24/10/17

CO-ORDINATION COMPOUNDS

Chlorophyll → Mg
Haemoglobin → Fe
Vitamin B12 → Co

Addition Compounds : When 2 or more salts are mixed in a fixed proportion and allowed to crystallise then new type of compound formed is known as Addition compounds.

Double salt

- Those addition compds. which are stable in crystalline form and get 100% ionised in aq. medium c/a double salt.

eg : $KCl + MgCl_2 + 6H_2O \rightarrow KCl.MgCl_2.6H_2O$
Carnellite

$K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \rightarrow K_2SO_4.Al_2(SO_4)_3.24H_2O$
Potash Alum

$FeSO_4 + (NH_4)_2SO_4 + 6H_2O \rightarrow FeSO_4.(NH_4)_2SO_4.6H_2O$
Ferrous ammonium sulphate
Mohr's Salt

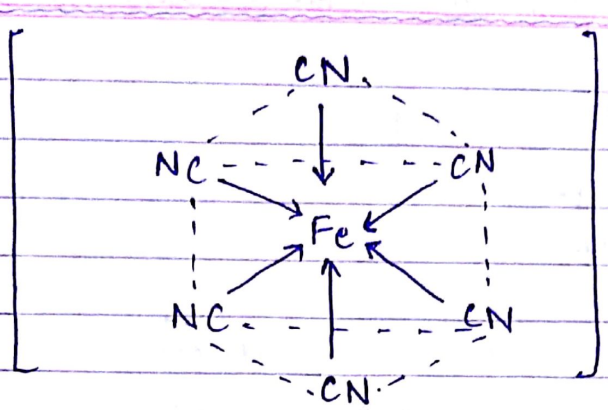
Coordination compounds.

- Those addition compds. which are stable in crystalline form as well as in aq. form or medium and donot get 100% ionised is c/a coordination compds.

Example of Coordination Compds :-

eg $K_4[Fe(CN)_6] \xrightarrow{aq.} 4K^+ + [Fe(CN)_6]^{4-}$

When $K_4[Fe(CN)_6]$ is dissolved in water then its aq. soln shows properties of K^+ ions but do not show properties of Fe^{2+} & CN^- ions becoz these are not in form of complex ion $[Fe(CN)_6]^{4-}$



Important terminology related to C.C. :-

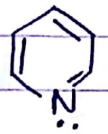
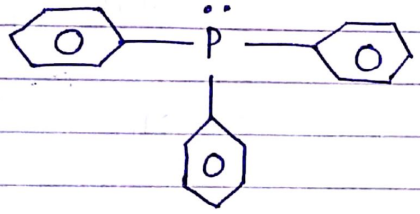
1. Central metal atom and ion : It is metal atom or ion which have same or nearly same energy vaccant orbital to accept lp donated by ligand
   * Central metal atom or ion behave as lewis acid.

2. Ligand : Any atom, molecule or ion which have lp to donate central metal atom or ion.
   * Ligand behave as lewis base.

Types of ligand :-

(a) Monodentate Ligand :- which have one donor atom.

	Ligand	Name	Charge
1.	$H_2\ddot{O}$	aqua	0
2.	$\ddot{N}H_3$	ammine	0
3.	CN^-	cyano	-1
4.	X^- (F^-, Cl^-, Br^-, I^-)	Halido (Fluorido, Chlorido, Bromido, Idido)	-1
5.	H^-	Hydrido	-1
6.	OH^-	Hydroxo	-1
7.	NO_2^-	nitro	-1
8.	NO_3^-	nitrato	-1

9.	NH_2^-	amido	−1
10.	NH^{2-}	imido	−2
11.	N^{3-}	nitrido	−3
12.	SO_4^{2-}	Sulphato	−2
13.	O^{2-}	oxo	−2
14.	O_2^{2-}	peroxo	−2
15.	S^{2-}	Sulphido	−2
16.	CH_3COO^-	acetato	−1
17.	CO	carbonyl	0
18.	NO	nitrosyl	0
19.		pyridene (py)	0
20.		triphenyl phosphine	0
21.	$\ddot{P}H_3$	phosphine	0

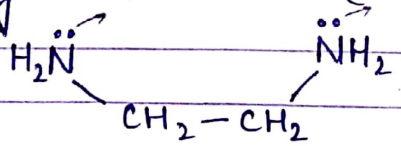
(b) Bidentate ligand : which have 2 donar atom.

eg: ① Oxalato ligand ($C_2O_4^{2-}$)

* $COO^- \rightarrow$
|
$COO^- \rightarrow$

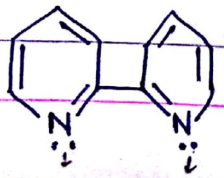
2 donor O-atom
charge = −2

*② Ethylene diamine (en) or (Ethane-1,2-diamine)

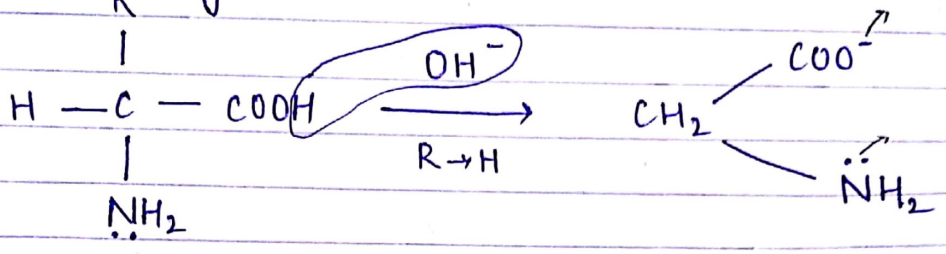


2 donor N-atom
charge = 0

③ 2, 2' - bipyridine

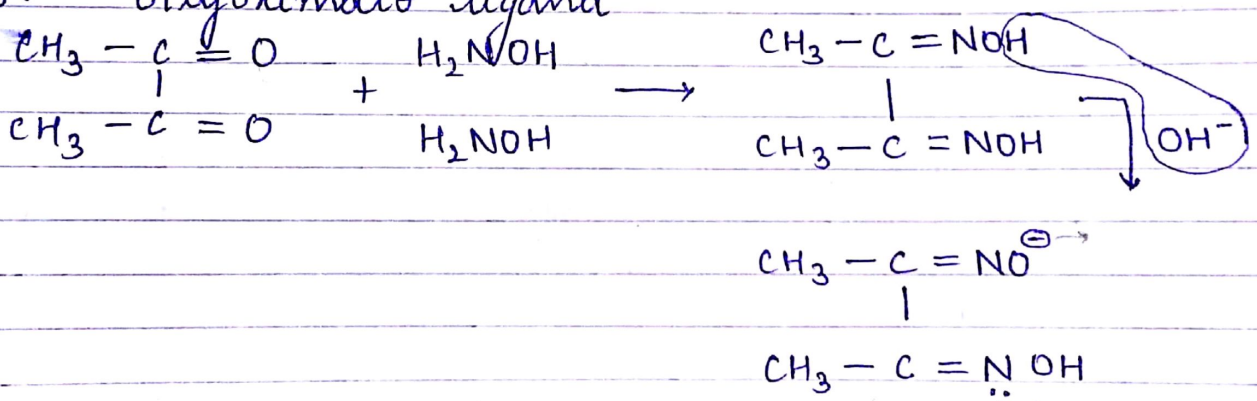


4. Glycinato ligand :



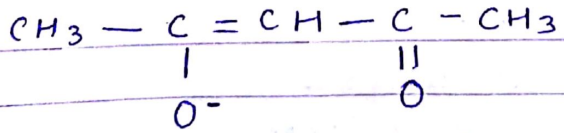
1 donor O-atom & 1 donor N-atom it is an eg example of unsymmetrical bidentate ligand.

5. Glyoximato ligand



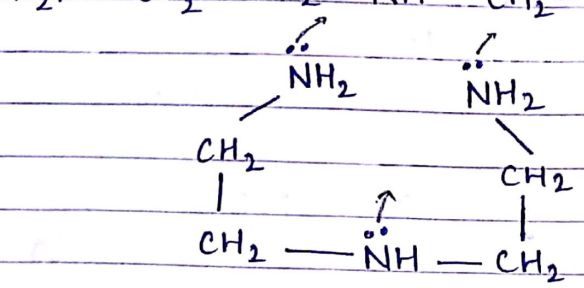
1 donor O atom & 1 donor N-atom

6. Acetyl acetonato $(acac)^-$



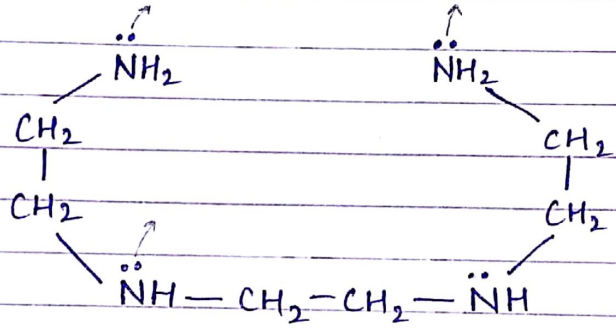
(c) Polydentate ligand : which have more than 2 donar atom

eg : (a) diethylene triamine (dien)



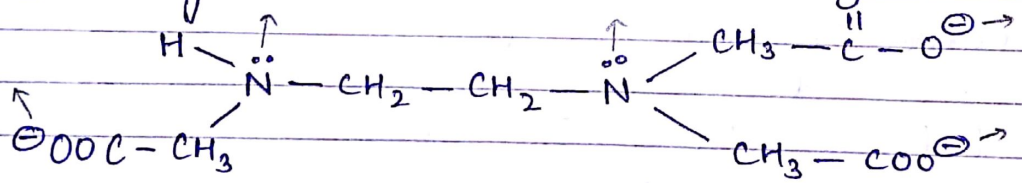
3 donar N-atom tridentate

(b) triethylene tetramine



4 donar N. atoms tetradentate

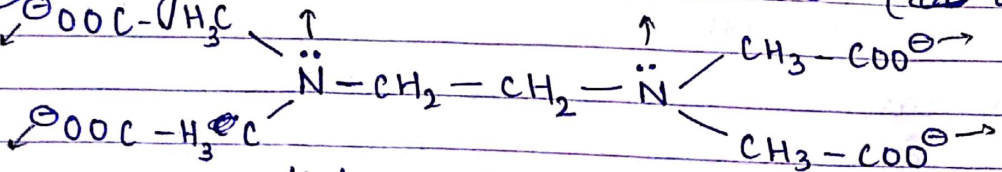
(c) ethylene diamine triacetate



3 donor O-atom & 2 donor N-atom (Unsymmetrical) Pentadentate

III

(d) Ethylene diamine tetracetate (EDTA)



4 donar O-atom & 2 donor N-atom (Unsymmetrical) Hexadentate

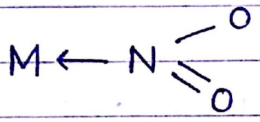
(d) Ambidentate ligand :- Those ligand which have 2 donor atom but either of them donate one time.

M ← CN
cyano

M ← NC
isocyano

M ← SCN
thiocyanato

M ← NCS
isothiocyanato



nitro

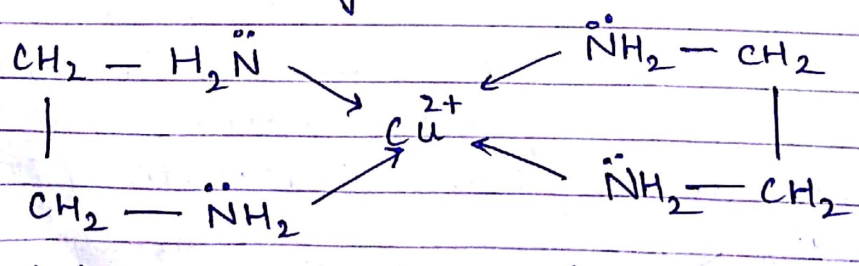
M ← O – N = O
nitrito

Ambidentate ligands are monodentate ligands.

(e) Chelating Ligand : When bidentate or polydentate ligand donate simultaneously to central atom. They form ring-like structure c/a chelate ligands.

Chelate → "Ring like structure"

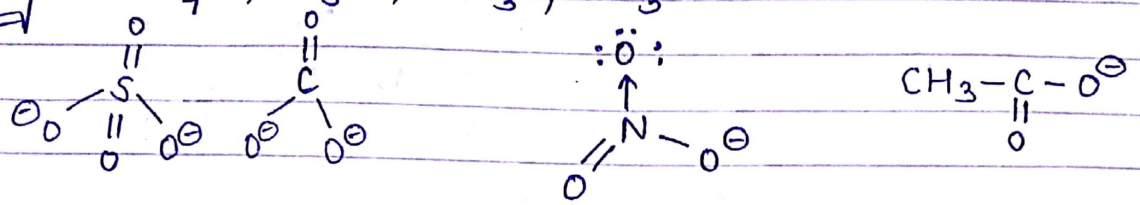
eg



- monodentate can not form ring like structure.
- as no. of donor atoms ↑ in chelating ligand Stability of molecule ↑
- EDTA form more stable str. than ethylene diamine.

f) Flexidentate ligand : which can change their denticity.

eg SO_4^{2-}, CO_3^{2-}, NO_3^-, CH_3COO^-



$[Co(NH_3)_5SO_4]Cl$ SO_4^{2-} → monodentate

26/10/17 $[Co(en)_2SO_4]Cl$ SO_4^{2-} → bidentate

3. Ionisation sphere :- Species outside coordination sphere form ionisation sphere.

4. Coordination sphere : Species ~~not~~ in square bracket form coordination sphere.

$K_4[Fe(CN)_6]$

Ionisation sphere — Coordination sphere

$[Co(NH_3)_6]Cl_3$ → I.S.

C.S.

