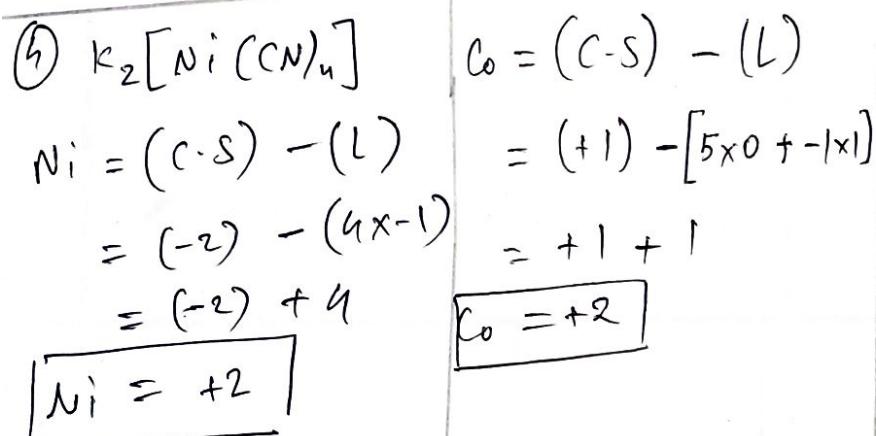
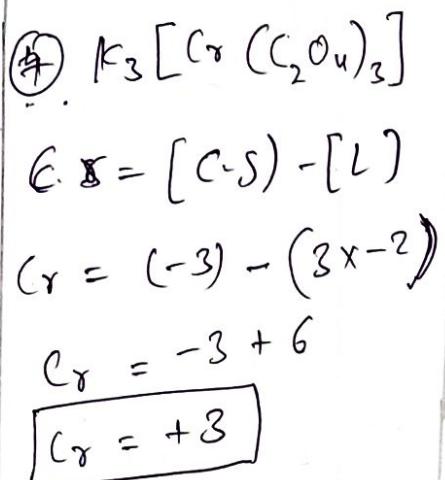
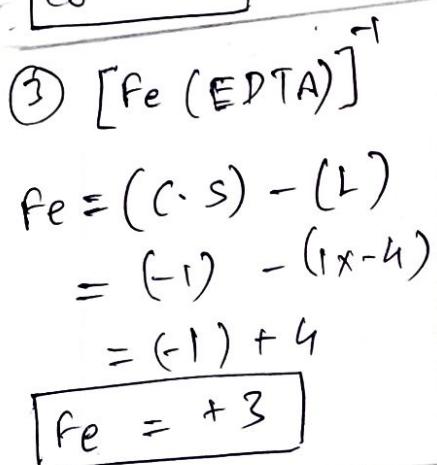
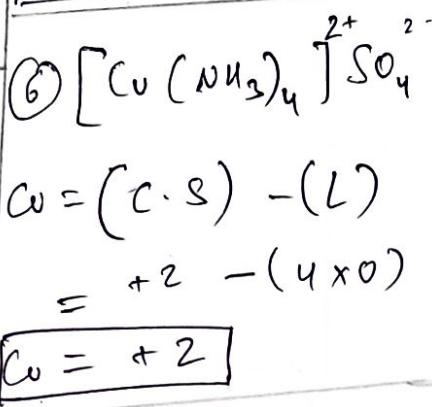
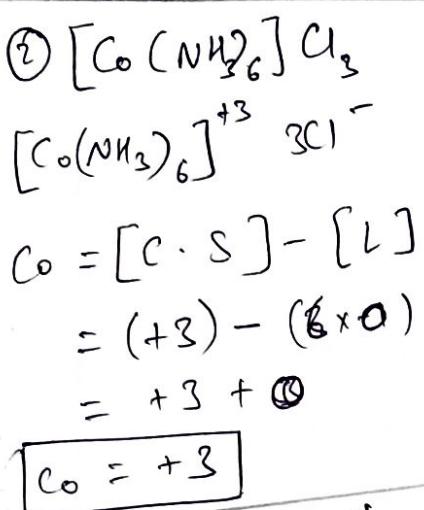
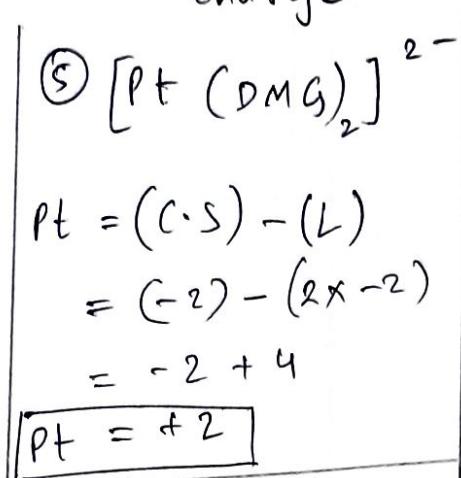
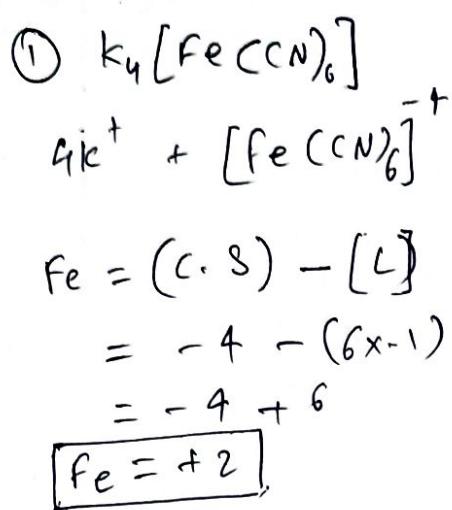


Oxidation state = [Co-ordination sphere charge] - [ligand Pa charge]



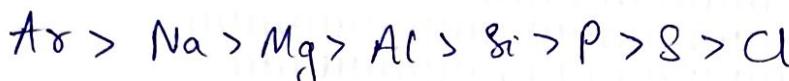
## ① Atomic Radius:

- i. In period ( $L \rightarrow R$ ):  $Z_{\text{eff}} \uparrow$  Att  $\uparrow$  Size  $\downarrow$
- ii. In group ( $T \rightarrow B$ ): shell no.  $\uparrow$  Size  $\uparrow$

### Exceptions #

① Inert gas has highest radii in respective period.

$$K < He$$



② 3d series: Sc  $>$  Ti  $>$  V  $>$  Cr  $>$  Mn  $>$  Fe  $\approx$  Co  $\approx$  Ni  $<$  Cu  $<$  Zn

③  $\gamma_{Al} \approx \gamma_{Ga}$  (due to poor screening of 3d<sup>10</sup>e<sup>0</sup>s in Ga)

④  $\gamma_{Lu} \approx \gamma_{Sc}$  (due to poor screening of 4f<sup>14</sup>e<sup>0</sup>s) (Lanthanoid contraction)

### Compare Size:

① Li, K, Na      ② V, Fe, Mn      ③ Ne, B, Be

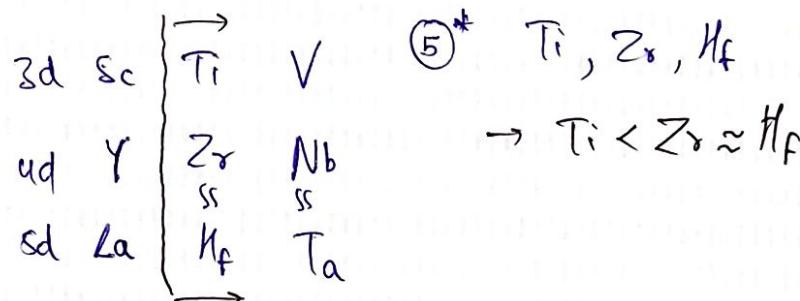
$$\rightarrow Li < Na < K \quad \rightarrow V > Mn > Fe \quad \rightarrow Ne > Be > B$$

