

## NEW CURRICULUM OF B.Sc. PART II

### CHEMISTRY

The new curriculum will comprise of three papers of 33, 33 and 34 marks each and practical work of 50 marks. The Curriculum is to be completed in 180 working days as per UGC norms and conforming to the directives of Govt. of Chhattisgarh. The theory papers are of 60 hrs. each duration and practical work of 180 hrs duration.

#### Paper – I INORGANIC CHEMISTRY

60 Hrs., Max Marks 33

#### UNIT-I

##### CHEMISTRY OF TRANSITION SERIES ELEMENTS

Transition Elements: Position in periodic table, electronic configuration, General Characteristics, viz., atomic and ionic radii, variable oxidation states, ability to form complexes, formation of coloured ions, magnetic moment  $\mu_{so}$  (spin only) and  $\mu_{eff}$  and catalytic behaviour. General comparative treatment of 4d and 5d elements with their 3d analogues with respect to ionic radii, oxidation states and magnetic properties.

#### UNIT-II

**A. Oxidation and Reduction:** Redox potential, electrochemical series and its applications, Principles involved in extraction of the elements.

**B. COORDINATION COMPOUNDS:** Werner's theory and its experimental verification, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelates, polynuclear complexes.

#### UNIT-III

##### COORDINATION CHEMISTRY

Valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, Crystal field splitting and stabilization energy, measurement of  $10 Dq$  ( $\Delta_o$ ), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of  $10 Dq$  ( $\Delta_o$ ,  $\Delta_t$ ). Octahedral vs. tetrahedral coordination.

#### UNIT-IV

##### A. CHEMISTRY OF LANTHANIDE ELEMENTS

Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds.

##### B. CHEMISTRY OF ACTINIDES

General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from uranium, similarities between the later actinides and the later lanthanides

#### **UNIT-V**

**A. ACIDS BASES :** Arrhenius, Bronsted-Lowry, conjugate acids and bases, relative strengths of acids and bases, the Lux-flood, solvent system and Lewis concepts of acids and bases.

#### **B. NON-AQUEOUS SOLVENTS**

.Physical properties of a solvent, types of solvents and their general characteristics, reaction in non-aqueous solvents with reference to liquid ammonia and liquid sulphur dioxide, HF, H<sub>2</sub>SO<sub>4</sub> , Ionic liquids.

#### **REFERENCE BOOKS**

1. Basic Inorganic Chemistry, F. A. Cotton, G. Wilkinson and P. L. Gaus, Wiley
2. Concise Inorganic Chemistry, J. D. Lee, ELBS
3. Concepts of Models of Inorganic Chemistry, B. Douglas, D. Mc Daniel and J. Alexander, John Wiley.
4. Inorganic Chemistry, D. E. Shriver, P. W. Atkins and C. H. Langford, Oxford.
5. Inorganic Chemistry, W. W. Porterfield, Addison – Wiley.
6. Inorganic Chemistry, A. G. Sharp, ELBS.
7. Inorganic Chemistry, G. L. Miessler and D. A. Tarr, Prentice Hall.
8. Advanced Inorganic Chemistry, Satya Prakash.
9. Advanced Inorganic Chemistry, Agarwal and Agarwal
10. Advanced Inorganic Chemistry, Puri, Sharma, S. Naginchand
11. Inorganic Chemistry, Madan, S. Chand
12. Aadhunik Akarbanic Rasayan, A. K. Shrivastav & P. C. Jain, Goel Pub
13. Uchchattar Akarbanic Rasayan, satya Prakash & G. D. Tuli, Shyamal Prakashan
14. Uchchattar Akarbanic Rasayan, Puri & Sharma
15. Selected topic in Inorganic Chemistry by Madan Malik & Tuli, S. Chand.

## **UNIT-I**

### **CHEMISTRY OF ORGANIC HALIDES**

Alkyl halides: Methods of preparation, nucleophilic substitution reactions –  $S_N1$ ,  $S_N2$  and  $S_Ni$  mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution, elimination reactions.

