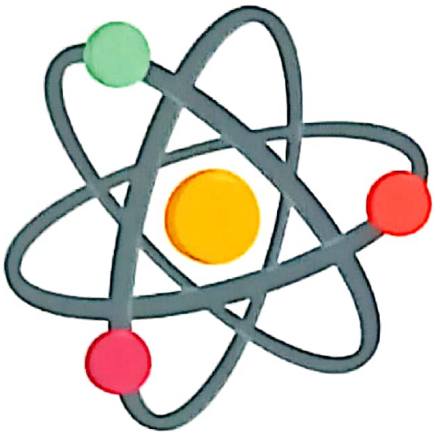
VICTORY ZONE CLASSES



CHEMISTRY

ESTD 2016
VICTORY ZONE
VZ

CLASS :- XII

VICTORY ZONE CHEMISTRY CLASSES

ADDRESS – 1ST FLOOR PRADEEP PLAZA, IN FRONT OF CHOPRA PALACE , ADARSH NAGAR DURG

MO 9424168056,8269055301

CHAPTER SCHEDULE

COORDINATE COMPOUNDS

29 JULY 2025 TO 24 AUGUST 2025

S. NO	CLASS DETAIL	TOPICS DETAILS	CHECK LIST
1.	LECTURE NO. 1	BASIC DEFINITIONS	
2.	LECTURE NO. 2	IUPAC NAME 30Q	
3.	LECTURE NO. 3	SADWICK, WERNER, 30Q	
4.	LECTURE NO. 4	VBT 20Q	
5.	LECTURE NO. 5	MAGNETIC, COLOR, OTHER PROPERTY 20Q	
6.	LECTURE NO. 6	ISOMERISM, STRUCTURE 20Q	
7.	LECTURE NO. 7	ISOMERISM, STEREO 20Q	
8.	LECTURE NO. 8	CFT THEORY	
9.	LECTURE NO. 9	CFT 20Q	
10.	LECTURE NO. 10	CFT 20Q	
11.	LECTURE NO. 11	APPLICATION OF COORDINATE COMPOUNDS	
12.	LECTURE NO. 12	BOARDS PYQS DISCUSSION	
13.	LECTURE NO. 13	COMPLETE CHAPTER QUESTIONS PYQS	
14.	LECTURE NO. 14	SELF ANALYSIS PAPER IN CLASS	
15.	TEST NO. 9	23/08/2025 MCQS 30Q MM:120 (YOUR MARKS)	
16.	TEST NO. 10	24/08/2025 THEORY 16Q MM:30 (YOUR MARKS)	
17.	HOME WORK	NUMBER OF QUESTION DONE BY YOUR SELF	
18.	HOME WORK	NCERT BOOK READING & BACK QUESTIONS	

[CHAPTER - 06]

COORDINATE COMPOUNDS

The Concept of Coordination Compound arrise From the complex Formation tendency of transistion Element.

This Compounds also play a vital role in our life Example - Haemoglobin and Chlorophyll Both have Fe and Mg respectively in the co-ordinate Sphere.

Types of Compounds

1) Double Salt

This type of Addition Compound loose their Identity in aqueous Solution in Aqueous Solution and get completely Ionized in H_2O

Example - Potassh Alum

$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$

$+(aq)$

$\rightarrow 2K^+ + SO_4^{-2}{}_{(aq)} + 2Al^{+3}{}_{(aq)} + 3(SO_4)^{-2}{}_{(aq)} \cdot 24H_2O$

2) COORDINATE OR COMPLEX COMPOUND

The molecular are addition compound which retain their identity in aqueous solution is called COMPLEX SALT.

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

On the Basis types of Ligands complex compound are divided as follow :-

→ Homo Leptic

Complex In which all ligands are identical is called Homoleptic compounds. / complex

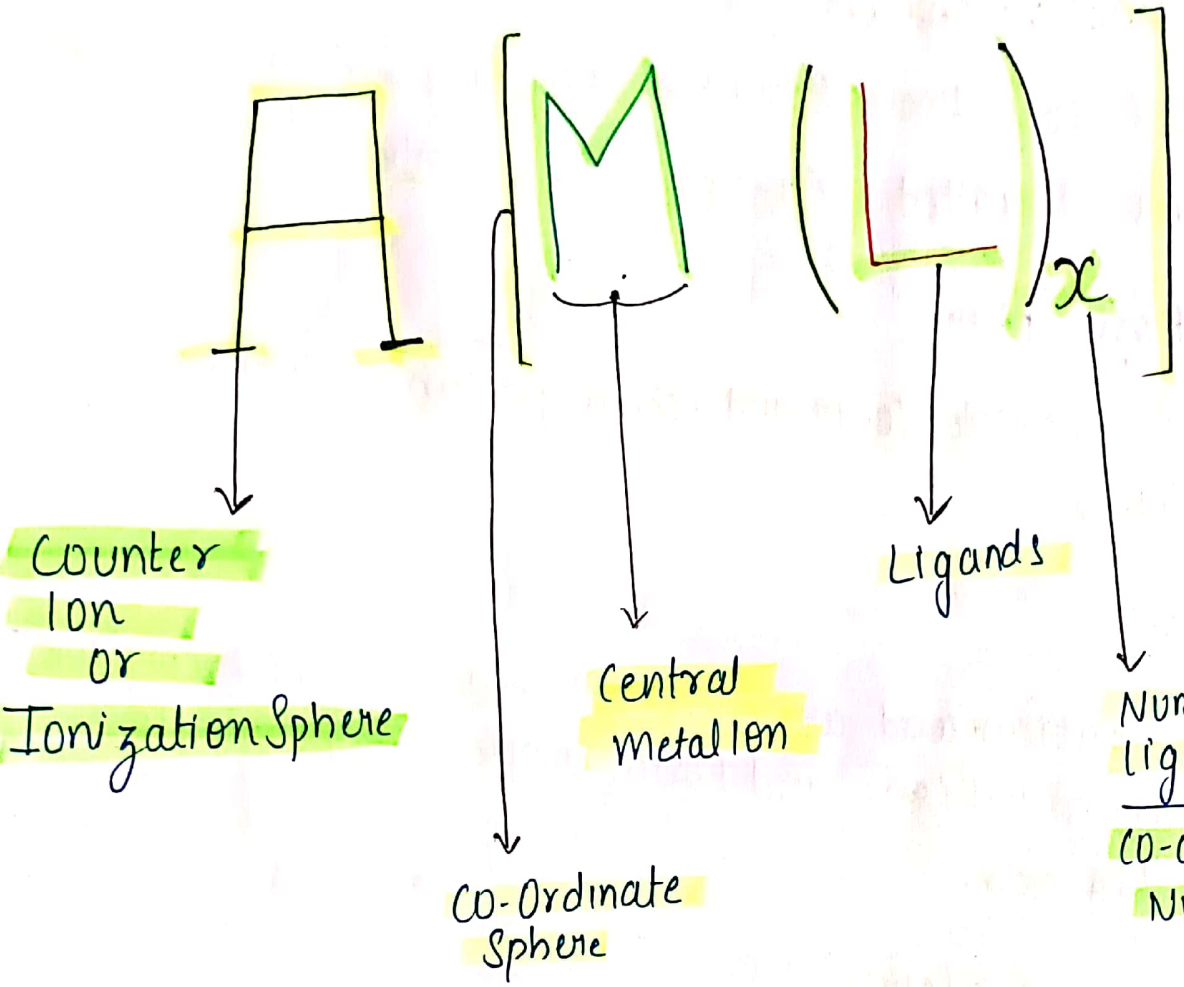
Example - $K_4[Fe(CN)_6]$

→ Hetroleptic

Complex in which all ligands are non identical is called Hetroleptic compound

Example $[Fe(en)_2Cl_2]$

→ IUPAC REPRESENTATION OF COORDINATE COMPOUND



① Complex Ion / Co-ordinate Sphere

An agreegate of metal ion with anian, cation or neutral molecule is called as complex ion.

It is a non-ionisable part of complex compound.

② Central metal Ion

The metal ion in which form complex Ion in combination with anian, cation and neutral atom is called central metal ion.

Central Metal ion act as electron pair acceptor and forms Co-ordinate Bond with Donor Species.

Generally They are d-block Elements and they have lots of Vacant Space in their d-orbital.

③ Co-ordination Number

The Number of Co-ordinate Bond Formed by any central atom with donor Species is called Co-ordination Number

④ Ionisation Sphere

The Part of Complex Compound which get Ionize is known as IonizationSphere.

⑤ Ligands

The anian catian are neutral molecules which combine with Central metal ion and Form Complex compounds / Ions. is called Ligands.

All the Ligands are lewis Base.

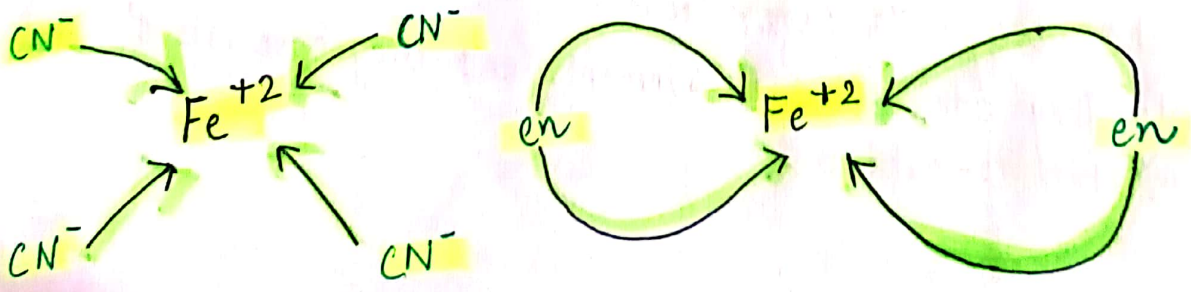
Number of Electron pair donated by any atom or ligand is called It's "Denticity".

Chelation

It is the Chemical Process in which molecules [Chelating agent] Binds to a metal Ions and forming a ring like Structure is called "Chelation".

All Bidentate and polydentate can Form Chelation

MonoDentate cannot Form Chelate.



IUPAC

International Union of Pure and Applied Chemistry

Cation + Anion

[ ]

$K_4[Fe(CN)_6]$

Bidentate

Bis, Tris, Tetrakis, Pentakis

Writting form

Number of ligand + Name of ligands + Name of central metal ion + Oxidation Number of central metal ion and [Romen Number with Bracket Denoted By ( )]

Ex- mono, di, Tri

IF [ ]$^-$ → Anian part

Suffix :- ate and Name will be in latin

$4K^+ + [Fe(CN)_6]^{-4}$ → anian

Fe - Iron → Ferrate (ate, latin)

Ag - Silver → argentate

Ni - Nickel → nickelate

Au - gold → Aurate

2 - II

3 - (III)

Oxidation Number

↓

Central atom

↓

Primarary Valency

↓

Calculation of x

→ By solving the linear equation with one variable

Coordinate Number

↓

central atom

↓

Secondary Valency

↓

= Calculation of Co-ordinate number

= number of ligand × Denticity

$[Fe(en)_2]Cl_2$

$[Fe(en)_2]^{+2} + 2Cl^-$

$x + 0 \times 2 = 2$

1) $x = 2$ is Oxidation Number

Co-ordinate Number

en

C.N.O. = Denticity × No. of ligands

C.N.O. = $2 \times 2 = 4$

#

en → charge = 0

↳ Denticity = 2

O^{-2} → charge = −2

↳ Denticity = 2

$(EDTA)^{-4}$ → charge = −4

↳ Denticity = 6

$K_4[Fe(CN)_6]$

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

$x - 1 \times 6 = -4$

$x = 2$

Oxidation No. = 2

Co-ordinate No. = 6

Name → Pottasium hexa cyano Ferrate (II)

$[Cr(NH_3)_6]Cl_3$

$[Cr(NH_3)_6]^{+3} + 3Cl^-$

$x + 0 \times 6 = 3$

$x = +3$

[ ]$^+$ the an ~~ate~~ will not use

Oxidation No. = +3

Co-ordinate No. = 6

Name

[Hexa ammine cromium(III) chloride]

Most Imp $K_2[Fe(CN)_2.(NH_3)_2 Cl NO_2]$

$2K^+ + [Fe(CN)_2(NH_3)_2 Cl NO_2]^{-2}$

alphabetical order: Fe, (CN)$_2$, (NH$_3$)$_2$, Cl, NO$_2$

Fe → x, CN → cy, NH$_3$ → a, Cl → ch, NO$_2$ → N

$x - 1 \times 2 + 0 \times 2 - 1 - 1 = -2$

$x = +2$

Coordinate = 6

Oxidation No. = +2

Pottassium diammine chloro dicyano nitro ferrate (II)

$[Cr(CO)_6]$

$x + 0 \times 6 = 0$

$x = 0$

$C_{No.} = 6$

$O_{No} = 0$

Hexa Carbonyl chromium (0)

$[Fe(NH_3)_6][Fe(CN)_6]$

let us assume

$[\quad]^{+1}$ $[\quad]^{-1}$

$x + 0 = +1$

Fe $x = +1$

$x - 6 = -1$

$x = 5$

$[\quad]^{+2}$ $[\quad]^{-2}$

$x + 0 = 2$

$x = 2$

$x - 6 = -2$

$x = +4$

$[\quad]^{+3}$ $[\quad]^{-3}$

$x + 0 \times 6 = 3$

$x = +3$

$x - 1 \times 6 = 3$

$x = 3$

Hexa ammine iron (III) hexa cyano ferrate (III)

Cation Anion

WERNER'S THEORY

According to him primary valency and Secondary valency, There are two valencies of co-ordinate compound

1) Primary valency

They are main valency of any central atom which is the real or oxidation number. or real valency of central atom

2) Secondary valency

They are the co-ordination number of any central atom

Secondary valency = Denticity × Number of ligands.

25 Stars only for Boards.

Difference Between

Primary Valency	Secondary valency
1) This is Oxidation Number	This is co-ordinate Number
2) It can balenced by negative charge.	It can balenced by negative, positive or neutral Charge
3) It can be ionizable.	It cannot be ionizable.
4) It is Non-directional	It is directional There Geometry are fixed.
5) We can't predict the geometry of molecule.	
6) Denoted By Dash line	Denoted By Solid line.

