

## Academic Year 2013-14 and onwards

B. Sc. 1<sup>st</sup> Year

### Inorganic Chemistry

60 hrs(2 hrs/week)

CHE101

Paper I

Max. Marks 33

#### 1. Atomic Structure:

6 hrs

Dual nature of matter; de Broglie concept. Heisenberg uncertainty principle; its significance. Atomic orbitals, Schrödinger wave equation (no derivation); 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 energy diagram, Pauli's exclusion principle. Hund's rule of maximum multiplicity. Electronic configuration of elements (s block, p block and first series of d-block elements). Effective nuclear charge.

#### 2. Periodic Properties:

5 hrs

Atomic and ionic radii, ionization potential, electron affinity, electronegativity-definition, methods of determination/evaluation, trends of variation in periodic table and their application in prediction and explaining the chemical behaviour of elements and compounds thereof.

#### 3. Chemical Bonding:

16 hrs

(a) Covalent bond-valence bond theory and its limitations; directional nature of covalent bond; various types of hybridization and shapes of different inorganic molecules and ions. Valence shell electron pair repulsion theory (VSEPR) and shapes of  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{H}_3\text{O}^+$ ,  $\text{SF}_4$ ,  $\text{ClF}_3$  and other simple molecules/ions.

Molecular orbital theory as applied to diatomic homonuclear/heteronuclear (CO and NO) inorganic molecules, difference between VB and MO theories. Multicentre bonding in electron deficient molecules. Polarization of covalent molecules; percentage ionic character from dipole and electronegativity difference.

(b) Ionic structures, radius-ratio effects and coordination number. Limitation of radius ratio rule. Lattice defects, semiconductors, lattice energy and Born-Haber cycle. Solvation energy and

solubility of ionic solids. Polarizing power and polarizability of ions; Fajan's rule. Metallic bond-Electron Pool and MO theories.

Weak interactions-hydrogen bonding and Van der Waals forces.

**4. s-Block elements:**

**6 hrs**

General discussion with respect to all periodic and chemical properties, diagonal relationship, salient features of hydrides, solvation and complexation tendencies, an introduction to their alkyls and aryls. Role of alkali and alkaline earth metal ions in bio-systems.

**5. p-Block elements:**

**16 hrs**

General discussion and comparative study (all periodic and chemical properties including diagonal relationship) of groups 13 to 17 elements; chemistry of elements-hydrides, oxides & oxy-acids, and halides (including inert pair effect). Diborane-properties & structure, borohydrides, carbides, fluorocarbons, inter-halogen compounds, polyhalides and basic properties of iodine.

Inert-pair effect: in heavier elements of 13, 14 & 15 group elements; its consequences in redox properties of their halides.

**7. Chemistry of Noble gases**

**5 hrs**

Chemical properties of the noble gases, chemistry of Xenon, structure and bonding in xenon compounds.

**8. Metallurgical processes:**

**6 hrs**

Minerals & ores; general metallurgical processes-concentration ores, calcination, roasting, smelting, slag & flux. Extraction and refining of metals., Chemistry of extraction and isolation of Lithium and Beryllium.

**Organic Chemistry**

**B.Sc. I year**

**60 hrs(2 hrs/week)**

**CHE102**

**Paper II**

**Max. Marks 33**

**1. Structure and bonding**

**5 hrs**

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.

## **2. Mechanism of organic reactions**

**8 hrs**

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. Energy considerations. Reactive intermediates; carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with examples). Assigning formal charges on intermediates and other ionic species. Methods of determination of reaction mechanism (product analysis, intermediates, isotope effects, kinetic and stereochemical studies).

## **3. Stereochemistry of organic compounds**

**12 hrs**

Concepts of isomerism. Types of isomerism. Optical isomerism- elements of symmetry, molecular chirality, enantiomers, stereogenic centers, 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, sequence rules, D & L and R & S systems of nomenclature. Geometric isomerism; determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes and alicyclic compounds.

Conformational isomerism; conformational analysis of ethane and n- butane, conformational conformations of cyclohexane, axial and equatorial bonds, conformations of monosubstituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.

## **4 Alkanes and Cycloalkanes**

**7 hrs**

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation ( with special reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), physical properties and chemical reactions of alkanes. Mechanism of free radical halogenation of alkanes: Mechanism of free radical, halogenation of alkanes: orientation, reactivity and selectivity.

Cycloalkanes; nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings (cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring-banana bonds.

## **5. Alkenes, Cycloalkenes, Dienes and Alkynes**

**12 hrs**

Nomenclature of alkenes, methods of formation, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides, regioselectivity in alcohol dehydration. The Saytzeff Rule, Hoffmann Elimination, physical properties and relative stabilities of alkenes. Chemical reaction of alkenes - mechanism involved in hydrogenation, electrophilic and free radical additions, Markownikoff's Rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration, hydroxylation and oxidation with  $\text{KMnO}_4$ , Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene. Methods of formation, conformation and chemical reactions of cycloalkenes. Nomenclature and classification of dienes; isolated, conjugated and cumulative dienes. Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions- 1,2 and 1,4 additions, 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, metal-ammonia reduction, oxidation and polymerization.

#### **6. Arenes and Aromaticity**

**8 hrs**

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: Molecular formula and Kekule structure. Stability and carbon-carbon bond length of benzene, resonance structure, MO picture. Aromaticity—the Hückel rule, aromatic ions.

