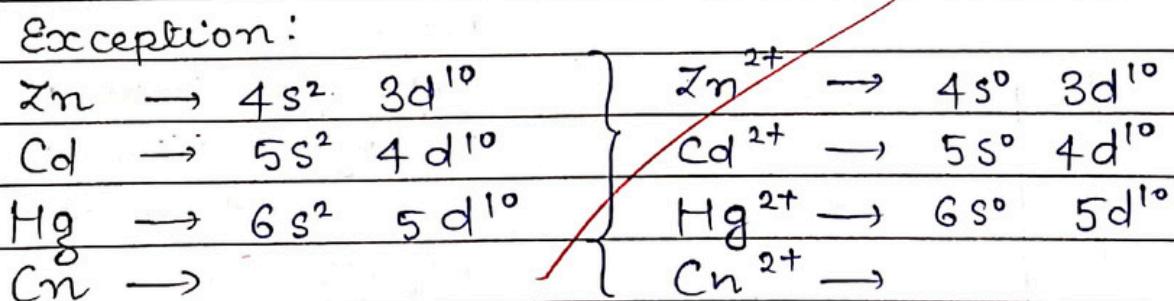


The d- and f- Block Elements

d-block -

- ↳ The elements that can be found from the G₁-3 to G₁-12 of modern periodic table are called d-block elements.
- ↳ Valence e⁻ of these elements falls under the d-orbital.
- ↳ d-block elements also called Transition elements because they exhibit transitional (bridging) behaviour between s- and p-block.
- ↳ In d-block elements, the valence shell has a constant number of electron, whereas the number of e⁻ in penultimate shell goes on increasing.
- ↳ Elements that have at least one unpaired electron in their d-orbital in atomic or any oxidation state are called transition elements.

Exception:



These three have fully filled d-orbital, so, they are not transition element and hence known as Pseudo Transition Elements.

'All transition elements are d-block elements but all d-block elements are not transition elements'.

f-block elements ~

- ↳ Also called 'inner transition' elements.,
- ↳ The elements in which the electron enters in $(n-2)f$ orbitals are called f-block elements.
- ↳ f-block elements are placed separately at the bottom of periodic table. They are subset of 6th and 7th period.
- ↳ g_{n-3} and $n=6$, after $57 La - 6s^2 5d^1$
 $4f$ series \rightarrow Lanthoids \rightarrow $58 Ce \leftrightarrow Lu$
(as they found after lanthanum) 14 elements have valence e⁻ in 4f-orbitals.
- ↳ g_{n-3} and $n=7$, after $89 Ac - 7s^2 6d^1$
Actinoids \rightarrow $90 Th \leftrightarrow Lr$ 14 elements
 $\rightarrow 5f$ -series 103 have valence e⁻ in 5f-orbitals.
- ↳ Lanthanoid and Actinoid form inner-transition elements.

Note - $n=4 \rightarrow 3d$ - series

$n=5 \rightarrow 4d$ - series

$n=6 \rightarrow 5d$ - series

$n=7 \rightarrow 6d$ - series.

Electronic Configuration of d-block elements:

General Electronic Configuration -

$$(n-1)d^{1-10} n s^{1-2}$$

except for Pd which have E.C. is $4d^{10} 5s^0$.

↳ In d-block element both the ns-orbital e- and $(n-1)d$ orbital e- participate in bonding. Also, very less energy gap between ns and $(n-1)d$ orbital. So, e- can easily jump and exchange position between orbitals.

3d-series

4-d-series

21 Sc - $4s^2 3d^1$	39 Y - $5s^2 4d^1$
22 Ti - $4s^2 3d^2$	40 Zr - $5s^2 4d^2$
23 V - $4s^2 3d^3$	41 Nb - $5s^1 4d^4$
* 24 Cr - $4s^2 3d^5$	42 Mo - $5s^1 4d^5$
25 Mn - $4s^2 3d^5$	43 Tc - $5s^1 4d^6$
26 Fe - $4s^2 3d^6$	44 Ru - $5s^1 4d^7$
27 Co - $4s^2 3d^7$	45 Rh - $5s^1 4d^8$
28 Ni - $4s^2 3d^8$	46 * Pd - $5s^0 4d^{10}$
29 Cu - $4s^1 3d^{10}$	47 Ag - $5s^1 4d^{10}$
30 Zn - $4s^2 3d^{10}$	48 Cd - $5s^2 4d^{10}$

5 - d-series

6 d-series

57 La - $6s^2 5d^1$

89 Ac - $7s^2 6d^1$

72 Hf - $6s^2 5d^2$

104 Rf - $7s^2 6d^2$

73 Ta - $6s^2 5d^3$

105 Db - $7s^2 6d^3$

74 W - $6s^2 5d^4$

106 Sb - $7s^2 6d^4$

75 Re - $6s^2 5d^5$

~~107 Bh - $7s^2 6d^5$~~

76 Os - $6s^2 5d^6$

108 Hs - $7s^2 6d^6$

77 Ir - $6s^2 5d^7$

109 Mt - $7s^2 6d^7$

78 Pt - $6s^1 5d^9$

110 Dm - $7s^2 6d^8$

79 Au - $6s^1 5d^{10}$

111 Rg - $7s^1 6d^{10}$

80 Hg - $6s^2 5d^{10}$

112 Cn - $7s^2 6d^{10}$

General Physical Properties of d-block elements and Trends :-

(n-1)d orbital is more towards the periphery of atoms and hence it affect the surrounding molecule / atom and affected by them also and that is the reason, d-block elements have different and unique property as compared to ns- and np-block elements.

i) Metallic Property :

All transition elements display metallic properties like high tensile strength, ductility, malleability, high thermal and electrical conductivity and metallic lusture.

→ Except Zn, Cd, Hg and Mn, they have one or more typical metallic structure at normal temperature.

→ d-block have loosely packed ns electron. ∵ are easily donated. They have very low ionisation enthalpy and hence shows metallic nature.

→ More the number of unpaired electron in d-orbital stronger will be the metallic bonding and hence harder / stronger will be the metal.

* Zn, Cd, Hg and Cr because of the unavailability of unpaired e⁻ they are soft metal.

* Cr, Mo, W have maximum number of unpaired e⁻. Hence strong will be the metallic bonding and have harder will be the metals.

ii) Melting and Boiling Point :

upto Cr, Mo, W : the melting point
(3d) (4d) (5d)

Seems to increase but Mn, Tc, Re :
Sudden decrease in melting point

upto the middle MP seems to increasing and
later on MP starts decreasing.

Reason: upto the middle of series the number
of unpaired e⁻ increases and therefore stronger
will be the metallic bonding and higher
will be the energy of atomisation. and
hence higher will be the melting point

later on upto the end of series number of
unpaired e⁻ start decreasing ; weaker
the metallic bonding and lower will
be the melting point.

in case of Mn	1s	1	1	1	1	1
	4s	3d				

stable electronic
configuration

and e⁻ are more attached towards the
nucleus and hence metallic bonding
weakens and melting point
decreases.

(3) Atomic and Ionic radius :-

In a series - $\rightarrow (\text{Sc} \rightarrow \text{Mn})$

→ Initially the atomic radius decreases

→ In the middle atomic radius not decreases

~~Fe-Co-Ni~~ significantly but a very small change observed.

→ In last the atomic radius increases with increase in atomic number.

~~(Cu \rightarrow Zn)~~

Reason -

(i) Effective Nuclear charge (Z_{eff}) :

Net attractive force available with nucleus to attract the valence shell e^- .

$$Z_{\text{eff}} = Z - \sigma$$

(ii) Screening Effect: (σ)

Repulsion by inner shell e^- (e^- from same shell also) on the electron of valence shell.

→ Initially atomic radius decrease because with increase in atomic number every time $1p^1$ is added to nucleus.

$\therefore Z_{\text{eff}} \uparrow$ and $1e^-$ is $(n-1)d$ orbital (screening Effect is not strong) of d -orbital.

