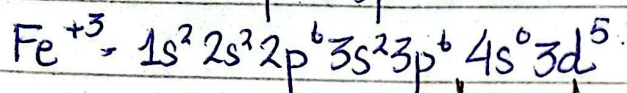
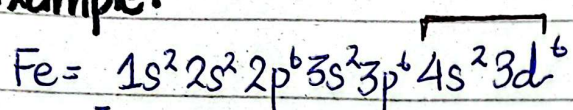


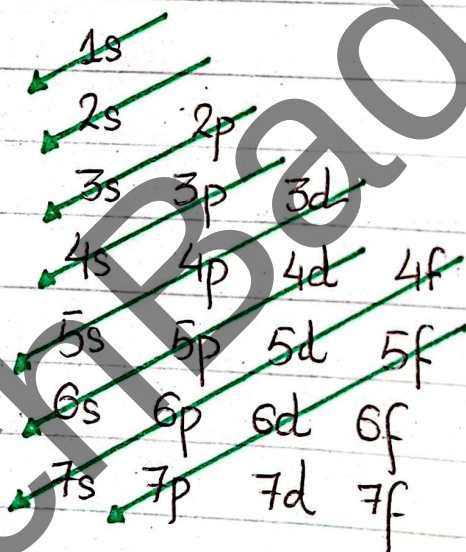
d and f block

The elements that have their outermost d and f shell incomplete whether in ionic or atomic state are called f and d block elements.

example:



configuration pattern :-



d and f being called Transition?

They are called transition elements because they are located between s and p block elements and their properties are in between metals of s block and non-metals of p block.

Series of transition elements :-

→ d block elements are divided into 4 series :-

- first outer transition series [3d]

Scandium (Sc^{21}) — Zinc (Zn^{30})

- Second outer transition series [4d]

Yttrium (Y^{39}) — Cadmium (Cd^{48})

- Third outer transition series [5d]

Lanthanum (La^{57}) — Mercury (Hg^{80})

- fourth transition series [6d]

Actinium (Ac^{89}) — onwards

→ f - block elements are divided into 2 series :-

- First inner transition series [4f]

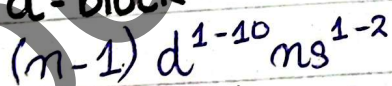
Cerium (Ce^{58}) — Lutetium (Lu^{71})

- Second inner transition series [5f]

Thorium (Th^{90}) — Lawrencium (Lr^{103})

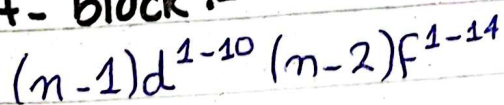
General electronic Configuration :-

d - block :

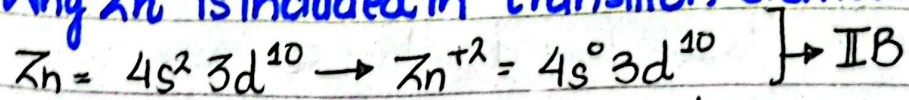


↳ refers to last shells (1, 2, 3, 4, 5, 6).

f - block :-

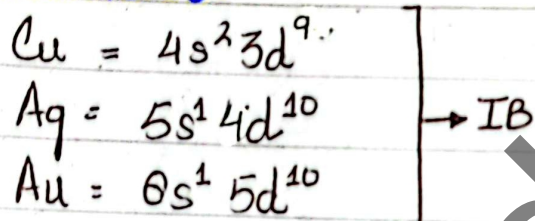


Why Zn is included in transition element?



The outershell of Zn in atomic state is completed but in ionic form its d is still filled. In addition it's still called transition because they form complexes with ammonia, halide ions, amines.

Why coinage metals are in transition elements?



- Their d-orbital is incomplete. Also they form color complexes and possess variable oxidation.

Typ - Transition element conditions

- They form complex comp
- They form colored comp
- They possess variable oxidation state
- They are malleable and ductile
- They have high m.p and B.p.

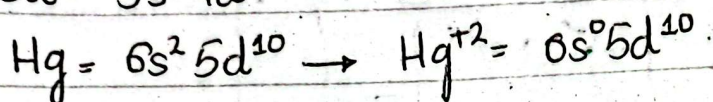
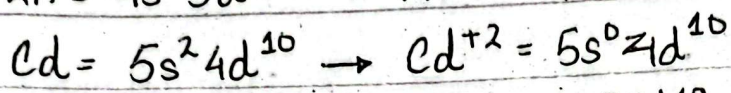
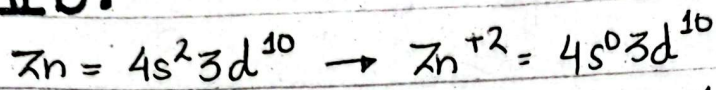
Non-Typ - Transition elements conditions

- They have completed subshell
- Limited oxidation state
- Lack of colored comp
- Absence of electronic configuration

→ example of non-typical transition elements

Non-typical transition elements include IIB and IIIB.

IIB:-



They are so called because:-

- They have complete d subshell
- They don't form colored compounds
- They don't show variable oxidation state because of their complete d.
- They are colorless

IIIB:-



They are so called because:-

- They have empty d-orbital in ionic form
- Do not show transition characteristic
- do not form colored compound

→ example of typical transition elements

All except IIB & IIIB are typical because

they have partially filled orbitals
IB, IVB, VB, VIB, VIIB, VIII B

- Cr and Cu deviation:-

Cr = $[Ar]4s^2 3d^4$ but in real $[Ar]4s^1 3d^5$

Cu = $[Ar]4s^2 3d^9$ but in real $[Ar]4s^1 3d^{10}$

- They should have filled s first but d later but to gain stability they deviate from Aufbau Principle.

binding energy

“The minimum amount of energy that's responsible for holding atom together.”

Binding energy $\propto$ No. of unpaired e⁻

Binding energy $\propto$ strength of metallic bonding

→ Mechanical properties of transition elements related to binding energy (hard, high density, Melting and boiling point, malleable, ductile).

→ The Highest Binding energy **Vanadium** due metallic structure.

trend:-

→ As we move from left to right Binding energy increases upto VB (vanadium) & VIB (chromium)

• After that it becomes approx to 0 due unavailability of unpaired e⁻.

variable O.S

^{ee} The apparent charge on an atom which may be (+) & (-) is called Oxidation state."

→ Transition elements are electropositive so they have +ve O.S.

→ The transition elements tend to have variable Oxidation state because they use 's' & 'd' as they have less energy gap.

