B.Sc. Semester-IV
Core Course-VIII (CC-VIII)
Inorganic Chemistry

I. Coordination Chemistry
7. The Spectrochemical Series

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I. Coordination Chemistry: 20 Lectures

Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq (Δo), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (Δo, Δt). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes.

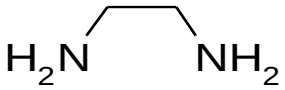
Coverage:

1. The Spectrochemical Series

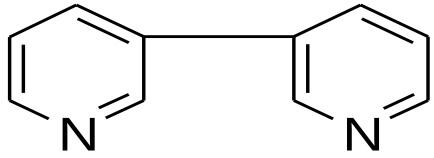
The Spectrochemical Series

An order of ligand field strength based on experiment.

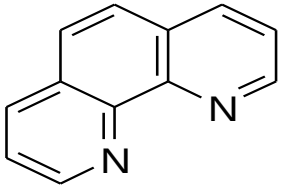
Weak Field I^- < Br^-< S^{2-}< SCN^-< Cl^-< NO_3^-< F^- < $C_2O_4^{2-}$< H_2O< NCS^-< CH_3CN< NH_3< en < bipy< phen< NO_2^-< PPh_3< CN^-< CO Strong Field



Ethylenediamine (en)



2,2'-bipyridine (bipy)



1.10 - penanthroline (phen)

The Spectrochemical Series

Purely σ ligands:

Δ: en > NH_3 (order of proton basicity)

π donating which decreases splitting and causes high spin:
Δ: H_2O > F > RCO_2 > OH > Cl > Br > I (also proton basicity)

π accepting ligands increase splitting and may be low spin
Δ: CO, CN^-, > phenanthroline > NO_2^- > NCS^-

Merging to Get Spectrochemical Series

CO, CN^- > phen > en > NH_3 > NCS^- > H_2O > F^- > RCO_2^- > OH^- > Cl^- > Br^- > I^-

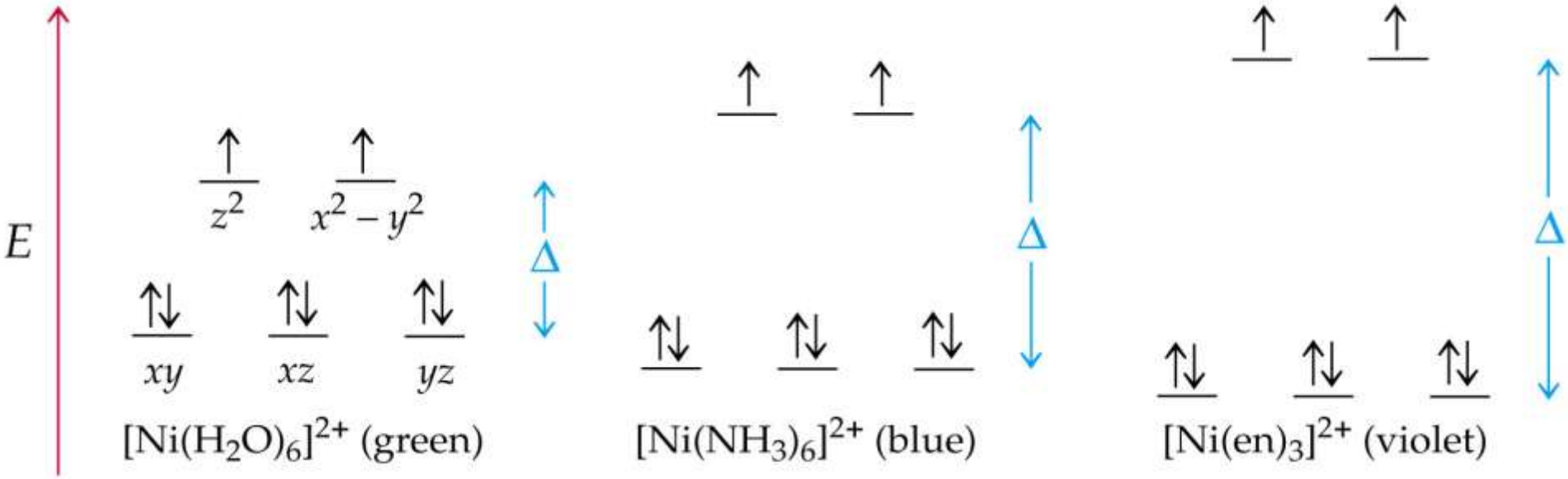
Strong field, π acceptors large Δ low spin