④ Sc, Y, La

$$\rightarrow Sc < Y < La$$

⑥ Al, B, Ga, In

$$\rightarrow B < Al \approx Ga < In$$



⑤\* Ti, Zr, Hf

$$\rightarrow Ti < Zr \approx Hf$$

## ② Ionic Radius

M-I\*: ①  $N^{3-} > O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$

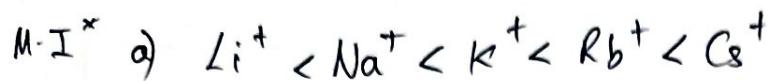
① L to R

②  $P^{3-} > S^{2-} > Cl^- > K^+ > Ca^{2+}$

Isoelectronic species

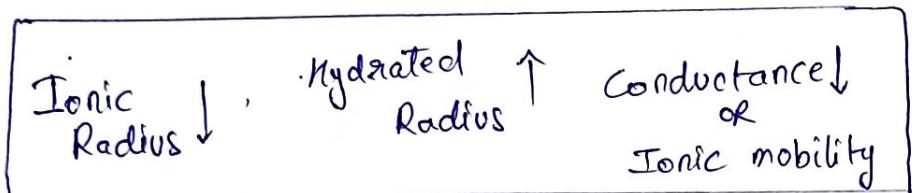
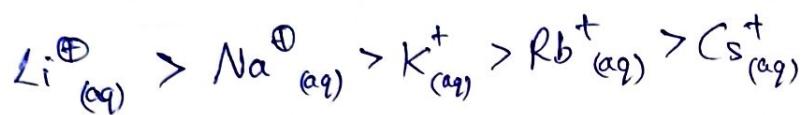
Size $\propto$	$\frac{1}{\text{Atomic radius}}$
----------------	----------------------------------

③ T to B : shell no. ↑ size ↓

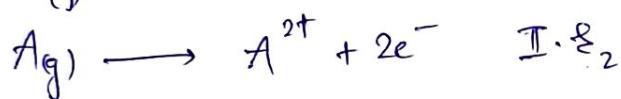
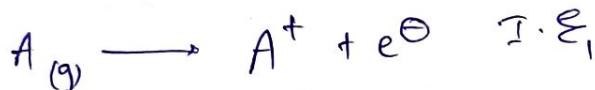


④  $A^\ominus > A > A^+ \rightarrow \text{e.g. } \text{N}^- > \text{N} > \text{N}^+$

⑤ Hydrated Radius



⑥ Ionization Energy : The amount of energy req to remove an electron from isolated gas atom.



$$\text{I.E}_1 < \text{I.E}_2 < \text{I.E}_3 \dots$$

i. L to R :  $Z_{\text{eff}} \uparrow \Rightarrow \text{I.E} \uparrow$

ii. T to B : shell no. ↑  $\Rightarrow \text{I.E} \downarrow$

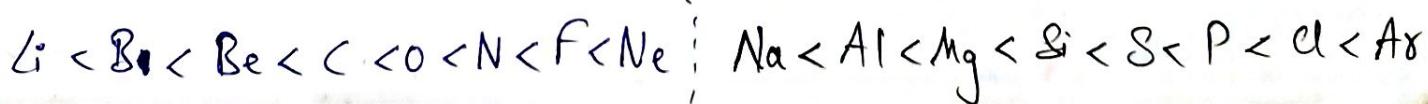
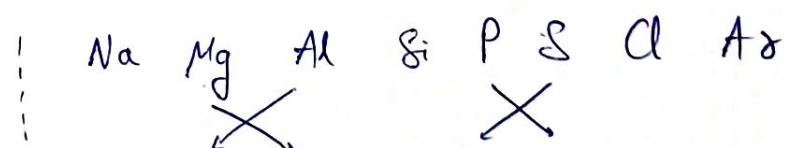
Exceptions:

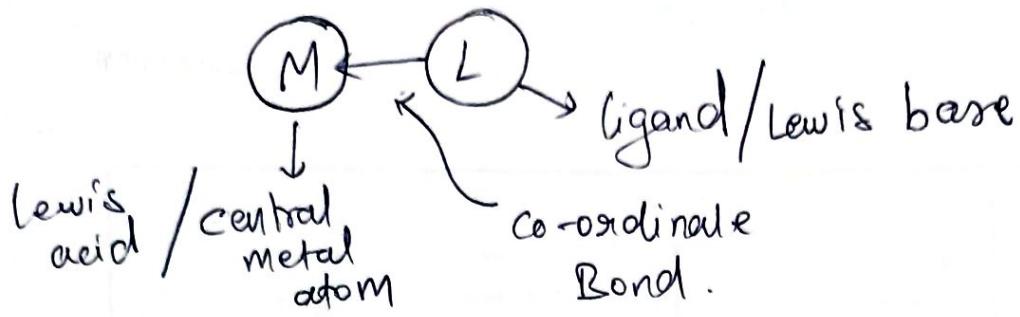
① Inert gas has highest I.E in respective period due to fully filled configuration.

② 2<sup>nd</sup> period:



③ 3<sup>rd</sup> period:





Note:- Lewis acid is accepting ~~all the~~ pair of electrons from each Lewis base.

eg Lewis Base:-  $\text{CN}^-$ ,  $\text{NH}_2^-$ ,  $\text{X}^-$ ,  $\text{H}_2\ddot{\text{O}}^-$ ,  $\text{CO}^-$ ,  $\text{ON}^-$

eg Lewis Acid:-  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ ,  $\text{AlF}_3$ ,  $\text{NO}_2^+$ ,  $\text{Cu}^{2+}$ ,  $\text{BeCl}_2$ ,  $\text{BF}_3$ ,  $\text{ZnCl}_2$ ,  $\text{AlCl}_3$ ,  $\text{SO}_3$ ,  $\text{FeX}_3$ ,  $\text{AlX}_3$

### Types of compound

Simple salt	Double salt	Co-ordination salt
→ only 1 cation only 1 anion eg $\text{NaCl}$	<u>Double salt</u> eg ① <u>Mohr's salt</u> $\text{FeSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ $\rightarrow \text{Fe}^{2+} + 2\text{SO}_4^{2-} + 2\text{NH}_4^+ + 6\text{H}_2\text{O}$ ② <u>Potash alum</u> $\text{K}_2\text{SO}_4 \cdot \text{Al}_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$ ③ <u>Carnalite</u> $\text{KCl} \cdot \text{MgCl}_2 \cdot 6\text{H}_2\text{O}$	$\text{K}_4[\text{Fe}(\text{CN})_6]$ $4\text{K}_4^+ + [\text{Fe}(\text{CN})_6]^{-4}$

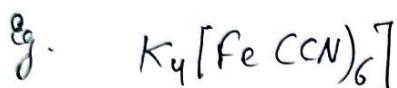
### Important Points eg: $[\text{Fe}(\text{CN})_6]^{4-}$

- (1) The square bracket  $\rightarrow$  co-ordination sphere/entity.
- (2) CN  $\rightarrow$  ligand, Fe  $\rightarrow$  central metal atom
- (3) CN  $\rightarrow$  denotes 2 lone pairs of electrons
- # The no. of lone pairs denotes it is called co-ordination number.

## Werner's Theory

(3)

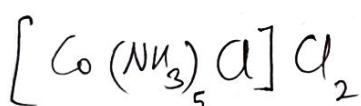
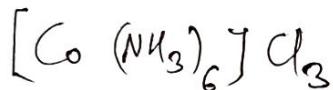
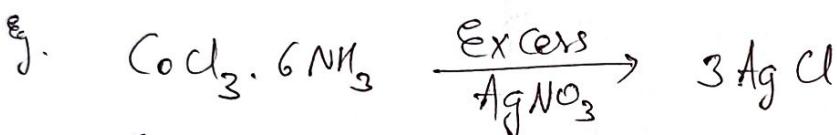
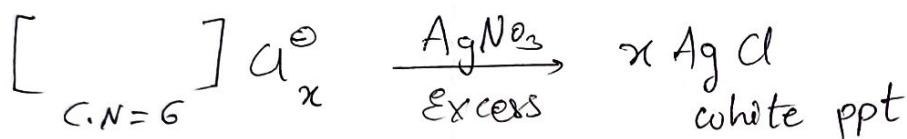
- i) Werner proposed the concept of primary valence and secondary valence  
is satisfied by anions
- ii) P.V is ionisable & it is equal to O.N of C.M.A.
- iii) S.V is Non-ionisable & it is equal to C.N of C.A or C.M.A