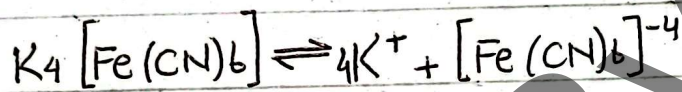
→ 3d series manganese have maximum oxidation state. (+1 → +7)

element	configuration	oxidation state
²¹ Sc	4s ² 3d ¹	+2, +3
²² Ti	4s ² 3d ²	+2, +3, +4
²³ V	4s ² 3d ³	+2, +3, +4, +5
²⁴ Cr	4s ¹ 3d ⁵	+2, +3, +4, +5, +6
²⁵ Mn	4s ² 3d ⁵	+1, +2, +3, +4, +5, +6, +7
²⁶ Fe	4s ² 3d ⁶	+1, +2, +3, +4, +5,
²⁷ Co	4s ² 3d ⁷	+2, +3, +4
²⁸ Ni	4s ² 3d ⁸	+2, +3, +4
²⁹ Cu	4s ¹ 3d ¹⁰	+1, +2, +3
³⁰ Zn	4s ² 3d ¹⁰	+2

Coordination compound

"Those compound which contain complex molecule or complex ion capable of independent existence."

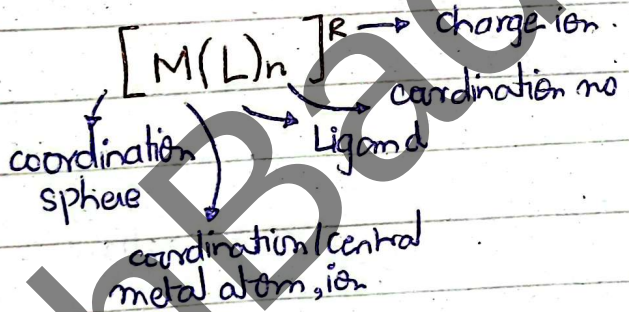
example :-



stable

- When dissolved in water, its geometrical shape is retained.

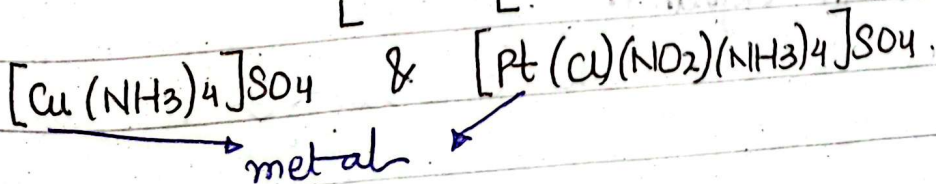
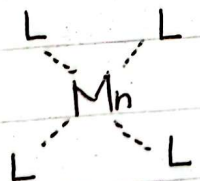
General formula :-



Components :-

a) Central metal atom or ion

The metal atom or ion that's surrounded by no. of Ligand.

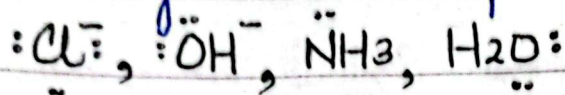


b) Ligand:

Substance which donate pair of e^- to central metal atom or ion.

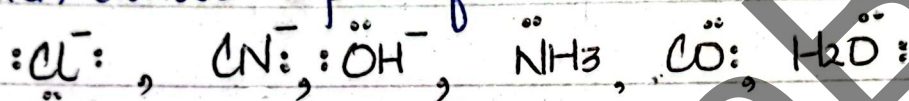
→ Co-ordinate covalent bond is formed between metal and Ligand.

→ They contain lone pairs.



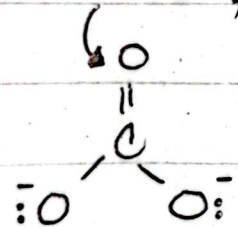
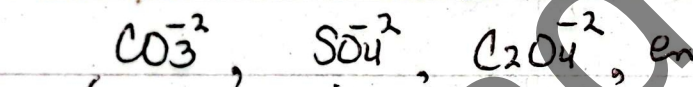
• Monodentate Ligand:

Which donate 1 pair of e^- or 1 donor atom.



• Bidentate Ligand:-

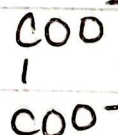
Which donate 2 donor atom or 2 pair of e^-



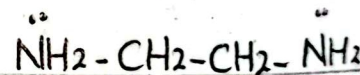
carbonate ion



Sulphate ion



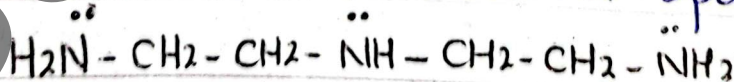
Oxalate ion



ethylene diamine

• Tridentate Ligand:-

Which donate 3 donor atom or 3 pair of e^-

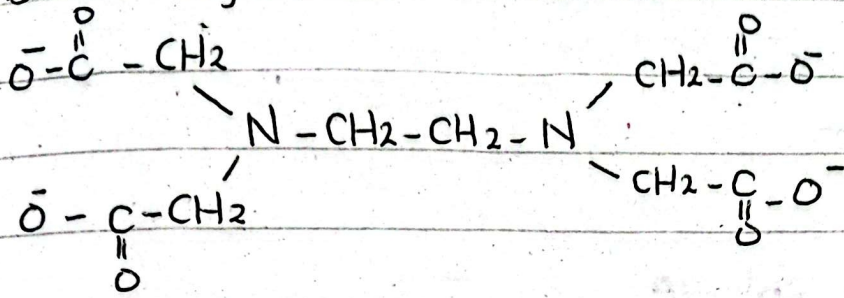


Diethylene triamine

• Hexadentate Ligand:

Which donate 6 donor atom or 6 pair of e^-

EDTA = ethylene diamine tetra acetate.



- Chelating Ligands:-

These rings Ligands form multiple bonds with central atom/ion creating a ring structure.

en, EDTA

- Bridging Ligands :-

These ligands connect 2 or metal atoms or ions.

OH^- , CN^-

- Ambidentate Ligands :-

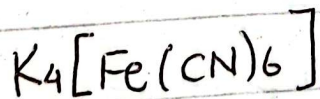
These Ligands can bind to the central atom or $\checkmark$ metal

ion through 2 different atoms.

 SCN^-

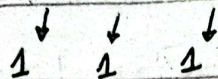
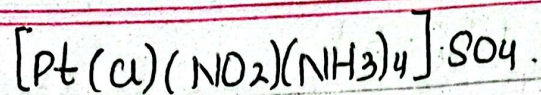
c) Coordination ion :-

4) Coordination No.
No. of e^- pair donated by ligand to central atom or ion.



6] $\rightarrow$ 6 (coordination no).

