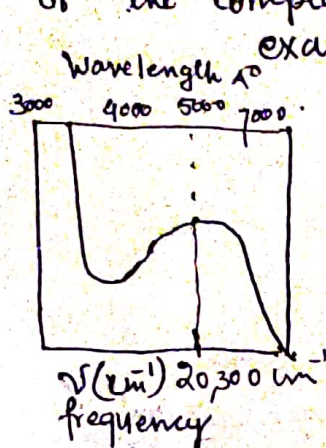
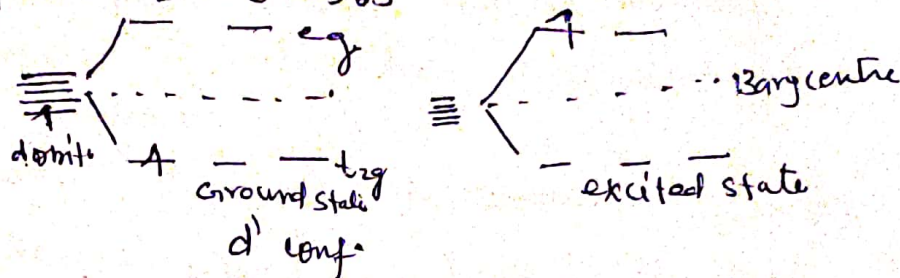


As we have discussed previous class that the difference in energy between two d levels is given either of the symbols Δ_0 or $10Dq$,

The size of the energy gap Δ_0 between the t_{2g} and e_g levels can be measured by UV-visible spectrum of the complex.



example - $[Ti(H_2O)_6]^{3+}$



The d-d transition is the single broad peak with max. at $20,300\text{ cm}^{-1}$.

$$\text{Since } 1\text{ KJ} = 83.7\text{ cm}^{-1}$$

$$\text{So, } 20,300\text{ cm}^{-1} = \frac{20,300}{83.7} = 243\text{ KJ mol}^{-1}$$

Because of the CFSE of d orbitals the single d electron in $[Ti(H_2O)_6]^{3+}$ occupies an energy level $\frac{2}{5}\Delta_0$ or $0.4\Delta_0$ below the average energy of d orbitals. As a result the complex is more stable.

$$\text{CFSE in this case } \frac{2}{5} \times 243 = 97\text{ KJ mol}^{-1}$$

The magnitude of Δ_0 depends on three factors

① The Nature of ligands.

Ligands are mainly two types. ① Strong ligand

② weak ligand.

Strong ligands - which cause a large splitting.

example - NH_3 , CN^- , CO , EDTA, ethylenedi-amine etc.

Weak ligands - ligands which cause only a small degree of crystal field splitting.

SPECTROCHEMICAL SERIES: - The ligand arranged in ascending order of crystal field splitting energy Δ_0 and this series is known as spectrochemical series.

Contd.

Spectrochemical series

$I^- < Br^- < S^{2-} < Cl^- < NO_3^- < F^- < OH^- < EtOH < Oxalate < H_2O < EDTA < (NH_3 \text{ \& } Pyridine) < ethylenediamine < dipyridentyl < O-Phenanthroline < NO_2^- < CN^- < Co.$

This is experimentally determined.

halides are in the order expected from electrostatic effects.

In other cases we must consider covalent bonding to explain the order. A pattern of increasing σ donation is followed:

halide donors $<$ O donors $<$ N donors $<$ C donors.

CFSE for CN^- ligand is about double that for weak ligands. due to formation of π bonding. $M^{filled} (+eg)$ donate electron to vacant orbital on the ligands.

Charge of Metal ion:
 $M^{++} < M^{+++}$

Whether the metal is in 1st, 2nd or 3rd row of transition series.

