

Semester-II (Theory)

Basic Concepts of Chemistry-II

Inorganic Chemistry-II (Theory)

UNIT-I: Chemistry of s, p and d Block Elements

12 Lectures

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and Catenation, Complex formation tendency of s and p block elements. Classification of Metal-Hydrides. Structure, Bonding, and Uses: Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of Nitrogen, Phosphorus Sulphur and Chlorine. Occurrence and uses, rationalization of inertness of noble gases, Bonding in noble gas compounds (Valence bond and MO treatment for XeF₂).

d block elements: General electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states. Difference between the first, second and third row transition elements.

UNIT-II: Bioinorganic Chemistry

8 Lectures

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on distribution of metals. Sodium/K-pump, Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), Iron and its application in biosystems, Haemoglobin.

Recommended books/references:

- 1 Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- 2 Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. Concepts & Models of Inorganic Chemistry 3rd Ed., John Wiley Sons, N.Y. 1994.
- 3 Greenwood, N.N., Earnshaw. Chemistry of the Elements, Butterworth-Heinemann. 1997.
- 4 Cotton, F.A. & Wilkinson, G. Advanced Inorganic Chemistry, Wiley, VCH, 1999.
- 5 Rodger, G.E. Inorganic and Solid State Chemistry, Cengage Learning India Edition, 2002.
- 6 Miessler, G. L. & Donald, A. Tarr. Inorganic Chemistry Fourth Ed., Pearson, 2010
- 7 Atkins, P. W and Shriver D. N. Atkins' Inorganic Chemistry 5th Ed. Oxford University Press (2010).

Organic Chemistry

UNIT I: Chemistry of aliphatic hydrocarbons

Alkanes and cycloalkanes: Preparation and general reactions of alkanes and cycloalkanes, Bayer Strain theory of strainless ring; Conformation of ethane, *n*-butane and cyclohexane, chlorination of methane and side chain chlorination of toluene.

Alkenes: General methods for preparation of alkenes, Reactions of alkenes: Addition reactions (Electrophilic and free radical), Halogenation, Hydrohalogenation, Hydration, Hydroxylation, Hydroboration-oxidation, Mercuriation-demercuration, Epoxidation and Ozonolysis.

Dienes: Conjugated and isolated Dienes; 1,2- versus 1,4-addition. Diels-Alder reaction of dienes: Mechanism

Alkynes: Preparation of alkynes, acidity and metal acetylides, Electrophilic addition reactions viz., Halogenation, Hydrohalogenation, Hydration, Hydroboration-oxidation, Mercuration-demercuration and Ozonolysis.

(16 Hours)

UNIT II: Stereochemistry:

Optical activity and plane-polarized light. Plane and centre of Symmetry, Chirality, enantiomers, diastereoisomers, mesomers, and racemic mixtures. Fischer, Newman and Sawhorse Projection Formula. E/Z, D/L and R/S nomenclature. Walden inversion. Stereochemistry of allenes and biphenyls.

(10 Hours)

Recommended Books/References:

- Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, 6th Edn., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- F. A. Carey, *Organic Chemistry*, Seventh Edition, Tata McGraw Hill (2008).
- J. Clayden, N. Greeves, S. Warren, *Organic Chemistry*, 2nd Ed., (2012), Oxford University Press.
- P Sykes, *A Guide Book to Mechanism in Organic Chemistry*, 6th Edition (1997), Orient Longman, New Delhi.
- “*Organic Chemistry*”, S. M. Mukherjee, S. P. Singh, and R. P. Kapoor, 1st Edition (1985), New Age International (P) Ltd. Publishers, New Delhi.
- “*Organic Chemistry*”, I. L. Finar, [Vol. I, 6th Edition (1973), Reprinted in 1980 & Vol. II, 5th Edition (1975), Reprinted in 1996], ELBS and Longman Ltd., New Delhi.
- “*Organic Chemistry – Structure and Reactivity*”, Seyhan N. Ege, 3rd Edition (1998), AITBS Publishers and Distributors, Delhi.
- “*Organic Chemistry*”, Paula Y. Bruice, 2nd Edition, Prentice-Hall, International Edition (1998).
- “*Organic Chemistry*”, G. Solomon, Willey India, Paper Back, 9th Edition.
- “*Modern Organic Chemistry*”, M. K. Jain and S. C. Sharma, Vishal Publishing CO. Jalandhar, India, 4th Edition (2012).
- “*Stereochemistry of Organic Compounds*”, D. Nasipuri, New Age International.
- “*Stereochemistry of Organic Compounds*”, P.S. Kalsi, New Age International.

Physical Chemistry

Unit – I: Thermodynamics – I

Introduction of different terms and processes in thermodynamics: State and path functions and their mathematical differentials treatment, partial derivatives, Euler’s reciprocity, and cyclic rule.

First Law: Concept of heat, q , work, w , internal energy, U , and sign convention for heat and work; Statement of first law; Enthalpy, H ; heat capacities (C_v and C_p) and their relationships. Reversible and irreversible processes, maximum work. Calculations of q , w , U , and H for reversible, irreversible, and free expansion of gases (ideal and van der Waals) under

isothermal and adiabatic conditions. Ideal gas law for adiabatic reversible expansion; comparison of adiabatic and isothermal reversible expansion. Joule-Thomson effect. Standard state and Thermochemistry (Hess's Laws and Kirchoff's equation).