Number of Chelate Ring = Dentisity − 1

* This is only valid for Polydenate ligand.

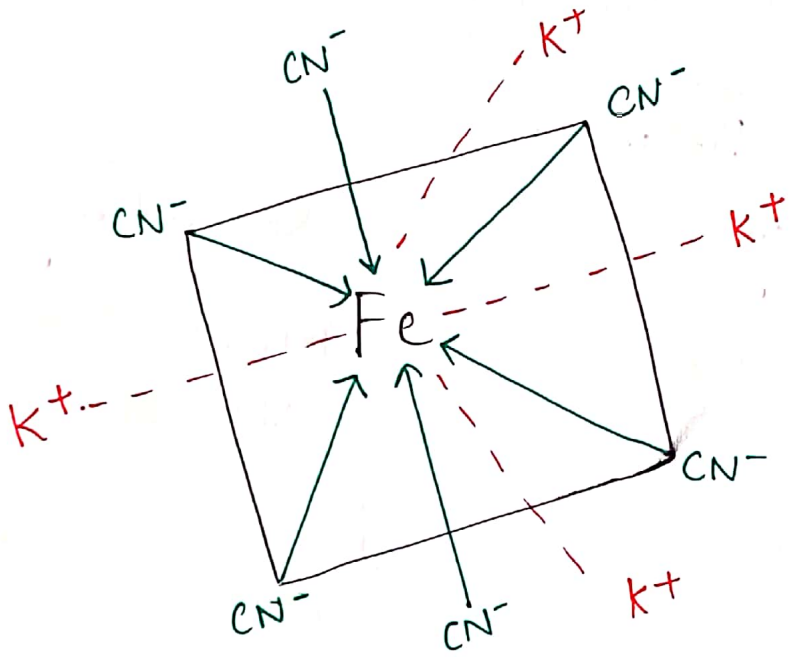
$$K_4[Fe(CN)_6] \longrightarrow 4K^+ + [Fe(CN)_6]^{-4}$$

$x - 1 \times 6 = -4$

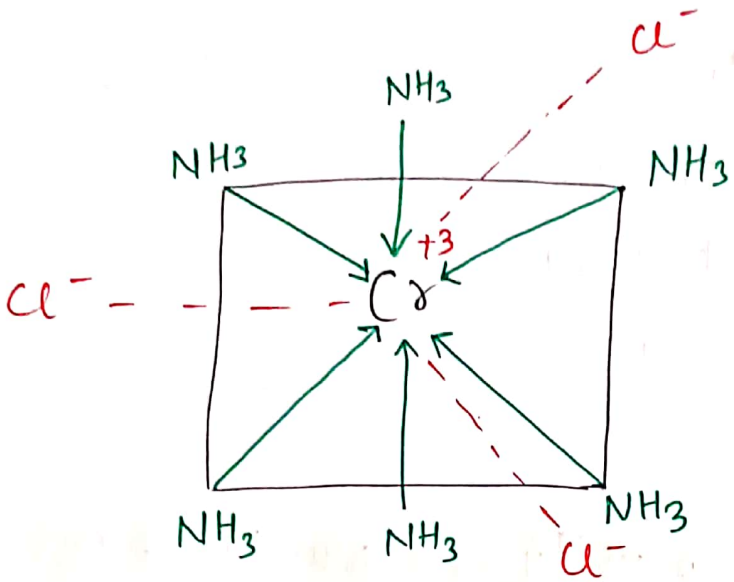
Primary valency $x = 2$

Secondary valency $6 \times 1 = 6$

PV = 2 SV = 6



$[Cr(NH_3)_6]Cl_3$



* Ionization Water

$$[\quad] \xrightarrow{\text{water}} [\quad]_{(aq)}$$

$Co(NH_3)_4Cl_4 + AgNO_{3(aq)} \longrightarrow$ 2 mol of AgCl (↓)

white ppt

Oxidation Number = 4

$[Co(NH_3)_4Cl_2]Cl_2$

{ Tetraammine dichloro cobalt (IV) Chloride }

Pg 150 Book - 2 Black cover

$[Fe(NH_3)_4Cl_2]Cl$ Tetraammine dichloro iron (III) chloride.

Oxidation Number = Fe = +3

$[Fe(NH_3)_4Cl_2]^+ + Cl^-$

$x + 0\times4 - 1\times2 = +1$

$x = +3$

* Electrical Conductivity $\propto$ Number of ions

				Ion
A)	$COCl_3 \cdot 6NH_3$ (1 mole)	$\xrightarrow[(Aq)]{AgNO_3 \text{ excess}}$	3 mol of AgCl $\rightarrow [CO(NH_3)_6]Cl_3$	4
B)	$COCl_3 \cdot 5NH_3$ (1 mole)	$\xrightarrow[(Aq)]{AgNO_3 \text{ excess}}$	2 mol of AgCl $\rightarrow [CO(NH_3)_5Cl]Cl_2$	3
C)	$COCl_3 \cdot 4NH_3$ (1 mole)	$\xrightarrow[(Aq)]{AgNO_3 \text{ excess}}$	1 mol of AgCl $\rightarrow [CO(NH_3)_4Cl_2]Cl$	2
D)	$COCl_3 \cdot 3NH_3$ (1 mole)	$\xrightarrow[(Aq)]{AgNO_3 \text{ excess}}$	0 mol of AgCl $\rightarrow [CO(NH_3)_3Cl_3]$	1

Decreasing Order

$[CO(NH_3)_6]Cl_3 > [CO(NH_3)_5Cl]Cl_2 > [CO(NH_3)_4Cl_2]Cl > [CO(NH_3)_3Cl_3]$

* SADWICK RULE

According To Sadwick

"Every Co-ordinate compound have Effective Atomic Number"

EAN = Number of e^- in Central atom at ground state − PV + 2SV

→ $K_4[Fe(CN)_6]$

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

$x - 1\times6 = 4$

$x = +2$

PV = 2

SV = no. of ligand × denticity

SV = $6\times1 = 6$

EAN = $26 - 2 + 2\times6$

EAN = 36 [Stable]

→ $[Cr(NH_3)_6]Cl_3$

PV = 3 SV = 6

EAN = $24 - 3 + 2\times6$

EAN = 21 + 12

EAN = 33 [Unstable]

IF EAN = Atomic Number of Noble gas It is Stable

Ne - 10
Ar - 18
Kr - 36
Xe - 54
Rn - 86

Compound

Atomic No. of compound

PV

SV

1) $K_3[Fe(CN)_6]$

26

3

6

$x - 6 = 3$

$x = 3$

EAN

$26 - 3 + 2(6)$

$= 26 - 3 + 12$

$= 23 + 12$

$= 45$

Stability

Unstable

2) $K_2[PtCl_4]$ $Z = 78$

$x - 4 = 2$

$x = 2$

PV = 2

SV = 4

Stability

Unstable

EAN

$78 - 2 + 2(4)$

$76 + 8$

EAN = 84

3) $[Co(NH_3)_6]Cl_3$ $Z = 27$

$x + 0 \times 6 = +3$

$x = +3$

$x = +3$

PV = 3

SV = 6

Stability = Stable

EAN = $27 - 3 + 2(6)$

EA = $24 + 12$

$= 36$

Valence Bond Theory

According to the VBT the overlapping of the central atom and ligand in the process of overlapping half filled and full filled, all type of orbital can participate.

The Hybridisation depend upon the number of co-ordinate number.

The ligand and central atom form co-ordinate bond in the presence of weak field and Strong field ligand.

* Given By Pauli.

Example- $K_4[Fe(CN)_6]$ CN = 6

$K_2[Ni(CN)_4]$ CN = 4

In the presence of Strong filled ligand the Orbital Supermise its energy or excited/Splitted. Due to this energy gap electrons get paired in the presence of Strong filled ligand.

Spectrochemical Series for weak filled and Strong filled ligand are as below:-

Exception Exception

$I^- < Br^- < [SCN^-] < Cl^- < S^{-2} < F^- < OH^- < C_2O_4^{-2} < H_2O < [NCS^-]$

$< (edta)^{-4} < NH_3 < en < CN^- < CO$

→ Strong field ligand

→ weak field ligand

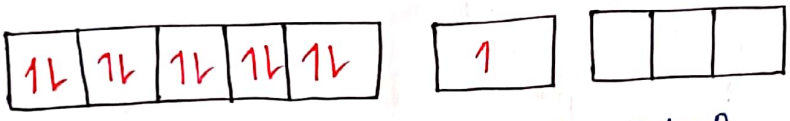
* Shape of Orbitals

See Victory zone Page NO- 11 to 13.

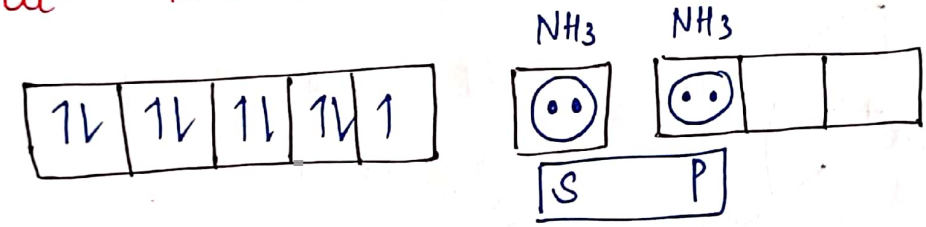
1) $[Cu(NH_3)_2]Cl_2 \rightarrow [Cu(NH_3)_2]^{+2} + 2Cl^-$

$Cu = +2$

Cu in ground state $- 3d^{10} 4s^1 4p^0$

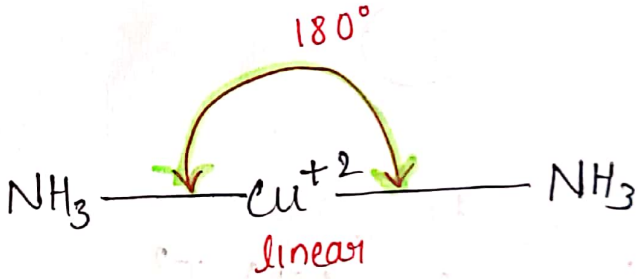


Cu^{+2} - in excited state $- 3d^9 4s^0 4p^0$



Hybridization - Sp

Shape - linear Angle - 180°.



Paramagnetic :- Magnetic behaviour

μ = Magnetic Behaviour

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

$\mu = \sqrt{1(1+2)} = \sqrt{3}$ BM

Colour - Colourfull.

(2) $(ZnI_3)^-$

$x - 1\times3 = -1$

$x = +2$

$Zn \Rightarrow 3d^{10}\ 4s^{02}\ 4p^0$

Ground state

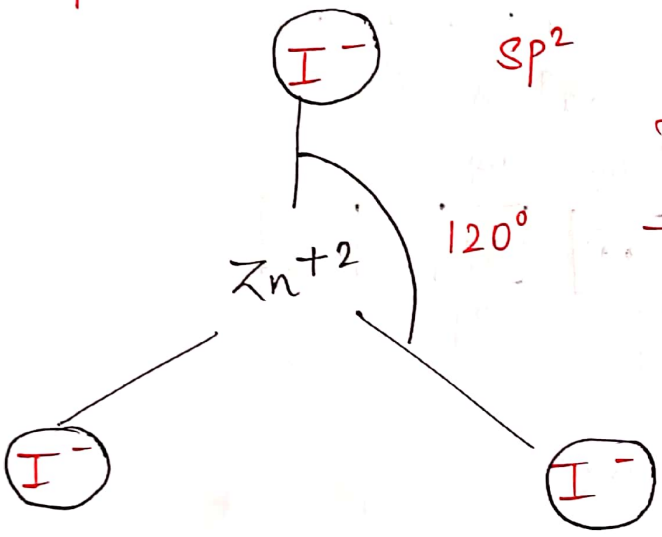
$Zn^{+2} \Rightarrow$ 

Excited

$3d^{10}\ 4s^0\ 4p^0$

S P·P

Shape



sp^2

Trigonal Planar

→ Magnetic :- Diamagnetic

→ Colorless.

(3) Sstar

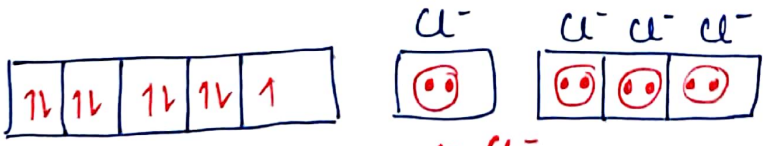
$[Cu(Cl)_4]^{-2}$

$\downarrow$

Cu^{+2}

$Cu_{G.S.} \rightarrow 3d^{10}\ 4s^1\ 4p^0$

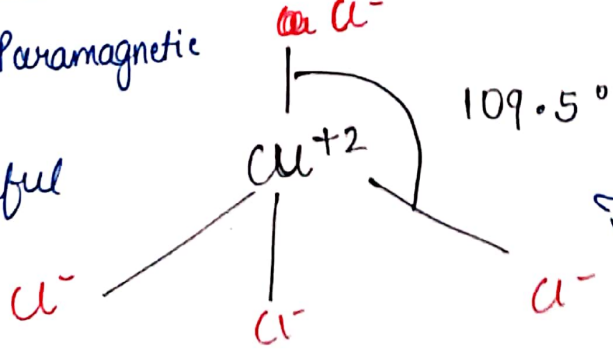
$Cu^{+2}_{E.S.} \rightarrow 3d^9\ 4s^0\ 4p^0$



→ Magnetic :- Paramagnetic

→ $\mu = \sqrt{3}$ BM

→ Colour - Colorful



109.5° or 109°28'