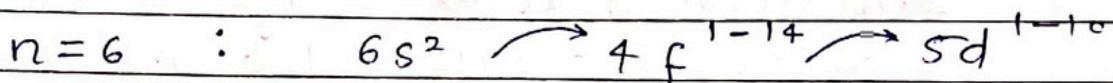
→ In midway Atomic radius between becomes almost constant : In $(n-1)d$ orbital, the increase in e^- causes interelectronic repulsion between the d -orbital e^- hence S-effect \uparrow

∴ here Z_{eff} is counter balance by S.Effect.

→ In the end atomic radius increases because of fully filled $(n-1)d$ orbital interelectronic repulsion is maximum. S.E (σ) max ; hence it overcomes Z_{eff} .

* Atomic radius within a group increases from 3d to 4d series it becomes almost similar from 4d to 5d series.

Reason -

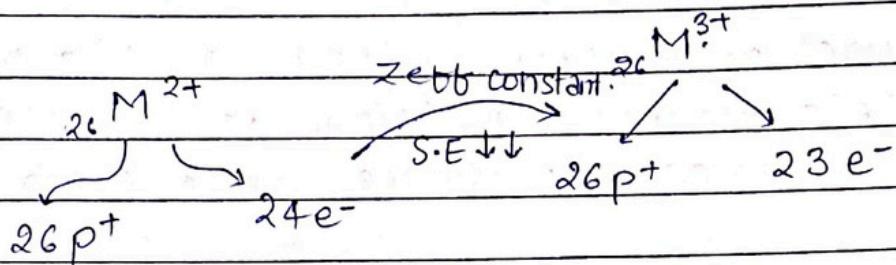


In 5d-series intervening 4f orbital is observed and filled before 5d.

so, because $(n-2)f$ and $(n-1)d$ orbital are at periphery of atom and have distorted shape ∴ are not influence by Nucleus very much and e- of these shell show very less Screening effect on ms orbitals.

But with increases in atomic number p^+ also increases in nucleus and hence Z_{eff} increases which is not counter balance by S.E. and ∴ Atomic radius decrease on going from 4d \rightarrow 5d series and this effect is called Lanthanoid contraction.

→ Ionic Radius decrease with increase in charge / oxidation state of metal



as compared to atomic radius the ionic radius is smaller.

4) Oxidation state → charge present on an atom when all the attached atoms are removed from it.

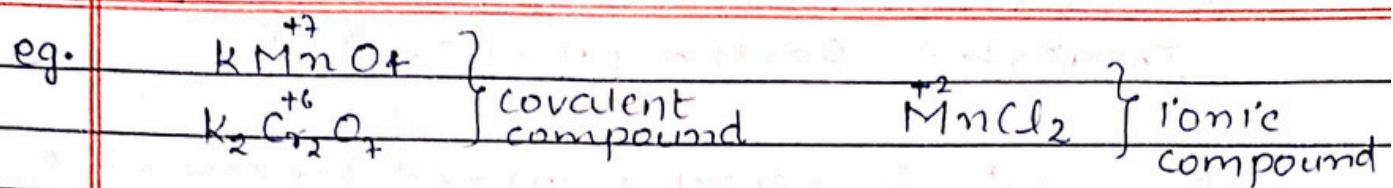
Generally; all the d-block elements shows oxidation state because of ns-orbital e- and (n-1)d orbital electron because the energy gap is very low.

Generally, $ns^2 e^-$ in +2 oxidation state (common oxidation state) exception Sc^{3+}

* Fajan's Rule

lower O.S ; more ionic will be the compound.
higher O.S ; less ionic or more covalent".

as soon as O.N $\uparrow +3, +4, +5, +6, +7$ (n-1)d orbital electron start participating in bond but (n-1)d e- are more stable and toward nucleus. ∵ difficult to donate e- hence share the e- and covalent bond formed.

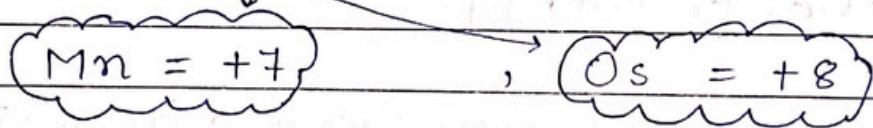


* Sc have +3 oxidation state only while as we move to the middle the O.S increases ↑ and then decreases ↓ as we go towards end of series i.e. Zn shows only +2 O.S.

Reason: as we move towards middle of sene number of unpaired electron increases and later on decreases as we go towards end of series.

* Sc^{3+} have Argon gas configuration hence rather release $2e^-$ from $4s^2$ it donates $3e^-$; 2 from $4s$ and 1 from $3d$.

* Elements with max. number of unpaired e- have max no. of oxidation state.
 i.e. \downarrow

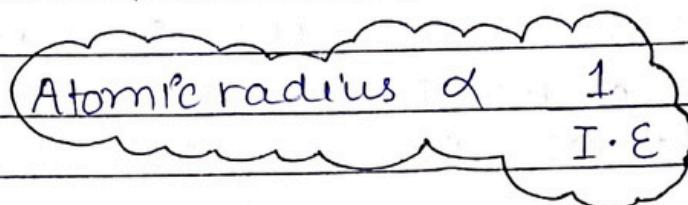


→ upto Mn; the maximum oxidation state that one element shows is sum of s+d orbital e-.

→ transition elements, arises out of incomplete filling of d-orbital → their O.S differ each other by unity.

Ionisation Enthalpy (I.E) :

Amount of energy required by one mole of gaseous atom in order to remove valence electron from it.



But I.E. trends ~~o~~ is very irregular.

Reason: Exchange and Re-organisation energy.

↓
as soon as the atoms gain stability it loses ^{some} energy that energy is called exchange energy

energy required by e⁻ to reorganise itself between ns and (n-1)d orbital

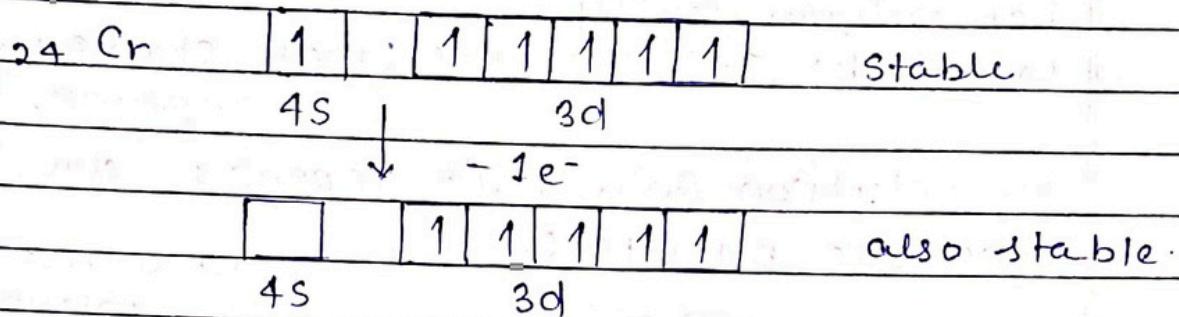
Therefore every atom have different type of reorganisation and exchange energy.

" atomic radius have not direct impact on I.E and hence an irregular trend in I.E is observed.

Trends :

- i) $\text{Sc} \rightarrow \text{Ti} \rightarrow \text{V}$ no significant change in I.E. partially I.E. increase upto V along with A.Radius decrease.

2). Cr : significant ↓ in I.E along with ↓ in A.R.



3). Mn → Fe

~~I.E in I.E. because of decrease atomic radius.~~

4) Fe → Co → Ni

~~I.E partially decreases because atomic radius increase partially.~~

5) Cu and Zn

~~I.E ↑es with ↑e in Atomic radius.~~

Cu and Zn have already stable electronic configuration.

I.E of 5d series is much higher than 3d and 4d series.