5. Coordination No. :- no. of coordinate covalent bond formed by C.M.A. is c/a C.N.

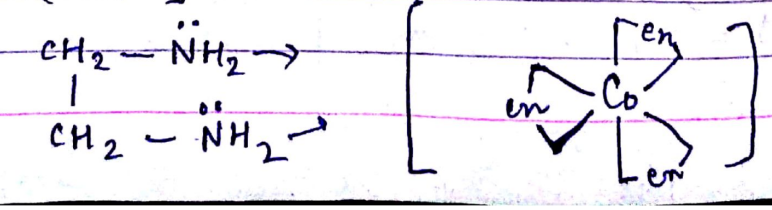
$K_4[Fe(CN)_6]$ C.N. = 6

$[Co(NH_3)_4Cl_2]Cl$ C.N. = 6

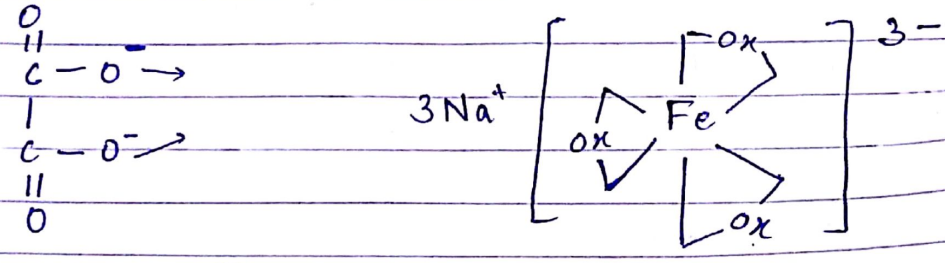
$[Ag(NH_3)_2]Cl$ C.N. = 2

$[Cu(CN)_4]^{2-}$ C.N. = 4

$[Co(en)_3]^{3+}$ C.N. = 3 × 2 = 6



$Na_3[Fe(C_2O_4)_3]$ C.N. = 3 × 2 = 6



$[Co(NH_3)_5SO_4]Cl$ C.N. = 6

$Na_3[CrOF_4]$ C.N. = 5

$Ni(CO)_4$ C.N. = 4
$Fe(CO)_5$ C.N. = 5
$Cr(CO)_6$ C.N. = 6

$[Cr(EDTA)]^{3+}$ C.N. = 1 × 6 = 6

6. Oxidation Number :-

$K_4[Fe(CN)_6]$
$x + 6(-1) = -4$
$x = -4 + 6 = 2$

$K_3[Fe(CN)_5CO]$
$x + 5(-1) + 0 = -3$
$x = 2$

$[Cr(NH_3)_4Cl_2]Cl$
$x + 4(0) + 2(-1) = +1$
$x = 3$

AIEEE

$K_4[Ni(CN)_4]$
$x + 4(-1) = -4$
$x = 0$

$[Co(NH_3)_6]Cl_3$
$x + 0 = +3$
$x = 3$

$[Co(en)_2F_2]Cl$
$x + 2(-1) = +1$
$x = 1 + 2 = 3$

$Na_3[Fe(C_2O_4)_3]$
$x + 3(-2) = -3$
$x = 3$

$NH_2-\overset{\oplus}{N}H_3$ (ium)

$NO = (+1)$ $\quad NO_2^{\oplus}$

CO = 0 charge

$[Ag(NH_3)_2]Cl$

$x + 0 = +1$

$x = 1$

II) $[Fe(H_2O)_5NO]SO_4 \Rightarrow x+5(0)+1 = 2 \Rightarrow x=1$

~~$x + 0 + 1 = +1$~~

~~$x = 0$~~

$x + 5(0) + 1 - 2 = 0$

$x = +1$

$Na_2[O_5F_5N]$

$x + 5(-1) - 3 = -2$

$x = 6$

$[Pt(en)_2Cl_2]Cl_2$

$x + 0 - 2 = +2$

$x = 4$

$Cr(CO)_6$

$x + 0 = 0 \Rightarrow x = 0$

$Ni(CO)_4$

$x + 0 = 0$

$x = 0$

$[Co(NH_3)_5SO_4]Cl$

$x + 0 - 2 = +1$

$x = 3$

$[Co(H_2O)_5SO_4]^+$

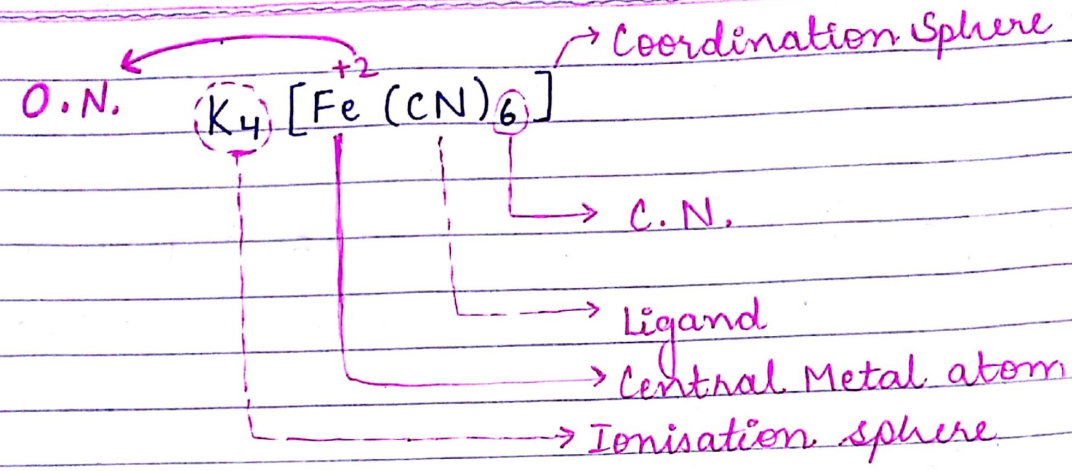
$x + 5(0) - 2 = +1$

$x = 3$

$[Pd(NH_3)_4Cl_2]^{2+}$

$x + 4(0) + 2(-1) = +2$

$x = 4$



Werner's Theory :-

Every C.M.A. has 2 valency in complex form.

Primary Valency	Secondary valency
• equal to O.N.	→ equal to C.N.
• due to anions (-ve charge)	• due to ligand (neutral, -ve, +ve)
• ionisable → means changes it O.N.	• non-ionisable → means not changes its C.N.
• non-directional	• directional
• donot play any role in geometry	• decide geometry

Note :- Every C.M.A. tends to satisfy both valencies.

$Cr(CO)_6$
↳ C.N. = 6
O.N. = 0

$[Cr(NH_3)_6]Cl_3$
CN = 6
O.N. = 3

- Secondary valency i.e. C.N is fix.

eg

Cr^{3+}	6
Co^{3+}	6
Pt^{4+}	6
Fe^{2+}	6
Cu^{2+}	4
Ag^{2+}	2

$Pt^{2+} \rightarrow 4$

eg $[Pt(NH_3)_6]Cl_4 \rightarrow [Pt(NH_3)_6]^{4+} + 4Cl^{\ominus} \rightarrow 4AgCl$

$4AgNO_3$

Compound	Pri. valency	Sec. valency	No. of Cl^- ions precipitated as AgCl if $AgNO_3$ added	Total no. of ions
1. $[Pt(NH_3)_6]Cl_4$	4	6	4	5 $[Pt(NH_3)_6]^{4+} + 4Cl^-$
2. $[Pt(NH_3)_5Cl]Cl_3$	4	6	3	4 $[Pt(NH_3)_5Cl]^{3+} + 3Cl^-$
3. $[Pt(NH_3)_4Cl_2]Cl_2$	4	6	2	3 $[Pt(NH_3)_4Cl_2]^{2+} + 2Cl^-$
4. $[Pt(NH_3)_3Cl_3]Cl$	4	6	1	2 $[Pt(NH_3)_3Cl_3]^{+} + Cl^-$
5. $[Pt(NH_3)_2Cl_4]$	4	6	0	1 $[Pt(NH_3)_2Cl_4]^{0}$

Question based on table :-

Ques Which of the following has max^m conductivity?
conductivity $\propto$ no. of ions.

(1) $[Pt(NH_3)_6]Cl_4$

Ques which of the following will give 3 mol AgCl when mixed with $AgNO_3$.

(2) $[Pt(NH_3)_5Cl]Cl_3$

Ques which of the following is electrically neutral

(5) $[Pt(NH_3)_2Cl_4]$

Ques which of the following do not form white ppt. when mixed with $AgNO_3$.

(5) $[Pt(NH_3)_2Cl_4]$

Ques which of the following will gives white ppt. when mixed with $BaCl_2$

(1) $[Co(NH_3)_4Cl_2]Cl$
(2) $[Co(NH_3)_5Cl]SO_4$
(3) $[Pt(en)_2Cl_2]Cl_2$
(4) $[Pt(NH_3)_5SO_4]Cl_2$

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

$BaCl_2$

$\downarrow$

$BaSO_4$

$BaSO_4$ → white ppt.

$Fe(NH_3)_6Cl_3 \rightarrow [Fe(NH_3)_6]Cl_3$
$Fe(NH_3)_5Cl_3 \rightarrow [Fe(NH_3)_5Cl]Cl_2$
$Fe(NH_3)_4Cl_3 \rightarrow [Fe(NH_3)_4Cl_2]Cl$

$Fe(H_2O)_5Cl_3$
- → $[Fe(H_2O)_5Cl]Cl_2$
- → $[Fe(H_2O)_4Cl_2]Cl.H_2O$
- → $[Fe(H_2O)_3Cl_3].2H_2O$ X

Effective Atomic Number or Sidgwick Rule :-

A metal atom or ion continue to accept $e^\ominus$ till ~~no~~ total no. of $e^\ominus$ on metal atom or ion and those accepted from ligand reach to a noble gas configuration.

E.A.N. = Atomic No. − Ox. No. + total $e^\ominus$ accepted from ligand or (2 × C.N.)

$[Co(NH_3)_6]Cl_3$ E.A.N. = 27 − 3 + 2 × 6 = 36 ← Kr
$K_4[Fe(CN)_6]$ E.A.N. = 26 − 2 + 2 × 6 = 36
$[Cu(CN)_4]^{3-}$ E.A.N. = 29 − 1 + 2 × 4 = 36
$[Pd(NH_3)_4Cl_2]Cl_2$ E.A.N. = 46 − 4 + 2 × 6 = 54 Xe

$[PtCl_4]^{2-}$ E.A.N. = 78 − 2 + 4×2 = 84 ✗
$[PtC_6]^{2-}$ E.A.N. = 78 − 4 + 6×2 = 86 ✓
$K_3[Fe(CN)_6]$ E.A.N. = 26 − 3 + 6×2 = 35 ✗
$Ni(CO)_4$ E.A.N. = 28 − 0 + 4×2 = 36
$Fe(CO)_5$ E.A.N. = 26 − 0 + 5×2 = 36
$Cr(CO)_6$ E.A.N. = 24 − 0 + 6×2 = 36

Applications :-

① To calculate no. of π carbon monoxide attached to metal atom in carbonyls.

$Ni(CO)_x$ ⇒ x = 4 $Fe(CO)_y$ ⇒ y = 5 $Cr(CO)_z$ z = 6

② $[Mn(CO)_6]^{\circ}$ behave as reducing agent

$Mn(CO)_6 \longrightarrow [Mn(CO)_6]^{+} + e^{\ominus}$
37 36

③ $[V(CO)_6]$ behave as oxidising agent

$[V(CO)_6] + e^{\ominus} \longrightarrow [V(CO)_6]^{-}$
23 − 0 + 12 = 35

IUPAC Nomencalture of C.C :-

Rules :-

① If cation is +nt in C.C then it is written is always 1st.

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

② Naming of coordination Sphere :-

First of all name of ligands is written in alphabetical order then name of C.M.A. is written following its O.N. in Roman number.

If multiple ligand are +nt :-

- Then write them in alphabatical order.
- Use di, tri, tetra - - - for monodentate ligands

if +nt in multiple no.

- For multiple no. of chelate ligand use bis, tris, tetrakis ---

di, tri, tetra are not used in alphabatical order
bis, tris --- ~~at~~ → used ~~at~~ in alphabatical order

Naming of -ve ligand	neutral	Cation
suffix 'o'	name as it	suffix 'ium'
Cl^- → Chlorido	NH_3 → amine	NO^+ nitrozonium
O^{2-} → oxo	H_2O → aqua	NO_2^+ nitronium
N^{3-} → Nitrido	CO → carbonyl	$NH_2-NH_3^{\oplus}$ hydrazinium
SO_4^{2-} → Sulphato		

$[Co(NH_3)_4Cl_2]^{\oplus}$ tetra amine dichlorido cobalt (III) ions

$[Co(en)_2Cl_2]^+$ bis (ethane-1,2-diamine) dichloro cobalt (III) ion

(3) If coordination sphere is +nt as anionic part then suffix '~~at~~ ate' is used after name of metal

$K_4[Fe(CN)_6]^{4-}$ Potassium hexacyano ferrate (II)

(4) If anion is +nt outside coordination sphere then name of anion is written at last.