Aryl halides: Preparation, including preparation from diazonium salts, Nucleophilic Aromatic Substitution;  $S_NAr$ , Benzyne mechanism. Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

## **UNIT-II**

### **ALCOHOLS**

- A.** Alcohols: Nomenclature, preparation, properties and relative reactivity of  $1^\circ$ ,  $2^\circ$ ,  $3^\circ$  alcohols, Bouvaelt-Blanc Reduction for the preparation of alcohols, Dihydric alcohols – methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [ $Pb(OAc)_4$  and  $HIO_4$ ] and pinacol-pinacolone rearrangement.
- B.** Trihydric alcohols - Nomenclature, methods of formation, chemical reactions of glycerol.

### **PHENOLS**

- A.** Structure and bonding in phenols, physical properties and acidic character, Comparative acidic strength of alcohols and phenols, acylation and carboxylation.
- B.** Mechanism of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoesh reaction, Lederer-Manasse reaction and Reimer-Tiemann reaction.

## **UNIT-III**

### **ALDEHYDES AND KETONES**

- A.** Nomenclature, structure and reactivity of carbonyl group. General methods of preparation of aldehydes and ketones.
- Mechanism of nucleophilic addition to carbonyl groups: Benzoin, Aldol, Perkin and Knoevenagel condensation. Condensation with ammonia and its derivatives, Wittig reaction, Mannich reaction, Beckmann and Benzil- Benzilic rearrangement.
- B.** Use of acetate as protecting group, Oxidation of aldehydes, Baeyer-Villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmensen reduction, Wolf-Kishner reaction,  $LiAlH_4$  and  $NaBH_4$  reduction. Halogenation of enolizable ketones, An introduction to  $\alpha,\beta$ -unsaturated aldehydes and

ketones.

#### **UNIT-IV**

##### **A. CARBOXYLIC ACIDS**

Preparation, Structure and bonding, Physical and chemical properties including, acidity of carboxylic acids, effects of substituents on acid strength, Hell-Volhard Zeilinsky reaction. Reduction of carboxylic groups, Mechanism of decarboxylation.

Di carboxylic acids: Methods of formation and effect of heat and dehydrating agents, Hydroxyacids.

##### **B. CARBOXYLIC ACID DERIVATIVES**

Structure of acid chlorides, esters, amides and acid anhydrides, Relative stability of acyl derivatives.

Physical properties, inter-conversion of acid derivatives by nucleophilic acyl substitution.

Mechanism of acid and base catalyzed esterification and hydrolysis.

#### **UNIT-V**

#### **ORGANIC COMPOUNDS OF NITROGEN**

**A.** Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium.

**B.** Reactivity, structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Preparation of alkyl and aryl amines (reduction of nitro compounds and nitriles), reductive amination of aldehydic and ketonic compounds. Gabriel-Phthalimide reaction, Hofmann-Bromamide reaction, Reactions of amines, electrophilic aromatic substitution of aryl amines, Reaction of amines with nitrous acid. Synthetic transformations of aryl diazonium salts, Azo coupling.

#### **REFERENCE BOOKS**

1. Organic Chemistry, Morrison and Boyd, Prentice-Hall.
2. Organic Chemistry, L. G. Wade Jr. Prentice Hall.
3. Fundamentals of Organic Chemistry, Solomons, John Wiley.
4. Organic Chemistry, Vol I, II, III S. M. Mukherjee, S. P. Singh and R. P. Kapoor, Wiley Easters (New Age).
5. Organic Chemistry, F. A. Carey, McGraw Hill.
6. Introduction to Organic Chemistry, Struiweisser, Heathcock and Kosover, Macmillan.
7. Organic Chemistry, P. L. Soni.

8. Organic Chemistry, Bahl and Bahl.
9. Organic Chemistry, Joginder Singh.
10. Carbanic Rasayan, Bahl and Bahl.
11. Carbanic Rasayan, R. N. Singh, S. M. I. Gupta, M. M. Bakidia & S. K. Wadhwa.
12. Carbanic Rasayan, Joginder Singh.