Reason: 5d series : $6s^{1-2} \underbrace{5}_{\downarrow}^{1-10}$
 $4f^{14}$

~~because of e⁻ present in inner 4f orbital~~
 $\therefore S.E \downarrow$ but $Z_{eff} \uparrow$ and A.R. ↓
 so, I.E ↑

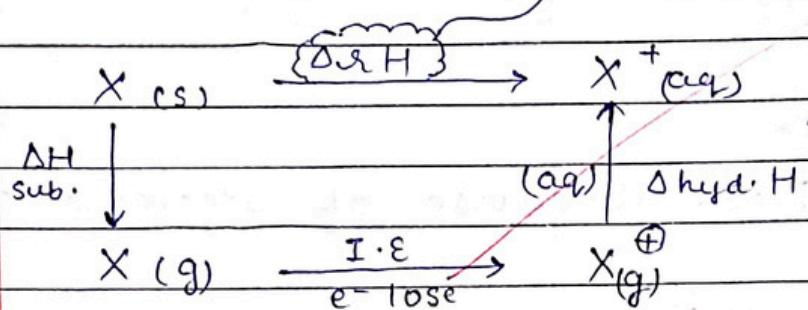
Standard Electrode Potential (E°):-

Thermodynamically;

Lower the I.E of metal; more stable will be the compound.

In solution form; it depends on the Electrode potential.

to measure this electrode potential is used.



$$\Delta_{rx}H = \Delta_{sub}H + IE + \Delta_{hyd}H$$

$E^\circ M^{2+} | M$:- more positive;
more stable the compound.

less negative/ positive; stability decrease.

Trends:

No regular pattern observed in $E^\circ M^{2+} | M$ value.

Because 3-d series elements have different sum of $I.E_1$, $I.E_2$, $\Delta_{sub}H$ and $\Delta_{hyd}H$.

But in general value of $E^\circ M^{2+} | M$ become less -ve with some exception because of increase in value of sum of $I.E_1$, $I.E_2$ & $\Delta_{sub}H$.



$$E^\circ_{\text{Cu}^{2+}/\text{Cu}} = +0.34$$

It can be easily reduced.

So, Cu²⁺ compound are less stable.

29 Cu	1	1	1	1	1	1
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4s¹ 3d¹⁰

I.E₁

4s⁰ 3d¹⁰ (stable)

I.E₂

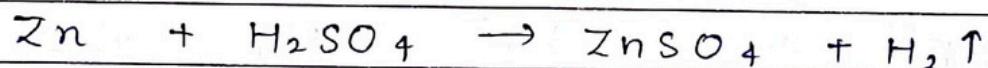
4s⁰ 3d⁹ (unstable)

In electrochemical series:

$$E^\circ_{2\text{H}|\text{H}^+} = 0.00 \text{ V}$$

except Cu, all other 3d-series elements

$E^\circ_{\text{M}^{2+}/\text{M}} = -\text{ve}$ hence can react with acid and displace H from the acid in H₂ form.



In case of Cu, $E^\circ_{\text{Cu}^{2+}/\text{Cu}} = +0.34 \text{ V}$

it can not displace H₂ from acid.

In case of Mn and Zn, Δ_rH is more negative.

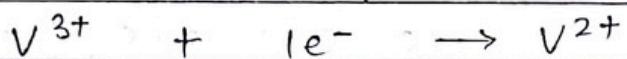
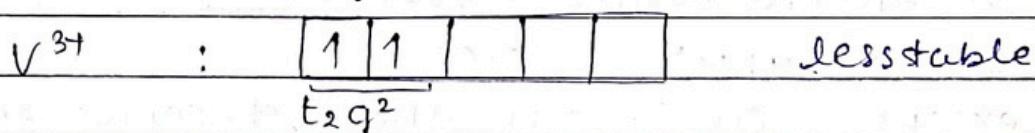
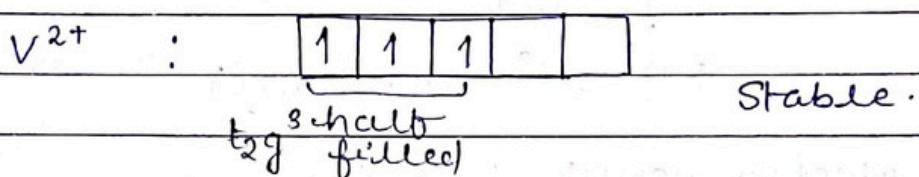
if $E^\circ M^{3+} / M^{2+}$; +ve

then reduction is easy.

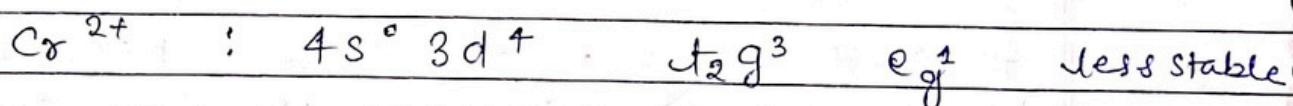
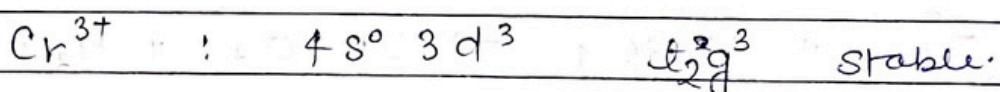
that M^{3+} form is less stable than M^{2+} form.

► Sc; have very -ve value of $E^\circ M^{3+} / M^{2+}$.
 less stable \rightarrow more stable
 ~~M^{2+}~~ ~~M^{3+}~~

► $E^\circ V^{3+} / V^{2+} = -0.26 \text{ V}$



► $E^\circ Cr^{3+} / Cr^{2+} = -0.41 \text{ V}$



not easy to reduce Cr^{3+} .

► $E^\circ Mn^{3+} / Mn^{2+} = +1.57 \text{ V}$

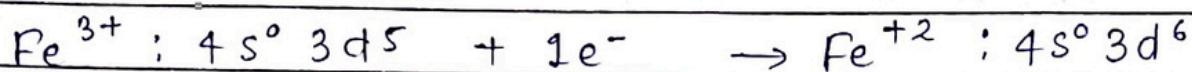
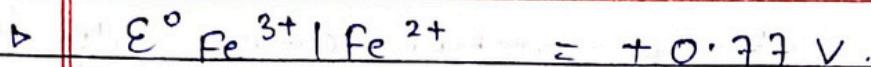


M^{3+}

unstable

stable.

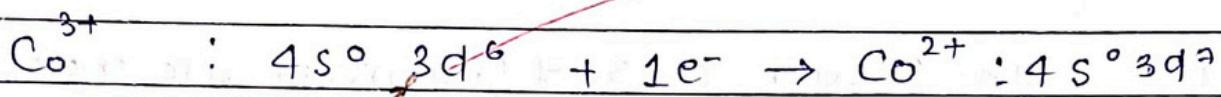
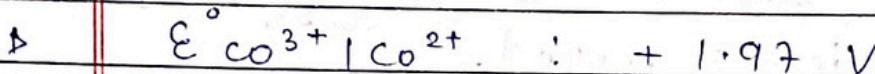
PS strong oxidising agent.



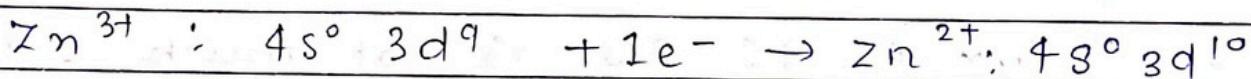
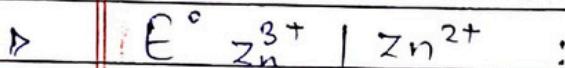
stable

unstable.

but Fe^{2+} have -ve $\Delta \text{hyd}\cdot\text{H}$.



have highly
-ve $\Delta \text{hyd}\cdot\text{H}$.



(less stable)

(stable)

easily reduce.

Trends in stability of higher oxidation state of Transitional metals :-

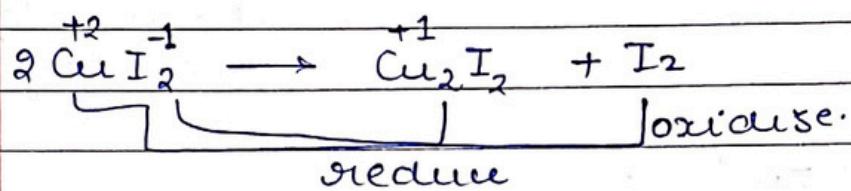
In general oxidation state increases from $\text{Sc}(+3)$, $\text{Ti}(+4)$, $\text{V}(+5)$, $\text{Cr}(+6)$, $\text{Mn}(+7)$ [but Mn do not show +7 oxidation state only with halogen but with oxygen and fluorine in MnO_3F compound].