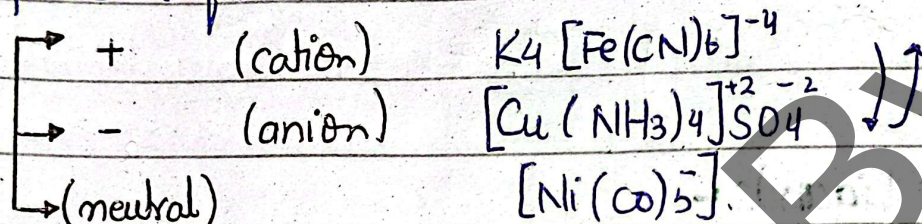
$$CN^- = 1 \text{ paire } e^- = 6.$$



= 6 pair of e^-

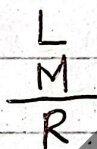
d) Coordination sphere

Central metal along with ligand place in a sphere (square bracket)



e) charge on coordination sphere

Sum of charge on metal ion & total charge on ligand.



mononuclear

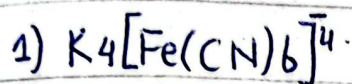
- 1) Cation is written first
- 2) Anion is written after
- 3) Words like Di, Tri, Tetra should not be used. Cation.
- 4) All rules applied inside bracket
- 7) H_2O = aqua
- 8) NH_3 = amine
- 9) CO = carbonyl

5) If there is a (-) Ligand, we will add 'o' to the name.

10) Polydentate.

6) Charge on metal then add 'ate' (2 = bis, 3 = tris, 4 = Tetrakis)

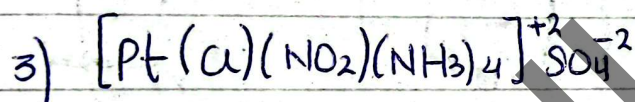
examples:-



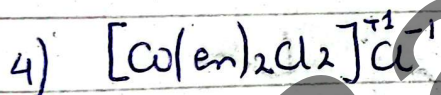
potassium hexacyanoferrate (II)



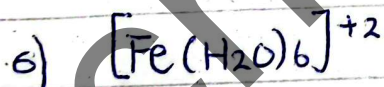
Sodium pentacarbonylmanganate (-I)



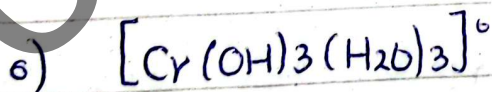
Tetraamminechloronitroplatinum (IV) sulphate.



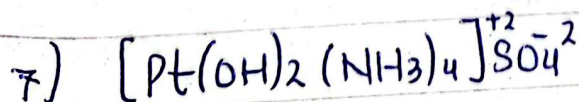
Dichlorobisethylenediamine cobalt (III) chloride.



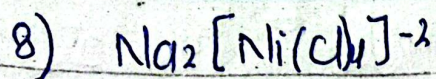
Hexaaqua iron (II) ion.



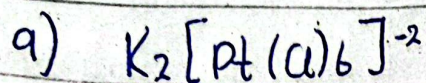
triaquatrihydroxochromium (III).



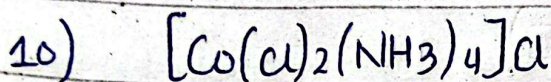
tetraammine dihydroxo platinum (IV) sulphate.



Sodium tetrachloro Nickel (II)



potassium tetrachloro platinum (IV)



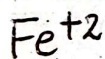
Tetraammine dichloro cobalt chloride
(III)

Chemistry of element

Iron

Oxidation State

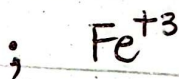
exists in 2 oxidation state.



ferrous

Green color

unstable

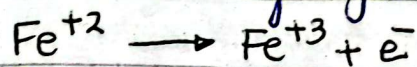


ferric

Yellow color

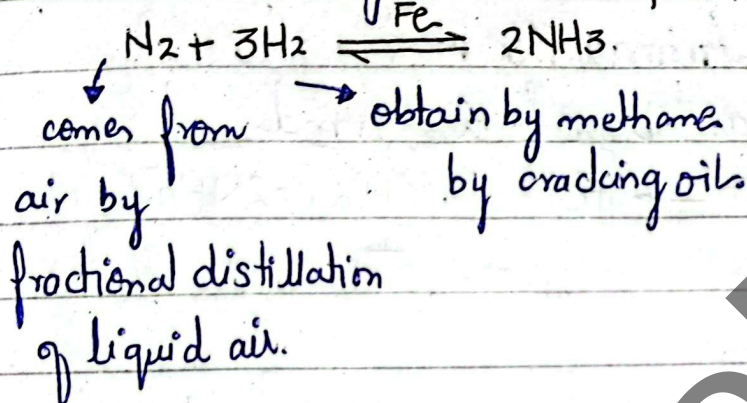
Stable

- Fe^{+2} is good reducing agent.
- Fe^{+3} is an oxidizing agent.

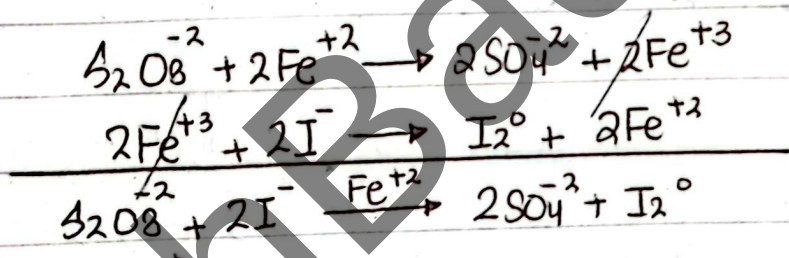


Catalytic property

→ Iron acts as a catalyst in Haber process.



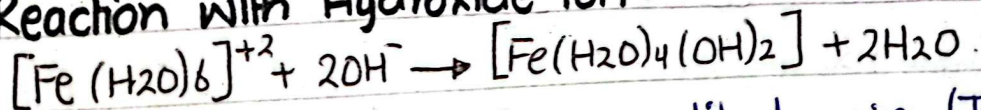
→ Iron ion act as a catalyst by reaction between per sulphate & iodide ion.



reaction

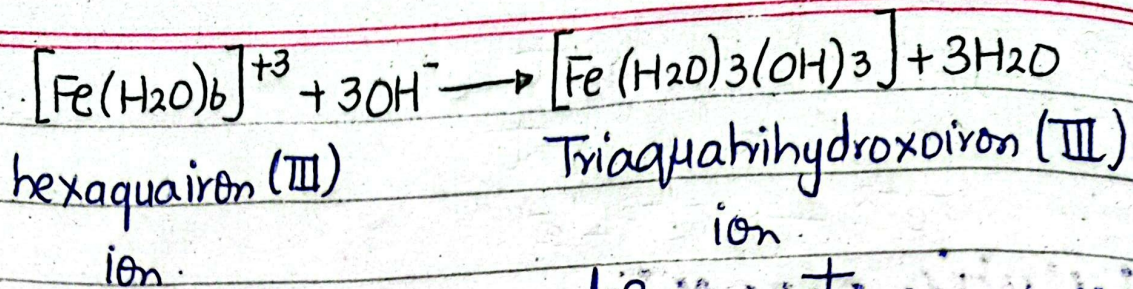
- hexaaquairon (II) ion $[\text{Fe}(\text{H}_2\text{O})_6]^{+2}$ = Green color sol
- hexaaquairon (III) ion $[\text{Fe}(\text{H}_2\text{O})_6]^{+3}$ = Yellow color sol.

a) Reaction with Hydroxide ion :-



hexaaquairon (II) ion
Green sol.