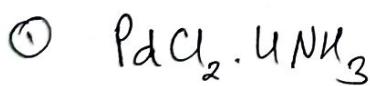
$$P.V = (-4) - (6 \times -1) = -4 + 6 = +2$$

$$\begin{aligned} S.V &= 6 \times \text{denticity} \\ &= 6 \times \text{monodentate} \\ &= 6 \times 1 = 6 \end{aligned}$$

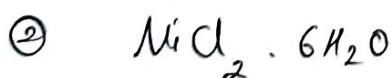
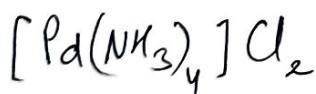
Rxn with Excess  $\text{AgNO}_3$



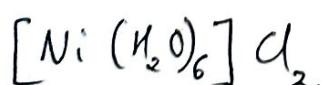
⊗ formula Moles of  $\text{AgCl}$  ppt per mole of comp with excess  $\text{AgNO}_3$



2



2



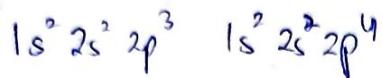
① 1<sup>st</sup> I.E : Be > B

2<sup>nd</sup> I.E : B > Be

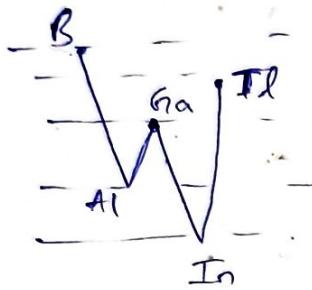


② I<sup>st</sup> I.E : N > O

2<sup>nd</sup> I.E : O > N



#### ④ Boron family:



B > Tl > Ga > Al > In

Tl > In (Lanthanoid contraction)

Ga > Al (Poor screening of 3d e<sup>-</sup>s)

⑤ [5d > 3d > 4d]

#### ⑥ Compare I.E

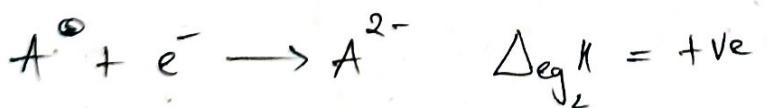
1) Be < N → O N Ne 3) P, S, Ar

→ N > C > Be → Ne > N > O → Ar > P > S

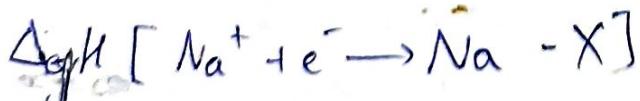
4) Ti Zr K<sub>f</sub> 5) Mg Ca Sr 6) Al, Ga, In

→ K<sub>f</sub> > Ti > Zr → Mg > Ca > Sr → Ga > Al > In

⑦ Electron gain enthalpy ( $\Delta_{egH}$ ): The amount of energy required or released by gain of an e<sup>-</sup> in isolated gas atom.



IE [Na → Na<sup>+</sup> + e<sup>-</sup> X] → Energy nikala



① L to R :  $Z_{\text{eff}} \uparrow$   $\epsilon \cdot A \uparrow$

\* : more -ve  $\Delta_{\text{eg}} H$  ka matlab  $\epsilon \cdot A$  jyada.

② T to B : Size  $\uparrow$   $\epsilon \cdot A \downarrow$

Exceptions:  $\underbrace{(\text{zero or +ve})}$

① 2<sup>nd</sup> period : Be < Ne < N < B < Li < C < O < F  
Bete ne na Bolkar Lodki ko fasaya

② 3<sup>rd</sup> period : Mg < Ar < Al < Na < P < Si < S < Cl  
maine aur alka ne pyari si shadi karle.  
 $\underbrace{\text{Zero or +ve}}$

③ 3 periods > 2 period  
(due to vacant d orbitals)

④ Al > F > Br > I

⑤ S > Se > Te > Po > O  $\rightarrow$  due to compact Nature.

⑥ Inert gases have zero or +ve electron gain enthalpy

Q) Compare  $\Delta_{\text{eg}} H$

1) Li, Be, O    2) Na, Ar, Si    3) Se, O, S

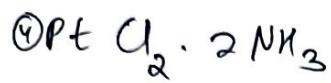
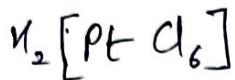
$\rightarrow$  Be < Li < O    Ar < Na < Si    S > Se > O

4) F, Al, Br    5) Si, C    6) N, B, F

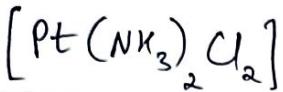
$\rightarrow$  Al > F > Br     $\rightarrow$  Si > C    N < B < F



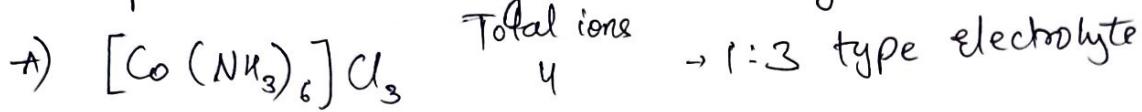
O



O



Q) Compare Conductivity of following compound.



$$\boxed{\therefore A > B > C}$$

### Ligands

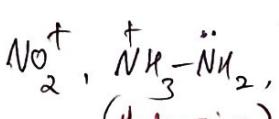
① Ligands can be  $1e^\ominus$  donor,  $2e^\ominus$  donor (L.P. donor) &  $\pi e^\ominus$  donor.

② Ligand is either Lewis Base OR NOT

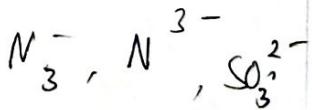
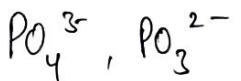
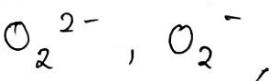
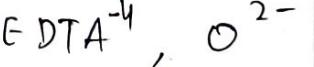
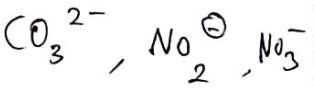
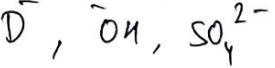
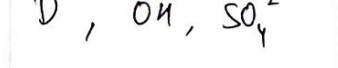
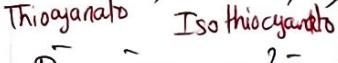
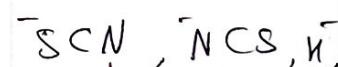
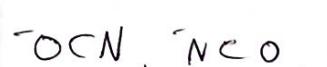
### Classification

① Based on charge

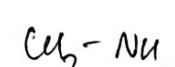
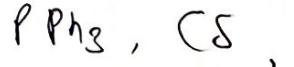
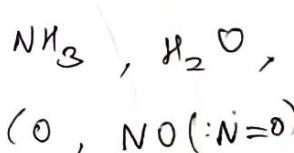
+ve



-ve



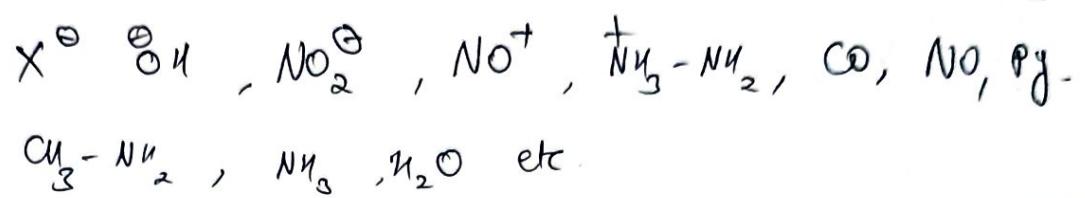
Neutral



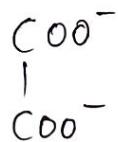
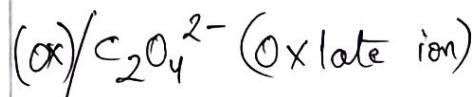
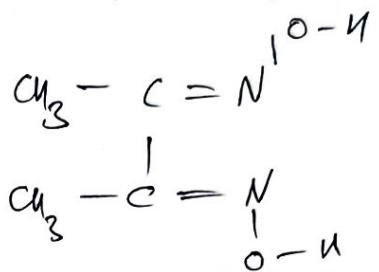
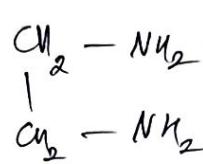
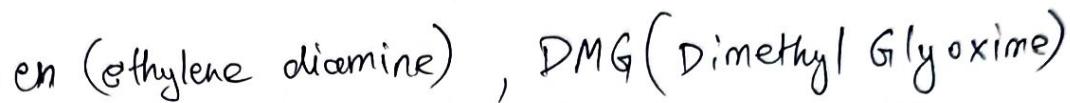
Based on donation

