

CHAPTER OVERVIEW

5: Coordination Chemistry and Crystal Field Theory

Learning Objectives

- Determine oxidation states and assign d-electron counts for transition metals in complexes.
- Derive the d-orbital splitting patterns for octahedral, elongated octahedral, square pyramidal, square planar, and tetrahedral complexes.
- For octahedral and tetrahedral complexes, determine the number of unpaired electrons and calculate the crystal field stabilization energy.
- Know the spectrochemical series, rationalize why different classes of ligands impact the crystal field splitting energy as they do, and use it to predict high vs. low spin complexes, and the colors of transition metal complexes.
- Use the magnetic moment of transition metal complexes to determine their spin state.
- Understand the origin of the Jahn-Teller effect and its consequences for complex shape, color, and reactivity.
- Understand the extra stability of complexes formed by chelating and macrocyclic ligands.

Coordination compounds (or complexes) are molecules and extended solids that contain bonds between a transition metal ion and one or more ligands. In forming these coordinate covalent bonds, the metal ions act as Lewis acids and the ligands act as Lewis bases. Typically, the ligand has a lone pair of electrons, and the bond is formed by overlap of the molecular orbital containing this electron pair with the d-orbitals of the metal ion.

[5.1: Prelude to Coordination Chemistry and Crystal Field Theory](#)

[5.2: Counting Electrons in Transition Metal Complexes](#)

[5.3: Crystal Field Theory](#)

[5.4: Spectrochemical Series](#)

[5.5: \$\pi\$ -Bonding between Metals and Ligands](#)

[5.6: Crystal Field Stabilization Energy, Pairing, and Hund's Rule](#)

[5.7: Non-octahedral Complexes](#)

[5.8: Jahn-Teller Effect](#)

[5.9: Tetrahedral Complexes](#)

[5.10: Stability of Transition Metal Complexes](#)

[5.11: Chelate and Macrocyclic Effects](#)

[5.12: Ligand Substitution Reactions](#)

[5.13: Discussion Questions](#)

[5.14: Problems](#)

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