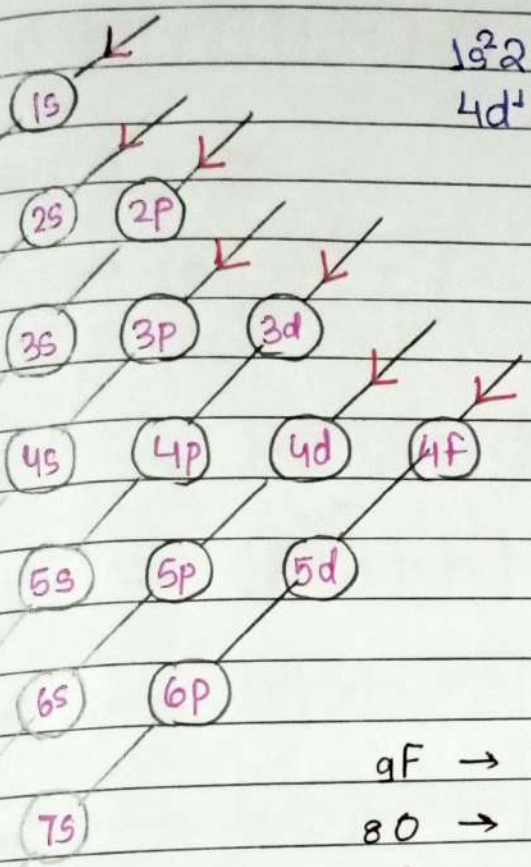
D & F Block Elements

Brice
Page
Date : / /

- Periodicity

→ Basic electron filling rule

→ Afbaus rule



$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{10} 5d^{10} 6p^6 7s^2$

$1s^2 2s^2 2p^6 \rightarrow [Ne]_{10}$

$1s^2 2s^2 2p^6 3s^2 3p^6 \rightarrow [Ar]_{18}$

$_9F \rightarrow 1s^2 2s^2 2p^5$

$_8O \rightarrow 1s^2 2s^2 2p^4$

$_6C \rightarrow 1s^2 2s^2 2p^2$

$_7N \rightarrow 1s^2 2s^2 2p^3$

$_{11}Na \rightarrow [Ne]\ 3s^1$

$_{15}P \rightarrow [Ne]\ 3s^2 3p^3$

$_{19}K \rightarrow [Ar]\ 4s^1$

$_{16}S \rightarrow [Ne]\ 3s^2 3p^4$

$_{17}Cl \rightarrow [Ne]\ 3s^2 3p^5$

21Sc → [Ar] $4s^2 3d^1$

22 Ti → [Ar] $4s^2 3d^2$

23 V → [Ar] $4s^2 3d^3$

24 Cr → [Ar] $4s^1 3d^5$

25 Mn → [Ar] $4s^2 3d^5$

26 Fe → [Ar] $4s^2 3d^6$

27 Co → [Ar] $4s^2 3d^7$

28 Ni → [Ar] $4s^2 3d^8$

29 Cu → [Ar] $4s^1 3d^{10}$

30 Zn → [Ar] $4s^2 3d^{10}$

exceptions

24 Cr → [Ar] $4s^1 3d^5$

29 Cu → [Ar] $4s^1 3d^{10}$

Bricc
Page :
Date : / /

Hund's rule

p^3 | ↑ | ↑ | ↑ |

d^6 | ↑↓ | ↑ | ↑ | ↑ | ↑ | HV PX

Pauli's rule

N S

p^4 | ↑↓ | ↑ | ↑ |

→ Fe^{+2} → | ↑↓ | ↑ | ↑ | ↑ | ↑ | ↑↓ |

→ Fe^{+3} → | ↑ | ↑ | ↑ | ↑ | ↑ | ↑ |

→ Cu^{+} → | ↑↓ | ↑↓ | ↑↓ | ↑↓ | ↑↓ | ↑ |

→ Zn^{+2} → | ↑↓ | ↑↓ | ↑↓ | ↑↓ | ↑↓ | ↑↓ |

→ **D block:-**
The elements in which the elements are enter in (n-1)d orbitals.
(n-1)d → penultimate shell

→ **Transisation element:-**
- D block element are called transition elements because their properties are between p & s blocks.
- [Zn, Cd, Hg] → They are d block elements but not transitation.

⇒ **Position in Periodic table**

D block elements lie between p & s block elements

→ 1st transition elements / 3d series :-
$_{21}Sc \longrightarrow {}_{30}Zn$

→ 2nd transition elements / 4d series :-
$_{39}Y \longrightarrow {}_{48}Cd$

→ 3rd transition elements / 5d series :-
$_{57}La$, $_{72}Hf \longrightarrow {}_{80}Hg$

→ 4th transition elements / 6d series :-
$_{89}Ac$, $_{109}Rf \longrightarrow {}_{112}Uub$

