

SEMESTER-III

PAPER-5

Marks: 150

THEORY

SECTION A-INORGANIC: PRINCIPLES OF METALLURGY and CHEMISTRY OF s-BLOCK ELEMENTS

Unit I: General principles of metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

Unit II: Chemistry of s-block elements:

- i. General Characteristics: Density, melting point, flame color, reducing nature, diagonal relationships and anomalous behaviour of first member of each group.
- ii. Oxidation states with reference to elements in unusual and rare oxidation states (alkali metal anions)
Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.
- iii. Common features such as ease of formation, thermal stability, solubility and % ionic character of the following Alkali Metal and Alkaline Earth Metal Compounds
Hydrides, Oxides, peroxides, superoxides, Carbonates, Bicarbonates, Nitrates, Sulphates.
- iv. Complex Formation tendency of s-block elements, Structure of the following complexes
Crown ethers, cryptates, basic beryllium acetate, beryllium nitrate, salicylaldehyde/acetylacetonato complexes of Group I, EDTA complexes of calcium and magnesium.
- v. Solution of alkali metals in liquid ammonia and their properties.
- vi. Uses of alkali metals with special reference to lithium in drugs & batteries.

Recommended Texts:

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.

- Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
- Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
- Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry 4th Ed.*, Pearson, 2010.
- Shriver & Atkins, *Inorganic Chemistry 5th Ed.*

SECTION B-PHYSICAL: CHEMICAL and IONIC EQUILIBRIA

Unit I: Chemical equilibrium

Criteria of thermodynamic equilibrium, chemical equilibria in ideal gases. Thermodynamic derivation of relation between Gibbs energy of reaction and reaction quotient. Equilibrium constants, relations between the various equilibrium constants K_p , K_c and K_x , and their quantitative dependence on temperature, pressure and concentration. Gibbs energy of mixing and spontaneity. Le Chatelier principle (quantitative treatment).

Unit II: Ionic equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and triprotic acids (exact treatment of monoprotic acid). Salt hydrolysis- calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.

Buffer solutions: derivation of Henderson–Hasselbalch equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry.

Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages in case of strong acid and strong base). Theory of acid–base indicators; selection of indicators and their limitations.

Recommended texts:

- Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.*, Oxford University Press 2010.
- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa 2004.
- McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi 2004.
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall 2012.
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics*. CRC Press: NY 2011.
- Zundhal, S.S. *Chemistry concept and applications* Cengage India 2011.

PRACTICAL

SECTION A-INORGANIC: IODO AND IODIMETRIC TITRATIONS

- i. Estimation of Cu (II) using sodium thiosulphate solution (Iodometrically).
- ii. Estimation of $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).
- iii. Estimation of antimony in tartar-emetie iodimetrically
- iv. Estimation of available chlorine in bleaching powder iodometrically.
- v. Estimation of dissolved oxygen in water samples.

Recommended text:

1. Vogel, A.I., Fundamentals of Quantitative Analysis, 5th Ed., Addison Wesley longman., 1989.

SECTION B-PHYSICAL: pH METRY

- a) Study the effect of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
- b) Preparation of buffer solutions of different pH
 - i. Sodium acetate-acetic acid
 - ii. Ammonium chloride-ammonium hydroxide
- c) pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.
- d) Determination of dissociation constant of a weak acid.

Recommended Texts:

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry*, R. Chand & Co.: New Delhi 2011.
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.*; McGraw-Hill: New York 2003.
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.*; W.H. Freeman & Co.: New York 2003.