

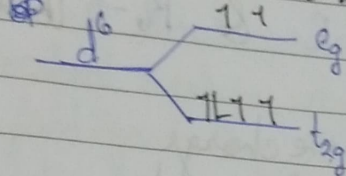
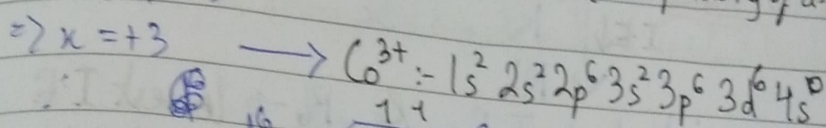
Internal Assessment - I (Set 2)

Part-A

1. $[\text{CoF}_6]^{3-} \rightarrow$ octahedral complex, F \rightarrow weak field ligand
(less splitting of d-orbitals)

$$x + (-6) = -3$$

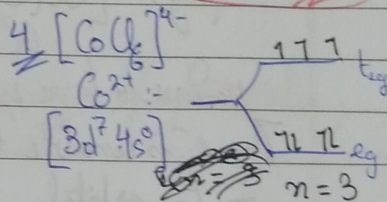
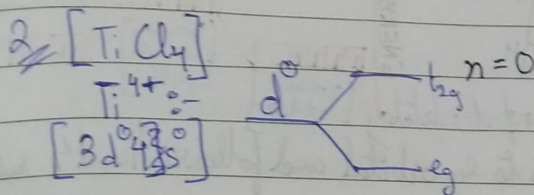
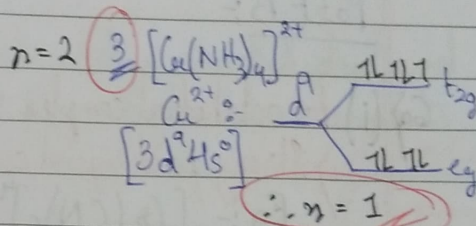
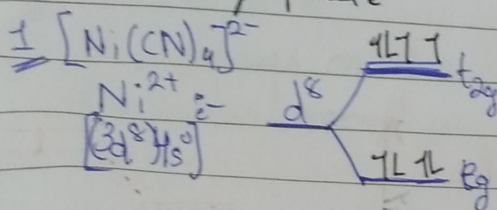
$$\Rightarrow x = +3$$



\therefore No. of unpaired $e^- = 4$

2. Given, $M_s = 1.73$

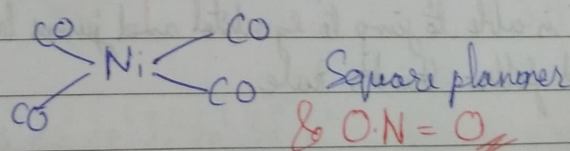
For $n = 1$, $M_s = \sqrt{1(1+2)} = \sqrt{3} = 1.73$
no. of unpaired e^-



3. $[\text{Ni}(\text{CO})_4] \rightarrow$ tetrahedral complex (neutral ligand)

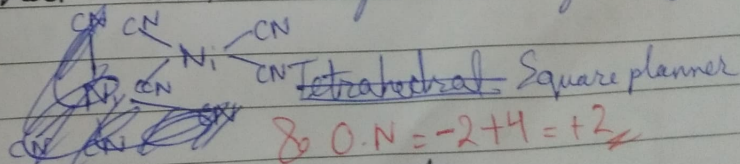
3. $[\text{Ni}(\text{CO})_4]^0$:- here, we have a neutral complex
That means there is no repulsion betⁿ ligands

Structure :-



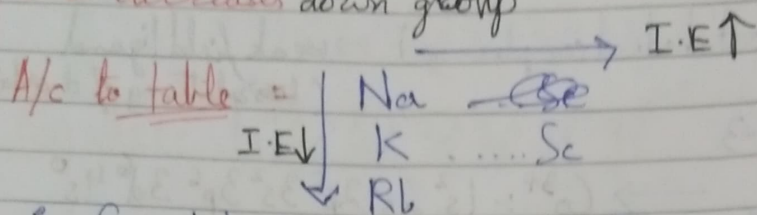
- $[\text{Ni}(\text{CN})_4]^{2-}$:- here, we have an anionic complex
That means there is repulsion betⁿ ligands (CN^-)