Brief
Page
Date / /

Electronic configration

In the d block elements the electronic configration are:-

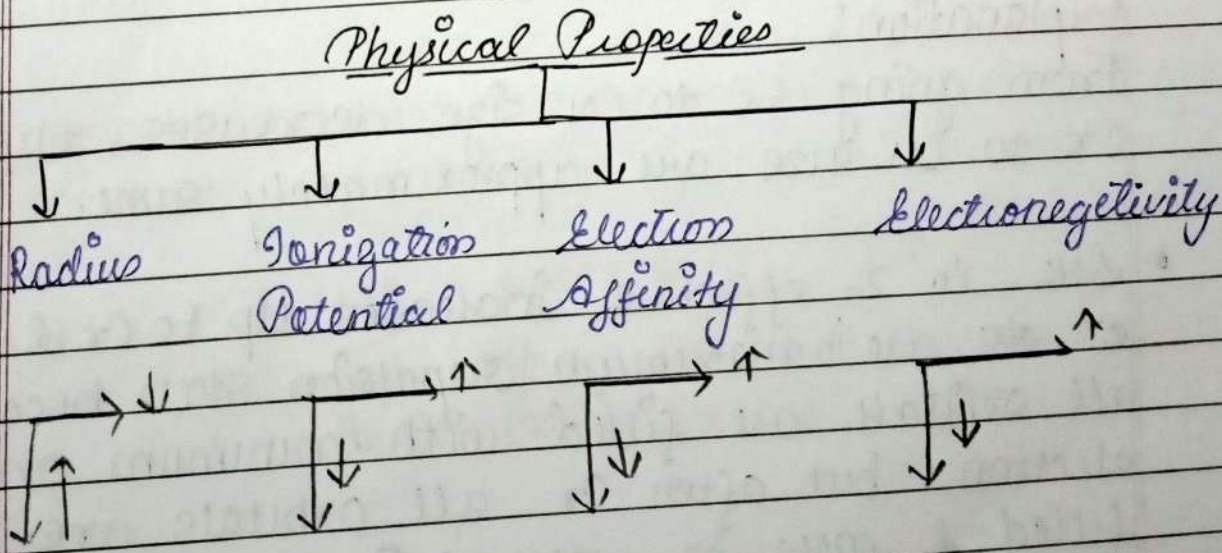
$(n-1)d^{1-10}\ ns^{1-2}$

Exceptional configration of Cu, Cr:-

The exception in 1st series is Z = 24 & Z = 29. It may be observed/noticed that unlike other elements. Cr & Cu have single electron in 4s orbitals this is due to the gain of additional stability by the atom either they have half filled or fulfilled.

In chromium orbital are filled with $5e^{\ominus}$ & in copper orbital filled with $10e^{\ominus}$ which is fulfilled.

Properties:-



=) Radius :-
The atomic radius of transition metal lie btw s & p which from going left to right size decreases rapidly after some element size is approximately same & at the end size again is slightly increases.

1 Atomic radius :-

- The size of d block elements lie between s & p block element.

Explanation:
D block elements are lie between s & p block so there size are slightly smaller than s & large than P.

- from going left to right size decreases upto Cr than size all approximately same

Explanation:
From going Sc to Cr size decreases, then Cr to Cu size are approximately same.

- Due to 2- effective increases up to Cr & e^- & e^- are in maximum repulsion state because all orbitals are filled with minimum one electron, but after Cr all orbitals are filled & new e^- entered in penultimate (n-1) shell.

- At the end the size are slightly increases.

Explanation
All electrons (orbitals) are filled with 2 electrons the repulsion force are greater than the attraction from repulsion force that's why size slightly increases.

- from going top to bottom size increases but 5d & 6d series, 6th & 7th period have approx. same size.

Explanation Due to lathanoids contraction & actanoids contraction.

2. Ionic Radius :-

- They all are metal so, they easily remove electrons so, they only make catton when electrons remove from an element their size always decreases.

Explanation: when electron removed Z-effective increases due to no. of proton increased.

$$M > M^{+} > M^{+2} > M^{+3}$$

xp xp xp xp
xe^- $(x-1)e^-$ $(x-2)e^-$ $(x-3)e^-$

Example

$CH > CH^{+}$, $Fe^{+2} > Fe^{+3}$

(+ve) charge $\propto \frac{1}{\text{size}}$

Brice
Page :
Date : / /

⇒ Metallic behaviours-

- Electricity conductor
- heat conductor
- hard
- ductile
- mallable
- Tensile

All transition element are metallic they are ductile, tensile, mallable, hard, heat, conductor, high melting point good conductor of electricity & heat.

→ Trends

- From getting left to right metallic behaviour increases upto manganese than decreases due to.

Unpaired electron ∝ metallic behaviour

- More unpaired electron more metallic more paired electron less metallic.
- That's why (Zn), (Cd), (Hg) are least metallic. [excepti
- one & only ~~one~~ metal which is formed in liquid state is Hg.

→ ... point

- Transition element have high melting point due to the metallic behaviour & strong metallic &.
- Metallic behaviour also directly proportional to unpaired electron.
- Melting point increases (Sc) to (Cr) than decreases Mn to Zn
- Tungsten have a high melting point that's why it is used in filament for making bulbs.

- Hg, have least melting & boiling point that's why it is used to making thermometer & barometer.

- In 3d series (Cr) & (Mn) have max. melting point and Zn have min. melting point

→ Ionization potential

- there ionization enthalpies are greater than s but lesser than p.

  $s < d < p$, This is due to their size.

- There are lots of irregulations in I-P of d block elements.

- There IPs are increases from going left to right but they show always IInd ionization enthalpy due to the extra electrons available in 4s, (ns). ~~But~~

- But, Exceptionally Cu & Cr shows the 1st ionizatio enthalpy. Due to exceptional configration (ns^1).

Brice
Page :
Date : / /

⇒ Oxidation number

The net numerical charge or no. of electrons transfered in any element of or metal of d-block are called as oxidation no.

1. D block element show variable oxidation no. except. Zn, Cd, Hg (only one oxidation no.) that why they are called non transition elements.

2. Common electronic configuration are +2 except Cr, Cu they show +1 oxidation no.

Cr Cu
+1 +1

3- After removing ns electron they are kernel

4- Kernel are unstable they loose more electron.

