

विषय : रसायन शास्त्र (Chemistry)

- 1. Atomic structure, Periodic properties and chemical bonding** — Idea of de Broglie matter waves, Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of  $\Psi$  and  $\Psi^2$ , quantum numbers, radial and angular wave functions and probability distribution curves, shapes of S, p, and d orbitals, Aufbau and Pauli's exclusion principles, Hund's rule, electronic configuration classification of elements as s, p, d and f-blocks.  
  
Periodic tables and periodic properties (atomic and ionic radii, ionization energy, electron affinity, electro-negativity) and their trends in periodic table, Their applications in chemical bonding.  
  
Covalen bonding. V.B. Theory, VSEPR Theory, M O. Theory, homonuclear and heteronuclear diatomic molecules, bond order and magnetic properties.  
  
Resonance, hydrogen bonds and vinder Waals forces. Ionic solids - Born-Haber cycle, Fajaris rule.
- 2. Gaseous states** — Postulates of kinetic theory of gases, deviation from ideal behavior of van der Waal's equation of state. Critical temperature, pressure and volume. Liquification of gases, Critical constants and vander Waals constants, the law of corresponding states, reduced equation of state Molecular velocities — r.m.s. velocity, average velocity, most probable velocity. Maxwell's distribution of molecular velocities.
- 3. Solid State** — Space lattice, Unit cell. Laws of crystallography. X-ray diffraction by crystals. Bragg's equation coordination number radius ratio rule, detects in crystals and their magnetic and electric behavior semi-conductors and super conductors
- 4. Thermodynamics** — Law of thermodynamics, work, heat, energy. State functions — E, H, S and G and their significance criteria for chemical equilibrium and spontaneity of reactions. Variations of free energy with T, P and V Gibbs Helmhotts equation. Entropy changes in gases for reversible and irreversible processes. Hess law Bond energy.

5. **Chemical kinetics and catalysis** — Order and molecularity, chemical kinetics and its scope, rate of a reaction, factors influencing rate of reaction. Rate equations of zero, first and second order reactions. Pseudo order, half life and mean life. Determination of order of reactions. Theories of chemical kinetics — collision theory, transition state theory, Arrhenius equation, concept of activation energy, effect of temperature on rate constant.  
Catalysis, characteristics of catalysed reactions, theories of catalysis, examples.
6. **Electrochemistry** — Electronic conduction in electrolytic solutions, specific, equivalents and molar conductance, effect of dilution on them, cell constant, experimental method of determining conductance.  
Migration of ions and Kohlrausch, law. Arrhenius theory of electrolytic dissociation and its limitations, weak and strong electrolytes Ostwald's dilution law, its uses and limitations Debye - Huckel Onsager's equation (elementary treatment) Transport number - definition, determination by Hittor method.  
Galvanic cells, electrodes and electrode reactions, Nernst equation, E.M.F. of cells, Hydrogen electrode, electrochemical series, concentration cell and their applications  $p^H$ . Buffer solutions theory of buffer action,
7. **Transition and inner transition metals and complexes** — General characteristics of d-block elements, co-ordination compounds - nomenclature, isomerism and bonding in complexes V.B. theory and crystal field theory. Werners theory, EAN metal carbonyls, cyclopentadienyls, olefin and acetylene complexes.  
Compounds with metal-metal bonds and metal atom clusters.  
General chemistry of f-block elements Lanthanides and actinides - ionic radii, separation, oxidation states, magnetic and spectral properties.
8. **Non-aqueous solvents** — Physical properties of a solvent, types of solvents and their general characteristics, reactions in non-aqueous solvents with reference to liquid  $NH_3$  and liquid  $SO_2$ .
9. **Photochemistry** — Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry — Grothus-Draper law, Stark-Einstein law, Jablonski diagram. Fluorescence. phosphorescence, Quantum yield Photoelectric cells.
10. **Hard and soft acids and bases** — Classification of acids and bases as hard and soft, Pearson's HSAB concept, acid-base strength and hardness and softness, symbiosis, theoretical basis of hardness and softness, symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.
11. **Structure and Bonding** — Hybridization, bond lengths and bond angles bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clathrates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.
12. **Mechanism of organic reactions** — Homolytic and heterolytic bond breaking, types of reagents - carbocations. and nucleophiles, types of organic reactions, Reactive

intermediates - Carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples) Different types of addition, substitution and elimination reactions -  $SN^1$ ,  $SN^2$ ,  $SN^i$ ,  $E_1$ ,  $E_2$ ,  $E_{1cb}$  etc.