**Paper – III**  
**PHYSICAL CHEMISTRY**

**60 Hrs., Max Marks 34**

**UNIT-I**

**A. THERMODYNAMICS-I**

Intensive and extensive variables; state and path functions; isolated, closed and open systems; Zeroth law of thermodynamics. First law: Concept of heat, work, internal energy and statement of first law; enthalpy, Relation between heat capacities, calculations of  $q$ ,  $w$ ,  $U$  and  $H$  for reversible, irreversible and free expansion of gases under isothermal and adiabatic conditions. Joule-Thompson expansion, inversion temperature of gases, expansion of ideal gases under isothermal and adiabatic condition

**B. THERMO CHEMISTRY**

Thermochemistry, Laws of Thermochemistry, Heats of reactions, standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions, Adiabatic flame temperature, explosion temperature.

**UNIT-II**

**A. THERMODYNAMICS-II**

Second Law of Thermodynamics: Spontaneous process, Second law, Statement of Carnot cycle and efficiency of heat engine, Carnot's theorem, thermodynamic state of temperature. Concept of entropy: Entropy change in a reversible and irreversible process, entropy change in isothermal reversible expansion of an ideal gas, entropy change in isothermal mixing of ideal gases, physical signification of entropy, Molecular and statistical interpretation of entropy.

**B.** Gibbs and Helmholtz free energy, variation of  $G$  and  $A$  with pressure, volume, temperature, Gibbs-Helmholtz equation, Maxwell relations, Elementary idea of Third law of Thermodynamics, concept of residual entropy, calculation of absolute entropy of molecule.

**UNIT III**

**A CHEMICAL EQUILIBRIUM**

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases. Concept of Fugacity, Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exergonic and endergonic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Thermodynamic derivation of relations between the various equilibrium constants  $K_p$ ,  $K_c$  and  $K_x$ . Le Chatelier principle (quantitative treatment). Equilibrium between ideal gas and a pure condensed phase.

## **B IONIC EQUILIBRIA**

Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono protic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

## **UNIT-IV**

### **PHASE EQUILIBRIUM**

**A.** Phase rule, Phase, component and degree of freedom, derivation of Gibbs phase rule, Clausius-Claperon equation and its applications to Solid-Liquid, Liquid-Vapor and solid-Vapor, limitation of phase rule, applications of phase rule to one component system: Water system and sulphur system.

Application of phase rule to two component system: Pb-Ag system, desilverization of lead, Zn-Mg system Ferric chloride-water system, congruent and incongruent, melting point and eutectic point.

Three component system: Solid solution liquid pairs.

**B.** Nernst distribution law, Henry's law, application, solvent extraction

## **UNIT V**

### **PHOTOCHEMISTRY**

Characteristics of electromagnetic radiation, Interaction of radiation with matter, difference between thermal and photochemical processes, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry: Grothus-Drapper law, Stark-Einstein law, quantum yield, actinometry, examples of low and high quantum yields, Photochemical equilibrium and the differential rate of photochemical reactions, Quenching, Role of photochemical reaction in biochemical process.

Jablonski diagram depicting various process occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem

crossing), photosensitized reactions, energy transfer processes {simple examples}, photostationary states, Chemiluminescence.

## REFERENCE BOOKS

1. Physical Chemistry, G. M. Barrow, International student edition, McGraw Hill.
2. University General Chemistry, C. N. R. Rao, Macmillan.
3. Physical Chemistry, R. A. Alberty, Wiley Eastern.
4. The elements of physical chemistry, Wiley Eastern.
5. Physical Chemistry through problems, S. K. Dogra & S. Dogra, Wiley Eastern.
6. Physical Chemistry, B. D. Khosla,.
7. Physical Chemistry, Puri & Sharma.
8. Bhautik Rasayan, Puri, Sharma and Pathania, Vishal Publishing Company.
9. Bhautik Rasayan, P. L. Soni.
10. Bhautik Rasayan, Bahl and Tuli.
11. Physical Chemistry, R. L. Kapoor, Vol I-IV .
12. Chemical kinetics, K. J. Laidler, Pearson Educations, New Delhi (2004).