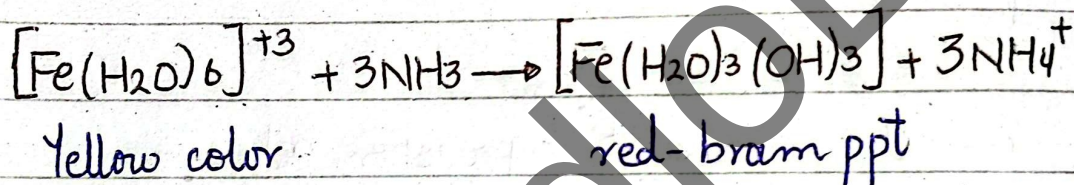
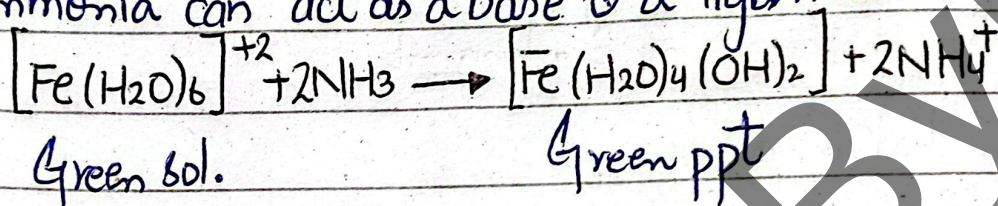
Tetraaquadihydroxoiron (II).
Green ppt.



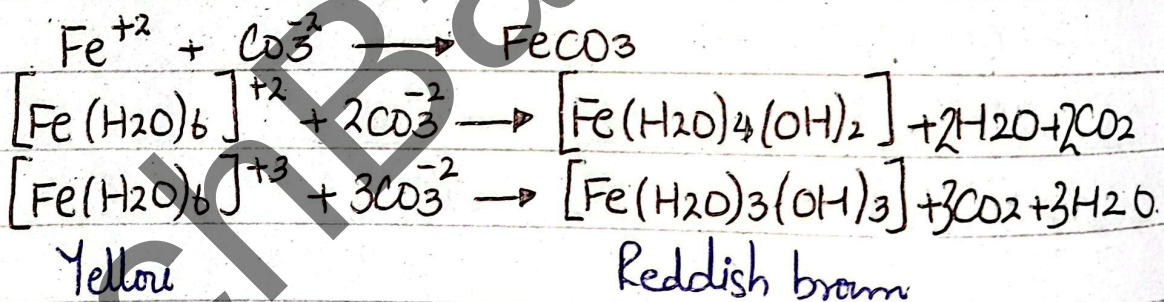
Yellow sol. red-brown ppt:

b) Reaction with Ammonia :-

Ammonia can act as a base & a ligand.

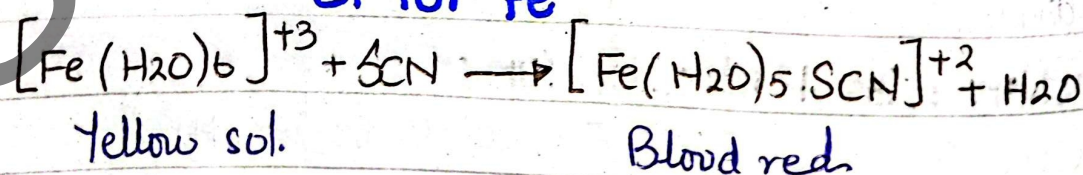


c) reaction with CO_3^{2-}



d) Reaction with thiocyanate ion :-

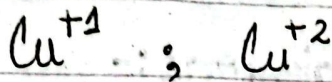
CT for Fe^{+3}



pentaqua thiocyanato (II) ion

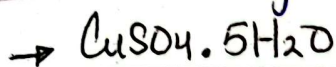
Copper Oxidation state

exists in 2 oxidation state.

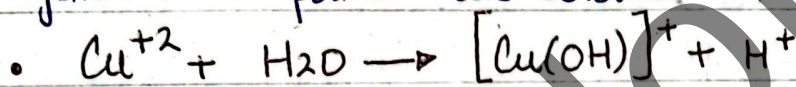


Cuprous
colorless
diamagnetic

Cupric
Coloured comp.
in hydration (Paramagnetic)

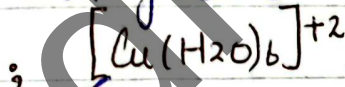
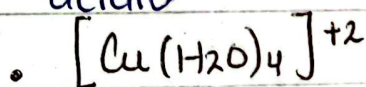


Cupric anhydrous compound are colorless but hydrated compounds are colored.



acidic

weakly acidic



blue

> tetraaqua Copper (I) ion

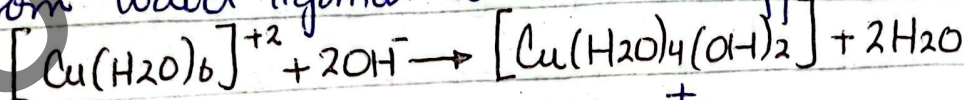
> hexaaqua Copper (II) ion

> Colorless

> Blue sol.

reaction of hexaaqua Copper II ion

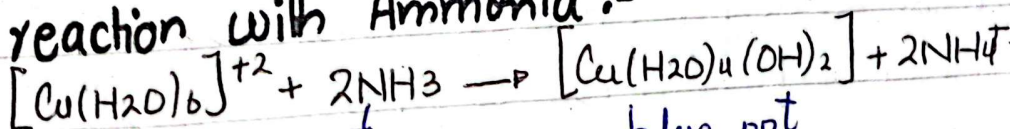
- OH^{-} from any base such as NaOH remove H^{+} ion from water ligands attached to Copper ion complex.



blue sol

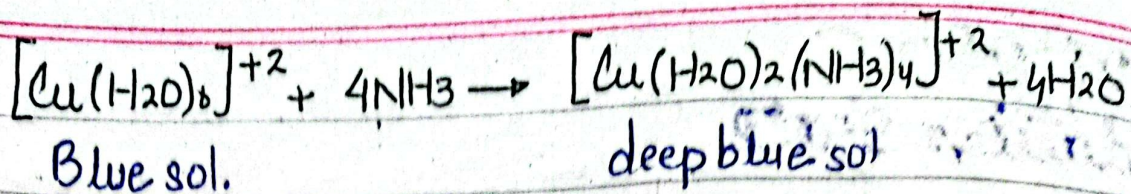
Blue ppt

- reaction with Ammonia :-



base

blue ppt

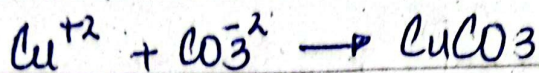


Blue sol.

deep blue sol

tetraammine diaqua Copper (II) ion

- reaction with carbonate ions:-



blue sol.

blue ppt

~~magnesium~~ manganese oxidation state

Manganese have 7 diff oxidation states.