Later after Mn; only $\text{Fe}(+3)$, $\text{Co}(+3)$ O.S with halogen while rest show either +2 or +1 O.S.

(ii) Higher O.S. of a metal can only be observed with F.

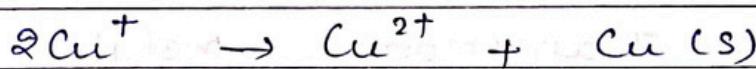
Reason: F being most electronegative have very high lattice energy in ionic compound. e.g. $[CoF_3]$ and high bond enthalpy in covalently bounded compound VF_5 and CrF_6 . (Fajan's rule).

(iii) In lower O.S. fluorides are not stable except : CuF_2 .



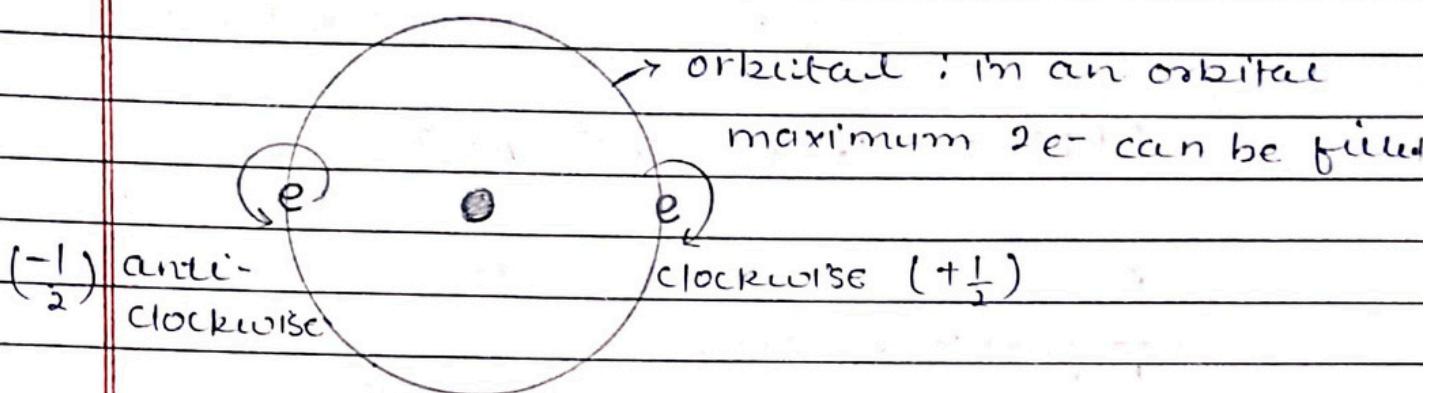
→ Cu_x in +1 O.S. is not much stable in solution form.

$Cu^{2+}(aq)$ more negative hydration E.



→ Fe 1's. seen in +3 O.S. but in ferrali ion $(FeO_4)^{2-}$ it shows +6 oxidation state but it decomposes in to Fe_2O_3 and O_2

Magnetic Property of transitional Elements :



→ While rotating on its own axis every electron behave like a magnet and creates magnetic field.

1b because of opposite spins both will cancel spin or magnetic field.

Hence, when e- are paired in an orbital they have net magnetic moment (μ) = 0 and are called as DIAMAGNETIC SUBSTANCE.

1 If there is only 1e- in orbital then there is no other e- to cancel its M.F. hence the substance are magnetic in nature.

* Bohr - Magneton and Magnetic moment (BM)

$$\mu = \sqrt{n(n+2)} \text{ BM}$$

where n is number of unpaired e-.

If $n=0$, $\mu = \sqrt{0} (0+2) \text{ BM}$

$$\mu = 0$$

" Diamagnetic substance.

$$1 \text{ BM} = 9.27 \times 10^{-24} \text{ A m}^2$$

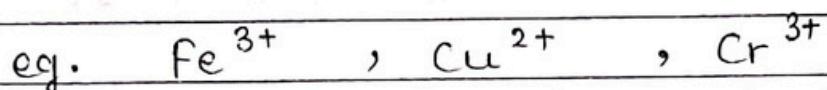
Diamagnetic : are not repelled by magnetic field.

$\mu = 0$, no unpaired e^-

* More the number of unpaired electron more value of μ .

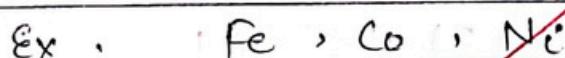
Paramagnetic : are attracted by magnetic field.

$\mu \neq 0$; have unpaired e^-



Ferromagnetic :

strongly attracted by magnetic field and they retain the magnetic behaviour even after the removal of magnetic field.



* Spin Only magnetic moment:

$$\mu_s = \sqrt{4s(s+1)}$$

where $S = g \times n$
 number of unpaired e-
 spin quantum number ($\frac{1}{2}$)

Formation of coloured compound / Ions :-

* Ligands - lone pair donor.

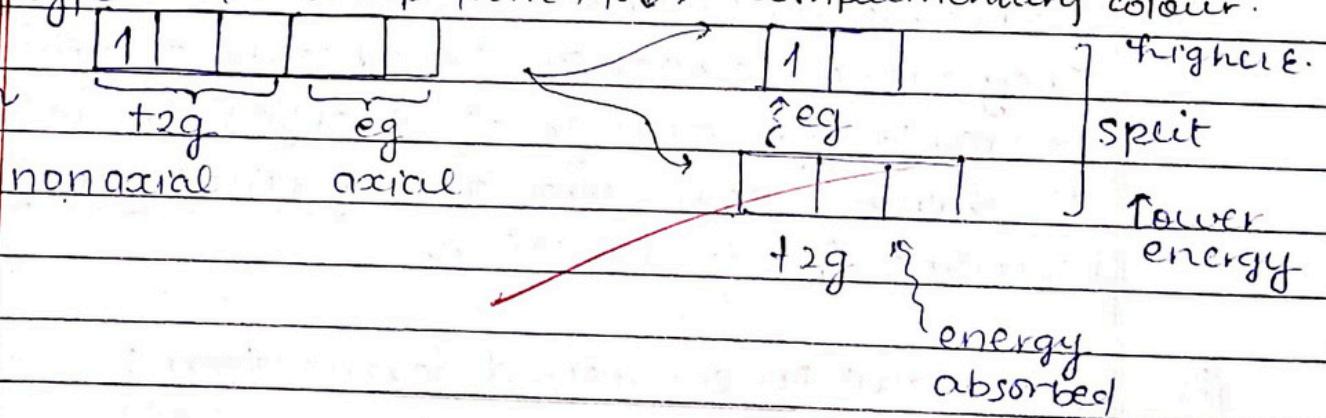
d-block elements ~~are~~ have vacant d-orbitals.

${}_{24}Cr$	1	1	1	1	1	1							
	3d				4s		4p			4d			

that is they are good lone pair acceptor.

∴ coordination compound formation take place.

* depending upon the ligand and energy absorbed the d-block element show colour of corresponding type and e- jump from \uparrow to \downarrow . complementary colour.



→ Those element which do not have unpaired electron they are colourless.

formation of complex compound :-
unique property → such complex compound
are not shown by s or p-block elements.

Reason ①. Smaller size of metal ions

- ② High charge density (charge ↑).
③ Vacant d-orbitals.

* Complex compound are those in which metals
ions bind a number of anions or neutral
molecules giving complex species with characteristic
properties.

Catalytic Properties :-

Transitional metals are widely used as catalyst
at industrial level.