$[Co(NH_3)_6]Cl_3$ hexaammine Cobalt (III) Chloride

1. $[Pt(NH_3)_4Cl_2]Cl_2$
tetra ammine dichlorido Platinium (IV) Chloride

2. $[Cr(H_2O)_4Cl_2]^+Cl$
Tetra aqua dichlorido cromium (III) Chloride

3. $K_4[Ni(CN)_4]$
Potassium tetracyano nickelate (0)

4. $K_3[Fe(CN)_5CO]$
Potassium carbonyl penta cyano Ferrate (II)
thio cyano

5. $(NH_4)_2[Pt(SCN)_6]$
hexathiocyanato Platinumate (IV)

6. $Na_2[CrOF_4]$
Sodium tetrafluorido oxo cromiate (IV)

7. $[Al(H_2O)_5OH]^{2+}$
Penta aqua hydroxo aluminaium (III)

8. $[Co(en)_2Cl_2]SO_4$ Dichlorido di (ethane 1,2-diamine) cobalt (IV) Sulphate

iso thio cyano

9. $[Co(NH_3)_5NCS]Cl_2$ Penta amine iso thio cyanato cobalt (III) Chloride

Lithium tetra hydrido aluminate (III)

10. $(LiAlH_4)^-$

11. $[\{(C_6H_5)_3P\}_3Rh]Cl$ tris (tri phenyl phosphine) Rhodium I Chloride

12. $K_2[PdCl_4]$ Potassium tetra chlorido pallidiumate (II)

13. $[Pt(NH_3)_2Cl(NH_2NH_3)]Cl$
Diamine chlorido hydrazinium Platium (I) Chloride

14. $K_3[Cr(C_2O_4)_3]$
Potassium tris-oxalato chromate (III)

15. $[Pt(NH_3)_2Cl(NO_2)]$ $x + -1 + 1 = 0$, $x = 0$
diamine chlorido nitronium Platinum

16. $Cr(CO)_6$
hexa carbonyl cromium

16

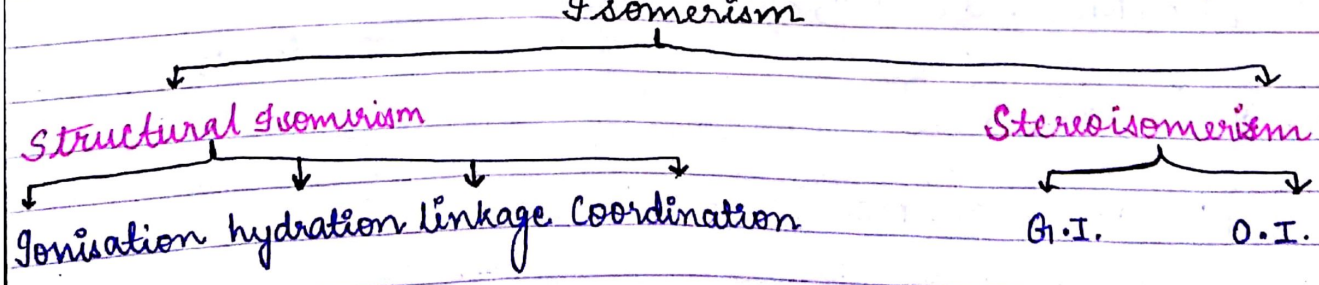
17. $[Cr(NH_3)_6]^{3+}$ $[Co(CN)_6]^{3-}$
Hexa amine Chromium (III) Hexacyano cobaltate (III)

Ques: Write formula of following :-

1. tetra carbonyl Nickel (0)
$Ni(CO)_4$
2. tetra amine aqua chlorido cobalt (III) Chloride
$[Co(NH_3)_4(H_2O)Cl]Cl_2$
3. bis (ethane-1,2-diamine) dibromido Chromium (II)
$(Cr(en)_2Br_2)$
4. Ammine bromido chlorido nitro - N - Platinate (II)
Pt
5. Iron (III) hexacyano ferrate (II)
$Fe^{3+}[Fe(CN)_6]^{4-}$ $Fe_4[Fe(CN)_6]_3$
6. Potassium tetracyano nickelate (II)
$K_2[Ni(CN)_4]$
7. Potassium tris oxalato aluminate (III)
$K_3[Al(C_2O_4)_3]$

IQ NEET/AIIMS

Isomerism :- Compds which have same molecular formula but different structural formula are k/a as isomers & phenomena is k/a as isomerism.



1. Ionisation isomerism : In these type of isomerism, interchange of ligands takes place b/w coordination & ionisation ~~isomerism~~ sphere

eg $[Co(NH_3)_5Br]SO_4$ or $[Co(NH_3)_5SO_4]Br$

Pentamine amine bromido Cobalt (III) Sulphate

Pentamine sulphato Cobalt (III) bromide.

$[Pt(NH_3)_4Cl_2]Br_2$ $[Pt(NH_3)_4Br_2]Cl_2$

$[Co(NH_3)_5NO_2]SO_4$ $[Co(NH_3)_4SO_4]NO_2$

$[PtCo(NH_3)_4SO_4]Cl_2$ $[Pt(NH_3)_4Cl_2]SO_4$

Hydration isomerism : water molecule are +nt in coordination as well as ionisation sphere

$Cr(H_2O)_6.Cl_3$ Soluation

$[Cr(H_2O)_6]Cl_3$ $[Cr(NH_3)_6]Cl_3$

$[Cr(H_2O)_5Cl]Cl_2.H_2O$ $[Cr(NH_3)_5Cl]Cl_2.NH_3$

$[Cr(H_2O)_4Cl_2]Cl.2H_2O$ $[Cr(NH_3)_4Cl_2]Cl.2NH_3$

$[Cr(H_2O)_3Cl_3].3H_2O$ X $[Cr(NH_3)_3Cl_3].3NH_3$ X

Hydration isomerism is a special case of ionisation isomerism

Linkage Isomerism :- Shown by those coordination compd which have ambidentate ligand.

- This type of Isomerism takes place due to change of donor atom due to ambidentate ligand.

eg $[Cr(NH_3)_5NO_2]Cl_2$. & $[Cr(NH_3)_5(ONO)]Cl_2$

Penta ammine nitro chromium (III) Chloride

Penta ammine nitrito-chromium (III)

Pentaammine nitro-N-chromium(III) chloride

Pentaamine nitro-O-chromium (III) chloride

$[Co(NH_3)_5(NCS)]Br_2$ $[Co(NH_3)_5(SCN)]Br_2$

Coordination isomerism :- This type of isomerism takes place in those compd in which cation & anion both are +nt as complex.

- This It takes place due to interchange of ligand b/w 2 complex.

eg : $[Cr(NH_3)_6]^{3+}[Co(CN)_6]^{3-}$ & $[Co(NH_3)_6][Cr(CN)_6]$

hexa amine chromium (III)
hexacyano cobaltate (III)

$[Pt\,Cl_4]^{2+}[Cu\,Cl_4]^{2-}$ $[Cu\,Cl_4]^{2+}[Pt\,Cl_4]^{2-}$

tetra chlorido Platinum (VI) tetra chlorido copper
tetra chlorido cuprate (VI)

- $[Pt\,Cl_4][Cu(CN)_4]$ $[Cu\,Cl_4][Pt(CN)_4]$

Stereo isomerism :- which have same M.F. or chemical formula but special arrangement

Geometrical isomerism — Cis, Trans

Cis :- If same ligand occupy similar pos^n w.r.t. each other c/a cis isomer.

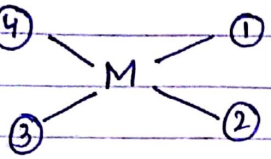
trans : If same ligand occupy opposite pos^n w.r.t each other, c/a trans isomer.

C.N. = 4

tetrahedral sp^3
G.I. X
$[Cu\,Cl_4]^{2-}$, $Ni(CO)_4$

~~dsp^2~~ Square Planar
$[Pt(NH_3)_2Cl_2]$

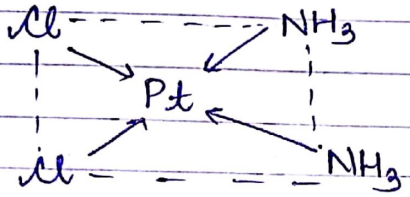
Type - I Ma_2b_2



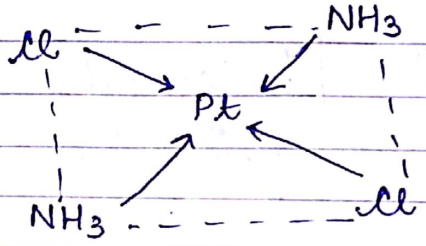
M → C.M.A.
a → Monodentate
b → Monodentate

cis 1-2, 2-3, 3-4, 4-1
trans 1-3, 2-4

$[Pt(NH_3)_2Cl_2]$



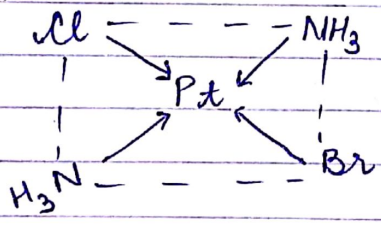
cis platin
anti cancerous used in chemotherapy



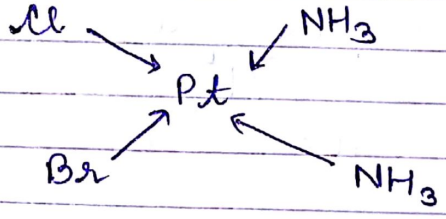
trans - platin

Type - II Ma_2bc

M → CMA
a, b, c → monodentate ligand



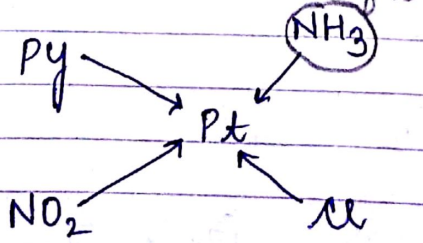
trans

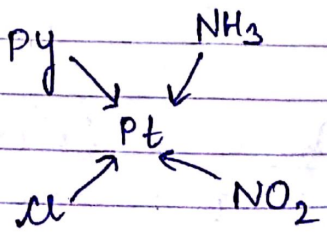


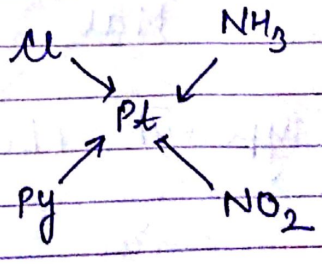
cis

Type - III Mabcd

G.I. = 3





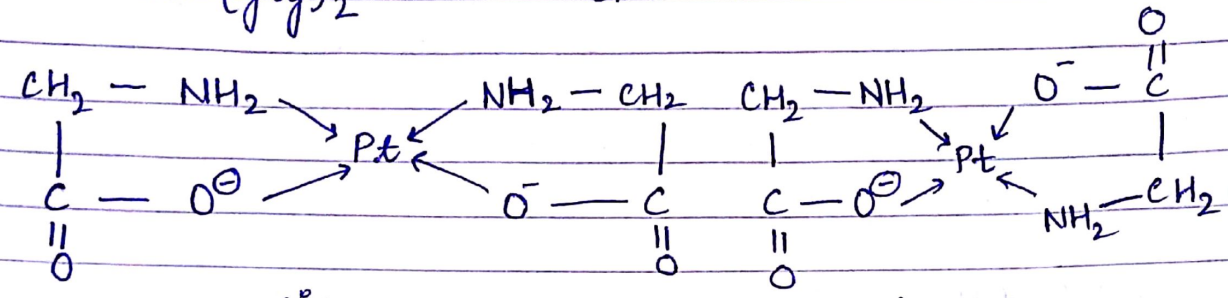


2/11/17

Type-IV $[M(ab)_2]$

↳ unsymm. bidentate

$Pt(gly)_2$ G.I. = 2

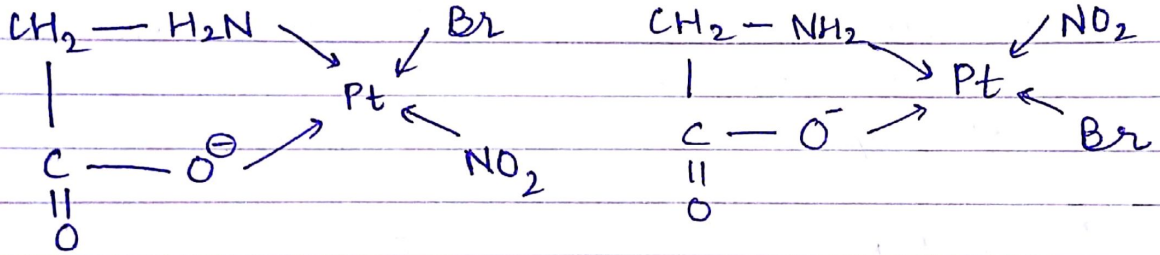


cis trans

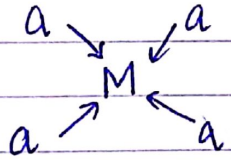
Type V $[M(ab)cd]$

unsy. bi mono

G.I. = 2

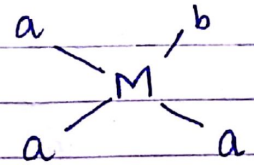


Type VI Ma_4



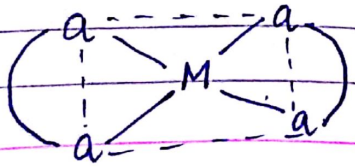
G.I. = 0

Type VII Ma_3b or Mab_3



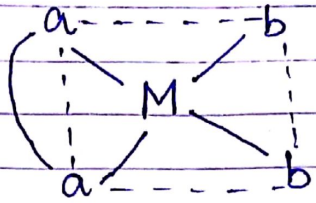
G.I = 0

Type VIII $M(aa)_2$ $Pt(en)_2$



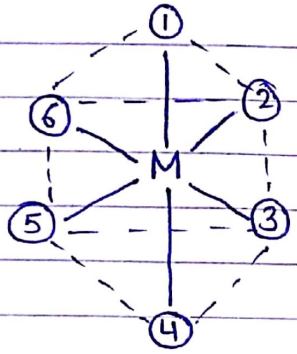
G.I. = 0

Type $M(aa)b_2$



G.I. = 0

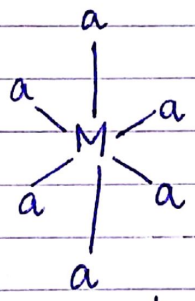
C.N. = 6 d^2sp^3 / sp^3d^2 Octahedral



cis → (1,2) (1,3) (1,5) (1,6) (4,3)
(4,2) (4,6) (4,5)
(2,6) (2,3)
(5,6) (5,3)