5. Maximum oxidation no. = ns e^- + no. of e^- in d orbital.

6. Min. oxidation no. = ns e^-

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
$3d^1 4s^2$	$3d^2 4s^2$	$3d^3 4s^2$	$3d^5 4s^1$	$3d^5 4s^2$	$3d^6 4s^2$	$3d^7 4s^2$	$3d^8 4s^2$	$3d^{10} 4s^1$	$3d^{10} 4s^2$
+2	+2	+2	+1	+2	+2	+2	+2	+1	+2
+3	+3	+3	+2	+3	+3	+3	+3	+2	
	+4	+4	+3	+4		+4	+4		
		+5	+4	+5			+5		
			+5	+6					
				+7					

The highest oxidation no. of d-block in Ru & Os

Ru
Os] +8

In 3d series maximum oxidation no. is Mn. ~~+7~~

Mn = +7

Trends

From going left to right oxidation no increases then decreases.

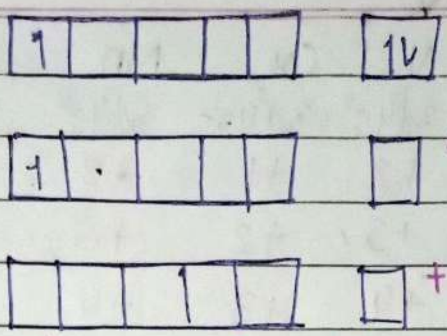
Most common oxidation no. are +2 & +3

Max. oxidation no. elements are always from mid range. Sometimes they also show zero oxidation no. example $[Ni(CO)_4]$

Most of the elements oxidation no. depend upon unpaired e^- d^0 d^5 d^{10} → Stable configration