Tetrahedral

(4) 50 Stars

$[Cu(NH_3)_4]Cl_2$

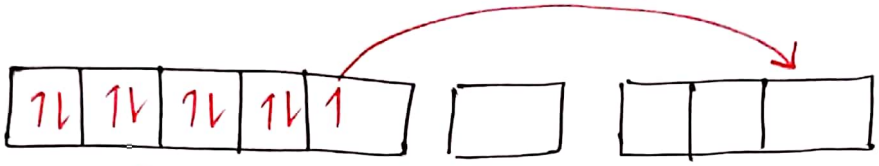
NH_3 Strong field ligand

Ground State :- $Cu - 3d^{10}\ 4s^1\ 4p^0$

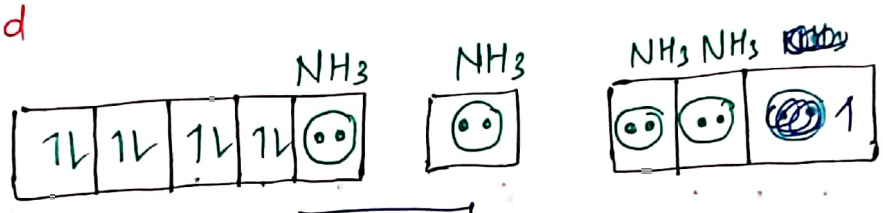
Cu^{+2}

Excited State :- $3d^9\ 4s^0\ 4p^0$

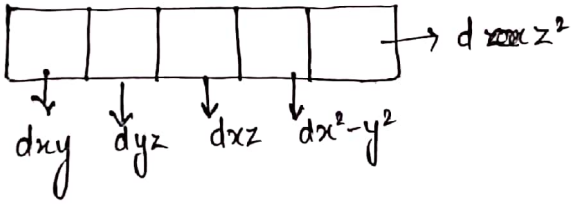
Cu^{+2} without ligand

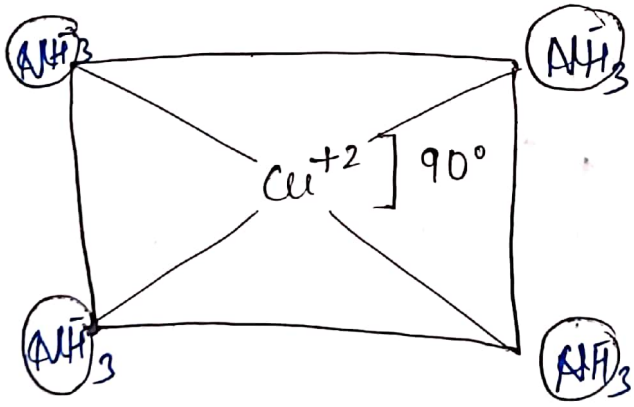


Cu^{+2} with Strong field ligand



dsp^2





Square Plane

Paramagnetic

$\mu = \sqrt{3}$ BM

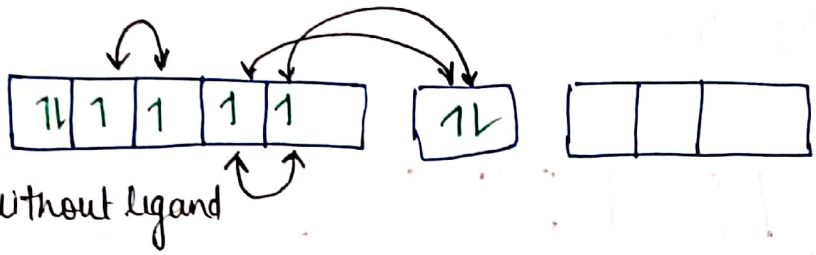
Colorfull.

(5) 100 stars

$[Fe(CO)_5]$

$x = 0$

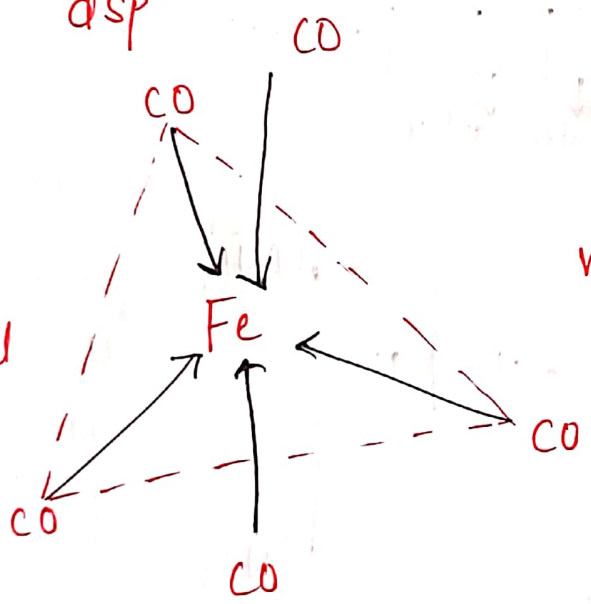
$Fe = 3d^6 4s^2 4p^0$



Without ligand

with ligand

dsp^3



Shape

Trigonal

Bipyramidal

Angle - 90° - 120°

magnetic - diamagnetic

colour - colourless

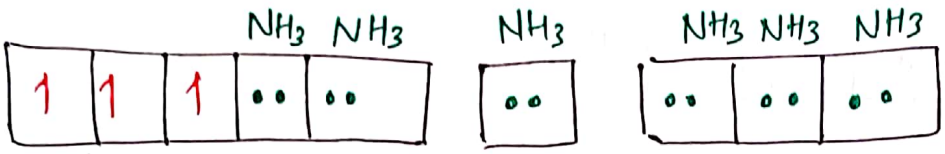
(6) 100 Stars

$[Cr(NH_3)_6]^{+3}$

* NH_3 strong field ligand

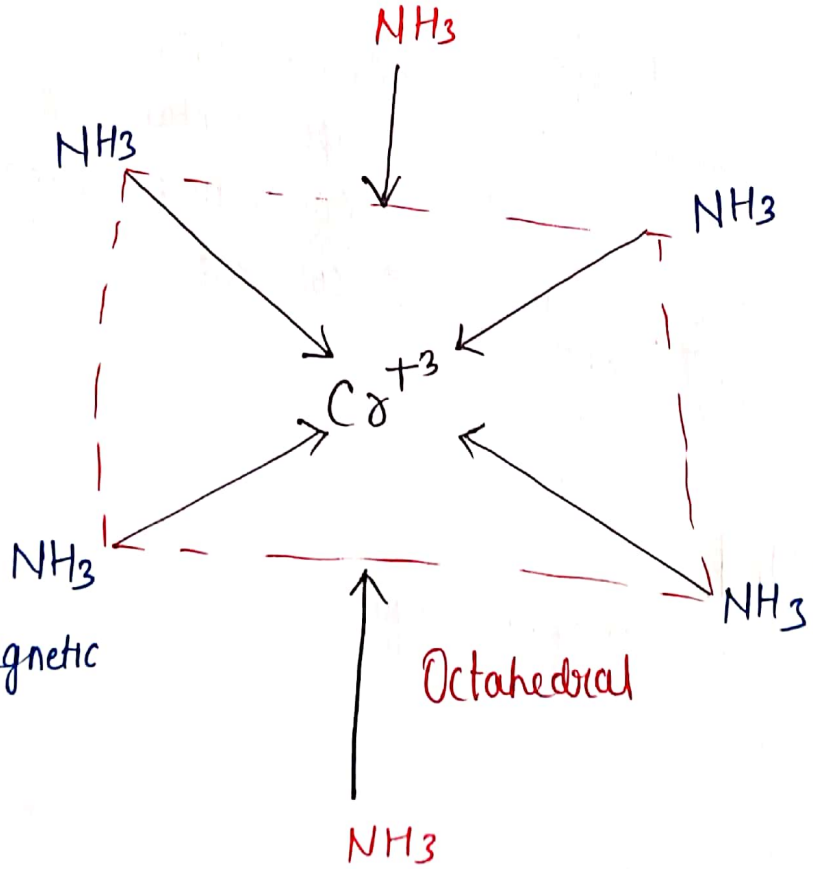
$Cr = 3d^5\ 4s^1\ 4p^0$

$Cr^{+3} = 3d^3\ 4s^0\ 4p^0$



With ligand
Without ligand } d^2sp^3

Shape



Octahedral

magnetic - Paramagnetic

$\mu = \sqrt{15}$ BM.

Color - Colorfull.

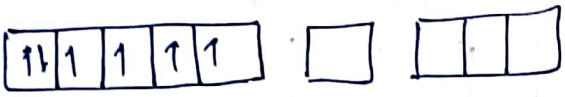
* VBT

1) $K_4[Fe(CN)_6]$

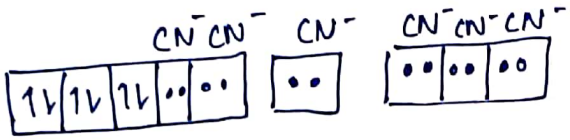
$Fe = +2$ CN^- is strong field ligand.

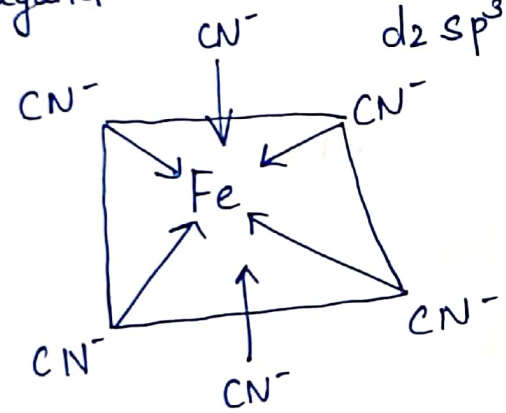
$Fe \rightarrow 3d^6\ 4s^2\ 4p^0$

$Fe^{+2} \rightarrow 3d^6$

Fe^{+2} :- 

Without ligand

Fe^{+2} with ligand :- 



d_2sp^3

→ Angle - 90°
→ Shape - Octahedral
→ Magnetic :- Diamagnetic
→ Colorless.

2) $K_3[Co(Cl)_6]$

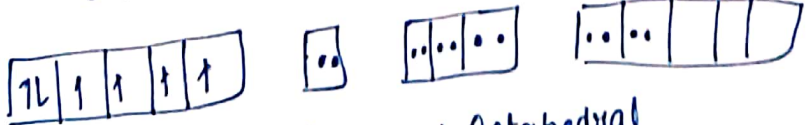
$Co = +3$ Cl^- is strong field ligand

$Co_{27} - 3d^7\ 4s^2\ 4p^0\ 4d^0$

$Co^{+3} = 3d^6\ 4s^0\ 4p^0\ 4d^0$

Co^{+3} : 

Without ligand

Co^{+3} :- 

With ligand

Hybridisation :- sp^3d^2

→ Octahedral
→ Magnetic :- Paramagnetic
$\mu = \sqrt{24}\ BM$ $n = 4$
* Colorful.

3) $[Zn(NH_3)_6]Cl_2$

$Zn \rightarrow 3d^{10}\ 4s^2\ 4p^0\ 4d^0$

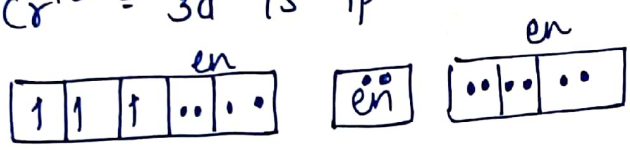
$Zn^{+2} \rightarrow 3d^{10}\ 4s^0\ 4p^0\ 4d^0$ → Hybridisation :- sp^3d^2

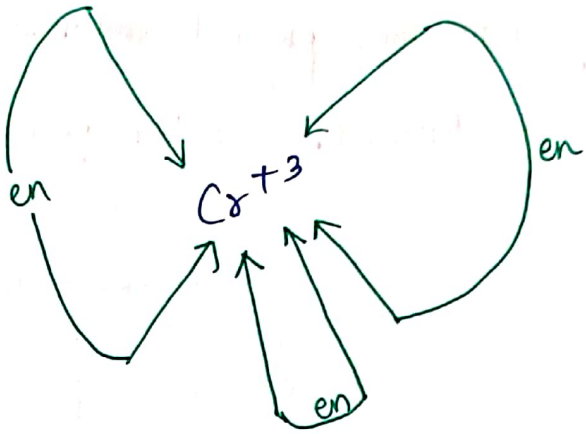
* en give 2 lonepair

4) $[Cr(en)_3]Cl_3$

$Cr = 3d^5\ 4s^1$

$Cr^{+3} = 3d^3\ 4s^0\ 4p^0$





magnetic :- Paramagnetic $= \sqrt{15}$ BM

colorfull.

* Drawback of VBT

① What is the reason that e^- get paired in the presence of strong field ligand.

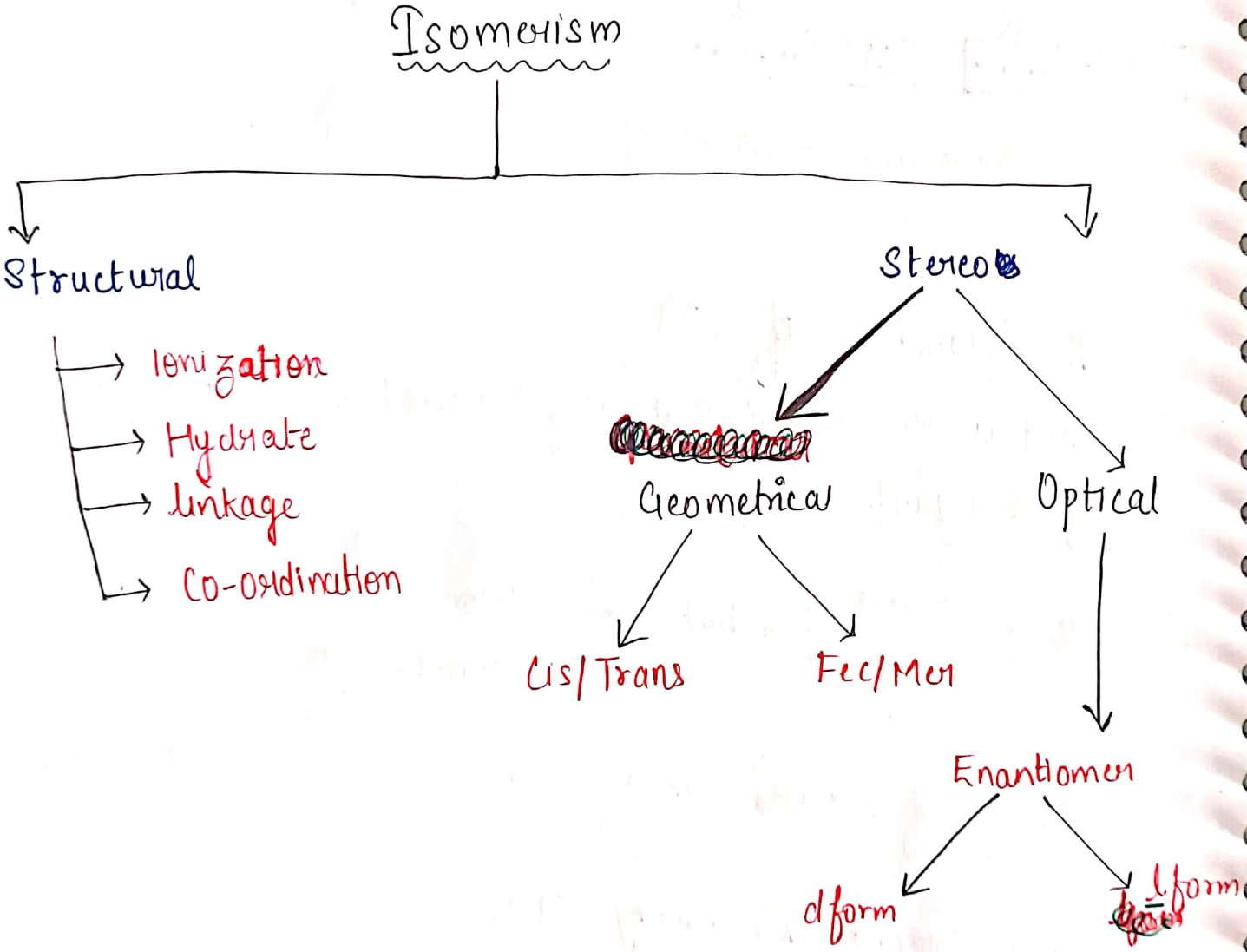
② color → less, full → but which color and what is its wave length

③ Spliting of d-orbital in t_{2g} and e_g reason not explained

→ This Drawback is resolved by CFT.

