6. COORDINATION COMPOUNDS

Counter ion ↑ ↗ Central Metal Atom — Coordination Sphere

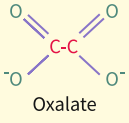
$$K_4[Fe(CN)_6] \longrightarrow 4K^+ + [Fe(CN)_6]^{4-}$$

LIGAND

UNIDENTATE

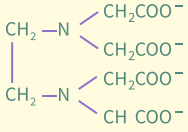
CN^-, H_2O, NH_3, Cl^-, Br^- etc

BIDENTATE



Oxalate

POLYDENTATE



AMBIDENTATE

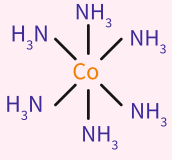
M ⟵ SCN Thiocyanate

M ⟵ NCS Isothiocyanate

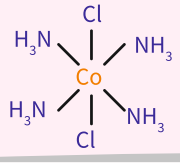
Complex Salt

Doesn't dissociate completely into ions

HOMOLEPTIC COMPLEX



HETEROLEPTIC COMPLEX



NOMENCLATURE

Naming of Mononuclear Complex

Naming of mononuclear complex
1. Cation is named first
2. Naming of ligands is done in alphabetical order
3. Anionic ligands end in -O, neutral and cationic are same.
4. Prefixes mono, di, tri, etc are used.It is followed by roman numeral in parenthesis.

Example: Triamminetriaqua chromium (III) chloride

Formula of Mononuclear Complex

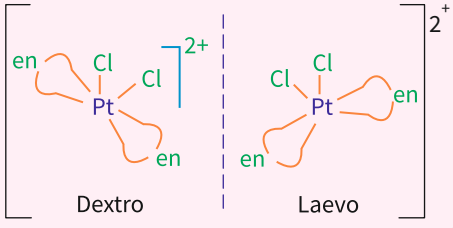
1. Central atom is listed first.
2. Ligands are placed in alphabetical order.
3. Formula is enclosed in square bracket.
4. No space between ligands and metal.
5. Charge is indicated outside brackets. Charge on cation(s) balanced by charge of anions(s)

Example: $[Cr(NH_3]_3(H_2O)_3]Cl_3$

ISOMERISM

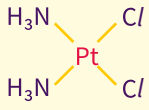
STEREO ISOMERS

OPTICAL ISOMERS

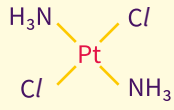


GEOMETRICAL ISOMERS

(i) COORDINATION NUMBER 4

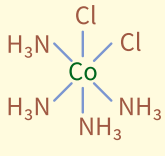


(cis-platin)

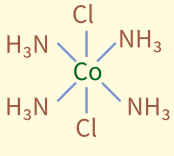


(trans-platin)

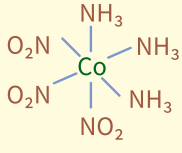
(ii) Coordination number 6



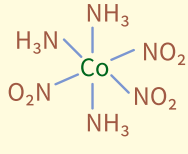
(cis-isomer)



(trans-isomer)



(fac-isomer)



(mer-isomer)

STRUCTURAL ISOMERS

Ionisation isomer
Different ions are produced in aqueous solution.
Ex: $[Co(NH_3)_5(SO_4)]Br$ and $[Co(NH_3)_5Br]SO_4$

Solvate isomer
Difference in number of water molecules attached.
Ex: $[Cr(H_2O)_6)]Cl_3$ and $[Cr(H_2O)_5Cl]Cl_2.H_2O$

Cordination isomer
Cordination entities are different.
Ex: $[Co(NH_3)_6][Cr(CN)_6]$ and $[Co(CN)_6][Cr(NH_3)_6]$

Linkage isomer
Occurs in ambidentate ligands
Ex: $[Co(NH_3)_5(NO_2)]$ and $[Co(NH_3)_5(ONO)]$

THEORIES OF COORDINATION COMPOUNDS

Limitation

- Only certain elements form coordination complex.
- Why coordination bonds have directional property
- Couldn't explain magnetic and optical properties of complex.