Aromatic electrophilic substitution reaction—general pattern of the mechanism, role of  $\sigma$  and  $\pi$  complex. Mechanism of nitration, halogenation, sulphonation, mercuriation and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

#### **7. Alkyl and Aryl Halides**

**8 hrs**

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanism of nucleophilic substitution reactions of alkyl halides,  $\text{S}_{\text{N}}2$  and  $\text{S}_{\text{N}}1$  reaction with energy profile diagrams.

Polyhalogen compounds - Chloroform, carbon tetrachloride. Methods of formation of aryl halides, nuclear and side chain reaction. The addition elimination mechanism and the elimination addition mechanisms of nucleophilic substitution reactions. Relative reactivity of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.

### **Physical Chemistry**

	<b>B.Sc. I year</b>	<b>60 hrs(2 hrs/week)</b>
<b>CHE103</b>	<b>Paper III</b>	<b>Max. Marks 34</b>

**1. Gaseous States**

**10 hrs**

Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waal's equation of states, Critical phenomena – PV isotherms of real gases, relationship between critical constants and van der Waals constants, the law of corresponding states, reduced equation of state.

Molecular velocities: Root mean square, average and most probable velocities, qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter, liquification of gases (based on Joule-Thomson effect).

**2. Liquid State**

**8 hrs**

Intermolecular forces, structure of liquids (a qualitative description) Structural differences between solids, liquids and gases. Physical properties of liquids including their methods of determination: surface tension, viscosity and refractive index. Liquid crystals, difference between liquid crystal, solids and liquids.

**3. Solid State**

**8 hrs**

Definition of space lattice, unit cell, crystal planes, Miller indices, Laws of crystallography – (i) law of constancy of interfacial angles (ii) law of rationality of indices (iii) law of symmetry. Symmetry elements in crystals, X-ray diffraction by crystals,. Derivation of Bragg's equation. Determination of crystal structure of NaCl, KCl and CsCl (Laue's method and powder method).

**4. Colloidal State**

**6 hrs**

Definition of colloids, classification of colloids. Solids in liquids (sols): properties – kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number. Liquids in liquids (emulsions): types of emulsions, preparation, emulsifier. Liquids in solids (gels): classification, preparation and properties, inhibition, general application of colloids.

**5. Chemical Kinetics and Catalysis**

**14 hrs**

Chemical kinetics and its scope, rate of a reaction, factors influencing the rate of a reaction– concentration, temperature, pressure, solvent, light, catalyst. Concentration dependence of rates mathematical characteristics of simple reaction – zero order, first order, second order, pseudo order, half life determination of the order of reaction – differential method, method of integration, method of half life period and isolation methods concept of activation energy. Radioactive decay a first order phenomenon. Catalysis, characteristics of catalyzed reactions, classification of catalysis, miscellaneous examples.

**6. Thermodynamics I**

**14 hrs**

Definition of thermodynamic terms, system, surroundings etc. types of systems, intensive and extensive properties, state and path functions and their differentials, thermodynamic process, concept of heat and work, First law of thermodynamics, definition of internal energy and enthalpy. Heat capacity – heat capacities at constant volume and at constant pressure and their relationship, Joule – Thomson coefficient and inversion temperature, calculation of  $w$ ,  $q$ ,  $dU$  &  $dH$  for the expansion of ideal gases under isothermal and adiabatic conditions for reversible processes, Thermochemistry; standard state, Standard enthalpy of formation – Hess's law of heat summation and its application, heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization, bond dissociation energy and its calculation from thermochemical data, temperature dependence of enthalpy, Kirchoff's equation.

**Lab course**

**B. Sc. Chemistry I year**

**Max. Marks 50**

**6 hrs/week**

1. Laboratory hazards and safety precautions; errors, significant figures, lab report writing.
2. Qualitative analysis: Mixture analysis; preparation of sodium carbonate extract, identification of anions cations including anions in combination and interfering radicals. Preparation of original solution for basic radical analysis; problems based on Law of mass action, Le Chatelier Principle; common ion effect, solubility product, pH and buffer solutions. Total number of cations and anions in a mixture shall be six.
4. Quantitative analysis: Volumetric exercises; preparation of a solution in normal/molar terms, its standardization using a primary standard solution, determination of the strength of unknown solution. Double titration-based on redox reactions involving internal as well as external indicators. Iodometry.
3. Determination of viscosity and relative viscosity of given liquids using Ostwald's viscometer. Determination of surface tension and relative surface tension of given liquids using drop pipette.

One exercise each from inorganic mixture(qualitative 06 radicals), physical chemistry experiment and volumetric exercise (quantitative) shall be given in the examination.

**Distribution of marks shall be as given below:**

i)	Inorganic mixture for six radicals	12
ii)	Physical chemistry experiment	08
iii)	Volumetric exercise	13
iv)	*Viva - voce	05

v) Annual lab record and attendance(06 for each)

12

\*Viva-Voce test of ex-students shall carry 17 marks.

**Note:**

- *The lab work of the student has to be evaluated and assessed carefully and periodically. A minimum of 12 experiments covering all the kind of exercises has to be performed during an academic year. The annual record has to be maintained by the department/college as an official record.*
- *Less than zero mark will not be awarded*
- *The total number of students to be examined per batch shall not be more than sixty.*
- *Duration of the practical examination shall be of 06 (six) hours.*
- *Marks have to be submitted to the Registrar/Controller examination in a sealed envelop making a copy to the Principal/Head of the department.*