(5)

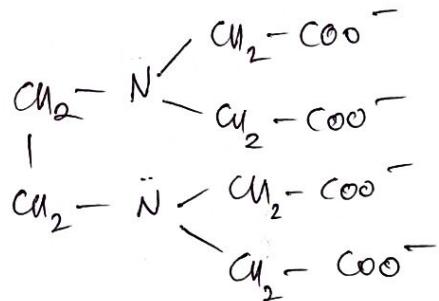
Monodentate  
(1 atom donor)



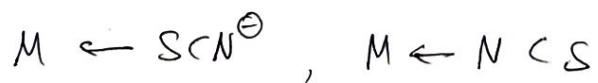
Bidentate  
(2 donor atoms)



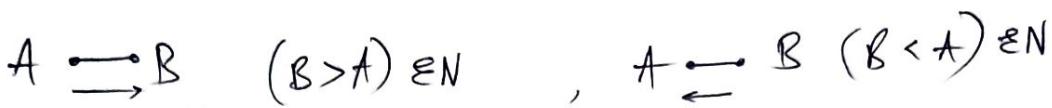
Polydentate  
(Hexadentate)  
[ 6 donor atoms ]



Ambidentate  
(2 Donor atoms But  
only one can.  
donate at a  
time )



⑥ Electronegativity: The tendency of an atom to attract shared pair e<sup>-</sup>s towards itself.

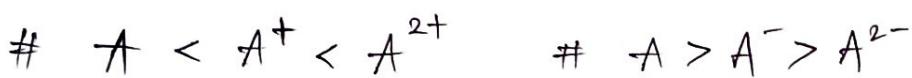


Trends: ① L to R : EN↑

② T to B : EN↓

Li	Be	B	C	N	O	F
1	1.5	2	2.5	3	3.5	4

H, P (2.1) , C, I, S (2.5) , N , Cl



⑤ Compare EN

① Be O Li    ② F Cl Br    ③ O S Se    ④ Ca, Mg, Se  
→ O > Be > Li    → F > Cl > Br    → O > S > Se    Be > Mg > Ca

⑦ Nature of Oxides

① Non-metallic oxides → Acidic

② Metallic oxides → Basic

③ Neutral oxides : NO, N<sub>2</sub>O, CO

④ Amphoteric oxides :

V<sub>2</sub>O<sub>5</sub>, Cr<sub>2</sub>O<sub>3</sub>, ZnO, Al<sub>2</sub>O<sub>3</sub>, SnO, PbO, BeO  
SnO<sub>2</sub>, PbO<sub>2</sub>

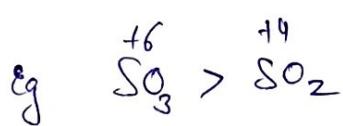
## Acidic strength:

① L to R : N.M.C ↑ ⇒ A.S↑

② T to B : N.M.C ↓ ⇒ A.S↓

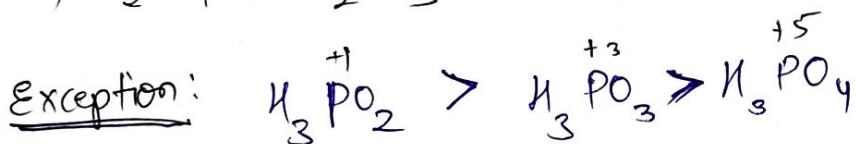
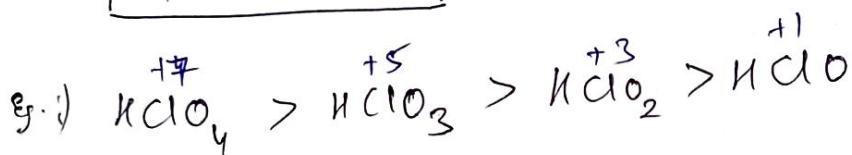
③ Oxides of same element

$$\boxed{A.S < O.N}$$



④ A.S of oxy acids:

$$\boxed{A.S < O.N}$$



## Hydrogen has 3 isotopes

1) Protium

2) Tritium

3) Deuterium

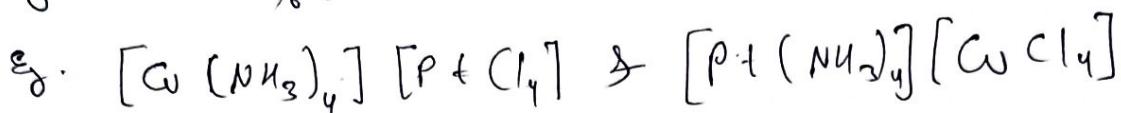
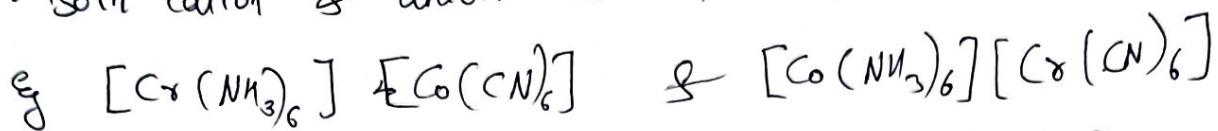
# Tritium is the ~~only~~ isotope which is radioactive

Covalent character  $\propto \frac{1}{\text{Melting point}}$

- Structural Isomers: ① Coordination Isomers ② Hydrate Isomers  
 ③ Linkage Isomers ④ Ionization

① Coordination Isomers

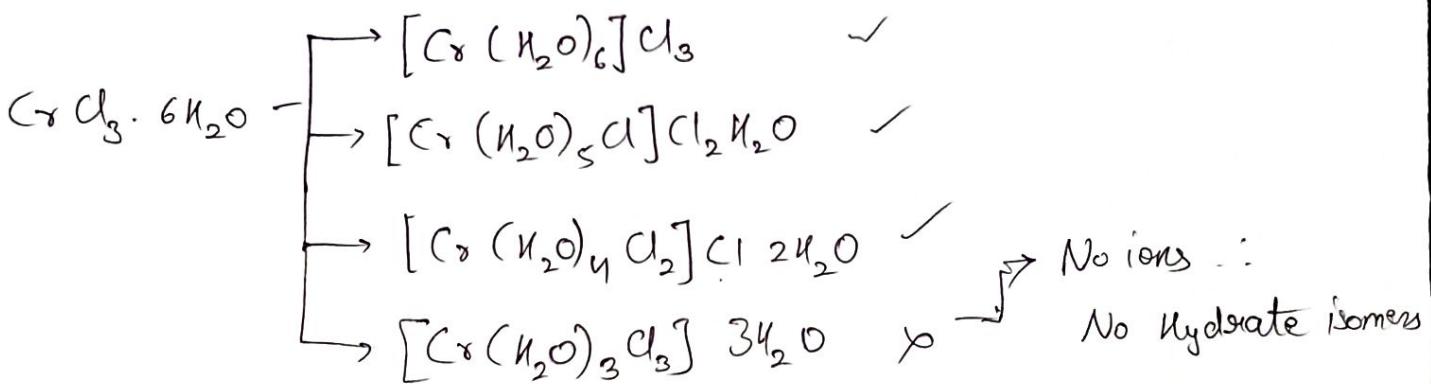
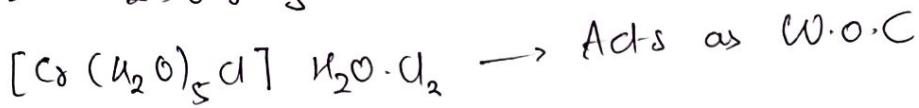
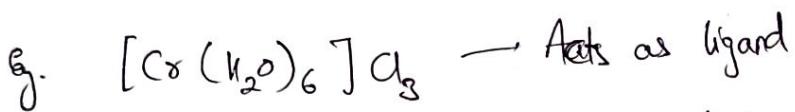
- Both cation & anion are in complex form.