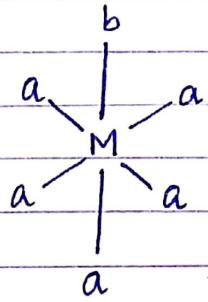
trans → (1,4) (2,5) (3,6)

(1) Ma_6



G.I. = 0

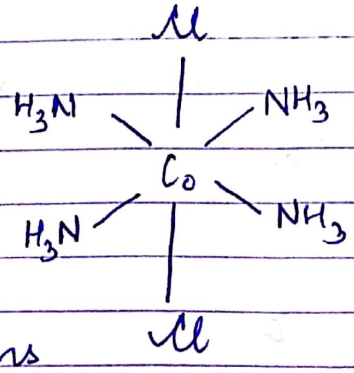
(2) Ma_5b



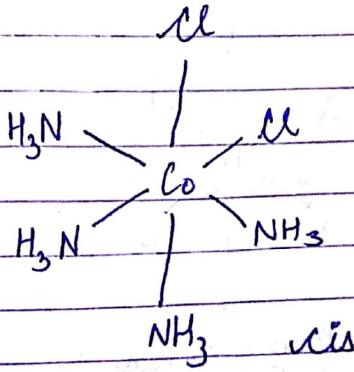
G.I. = 0

(3) Ma_4b_2

G.I. = 2

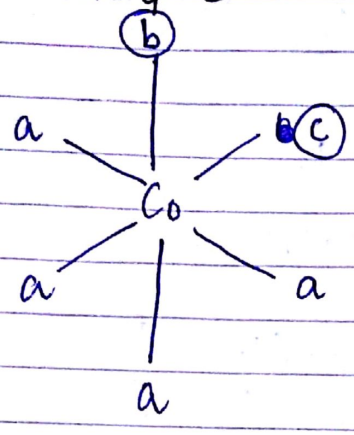


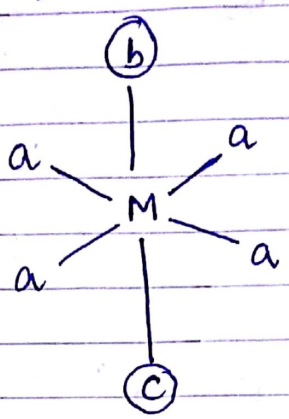
trans



cis

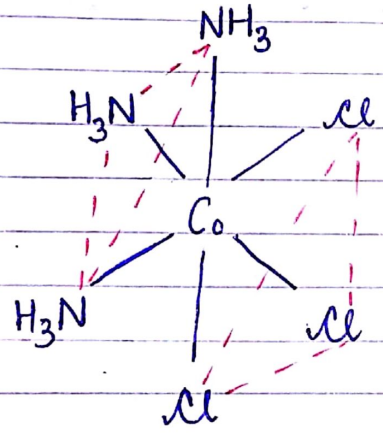
(4) Ma_4bc G.I. = 2



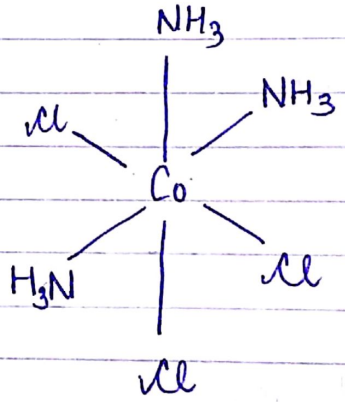


trans

(5) Ma_3b_3 G.I. = 2

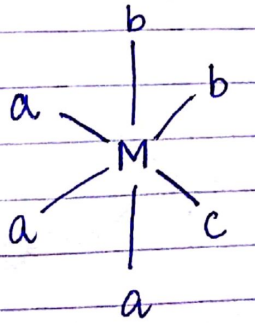


Facial or fac isomer

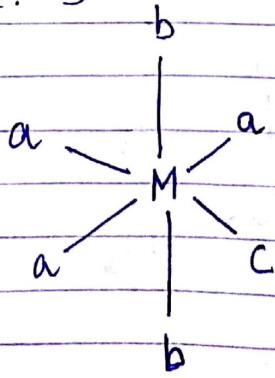


Meridonal or mer isomer

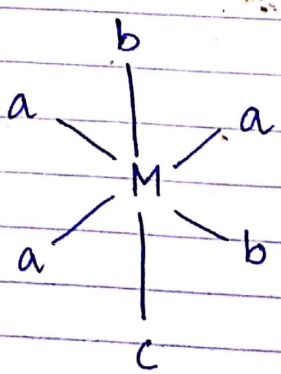
(6) Ma_3b_2c G.I. = 3



a-b, a-c] trans
b-b, a-b, a-c] cis

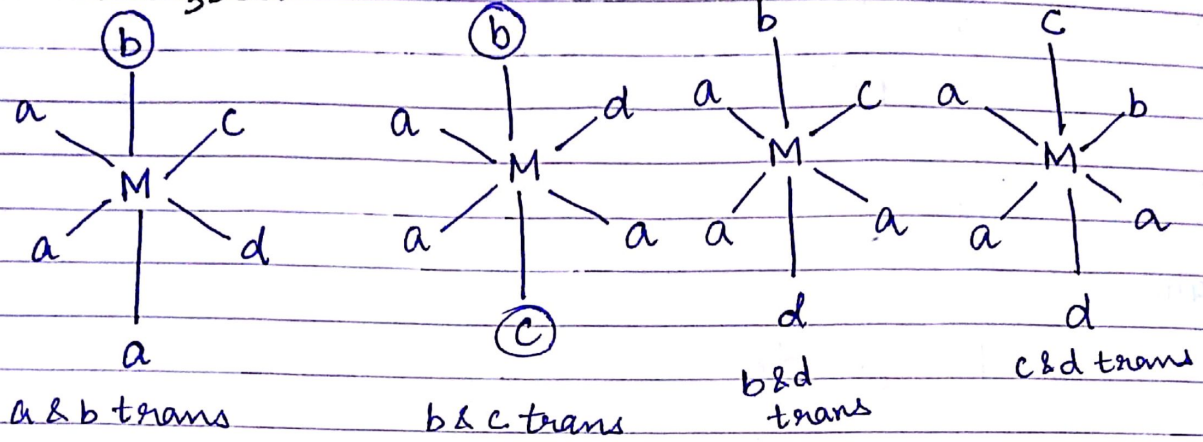


a-a, a-c] trans
b-b
a-a, ac, bc, ab → cis

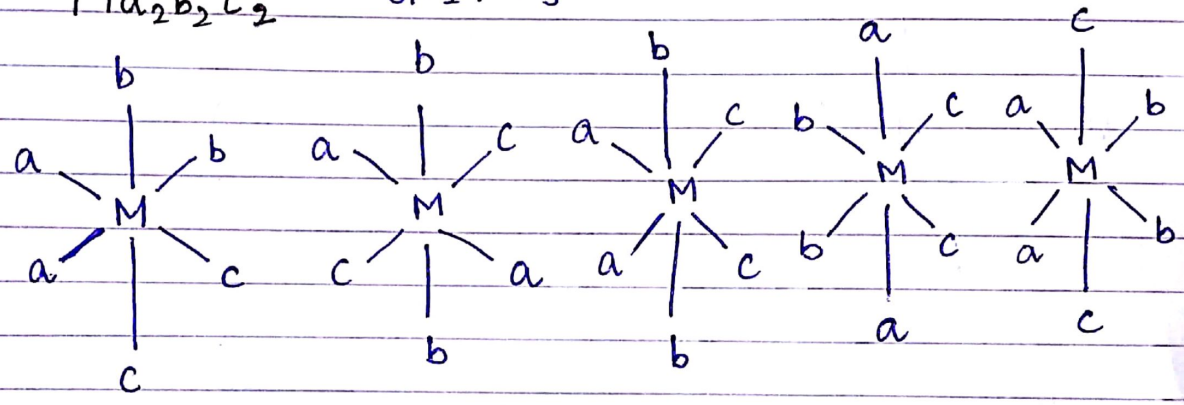


ab, aa, bc → trans
aa, ab, ca, cb, ba, bb → cis

(7) Ma_3bcd G.I. = 4

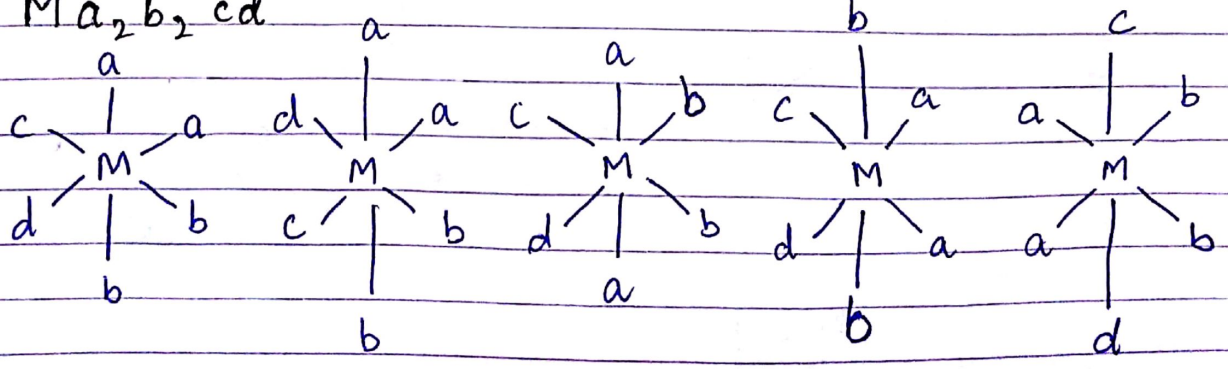


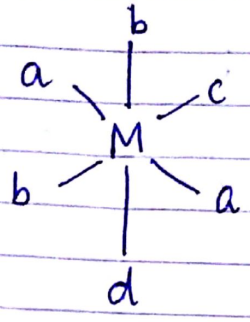
(8) $Ma_2b_2c_2$ G.I. = 5



a → b/c/d → 3
a, b → c, d → 2
a, b, c → d → 1
6

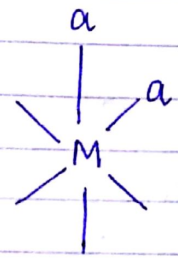
(9) Ma_2b_2cd





4/11/17

(10) Ma_2bcde



a-a cis

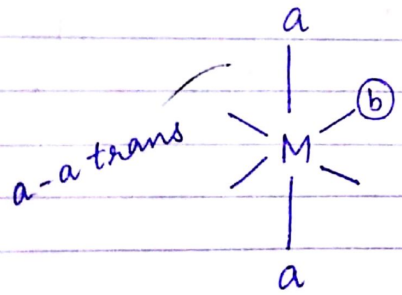
fix

(b) - c, d, e → 3

(b, c) - d, e → 2

(b, c, d) → e → 1

(6)



(b) → c, d, e → 3

total = 6 + 3 = 9

(11) $Mabcdef$

(a) → bcdef → 5

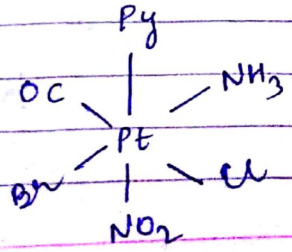
a, b → cdef → 4

a, b, c → d, e, f → 3

a, b, c, d → e, f → 2

abcde → f ⇒ 1

15



	G.I.	O.I.
$Mabcdef$	15	30
Ma_2bcde	9	12
Ma_2b_2cd	6	
$Ma_2b_2c_2$	5	
Ma_3bcd	4	
Ma_3b_2c	3	
Ma_3b_3	2	
Ma_4bc	2	
Ma_4b_2	2	
Ma_5b	0	
Ma_6	0	

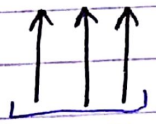
Optical Isomerism :- which form & non-superimposable mirror images of each other c/a optical isomers and phenomena c/a optical isomerism

PPL

Optically Active

Clockwise → dextro rotatory → d (+)

anticlockwise → laevorotatory → l (−)

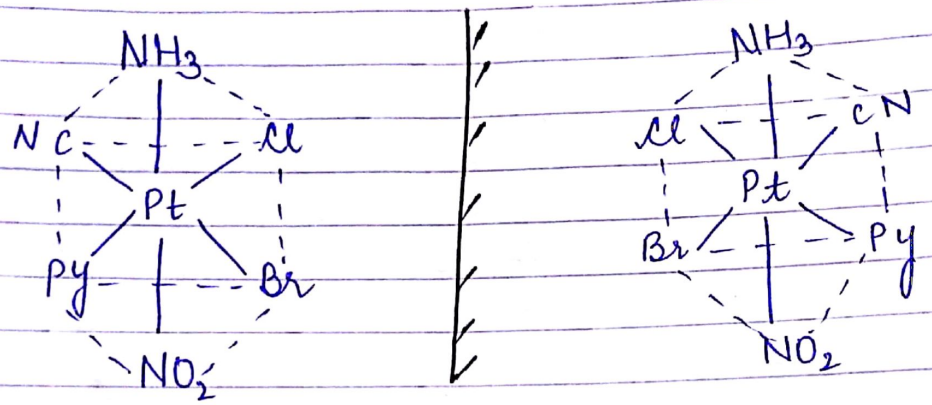


Optically inactive

Note : Unsymmetrical compds shows optical isomerism i.e. pdsn, centre and axis of symmetry is absent in optically Active compds.