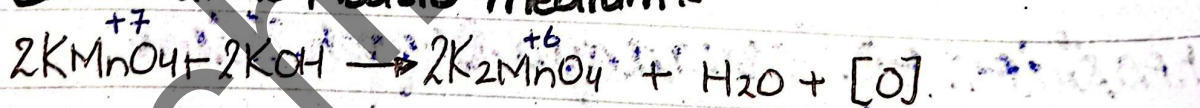
+1, +2, +3, +4, +5, +6, +7

But the most stable ones are:- +7, +4, +2

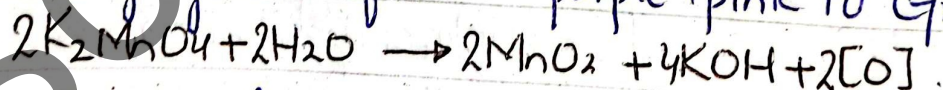
KMnO_4 as oxidizing agent

It's one of the strongest oxidizing agent.

In alkaline / Basic medium:-



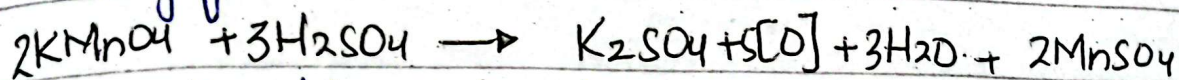
- The MnO_4^- is reduced from +7 to +6 state changing color from purple / pink to Green sol.



- The reaction with water changes its oxidation state from +7 to +4 further changing color from green sol to brown sol.

In acidic medium:-

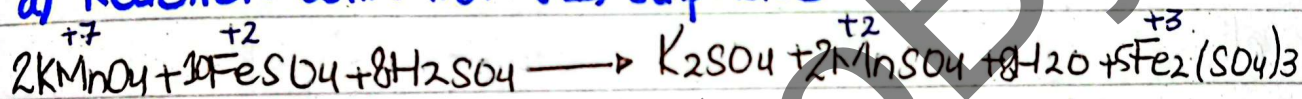
It also act as oxidizing agent but in more strong form



- The oxidization state changes from +7 to +2.
- The color purple is discharged.
- It's used to find out the conc. of all sorts of reducing agents.

KMnO₄ as oxidizing agent in titration:-

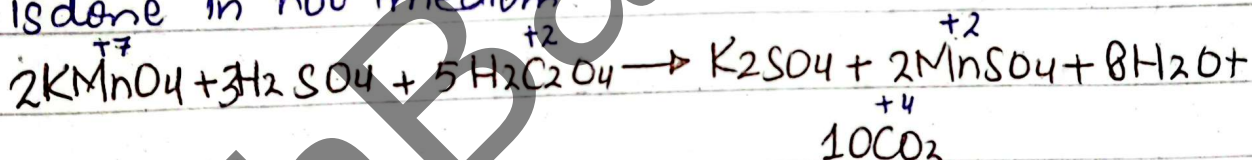
a) Reaction with iron (II) sulphate:-



- The manganese is reduced but has oxidized iron.

b) Reaction with oxalic acid:-

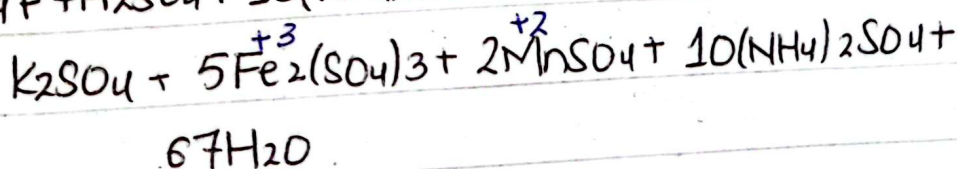
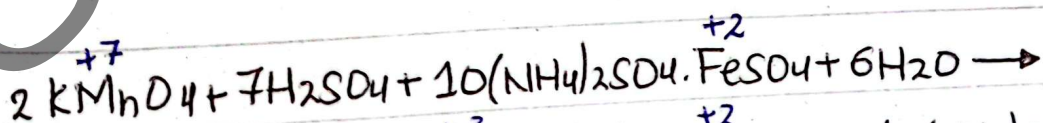
- Oxalic acid (ethanedioic acid) reaction with KMnO₄ is done in hot medium.



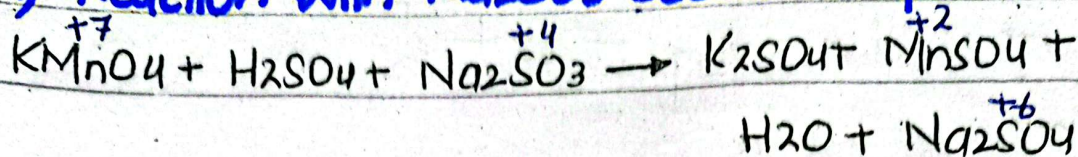
c) Reaction with Mohr's salt:-

- Mohr's salt is a double salt.

↓
a salt which contains 2 salts within a crystal is called double salt.

