T.Y.B.SC. INORGANIC CHEMISTRY

PRACTICAL SEM-II

ONLINE LECTURE NO. 4

INORGANIC PREPARATIONS

DATE:- 20, MAY 2021

TIME: (10.00 A.M.)

A salt is formed by the neutralization of an acid by a base. There are different types of salts. They are:

1) Simple salt: $KOH + HCl \rightarrow KCl + H_2O$

2) Molecular (or) addition compounds:

a) Double salts are molecular compounds which are formed by the evaporation of solution containing two (or) more salts in stoichiometric proportions. Hence the molecular compounds which dissociate in solution into its constituent ions are known as double salt. Double salts retain their properties only in solid state. They are also called as lattice compounds. **Example** Mohr's salt:

$$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 6H_2O \rightarrow 2K^+ + 2Al^{3+} + 4SO_4^{2-} + 6H_2O^\circ$$

b) Coordination (or complex) compounds is 'a compound formed from a Lewis acid and a Lewis base'. The molecular compounds, do not dissociate into its constituent ions in solution are called coordination compounds.

$$Fe(CN)_2 + 4KCl \rightarrow K_4[Fe(CN)_6] \quad or \quad Fe(CN)_2 \cdot 4KCl$$

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

Ferrous cyanide

Double salt and coordination compound

- Ex: An aqueous solution of potash alum will give the tests for K^+, Al^{+3}, and SO_4^{-2}

$$K_2SO_4.Al_2(SO_4)_3.24H_2O \rightarrow 2K^+ + 2Al^{+3} + 4SO_4^{-2} + 24H_2O$$

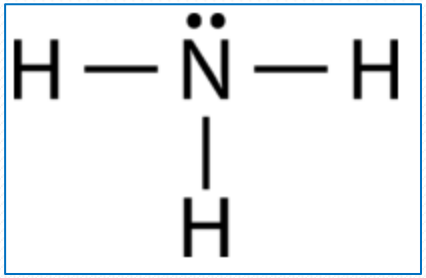
- On the other hand, coordination compounds are molecular compounds that retain their identity even when dissolved in water.
- Ex: When potassium ferrocyanide is dissolved in water, it does not give the usual tests for Fe^{+2} and CN^{-1}, indicating that, $[Fe(CN)_6]^{-4}$ does not dissociate into Fe^{+2} and CN^{-1}.

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

$$[Fe(CN)_6]^{-4} \not\longrightarrow Fe^{+2} + 6CN^-$$

Ligand: Electron rich species having tendency to donate electrons

N (7) → $1S^2$, $2S^2$, $2P_x^1$ $2P_y^1$ $2P_z^1$



H2N-CH2-CH2-NH2

Chelate

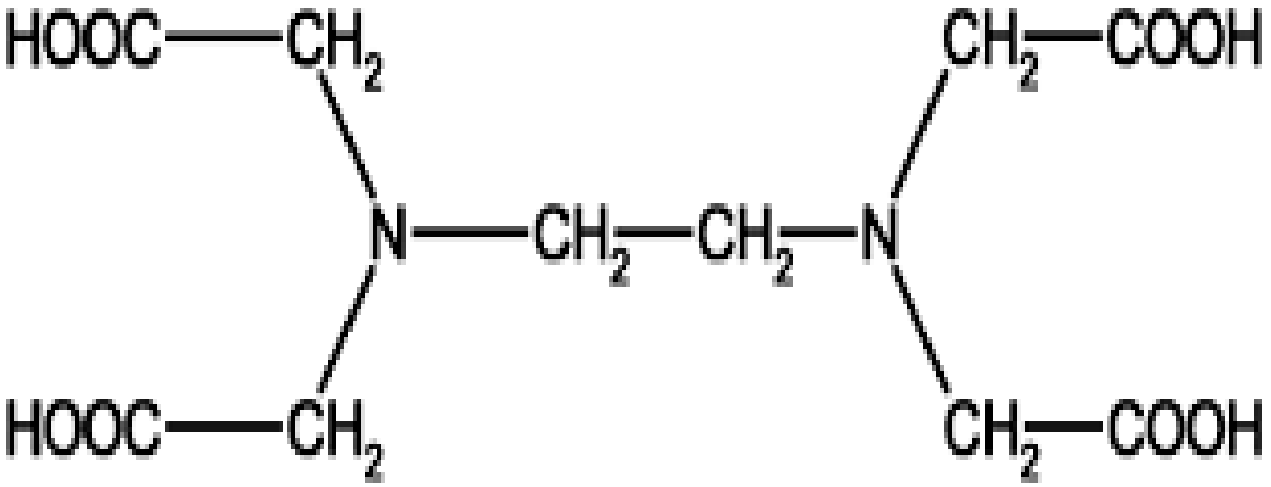
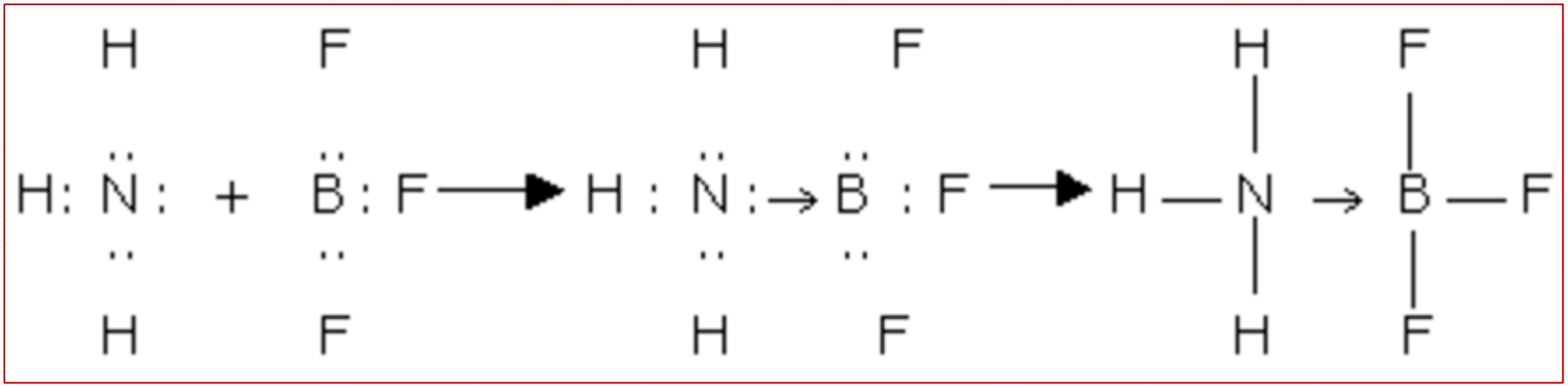