ISOMERISATION

Isomer :- Compound which have the same molecular formula but different in their physical and chemical properties. due to the difference in their Structure. and the phenomenon is known as Isomerisation.



Structural Isomer — Same formula but different structure.

① Ionization

$Cu(NH_3)_5ClSO_4$

$[Cu(NH_3)_5Cl]SO_4$
Red Violet

$[Cu(NH_3)_5Cl] + SO_4^{-2} + BaCl_2$

$BaSO_4$ (↓) white ppt.

$[Cu(NH_3)_5SO_4]Cl$
Red

$[Cu(NH_3)_5SO_4] + Cl^- + BaCl_2$ — No Rxn

$AgNO_3 \rightarrow AgCl$ white ppt

Example - ① $[Pt(NH_3)_4Cl_2]Br_2$ & $[Pt(NH_3)_4Br_2]Cl_2$

② $[CO(NH_3)_4(NO_3)_2]SO_4$ and $[CO(NH_3)_4SO_4](NO_3)_2$

Compound have same Molecular formula but give different type of ions in their aqueous solution are known as "Ionisation Isomer".

Due to the Exchange of ions between Co-ordinate Sphere and Ionisation Sphere that is called as "Ionisation Isomer".

→ Hydrate Isomer

This type of Isomer is due to presence of different number of ions, water molecules inside the co-ordinate sphere.

Example :- $Cr(H_2O)_6Cl_3$

→ $[Cr(H_2O)_6]Cl_3$ → violet

→ $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$ → green

→ $[Cr(H_2O)_4Cl_2]Cl \cdot 2H_2O$ → dark green

→ $[Cr(H_2O)_3Cl_3] \cdot 3H_2O$ → Red.

→ Linkage Isomers

This type of Isomer arise due to the presence of Ambidentate ligands.

This ligand have two donor atoms but at a time only one atom is directly linked with central Metal atom of complex.

In NO_2^- $-O-\ddot{N}=O$

Brown → $[Co(NH_3)_5 N\ddot{O}_2]Cl_2$ (→ donor atom)

Green → $[Co(NH_3)_5 O\ddot{N}O]Cl_2$ (→ donor atom)

→ Co-ordinate Isomer

This type of isomer exhibit when in complex compound both Cation and anion are present in co-ordinate complex.

$[Co(NH_3)_6]\ [Cr(Cl)_6]$

⇌

$[Cr(NH_3)_6]\ [Co(Cl)_6]$

Co → [ ]$^+$ & NH_3

Cr → [ ]$^-$ & Cl^-

Cr → [ ]$^+$ & NH_3

Co → [ ]$^-$ & Cl

To find Total No. of Isomer

Number of Isomer

[ ] [ ] Both [ ] have Same central atom then no. of isomer = $\frac{CN}{2}$

Both [ ] have different atom then no. of isomer = Co-ordinate Number.

DPP-10

1) Opt 1

2) Isomer CN = 4

3) $[Co(NH_3)SO_4]Br$] → Ionisation

$[Co(NH_3)Br]SO_4$

4) Opt (2) NH_3 NO_2 ✓

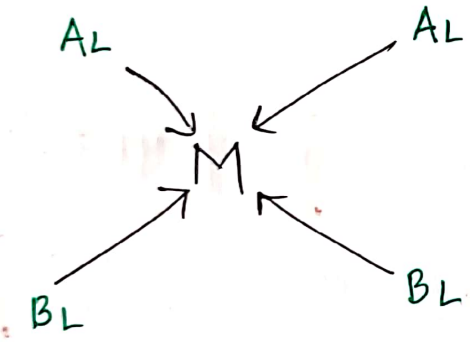
5) [ ]H_2O [H_2O] Hydrate.

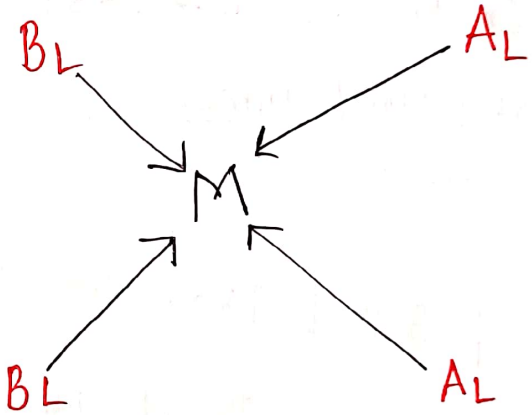
* Geometrical Isomer

That have Same molecular formula but different with respect to spactial orientation of Ligand in Space around metalion. is called Stereo Isomer.

Due to the change in releative position of ligand around the centralion, different forms are obtained is called Geometrical Isomer.

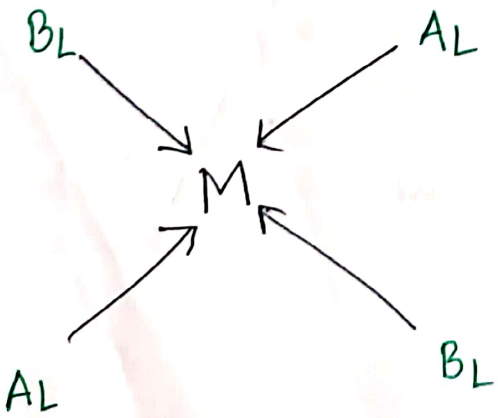
CIS - ISOMER



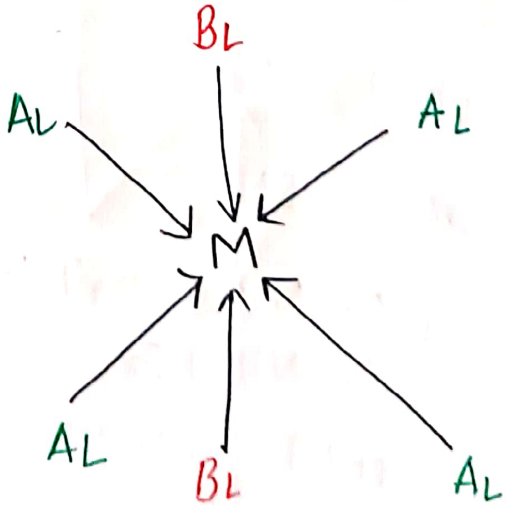


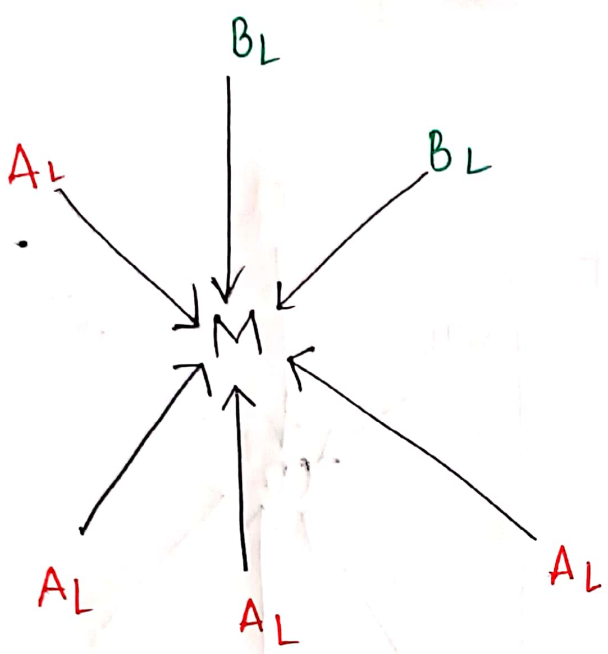
Co-ordination no. = 4

TRANS - ISOMER



Co-ordination = 6

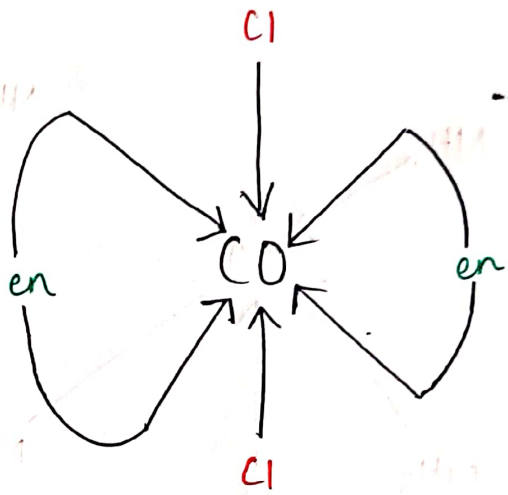




cis - Isomer

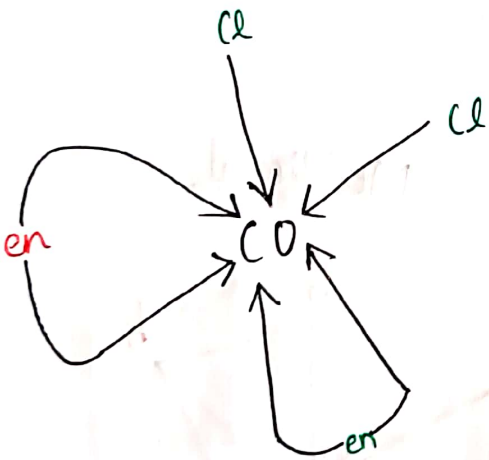
Example $CN = 6$

$[Co(en)_2Cl_2]$



Trans - Isomer

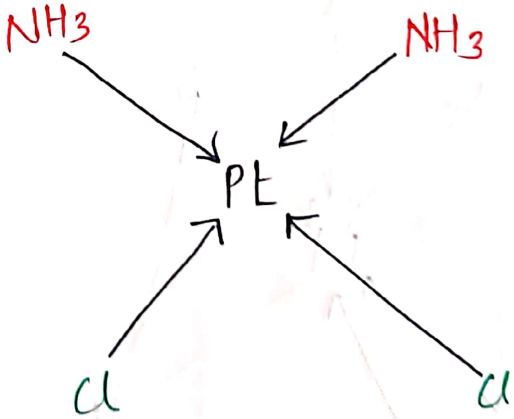
NCERT EXAMPLE



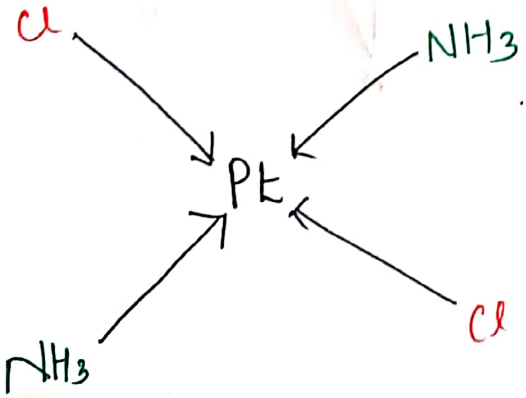
• CISPLATIN

It is used in anti-cancer

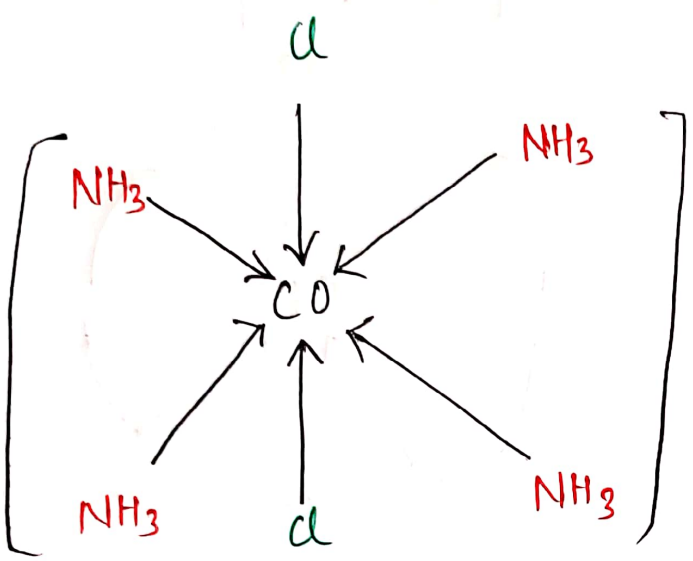
$[Pt(NH_3)_2Cl_2]$



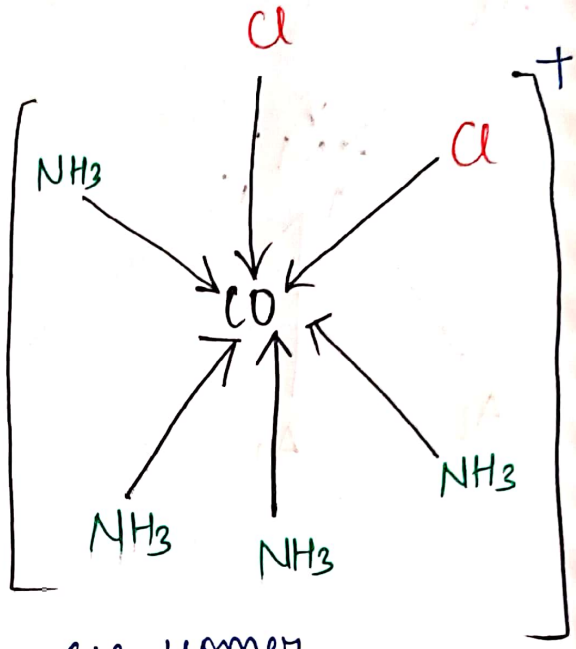
• TRANSPLATIN



$[CO(NH_3)_4Cl_2]^+$



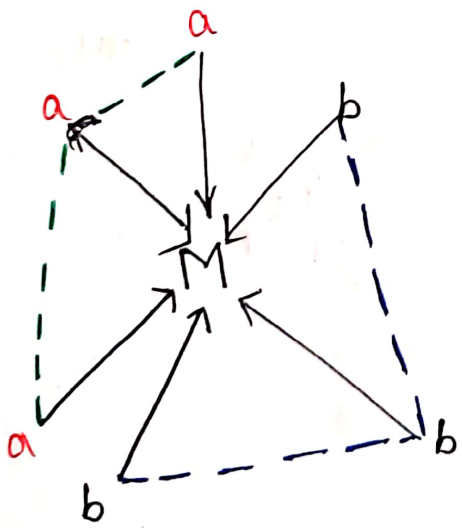
Trans-Isomer.