(10 Hours)

Unit – II: Chemical and Phase Equilibria

Law of mass action; K_p , K_c , and K_x ; Effect of temperature on K ; Le-Chatelier principle; Ionic equilibria in solutions; pH and buffer solutions; Derivation of Henderson-Hasselbalch equation, buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry, Salt hydrolysis, hydrolysis constant, degree of hydrolysis and pH for different salts; Solubility and solubility product; Acid – base titration curves; Theory of acid–base indicators; selection of indicators and their limitations.

Concept of phases, components and degrees of freedom; Gibbs Phase Rule; Phase diagrams with applications for one-component systems (water and sulfur) and two component systems involving eutectics, congruent, incongruent melting points and solid solution (lead-silver, $\text{FeCl}_3\text{-H}_2\text{O}$ and Na-K etc.).

(15 Hours)

Reference Books:

- P. Atkins, J. d. Paula and K. James, *Physical Chemistry*, 11th Ed., Oxford University Press, **2018**.
- T. Engel and P. Reid, *Physical Chemistry*, 3rd Ed., Pearson, **2014**.
- S. Glasstone, *Thermodynamics for Chemists*, Affiliated East-West Press P. Ltd, **2003**.
- K. L. Kapoor, *A Text Book of Physical Chemistry: Thermodynamics and Chemical Equilibrium, Vol. 2*, 5th Ed., McGraw-Hill, **2015**.
- K. J. Laidler and J. H. Meiser, *Physical Chemistry*, 2nd Ed., CBS Publishers, **2006**.
- B. R. Puri, L. R. Sharma and M. S. Pathania, *Principles of Physical Chemistry*, 47th Ed., Vishal Publishing Co., **2018**.
- R. P. Rastogi and R. R. Mishra, *An Introduction to Chemical Thermodynamics*, 6th Ed., Viksh Publishing House, **2018**.
- S. Alberty, *Physical Chemistry*, 3rd Ed., John Wiley & Sons, Inc., **2003**.
- D. R. Crow, *Principles and Applications of Electrochemistry*, 4th Ed., Blackie Academic & Professional, **1994**.

Semester-II (Practical)

Basic Concepts of Chemistry-II

Physical Chemistry

1. Thermochemistry:

- (a) 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).
- (b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
- (c) Calculation of the enthalpy of ionization of ethanoic acid.
- (d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
- (e) Determination of basicity/proticity of a poly-protic acid by the thermo-chemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
- (f) Determination of enthalpy of hydration of copper sulfate.
- (g) Study of the solubility of benzoic acid in water and determination of ΔH .

2. pH metry

- (a) Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
- (b) Preparation of buffer solutions of different pH by:
Sodium acetate-acetic acid
Ammonium chloride-ammonium hydroxide
- (c) pH metric titration of (i) strong acid *versus* strong base, (ii) weak acid *versus* strong base.
- (d) Determination of dissociation constant of a weak acid.
- (e) To study the dissociation constant of amino acid (glycine) and hence the isoelectric point of the acid.

3. Chemical Equilibrium:

- Equilibrium constant of methyl acetate hydrolysis reaction.
- Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.
- Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
 - (a) simple eutectic and
 - (b) congruently melting systems
- Distribution of acetic/ benzoic acid between water and cyclohexane.
- Study the equilibrium of at least one of the following reactions by the distribution method:
 - (a) $I_2(aq) + I^-(aq) \rightleftharpoons I_3^-(aq)$
 - (b) $Cu^{2+}(aq) + nNH_3(aq) \rightleftharpoons [Cu(NH_3)_n]^{2+}$

Any other experiment carried out in the class if permit.

Reference Books:

- J. Elias, *A Collection of Interesting General Chemistry Experiments*, Revised Ed., University Press, **2007**.
- C. W. Garland, J. W. Nibler and D. P. Shoemaker, *Experiments in Physical Chemistry*, 8th Ed., McGraw-Hill, **2003**.
- A. M. Halern and G. C. McBane, *Experimental Physical Chemistry: A Laboratory Textbook*, 3rd Ed., W. H. Freeman and Company, **2006**.
- P. C. Kamboj, *University Practical Chemistry*, 1st Ed., Vishal Publishing, **2013**.
- S. K. Maity and N. K. Ghosh, *Physical Chemistry Practical*, NCBA, **2015**.
- A. K. Nad, B. Mahapatra and A. Ghoshal, *An Advanced Course in Practical Chemistry*, 3rd Ed., New Central Book Agency, **2014**.
- J. B. Yadav, *Advanced Practical Physical Chemistry*, Krishna Prakashan Media, **2010**.
- B. Viswanathan and P. S. Raghavan, *Practical Physical Chemistry*, Viva Books, **2009**.

Organic Chemistry practical

1. Detection of special elements (N, S, Cl, Br, I).
2. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry*, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry*, 5th Ed., Pearson (2012)

Inorganic Chemistry Practical

(A) Iodo / Iodimetric Titrations

- (i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).
- (ii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

- (i) Preparation of Aluminium potassium sulphate (Potash alum) and Chrome alum.

(Note: Experiments may be added/deleted subject to availability of time and facilities)

Reference Books:

- Mendham, J., A. I. Vogel's Quantitative Chemical Analysis Sixth Edition Pearson, 2009.