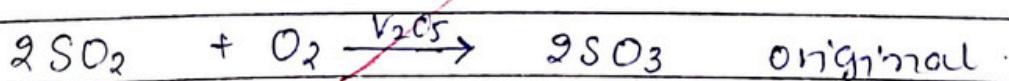
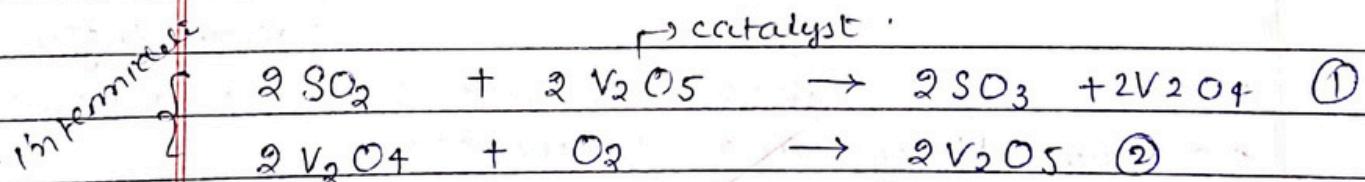
Theories that explains the catalytic behavior
of these metals.

i) Variable oxidation state

They have capacity to absorb or emit variable
variable type range of energies.

∴ hence can provide Activation energy
required for a reaction.

ii) Intermediate compound formation :



Catalyst form an intermediate compound with reactant followed by degeneration of intermediate into product and catalyst released as such.

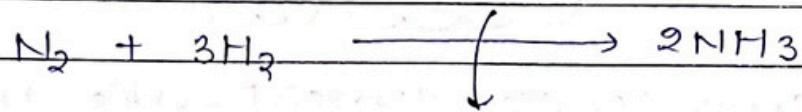
③ Adsorption theory:

↳ exothermic process.

because of large surface area and free valencies on surface maximum number of e⁻ adsorb on the surface of catalyst and thus process is exothermic. Therefore the energy absorbed is used by reactant to form product and datum leaves the surface of catalyst.

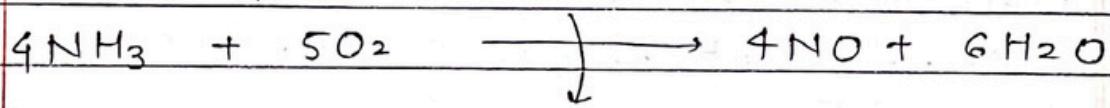
Use -

i) Haber's Process:

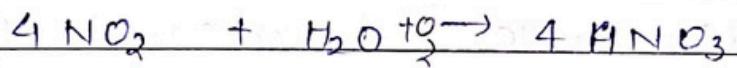


Mo → promoter

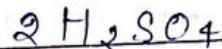
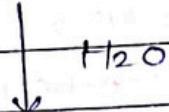
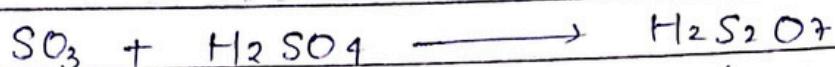
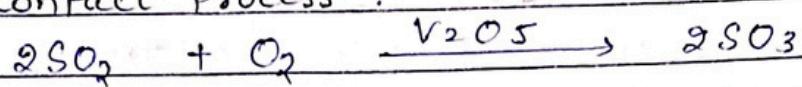
ii) Oswald Process :



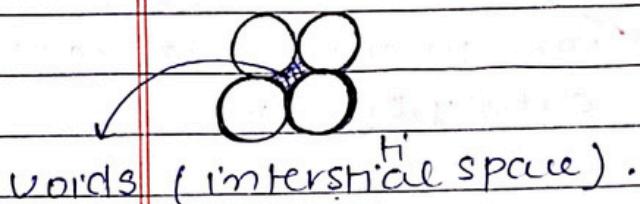
(Platinised asbestos)



iii) Contact Process :



Formation of Interstitial compounds :-



↓
Trapped elements : H, N, C, B

- when smaller size element like H, N, B, C are trapped inside the voids b/w metal atoms such compound are called interstitial comp.
- neither ionic nor covalent.
- Non-stoichiometric in nature.

$\text{TiH}_{1.7}$, $\text{Fe}_{0.98}\text{O}$ etc.

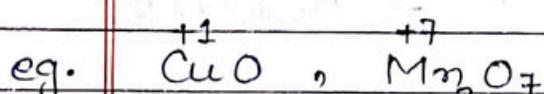
- ▶ High melting point higher than of pure metal.
- ▶ very hard.
- ▶ They retain metallic conductivity.
- ▶ they are chemically inert.

Alloy formation :

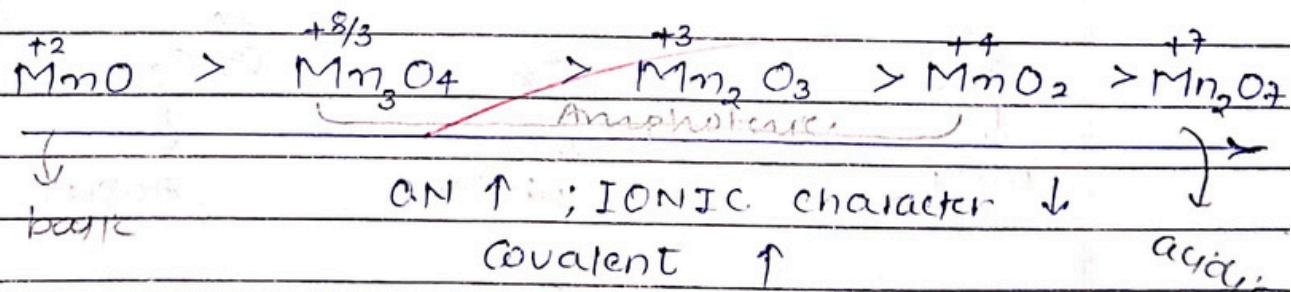
- It's a blend of metals .
- These are homogeneous solid solution.
- * Alloys are formed by atoms with metallic radii that are within 15% of each other.
- Hard and high melting point.
- Alloy of non-transition metals are brass ($Cu + Zn$) and bronze ($Cu + Sn$).

Oxides and Oxoanion of transitional Elements = .

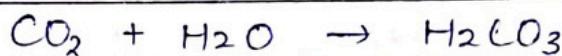
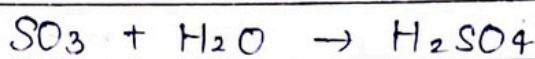
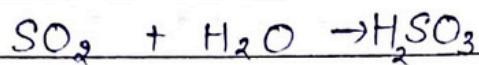
- 3d metals form oxides with O_2 at high temperature and their oxidation state varies from +1 to +7 .



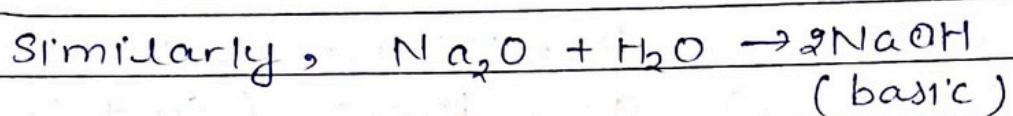
- Oxide of 3d metal are ionic in nature but as the oxidation state increases the ionic nature decreases.



► Generally, metal oxides are BASIC in nature



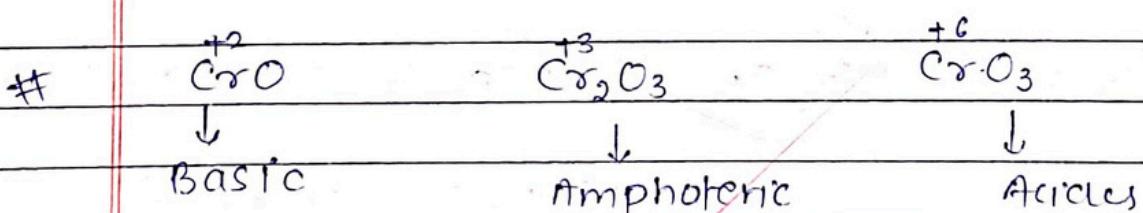
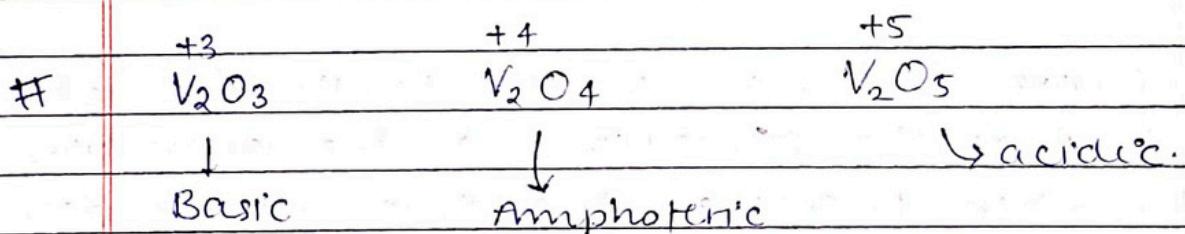
] acidic



But it's not directly applicable on transitional elements.