Figure 1. *Molecular structure of EDTA*

Coordinate bond and complex



Difference between Double Salt and Complex Compound

Double Salt	Complex Compound
They do not have coordinate bonds.	They have coordinate bonds.
They exist in solid state.	They exist in solid state as well as in aqueous solutions.
They lose their identity in aqueous solution.	They do not lose their identity in aqueous solution.
They contain two salts in equimolar ratio.	They contain ions which may or may not be in equimolar ratio.

DOUBLE SALT VERSUS COMPLEX SALT

DOUBLE SALT	COMPLEX SALT
A double salt is a compound prepared by the combination of two different salt compounds	A complex salt is a compound composed of a central metal atom having coordination bonds with ligands around it
Completely dissociate into its ions in water	Do not completely dissociate into its ions in water
Give simple ions when added to water	Do not give simple ions
Can easily be analyzed by determining the ions present in the aqueous solution	Cannot be easily analyzed by determining the ions in the aqueous solution

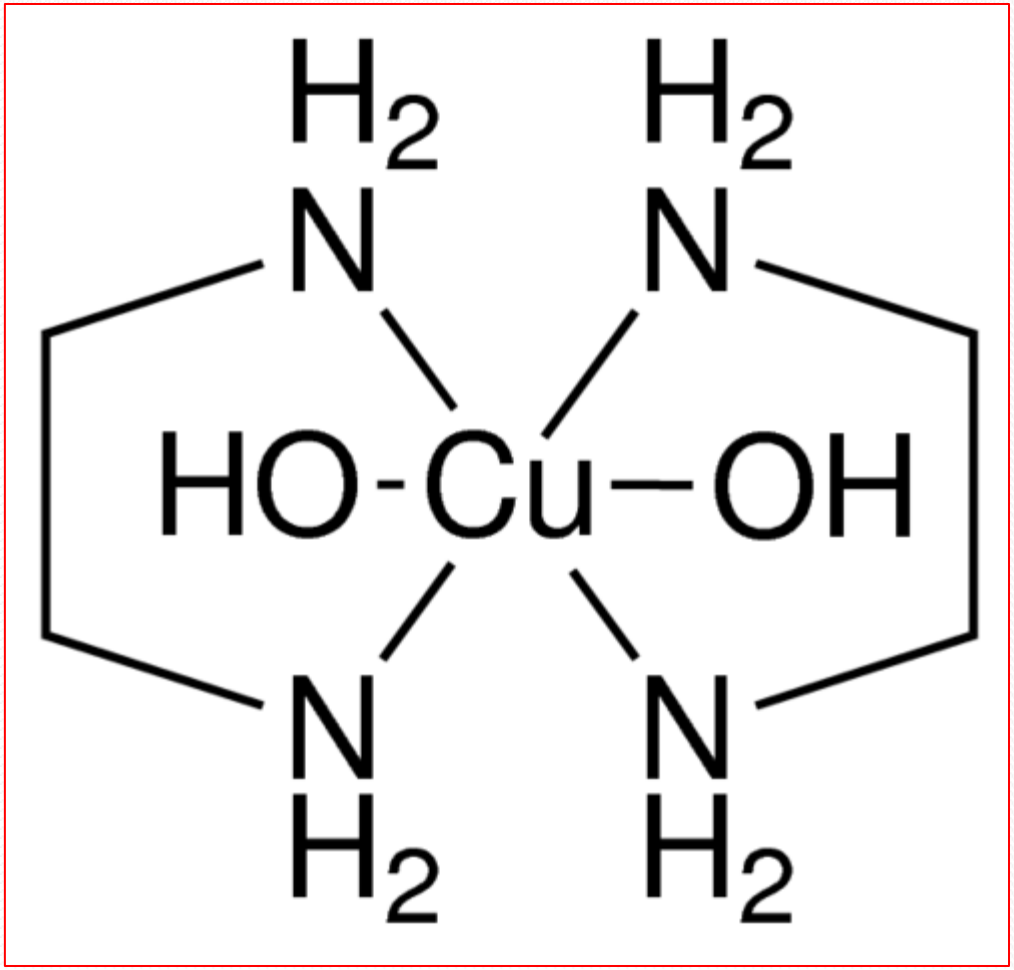
Double Salts	Complex Compound
➢ They usually contain two simple salts in equimolar proportions.	➢ The simple salts from which they are formed may or may not be in equimolar proportions.
➢ They exist only in the solid state. In aqueous solution, they dissociate completely into ions.	➢ They exist in the solid state as well as in aqueous solutions. This is because even in the solution, the complex ion does not dissociate into ions.
➢ They are ionic compounds and do not contain any coordinate bond.	➢ They may or may not be ionic but the complex part is always contains coordinate bonds.
➢ The properties of the double salt are the same as those of its constituent compounds.	➢ The properties of the coordination compound are the different from its constituents.
➢ In the double salts, the metal ions show their normal valency.	➢ In a coordination compound, the metal ions satisfy its 2 types of valencies called primary and secondary valencies.
➢ A double salt loses its identity in the solution.	➢ A coordination compound retains its identity in its solution.