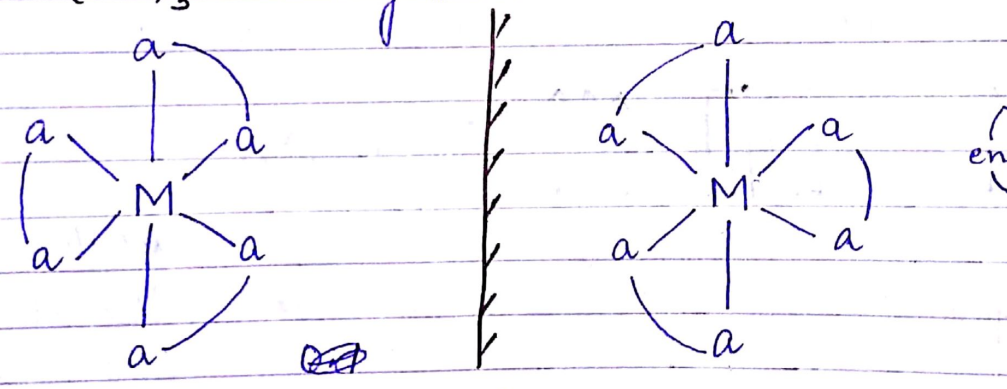
Note : cis give O. Active

Mabcdef



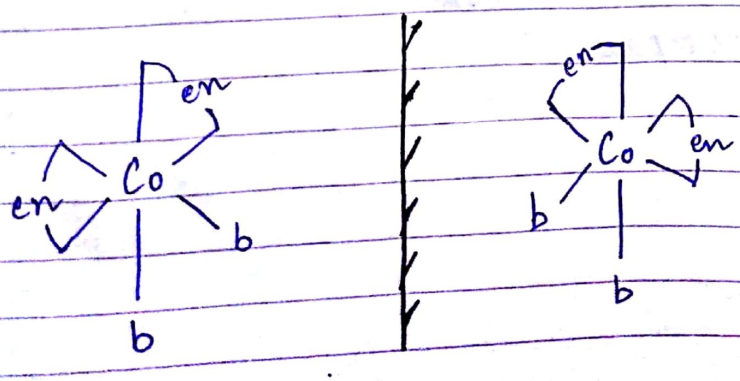
G.I. = 15
O.I. = 30

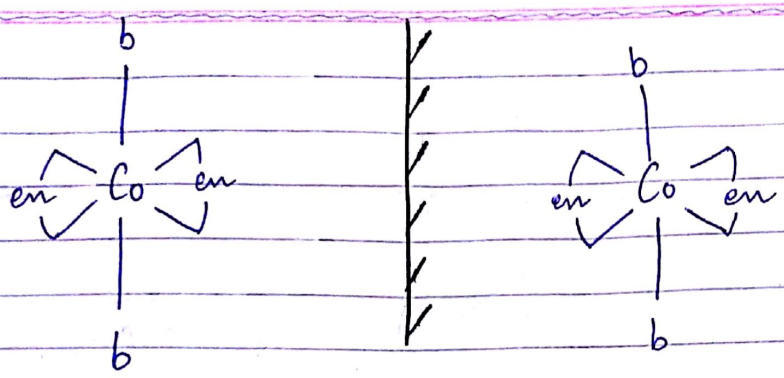
M(aa)3 eg $[Co(en)_3]^{3+}$



v. imp

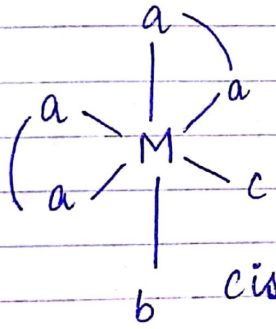
$M(aa)_2b_2$





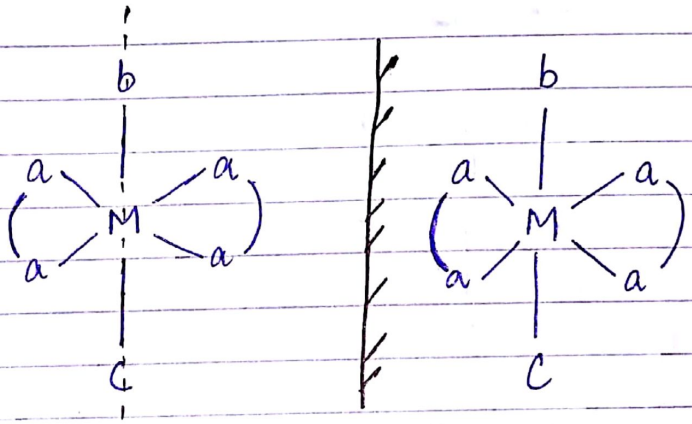
trans O.A.X

$M(aa)_2bc$



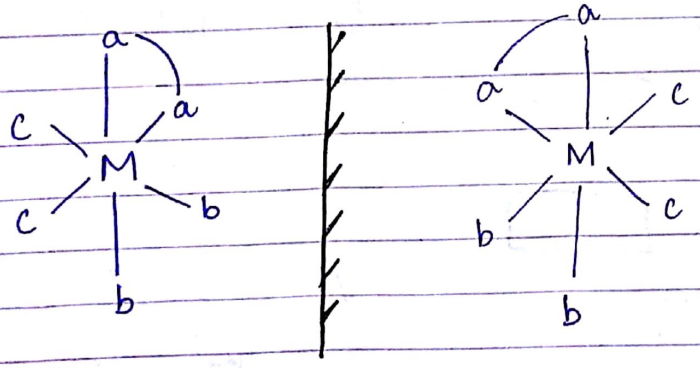
cis

O.A.



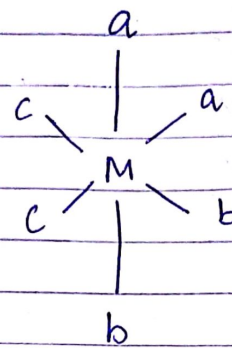
Optically Inactive

$M(aa)b_2c_2$

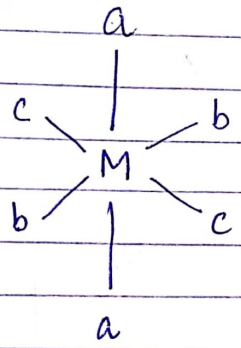


O.A.

$Ma_2b_2c_2$

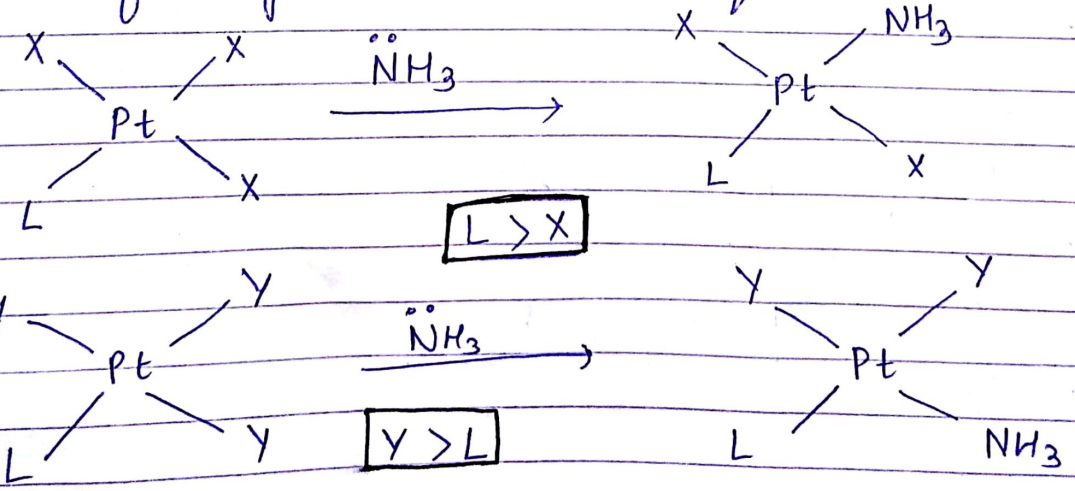


cis O.A.



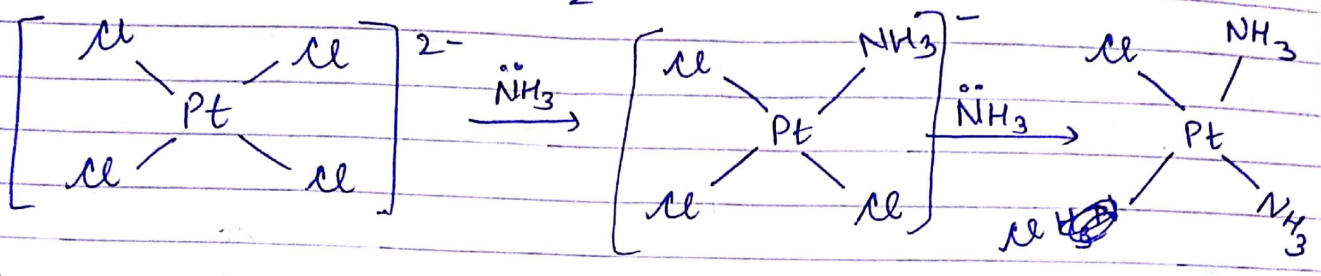
trans O. inactive

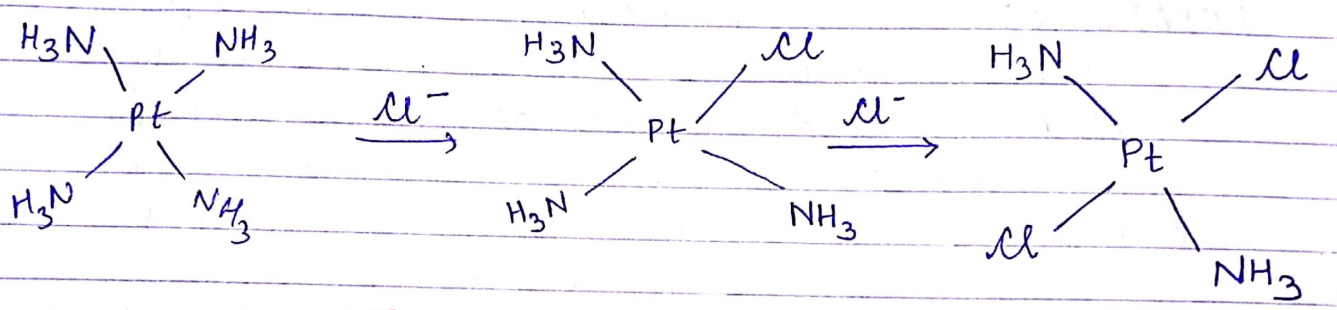
- **Trans - Effect** : It is kinetic phenomena which means that to it promotes faster substitution rate for ligands trans to itself than cis to itself.



Strength of trans director

$H_2O < OH^- < NH_3 < Py < Cl^- < Br^- < SCN^- < I^- < NO_2^- < Ph^- < CH_3^- < H^- < PR_3 < C_2H_4 < CN^- < CO$





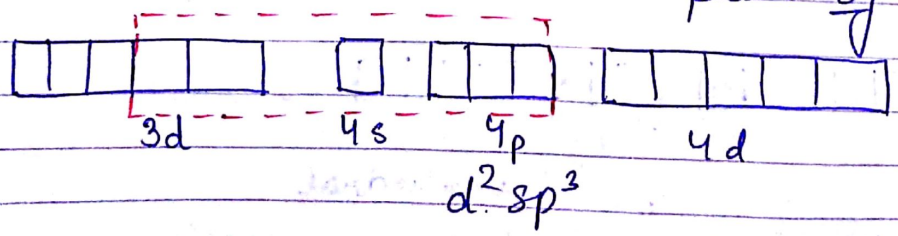
Valence Bond Theory :- given by Pauling.

Postulate 1 : C.M.A or ion must have vacant orbitals to accept lp donated by ligands.

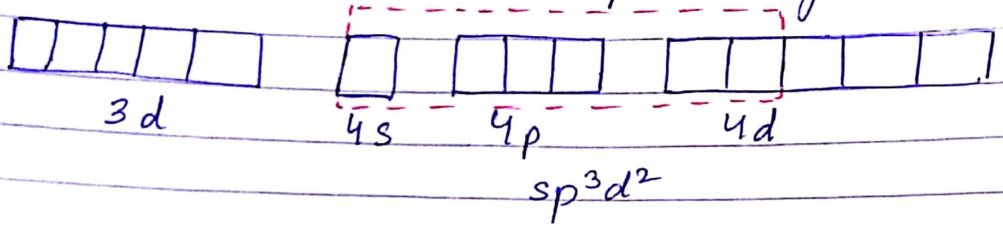
Postulate 2 : Vaccant orbitals of same or nearly same energy undergoes hybridisation & forms new set of —

Postulate 3: If inner & (n-1)d take part in hybridisation complex formed is $\perp$ as.

Inner orbital complex eg d^2sp^3



Postulate-4 : If outer 'n d' orbitals take part in hybridisation then complex formed is K/n as outer orbital complex eg : sp^3d^2



Postulate5 :- Outer ~~com~~ orbital complex is formed in ~~+nce~~ presence of weak ligand while inner orbitals complex is formed in presence of strong ligand. Ligands are arranged in a series acc^h to their strength known as spectrochemical series

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

← Weak →

$< py < NH_3 < NO_2^- < en < CN^- < CO$

← STRONG →

Halogen atom < O-donor < N-donor < C-donor

Postulate-6

Generally complex are diamagnetic in presence of strong ligand ∵ SL cause pairing $e^{\ominus}$.

→ Inner orbital complex / low spin complex

and in presence of weak ligand complex are paramagnetic ∵ WL donot cause pairing of $e^{\ominus}$.