* As the oxidation number increases the nature of oxide changes from basic to amphoteric to acidic.

BASIC \rightarrow AMPHOTERIC \rightarrow ACIDIC

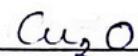
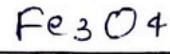
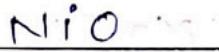
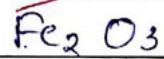
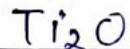
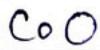
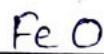
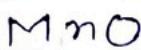
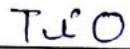
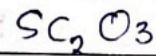


► Oxides are insoluble in water.

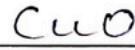
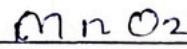
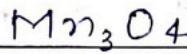
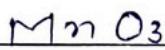
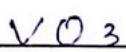
but basic or amphoteric oxide they are soluble in non-oxidising acid like HCl to form complex salt.

Oxides are soluble in acids / bases. It gives oxo metallic salts like $KMnO_4$, $K_2Cr_2O_7$, K_2CrO_4 , and are coloured.

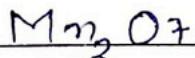
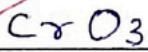
Basic:



Amphoteric:



Acidic:

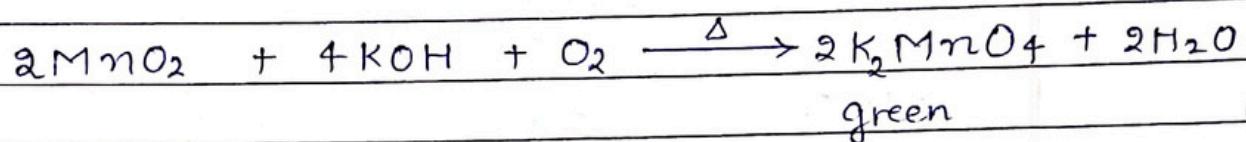


Preparation and Properties of the compounds :-

1). Potassium Permagnate ($KMnO_4$)

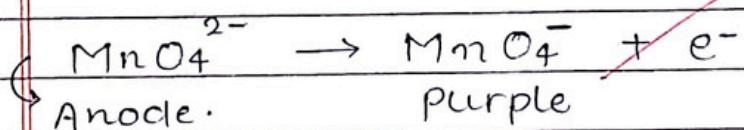
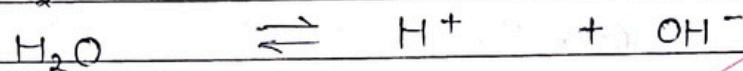
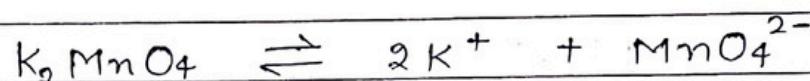
Preparation

(i) Pyrolusite in Potassium magnet

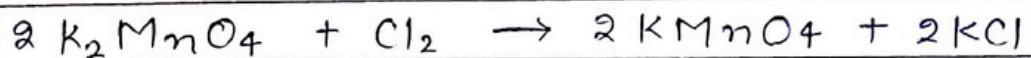


(ii) K_2MnO_4 into $KMnO_4$

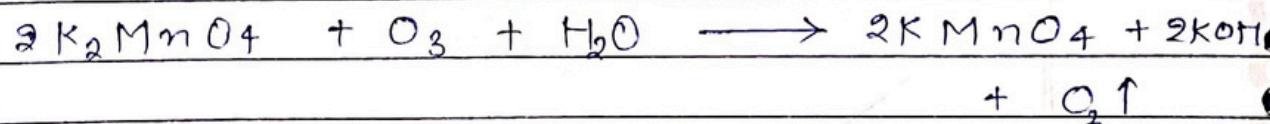
(a) Electrolytic oxidation :-



(b) Oxidation by Cl_2 :-



(c) Oxidation by Ozone :-

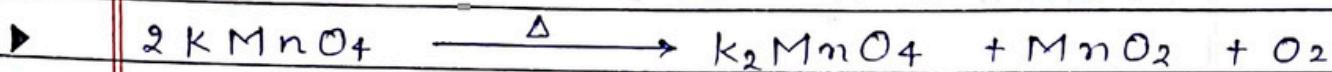


Properties :-

► Dark purple needle like crystal with metallic lustre.

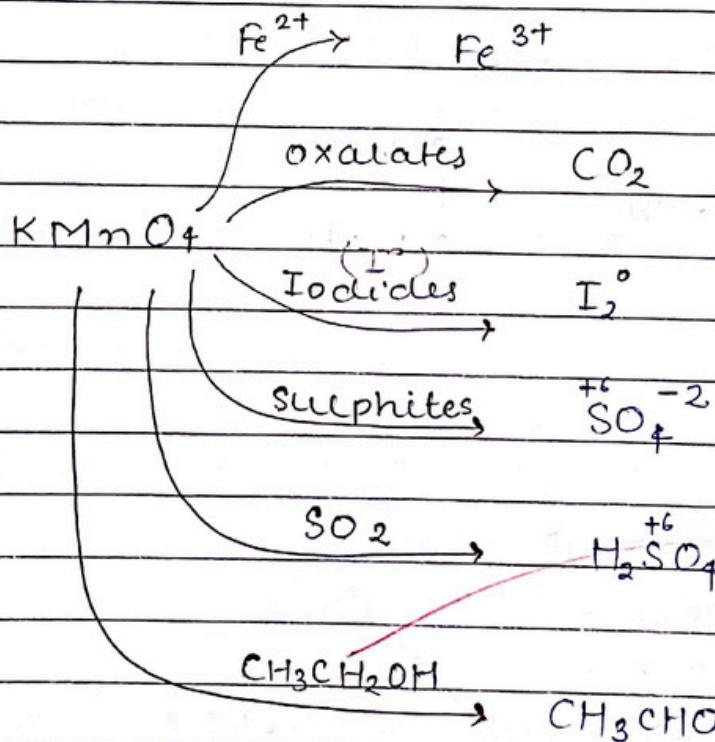
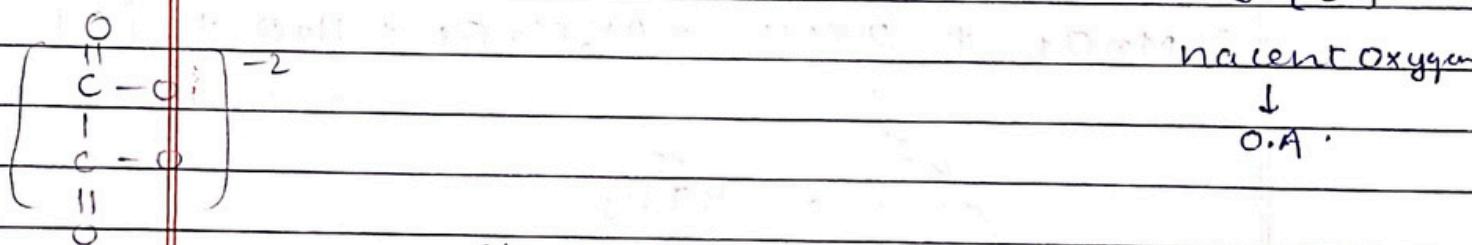
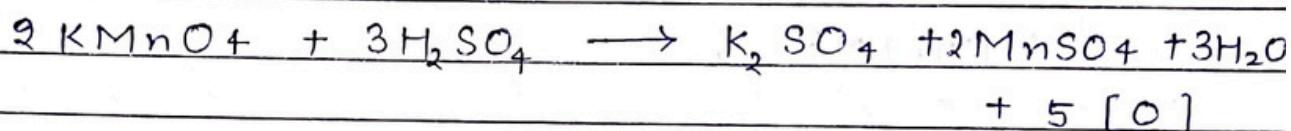
► Melting point - 523 K