WERNER'S THEORY

- Central metal ion shows primary and secondary valences
- Primary valences are ionisable.
- Secondary valences are non-ionisable.
- Ions bonded to metal via secondary linkages have different spatial arrangement

VALENCE BOND THEORY

Shape	Coordination Number	Hybridisation	Example
Tetrahedral	4	sp^3	$[CuCl_4]^{2-}$
Square Planar	4	dsp^2	$[Ni(CN)_4]^{2-}$
Trigonal Bipyramidal	5	sp^3d	$[Fe(CO)_5]$
Square Pyramidal	5	sp^3d	$[SbF_5]^{2-}$
		sp^3d^2	$[Ti(H_2O)_6]^{3+}$
Octahedral	6	d^2sp^3	$[Co(NH_3)_6]^{3+}$

MAGNETIC PROPERTY

Magnetic moment = $\sqrt{n(n+2)}$ BM

PARAMAGNETIC

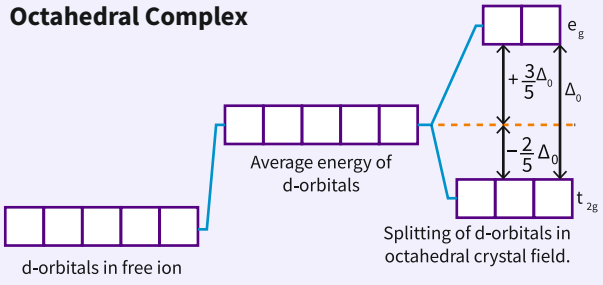
One or more than one unpaired electron present.
Eg- $[CoF_6]^{3-}$

DIAMAGNETIC

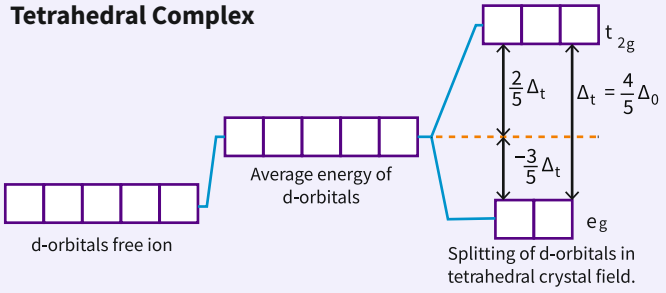
No unpaired electron present.
Eg- $[Ni(CN)_4]^{2-}$

CRYSTAL FIELD THEORY

Octahedral Complex



Tetrahedral Complex



HIGH SPIN COMPLEX

Δ_0 < Pairing Energy
Ex: $[Cr(NH_3)_6]^{3}+$

LOW SPIN COMLEX

Δ_0 > Pairing Energy
Ex: $[CrCl_6]^{3-}$

COLOUR IN COMPLEX

Caused by d-d transition. Colour is complementary to wavelength absorbed.

SPECTRO CHEMICAL SERIES

$I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < EDTA^{4-} < NH_3 < en < CN^- < CO$

STABILITY

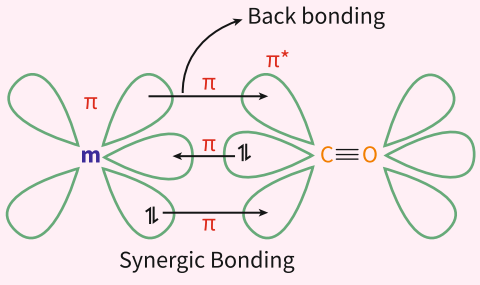
$$M^+ + nL^{x-} \longrightarrow [ML_n]^{y-}$$

$$\text{Stability constant, } K = \frac{[ML_n]^{y-}}{[M^+][L^{x-}]^n}$$

FACTOR AFFECTING STABILITY

- Charge density on the central metal ion.
- Nature of ligands.

METAL CABONYL



metal Carbonyl posses both s and p bond.

USES OF COORDINATION COMPOUNDS

- EDTA is used in estimation of hardness of water.
- Haemoglobin is a coordination compound of Iron.
- Coordination compounds are used in extraction of metals like gold.