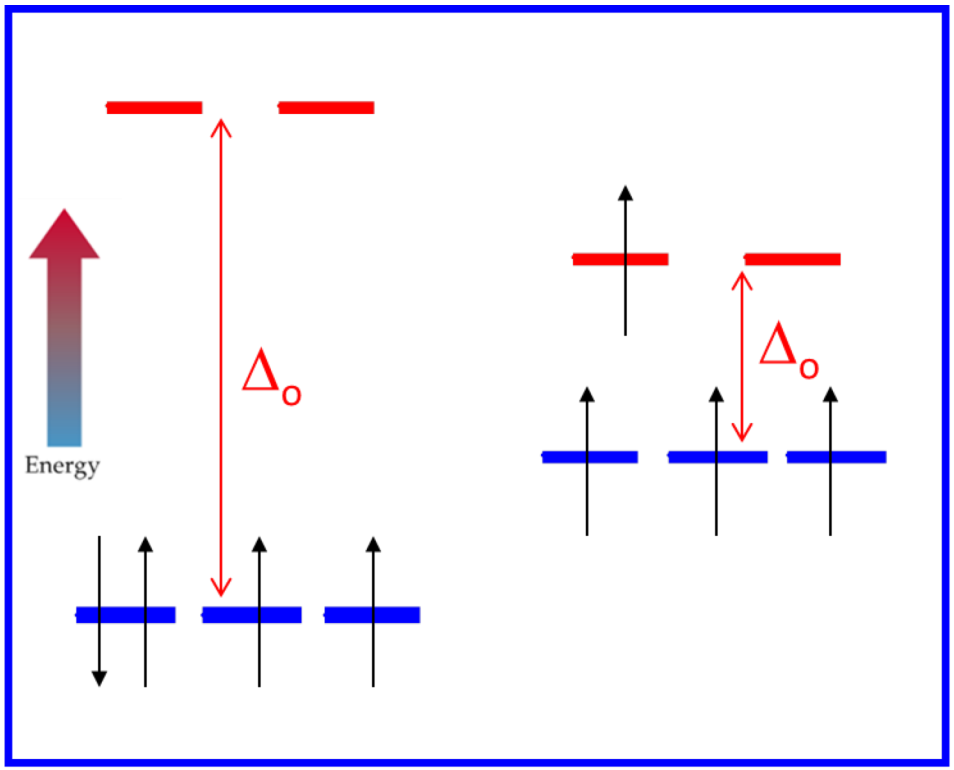

THE PROBLEM
IS CHOICE

Π vs. Δ_o: High Spin and Low Spin Complexes

Strong field = Low spin (2 unpaired)