On the basis of nature, addition (or) molecular compou are divided into two categories. They are double salts a coordination (or) complex compounds.

differences between double salt and co-ordination compound.

Double Salt	*Co-ordination compound*
1. These exist only in solid state and dissociate into constituent species in their solution.	1. They retain their identity in solid as well as in solution state.
2. They lose their identity in dissolved state.	2. They do not lose their identity in dissolved state.
3. Their properties are essentially the same as those of constituent species.	3. Their properties are different from those of their constituents. For example $K_4[Fe(CN)_6]$ does not show the test of Fe^{2+} and CN^- ions.
4. In double salts the metal atom/ion exhibit normal valency.	4. In co-ordination compounds, the number negative ions or molecules surrounding the central metal atom is beyond its normal valency.

Mohr's salt: $FeSO_4.(NH_4)_2SO_4.6H_2O$ double salt.


H2
H2
N
N
HO-Cu-OH
N
N
H2
H2

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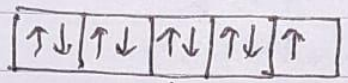
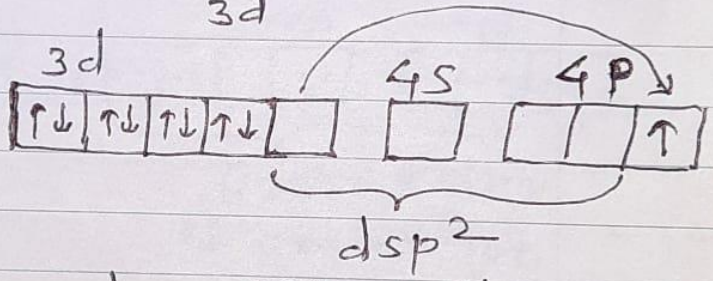
Cu (29) → $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^9$
G.S.

Cu (29) → $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^{10}$

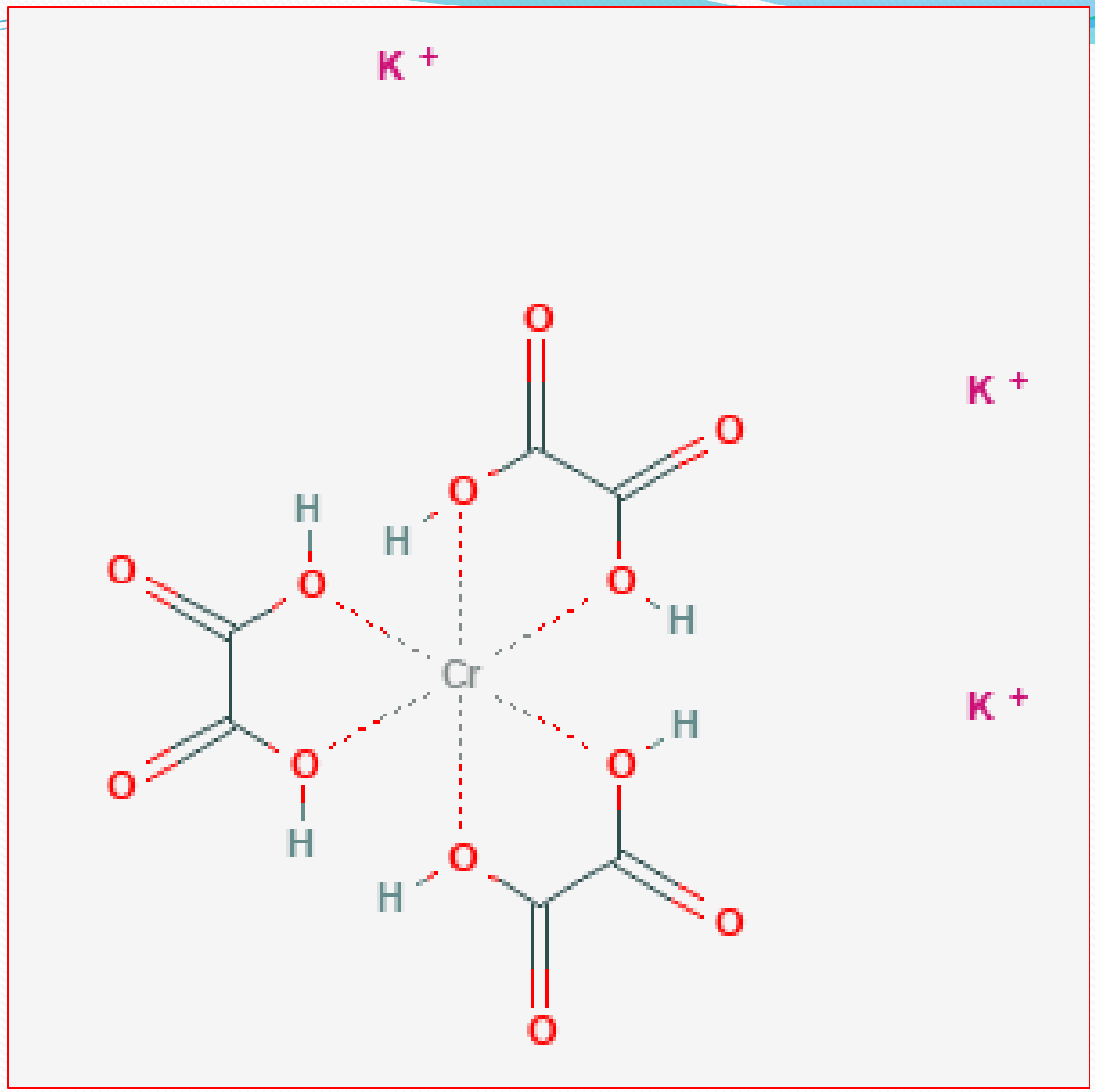
$Cu \longrightarrow Cu^{+2} + 2e^-$
29 e^- 27 e^-