→ Outer orbital Complex / high spin complex.

eg ① $[NiCl_4]^{2-}$

Ni^{2+}

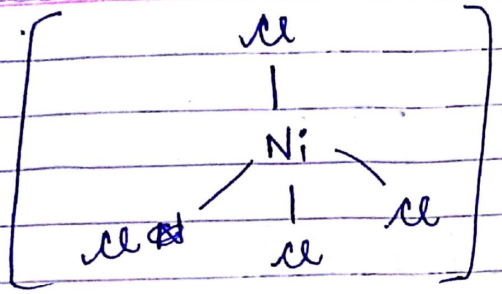
sp^3 tetrahedral

$Cl^- \rightarrow$ W.L

pairing X

→ 2 unpaired, Paramagnetic

(2)



(2) $[Ni(CN)_4]^{2-}$

Ni^{2+} ↑↓ ↑↓ ↑↓ ↑ ↑ | | | | |

3d

CN^- S.L. Pairing ✓

Ni^{2+} ↑↓ ↑↓ ↑↓ ↑↓ ×× | ×× | ×× ×× | | |

CN^-

dsp^2, Square Planar

diamagnetic

(3) $Ni(CO)_4$

Ni ↑↓ ↑↓ ↑↓ ↑ ↑ | ↑↓ | | |

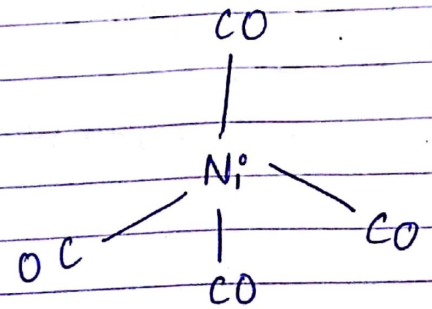
$3d^8$ $4s^2$

CO → SL, pairing ✓

Ni ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ | ×× | ×× ×× ××

sp^3, tetrahedral

dia



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

Co^{3+} 3d 4s 4p

Co^{3+}

NH_3 → S.L.

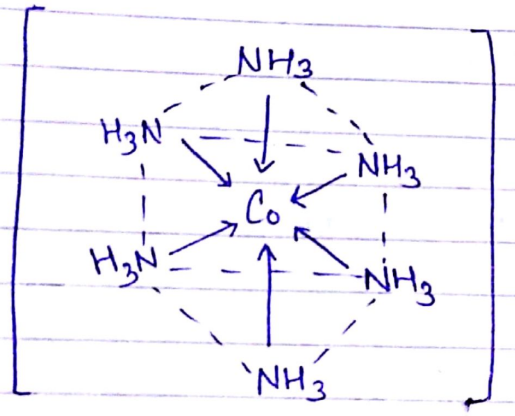
Pairing

d^2sp^3, Octahedral

dia. IOC / LSC

↓ Inner orbital Complex

↳ low spin complex



(5) $[CoF_6]^{3-}$

Co^{3+}

F^- → W.L.

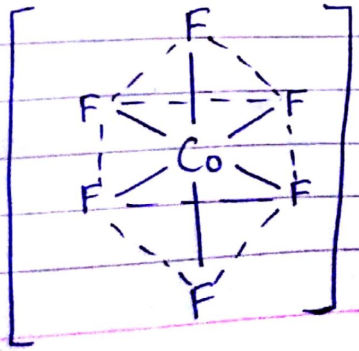
pairing ✗

F^-

sp^3d^2, Octahedral

$n = 4$, Paramagnetic

outer orbital complex ← OOC / HSC ↳ High spin complex



6. $[Fe(CN)_6]^{4-}$

Fe^{2+} ↑↓ | ↑ | ↑ | ↑ | ↑ | 3d | ↑ | 4s | | | | 4p

$CN^- \rightarrow$ S.L.

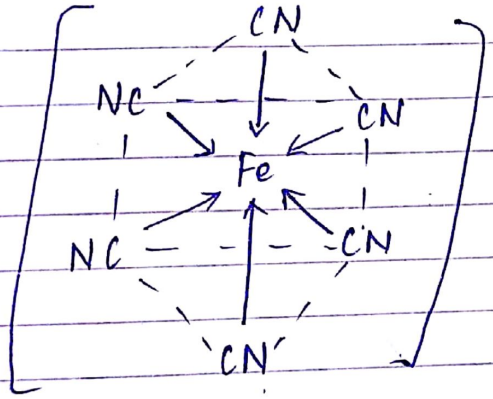
Fe^{2+} ↑↓ | ↑↓ | ↑↓ | ✕✕ | ✕✕ | ✕✕ | ✕✕ | ✕✕ | ✕✕ | ✕✕

CN^-

d^2sp^3, Octahedral

$n = 0$ dia

IOC / L.S.C.



7. $[Fe(CN)_6]^{3-}$

Fe^{3+} ↑ | ↑ | ↑ | ↑ | ↑ | | | |

$CN^- \rightarrow$ S.L. $\rightarrow$ pairing ✓

Fe^{3+} ↑↓ | ↑↓ | ↑ | ✕✕ | ✕✕ | ✕✕ | ✕✕ | ✕✕ | ✕✕ | | | | | |

d^2sp^3, Octahedral

$n = 1$ Paramagnetic

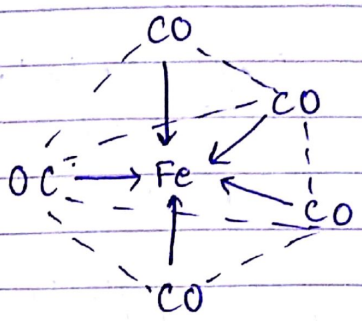
IOC / L.S.C.

8. $Fe(CO)_5$

Fe ↑↓ | ↑ | ↑ | ↑ | ↑ | ↑↓ | | | |

CO → S.L. → Pairing

$Fe(CO)_5$ ↑↓ | ↑↓ | ↑↓ | ↑↓ | ×× | ×× | ×× | ×× | ××



dsp^3, Trigonal Bipyramidal

$n = 0$ dia

IOC / LSC

9. $Cr(CO)_6$

Cr ↑ | ↑ | ↑ | ↑ | ↑ | ↑ | | |

3d 4s 4p

CO → S.L → pairing

$Cr(CO)_6$ ↑↓ | ↑↓ | ↑↓ | ×× | ×× | ×× | ×× | ××

d^2sp^3, Octahedral

$n=0$, dia

IOC / L.S.C.

10. $[Ag(NH_3)_2]^+$

Ag^+ ↑↓ | ↑↓ | ↑↓ | ↑↓ | ↑↓ | ×× | ×× | | |

4d 5s 5p

sp, linear

$[NH_3 \rightarrow Ag \leftarrow NH_3]^+$ $n=0$, dia

$[Cu(H_2O)_4]^{2+}$ → S.L

$[Ni(H_2O)_6]^{3+}$ → W.L

Note :- 1. NH_3 & H_2O works as strong Ligand in case of Cu^{2+} & Co^{3+}.

ALEEE

① $[Ni(NH_3)_6]^{2+}$

Ni^{2+} ↑↓ ↑↓ ↑↓ ↑ ↑ | 3d | 4s | 4p

NH_3 → S.L., pairing ✗ → Cu^{2+} & Co^{3+}

NH_3 → W.L., Pairing ✗

Ni^{2+} ↑↓ ↑↓ ↑↓ ↑ ↑ | ✗✗ | ✗✗ ✗✗ ✗✗ | ✗✗ ✗✗

sp^3d^2, Octahedral

** n = 2, Paramagnetic

OOC / HSC

② $[Fe(NH_3)_6]^{2+}$

Fe^{2+} ↑↓ ↑ ↑ ↑ ↑ | | | Cu^{2+} & Co^{3+}

NH_3 → SL, pairing ✗

NH_3 → WL, Pairing ✗

Fe ↑↓ ↑ ↑ ↑ ↑ | ✗✗ | ✗✗ ✗✗ ✗✗ | ✗✗ ✗✗

sp^3d^2, Octahedral

OOC / HSC

n = 4, Para

③ $[Cu(NH_3)_4]^{2+}$

Cu^{2+} ↑↓ ↑↓ ↑↓ ↑↓ ↑ | 3d | 4s | 4p

NH_3 → SL, excitation

↑↓ ↑↓ ↑↓ ↑↓ ✗✗ | ✗✗ | ✗✗ ✗✗ ↑ | 3d | 4s | 4p

IOC / HSC

dsp^2, Square Planar

n = 1, Paramagnetic

$Pd \rightarrow [Kr]\ 4d^{10}\ 5s^0$

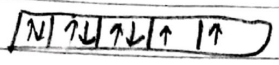
36

Note : W.L. works as S.L. in +nce of 4d & 5d metals

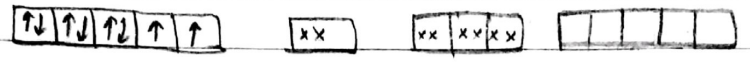
$[NiCl_4]^{2-}$ $Cl^- \rightarrow$ W.L. Pdra

$[PdCl_4]^{2-}$, $[PtCl_4]^{2-}$ $Cl^- \rightarrow$ S.L. dia

$[NiCl_4]^{2-}$

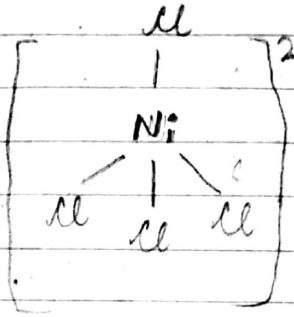
Ni^{+2} 

$Cl^- \rightarrow$ W.L.

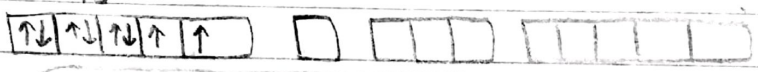
Ni^{2+} 

sp^3 tetrahedral

$n = 2$ Para.

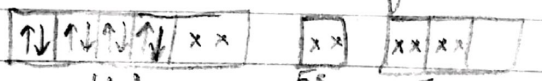


$[PdCl_4]^{2-}$

Pd^{2+} 

$Cl^- \rightarrow$ W.L. Pairing ✗ ✗

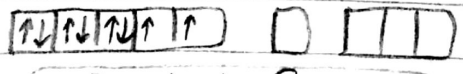
$Cl^- \rightarrow$ S.L. Pairing ✓

Pd^{2+} 

dsp^2 Square Planar

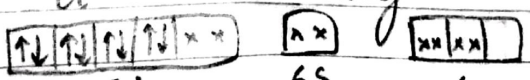
diamagnetic

$[PtCl_4]^{2-}$

Pt^{2+} 

$Cl^- \rightarrow$ W.L. Pairing ✗ ✗

$Cl^- \rightarrow$ S.L. Pairing ✓

Pt^{2+} 

dsp^2 Square Planar

$n = 0$ diamagnetic

NCERT NEET-2018

$[Co(C_2O_4)_3]^{3-}$ → dia

oxalato → $C_2O_4^{2-}$ in +nce of Co^{3+} works as S.L.

Co^{3+} | ↑↓ | ↑ | ↑ | ↑ | ↑ | | | | |

Co^{3+} | ↑↓ | ↑↓ | ↑↓ | × | × | | × | | | |

d^2s

$C_2O_4^{2-}$ → W.L. Pairing ✗

$C_2O_4^{2-}$ → Pairing, S.L.

diamagnetic

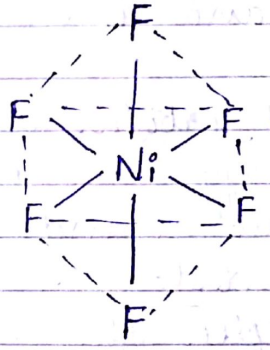
AIIMS

F^- works as S.L. in +nce Ni^{4+}

$[NiF_6]^{2-}$ → dia

→ d^2sp^3

Ni^{4+} | ↑↓ | ↑ | ↑ | ↑ | ↑ | |



F^- → ~~SFL~~ W.L. Pairing ✗ ✗

F^- → S.L, Pairing

Ni^{4+} | ↑↓ | ↑↓ | ↑↓ | × | × | | × | | × | × | × |

d^2sp^3, Octahedral

diamagnetic.

LIMITATIONS OF V.B.T. :-

1. It ~~could not~~ involves a no. of assumptions.
2. It doesnot give ~~quantative~~ titative interpretion of magnetic data.
3. It doesnot explain color exhibit by V.B.T. compd.

4. It doesnot explain stability of coordination comped.
5. It couldnot distinguish W.L. and S.L.
6. It couldnot explain tetrahedral and square planar structures of compd.

Spectro chemical series :-

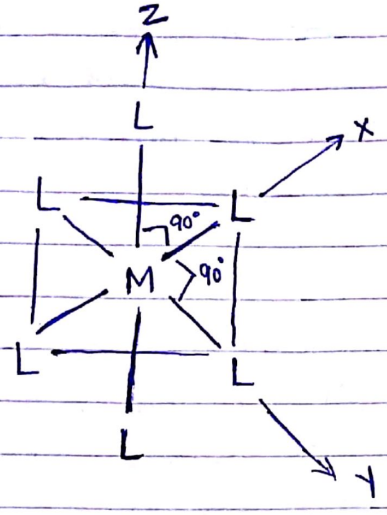
$I^- < Br^- < SCN^- < Cl^- < S^{-2} < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS < EDTA < py < NH_3 < en < CN^- < CO$

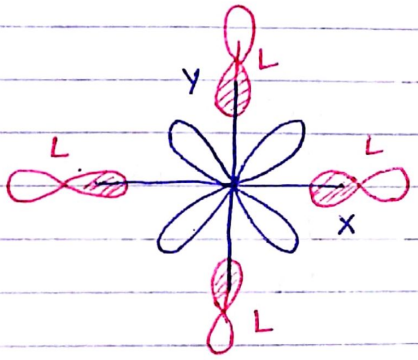
C.F.T. :-

1. Ligands are considered as point charges. 2. There is only electrostatic force of attraction b/w metal orbital & ligand orbital i.e. bond b/w metal & ligand is purely ionic.