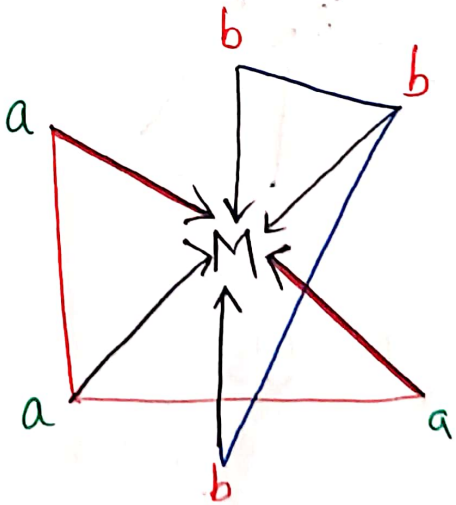
cis-isomer

→ FAC | MER

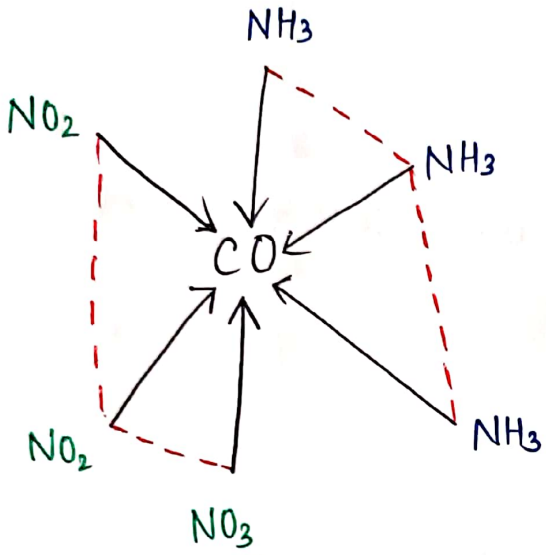
Facial

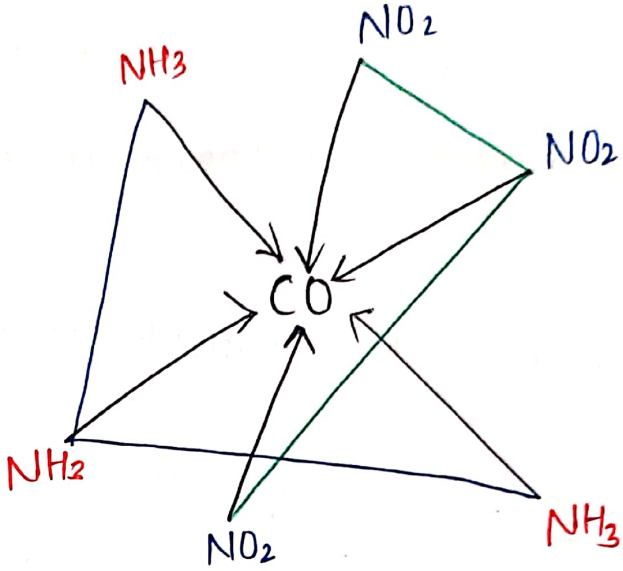


Meridional



Example- $Co(NH_3)(NO_2)_3$





25 Stars

* LIST OF IUPAC COMPOUND EXPERIMENTAL OF GEOMETRICAL ISOMER

=> no. of isomers

1)	$ma_1b_1c_1d_1e_1f_1$	15	
2)	$ma_2b_1c_1d_1e_1$	9	
3)	$ma_2b_2c_1d_1$	6	
4)	$ma_2b_2c_2$	5	
5)	$ma_3b_1c_1d_1$	4	
6)	$ma_3b_2c_1$	3	
7)	ma_3b_3	2	
8)	ma_4b_2	2	
9)	ma_2b_2	2	
10)	ma_5b	NIL	
11)	ma_6	Nil	

Optical Isomer

Compound which are mirror image of each other but don't Superimpose are known as Optical Isomer.

A Compound which optically Active are called Enantiomer

Enantiomer has 2 form

→ When it rotate ppl [Plane polarised Light]

In Left hand Side is levorotatory or l-form or -ve form.

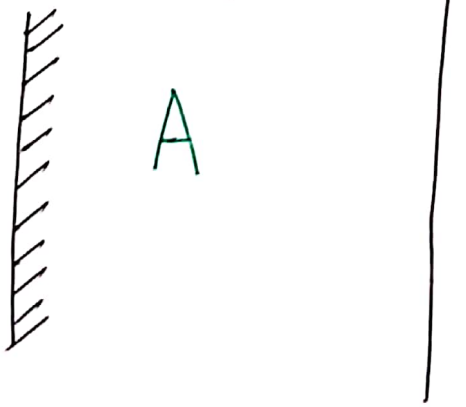
~~It rotate Anticlock wise is called~~

→ It rotate Right Hand Side is called Dextro rotatory form.

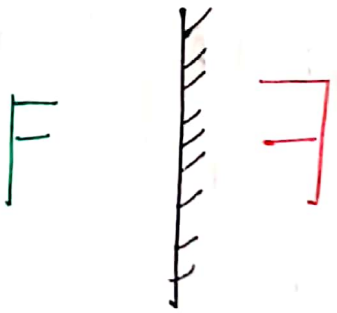
Trick

A

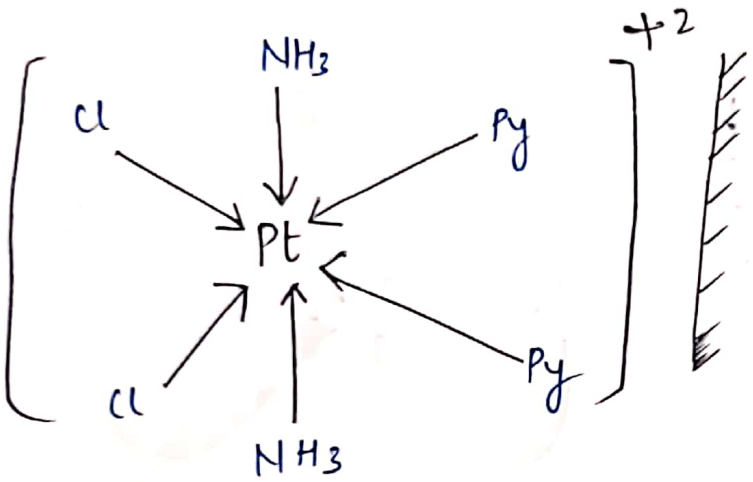
Optically inactive



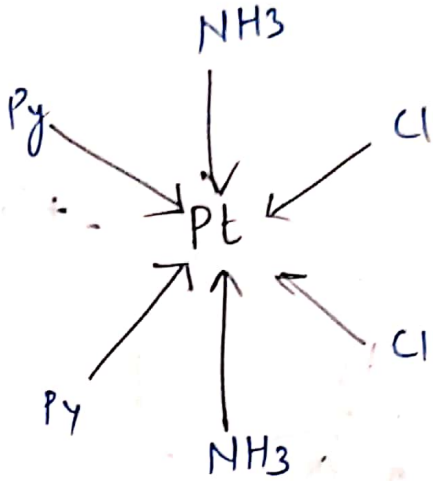
Optically Active



$[Pt(py)_2Cl_2(NH_3)_2]^{+2}$

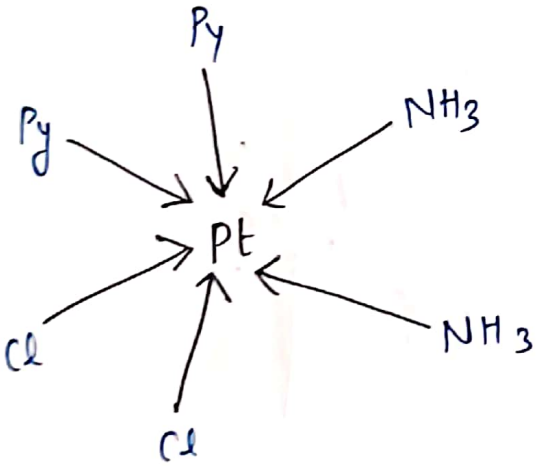


Trans [d form]

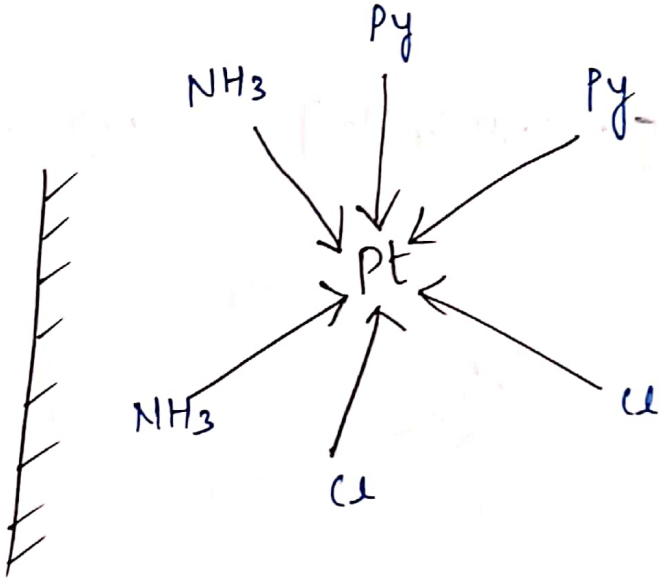


Trans :- [l form]