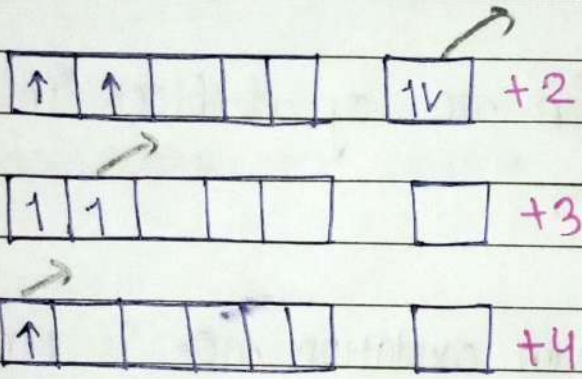
Brice
Page :
Date : / /

o- $_{21}Sc$ – $3d^1 4s^2$

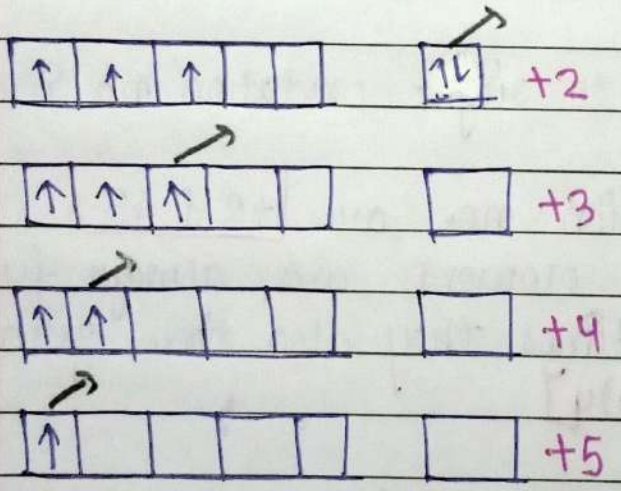


d^0 → configration

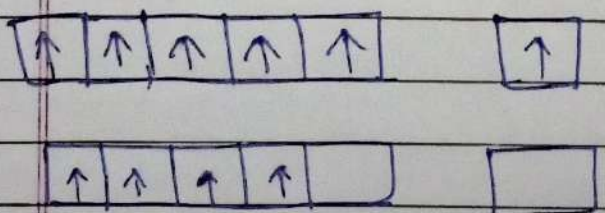
o- $_{22}Ti$ – $3d^2 4s^2$



o- $_{23}V$ – $3d^3 4s^2$

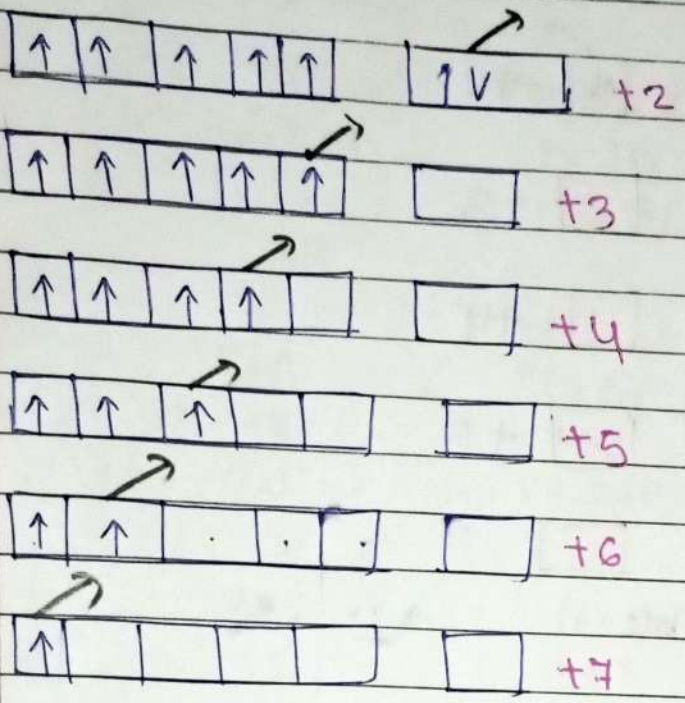


o- $_{24}Cr$ – $3d^5 4s^1$

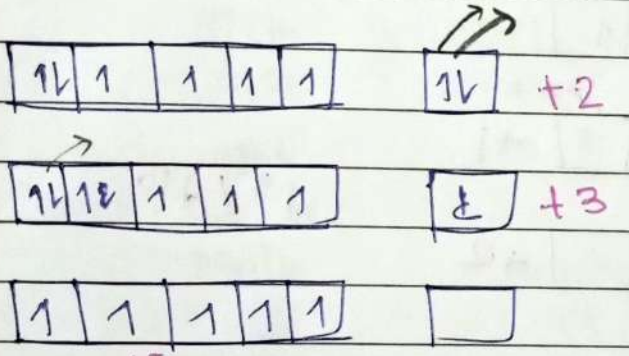


Brice
Page :
Date : / /

o- $_{25}Mn - 3d^5 4s^2$

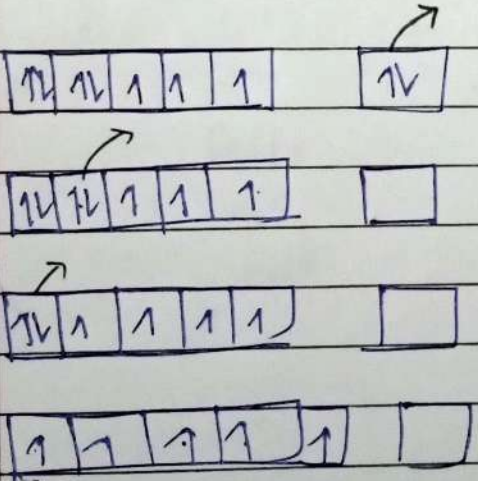


o- $_{26}Fe - 3d^6 4s^2$



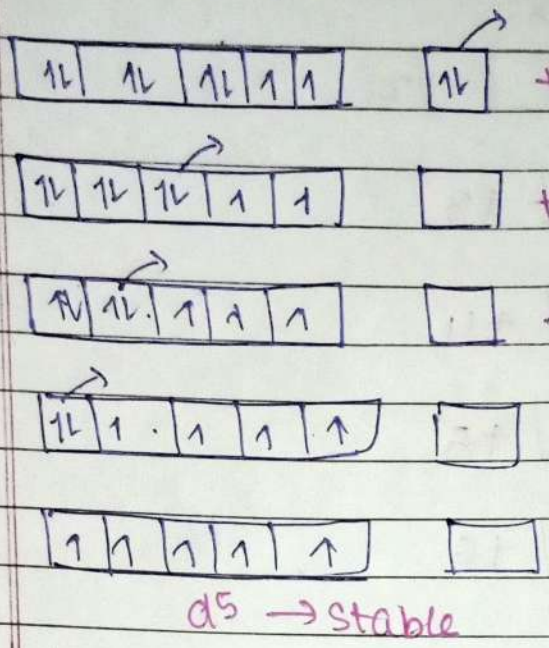
$d^5 \rightarrow$ stable

o- $_{27}Co - 3d^7 4s^2$



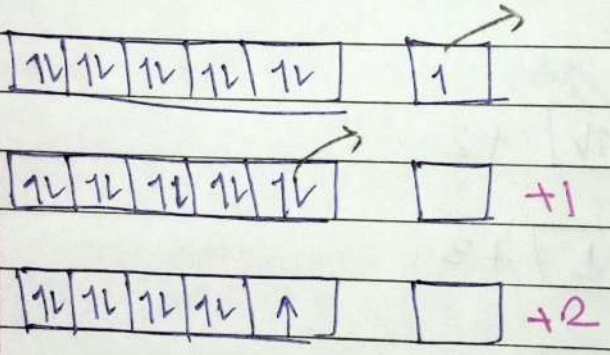
Brice
Page :
Date : / /

o- $_{28}Ni^{0}$ - $3d^8 4s^2$



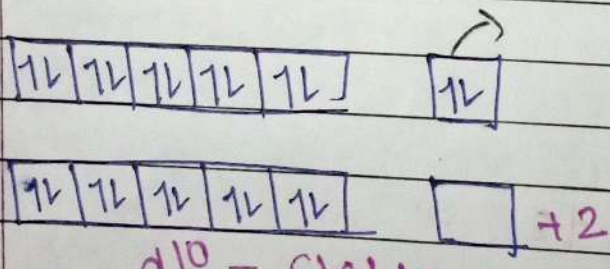
d^5 → stable

o- $_{29}Cu$ - $3d^{10} 4s^1$



d^5 & d^{10}

o- $_{30}Zn$ - $3d^{10} 4s^2$



d^{10} - Stable

d^5 d^{10} d^0

Stable. conf.

Brice
Page :
Date : / /

⇒ Stable Configration.