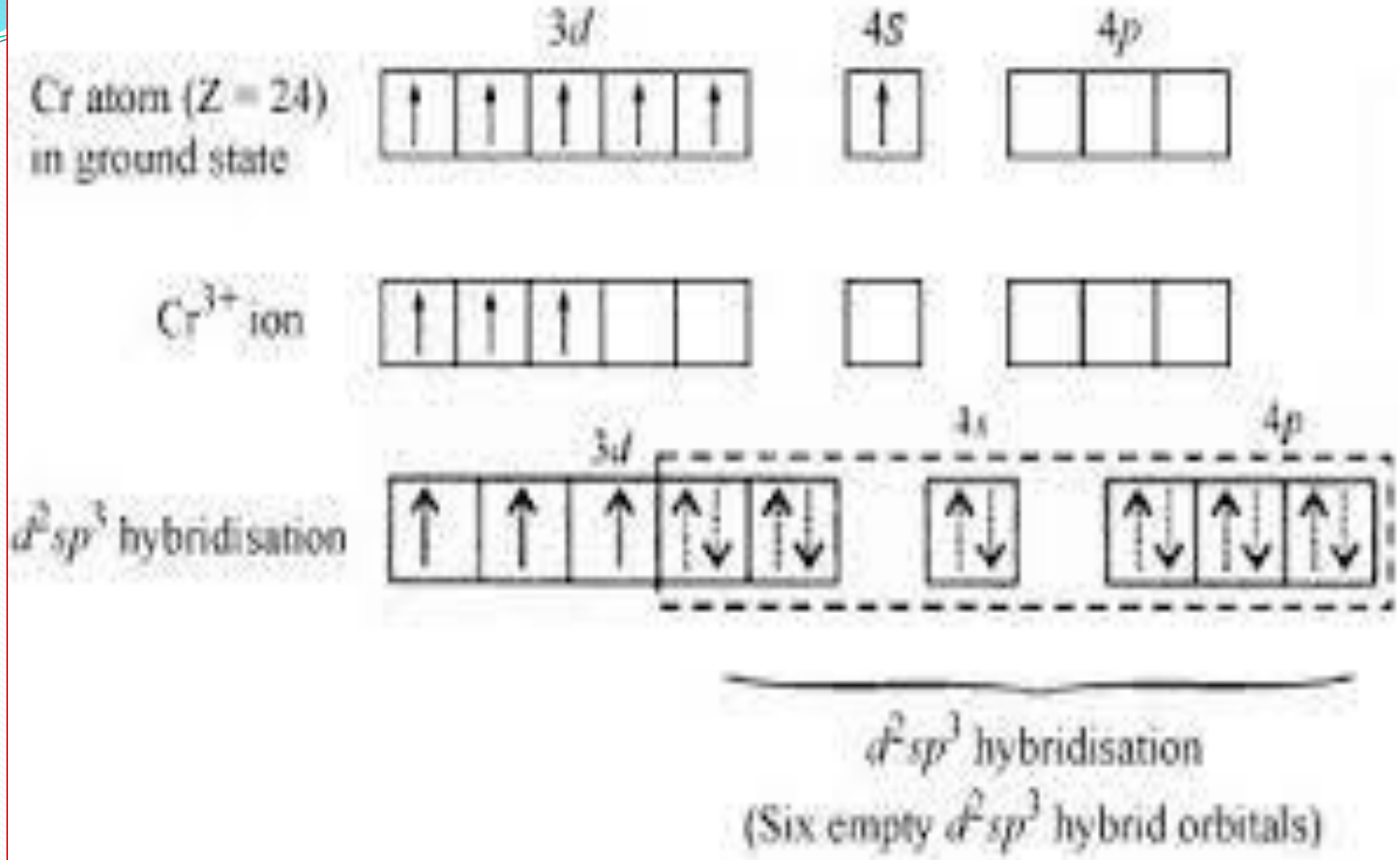
$Cu^{+2}(27) \rightarrow 4s^0\ 3d^9$

Cu (G.S.) → 

Cu (G.S.) → 

Four lone pairs of ethylene diamine


K +
K +
K +
O
O
O
H
O
H
O
H
O
O
Cr
O
O
H
O
H
O
O
O

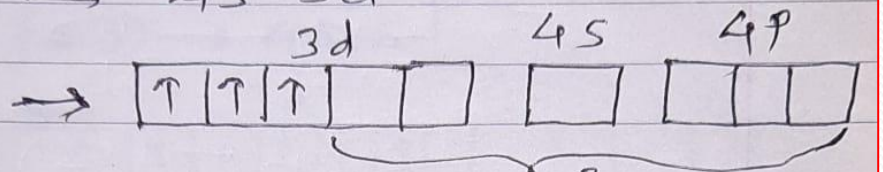

3d
4S
4p
Cr atom (Z = 24) in ground state
Cr^{3+} ion
3d
4s
4p
d^2sp^3 hybridisation
d^2sp^3 hybridisation
(Six empty d^2sp^3 hybrid orbitals)

