

What is Ligand Field Theory?

Worksheet

Ligand field theory combines valence bond theory with molecular orbital theory to describe how ligands electrostatically repel d-electrons, causing d-orbital splitting. The magnitude of splitting determines the color (wavelength of light absorbed) and magnetic properties of the complex.

Questions

1. In tetrahedral crystal field, how many d-orbital energy levels are there?
A) 1
B) 2
C) 3
D) 5
2. Which ligand is a strong-field ligand?
A) HO
B) Cl
C) CN
D) I
3. A complex absorbs blue light (high energy). What is the crystal field splitting magnitude?
A) Small
B) Large
C) Zero
D) Negative
4. Is $[\text{Fe}(\text{CN})]$ high-spin or low-spin?
A) High-spin
B) Low-spin
C) Cannot determine
D) Medium-spin
5. In octahedral $[\text{Fe}(\text{HO})]$, which d-orbitals are higher in energy, e_g or t_{2g} ?
6. Why do $[\text{Fe}(\text{CN})]$ (deep red) and $[\text{Fe}(\text{HO})]$ (pale yellow) have different colors?
7. Predict the coordination geometry (octahedral vs tetrahedral) for $[\text{NiCl}]$ based on the d-orbital splitting.
8. Define: What is crystal field splitting?
9. Define: In octahedral field, which orbitals are e_g ?
10. Define: What does 'strong-field' ligand mean?

Answer Key

1. C) 3 - Tetrahedral field splits d-orbitals into e and t₂ levels (2 distinct energies).
2. C) CN - CN (cyanide) is at the top of the spectrochemical series (strong field).
3. B) Large - High-energy light absorbed means large energy gap large crystal field splitting.
4. B) Low-spin - CN is a strong-field ligand with large Δ , favoring low-spin configuration.
5. In octahedral field geometry, ligands approach along the x, y, z axes. Orbitals pointing toward ligands (dz and dxy) repel more higher energy (eg). Orbitals pointing between axes (dx_y, dx_z, dy_z) repel less lower energy (t_{2g}).
Answer: eg orbitals are higher in energy.
6. Different ligands create different crystal field splittings (Δ). CN is a strong-field ligand large splitting (Δ is large). HO is a weak-field ligand small splitting (Δ is small). The absorbed photon energy differs different colors observed.
7. Cl is a weak-field ligand. Weak-field ligands prefer tetrahedral geometry (smaller splitting penalty). Strong-field ligands prefer octahedral (larger splitting, more pairing). [NiCl₄] is tetrahedral, not octahedral.
8. The splitting of d-orbital energies caused by the electrostatic field of surrounding ligands.
9. dz and dxy (pointing toward ligands, higher energy).
10. A ligand that creates a large crystal field splitting (large Δ); causes pairing of electrons.

Bounlu

All cards, step-by-step solutions and an AI tutor are in the Notek app.
Promy turns exam dates into automatic reminders.