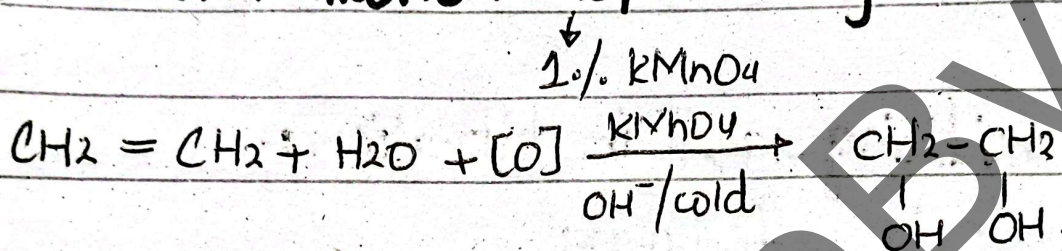


4) Reaction with Na_2SO_3 sodium sulphite :-



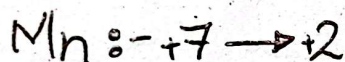
d) KMnO_4 as an oxidizing agent in Organic chemistry :-

1) Rxn with alkene (Baeyer's Reagent)

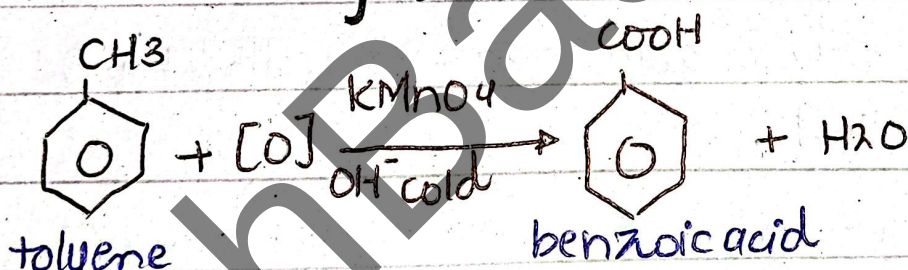


ethene

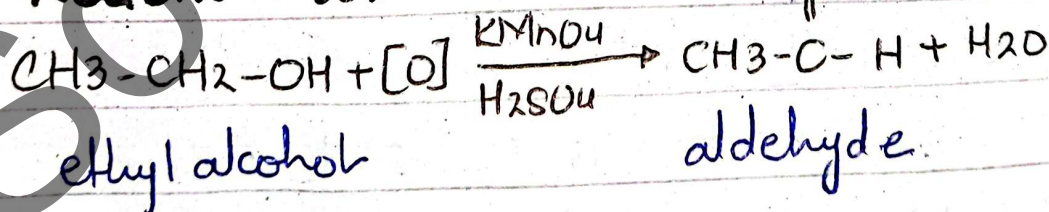
ethylene glycol



2) Rxn with alkyl benzene



3) Reaction with alcohol



Vanadium

- silvery white metallic element

Oxidation State

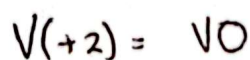
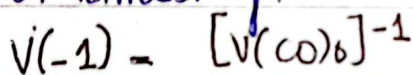
- It has 7 different oxidation state

-1, 0, +1, +2, +3, +4, +5

- The lower oxidation state vanadium are unstable & act as reducing agent (Powerful) (-1, 0, +1)
- The most stable one are +4, +5.

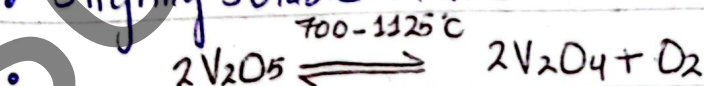
Reason of variable O.S :-

due to availability of d electrons in addition to ns^2 electron. The energy diff b/w ns & $(n-1)d$ are very close therefore $(n-1)d$ also take parts in rxn or variability.

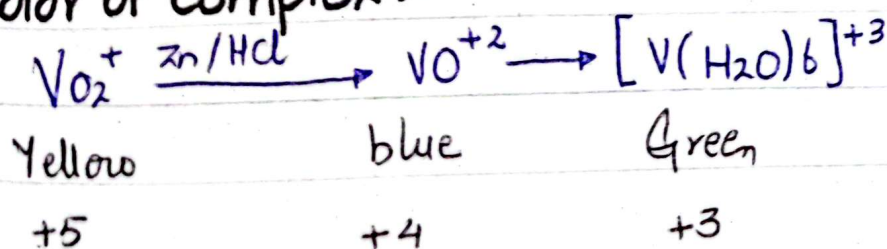


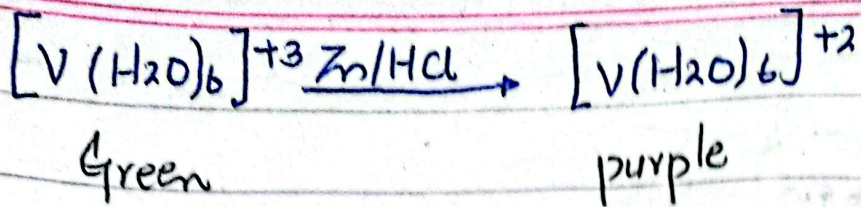
physical state and dissociation of V_2O_5

- Yellow-red poisonous solid
- melting point = $670^\circ C$
- Slightly soluble in H_2O



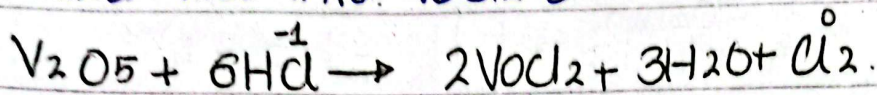
Color of complex :-



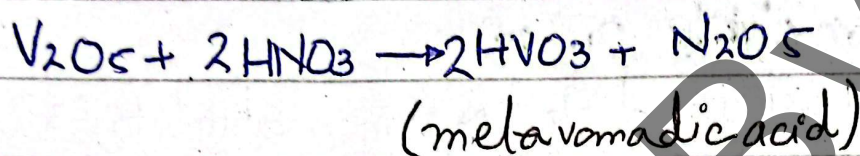


Vanadium as an oxidizing agent

- Rxn with HCl:-
- Oxidizes HCl into VOCl_2 & Cl_2 .



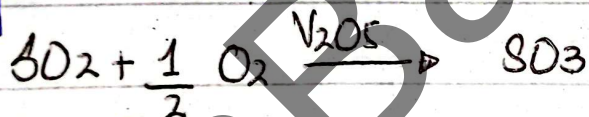
- Rxn with Nitric acid:-



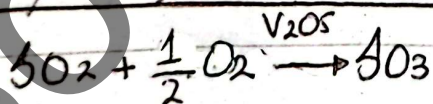
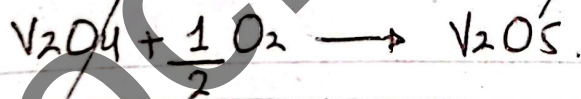
- Rxn with or as catalyst

Why transition metal is used as catalyst in Organic Chemistry?