$Cr(24) \longrightarrow 4s^2\ 3d^4$

$Cr \longrightarrow Cr^{+3} + 3e^-$

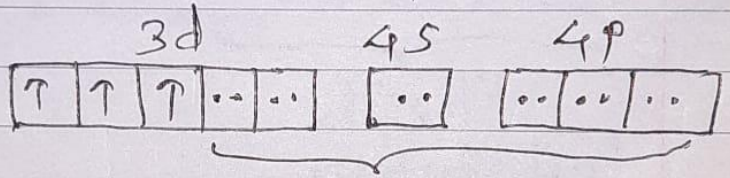
$24e^- \longrightarrow 21e^-$

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

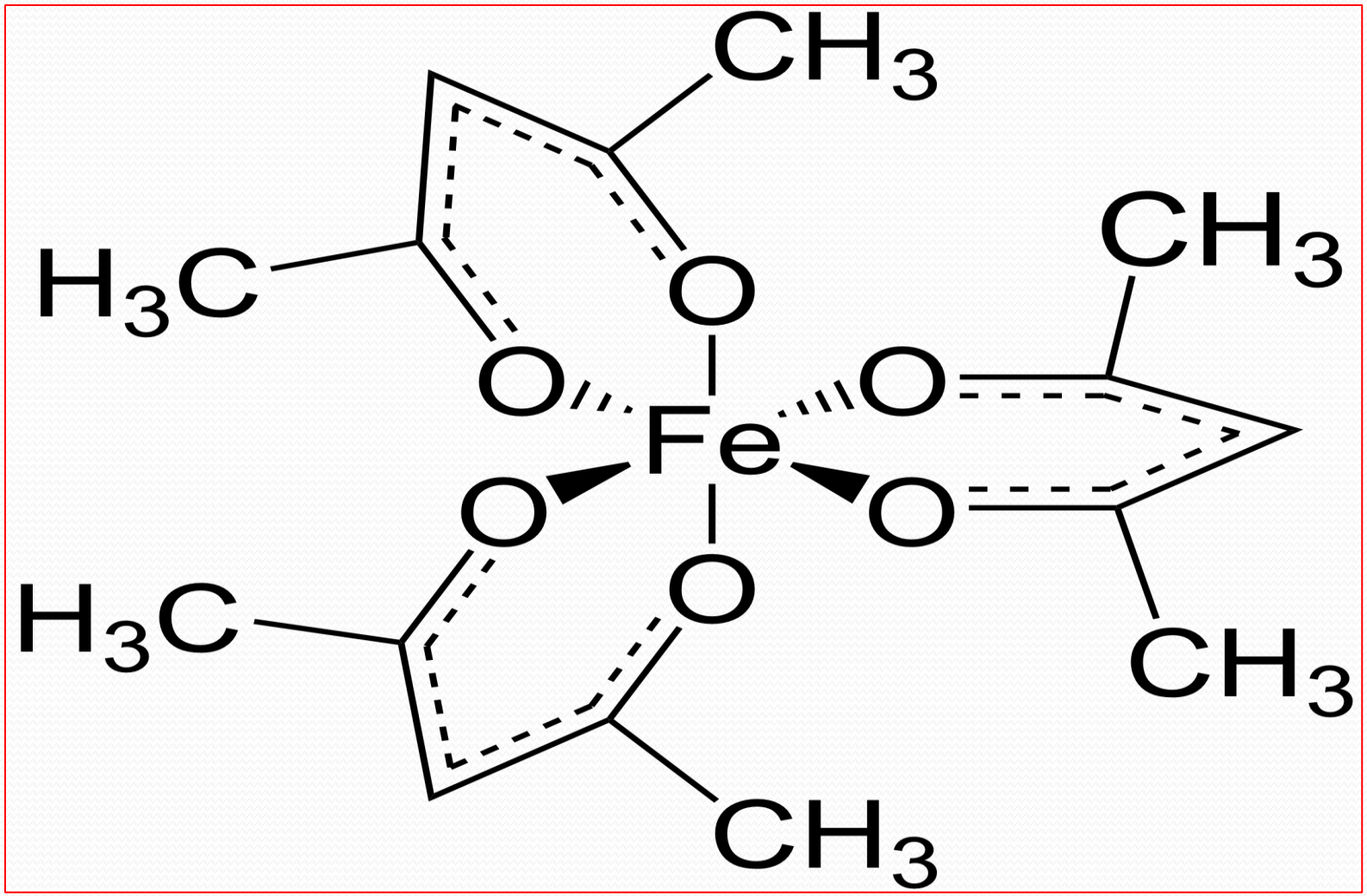


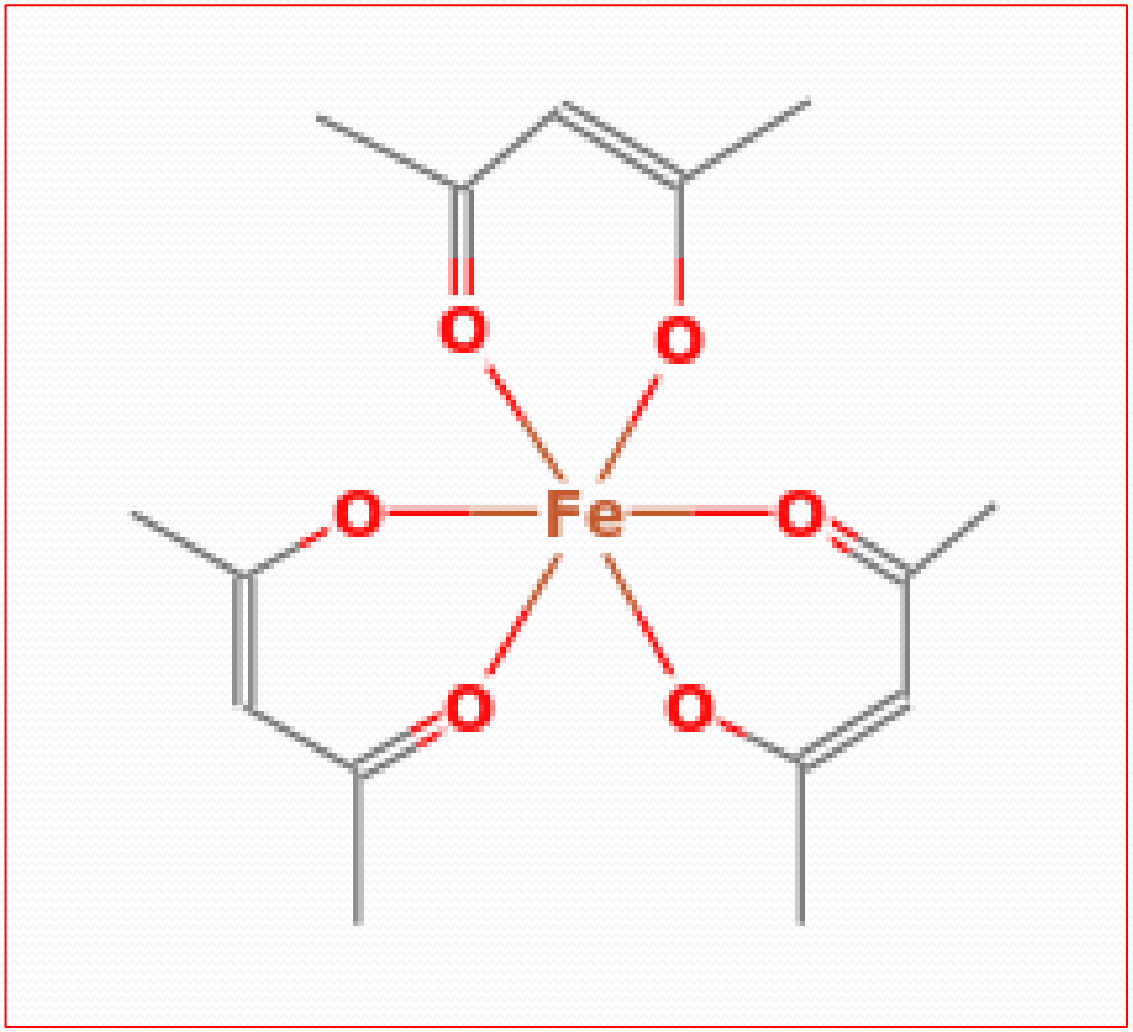
d^2sp^3

octahedral



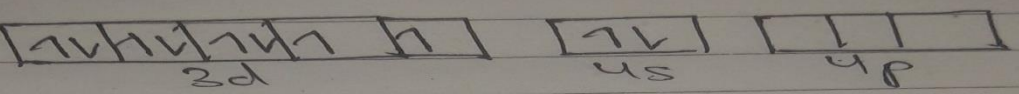
6 lone pairs of oxalato ion

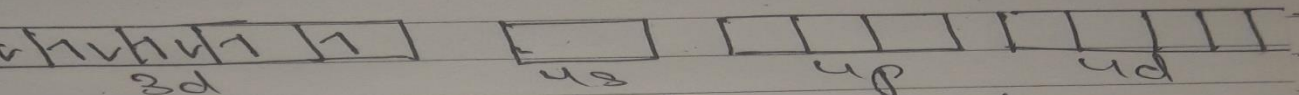

CH3
H3C
O
O
Fe
O
O
CH3