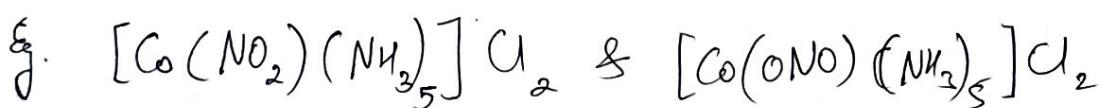
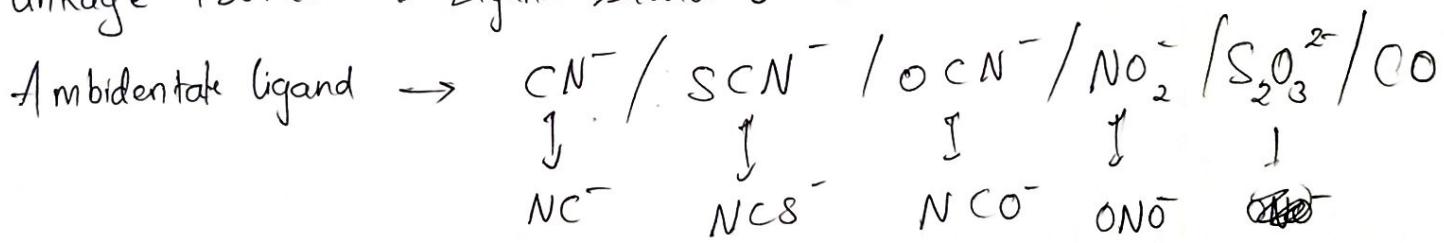
② Hydrate Isomers:  $(\text{H}_2\text{O})$  is written in place of ions.

i)  $\text{H}_2\text{O} \rightarrow$  Inside Co-ordination sphere  $\rightarrow$  ligand

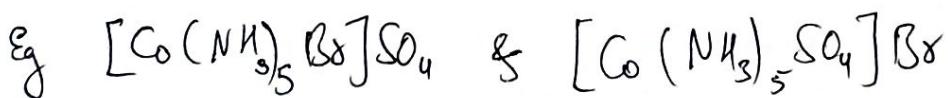
ii)  $\text{H}_2\text{O} \rightarrow$  Outside Co-ordination sphere  $\rightarrow$  W.O.C (Water of Crystallization)



③ Linkage Isomers: Ligand should be ambidentate



④ Ionisation Isomers: Comp. which give diff. ion in soln.



# Stereo - Isomerism

↓  
Geometrical Isomers

↓  
Optical Isomers

$C \cdot N = 4 \rightarrow$  Tetrahedral  
 square planar  
 $C \cdot N = 6 \rightarrow$  Octahedral

① Geometrical Isomers

i) In  $C \cdot N = 4$

→ Tetrahedral complex do not show G.I

ii) G.I in square planar

①  $Ma_4$  ] X No G.I  
 ②  $Ma_3b$  ]

③  $Ma_2b_2$  ] →  $G \cdot I = 2 \rightarrow$  Cis & Trans

④  $Ma_2bc$  ] ✓ G.I →  $G \cdot I = 2 \rightarrow$  Cis & Trans

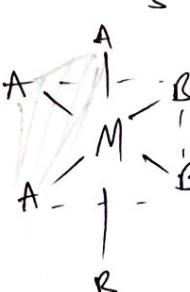
⑤  $Mabc d$  ] →  $G \cdot I = 3 \rightarrow$  (Cis & Trans)  
 Not defined

⑥  $[M(AA)_2]$  ] X

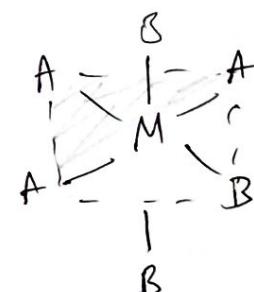
⑦  $[M(AB)_2]$  ] ✓ G.I →  $G \cdot I = 2$

ii) In  $C \cdot N = 6$

Complexes	No. of G.I	→ In $Ma_3B_3$
$Ma_4B_2$	2	
$Ma_4BC$	2	
* $Ma_3B_3$ *	2	
$Ma_3b_2c$	3	
$Ma_3bcd$	4	
$Ma_2b_2c_2$	5	
$Ma_2b_2CD$	6	
$MA_2BCDE$	9	
$MABCDEF$	15	

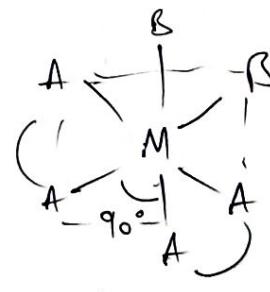


facial

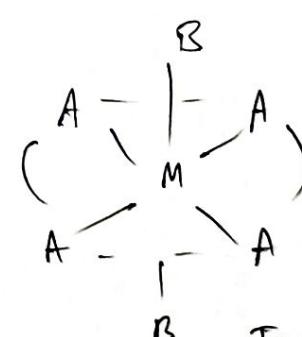


meridional

→ In  $M(AA)_2B_2$



Cis



Trans

$[M(AA)_2B_2]$	2
$[M(AA)_2BC]$	2
$[M(AB)_3]$	2

8

$M(AA)_3$  does  
Not exhibit  
G-I

## ② OPTical Isomerism

Case I: In C.N = 4

O.I does NOT exhibits in C.N = 4

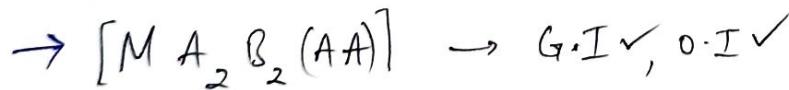
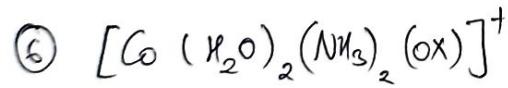
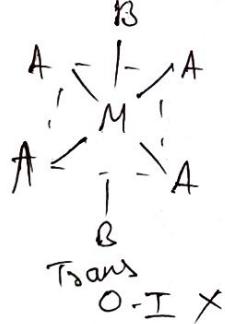
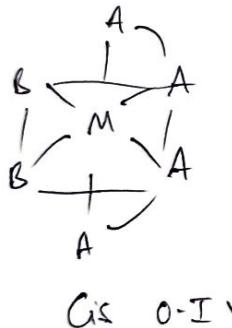
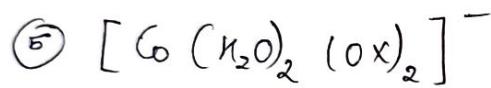
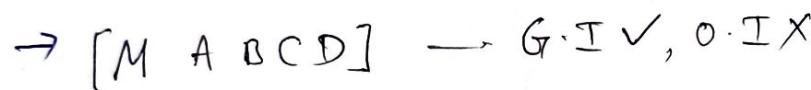
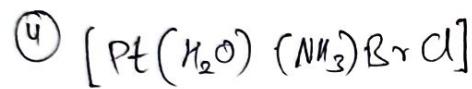
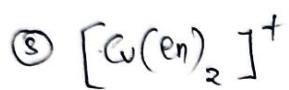
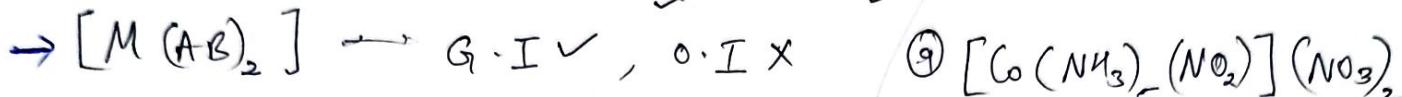
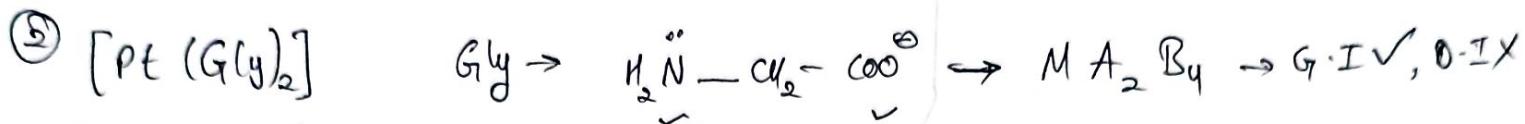
Tetrahedral X & square planar X