- V_2O_5 is used in contact process.
- Sulphur dioxide to trioxide



mechanism:-

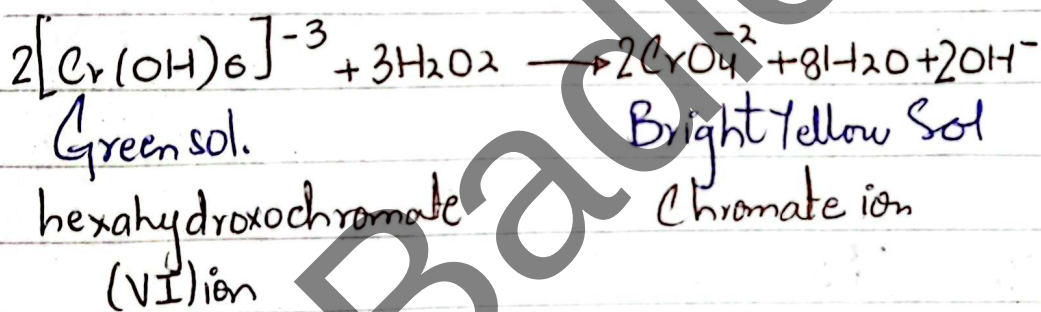
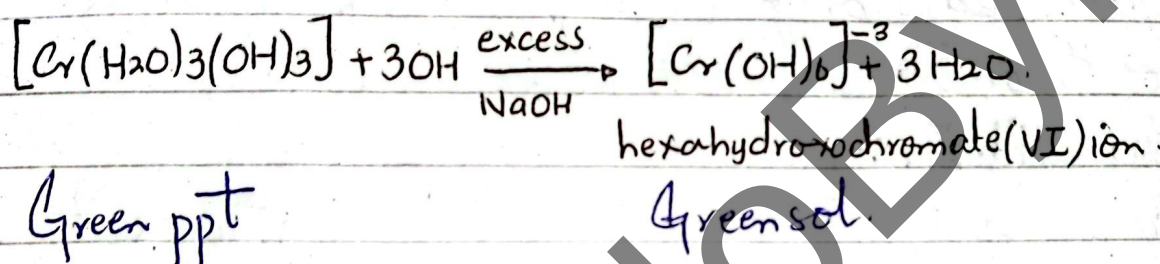
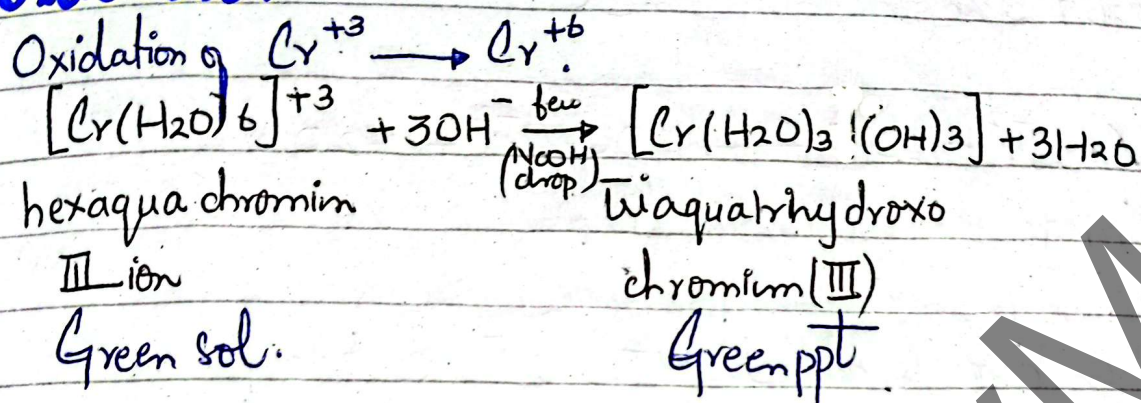


It is used because of O.S that's variable.

Chromium

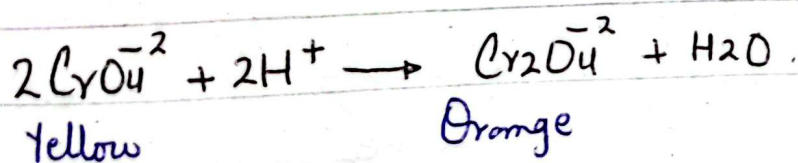
- Shining, metallic, Corrosion resistant element.

Oxidation

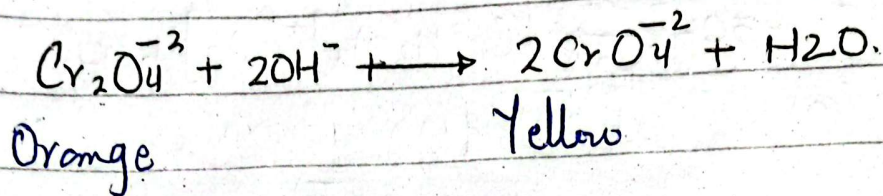


Chromate (VI) & dichromate (VI) eq

- Chromates are soluble in water & give brilliant yellow sol.
- When acid is added to chromate(VI) CrO_4^{2-} ions, an equilibrium is established & dichromate $\text{Cr}_2\text{O}_7^{2-}$ ions is formed.



- When we add acid (H^+), Conc of H^+ increase thus equilibrium will shift to right & Orange $Cr_2O_7^{2-}$ dichromate is formed.



- When base is added H^+ & OH^- react to form water, equilibrium will shift to left & Yellow chromate is formed.

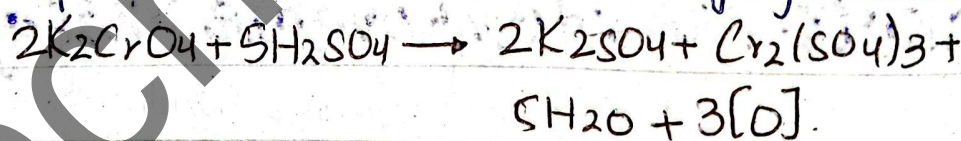
Rxn with Zn:-

When K_2CrO_4 is added, to neutral sol. of Zinc salt, basic Zinc chromate ($Zn(OH)_2 \cdot ZnCrO_4 \cdot H_2O$) is obtained.



Rxn with acid:-

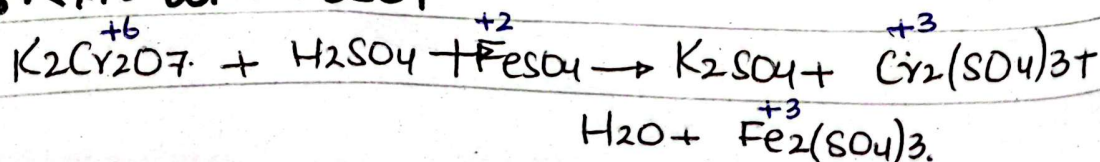
Acidified K_2CrO_4 act as Oxidizing agent.