## Paper –IV

### LABORATORY COURSE

#### INORGANIC CHEMISTRY

Qualitative semimicro analysis of mixtures containing 5 radicals. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

$\text{CO}_3^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{S}_2\text{O}_3^{2-}$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{F}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{BO}_3^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NH}_4^+$ ,  $\text{K}^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Sn}^{2+}$ ,  $\text{Sb}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Co}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ .

Mixtures should preferably contain one interfering anion, or insoluble component ( $\text{BaSO}_4$ ,  $\text{SrSO}_4$ ,  $\text{PbSO}_4$ ,  $\text{CaF}_2$  or  $\text{Al}_2\text{O}_3$ ) or combination of anions e.g.  $\text{CO}_3^{2-}$  and  $\text{SO}_3^{2-}$ ,  $\text{NO}_2^-$  and  $\text{NO}_3^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ , and  $\text{I}^-$ .

#### Volumetric analysis

- (a) Determination of acetic acid in commercial vinegar using NaOH.
- (b) Determination of alkali content-antacid tablet using HCl.
- (c) Estimation of calcium content in chalk as calcium oxalate by permanganometry.
- (d) Estimation of hardness of water by EDTA.
- (e) Estimation of ferrous & ferric by dichromate method.
- (f) Estimation of copper using thiosulphate.
- Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions: i. Ni (II) and Co (II) ii. Fe (III) and Al (III)

#### ORGANIC CHEMISTRY

- Detection of elements (X, N, S).
- Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols, nitro, amine, amide, and carbonyl compounds, carbohydrates)
- Preparation of Organic Compounds:
  - (i) m-dinitrobenzene, (ii) Acetanilide, (iii) Bromo/Nitro-acetanilide, (iv) Oxidation of primary alcohols-Benzoic acid from benzylalcohol, (v) azo dye.

#### PHYSICAL CHEMISTRY

Transition Temperature

- Determination of the transition temperature of the given substance by thermometric/ dilatometric method (e.g.  $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$  /  $\text{SrBr}_2 \cdot 2\text{H}_2\text{O}$ ).

#### Thermochemistry

- Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
- Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
- To determine the solubility of benzoic acid at different temperature and to determine  $\Delta H$  of the dissolution process.
- To determine the enthalpy of neutralization of a weak acid/ weak base versus strong base/ strong acid and determine the enthalpy of ionization of the weak acid/ weak base.
- To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born Haber cycle.

#### Phase Equilibrium

- To study the effect of a solute (e.g. NaCl, Succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system.
- To construct the phase diagram of two component system (e.g. diphenylamine– benzophenone) by cooling curve method.
- Distribution of acetic/ benzoic acid between water and cyclohexane.
- Study the equilibrium of at least one of the following reactions by the distribution method:
  - (i)  $\text{I}_2(\text{aq}) + \text{I}^- \rightarrow \text{I}_3^-(\text{aq})$
  - (ii)  $\text{Cu}^{2+}(\text{aq}) + n\text{NH}_3 \rightarrow \text{Cu}(\text{NH}_3)_n$

#### Molecular Weight Determination

Determination of molecular weight by Rast Camphor and Landsburger method.

**Note:** Experiments may be added/ deleted subject to availability of time and facilities.

## Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. Practical Organic Chemistry, 5th Ed. Pearson (2012)
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000). 22
4. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).
5. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011). Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
6. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York

Hrs.5

PRACTICAL EXAMINATION

M.M.50

Three Experiments are to be performed.

1. Inorganic – Qualitative semimicro analysis of mixtures. **12 marks**

OR

One experiment from synthesis and analysis by preparing the standard solution.

2. (a) Identification of the given organic compound & determine its M.Pt./B.Pt.

**6 marks**

(b) Determination of R<sub>f</sub> value and identification of organic compounds by paper chromatography.

**6 marks**

3. Any one physical experiment that can be completed in two hours including calculations.

**12 marks**

4. Viva

**10 marks**

5. Sessional

**04 marks**

In case of Ex-Students one marks will be added to each of the experiment.