CHEMISTRY (CODE NO. 05)

1. Inorganic Chemistry

1.1 Atomic Structure

Idea of de Broglie matter waves. Schrodinger wave equation, Significance of ? and ? ^{2}, quantum numbers, radial and angular wave functions, shapes of orbitals, relative energies of atomic orbitals as a function of atomic number. Electronic configurations of elements; Aufbau principle, Hund's multiplicity rule, Pauli exclusion principle. Effective nuclear charge.

1.2 Periodic Properties

Periodic classification of elements, salient characteristics of s,p,d and f block elements. Periodic trends of atomic radii, ionic radii, ionisation potential, electron affinity and electronegativity in the periodic table.

1.3 Chemical Bonding and Molecular Structure

Chemical bonds., overlap of atomic orbitals, Shapes of molecules (VSEPR theory). Molecular orbital theory, bond order, bond length. The concept of hybridization, character of bonds and shapes of molecules and ions. Percent ionic character from dipole moment and electronegativity difference. Weak interactions- hydrogen bonding and Van der Waals forces. Metallic bonding.

1.4 Acids and bases

Bronsted and Lewis theories of acids and bases. Hard and soft acids and bases. HSAB principle, relative strengths of acids and bases and the effect of substituents and solvents on their strength.

1.5 Chemistry of Non-metals-I

Hydrogen (position in the periodic table, isotopes, ortho and para hydrogen, heavy water). Hydrogen peroxide- preparation, properties, structure and uses. Compounds of nitrogen-ammonia, oxides of nitrogen, nitric acid.

1.6 Chemistry of Non-metals-II

Preparation, properties and structures upto boric acid, borates, boron nitrides, borohydride (diborane), carboranes or oxides and oxyacids of

phosphorous, sulphur and chlorine; interhalogen compounds, polyhalide ions, pseudohalogens, fluorocarbons and basic properties of halogens. Chemical reactivity of noble gases, preparation, structure and bonding of noble gas compounds.

1.7 Transition metals including lanthanides

General characteristic properties, oxidation states of transition metals. First row transition metals and general properties of their compounds (oxides, halides and sulphides). Lanthanide: Electronic configuration, Oxidation states and lanthanide contraction.

1.8 Extraction of metals

Principles of extraction of metals as illustrated by sodium, magnesium, aluminium, iron, copper and gold.

1.9 Nuclear Chemistry

Nuclear reactions; mass defect and binding energy, nuclear fission and fusion. Artificial transmutation of elements. Nuclear reactors; radioisotopes and their applications. Radio carbon-dating.

1.10 Coordination compounds and Organometallics

Nomenclature, isomerism in coordination compounds, bonding in coordination compounds. Magnetic properties of transition metal complexes. Compounds containing metal-carbon bonds, Application of Organometallics.

1.11 Bioinorganic Chemistry

Essential and trace elements in biological processes, Biological role of alkali and alkaline earth metal ions.

2. Organic Chemistry

2.1 Structure and Bonding

Electronegativity, electron displacements-inductive, mesomeric and hyperconjugative effects; bond polarity and bond polarizability, dipole moments of organic molecules; hydrogen bond; fission of covalent bonds: homolysis and heterolysis; reaction intermediates-carbocations, carbanions, free radicals and carbenes; Arynes,

nitrenes, generation, geometry and stability; nucleophiles and electrophiles. Hybridization.

2.2 Aliphatic compounds

Nomenclature: alkanes-synthesis, reactions (free radical halogenation), pyrolysis; cycloalkanes-Baeyer's strain theory; alkenes and alkynes-synthesis, electrophilic addition reactions, Markownikov's rule, peroxide effects, nucleophilic addition to electron-deficient alkenes; polymerisation; relative acidity; synthesis and reactions of alkyl halides, alkanols, alkanals, alkanones, alkanoic acids, esters, amides, amines, acid anhydrides, and nitro compounds.

2.3 Stereochemistry of carbon compounds

Elements of symmetry, chiral and achiral compounds. Fischer projection formulae; optical isomerism of lactic and tartaric acids, enantiomerism and diastereoisomerism; configuration (relative and absolute); conformations of ethane, n-butane, and cyclohexane. D, L- and R, S-notations of compounds containing chiral centres; projection formulae-Fischer, Newman and Sawhorse projection of compounds containing two adjacent chiral centres; meso and dl-isomers, erythro and threo isomers; racemization and resolution; geometrical isomers; E and Z notations.