O
O
H3C
O
CH3
CH3


O
O
O
Fe
O
O
O

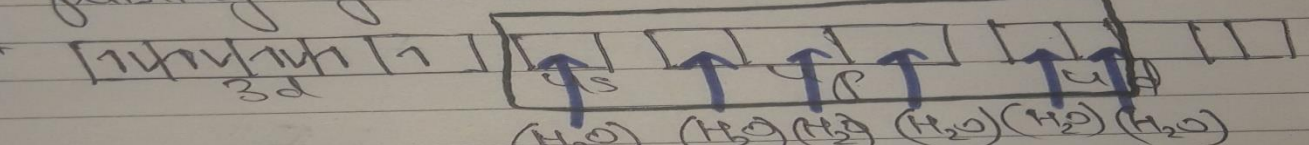
$[Ni(H_2O)_6]^{2+}$

Ni is in +2 state as the charge of H_2O is 0.

Ni 

Ni^{2+} 

∵ H_2O is weak field ligand it won't be able to do pairing of e's.

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

sp^3d^2

Hybridization ⇒ sp^3d^2

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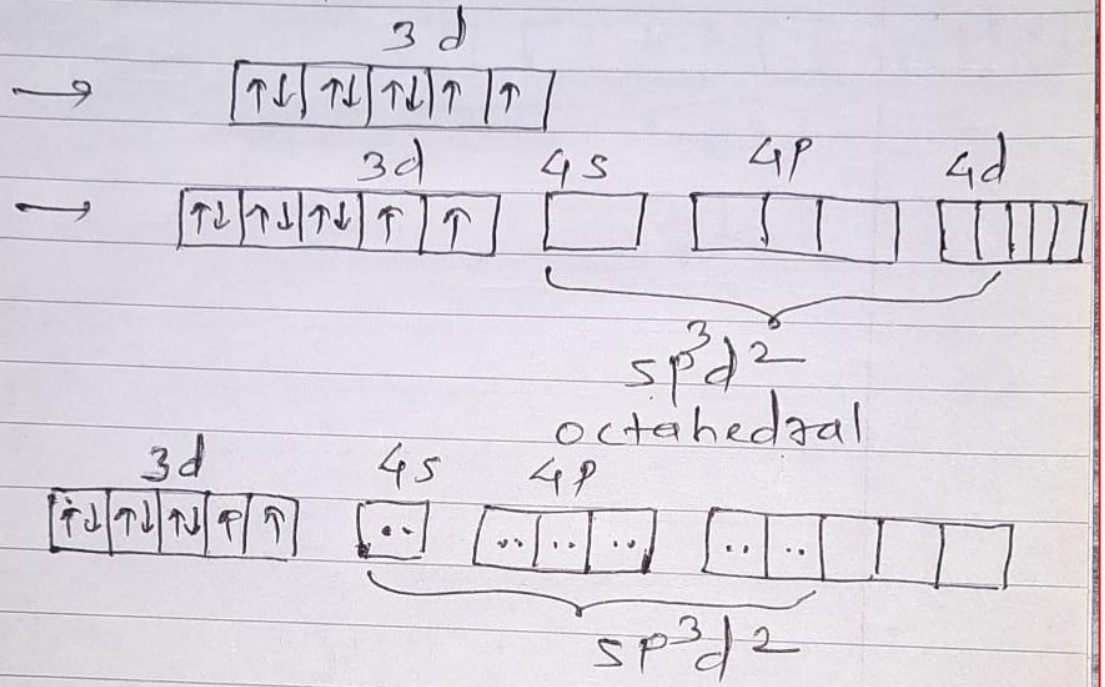
$Ni(28) \rightarrow 4s^2\ 3d^8$