► Moderately soluble in H₂O

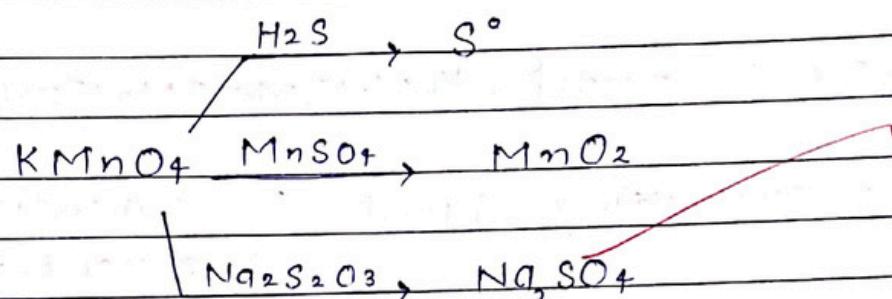
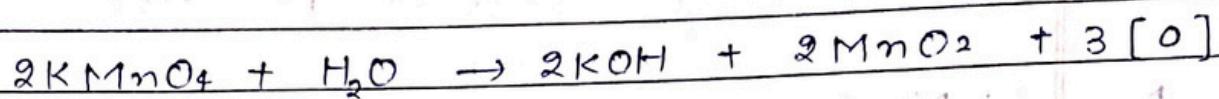


► Strong oxidising Agent (all acidic, Basic
and neutral medium)

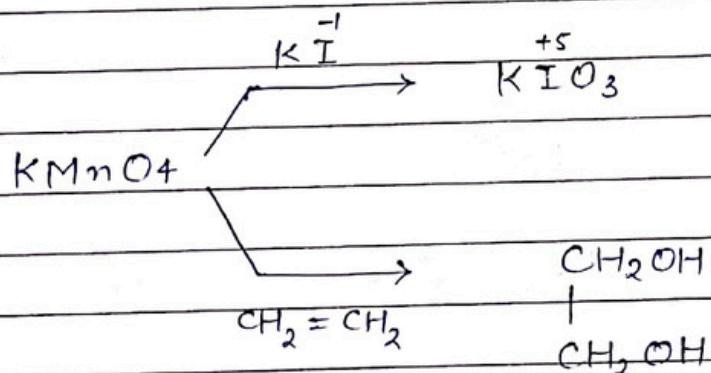
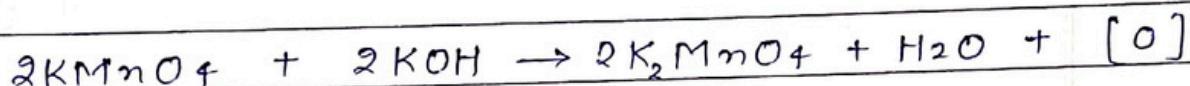
Acidic :



Neutral :-



ALKALINE :-



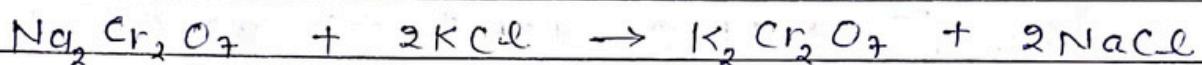
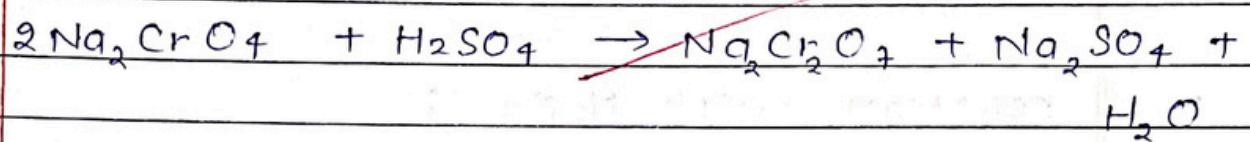
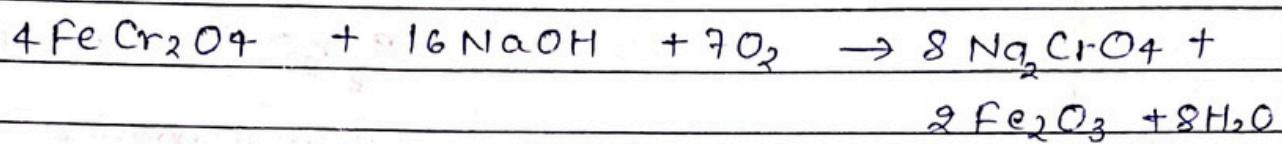
Uses :-

- (i) Oxidising Agent
- (ii) In Dry cell
- (iii) Disinfectant
- (iv) volumetric analysis of salts

(2) Potassium Dichromate ($K_2Cr_2O_7$) :-

Preparation :-

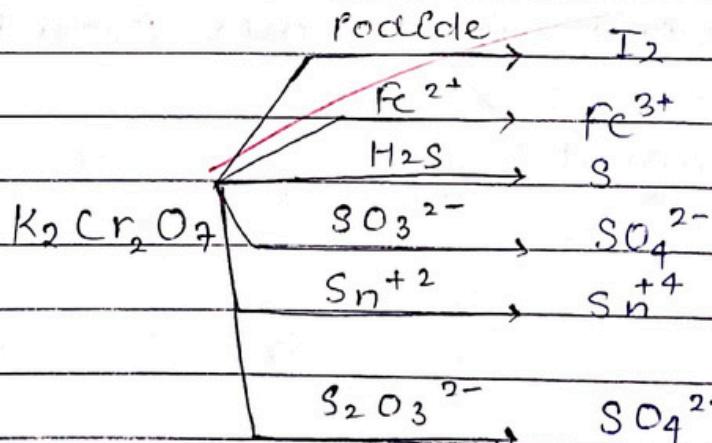
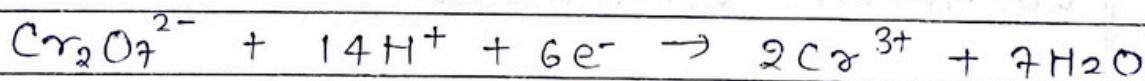
(a) Preparation of sodium chromate.



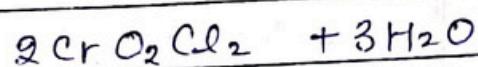
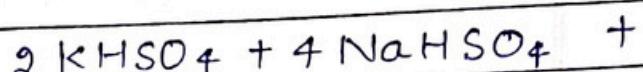
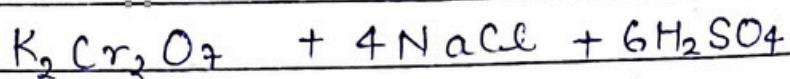
Properties -

- Orange colour
- m.p. \rightarrow 670 K
- Appreciably soluble in hot water
- Moderately soluble in cold water.
- $4KMnO_4 \xrightarrow{\Delta} 4K_2CrO_4 + 2Cr_2O_3 + 3O_2$

► Oxidising nature :

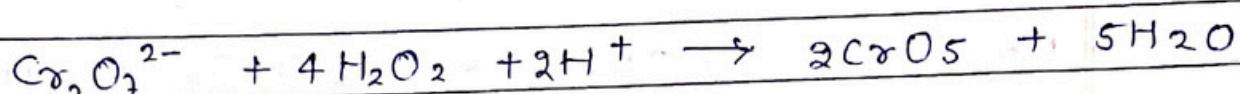


► * Chromyl chloride test :-

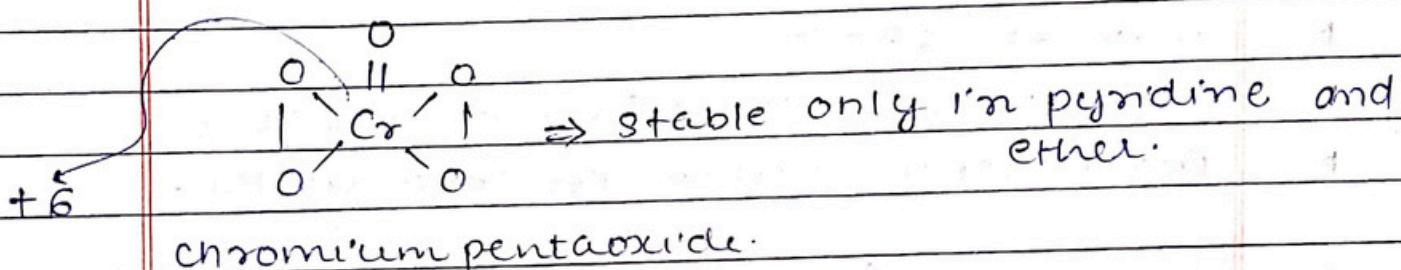


* Chromyl chloride

► reaction with H_2O_2 :-



deep
blue
colour



Uses :

① Volumetric estimation.