TiO < Ti_2O_3 < TiO_2

$x-2=0$ | $2x-3\times2$ | $x-2\times2=8$

$\boxed{x=+2}$ | $\boxed{x=+3}$ | $\boxed{x=4}$

$3d^2$ | $3d^1$ | $3d^0$

$_{22}Ti$
$3d^2 4s^2$

ScO < Sc_2O_3

$+2$ | $+3$

$3d^1$ | $3d^0$

$_{21}Sc$
$3d^1 4s^2$

FeO < Fe_2O_3

$+2$ | $+3$

$3d^6$ | $3d^5$

$_{26}Fe$
$3d^6 4s^2$

$TiCl_4$ > $TiCl_2$

$+4$ | $+2$

$3d^0$ | $3d^2$

$_{22}Ti$
$3d^2 4s^2$

MnO_2 < Mn_2O_7

$+2+4$ | $+7$

$3d^5$ | $3d^0$

$_{25}Mn$
$3d^5 4s^2$

Cr_2O_3 < CrO_3

$+3$ | $+6$

$_{24}Cr$
$3d^5 4s^1$

$FeCl_2$ < $FeCl_3$

$+2$ | $+3$

$3d^6$ | d^5

$_{26}Fe$
$3d^6 4s^2$

⇒ Ionic form

- Mn^{+2} > Mn^{+3}
  $+2$ $+3$
  d^5 d^4
- V^{+5} > V^{+3}
  $+5$ $+3$
  d^0 d^2
- Ti^{+4} > Ti^{+3}
  $+4$ $+2$
  d^0 d^2
- Cr^{+3} < Cr^{+1}
  $+3$ $+1$
  d^3 d^5

50★

- Cu^{+2} more stable in aqueous phase due to very high heat of hydration while Cu^{+1} have d^{10} configration

→ Standard electrode potential

Thermodynamically, Transition of element can be defined as smaller the ionization enthalpy greater the stability but in solution the stability depends on 3 factors.

$M(s) \xrightarrow{\text{Sublimation}} M(g)$ ΔH_{sub}

$M(g) \xrightarrow{I.P.} M(g)^{th} + ne^-$ $\Delta H_{I.P}$

$M^{th}(g) \xrightarrow{\text{hydration}} M^{th}(aq)$ $-\Delta H_{hyd.}$

- Total energy = $\Delta H_{sub} + \Delta H_{IP} + \Delta H_{Hyd}$.

So, If we want to change any metal into its aqueos solution so, we must have three stages to do that.

$Mg(s) \xrightarrow{\Delta H \text{ total}} Mg^{+n}(aq)$

$Mg(s) \xrightarrow{\Delta H_{sub}} Mg(g)$

$Mg(g) \xrightarrow{\Delta H_{IP}} Mg^{+n} + ne$

$Mg^{+n}(aq) \xleftarrow{\Delta H_{Hyd}} Mg^{+n} + H_2O$

→ $M^{+2}/Metal$
→ M^{+3}/M^{+2}
} S.H.E.P

Hydration energy $\propto$ $\frac{\text{cation charge}}{\text{cation size}}$

eg:- $Cu^{+} < Cu^{+2}$

⇒ Trends in M^{+2}/M

There is no regular trend because Ip 1st & IP second & Sublimation do not show any regular trend but there is some sufficient information about stability.

eg:-

less E°

$Cr \rightarrow Cr^{+2}$

$3d^5 4s^1$ $3d^4 4s^0$

E° more

$Mn \rightarrow Mn^{+2}$

$3d^5 4s^2$ $3d^5$

$Fe \rightarrow Fe^{+2}$

$3d^6 4s^2$ $3d^6 4s^0$

E° more – Stability more
E° less – Stability less

E^0

Zn → Zn^{+2}

$3d^{10}4s^2$ → $3d^{10}4s^0$

$E^\circ_{Zn} > E^\circ_{Mn} > E^\circ_{Fe} > E^\circ_{Cr}$

The value of ε° for ~~MN~~ Mn, Zn, Ni are more –ve than due to greater stability of Mn^{+2} (d^5), Ni, Zn^{+2} (d^{10}) configuration & the Ni show ~~exception~~ unexpected behaviour because of high –ve enthalpy of hydration.

- Copper show unique behaviour in the series this only metal having +ve value of ε°. That's why it do not liberate acid from H_2. only react with oxidizing acid [HNO_3, ~~H_2SO_4~~ H_2SO_4] the reason thats ε° are positive. The ~~total~~ energy are not balanced by hydration energy

$$\Delta H_{Total} = \Delta_{sub}H + \Delta_{ion}H + \Delta_{Hyd}H$$

Brice
Page :
Date : / /

Trends on Mn^{+3}/Mn^{+2}

1. Very low value of Sc^{+3}/Sc^{+2} → Sc^{+3} more stable due to d^0 configiation

2. The highest value of Zn. Zn^{+2}/Zn^{+3} → Zn^{+2} more stable d^{10} configration.

3. It is not possible to create Zn^{+3} due to its stability.

4. High value of Mn^{+3}/Mn^{+2} → Mn^{+2} more stable d^5 configration. It is not possible to make Mn^{+3} easily.

5. Very low value of E° in Fe.

Fe^{+3}/Fe^{+2} → Fe^{+3} more stable d^5 configration.

More negative E° values means more tendancy to form that ion.

Note :- V^{+2} are also stable due to the half filled t_{2g}.

Brice
Page :
Date : / /

⇒ Oxidizing agent and reducing agent

- Compound that show high oxidation no. they are good oxi. agent because they want to take electrons from other.

eg :- CrO_3, $KMnO_4$, $K_2Cr_2O_7$.

- Reducing agent

Compounds which are in the lower oxidize state show good red. agent they want to oxid. him self & Red. other.

eg :- NO, Cr_2O_3, MnO_2.

