

Semester IV

CHE-HC-4016: INORGANIC CHEMISTRY-III

(Credits: Theory-04, Lab-02)

Theory: 60 Lectures

Course Objective: This course introduces students to coordination chemistry. Various aspects like nomenclature, structure, bonding, variety and reactivity of the coordination compounds are included for the students to appreciate.

Bioinorganic chemistry is included in this course to acquaint students on the useful and harmful aspects of metals in biological systems.

Through the accompanying lab course, experiments related to gravimetric analysis, synthesis of coordination compounds and separation of metal ions using chromatography is included. This will broaden the experimental skills of the students where students will learn about various aspects of experiment design depending upon the requirements like synthesis, estimation or separation.

Learning Outcome: On successful completion, students will be able name coordination compounds according to IUPAC, explain bonding in this class of compounds, understand their various properties in terms of CFSE and predict reactivity. Students will be able to appreciate the general trends in the properties of transition elements in the periodic table and identify differences among the rows.

Through the experiments students not only will be able to prepare, estimate or separate metal complexes/compounds but also will be able to design experiments independently which they should be able to apply if and when required.

Coordination Chemistry:

Coordination compounds, types of ligands, Werner's theory, IUPAC nomenclature and isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers.

Valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of $10 Dq$ (Δ_o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of $10 Dq$ (Δ_o , Δ_t). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspects of ligand field and MO Theory.

Chelate effect, polynuclear complexes, labile and inert complexes.

(26 Lectures)

Transition Elements:

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Frost diagrams). Difference between the first, second and third transition series.

Chemistry of Ti, V, Cr Mn, Fe and Co (Chemistry of first -row transition elements) in various oxidation states as halides, oxides, hydroxides.

(18 Lectures)

Lanthanoids and Actinoids:

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

(6 Lectures)

Bioinorganic Chemistry:

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.

Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

(10 Lectures)

Recommended Books:

1. Cotton, F.A., Wilkinson, G. and Gaus, P. L., Basic Inorganic Chemistry, 3rd Ed., Wiley, 2007.
 2. Huheey, J. E., Keiter, E. A., Keiter, R. L., Medhi, O. K., Inorganic Chemistry: Principles of Structure and Reactivity, 4th Ed., Pearson Education India, 2006.
 3. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry, Panima Publishing Company, 1994.
 4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. 6th Ed., Wiley-VCH, 2007.
 5. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
 6. Greenwood, N.N. & Earnshaw, A., Chemistry of the Elements, 2nd Ed., Elsevier India, 2010.
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LAB**60 Lectures****Gravimetric Analysis:**

- i. Estimation of nickel(II) using dimethylglyoxime (DMG).
- ii. Estimation of copper as CuSCN
- iii. Estimation of iron as Fe₂O₃ by precipitating iron as Fe(OH)₃.
- iv. Estimation of Al (III) by precipitating with oxine and weighing as Al(oxine)₃ (aluminium oxinate).

Inorganic Preparations:

- i. Tetraamminecopper(II) sulphate, [Cu(NH₃)₄]SO₄.H₂O
- ii. *Cis* and *trans* K[Cr(C₂O₄)₂.(H₂O)₂] Potassium dioxalatoaquachromate (III)
- iii. Tetraamminecarbonatocobalt (III) ion
- iv. Potassium tris(oxalato)ferrate(III)

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

- i. Ni(II) and Co(II)
- ii. Fe(III) and Al(III)

Recommended Book:

1. Mendham, J. et al.: Vogel's Textbook of Quantitative Chemical Analysis ; 6th Ed. Pearson Education, 2009.

2. Marr, G. and Rockett, R.W. *Practical Inorganic Chemistry*, Van Nostrand Reinhold. 1972.
 3. *Inorganic Syntheses*, Vol. 1-10.
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