② Chrome tanning in leather industries.

③ oxidising agent.

→ Rare earth metals.

LANTHANOIDS :- These 14 elements are found after an element known as Lanthanum $6s^2 5d^1$.

Lanthanoids → $6s \curvearrowright 4f \curvearrowright 5d$

* Monazite sand mineral contains lanthanoid metal.
General.

La

Electronic Configuration

Ce

P

$4f^{0-14} 5d^{0-1} 6s^2$

Nd

Pm

Sm

Eu

Eu²⁺ is strong reducing agent because

Gd

it is more stable than Eu³⁺.

Tb

$Eu^{2+} \rightarrow Eu^{3+} + e^-$

Dy

Ho

Er

Er

Tm

Yb

Lu

Atomic and Ionic Radius:

On moving along the lanthanoid series (Ce → Lu)

A.R and I.R decreases continuously.

* $6s^2 5d^{0-1} 4f^{1-14}$

* 4f orbital is more toward the nucleus.
also, e^- increases in 4f-orbital p^+ also increases in nucleus hence Z_{eff} increases.

* because of highly distorted or discrete shape the electron present in these orbitals show poor shielding effect and hence atomic and ionic radius decreases.

This effect is called LANTHANOID CONTRACTION

Oxidation State :-

- The most stable configuration +3 however +2 and +4 is also observed in solid or solution compound.
- Irregular oxidation state in O. state just like Ionisation Enthalpy is observed, because of half, fully or empty 4f orbitals.
- Both +2 and +4 have tendency to revert back to +3 oxidation state.
- $E^\circ Ce^{+4}/Ce^{3+} = +1.74 \text{ V}$ it can be oxidised by water.

But it can be used as oxidising Agent.

- Pr, Nd, Tb, Dy show +4 oxidation state.
only in oxides $M O_2$.
- Eu^{2+} and Yb^{2+} have tendency to undergoes
oxidation to +3 oxidation state. [R.A]
- Ce^{4+} and Tb^{+4} have tendency to undergoes
reduction to +3 O.S and is oxidising
Agent.
- Eu and Sm have +2 and +3 oxidation s.

Physical Properties :-

- ① All lanthanoids are silvery white soft metals and tarnish rapidly in air.
Hardness increases with increase in atomic number.
'Sm' is exceptionally hard.
- ② Typical metallic structure and are good conductor of heat and electricity.
- ③ High density 6.77 to 9.74 g/cm³.
- ④ High Melting point 1000 K - 1200 K
(Sm - 1623 K).
- ⑤ La^{3+} , Ce^{+4} , Lu^{3+} have no unpaired electron.
∴ DIAMAGNETIC. and rest are paramagnetic.

⑥ most of the M^{3+} ions are coloured both in solid and aq. solution. This is due to partly filled f-orbitals which permits f-f transition but rest do so.

⑦ IE_1 of lanthanoid are around 600 kJ/mol and IE_2 is 1200 kJ/mol (comparable to Ca). The variation of IE_3 shows that just as in case of 3d.

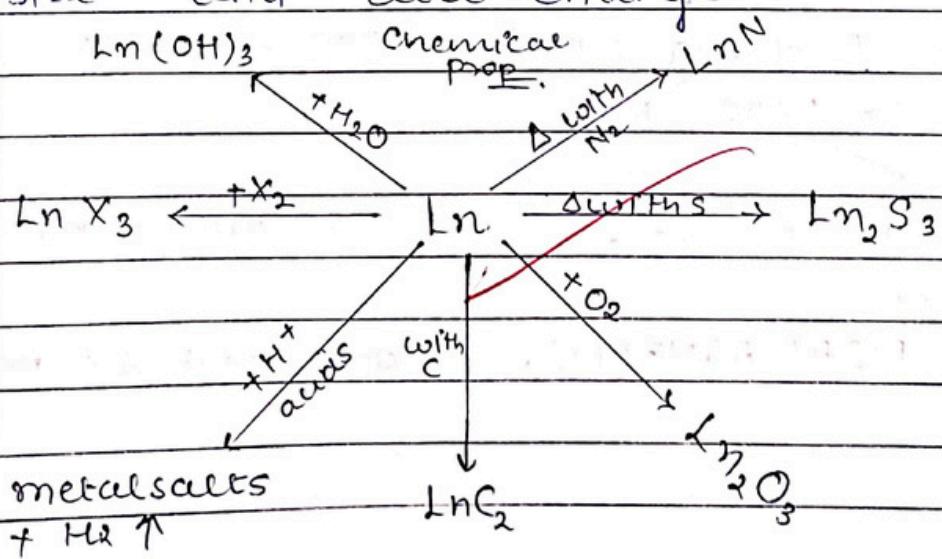
transition series the loss of first 2 e⁻ is accompanied by exchange enthalpy. further the loss of 3rd e⁻ is easier; IE_3 is low if it leads to stable empty, half or completely filled configuration.

⑧ $E^\circ_{M^{3+}/M} = -2.2 \text{ to } -2.4 \text{ V}$
($E_u = -2.0$)

⑨ They loss e⁻ easily \therefore Reducing Agent

⑩ Highly electropositive.

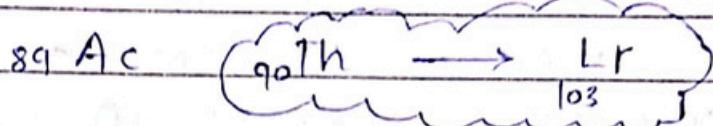
⑪ They do not form complex salt because of large size and low charge



Actinoids :-

↳ are those 14 elements that are found after Actinium.

also known as 5f-block elements.



→ They all are radioactive.

Initially ~~transition metals~~ are having half-life of a day and of latter element have a lesser half-life of 3 min (Lr)

↳ 7s, 6d, 5f energy gap is less \rightarrow variable oxidation state.

89 Ac

90 Th

* Electronic Configuration :

Pa

↳ 5f-series

U

↳ 7s² 6d⁰⁻¹ 5f¹⁻¹⁴

Np

Pu

* no regular pattern in E.C.

Am

because of stability factors

Cm

like 5f⁰, 5f⁷, 5f¹⁴.

Bk

Cf

* Bk \Rightarrow 5f⁹ 6s⁰ 7s² (stable)

Es

* Th \Rightarrow 7s² 6d²

Fm

↳ no e⁻ in f-orbital.

Md

Because Ac and Th show

102 No

similar property to 5f block

103 Lr

elements.

Ionic Radius:

On moving from Ac to Lr (5f) the Ionic radius decrease continuously because 5f orbital have very poor shielding effect and because of its distorted shape the e^- in 5f orbital do not repel such. $\therefore Z_{eff} e^-$ increases and I.R decreases. \Rightarrow ACTENOID CONTRACTION.

Oxidation state of Actenoid:

- (i) Large no. of oxidation state (because of very small energy gap between 5f, 6d and 7s orbital).
- (ii) +3 is dominant oxidation state of all.
- (iii) O.S increases upto middle and then decreases.
 \rightarrow Actenoids have low Ionisation Enthalpy because of very less energy gap.

Physical Properties:

- (i) Silvery Appearance
- (ii) High melting and Boiling point (not regular trend).
- (iii) Except Th and Am, have high density
- (iv) Cations are coloured (f-f transition of unpaired e^-).

Date: _____
Page: _____

- ① Electropositive (low· I.E)
- ② Strongly ~~PARAMAGNETIC~~
- ③ Strong Reducing Agent (e- donor).