σ only

Weak field, π donors small Δ high spin

The Splitting of d-Orbitals Depends on the Nature of Ligands Bonded to Central Metal

d^8: $t_{2g}^6 e_g^2$ configuration

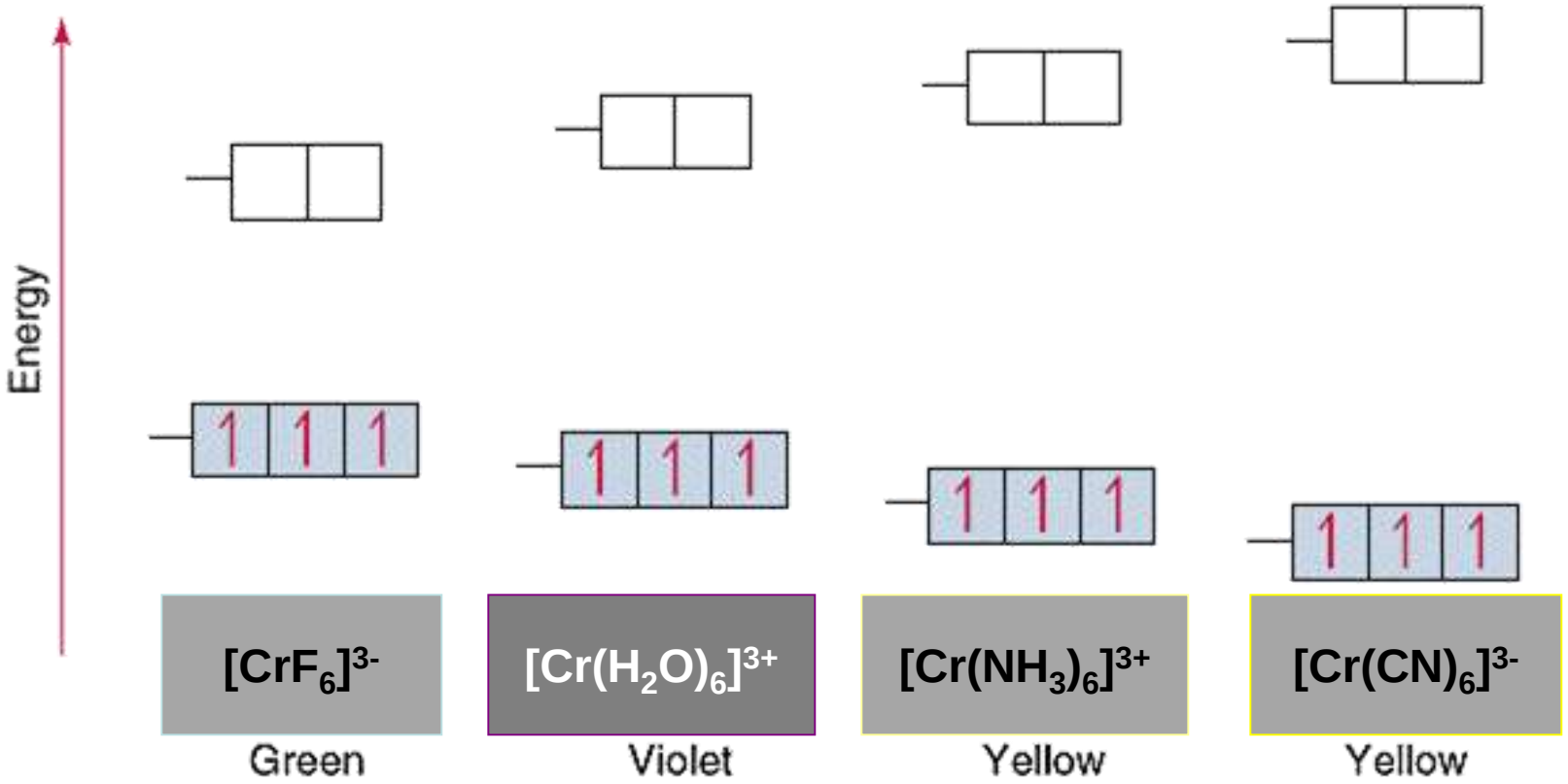


The Spectrochemical Series

Weak-field ligands $I^- < Br^- < Cl^- < F^- < H_2O < NH_3 < en < CN^-$ Strong-field ligands

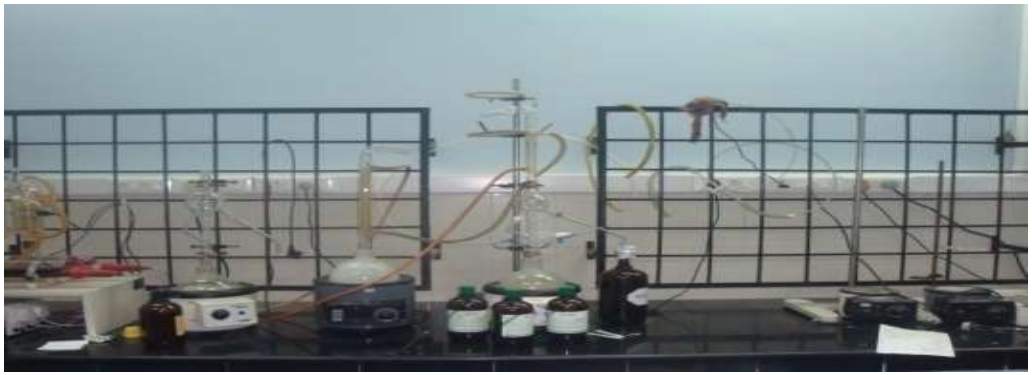
Increasing Δ

A Weak Field Ligand to a Strong Field Ligand



As Cr^{3+} goes from being attached to a weak field ligand to a strong field ligand, Δ increases and the color of the complex changes from green to yellow.

Thank You



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