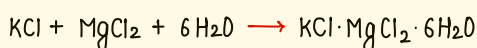


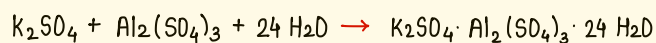
COORDINATION COMPOUNDS SHORT NOTES

Molecular or addition compounds

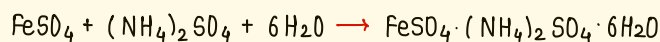
When two or more simple salts are mixed and crystallised then addition compounds are formed.



Carinallite



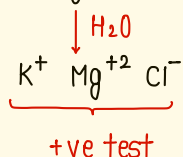
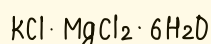
Potash alum



Mohr salt.

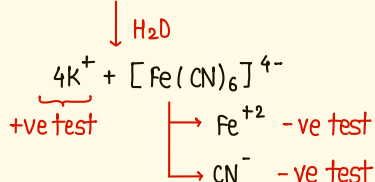
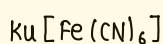
Double salt

Stable in solid state but dissociates in aqueous state.
Give +ve test of all ions.



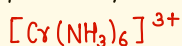
Co-ordination compounds

- stable in Both solid as well as aqueous state.
- Does not give +ve test of its ions.

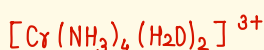


Some important terms

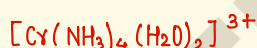
a) **Homoleptic complex** - same type of ligands



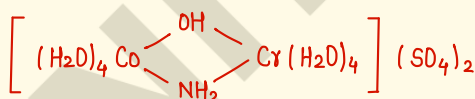
b) **Heterolytic complex** - Different type of ligands



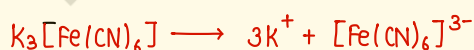
c) **Homonuclear complex** - only one central metal



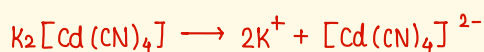
d) **Heteronuclear complex** - more than one central atom.



e) **Perfect complex** - where complex ion is stable.



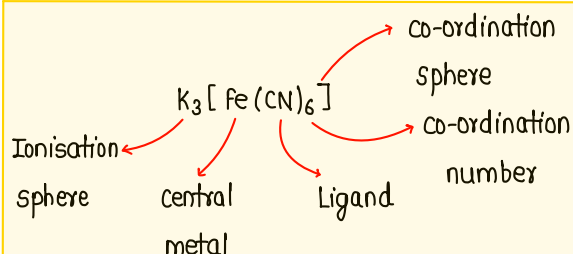
f) **Imperfect complex** - where complex ion is not very stable.



g) **Co-ordination polyhedron** - arrangement of ligand in space.

M - Metal

L - Ligand



Ionisation sphere

Ionisable part

Central metal

accept electron

Lewis acid

Co-ordination sphere

Non-ionisable part

generally d-Block element.

Ligands

electron donors

Lewis Bases

Co-ordination number

Number of lone pair accepted by metal atom/ion.

ML ₂	$\text{L} \rightarrow \text{M} \leftarrow \text{L}$	Linear	C.N = 2
ML ₃	$\begin{array}{c} \text{L} \searrow \\ \text{M} \\ \text{L} \nearrow \end{array} \leftarrow \text{L}$	Trigonal planar	C.N = 3
ML ₄	$\begin{array}{c} \text{L} \nearrow \quad \text{L} \searrow \\ \text{M} \\ \text{L} \searrow \quad \text{L} \nearrow \end{array}$	Square planar	C.N = 4
ML ₆	$\begin{array}{c} \text{L} \\ \text{L} \nearrow \quad \text{L} \searrow \\ \text{M} \\ \text{L} \searrow \quad \text{L} \nearrow \\ \text{L} \end{array}$	Octahedral	C.N = 6

Denticity

Number of lone pairs donated by ligand.

Monodentate — Donates 1 LP

Bidentate — Donates 2 LP

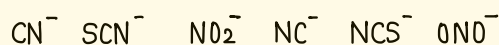
Tridentate — Donates 3 LP

Tetradentate — Donates 4 LP

Pentadentate — Donates 5 LP

Hexadentate — Donates 6 LP

Ambidentate - which have 2 donor site but can donate from 1 site at a time.