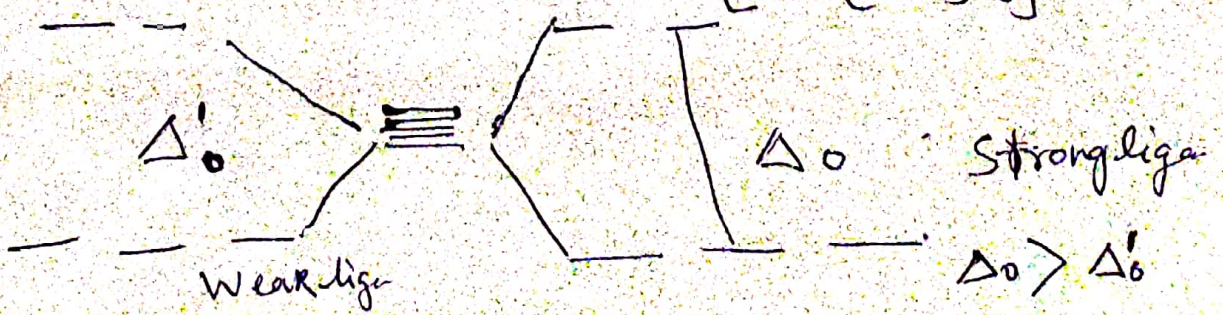
Δ_o also increases by about 30% between adjacent members down a gr. of T. Elements

	Δ_o	$kT \Delta_o$
$[Co(NH_3)_6]^{3+}$	24800	296
$[Rh(NH_3)_6]^{3+}$	34000	406
$[Ir(NH_3)_6]^{3+}$	41000	490

Effects of ligands

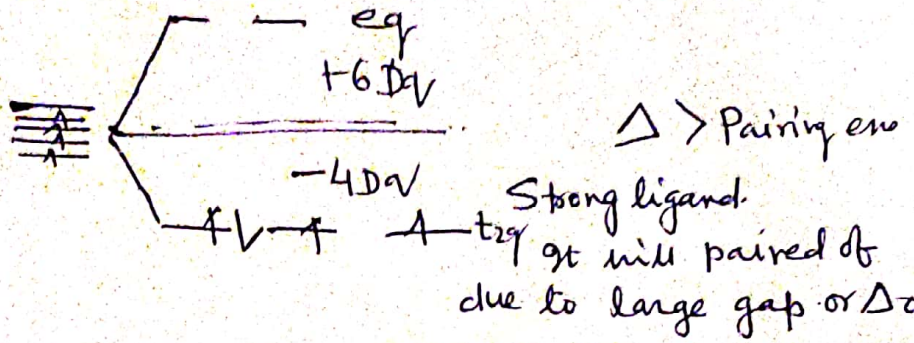
example 1. $[Cr^{III}(Cl_6)]^{3-}$ - weak ligand

2. $[Cr^{III}(NH_3)_6]^{3+}$ - strong ligand



For d4 system. 5

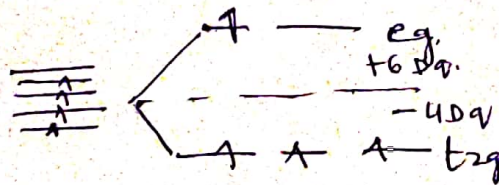
How the electron will fill in the case of strong ligands and weak ligand.



$$CFSE = 4 \times -4 = -16Dq$$

Complex will be known as low spin complex or spin paired complex
 $P =$ Pairing energy.

Weak field



$$CFSE = -12 + 6 = -6Dq$$

$P > CFSE$

high spin complex or spin free complex.

$$CFSE = 3 \times -4 + 6 = -6Dq$$

$$CFSE (\text{octahedral}) = -0.4n_{t2g} + 0.6n_{eg}$$

n_{t2g} and $n_{eg} =$ no. of electron present

calculate CFSE (up to d³ system both have same Strong field)

	Weak field	CFSE Δ_0	Magnetic moment $\mu = n\sqrt{n+2}$	Arrangement	CFSE Δ	Spin only mag. moment
d ⁴		-0.4	2.83	d ⁴	-1.6 + P	2.83
d ⁵		-0.0	5.92	d ⁵	-2.0 + 2P	1.73

You can calculate it like this way
 For d⁵, d¹⁰
 $CFSE = 0$
 $d^{10} = CFSE = 0.0$