- 13. Stereochemistry of Organic Compounds** — 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.

Relative and absolute configuration R/S rule, D & L and R & S nomenclature.

Geometric isomerism: Determination of configuration of geometric isomers - E & Z nomenclature, geometric isomerism of oximes and alicyclic compounds. Configuration and conformation, conformations of ethane, butane and cyclohexane.

- 14. Organometallic Compounds** — Organometallic compounds of Mg, Li & Zn their formation, preparation, structure and synthetic applications.

- 15. Organic Synthesis via enolates** — Acidity of  $\alpha$ -hydrogens, preparation, properties and synthetic applications of diethyl malonate and ethyl acetoacetate, keto-enol tautomers.

- 16. Carbohydrates** — Classification and nomenclature Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses and ketoses, Anomers and epimers Formation of glycosides, ethers and esters Ring structure of glucose and fructose mechanism of mutarotation.

- 17. Polymers** — Addition or chain growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerizations, Ziegler - Natta polymerization and vinyl polymers. Condensation or step-growth polymerization, Polyesters, polyamide, phenol-formaldehyde resins, urea-formaldehyde resins, epoxy resins and polyurethanes.

Natural and synthetic rubbers. Inorganic polymeric systems - silicones and phosphazenes, nature of bonding in triphosphazenes

- 18. Study of following types of organic compounds:**

- a. Alkanes and cycloalkanes — Preparation of alkanes - Wurtz-Fittig reaction, Kolbe reaction, Corey - House reaction etc physical and chemical properties, free-radical halogenation of alkanes - reactivity and selectivity.

Cycloalkanes : Nomenclature, formation, properties - Baeyer's strain theory

- b. Alkenes, cycloalkenes, Dienes & Alkynes — Mechanism of dehydration of alcohols, and dehydrogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination Mechanism involved in hydrogenation, electrophilic and free radical additions, Markovnikov's rule, Karasch effect, hydroboration - oxidation, oxymercuration - reduction, Epoxidation, Ozonolysis, hydration, hydroxylation and oxidation with  $KMnO_4$ . Polymerization.

Substitution at the allylic and vinylic positions of alkenes. Conjugated Dienes: Classification, preparation, properties Alkynes : Preparation, properties, acidic reactions of alkynes,

mechanism of electrophilic and nucleophilic addition reactions, hydroboration - oxidation, metal-ammonia reductins, oxidation and polymerization.

- c. Arenes and Aromaticity — Aromaticity : The Huckel rule, arematic ions, M.O. diagram, anti-aromatic, Aromatic electrophilic substitution — Mechanism, role of  $\sigma$  and  $\pi$  complexes. Mechanism of nitration, halogenters sulphonation, mercuration and Friedel Crafts reaction. Energy profile diagram, activating and deactivating substituents, orientation, ortho-para ratio. Side-chain reactions of benzene derivatives. Birch reduction.
- 19. Study of some reactions** — Pinacol - pinacotone rearrangement, aldol reaction, perkin reaction. Cannizzaro's reaction, Mannich reaction, Clemmensen reduction, claisen rearrangement, Peimer Tiemann reaction, Friedel crafts reaction, Fries rearrangement. Reformatsky reaction.
- 20. Spectroscopy** — Basic principles of the following type of spectroscopy and their applications in determining structures.
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|----|------|---|----------------------|
| a. | UV   | - | Visible spectroscopy |
| b. | IR   | - | "                    |
| c. | NMR  | - | "                    |
| d. | Mass | - | "                    |
| e. | ESR  | - | "(cemples)           |

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