2.4 Organometallic compounds

Preparation and synthetic uses of Grignard reagents and alkyl lithium compounds, organo Zinc compounds.

2.5 Active methylene compounds

Diethyl malonate and ethyl acetoacetate-applications in organic synthesis; tautomerism (keto-enol).

2.6 Aromatic compounds

Aromaticity; Huckel's rule; electrophilic aromatic substitution-nitration, sulphonation, halogenation (nuclear and side chain), Friedel-Crafts alkylation and acylation, substituents effect; chemistry and reactivity of aromatic halides, phenols, nitro and diazonium compounds.

2.7 Carbohydrates

Classification, reactions, structure of glucose, D, L-configuration, osazone formation; fructose and sucrose; step-up step-down of aldoses and ketoses.

2.8 Amino acids

Essential amino acids; zwitterions, isoelectric point, polypeptides; proteins; methods of synthesis of a-amino acids.

2.9 Basic principles and applications of UV - visible, IR and NMR spectroscopy of simple organic molecules.

2.10 Name reactions

Aldol condensation, Cannizzaro reaction, Perkin reaction, Riemer-Tiemann reaction.

2.11 Heterocyclic compounds

Aromatic characteristics, chemical reactions.

2.12 Fats, Oils, and Detergents.

3. Physical Chemistry

3.1 Gaseous state

Deviation of real gases from the equation of state for an ideal gas, van der Waals equation of state, critical phenomena, law of corresponding states, equation for reduced state. Liquification of gases, distribution of molecular velocity, collisions between molecules in a gas; mean free path.

3.2 Thermodynamics

First law and its applications: Thermodynamic systems, states and processes, work, heat and internal energy, zeroth law of thermodynamics, various types of work done on a system in reversible and irreversible processes. Calorimetry and thermochemistry: Hess's law, heat of reaction at constant pressure and constant volume. Bond dissociation energy in Kirchoff equation. Joule-Thomson effect, inversion temperature. Heat capacities and temperature dependence of

enthalpy and internal energy changes..Second law of thermodynamics and its applications : Carnot's cycle its efficiency, thermodynamics scale of temperature. Spontaneity of a process, entropy and entropy changes in various processes, free energy functions, criteria for equilibrium, relation between equilibrium constant and thermodynamic quantities.

3.3 Phase rule and its applications

Equilibrium between liquid, solid and vapours of a pure substance, Number of components, phases and degrees of freedom; phase rule and its applications; simple systems with one (water and sulphur) and two components (lead-silver, salt hydrates). Distribution law, its modifications, limitations and applications.

3.4 Solutions

Solubility and its temperature dependence, partially miscible liquids, upper and lower critical solution temperatures, vapour pressures of liquids over their mixtures, Raoult's and Henry's laws, fractional and steam distillations.

3.5 Colligative Properties

Dilute solutions and colligative properties, determination of molecular weights using colligative properties.

3.6 Electrochemistry

Ions in solutions, ionic equilibria, dissociation constants of acids and bases, hydrolysis, pH and buffers, theory of indicators and acid-base titrations. Conductivity of ionic solutions, its variation with concentration, Ostwald's dilution law, Kohlrausch law and its application. Transport number and its determination. galvanic cells and measurements of their e.m.f., cell reactions, standard cell, standard reduction potential, Nernst equation, relation between thermodynamic quantities and cell e.m.f..

3.7 Chemical kinetics

Rate of chemical reaction and its dependence on concentrations of the reactants, rate constant and order of reaction and their experimental determination; differential and integral rate equations for first and

second order reaction, half-life periods; temperature dependence of rate constant and Arrhenius equation.

3.8 Photochemistry

Absorption of light, laws of photochemistry, quantum yield, the excited state and its decay by radiative, nonradiative and chemical pathways; simple photochemical reactions.

3.9 Catalysis

Homogeneous and heterogeneous catalysis and their characteristics, mechanism of homogeneous catalysis; enzyme catalysed reactions (Michaelis-Menten mechanism).

3.10 Colloids

The colloidal state, preparation and purification of colloids and their characteristics properties; lyophilic and lyophobic colloids and coagulation; protection of colloids; gels, emulsions, surfactants and micelles.

3.11 Spectroscopy

Electromagnetic radiation. Basic principles of UV-visible, rotational, Infra-red and Raman spectroscopy with selection rule.