$[Pt(NH_3)_2Cl_2(Py)_2]^{+2}$

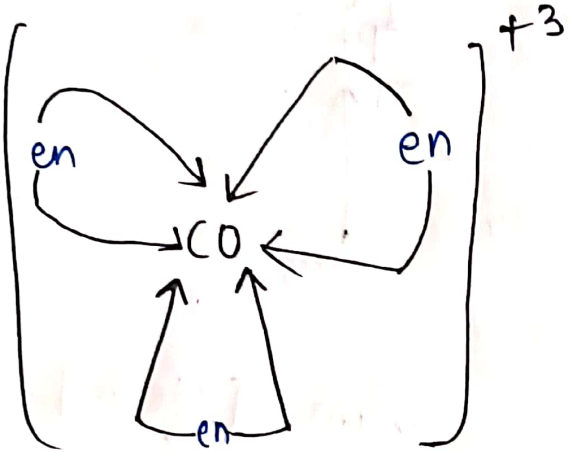


cis- d-form

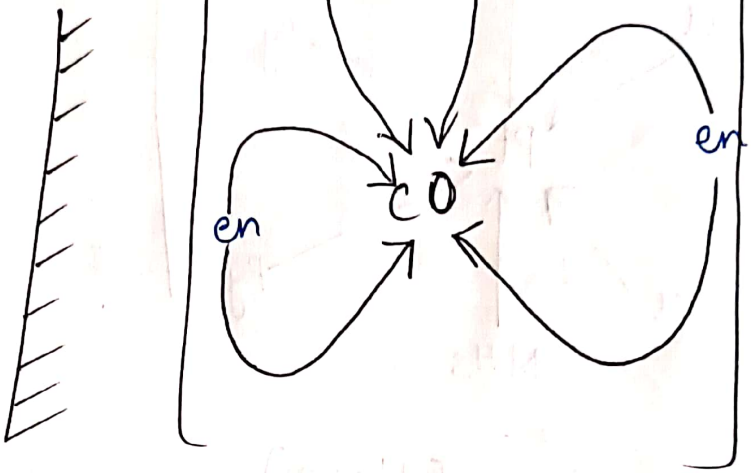


l form

$[Co(en)_3]^{+3}$

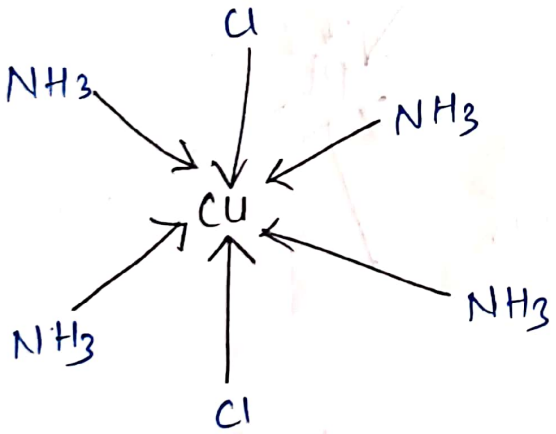


dform

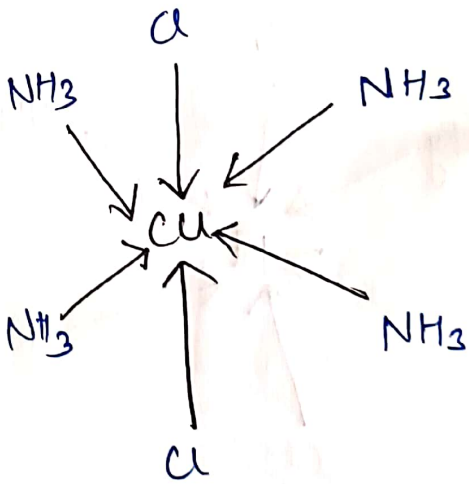


lform

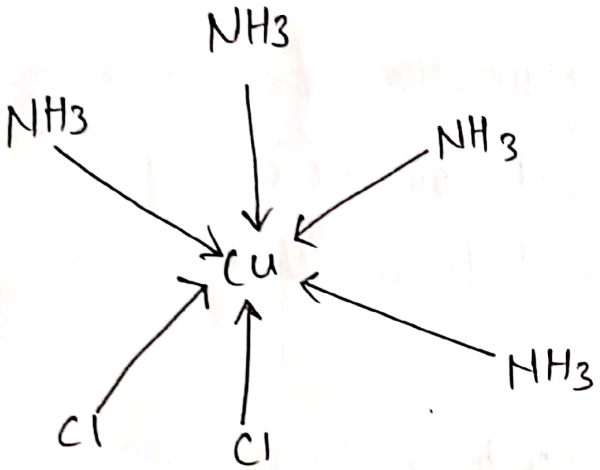
$[Cu(NH_3)_4Cl_2]$ Optically Inactive



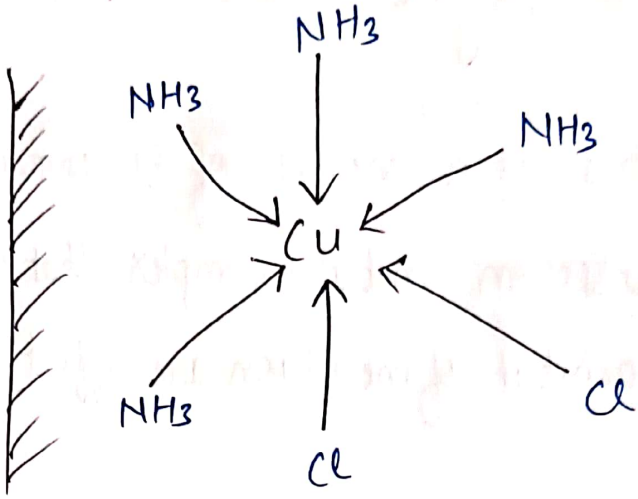
Trans



$Cu(NH_3)_4Cl_2$



cis- form d form



l form

* Crystal Field Theory

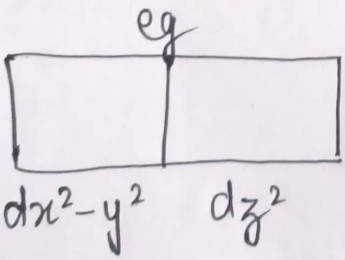
This is a model of Electronic Configuration of structure of transistion metal complex that considered how the energy of d-orbital of metal ion are affected by Electrical Field of Ligand

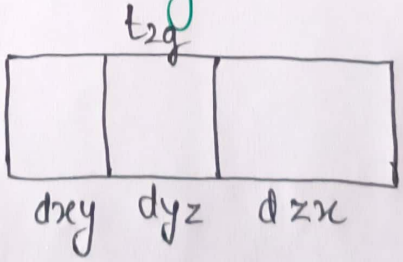
1) Central Metal atom considered as a positively charge anion as a negative point charge, neutral ligand as point a dipole and a attraction b/w ligand and metal ion is electrostatic in nature.

2) The d-orbital are called d-generated orbital which have a same energy Level. and deorbital have exact same 5 degenerated orbital.

d_{xy}	d_{yz}	d_{xz}	$d_{x^2-y^2}$	d_{z^2}

3) These degenerated Orbital are surrounded by ligand. their orbital are spillited into two parts. ⟶ eg and t_{2g}





→ eg contains dx^2-y^2 and dz^2 and t_{2g} contains dxy, dyz and dzx.

→ The Spliting of orbitals depends upon number of ligands surroundedby any central atom.

→ For Co-ordination number 6.

Orbitals are divided into two parts

1> eg 2> t_{2g}

In the presence of ligand the central metal get more energised The place where spliting are started that is called Bary Centre.

The Gap between eg and t_{2g} are called as Δo [Delo]

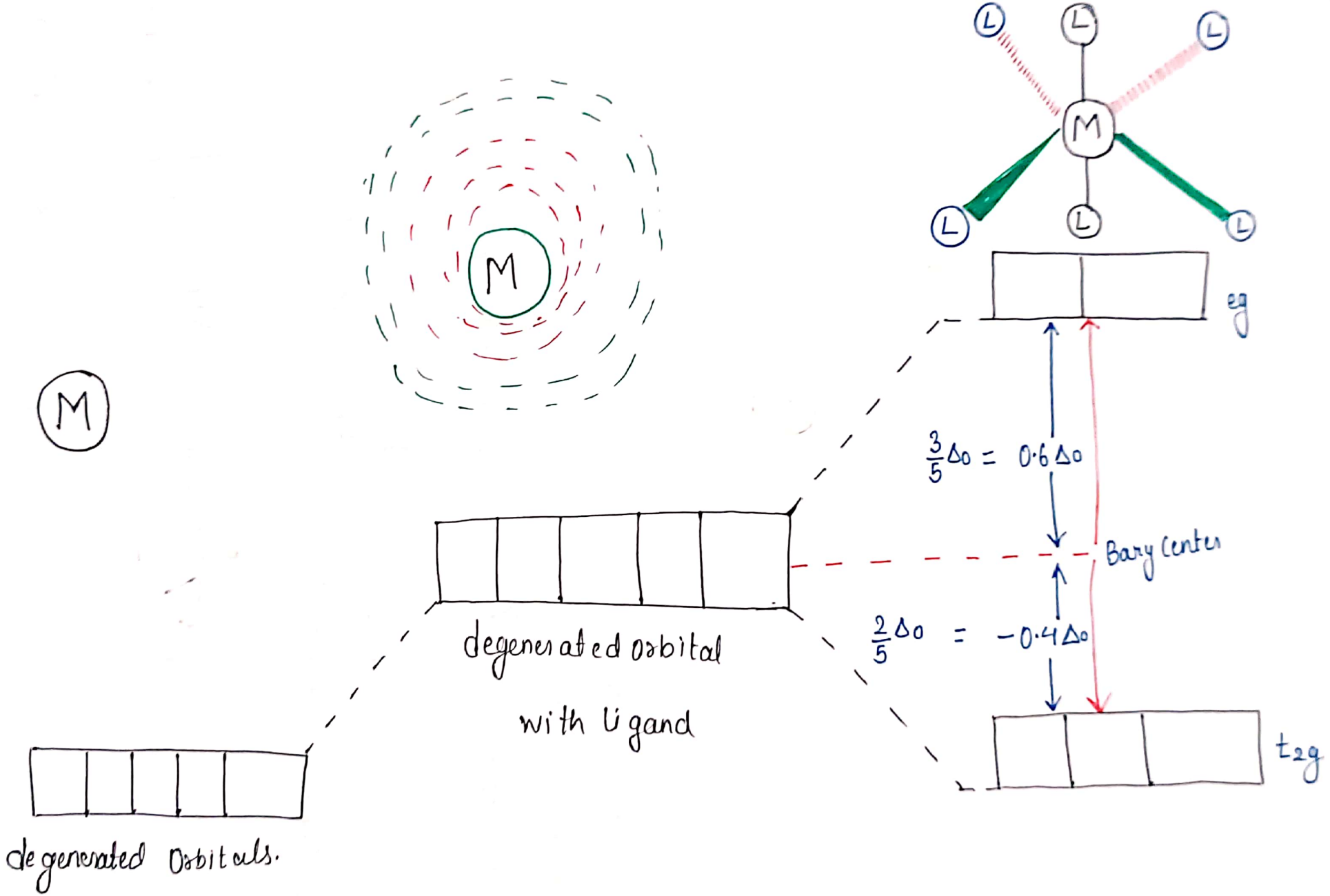
"Crsystal Field Spliting Energy of Octahedral Complexes"

The Energy gap b/w t_{2g} and eg is not exact same They are splited into 2 uneven ratio.

For Octahedral Complex the ratio are 2:3

"For Co-ordination number 6., The Spliting above bary centre are eg." and below bary centre are t_{2g}.

The Energies calculation is from Bary Centre.



CN = 6

CFSE = Crystal Field Stablization Energy

$$CFSE = \left[-0.4\, n_{t_{2g}} + 0.6\, n_{eg}\right]\Delta_o + x \cdot P.E$$

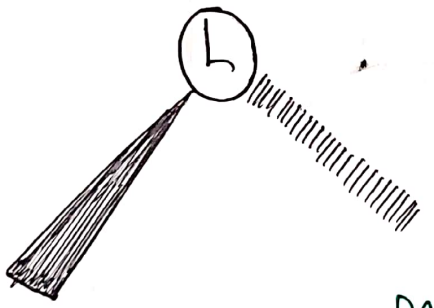
P.E → pairing energy

$n_{t_{2g}}$ = number of e^- in t_{2g}

n_{eg} = number of e^- in eg

x = no. of lone pair of e^- in paired form

Δ_o = crystal field Spliting energy for octahedral complex.

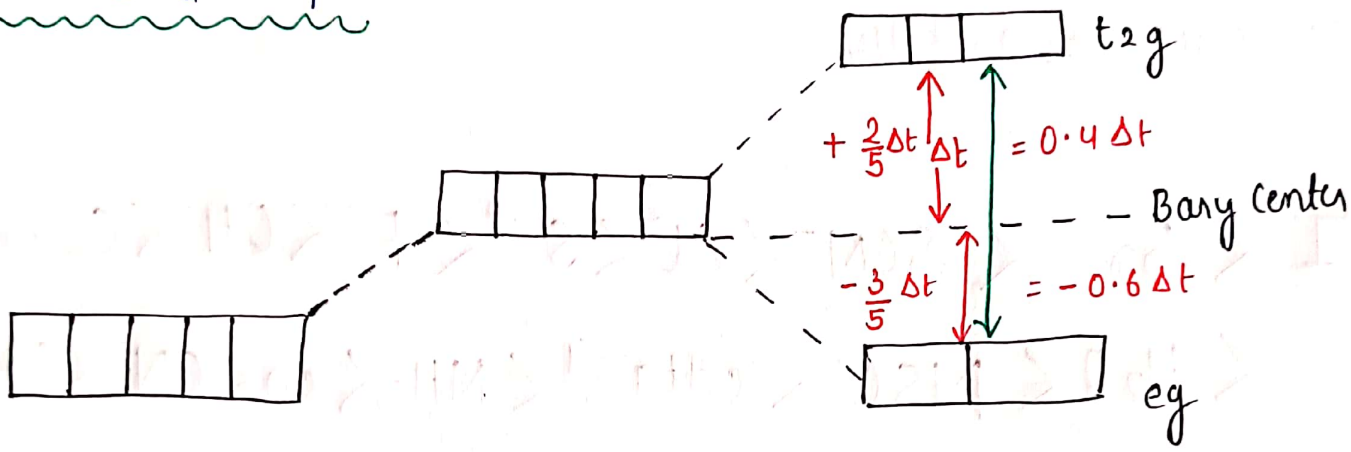


Solid line Towards Observer

Dash line away from Observer.

For Co-ordination number 4

It is in tetrahedral complex t_{2g} is in above bary centers and eg is below bary centers. The difference between t_{2g} and eg are called Δt i.e Crystal Field Spiliting Energy of Tetrahedral complex



For CN = 4

CFSE of Tetrahedral complex

$$CFSE = (-0.6\,\eta_{eg} + 0.4\,\eta_{t_{2g}})\,\Delta_t + x\,PE$$

Δ_t = Crystal field spilting energy for Tetrahedral complex.

* 50 Stars Releationship between Δ_t and Δ_o

Central atoms same and Ligand same

$$\Delta_t = \frac{4}{9}\Delta_o$$

The gap between t_{2g} and e_g depend on the types of Ligand This is experimental and the gap between t_{2g} and e_g are followed by Spectro chemical Series.

The Series are as follow:-

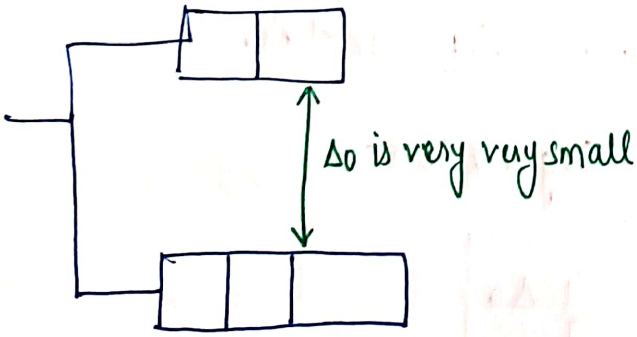
$$I^- < Br^- < SCN^- < Cl^- < S^{-2} < F^- < OH^- < C_2O_4^{-2} < H_2O < NSC^- < edta^{-4} < NH_3 < en < CN^- < CO$$

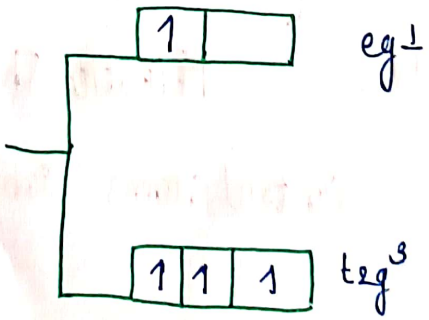
* High Spin Complexes

For High Spin complexes it is only possible in weakfield Ligands.

