative lowering of vapour pressure (ii) Elevation in boiling point (iii) depression in freezing point (iv) osmotic pressure. Thermodynamic derivation of relation between amount of solute and elevation in boiling point and depression in freezing point.. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.</p> <p><b>Amino Acids, Peptides&amp; Proteins</b></p> <p>Classification, of amino acids. Acid-base behavior, isoelectric -amino acids. <math>\alpha</math>point and electrophoresis. Preparation of Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid– phase peptide synthesis. Structures of peptides and proteins: Primary &amp; Secondary structure.</p>
July	<p><b>Silicones and Phosphazenes</b></p> <p>Nomenclature, classification, preparation and uses of silicones, elastomers, polysiloxane copolymers, poly phosphazenes and bonding in triphosphazene</p> <p><b>Phase Equilibrium</b></p> <p>Statement and meaning of the terms – phase, component and degree of freedom, thermodynamic derivation of Gibbs phase rule, phase equilibria of one component system –Example – water system. Phase equilibria of two component systems solid-liquid equilibria, simple eutectic Example Pb-Ag system, desilverisation of lead.</p> <p><b>Synthetic Polymers</b></p> <p>Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyde resins. Natural and synthetic rubbers.</p>