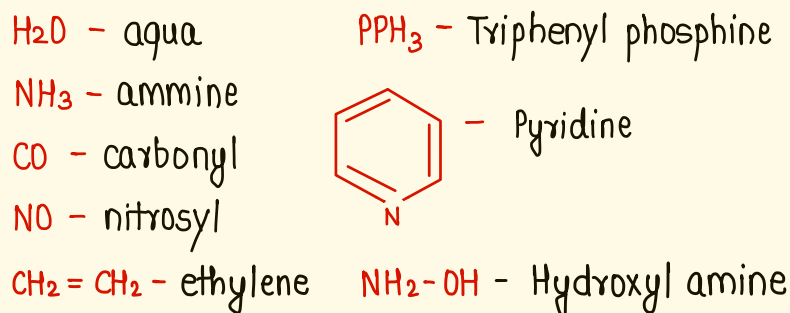
Flexidentate - which can vary denticity



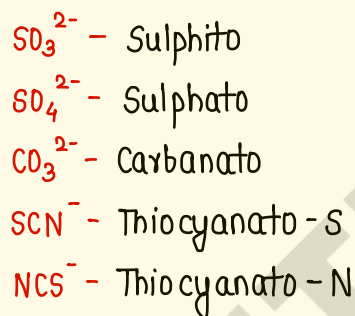
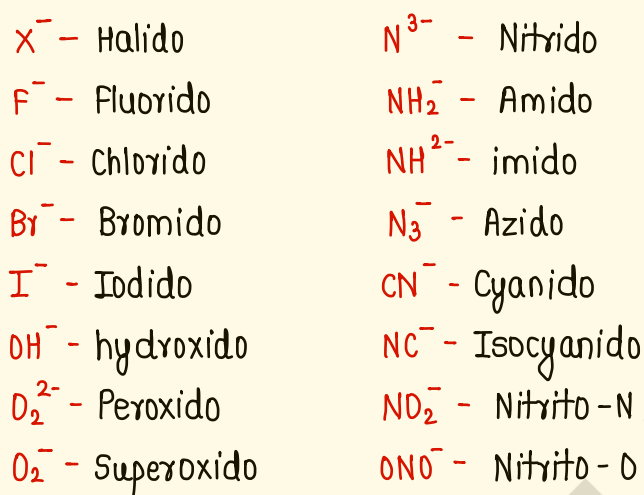
COORDINATION COMPOUNDS SHORT NOTES

Monodentate ligands

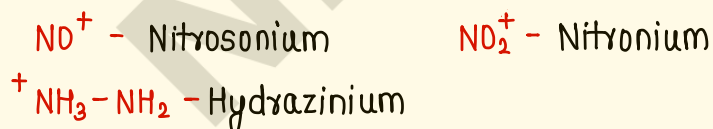
a) Neutral



Anionic

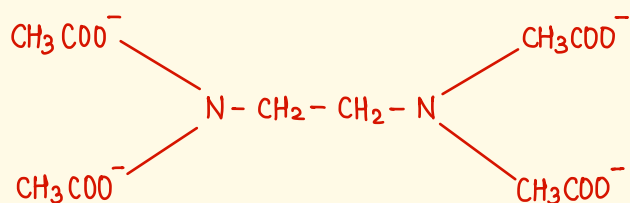


Cationic

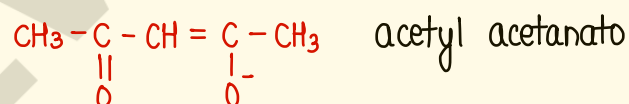
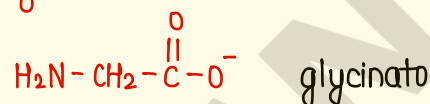
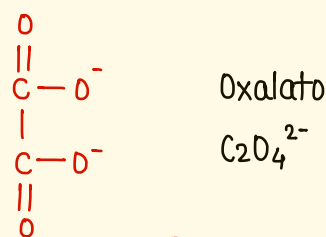
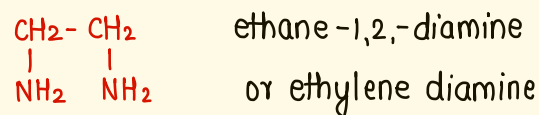


Hexadentate

Ethylene diamine tetra-acetato (EDTA^{4-})



Bidentate



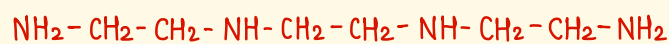
Tridentate

Diethyl triamine



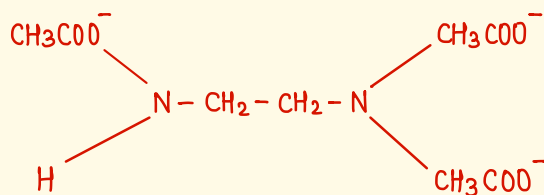
Tetradentate

Triethylene tetramine



Pentadentate

Ethylene diamine tri acetato (EDTA^{3-})