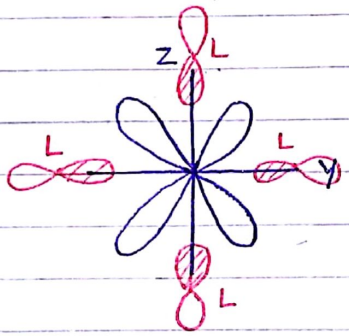
3. 5 d orbital are degenerate orbital i.e. have same energy.
When ligands approaches these degenerate orbitals they destroy degeneracy of these 5 d orbitals and splits them into 2 new set of orbitals c/a t_{2g} orbitals & eg orbitals.
This splitting of orbitals into is c/a Crystal Field splitting and amt. of energy released is c/a Crystal Field Stabilisation Energy (CFSE)
(CFSE)
The amt. of energy released in +nce of strong ligand is more than the amt. of energy released in +nce of weak ligand. So strong field ligand form more stable complex than weak field ligand.

CFS in Octahedral Complex :-

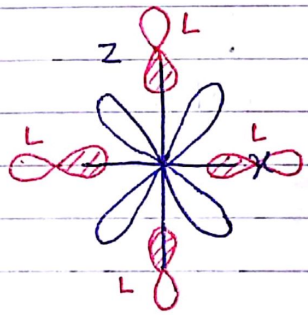




dxy

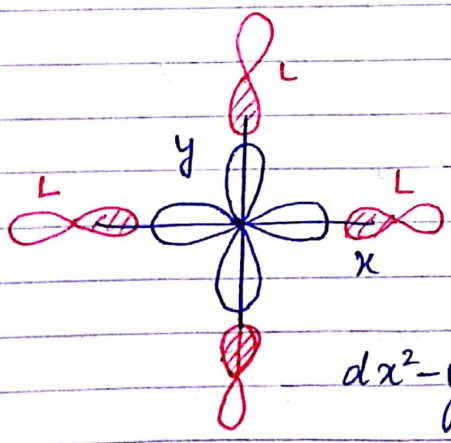


dyz



dzx

t_{2g} orbitals



dx^2-y^2

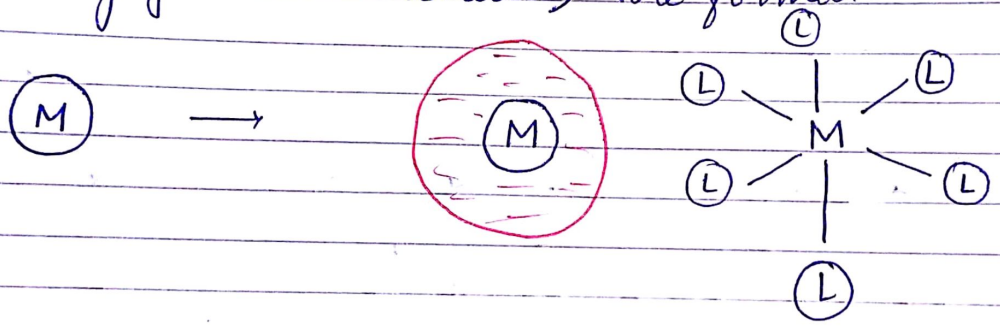
dz^2

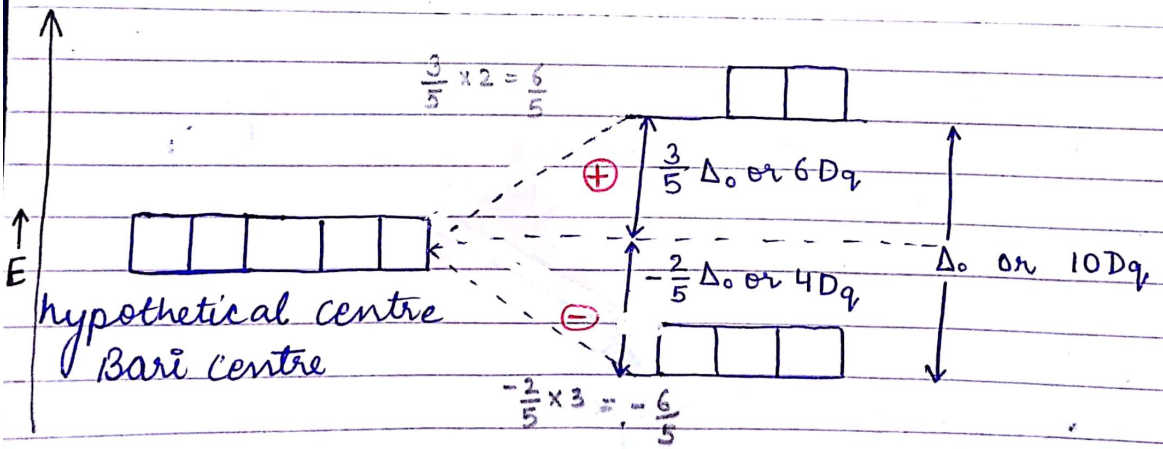
eg orbitals

→ Acc^n. to CFT, ligands always approach along the axes.

dxy, dyz & dxz orbitals does not come directly in path of approaching ligand so ~~that~~ there is less repulsion b/w metal orbital & ligand orbital hence lower energy t2g orbital (tripally generate orbitals) are formed.

dx^2-y^2 & dz^2 orbitals comes direct in path of approaching ligands so there is more ~~to~~ repulsion b/w metal orbital & ligand orbital ~~hatt~~ hence higher energy eg orbitals (doubly genertate orbitals) are formed.





Δ_o → CFSE for Octahedral complex

$e^\ominus$ are filled acc^ to Hund's Rule

(e^- are filled in t2g / lower energy orbitals acc^n to Hund's Rule)

Conf.	weak ligand $\Delta_o < P$	n	μ	Strong ligand $\Delta_o > P$	n	μ
d^1	$t_{2g}^1 e_g^0$	1	1.73	$t_{2g}^1 e_g^0$	1	1.73
d^2	$t_{2g}^2 e_g^0$	2	2.84	$t_{2g}^2 e_g^0$	2	2.84
d^3	$t_{2g}^3 e_g^0$	3	3.90	$t_{2g}^3 e_g^0$	3	3.90
d^4	$t_{2g}^3 e_g^1$	4	4.92	$t_{2g}^4 e_g^0$	2	2.84
d^5	$t_{2g}^3 e_g^2$	5	5.	$t_{2g}^5 e_g^0$	1	1.73
d^6	$t_{2g}^4 e_g^2$	4	4.	$t_{2g}^6 e_g^0$	0	0
d^7	$t_{2g}^5 e_g^2$	3	3.90	$t_{2g}^6 e_g^1$	1	1.73
d^8	$t_{2g}^6 e_g^2$	2	2.84	$t_{2g}^6 e_g^2$	2	2.84
d^9	$t_{2g}^6 e_g^3$	1	1.73	$t_{2g}^6 e_g^3$	1	1.73
d^{10}	$t_{2g}^6 e_g^4$	0	0	$t_{2g}^6 e_g^4$	0	0.

P → Pairing energy required for pairing of $e^\ominus$ in an orbitdl.

in case of d^1, d^2, d^3, d^8, d^9, d^{10} conf. does not depend upon strength of ligand.

but in case of d^4, d^5, d^6, d^7 conf. depend upon strength of ligand.

Ques Which of the following configuration will show magnetic moment equal to 2.84 BM ?

① d^3
② d^5 (in case of weak ligand)
③ d^4 (in case of strong ligand)
④ d^4 (in case of weak ligand)

AIEEE
Ques Which of the following have least value of magnetic moment ?

① $[Fe(CN)_6]^{3-}$ ② $[Co(CN)_6]^{3-}$ ③ $[Cr(CN)_6]^{3-}$ ④ $[Mn(CN)_6]^{3-}$

$3d^5$ $n=1$ $3d^6$ $n=0$

$CN^- \rightarrow$ S.L.

CFSE for octahedral complex = $[-0.4 \times n_{t_2g} + 0.6 n_{eg}]\Delta_o + P$

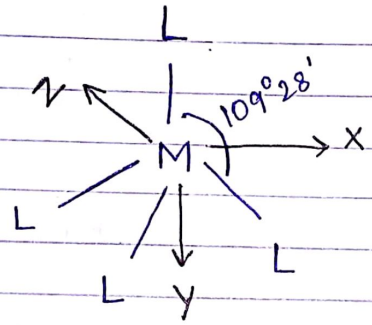
P → Pairing energy

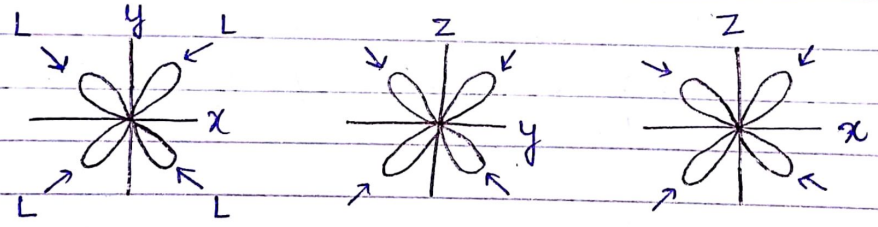
Δ_o → CFSE for octahedral complex

n_{t_2g} → no. of $e^\ominus$ in t_2g orbitals

n_{eg} → no. of $e^\ominus$ in eg orbitals.

CFS in Tetrahedral complex :-

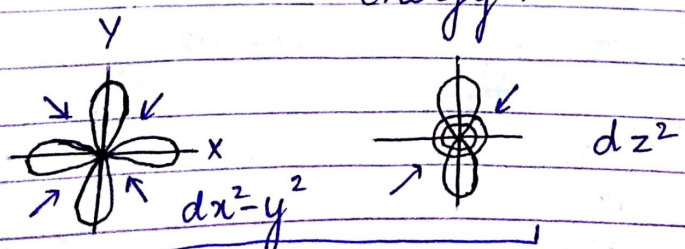




dxy dyz dzx

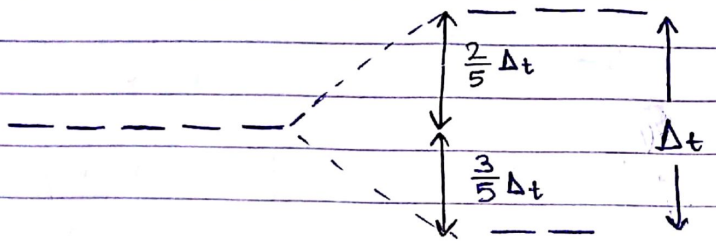
t_{2g}

t_{2g} orbitals point directly to ligand repulsion ↑ energy ↑



eg

eg orbitals does not point directly to ligand
repulsion ↓
energy ↓



$\Delta t \rightarrow$ CFSE for Tetrahedral complex

$$CFSE = (+0.4\,\Delta t)\,n_{t_{2g}} + (-0.6\,\Delta t)\,n_{eg} + P$$

Note : Tetrahedral Complex are formed in +nce of W.L.

Conf.	Weak ligand $\Delta_t < P$	n	μ
d^1	$t_{2g}^0 eg^1$	1	1.73
d^2	$t_{2g}^0 eg^2$	2	2.84
d^3	$t_{2g}^1 eg^2$	3	3.87
d^4	$t_{2g}^2 eg^2$	4	4.90
d^5	$t_{2g}^3 eg^2$	5	5.92
d^6	$t_{2g}^3 eg^3$	4	4.90
d^7	$t_{2g}^3 eg^4$	3	3.87
d^8	$t_{2g}^4 eg^4$	2	2.84
d^9	$t_{2g}^5 eg^4$	1	1.73
d^{10}	$t_{2g}^6 eg^4$	0	0

Que Arrange following in ↑ order of magnetic moment

$[Fe(CN)_6]^{3-}$ $[MnCl_4]^{2-}$ $[CoCl_4]^{2-}$

Fe^{3+} → S.L. Mn^{2+} Co^{2+} W.L.

d^5 $3d^5$ $3d^7$

$t_{2g}^5 eg^0$ $n = 3$.

$t_{2g}^3 eg^2$ $eg^4 t_{2g}^3$

↑↓ ↑↓ ↑ | | ↑ ↑ ↑ ↑ ↑ | ↑↓ ↑↓ | ↑ ↑ ↑

$n = 1$ $n = 5$ $n = 3$

Factor affecting CFSE :-

1. Nature of metal
   Energy $3d < 4d < 5d$

2. O.S. on C.M.A. CFSE ∝ O.S. of C.M.A.
   $[Fe^{+3}(CN)_6]^{3-} > [Fe^{+2}(CN)_6]^{4-}$

3. Nature of ligand : S.L. > W.L.
   $Fe(CO)_5 > [Fe(CN)_6]^{3-} > [Fe(CN)_6]^{4-}$
   CO > CN^- O.S.

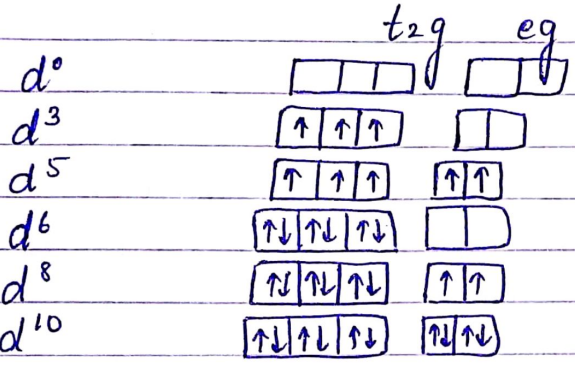
4. Nature of complex Octahedral > tetrahedral

$$\Delta_t = \frac{4}{9}\Delta_o = 0.45\,\Delta_o = 45\%\,\Delta_o$$

JOHN TELLER EFFECT :-

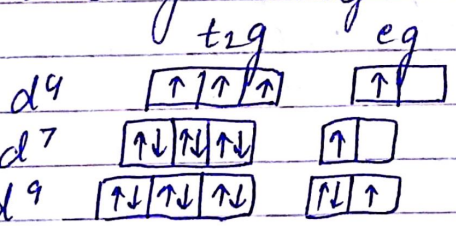
Acc^{n} to John Teller Effect, distoration in regular octahedral geometry occurs when unsymmetric configuration in of easy orbitals of C.M.A.