~~⇒ Acid Oxide~~

⇒ Oxides

- higher oxidation oxides are acidic & covalent type.
- Lower ox. no. oxides are basic ionic type.

Intermediate O. No. are amphoteric.

Brice
Page
Date / /

+1 ⇒			Cr_2O						Cu_2O	
+2	ScO	TiO	VO	CrO	MnO	FeO	CoO	NiO	CuO	ZnO
+3	Sc_2O_3	Ti_2O_3	V_2O_3	Cr_2O_3	Mn_2O_3	Fe_2O_3	Co_2O_3	Ni_2O_3	Cu_2O_3	Zn_2O_3
+4		TiO_2	V_2O_4	Cr_2O_4	MnO_2		CoO_2	NiO_2		
+5			V_2O_5	Cr_2O_5	Mn_2O_5					
+6				CrO_3	MnO_3			Ni_2O_5		
+7					Mn_2O_7					

⇒ **Halides**

The highest oxidation no. in halide are TiX_4 but fluoride show +5 & +6 also.

Some examples:

+6			CrF_6						
+5		VF_5	CrF_5						
+4	TiX_4	VX_4	CrX_4	MnF_4					
+3	TiX_3	VX_3	CrX_3	MnF_3	FeX_3	CoF_3			
+2	TiX_2	VX_2	CrX_2	MnX_2	FeX_2	CoX_2	NiX_2	CuX_2	ZnX_2
+1								CuX	

$X = F$ ~~$\rightarrow I$~~ , $I = X^{I} = F \rightarrow Br, X^{II} - F, Cl : X^{III} = Cl - I$

Brice
Page :
Date : / /

⇒ Lower Oxidation no. are Ionic. High ox. no. are covalent.

Que.1 Which oxides are more stable?

(a) MnO_2 < (b) MnO < (c) Ti_2O_3 (d) TiO

+4 +2 d⁰ +3 d¹ +2 d²

Que.2 Which oxide are more acidic.

Cr_2O_3 < CrO_3 Mn_2O_7 > MnO

+3 +6 +7 +2

Que.3 Order of acidity in Mn Oxide.

(a) MnO < Mn_2O_3 < MnO_2 < Mn_2O_7 < Mn_2O_7

basic basic amphoteric acidic

Q.4) Which oxide are amphoteric

MnO_2 CrO_3 Sc_2O_3

+4 +6 max +3 max

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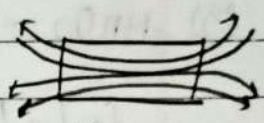
amphoteric.

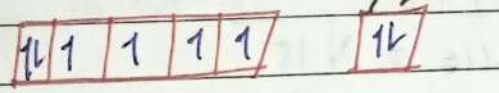
Brice
Page :
Date : / /

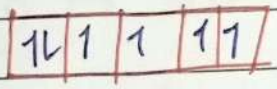
⇒ Magnetic Behaviour

paramagnetic	diamagnetic	ferromagnetic
→ e unpaired	All e are paired	Fe, Co, Ni
→ $\mu = \sqrt{n(n+2)}$ BM		
n = no. of unpaired e^-		
magnetic moment		



eg:- FeO = $_{26}Fe \rightarrow 3d^6\ 4s^2$





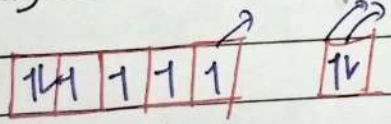
– Paramagnetic

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

$= \sqrt{4(4+2)}$

$\mu = \sqrt{24}$ BM

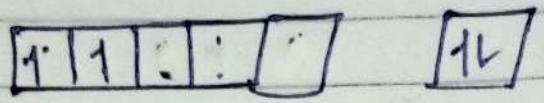
Que:1 $FeCl_3 \rightarrow {}_{26}Fe \rightarrow 3d^6\ 4s^2$



• Paramagnetic

$\mu = \sqrt{5(5+2)} = \sqrt{35}$

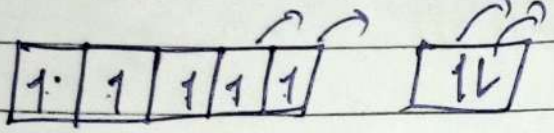
(2) $TiCl_2$ = $_{22}Ti$ = $3d^2 4s^2$



Paramagnetic

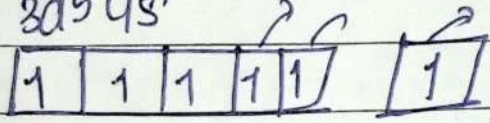
$$\mu = \sqrt{n(n+2)} = \sqrt{2(2+2)} = \sqrt{8}\ BM$$

(3) MnO_2 - $3d^5 4s^2$



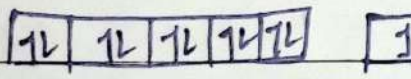
Paramagnetic $\mu = \sqrt{5(5+2)} = \sqrt{35}$