Effective atomic number:

$$\text{EAN} = \text{Atomic number} - \text{Oxidation number} + 2 \times \text{Co-ordination number}$$



COORDINATION COMPOUNDS SHORT NOTES

Chelating ligands

Bidentate or polydentate ligand which can form chelates (ring)

Increases stability of complex

$$\text{Ring stability} \propto \frac{1}{\text{Angle strain}}$$

Angle strain - $3 > 4 > 5 > 6$

Stability - $3 < 4 < 5 < 6$

Ni^{+2} forms scarlet red color complex with Dimethyl glyoxine. - $\text{Ni}(\text{dmg})_2$

Co-ordination number - No. of ligand $\times$ Denticity

Sidgwick EAN Rule :

If EAN is equal to atomic number of next nearest noble gas then that complex is stable.
Applicable mainly for metal carbonyls.

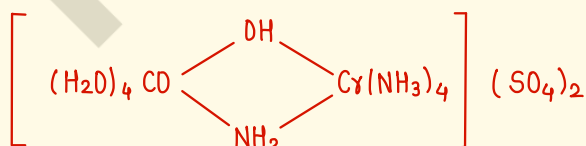
IUPAC Nomenclature :

- Name of cation is written first and then anion.
- While writing complex ion, name of ligand is written first in alphabetical order.
- Prefixes di, tri etc are used.

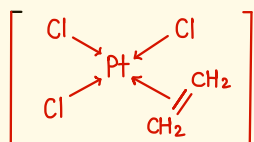
Note : If names of ligands already have words like bi, tri, tetra then we use special words like bis, tris, tetrakis are used.

Some special compounds :

- Tetra aqua cobalt (III) - μ - amido - μ - hydroxido - tetra ammine chromium (III) Sulphate.



- Zeisse's salt $\text{K}[\text{PtCl}_3(\text{n}^2\text{-C}_2\text{H}_4)]$



Naming of the central atom

Metal	Complex is cationic or neutral	Complex is anionic
Cr	Chromium	Chromate
Mn	Manganese	Manganate
Fe	Iron	Ferrate
Co	Cobalt	Cobaltate
Ni	Nickel	Nickelate
Cu	Copper	Cuprate
Zn	Zinc	Zincate
Pd	Palladium	Palladate
Pt	Platinum	Platinate
Ag	Silver	Argentate
Au	Gold	Aurate
Hg	Mercury	Mercurate
Ti	Titanium	Titanate

- Oxidation number of metal is written just after the naming of central atom in roman numbers.

Werner's theory :

- Primary Valency (PV) - Oxidation number
- Secondary Valency (SV) - Co-ordination number

Valence Bond theory :

Ligand donates lone pair to vacant orbital of central metal.

Strong feild ligand :

C and N are donor
Pairing if required - Low spin complex

Weak feild ligand

O and Halogen are donor
No pairing - High spin complex.

Hybridisation

sp - linear
 sp^2 - Trigonal planar
 sp^3 - Tetrahedral $C:N = 4$
 dsp^2 - Square planar $C:N = 4$
 sp^3d^2 - octahedral $C:N = 6$
 Outer orbital complex
 d^2sp^3 - Square planar $C:N = 6$
 Inner orbital complex

Diamagnetic - Colourless

Paramagnetic - Coloured

Dipole moment - $\mu = \sqrt{n(n+2)} \text{ BM}$
 n = unpaired electron



COORDINATION COMPOUNDS SHORT NOTES

Some important points -

Pt, Pd with C.N = 4 always form square planar complex irrespective of ligand.

$[PtCl_4]^{2-}$ — Square planar

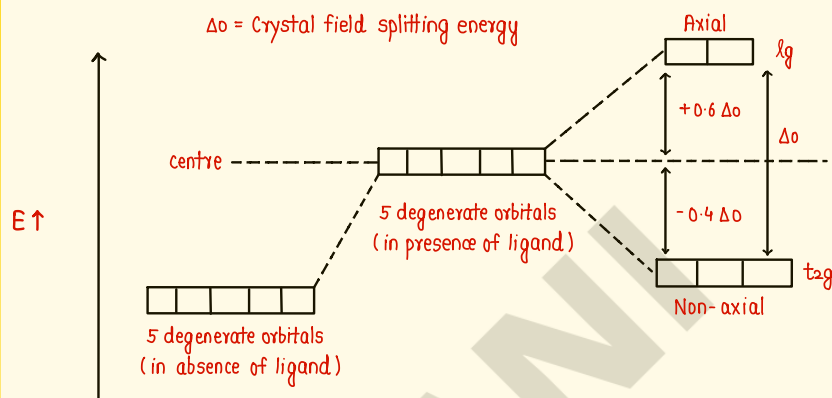
$[Pd(NH_3)_4]^{2+}$ — Square planar

Drawbacks of VBT :