Structure :-



\therefore Both have square planar geometry

4. I.E increases along period
I.E decreases down group



\therefore Sc \rightarrow highest I.E & Rb \rightarrow lowest I.E

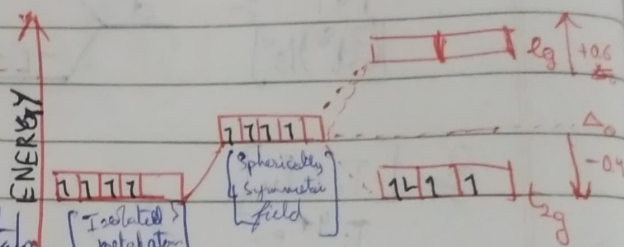
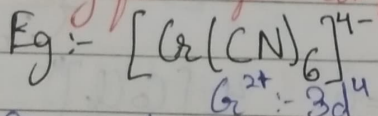
5. Hard acids :-
- Highly +ve charge
 - small atomic radius

\therefore BH_3 is not a hard acid $\left[\because \text{B} + 3\text{H}^- \rightarrow \text{BH}_3 \right]$
acid hydride

Part B:-

- 6a) (i) For octahedral complex:-

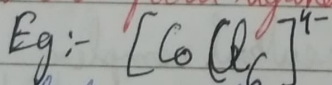
1) Strong field ligand complex:-



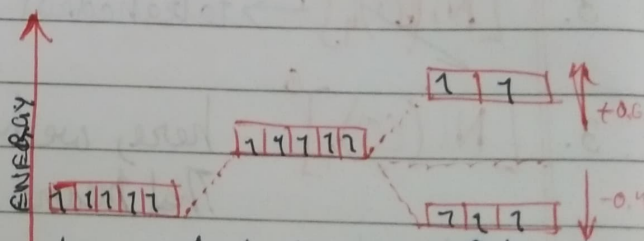
~~Due to large splitting of d-orbitals,~~

The e^- is unable to jump to e_g orbital and follows Hund's rule in t_{2g} orbital.

2) Weak field ligand complex:-



Due to less splitting of d-orbitals,



The e^- is able to jump to e_g orbital and jumps back down to t_{2g} and follow Hund's rule.

to (ii) Limitations of CFT:-

1. Neglects Covalent Bonding bet Ligand & C.M.A:-

CFT treats metal-ligand interaction as purely ionic

However, few strong field ligands exhibit covalent bonding. $[Ni(CO)_4]$

2. No Explanation about Spectrochemical Series:-

CFT does not explain why certain ligands are stronger or weaker field ligands than others in spectrochemical series.

It was later found out that the halogenic ligands were actually at the far end of the spectrochemical series

3. Limited to d-orbital Splitting:-

CFT focuses on d-orbital splitting in octahedral and tetrahedral geometries. It does not address aspects such as ligand field stabilization or effects of distortions (in geometries)

4. Fails to predict magnetic properties:-

CFT does not take into consideration of spin states, neglects ~~orb~~ orbital mixing etc.

6.6) For Br (35):- $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^5$

$\underbrace{1s^2 2s^2 2p^6}_{n-2=28} \quad \underbrace{3s^2 3p^6 3d^{10}}_{n-1=2} \quad \underbrace{4s^2 4p^5}_{n=4}$

$1s$
 $2s 2p$
 $3s 3p 3d$
 $4s 4p$

$$\therefore S = 0.35n + 0.85(n-1) + 1(n-2)$$

$$= 0.35(4) + 0.85(2) + 1(28)$$

$$= 1.4 + 1.7 + 28$$

$$= 31.1$$

$$\therefore Z_{eff} = Z - S$$

$$= 35 - 31.1$$

$$= 3.9$$

For Zn (30):- $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$

$\underbrace{1s^2 2s^2 2p^6}_{n-2=10} \quad \underbrace{3s^2 3p^6}_{n-1=8} \quad \underbrace{3d^{10} 4s^2}_{n=9}$

$\rightarrow 9$ (zero contribution)

$$\therefore S = 0.35(9) + 0.85(8) + 1(10)$$

$$= 3.15 + 6.8 + 10$$

$$= 19.95$$

$$Z_{eff} = 30 - 19.95$$

$$= 10.05$$

7a) (i) Impact of metal factors on d-orbital splitting:-

1. Position on periodic table:-

Down the group, d-orbital splitting \uparrow as no. of shells \uparrow
~~Across period, d-orbital splitting \downarrow as nuclear charge \uparrow~~
Here, 3d metals have smaller splitting compared to 4d & 5d

2. Oxidation state of Metal Ion:-

Higher charge on metal ion \rightarrow Higher splitting of d-orbitals
This is because higher charge on metal leads to stronger electrostatic interactions with the ligands

3. Coordination Geometry:-

This geometry is determined by ligands such as Oh , Td / Square planar
~~Certain geometries are preferred~~

4. Spin State:-

The Magnitude of CFSE determines if a complex adopts a low/high spin complex.

Metals with stronger crystal field splitting tend to form low spin complexes

5. Electronic Configuration of Metal Ion:-

The electronic configuration of metal ion affects how d-orbitals will split.