Case 2: In C.N = 6

Complexes	Enantiomer pair	G.I	Stere o
$[MA_4B_2]$	0	2	2
$MA_4BC$	0	2	2
$MA_3B_3$	0	2	2
$MA_3B_2C$	0	3	3
$MA_3BCD$	1	4	5
$MA_2B_2C_2$	1	5	6
$MA_2B_2CD$	2	6	8
$MA_2BCDE$	6	9	15
$MABCDEF$	15	15	30
$M(AA)_2B_2$	1	2	3
$M(AA)_2BC$	1	2	3
$M(AB)_3$	2	2	4

$[M(AA)_2]$  exhibits O.I & NOT G.I

Identify which complexes exhibits G.I or O.I or Both? (9)



Because Tetrahedral

## Valence Bond theory

- C.M.A/ion used  $(n-1)d$ ,  $n\sigma$ ,  $n\pi$  or  $ns$ ,  $np$ ,  $nd$  for Bonding  
 inner orbitals                          outer orbitals
- Ligand will donate L.P to the vacant orbital of C.M.A/ion.
- Pairing occurs when strong field ligands like  $NH_3$ ,  $CN^-$ ,  $CO$  etc are present

C.N	Hybridization	Geometry	Examples
2	$sp$	Linear	$[Ag(NH_3)_2]^+$ , $[Ag(CN)_2]^-$
3	$sp^2$	Trigonal planar	$[AgI_3]^-$
4	$sp^3$	Tetrahedral	$Ni(CO)_4$ , $[NiX_4]^{2-}$ , $[ZnCl_4]^{2-}$ , $[CuX_4]^{2-}$ $X = Cl^-$ , $Br^-$ , $I^-$
	$ds p^2$	Square planar	$[Ni(CCN)_4]^{2-}$ , $[Cu(NH_3)_4]^{2+}$ , $[Ni(NH_3)_4]^{2+}$
5	$dsp^3$	Trigonal Bipyramidal	$[Fe(CO)_5]$ , $[CuCl_5]^{3-}$
	$sp^3d$	Square pyramidal	$[SbF_5]^{2-}$
6	$d^2sp^3$	Octahedral (Inner orbital)	$[Cr(NH_3)_6]^{3+}$ , $[Fe(CN)_6]^{3-}$
	$sp^3d^2$	" (Outer orbital)	$[FeF_6]^{3-}$ , $[Fe(H_2O)_6]^{2+}$ , $[Ni(NH_3)_6]^{2+}$

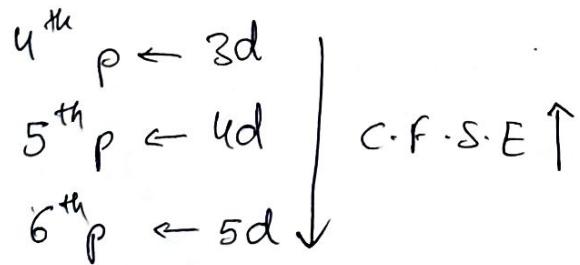
① Pt, Pd & Au in C.N = 4 always square planar.

②  $[Co(C_2O_4)_3]^{3-}$  is diamagnetic ( $d^2sp^3$ ), here  $(C_2O_4)_3$  act as strong field ligand

## CFT (Crystal field theory)

factors affecting CFSE

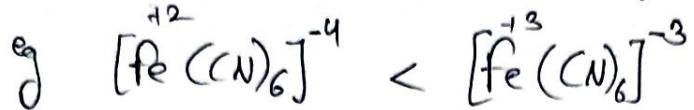
① As we go down the group the CFSE ↑



②  $(CFSE)_{\text{octahedral}} > (CFSE)_{\text{Tetrahedral}}$

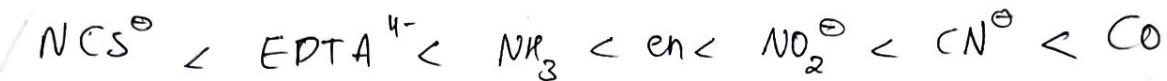
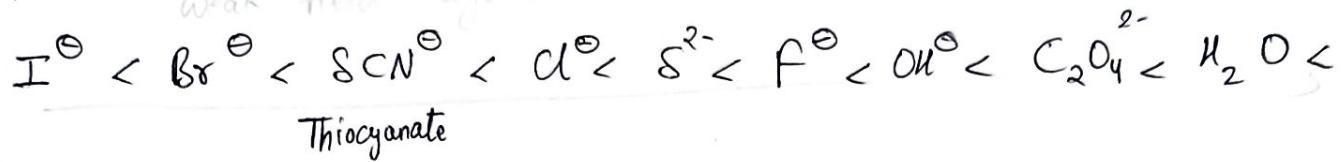
③  $9\Delta_t = 4\Delta_o$

$C.F.S.E \propto$  Oxidation no. of C.M.A



⑤ Strong field ligand (SFL)  $\Rightarrow C.F.S.E \uparrow$  } eg  $[\text{Ni}(\text{CO})_4] > [\text{NiCl}_4]^{4-}$   
 Weak field ligand (WFL)  $\Rightarrow C.F.S.E \downarrow$

Spectrochemical series:



IsoThiocyanate

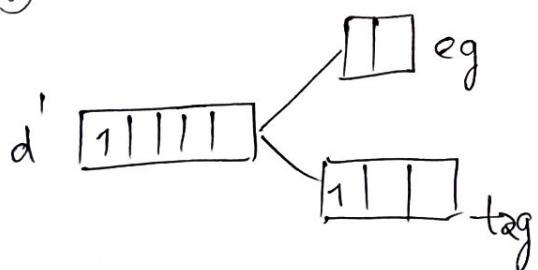
Strength of ligand:  $\frac{\text{Carbon}}{\text{donor}} > \frac{\text{N donor}}{\text{donor}} > \frac{\text{Oxygen}}{\text{donor}} > \frac{\text{X donor}}{\text{donor}}$

$\swarrow$  strong field ligand       $\searrow$  weak field ligand

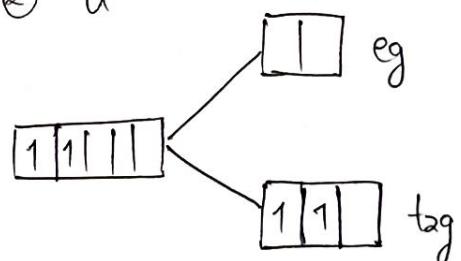
Calculation of C.F.S.E in octa. field.

$$C.F.S.E = x \times (-0.4 \Delta_o) + y \times (+0.6 \Delta_o) + z \times p$$

①

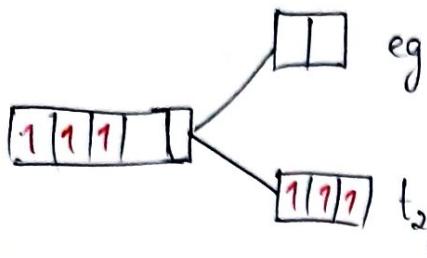


②  $d^2$



$$\begin{aligned} C.F.S.E &= 1 \times (-0.4 \Delta_o) + 0 + 0 \\ &= -0.4 \Delta_o \end{aligned} \quad \begin{aligned} C.F.S.E &= 2 \times (-0.4) \Delta_o + 0 + 0 \\ &= -0.8 \Delta_o \end{aligned}$$