$Ni \longrightarrow Ni^{+2} + 2e^-$

$28e^- \qquad 26e^-$

$Ni^{+2} \longrightarrow 4s^0\ 3d^8$



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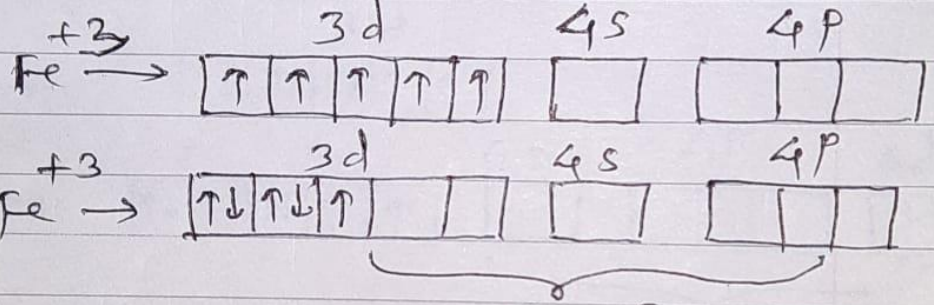
$Fe(26) \longrightarrow 4s^2\ 3d^6$

$Fe \longrightarrow Fe^{+3} + 3e^-$

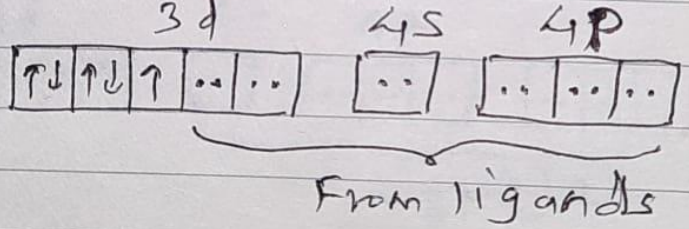
$26e^- \qquad 23e^-$

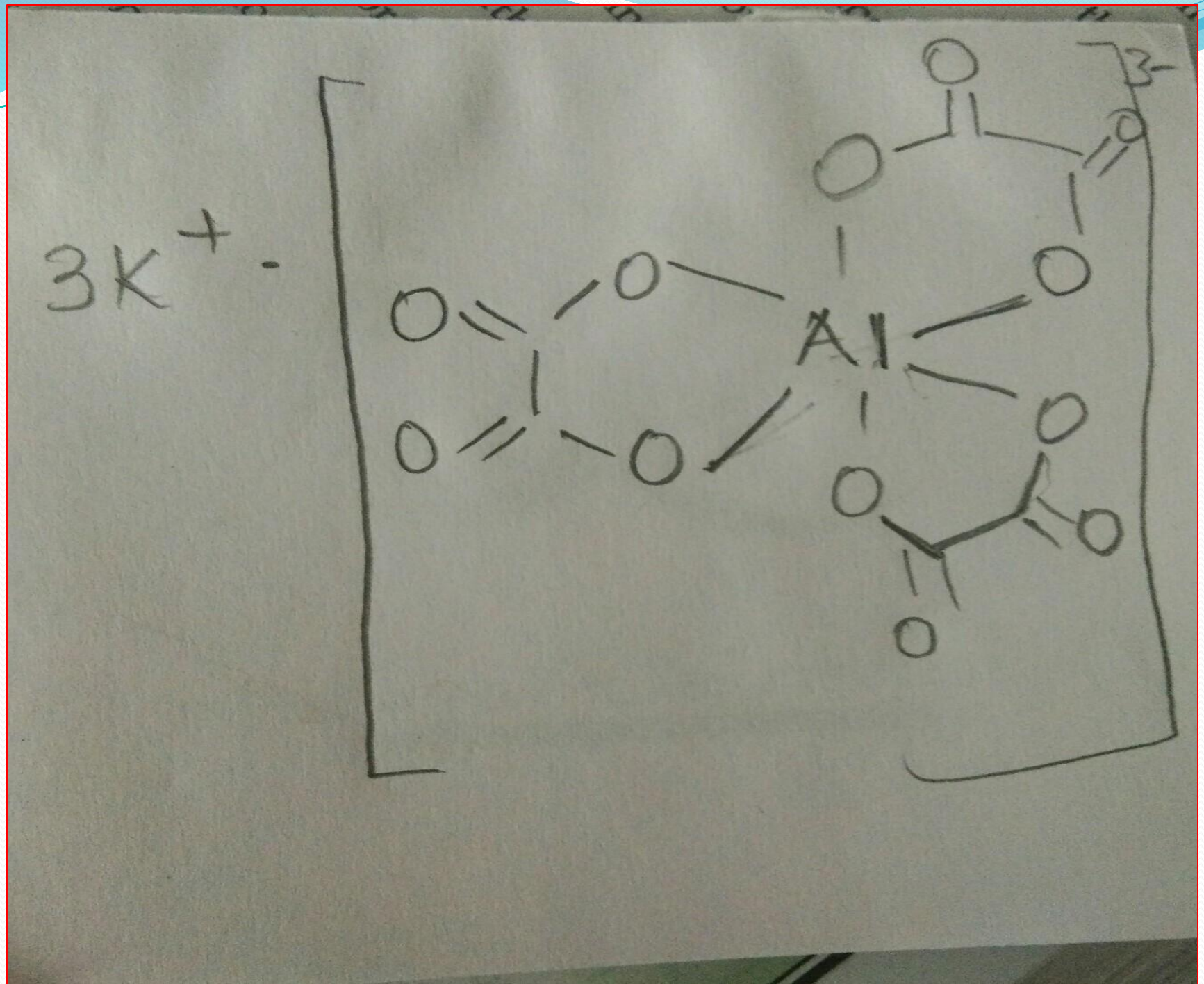
$Fe^{+3}(23) \longrightarrow 4s^0\ 3d^5$