In Octahedral field if all d $e^{\ominus}$ are symm. arranged then they will repel six ligands equally. Thus the structure will be a complete regular Octahedral.



$[Cr(CN)_6]^{3-}$ $[Cr(NH_3)_6]^{3+}$
S.L. or W.L. $[TiCl_6]^{2-}$
S.L. or W.L ~~$[Cr(CN)_6]^{3-}$~~
W.L $[Fe(H_2O)_6]^{3+}$
S.L $[Fe(CN)_6]^{4-}$
SL or W.L $[Ni(NH_3)_6]^{2+}$ $[Ni(CN)_6]^{4-}$
S.L. or W.L
$[Zn(NH_3)_6]^{2+}$, $[Zn(H_2O)_6]^{2+}$

In Octahedral field if d e^{-} are unsymm. arranged then some of ligands will repel more than other hence geometry will be distorated octahedral



WL → HSC Cr (II)
SL Co (II) Ni (III)
S.L. or WL Cu (II)

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Quss Which does not undergo John Teller distortion?
① d^4 ② d^7 ③ d^8 ④ d^9

If eg orbitals point directly at ligands so unsymm. filling of $e^{\ominus}$ in eg orbitals cause distortion in Octahedral geomktry.

* t_{2g} orbitals lies b/w ligand approaching dir^n so in unsymm. filling of $e^\ominus$ in t_{2g} orbital cause less distortion which is negligible.

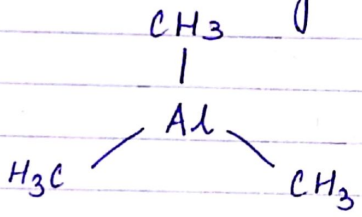
Organo Metallic Compound :-

Those compd in which metal atom is attached to carbon atom of some organic group are c/a O.M.C.

1. Sigma bonded O.M.C

Metal ——— Carbon
(σ bond)

eg : $Al(CH_3)_3$ → Trimethyl aluminium



$R - Mg - X$ Grignard Reagent

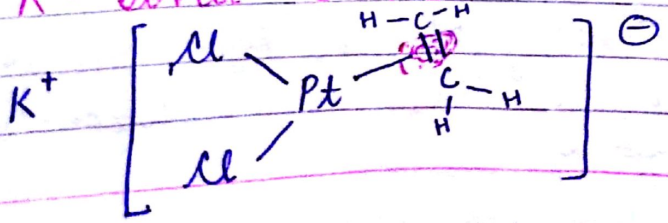
$(CH_3)_2 Zn$ Frankland Reagent

$(C_2H_5)_4 Pb$ → tetra ethyl lead
(TEL) → used as antiknocking agent in petrol.

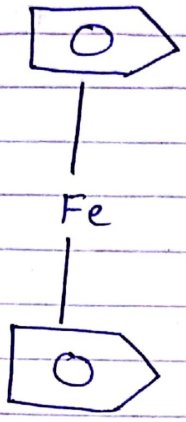
$(C_2H_5)_2 Zn$ Frankland Reagent

phenyl lithium

2. π - bond O.M.C.



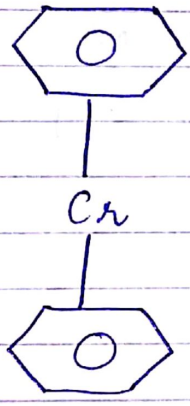
Zeise's salt $K^+ PtCl_3 \eta^2 (C_2H_4)]^{\ominus} \times H_2O$



$\eta^5 (C_6H_5)_2 Fe (II)$

Ferrocene
Bicyclo Pentadienyl Iron (II)

~~bi~~ dibenzene Chromium (0)



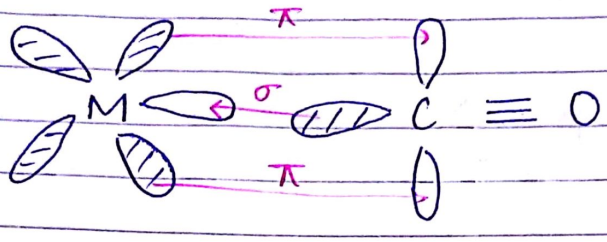
$\eta^6 (C_6H_2)_2 Cr (0)$

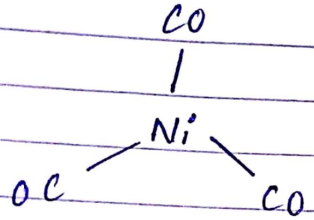
σ and π bond

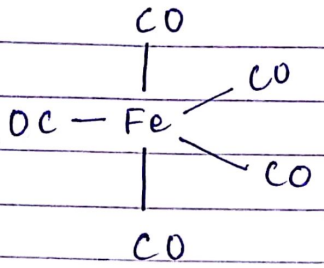
→ include metal carbonyls like $Ni(CO)_4$, $Fe(CO)_5$

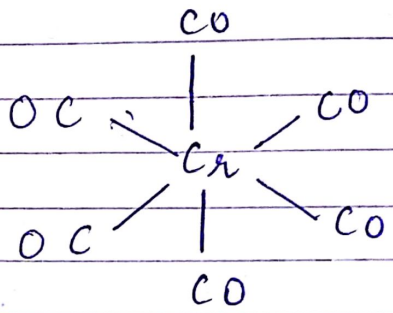
→ In this compd, σ bond formed b/w vaccant hybrid orbital of metal & lp of carbon atom in CO.

→ While a π bond is formed b/w antibonding orbital (π^*) of CO & filled orbital of Metal atom. This bonding is also k/n as cinergic bonding.



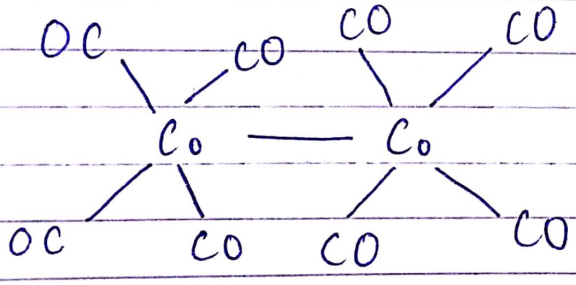




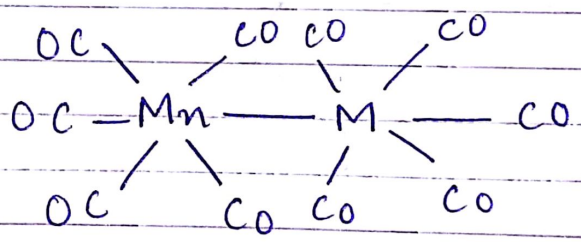


C-O B.L. order $[Fe(CO)_5]^- > [Cr(CO)_6]^0 > [V(CO)_6]^+$

$Co_2(CO)_8$



$Mn_2(CO)_{10}$



App^n of O.M.C.

1. Ziegler Nata Catalyst :-

$(C_2H_5)_3Al + TiCl_3$

Triethyl aluminium Titarium chloride

→ used in polymerisation of alkene

$$n\,CH_2 = CH_2 \xrightarrow{(C_2H_5)_3Al + TiCl_3} -(CH_2 - CH_2)_n-$$

ethene → Polythene

2. Wilkinson's catalyst $[\{(C_6H_5)_3\ddot{P}\}_3 Rh]Cl$ used in hydrogenation of alkene

$$CH_2 = CH_2 + H_2 \xrightarrow[\text{Catalyst}]{\text{Wilkinson}} CH_3 - CH_3$$

3. C_2H_5HgCl (ethyl Mercury Chloride) used as fungicide in agriculture (Toxic)

Application of Coordination Compd :-

In Qualitative Analysis

1. To separate group I radical like Ag^+ & Hg^{2+} complexation formation with NH_4OH is done

$$AgCl + NH_4OH \longrightarrow \underset{\text{(soluble}}{[Ag(NH_3)_2]Cl}$$

$$HgCl_2 + NH_4OH \longrightarrow \underset{\text{black insoluble ppt.}}{Hg(NH_2)Cl + Hg}$$

2. To detect Cu^{2+} ion

Complex for^m with ammonia is done

$$CuSO_4 + 2NH_3 \longrightarrow \underset{\text{dark blue}}{[Cu(NH_3)_4]SO_4}$$

$$Cu^{2+} + K_4[Fe(CN)_6] \longrightarrow \underset{\text{Chocolate brown}}{Cu_2[Fe(CN)_6]}$$

3. To ~~dect~~ detect Fe^{3+} ~~color~~ ion

$$Fe^{3+} + KSCN \longrightarrow [Fe(SCN)]^{2+} + K^{\oplus}$$

~~blood~~ blood red color

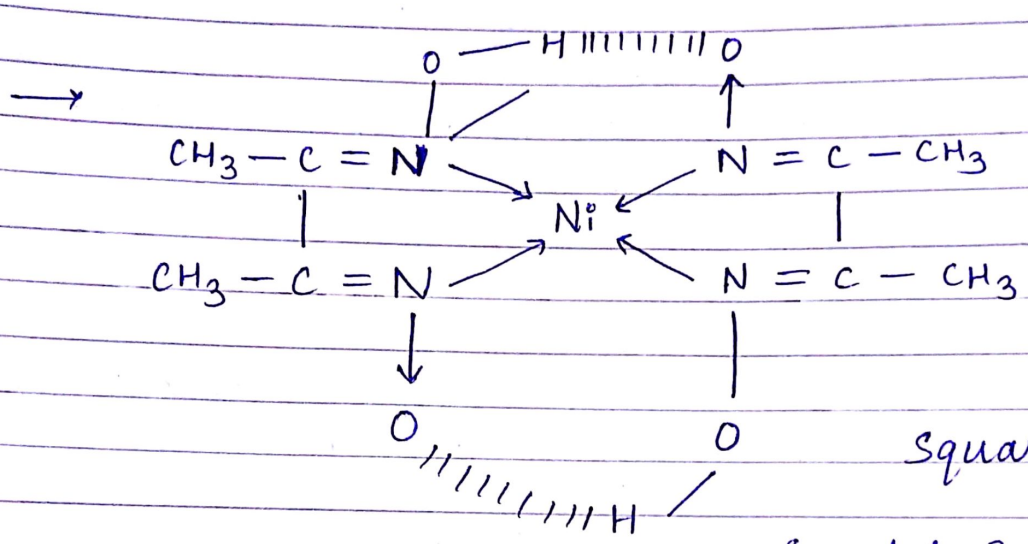
4. To detect sulphide ~~ion~~ (S^{2-}) ion

$$Na_2S + Na_2[Fe(CN)_5NO] \rightarrow \underset{\text{Violet color}}{Na_4[Fe(CN)_5NOS]}$$

Sodium Nitro Prusside

5. To ~~det~~ detect Ni^{2+} ion

$$NiCl_2 + 2\,CH_3-C(=N-OH)-CH_3 + NH_4OH \longrightarrow$$



Square Planar

Scarlet Red Color

$NO_3^{\ominus}$ test

$[Cu(H_2O)_4]SO_4 \xrightarrow{4NH_3} [Cu(NH_3)_4]SO_4$

light blue → dark blue

$$\underset{\text{O.A.}}{NO_3^{\ominus}} + \underset{\text{R.A.}}{Fe^{2+}} + 4H^+ \longrightarrow Fe^{3+} + NO + H_2O$$

$$[Fe(H_2O)_6]SO_4 + NO \longrightarrow [Fe(H_2O)_5(\overset{+}{N}O^{\bullet})]SO_4$$

Brown Ring complex

Fe^{+1}

In Medical field :-

① cis-platin is used in anti-cancer drug.

② Ca-EDTA is used for treatment of patients suffering from lead poisoning.
Ca EDTA dissociates lead ~~into~~ inside the body & more stable Pb-EDTA complex is formed which is excreted through urine by body. while harmless Ca^{2+} ions remains inside the body.

Vitamin B12 : cyanocabalamine is a cobalt vitamin in which Co^{2+} is ~~central ion~~ central metal ion. It is anti-pernicious anemia factor.

Chlorophyll (Mg^{2+})

AIIMS-13
Haemoglobin (Fe^{2+})

Myoglobin (Fe^{3+})

Insulin (Zn)

Carboxypeptide (Zn)

In Metallurgy :-

In extraction of metals like silver & gold, complex form with sodium cyanide (NaCN) soln is done.

$$Ag_2S + 2NaCN \rightleftharpoons \underset{\text{Soluble complex}}{2Na[Ag(CN)_2]}_{sp} + Na_2S$$

$$4Na_2S + 5H_2O + 2O_2 \longrightarrow 2Na_2SO_4 + 4NaOH + 2S$$

$2\,Na[Ag(CN)_2] + Zn \rightarrow Na_2[Zn(CN)_4] + 2\,Ag\downarrow$

In Electroplating :-

In electroplating of noble metals like silver & gold, their complex forming tendency is used.

For eg :-

In electroplating of silver complex potassium dicyano argento (I)- $K[Ag(CN)_2]$ is formed due to which Ag^+ ions are not available for displacement & layer over silver remain stable for a longer time.

In a masking agent :-

To detect a particular ion in +nce of other ions. A specific ligand is added which form stable complex with all the other ions. Except the ion to be detected, this is k/n as masking Method.

For eg : Cd^{2+} ions are detected in +nce of the Cu^{2+} ions by this method.

$Cu^{2+} + 4CN^- \longrightarrow [Cu(CN)_4]^{2-}$ stable complex

$Cd^{2+} + 4CN^- \longrightarrow [Cd(CN)_4]^{2-}$ Unstable

$Cd^{2+} + H_2S \longrightarrow CdS\downarrow$ Yellow

In photography :-

Sodium Thiosulphate is used in photography becoz of its complex forming tendency as it removes undecomposed AgBr by forming complex with it.

$Na_2S_2O_3 + AgBr \longrightarrow Na_3[Ag(S_2O_3)_2] + NaBr.$