(4) Cr_2O_3 $3d^5 4s^1$



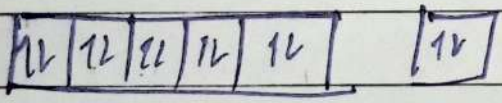
Para magnetic $\mu = \sqrt{15}$

(5) Cu^{+2} - $3d^{10} 4s^1$



Diamagnetic

(6) $ZnCl_2$



Diamagnetic

Colour property

⇒ unpaired - colourful
⇒ paired - colourless

Q.1 $ScCl_3$ → $3d^0\ 4s^2$ → d^0
+3 colourless

2. $TiCl_4$ → $3d^2\ 4s^2$ → d^0
+4 colourless

3. V_2O_3 → $3d^3\ 4s^2$ colourful
+3

4. MnO → $d^5 s^2$ → d^5 colourfull
+2

5. Fe_2O_3 $3d^6\ 4s^2$ → colourfull
+3

6. MiO - $3d^8\ 4s^2$ - colourful
+2

7 CuO → $3d^{10}\ 4s^1$ - colourful
+2

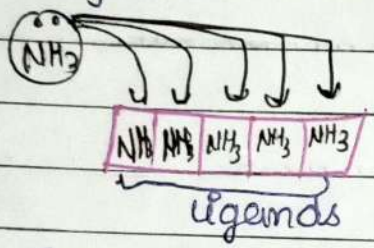
8 $CuCl$ - $3d^{10}\ 4s^1$ → colourless
+1

9 ZnO $3d^{10}\ 4s^2$ → colourless
+2

Brice
Page :
Date : / /

⇒ Making of Coordinate Compounds

D-block element easily make co-ordinate because they have lot of space in d orbitals So, any compound which have extra lone pair can be put in this vacant d-orbital i.e called ligands. & the bond are called 'co-ordinate bond we'll further discuss in next chapter



→ $K_4[Fe(CN)_6]$
→ $[Cr(NH_3)]Cl_3$
→ ~~Ni(CO)4~~ $Ni(CO)_4$

→ Catalytic property

D-block element show catalytic properties bcz they have variable valencies. They can make space for substrate and product. [reactent].

We can increase space by powdering the catalyst.

Brice
Page
Date / /

	Catalyst	Reaction / Uses
(1)	$TiCl_3$	Ziglar - Natta catalyst making of polyethene
(2)	V_2O_5	$SO_2 \xrightarrow{V_2O_5} SO_3$ contact process making of H_2SO_4
(3)	MnO_2	$2KClO_3 \xrightarrow{MnO_2} 2KCl + O_2$ decomposition
(4)	Fe	$N_2 + 3H_2 \xrightarrow{Fe} 2NH_3$ Habber's process
(5)	$FeCl_3$	$CS_2 + 2Cl_2 \xrightarrow{FeCl_3} CCl_4 + 2S$ fire extinguisher
(6)	$FeSO_4 + H_2O_2$	Alcohol $\longrightarrow$ Aldehyde fenton's Reagent
(7)	$PbCl_2$	$C_2H_4 + H_2O + PbCl_2 \longrightarrow CH_3CHO + HCl + Pd$ Waker's process
(8)	Pd	Phenol $\longrightarrow$ cyclohexane (hydrogenation)
(9)	Pt / PtO	Adam's Catalyst (reduction.
10	~~Pt / Rh~~ Pt / Rh	Gauge catalyst, Ostwald process, making of HNO_3
(11)	Cu	Making of Silicates
12)	Cu/V	Making of Nylon. 6,6
(13)	$CuCl_2$	Decons process making HCl
(14)	Ni	Raney Nickel making Alkanes (Reductions) (Hydrogenation)

Brice
Page :
Date : / /

* Alloy formation

⇒ D block element can make easily alloy with other metals bcz their size are approx. same

examples:

(1) Brass → Cu + Zn 2:1
(2) Bronze → Cu + Tin (Sn) 3:1
(3) Gun metal → Cu + Zn + Sn
(4) German silver → Cu + Zn + Ni 2:1:1
(5) Bell metal → Cu + Sn [4:1]
(6) Nichrome → Ni + Cr + Fe
(7) Al NiCo → Al + Ni + Co
(8) Type metal → Pb + Sn + Sb
(9) Solder → Pb + Sn
(10) Magnelium → Al + Mg [9:1]
(11) Duralumin → Al + Mn + Cu
(12) Artificial gold → Cu + Al [9:1]
(13) Constatan → Cu + Ni [3:2]

⇒ Iron alloy

		C%
a)	Wrought Iron (purest form)	0.1 - 0.25
b)	Steel (strongest form)	0.25 - 2.0
c)	Cast Iron	2.6 - 4.3
d)	Pig Iron (from blast furnace)	2.3 - 4.6

Brice
Page :
Date : / /

⇒ Gold Alloy :-

24 carat gold → 100% pure Au
22 carat gold → 91.6% Au
20 Carat gold → 87.6% Au
14 Carat gold → Au + Ag + Cu
5 : 3 : 2

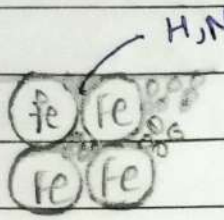
⇒ Steel Alloy :-

(1) Vanadium Steel → Fe + V
(2) Chromium Steel → Fe + Cr
(3) Nickel Steel → Fe + Ni
(4) Magnese Steel → Fe + Mn
(5) Stainless Steel → Fe + Cr + Ni
(6) Tungeston Steel → Fe + W
(7) Invar → Fe + 36% Ni

Brice
Page :
Date : / /

=> Interstial Compounds

- The transitional element form large of interstecial compound. In which small atoms such as hydrogen, nitrogen, carbon, oxygen ~~form~~ found in interstecial sites or in voids. It is because of large size of d-block elements.



eg:- TiC, TiH_2, Mn_4N, Fe_3H, Fe_3C etc.

- The bond present in them neither covalent nor ionic.
- There some important characters are:-

a) They are very hard, rigid;
example:- steel, which is alloy of Fe & carbon are very harder & its hardness is similar as diamond.

b) They have high melting point which are higher than pure metal.