d^2sp^3

octahedral




3K+ .
O
O
O
O
Al
O
O
O
O
O
O
O
O
O
3-

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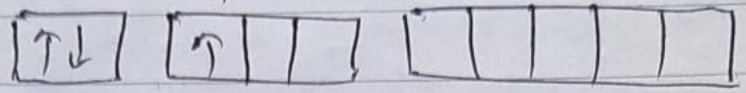
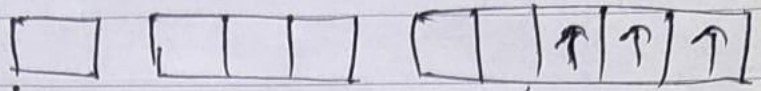
Al (13) → 3s² 3p¹ 3d



Al (13) → 3s 3p 3d³

E.S.



sp^3d2

Oh.

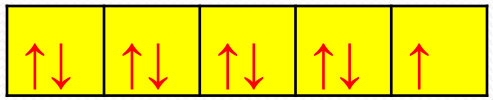
Cu (29) → $1S^2$, $2S^2$, $2P^6$, $3S^2$, $3P^6$, **$\underline{4S^2, 3d^9}$**

In $CuSO_4$, the oxidation state of Cu is +2. i.e. Cu+2

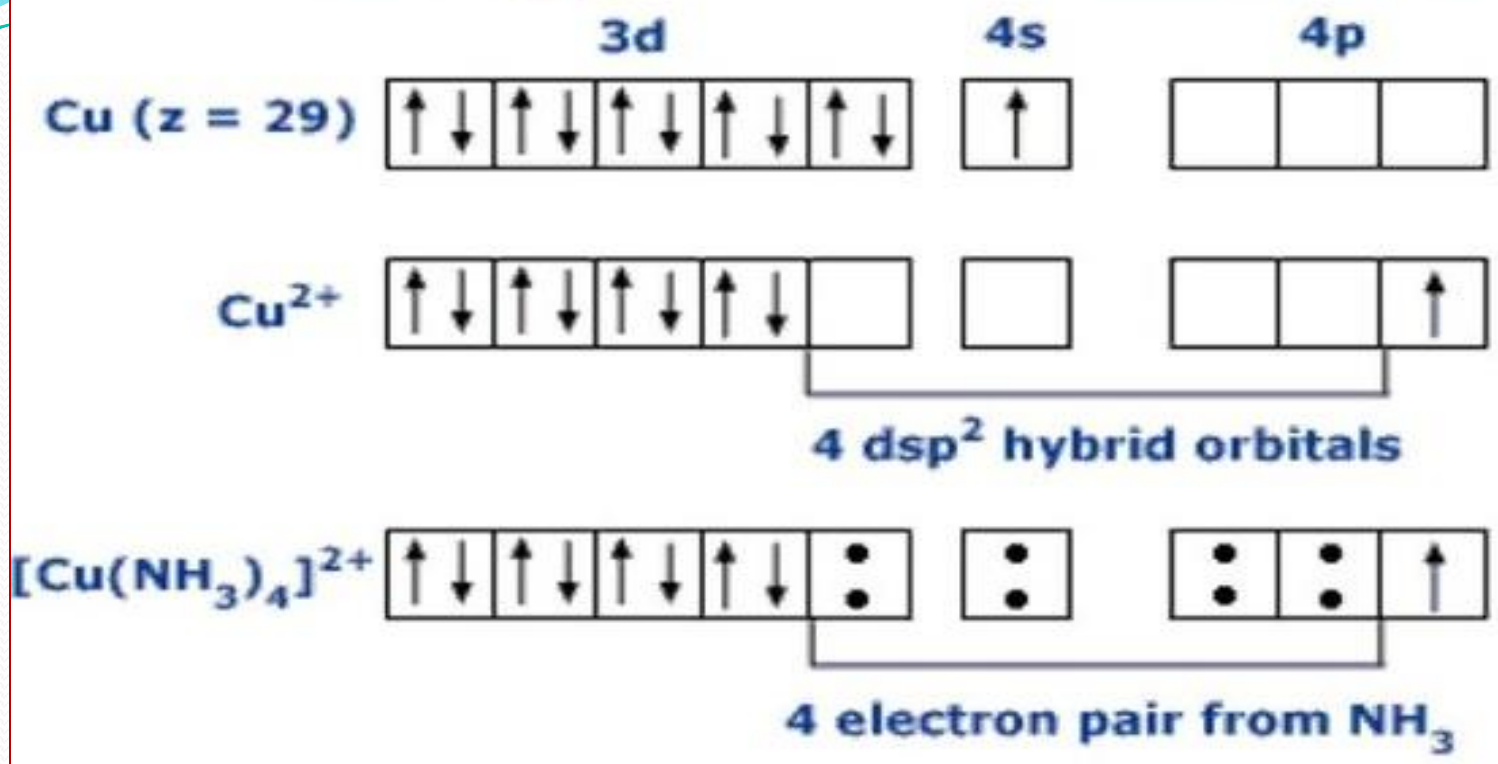
$Cu(29) = 4S^2 3d^9$

$Cu \rightarrow Cu^{+2} + 2e^-$

Cu^{+2} = 27 electrons = $4S^0\ 3d^9$



$[Cu(NH_3)_4]^{2+}$ Oxidation state of Cu^{2+}



dsp^2 - square planar, paramagnetic - one unpaired electron

Thank You.

STAY HOME,
STAY SAFE