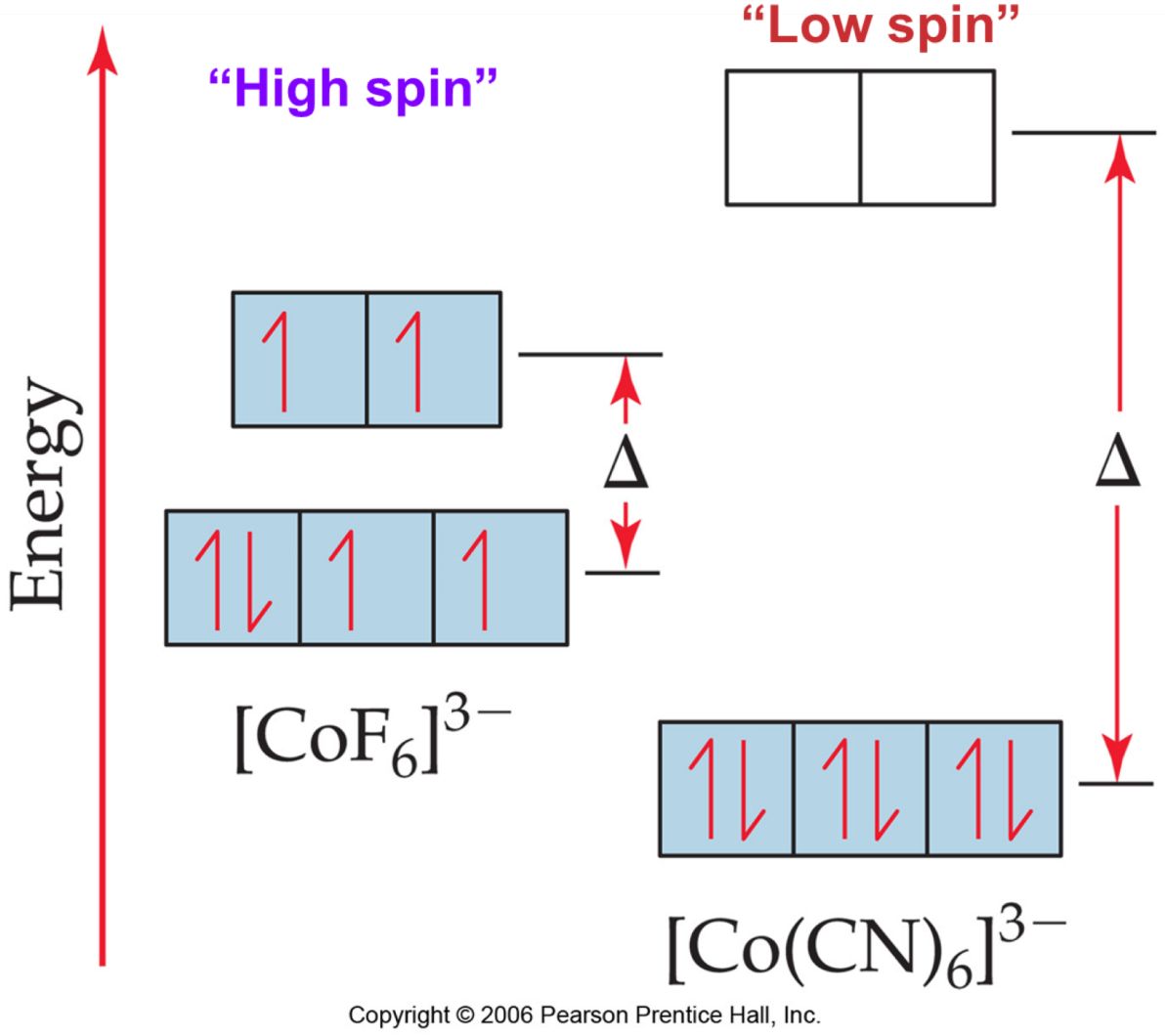


Weak field = High spin (4 unpaired)

- When the 4th electron will either go into the higher energy e_g orbital at an energy cost of Δ_o or be paired at an energy cost of Π, the pairing energy.

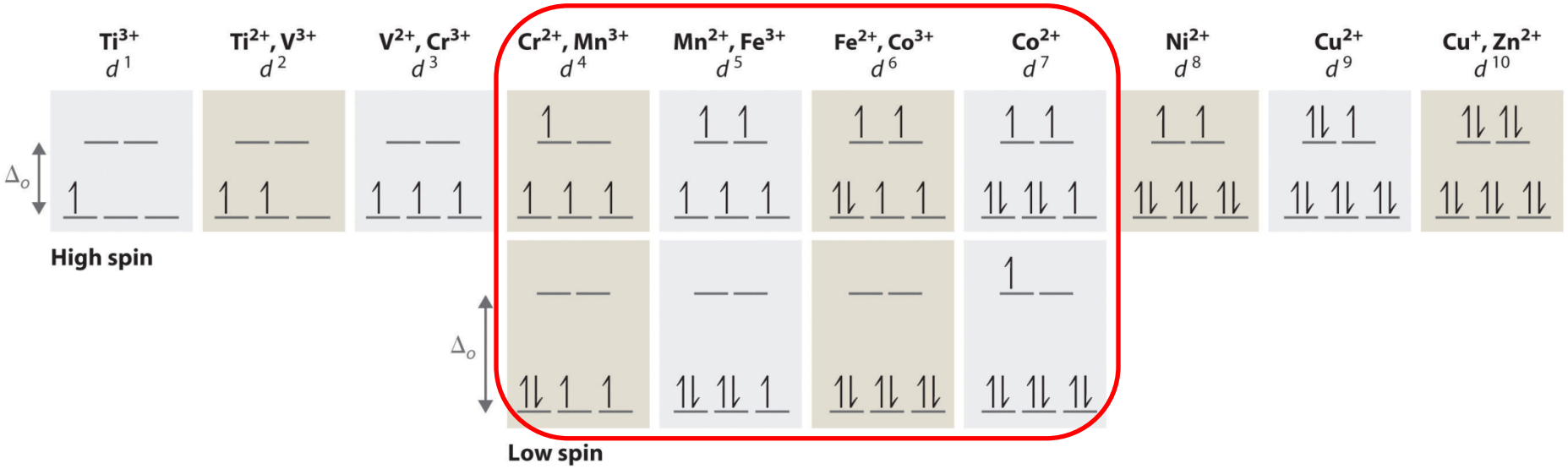
High Spin and Low Spin Complexes: Example

- As ligand Changes, electronic configuration also may change (occupancy of t_{2g} and e_g orbitals may become different).



High Spin and Low Spin Complexes

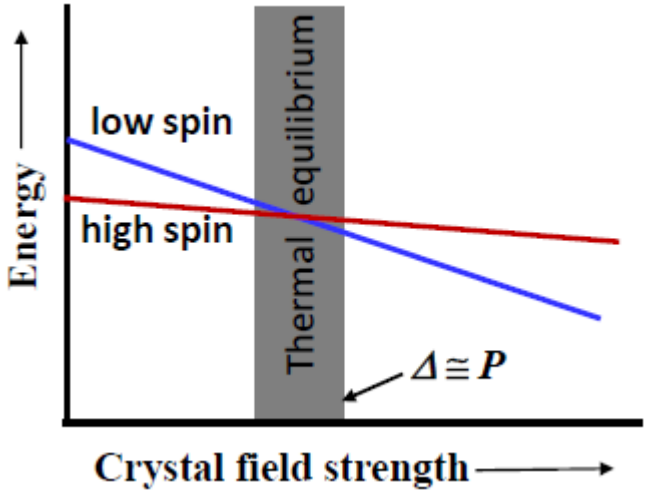
- Two different configurations are possible for octahedral complexes of metals with d^4, d^5, d^6, and d^7 configurations.