- Doesn't explain colour of compounds
- Doesn't distinguish b/w weak field ligands and strong field ligands.
- Does not give quantitative interpretation of magnetic data.

Crystal field splitting in octahedral complex :

- In octahedral complex, ligands approach towards axis.
- Axial orbitals face more repulsion.



Bonding in metal carbonyls

- Metal and carbon sigma bond is formed by donation of carbonyl carbon into vacant orbital of metal M.
- Metal and Carbon π Bond is formed by sidewise overlapping of M and carbonyl carbon.

Synergic Bonding :

$\left. \begin{matrix} CO \\ CN^- \end{matrix} \right\}$ π -acid ligands

Effect of synergic Bonding :

Metal and carbon - $BD \uparrow = BE \uparrow = BL \downarrow$

Carbon and oxygen - $BD \downarrow = BE \downarrow = BL \uparrow$

- More the -ve charge on metal
More is the synergic bonding.

Crystal field theory :

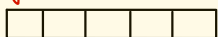
- Interaction b/w metal atom and ligand is purely electrostatic.
- Anionic ligands are considered as -vely point charges and neutral ligands as point dipoles.
- Different d-orbitals face different repulsions and hence lose degeneracy.
- Loss of degeneracy leads to splitting of d-orbitals

Types of d-orbitals :

Non-axial - d_{xy} d_{yz} d_{zx}

Axial - $d_{x^2-y^2}$ d_{z^2}

Degenerate orbitals - Having same energy



Factors affecting CFSE :

a) Oxidation number of central atom



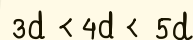
b) Geometry

Octahedral > Tetrahedral

c) Ligand

More the strong field ligand $\rightarrow$ More is CFSE.

d) Transition metal series.



How to calculate CFSE ?

$$CFSE = (x \times +0.6 \Delta_o) + (y \times -0.4 \Delta_o) + np$$

x = No. of electrons in eg orbitals.

y = No. of electrons in t_{2g} orbitals.

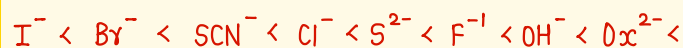
p = pairing energy

n = number of pairs.

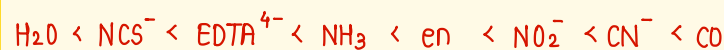
$d^1 d^2 d^3 d^8 d^9 d^{10} \rightarrow$ same for SFL and WFL

$d^4 d^5 d^6 d^7 \rightarrow$ diff for SFL and WFL

Stereochemical series



Ik baar sachin class se farar or oxalate ka



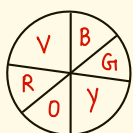
Paani Nachte udta Ammonia in North Canada Columbo se pyaar hue mila

C-Donor > N Donor > O Donor > Halogens

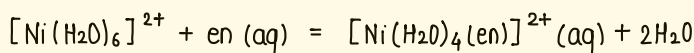


COORDINATION COMPOUNDS SHORT NOTES

Colour of compounds

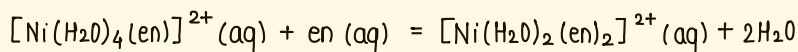


$$CFSE \propto \frac{1}{\lambda_{ab}} \propto \lambda_{em}$$

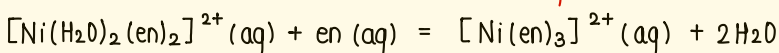


Green

Pale Blue

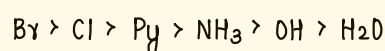
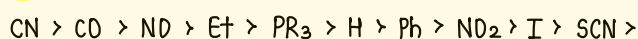


Blue / Purple



Violet

Trans effect:

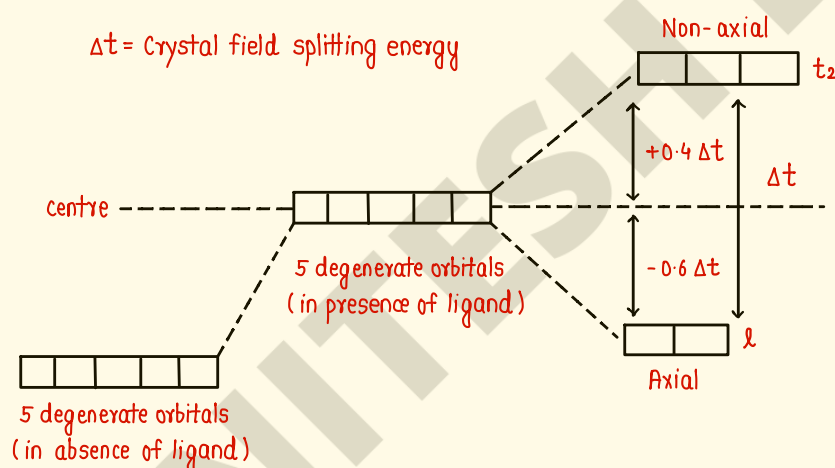


Chelating ligands are more stable than non-chelating ligands complex.

More the ON of central atom more is the stability.

Crystal field splitting in tetrahedral complex

- Ligands approach from b/w the axis.
- Non-axial orbitals face more repulsion.



$$\text{Note: } \Delta t = \frac{4}{9} \Delta O \quad \Delta O > \Delta t$$

- No pairing in tetrahedral complex
- Both for SFL and WFL

Isomerism

Structural

Hydrate

Linkage

Ionisation

Coordination

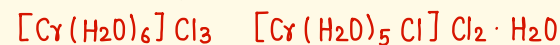
Stereo

Geometrical

Optical

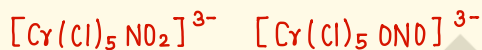
Hydrate isomerism

Water molecules acting as both ligand and water of Crystallisation



Linkage isomerism

Arises when there are ambidentate ligands.



Ionisation isomerism:

Arises when counter ions are different.



Co-ordination isomerism:

Arises when both cation and anion are complex.

In this ligands or central atom is exchanged.



Stereoisomerism

G.I - occurs Because of different angle

O.I - No PDS or No COS.

Terminology - M = metal atom

A B C D E F - Monodentate

AA - Symmetrical Bidentate ligand.

AB - Unsymmetrical Bidentate ligand.

General Formulae

Geometrical isomers

Ma₁bcd₂f

15

Ma₂bcd₂e

09

Ma₂b₂cd

06

Ma₂b₂c₂

05

Ma₃bcd

04

Ma₃b₂c

03

Ma₃b₃

02

Ma₄bc

02

Ma₄b₂

02

Ma₅b

Nil

Ma₆

Nil



Learning Tales



niteshdevnani194



learningtales

COORDINATION COMPOUNDS SHORT NOTES

C.N = 4 Tetrahedral

No GI

OI formed only in M_{ABCD}

C.N = 4 Square planar

No OI

GI Present

MA_4 No GI

MA_3B No GI

MA_2B_2 2 GI

MA_2BC 2 GI

$MABCD$ 3 GI

$M(AA)_2$ No GI

$M(AB)_2$ 2 GI

Cis-platin - $cis [Pt (NH_3)_2 Cl_2]$

→ Anti-cancer.

Wilkinson catalyst - $[Rh (PPh_3)_3 Cl]$

→ Hydrogenation of alkene

Stability and dissociation constant:

$$\text{Dissociation constant} = \frac{1}{\beta}$$

$$\beta = K_1 \times K_2 \times K_3$$

→ stability constant
Higher the value of β = More stable is complex.

Optical isomerism

Case - I - Monodentate ligand

x = Total diff. monodentate ligand

$x \geq 3$ always optically active

Except MA_4bc

MA_4b_2 $x = 2$ Inactive

MA_5b $x = 2$ Inactive

$MA_2b_2c_2$ $x = 3$ active

MA_4bc $x = 3$ Inactive

MA_3b_2c $x = 3$ active

Case 2: Bidentate

Total rings ≥ 2 — optically active
except trans - $[M(AA)_2 B_2]$

$M(AA)_3$ — Active

$M(AB)_3$ — Active

$[Co(en)_3]^{3+}$ — Active

$[Cr(gly)_3]^{3+}$ — Active

Cis - $[M(AA)_2 B_2]$ — Active

Cis - $[Co(AA)_2 B_2]$ — Active

Trans - $[M(AA)_2 B_2]$ — Inactive

Trans - $[Co(C_2O_4)_2 Cl_2]$ — Inactive