CN = 6

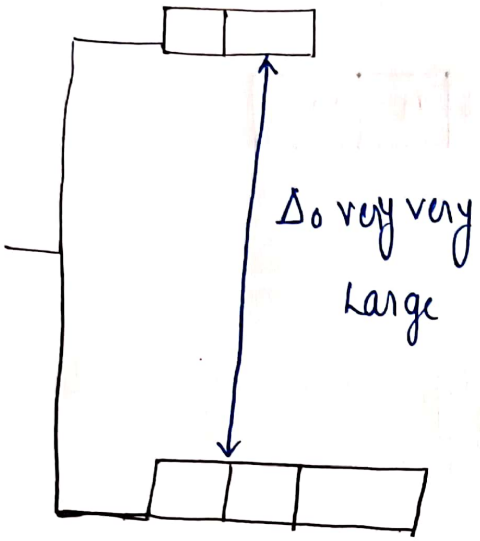
$\Delta_o < P$

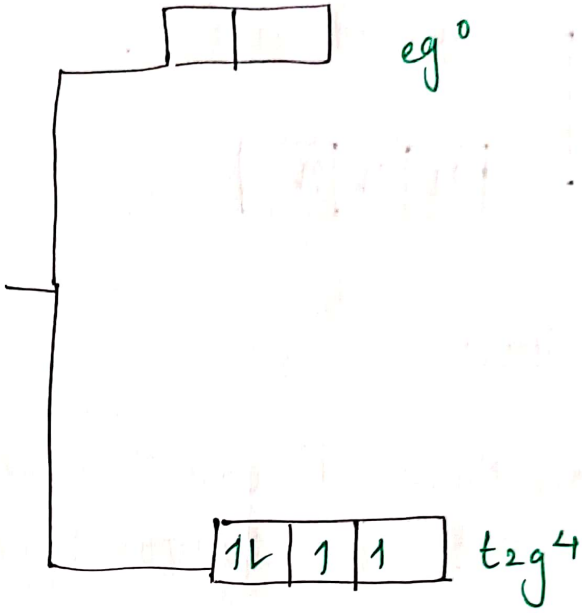




* Low Spin Complexes

For Strong field ligands

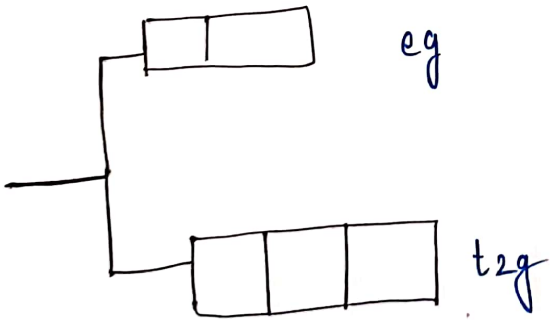




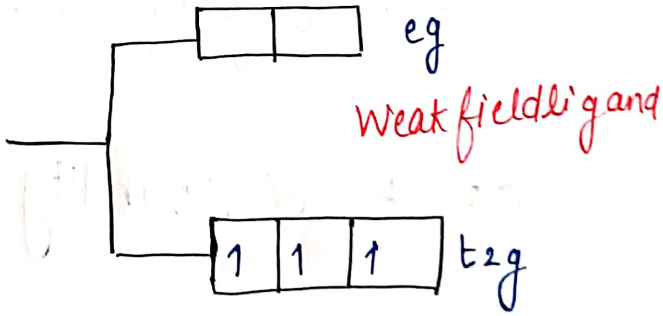
* APPLICATION OF CFT

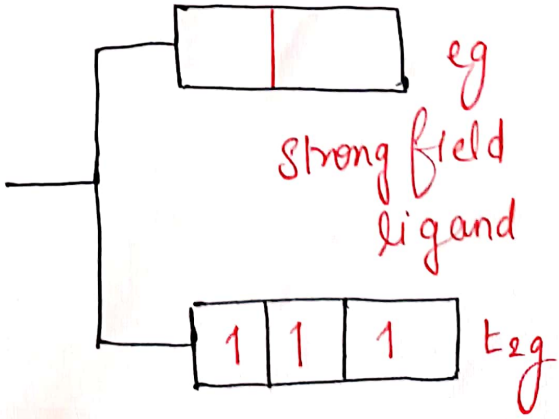
1) Configuration of d^3 and d^8 and not depend upon type of ligand neither weak field not strong field

For, CN = 6

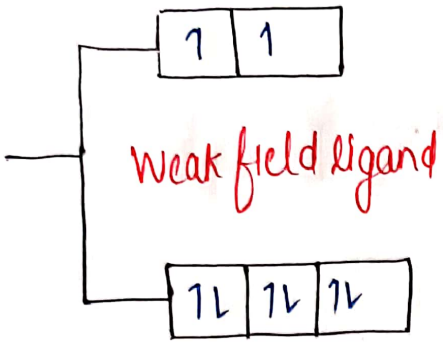


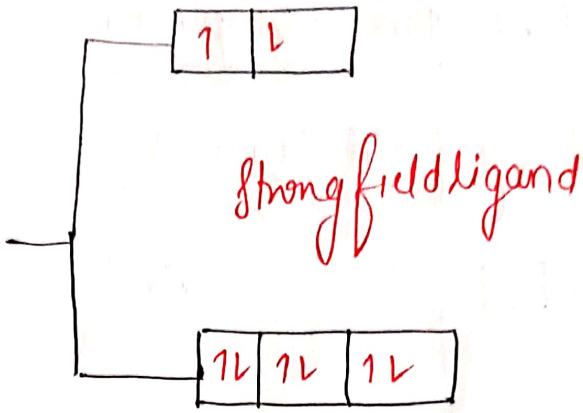
d^3





d^8





50 Stars

Hence Prove d^3 and d^8 have same configuration of orbitals and not depends upon type of ligand

Difference $d^4 \rightarrow d^7$

2) Calculation of CFSE

$CFSE = (-0.4 n_{t_{2g}} + 0.6 n_{eg})\Delta_o + x\ P.E$

3) CFSE. $\propto$ Stability

$K_4[Fe(CN)_6]$

$Fe = d^6 s^2$

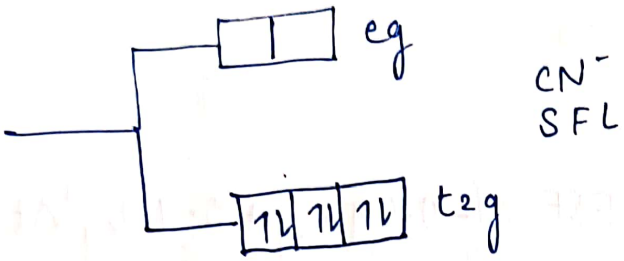
$Fe^{+2} = d^6$

$\Delta o = 1.2 ev$ $\quad PE = 2 ev$

$t_{2g} = 6e^-$

$eg = 0e^-$

Pair = 3



CN^-
SFL

$CFSE = (-0.4 \times 6 + 0.6 \times 0) 1.2 + 3 \times 2$

CFSE = 3.12 ev

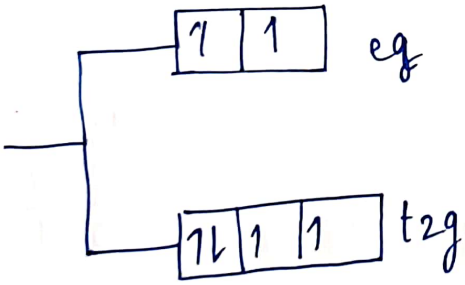
$K_4[Fe(CN)_6]$

$Fe = d^6 s^2$

$Fe^{+2} = d6$

$\Delta o = 1.2 ev$

$PE = 2 ev$



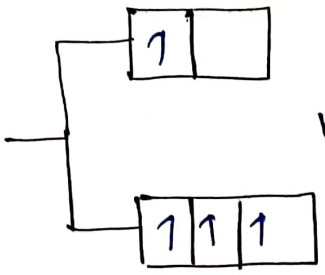
$t_{2g} = 4$ $\quad eg = 2$ $\quad$ Pair = 1

$CFSE = (-0.4 \times 4 + 2 \times 0.6) 1.2 + 1 \times 2$

$CFSE = (-1.6 + 1.2) 1.2 + 2$

CFSE = 1.52 ev

d^4

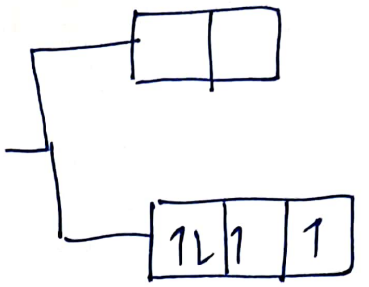


n = 4

$\mu = \sqrt{24}$ BM

High Spin Complex

WFL



n = 2

$\mu = \sqrt{8}$ BM

High Valuable Hint

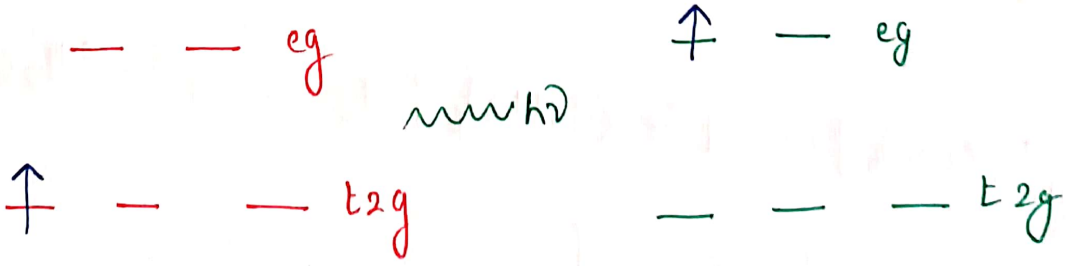
If S/O/Halogen — Donor — So W.F.L

C/N — SFL

5> Color Property in Co-ordination

due to d-d transition between t2g and eg

CN = 6



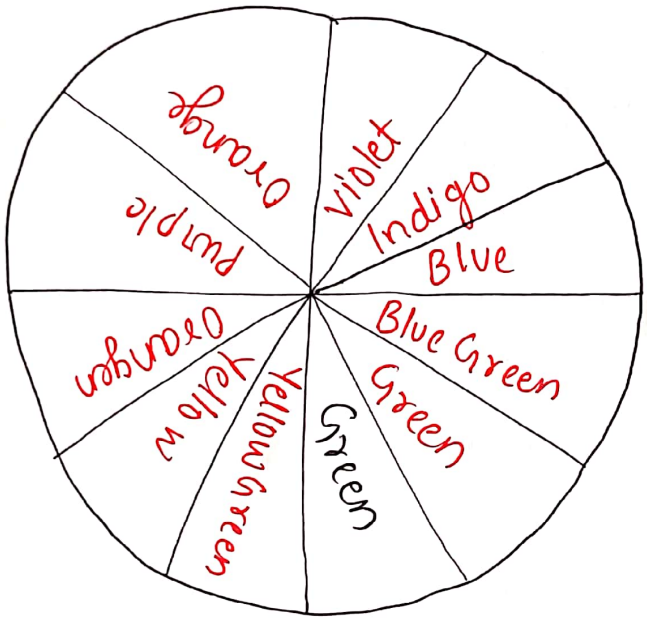
VIBGYOR

⟶ Energy ↓ λ(↑)

(↑) Energy ⟵

λ(↓)

* Complementary Color



Q. Write the series of absorbtion increasing order of their wavelength

$K_4[Fe(CN)_6]$ $[Fe(H_2O)_6]Cl_3$ $[Fe(NH_3)_6]Cl_2$

$K_4[Fe(CN)_6] < [Fe(NH_3)_6]Cl_2 < [Fe(H_2O)_6]Cl_2$

$\lambda \propto \frac{1}{\text{Energy}} < \frac{1}{\text{Strength of ligand}}$

$K_4[Fe(CN)_6]$ → yellow

$K_4[FeCl_6]$

$K_4[Fe(Cl)_6]$ which color is not possible

a) Red (Possible)

b) violet (NP)

c) Green (NP)

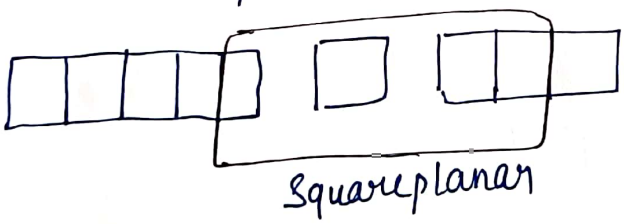
d) Yellow (NP)

VIBGYOR

Pg = 21 DPP - 06

Que 1

(1) Squareplanar → dsp^2



(2) Square Planar

(3) Square Planar

$[Ni(CN)_4]^{2-}$ Oxidation No. = 2

$Ni = 3d^8 4s^2$

$Ni^{+2} = 3d^8$ SFL

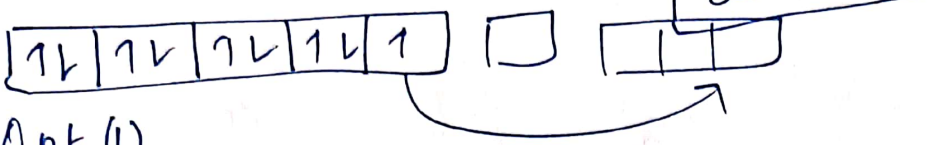
Opt (4) All

Q 4) 1.73 BM

$\sqrt{n(n+2)}$ BM

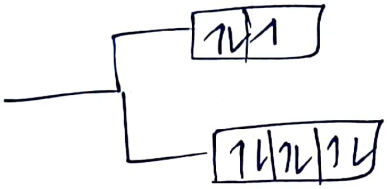
$n = 1$ $\sqrt{3}$ BM = 1.73 BM

$[Cu(NH_3)_4]^{+2}$ $Cu - d^{10}s^1$ $Cu^{+2} = d^9$



Opt (1)

Q5) High Spin



Opt (2) Fe $\rightarrow d^5$

Application

5) Stability of compounds

→ CFSE Value

$\Delta_{tetrahedral} = \frac{4}{9}\Delta_o$

$\Delta_{square planare} = 1.3\,\Delta_o$

$\Delta_{sq} > \Delta_{octahedral} > \Delta_{tetrahedral}$

→ CFSE ∝ Strength of ligand

→ CFSE ∝ Chelate Ring

→ CFSE ∝ K value

→ CFSE ∝ no. of Orbitals [3d < 4d < 5d]

→ CFSE ∝ Oxidation Number

→ CFSE ∝ Charge of central metal ion

→ CFSE ∝ Synergic bond

$[Fe(NH_3)_6]^{+2} < [Fe(en)_3]^{+2} < [Fe(EDTA)]^{-2}$

Ligand	6	3	1
Co-ordination Number	6	6	6
Chelate Ring	0	3	4
K value -	$\frac{[\ ]}{7}$	$\frac{[\ ]}{4}$	$\frac{[\ ]}{2}$

→ K Value

$M + nL \longrightarrow [M(L)n]$

$K = \frac{[M(L)n]}{[M][L]^n}$

$K_4[Fe(CN)_6] \longrightarrow Fe^{+2}$

$K_3[Fe(CN)_6] \longrightarrow Fe^{+3}$

$Fe^{+2} < Fe^{+3}$

$K_4[Ni(CN)_6] \longrightarrow 3d$

$K_4[Pd(CN_6)] \longrightarrow 4d$

$K_4[Pt(CN)_6] \longrightarrow 5d$

$5d > 4d > 3d$

✳ CHEMICAL REACTION IN CO-ORDINATE BOND

Co-ordinate can react with different type of ligand directly.
Example- $[Ni(H_2O)_6]^{+2}$ can react with ethylene diammine and form different colors in different ration like 1:1, 2:1, 3:1.