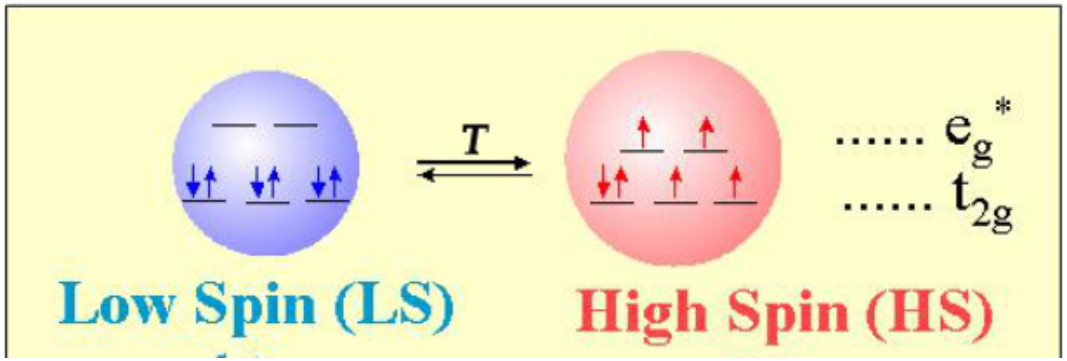
- For d^4, d^5, d^6, and d^7 configurations, the magnitude of Δ_o determines which configuration is observed.

Curiosity: What Happens When Δ_o is Close to Π

- When $\Delta_o \sim \Pi$, interconversion between high spin and low spin states should be possible



- Has been observed for Fe(II)-d^6 systems. Can be brought about by heat and light



Recap and Some Important Generalizations

- **Oxidation state of the metal ion**
  Δ increases with increase in ionic charge

- **Nature of Metal**
  3d < 4d < 5d
  Really large Δ, normally low spin (As you go down the periodic table, Δ increases)

- **Number and geometry of ligands**
  $\Delta_{tetrahedral}$ only ~50% of $\Delta_{octahedral}$

- **3d metals are generally high spin complexes except with very strong ligands. CN^- forms low spin complexes, especially with M^{3+} ions.**

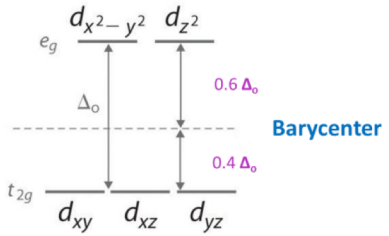
- **4d & 5d metals generally have a larger value of Δ_o than for 3d metals. As a result, complexes are typically low spin.**

- **For 3d metals, tetrahedral splitting is rarely large enough to result in pairing of the electrons. As a result, low-spin tetrahedral complexes are not common.**

CFSE will Vary for Different Electronic Configurations

❑ CFSE = [-0.4 x n(t_{2g}) + 0.6 x n(e_g)] Δ_o

where n(t_{2g}) and n(e_g) are number of electrons in the respective levels



❑ Distribution of electrons and CFSE

TABLE 8.5

Electron Configurations and Crystal Field Stabilization Energies for High- and Low-Spin Octahedral Complexes

Configuration		d^1	d^2	d^3	d^4	d^5	d^6	d^7	d^8	d^9	d^{10}
Examples		Ti^{3+}	Ti^{2+}, V^{3+}	V^{2+}, Cr^{3+}	Cr^{2+}, Mn^{3+}	Mn^{2+}, Fe^{3+}	Fe^{2+}, Co^{3+}	Co^{2+}, Ni^{3+}	Ni^{2+}, Pt^{2+}	Cu^{2+}	Zn^{2+}
HIGH SPIN	e_g	⟋⟍	⟋⟍	⟋⟍	↑⟍	↑↑	↑↑	↑↑	↑↑	↓↑	↓↑
	t_{2g}	↑	↑↑	↑↑↑	↑↑↑	↑↑↑	↓↑↑	↓↓↑	↓↓↓	↓↓↓	↓↓↓
	CFSE	$-\frac{2}{5}\Delta_o$	$-\frac{4}{5}\Delta_o$	$-\frac{6}{5}\Delta_o$	$-\frac{3}{5}\Delta_o$	0	$-\frac{2}{5}\Delta_o$	$-\frac{4}{5}\Delta_o$	$-\frac{6}{5}\Delta_o$	$-\frac{3}{5}\Delta_o$	0
LOW SPIN	e_g				⟋⟍	⟋⟍	⟋⟍	↑⟍			
	t_{2g}				↓↑↑	↓↓↑	↓↓↓	↓↓↓			
	CFSE	Same as high spin			$-\frac{8}{5}\Delta_o$	$-\frac{10}{5}\Delta_o$	$-\frac{12}{5}\Delta_o$	$-\frac{9}{5}\Delta_o$	Same as high spin		

CFSE, Crystal field stabilization energies.