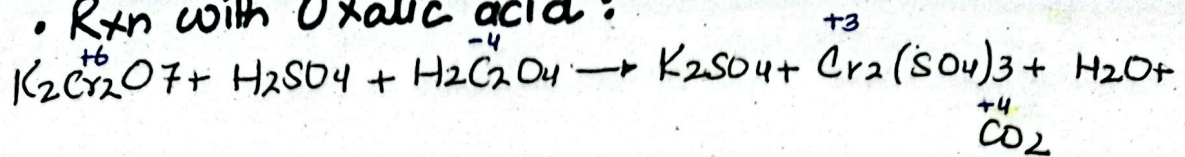


K_2CrO_4 as oxidizing agent

- K_2CrO_4 (acidified) with dilute H_2SO_4 is commonly used as O.A.

Rxn with $FeSO_4$

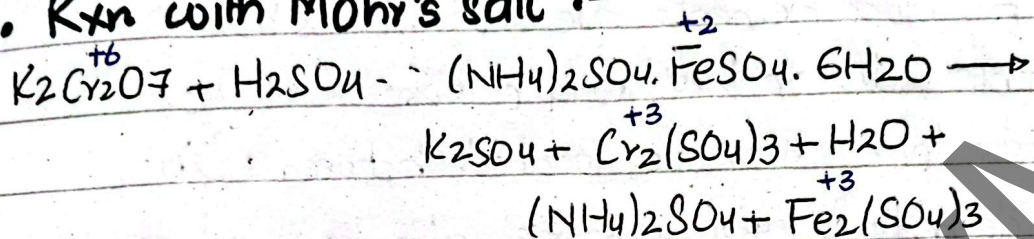




Chromium = $+6 \rightarrow +3$

Fe (iron) = $+2 \rightarrow +3$

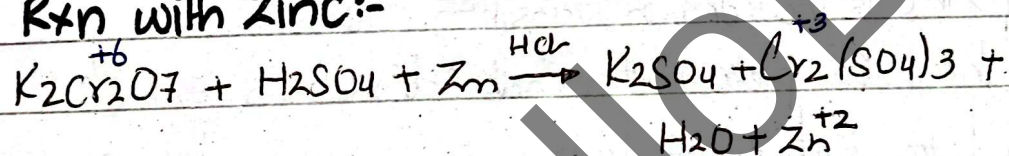
• Rxn with Mohr's salt:-



Chromium = $+6 \rightarrow +3$

Iron = $+2 \rightarrow +3$

• Rxn with Zinc:-

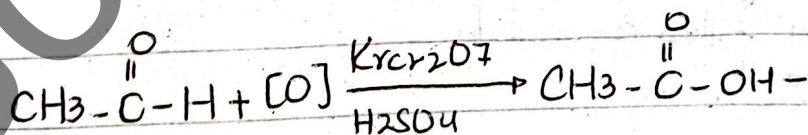
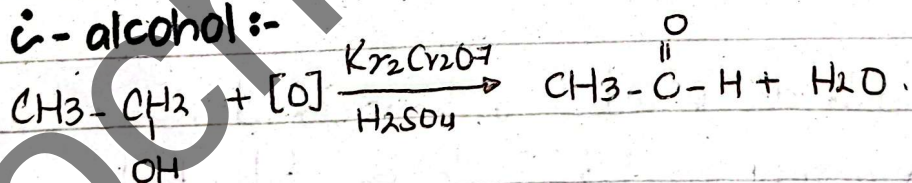


Chromium = $+6 \rightarrow +3$

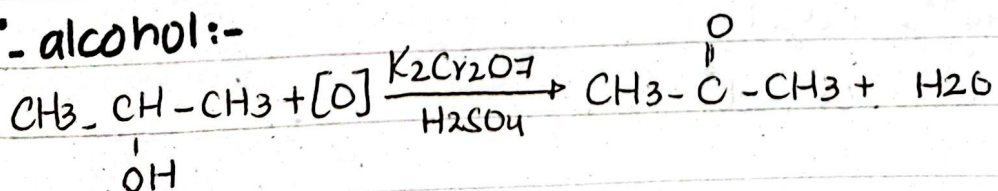
$Zn^0 \rightarrow +2$

• $K_2Cr_2O_7$ as oxidizing agent in Organic Reaction:-

1° - alcohol:-



2° - alcohol:-



Q. Why d & f block elements are called as transition elements?

d & f block elements are called transition elements due to their unique position in the periodic table, they are located between s & p block elements & their properties also lie in between metals of s & non-metals of p-block.

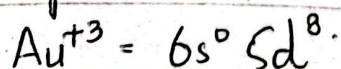
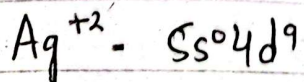
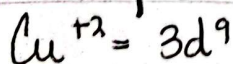
Q. Why Zinc is included in transition elements?

Zinc has complete outer shell 'd' in both ionic & atomic form but it's included in transition elements because it can form complex ions such as $[Zn(NH_3)_4]^{+2}$ which showcase its ability to coordinate with ligands, This is one of the behaviour of transition metals.

Q. Why are coinage metals included in transition elements?

Coinage metals are included in transition elements as they commonly exist in oxidation states that involve partially filled d-orbitals.

example



Q. Why IIB group elements do not show all the Properties of transition elements.

IIB group elements do not show all properties of transition elements because in ionic state they have an empty d-orbital.

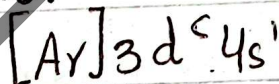
Q. Why Cr does not follow general rule of electronic Configuration.

Chromium (Cr) doesn't follow the general rule of electronic Configuration due to e^- & e^- repulsion minimization & increased stability of half filled subshells.

normal Configuration:-



Actual Configuration:-



The Configuration lowers energy levels of atom as half-filled 3d sub-shell is more stable because of symmetrical distribution of e^- & minimize repulsion.

Q. Why $PbCl_2$ is ionic but $PbCl_4$ is covalent?
lead can exhibit 2 common oxidation states i.e. +2 & +4.

- In $PbCl_2$, Pb has an oxidation state of +2.
- In $PbCl_4$, the oxidation state that's exhibited is +4.

• According to Fajan's rule.

"The smaller the cations with high charge density makes bond more covalent."

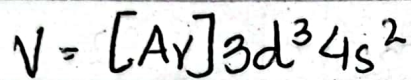
Therefore, $PbCl_2$ is ionic while $PbCl_4$ is covalent.

Q. Why tetrahalides of CCl_4 are not hydrolysed but tetrahalides of Si, Sn, Ge are readily hydrolyzed.

- Carbon does not have available d-orbitals to facilitate bond breaking or to accept e^- pair during hydrolysis.

• Silicon, Germanium, and tin have more vacant d-orbitals that it can accept lone pairs from water molecules making hydrolysis feasible.

Q Why Vanadium shows Variable Oxidation State.
It exhibits variable Oxidation state because ^{of} its electronic Configuration & energy levels of its d & s orbital.



It can loose e^- from both 4s & 3d orbitals.
As there's less gap b/w energy levels s & d.
As a result, Vanadium can loose varying number of e^- s.