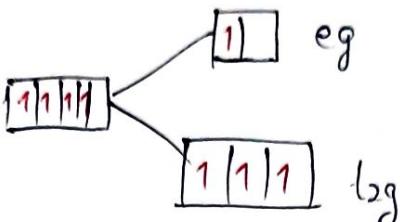
③ d<sup>3</sup>



$$C.F.S.E = 3x - 0.4\Delta_0 + 0 + 0 \\ = -1.2\Delta_0$$

④ d<sup>4</sup>

Case I:  $\Delta_0 < P(W.F.L)$



$$C.F.S.E = 3x - 0.4\Delta_0 \\ + 1x + 0.6\Delta_0 + 0 \\ = -0.6\Delta_0$$

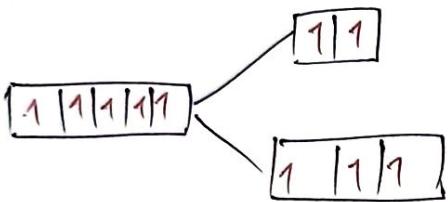
Case II:  $\Delta_0 > P(S.F.L)$



$$C.F.S.E = 4x(-0.4\Delta_0) + 0 \\ + 1xP \\ = -1.6\Delta_0 + P$$

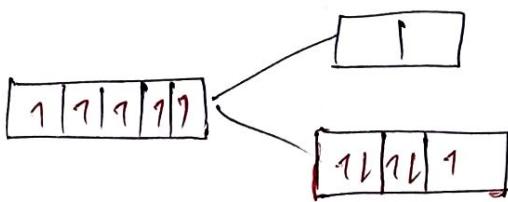
⑤ d<sup>5</sup>

Case I:  $\Delta_0 < P(W.F.L)$



$$C.F.S.E = 3x - 0.4\Delta_0 + 2x + 0.6\Delta_0 + 0 \\ = -1.2\Delta_0 + 1.2\Delta_0 = 0$$

Case II:  $\Delta_0 > P(S.F.L)$



$$C.F.S.E = 5x(-0.4\Delta_0) + 0 + 2xP \\ = -2\Delta_0 + 2P$$

⑥ d<sup>6</sup>

Case I:  $\Delta_0 < P(W.F.L)$

$$C.F.S.E = 4x(-0.4\Delta_0) + 2x(+0.6\Delta_0) + 0 \\ = -1.6\Delta_0 + 1.2\Delta_0 \\ = -0.4\Delta_0$$

Case II:  $\Delta_0 > P(S.F.L)$

$$C.F.S.E = 6x(-0.4\Delta_0) + 0 + 2xP \\ = -2.4\Delta_0 + 2P$$

⑦ d<sup>7</sup>

Case I:  $\Delta_0 < P(W.F.L)$

$$C.F.S.E = 5x(-0.4\Delta_0) + 2x(+0.6\Delta_0) + 0 \\ = -2\Delta_0 + 1.2\Delta_0 \\ = -0.8\Delta_0$$

Case II:  $\Delta_0 > P(S.F.L)$

$$C.F.S.E = 6x(-0.4\Delta_0) + 1x(+0.6\Delta_0) \\ + 1xP \\ = -2.4\Delta_0 + 0.6\Delta_0 + P \\ = -1.8\Delta_0 + P$$

8) d<sup>8</sup>

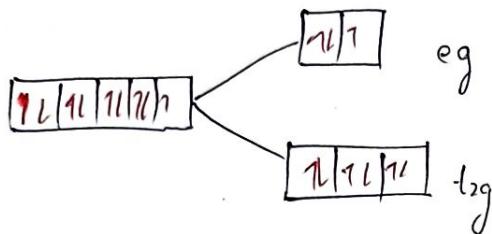
Case I:  $\Delta_o < P(w.f.l)$

$$C.F.S.E = 6(-0.4\Delta_o) + 2(+0.6\Delta_o) + 0 \\ = -2.4\Delta_o + 1.2\Delta_o \\ = -1.2\Delta_o$$

Case II:  $\Delta_o > P(s.f.l)$

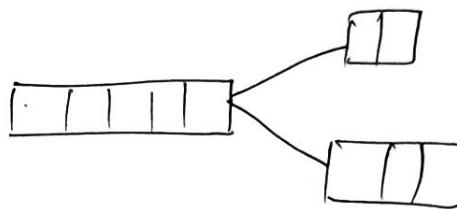
$$C.F.S.E = 6(-0.4\Delta_o) + 2(+0.6\Delta_o) + 0 \times P \\ = -2.4\Delta_o + 1.2\Delta_o \\ = -1.2\Delta_o$$

⑨ d<sup>9</sup> either w.f.l or s.f.l



$$C.F.S.E = 6(-0.4\Delta_o) + 3(+0.6\Delta_o) + 0 \\ = -2.4\Delta_o + 1.8\Delta_o \\ = -0.6\Delta_o$$

⑩ d<sup>10</sup> either w.f.l or s.f.l



$$C.F.S.E = 6(-0.4\Delta_o) + 4(+0.6\Delta_o) + 0 \\ = -2.4\Delta_o + 2.4\Delta_o \\ = 0$$

### John-Teller Distortion (J.T.D.)

# In symmetrical octahedral field, J.T.D. is absent

e.g. Half filled, fully filled, half-filled + half-filled

① d<sup>1</sup> ✓ d<sup>6</sup> ✓  
 (w.f.l)

d<sup>2</sup> ✓ d<sup>6</sup> X

d<sup>3</sup> X (s.f.l)

d<sup>4</sup> ✓ d<sup>7</sup> ✓

d<sup>5</sup> X d<sup>8</sup> X  
 (w.f.l) (s.f.l)

d<sup>5</sup> ✓ d<sup>9</sup> ✓  
 (s.f.l) d<sup>10</sup> X

JTD is absent

d<sup>3</sup>, d<sup>5</sup>, d<sup>6</sup>  
 (WFL) (SFL)

d<sup>8</sup>, d<sup>10</sup>

3 5 6 8 10

## Organometallic Comp

Comp in which metal is directly Bonded with carbon.

Two types:

Ionic  
Metal & carbon Ionic  
Bond

Covalent  
Metal & carbon moe  
Covalent Bond

- i)  $\sigma$ - Bonded
- ii)  $\pi$ - Bonded
- iii)  $\sigma$ - &  $\pi$ - Both

① Ionic Organometallic compound.

e.g.  $R^{\oplus}/Li^+$ ,  $Cu_3^- - C \equiv N^{\oplus} Na^+$ , etc

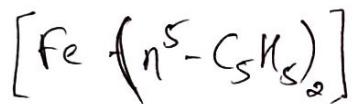
② Covalent Organometallic compound

①  $\sigma$ - Bonded.

e.g.  $R - Mg^{\delta+} - X^{\delta-}$ ,  $(Cu_3)_4 Sn$ ,  $Al_2 Me_6$  etc

②  $\pi$ - Bonded.

e.g. ferrocene

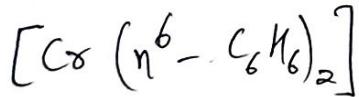


Hapticity ( $\eta$ ) : no. of C in Ring.



