

**COMMON POOL OF GENERIC ELECTIVES
OFFERED BY DEPARTMENT OF CHEMISTRY**

GENERIC ELECTIVES -12: Coordination and Organometallic Compounds

Credit distribution, Eligibility and Pre-requisites of the Course

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course |
|---|---------|-----------------------------------|----------|---------------------|----------------------|-----------------------------|
| | | Lecture | Tutorial | Practical/ Practice | | |
| Coordination and Organometallic Compounds (GE-2) | 4 | 2 | 0 | 2 | Class XII Pass | --- |

Learning Objectives

The Learning Objectives of this course are as follows:

- To introduce students to some important d-block metals and their compounds which they are likely to come across.
- To make students learn about organometallic compounds, a frontier area of chemistry providing an interface between organic and inorganic chemistry.
- To familiarize students with coordination compounds which find manifold applications in diverse fields.

Learning outcomes

By the end of the course, the students will be able to:

- Familiarize with different types of organometallic compounds, their structures and bonding involved.
- Understand the nature of Zeise's salt and compare its synergic effect with that of carbonyls.
- Identify important structural features of tetrameric methyl lithium and understand the concept of multicenter bonding in these compounds
- Apply 18-electron rule to rationalize the stability of metal carbonyls and related species
- Use IR data to explain the extent of back bonding in carbonyl complexes
- Understand the terms, ligand, denticity of ligands, chelate, coordination number and use standard rules to name coordination compounds
- Use Valence Bond Theory to predict the structure and magnetic behaviour of metal complexes and understand the terms inner and outer orbital complexes
- Understand the properties of coordination compounds and VBT and CFT for bonding in coordination compounds

- Explain the meaning of the terms Δ_o , Δ_t , pairing energy, CFSE, high spin and low spin and how
- CFSE affects thermodynamic properties like lattice enthalpy and hydration enthalpy

Theory:

Unit 1: Coordination Chemistry

4 Hours

Brief discussion with examples of types of ligands, denticity and concept of chelate. IUPAC system of nomenclature of coordination compounds (mononuclear and binuclear) involving simple monodentate and bidentate ligands.

Unit 2: Bonding in coordination compounds

14 Hours

Valence Bond Theory (VBT): Salient features of theory, concept of inner and outer orbital complexes of Cr, Fe, Co and Ni. Drawbacks of VBT.

Crystal Field Theory: Splitting of d orbitals in octahedral symmetry. Crystal field effects for weak and strong fields. Crystal field stabilization energy (CFSE), concept of pairing energy. Factors affecting the magnitude of Δ_o .

Spectrochemical series. Splitting of d orbitals in tetrahedral symmetry. Comparison of CFSE for octahedral and tetrahedral fields, tetragonal distortion of octahedral geometry. Jahn-Teller distortion, square planar coordination.

Unit 3: Organometallic Compounds

12 Hours

Definition and classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structure and bonding of methyl lithium and Zeise's salt. Structure and physical properties of ferrocene. 18-electron rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. π -acceptor behaviour of carbon monoxide (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Practicals:

60 Hours

1. Gravimetry

Discuss basic principles of gravimetry (precipitation, co-precipitation and post precipitation, digestion, washing etc)

- Estimation of Ni(II) using dimethylglyoxime (DMG).
- Estimation of copper as CuSCN.
- Estimation of Al(III) by precipitating with oxine and weighing as Al(oxine)₃ (aluminium oxinate).

2. Inorganic Preparations

- (i) Schiff's base involving ethylenediamine and salicylaldehyde (or any other amine and aldehyde/ketone) and to check its purity using TLC.
- (ii) Nickel/ Copper complex of the above prepared Schiff's base and its characterisation using UV/Vis spectrophotometer. The IR spectra also to be interpreted
- (iii) tetraamminecopper (II) sulphate
- (iv) potassium trioxalatoferrate (III) trihydrate.
- (v) tetraamminecarbonatocobalt(III) nitrate

References:

Theory:

1. Atkins, P.W.; Overton, T.L.; Rourke, J.P.; Weller, M.T.; Armstrong, F.A. (2010), **Shriver and Atkins Inorganic Chemistry**, W. H. Freeman and Company.
2. Miessler, G. L.; Fischer P.J.; Tarr, D.A. (2014), **Inorganic Chemistry**, Pearson.
3. Huheey, J.E.; Keiter, E.A., Keiter; R.L., Medhi, O.K. (2009), **Inorganic Chemistry- Principles of Structure and Reactivity**, Pearson Education.
4. Pfennig, B. W. (2015), **Principles of Inorganic Chemistry**. John Wiley & Sons.
5. Cotton, F.A.; Wilkinson, G. (1999), **Advanced Inorganic Chemistry** Wiley-VCH.

Practicals:

1. Jeffery, G.H.; Bassett, J.; Mendham, J.; Denney, R.C. (1989), **Vogel's Textbook of Quantitative Chemical Analysis**, John Wiley and Sons.
2. Schiff Base Complex of Cu (II) with Antibacterial and Electrochemical Study, Arjun C. Bhowmick, Majharul I. Moim, Miththira Balasingam , **American Journal of Chemistry** 2020, 10(2): 33-37, DOI: 10.5923/j.chemistry.20201002.03

Keywords: Organometallic compounds, metal carbonyls, synergistic effect, Coordination compounds, VBT, Crystal field theory, Splitting of d levels, Dq

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.