$[Ni(H_2O)_6]^{+2} + en \longrightarrow [Ni(H_2O)en] + 2H_2O$

Green color — Paleblue color

$[Ni(H_2O)_4 en]^{+2} + en \longrightarrow [Ni(H_2O)_2 en_2] + 2H_2O$

Blue/Purple

$[Ni(H_2O)_2 en_2]^{+2} + en \longrightarrow [Ni(en)_3] + 2H_2O$

Violet

It is clearly observed that when ligand changed into weak field to strong field wave length decreases due to the energy decrease increases and in the spectrum we shifted to left hand side.

$[Ti(H_2O)_6]_6$ are yellow in color but when we heat the crystal it turns into colorless due to the removal of water from co-ordinate sphere.

$CuSO_4$ are colorless which it can turns into colorfull when it reacts with water are form crystalline aqueous solution.

$[Ti(H_2O)_6]^{+3} \xrightarrow{\Delta} Ti^{+3} + 6H_2O$

Yellow — colorless

$CuSO_4 + 5H_2O \longrightarrow [Cu(H_2O)_5]SO_4$

Colorless — Blue color.

Color of GemStone

The color of GemStone is due to d-d transition.

Example- Ruby is Red in color due to presence of Cr^{+3} in Al_2O_3

Emerald is Green in color due to the presence of Cr^{+3} in Beryl [$Be_3Al_2Si_6O_{18}$]

DRAW BACK OF CFT

1) Low Spin in Tetrahedral complex is rarely observed This is because of the orbital spilting energy are not sufficiently large for forcing pair.

2) CFT can easily explain color magnetic property and Structure But donot explain the reason of Spiliting. Some ligands are point charges

But Some anianic ligand like F^-, Cl^-, Br^-, I^- are found at low end of Spectochemical Series.

It doesn't take a count that covalent character in co-ordinate bonds.

Bond In Mettallic Carbonyl In Synergic Bond

Some Homoleptic Carbonyl compound are most stable Carbonyl compound of Co-ordinate Chemistry with in the Ground State i.e. the oxidation number of all compounds are zero.

Eg:- $[Ni(CO)_4]$ Ni = 0

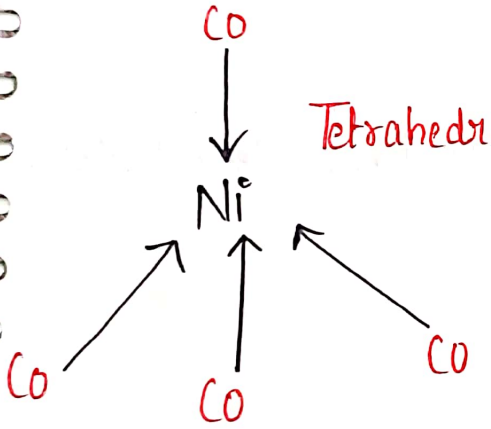
$[Fe(CO)_5]$ Fe = 0

$[Cr(CO)_6]$ Cr = 0

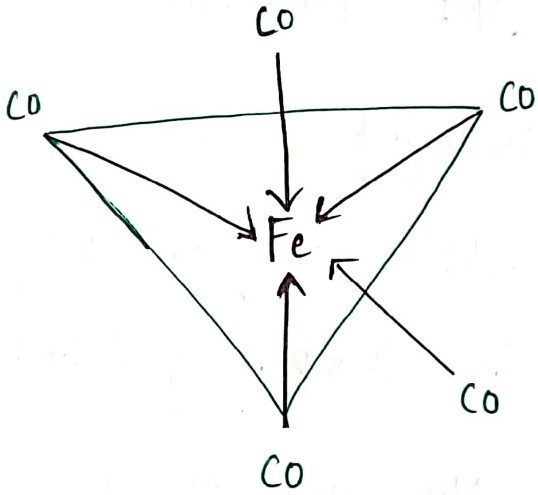
$[Co_2(CO)_8]$ CO = 0

$[Mn_2(CO)_{10}]$ Mn = 0

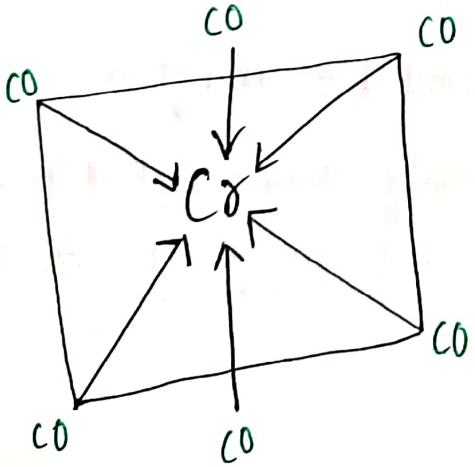
$[Ni(CO)_4]$



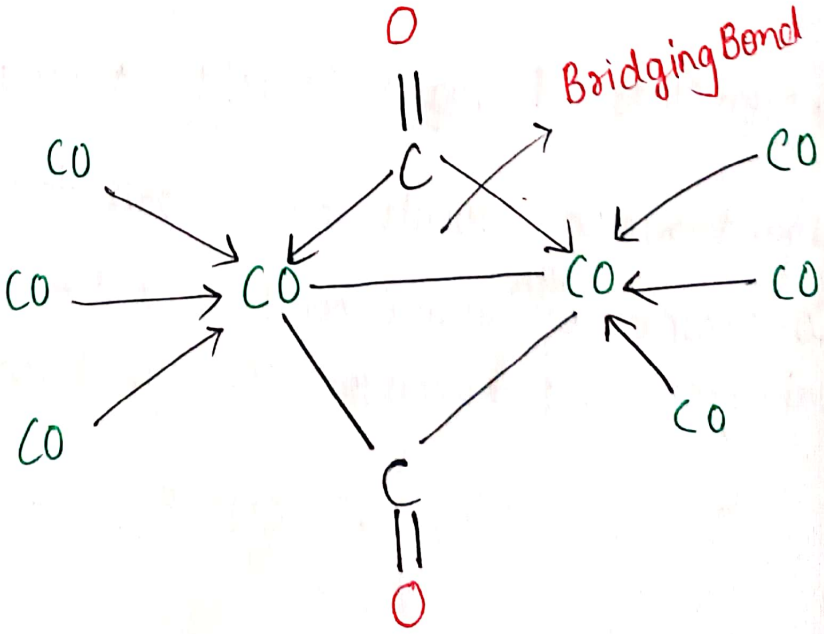
$[Fe(CO)_5]$ Trigonal bipyramidal



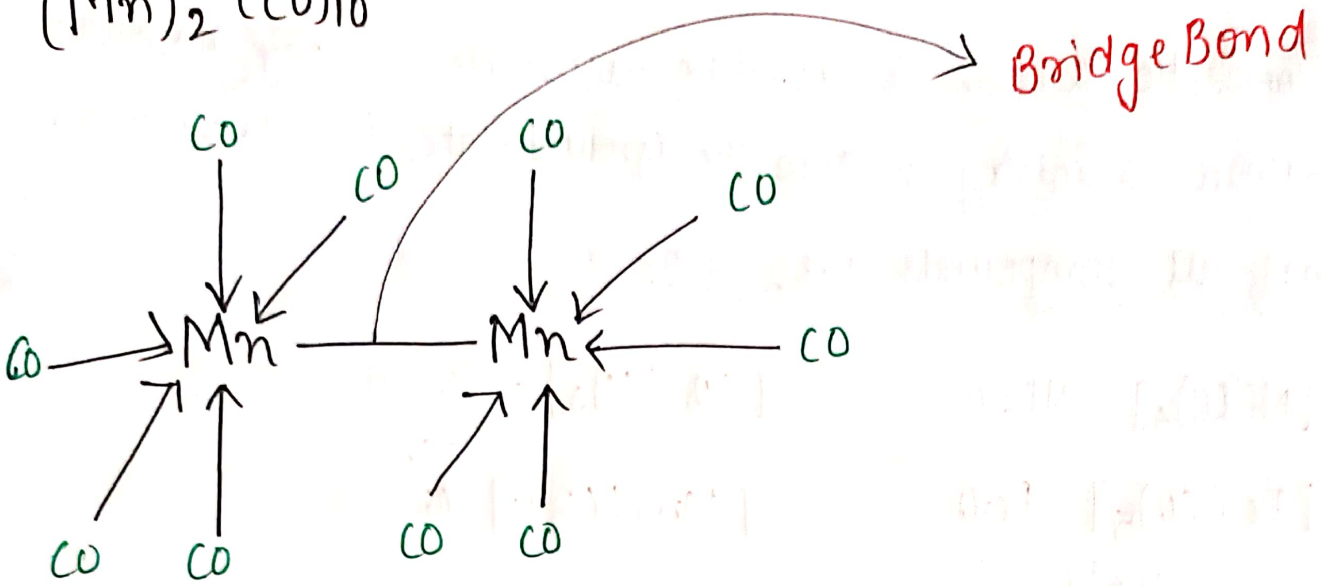
$[Cr(CO)_6]$



$Co_2(CO)_8$



$(Mn)_2(CO)_{10}$



TYPES OF LIGAND FOR FORMING SYNERGIC BOND

1> Classical ligand

A Ligand which can form co-ordinate sigma bond [σ] with Central Metal Ion By donating lonepair of Electron

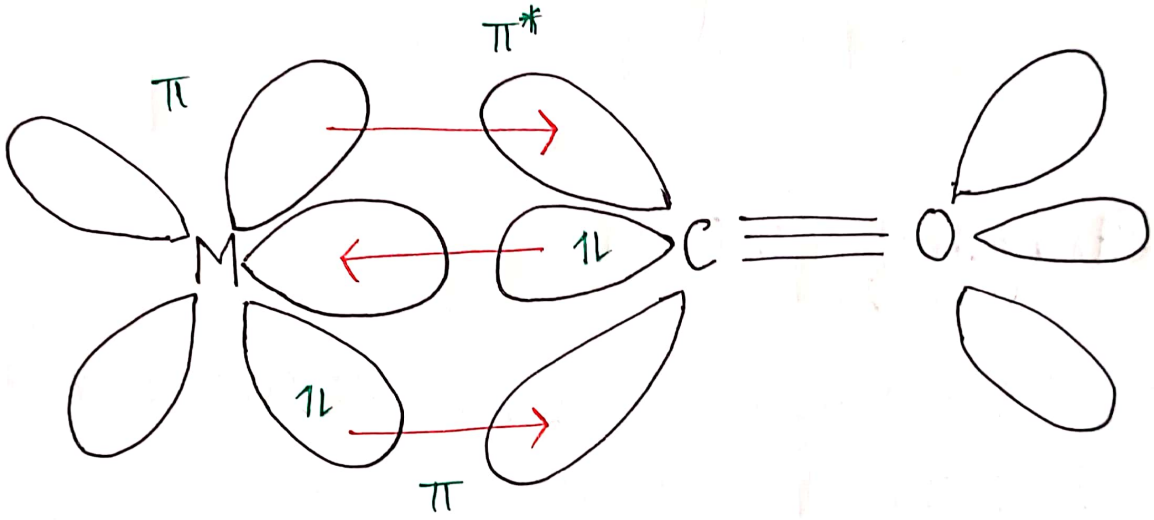
Example - NH_3, H_2O, Cl^- etc.

2> Nonclassical Ligand / π acid / π acceptor ligand

Ligand which donate Electron pair to central metal ion and form Co-Ordinate with or sigma bond and simultaneously they accept Electron pair from central metal ion through "Back Bonding" or Synergic Bond.

Example CO, NO^-, CN^-, R_3P, R_3As

The Metal Carbon Bond in Carbonyl Sigma and π both both. The M–C Sigma Bond is formed By the donation of Lonepair of electron on the Carbonyl Carbon into a vacant orbital of the metal The M–C pibond is formed By the donation of a pair of Electron from a filled d-orbital of metal into the vacant antibonding [π^*] orbital of Carbon Mono-Oxide. The metal to ligand bonding creates a Synergic effect which Strengths the bond between CO and the metal.



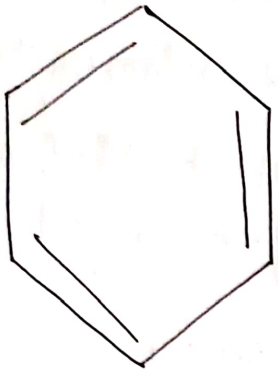
Synergic Bond.

π-Donor π-acceptor Type of Bond / ligand

Example $CH_2 = CH_2$ η^2 ethylene $2\pi e^-$ donate

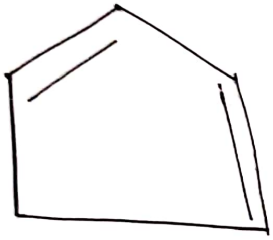
A ligand which donate πe^- pair to central Metal Ion and also accept Electron pair from Central Metal Ion through Synergic Bond.

2)



η^6 - benzene 6 πe^- ~~donate~~ donor

3)



η^5 cyclopentane 6 πe^- donor

* Strength of CO Bond

When M-C Bond length decreases when MC Bond increases, Because double Bond Character Increases.

CO Bond Strength Increases when CO Bond length decreases because Bond-Order b/w C – O Increases.