IUPAC: Bis-(cyclopentadienyl) iron(II)

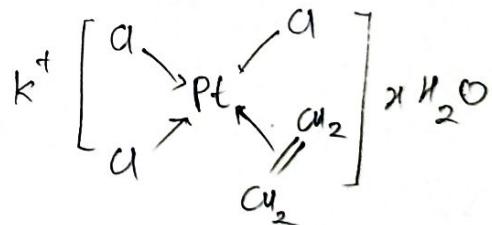
e.g. Dibenzene chromium $_2$



IUPAC: Bis(Benzene)chromium(0)

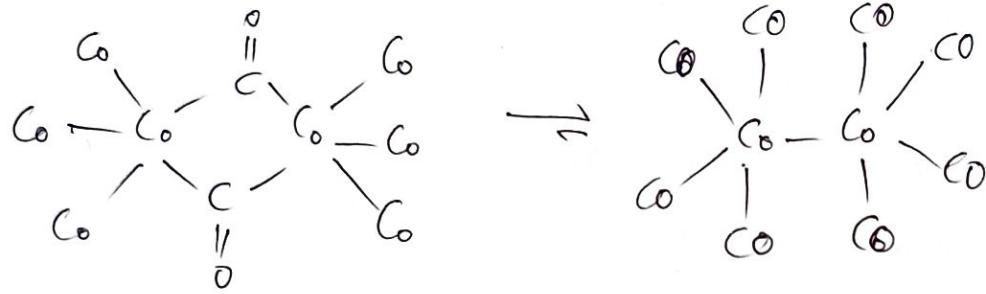
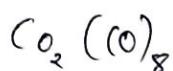
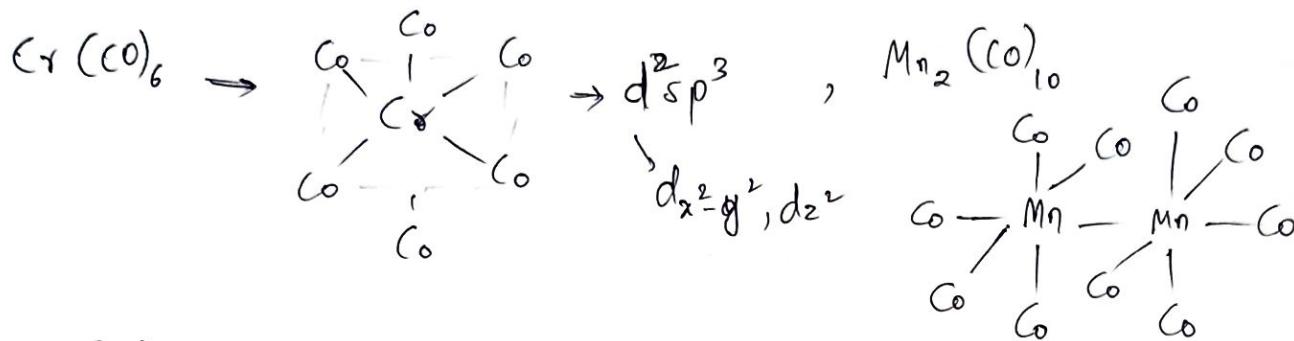
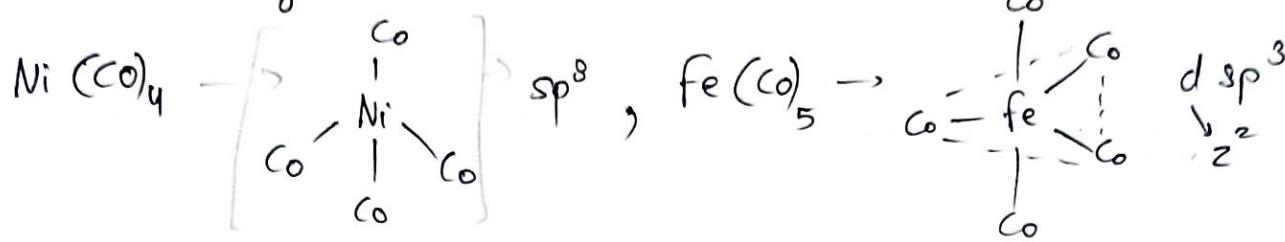
O.N of Cr = 0

e.g. Zeise's salt :  $K[PtCl_3(C_2H_4)] \cdot xH_2O$

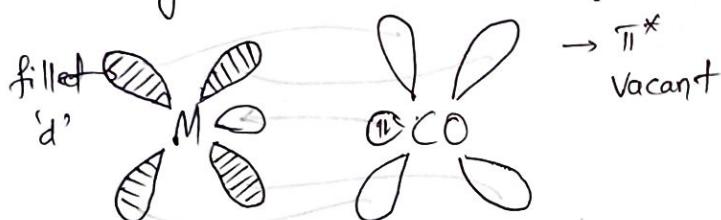


③  $\sigma$  &  $\pi$  Both Bonded.

## # Metal carbonyl



## Bonding in Metal carbonyls



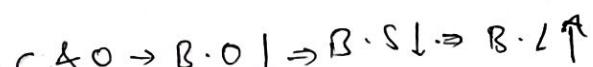
and ligands are called  $\pi$ -add ligands  
 $\text{CO}^*, \text{CN}^-, \text{PR}_3, \text{PF}_3$  etc

① M & C  $\sigma$  Bond is formed by donation of L.P of carbonyl carbon to the vacant 'd' orbital of metal.

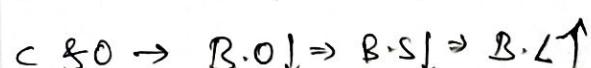
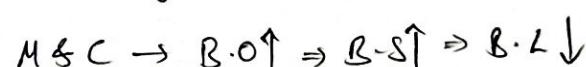
② M & C  $\pi$  Bond is formed by sideways overlapping of M & C ( $\pi^*$  orbitals) (filled 'd')

③ This Bonding is known as synergic Bonding & effect is called synergic effect

① due to synergic Bonding



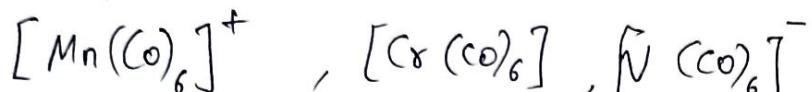
② Charge density on metal  $\uparrow$



Q.1) If Co Bond length in Co is  $1.123\text{ \AA}$  then what is the value of Co Bond length in  $\text{Fe}(\text{Co})_5$ ?

- A)  $1.15\text{ \AA}$  B)  $1.128\text{ \AA}$  C)  $1.72\text{ \AA}$  D)  $1.118\text{ \AA}$

Q.2) Compare Co Bond strength in



①

②

③



B.S in M & C :  $\text{V}^- > \text{Cr} > \text{Mn}^+$  i.e  $3 > 2 > 1$

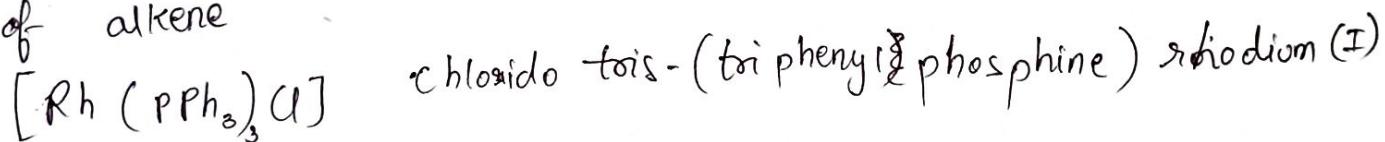
B.S in CO :  $\text{V}^- < \text{Cr} < \text{Mn}^+$  i.e  $3 < 2 < 1$

Some Imp Points:

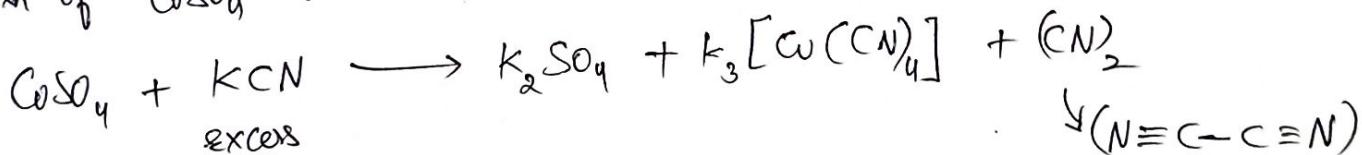
① Chlorophyll, Haemoglobin & Vitamin  $\text{B}_{12}$  are co-ordination complexes of Mg, Fe & Co respectively.

② Anti cancer agent is cis-platin  $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$   $\rightarrow$

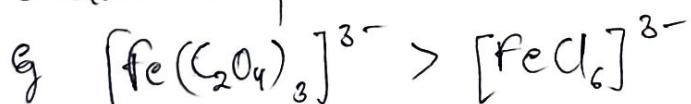
③ Wilkinson catalyst is used for hydrogenation of alkene



④ Rxn of  $\text{CuSO}_4$  with excess KCN



⑤ Chelate Complexes are more stable than non-chelate complexes usually.



⑥ O.N of metal in metal Carbonyl's may be -ve e.g.  $\text{K}[\text{Co}(\text{CO})_4]$