Presence of ~~d-orbital~~ e^- in d-orbital itself can contribute to inter-orbital repulsion & modifying the splitting pattern

6. Atomic Number of Metal Ion:-

Transition metals with higher atomic no. ~~exhibit~~ exhibit larger crystal field splitting.

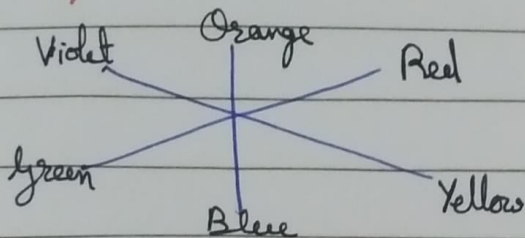
This is true for 4d & 5d series metals as effective nuclear charge or Z_{eff} increases, allowing stronger metal-ligand interaction.

7d) (ii) Complementary color:-

Complementary colors are pair of colours when mixed, cancel out each other by producing a greyscale color like white or black.

Such pairs are opposite to each other in the color wheel

Color wheel / Munsell wheel



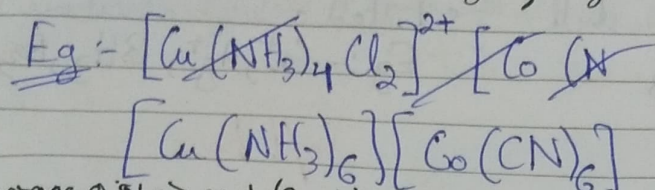
Here, the pairs of colours opposite to each other are complimentary to each other

That is

Here, The 1st color of pair → primary
 2nd color of pair → secondary] → complementary colours

b) (i) Co-ordination Isomerism:-

This type of isomerism occurs only in a cationic anionic complex where there is exchange of ligands betⁿ the cation & anion's part.



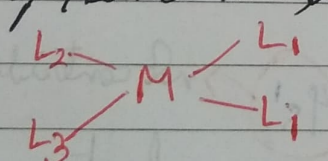
Average O.S. $\Rightarrow x + (0 \times 6) + x + (-6) = 0$
 $\Rightarrow 2x = 6$
 $\Rightarrow x = +3$

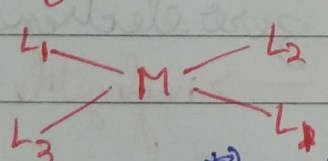
Coordination isomers are:-

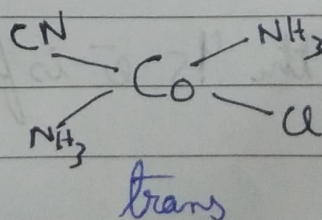
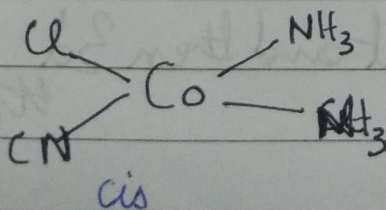
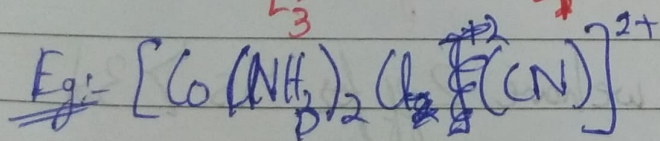
- 1) $[Cu(NH_3)_5(CN)]^{+2} [Co(NH_3)(CN)_5]^{-2}$
- 2) $[Cu(NH_3)_4(CN)_2]^{+2} [Co(NH_3)_2(CN)_4]^{2-}$
- 3) $[Cu(NH_3)_3(CN)_3] [Co(NH_3)_3(CN)_3]$
- 4) $[Co(CN)_6]^{3-} [Cu(NH_3)_6]^{3+} [Cu(CN)_6]^{4-}$

(ii) Cis-trans isomerism:-

This type of isomerism occurs in case of geometrical isomerism

In cis,  When same two ligands on same side of complex
 it is a cis-complex

In trans,  When same two ligands are on opposite side of the complex, it is a trans complex



76 ~~ii~~ (ii)

Hard acid

- Small ionic radius
- Highly +ve charge
- Empty orbitals at valence shell

Eg:- Na^+ , Ca^{2+} , K^+ , BF_3

Soft acid

- Large ionic radius
- Low +ve charge
- Filled orbitals at valence shell

Eg:- Cu^+ , Ag^+ , BH_3 , Br_2 ...

Hard Base

- Small ionic radius
- Highly -ve charge
- Empty orbitals at valence shell
- Low polarisability

Eg:- F^- , SO_4^{2-} , OH^- , H_2O , NH_3

Soft Base

- Large ionic radius
- Low -ve charge
- Filled orbitals at valence shell
- High polarisability

Eg:- I^- , S^{2-} , NC S^-