- They show higher conductivity than metal (Electri and thermal).
- They are chemically inert, chemically they do not react with acid, base, salt.

Bricc
Page
Date / /

⇒ Some compounds of D-block

1 → $K_2Cr_2O_7$

- Potassium dichromate is a very imp. chemical substance which is used in leather industries, oxidant for many substance like Azo-compounds peroxides etc.
- It is obtained by the chromate ore [$FeCr_2O_4$] → ferrus chromate.

→ Preparation

1* $4FeO \cdot Cr_2O_3 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8C$

→ Iron chromate reacts with sodium carbonate and makes sodium chromate in reverberatory furnance were roasting process takes place. Th process ores directly react in presence of oxyg

→ Now, this sodium chromate which is yellow in colour directly react with oxidized acids & make orange colour sodium dichromate

2* $Na_2CrO_4 + H_2SO_4 \longrightarrow Na_2Cr_2O_7 + H_2O + Na_2SO_4$
yellow → orange

→ Now this sodium di-chromate reacts with KCl & makes potassium dichromate

3* $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + NaCl$
orange colour crystalline salt

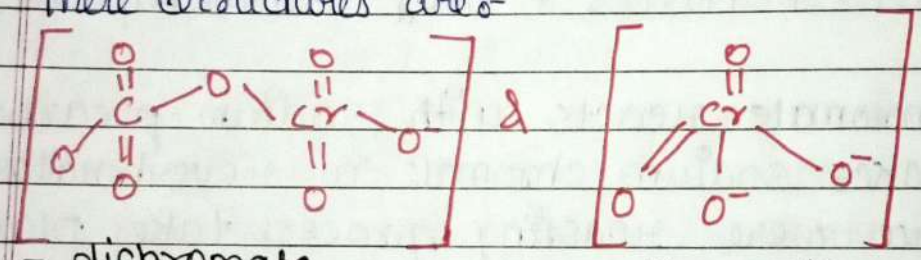
⇒ Physical Properties.

1. $K_2Cr_2O_7$ are orange in color whose melting point are 6,069 K.
2. They are moderate soluble in cold water & highly soluble in hot water.
3. When it is heated direct in air gives / evolve oxygen

$$4K_2Cr_2O_7 \longrightarrow 4K_2CrO_4 + 2Cr_2O_3 + 3O_2$$

4. They are found in two ionic forms :-
   $Cr_2O_7^-$ & CrO_4^-

There structures are :-



- dichromate
- orange in colour

&

- chromate
- yellow in colour

⇒ Chemical properties

1. In Acidic medium chromate ion turns into dichromate ions & in basic medium dichromate ion turns into chromate ion.

$$2CrO_4^- + 2H^+ \longrightarrow Cr_2O_7^- + H_2O$$
$$Cr_2O_7^- + 2OH^- \longrightarrow 2CrO_4^- + H_2O$$

They mostly react in acidic medium & they give 6 e⊖ in acidic medium. So, its equ. weight is :-

$$Equ = \frac{M.W \text{ of } K_2Cr_2O_7}{6} = \frac{294}{6} = 49$$

They are good oxidizing agent because they give high electrode potential during reactions with acid.

$Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$

$E^\circ = 1.33$ Volt

- Rxn with non metals:

(1) $6I^- \longrightarrow 3I_2 + 6e^-$

(2) $3H_2S \longrightarrow 6H^+ + 3S + 6e^-$

- Rxn with metals:

(1) $3Sn^{+2} \longrightarrow 3Sn^{+4} + 6e^-$

(2) $6Fe^{2+} \longrightarrow 6Fe^{3+} + 6e^-$

Overall rxn

$Cr_2O_7^{-2} + 14H^+ + 6Fe^{+2} \longrightarrow 2Cr^{+3} + 6Fe^{3+} + 7H_2O$

⇒ Uses of $K_2Cr_2O_7$

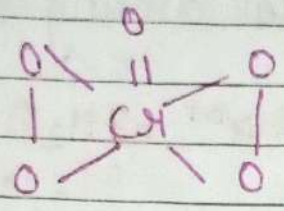
1. Test of drunken & drive. The above rxn helps to identify the drunk & driven & the amount of alcohol consumed by driver.
If she/he asked to breath into acidified $K_2Cr_2O_7$ soln. taken in test tube. Orange colour of $K_2Cr_2O_7$ soln turns green that means driver are drunken.

2. $C_2H_5-OH + [O] \longrightarrow CH_3-CHO$

$CH_3-CHO + [O] \longrightarrow CH_3COOH$

Reaction with peroxide - $K_2Cr_2O_7$ reacts with peroxide and makes blue colour oxide of CrO_5

$K_2Cr_2O_7 + H_2O_2 \longrightarrow CrO_5$



→ Butterfly structure of CrO_5

3. It is used in tanning in leather industries.
4. It is used in preparation of chrome alum, Cr_2O_3, CrO_3, CrO_2Cl_2, K_2CrO_4, $CrCl_3$
5. It is used in the photography ~~hard~~ for harding of gelatin film.
6. In organic chemistry used as oxidizing agent

⇒ $KMnO_4$

- Potassium permagnate is prepered by the mineral pyrolucite MnO_2.

- Method of Preparation.

→ MnO_2 react with KOH and makes potassium ~~mag~~ mangnet. this potassium mangnet oxidized in the presence of acid & makes potassium permagnet and MnO_2 by disproportionation reaction.

- Disproportionation rxn :-

A compound which can oxidize & reduce himself that is called Disproportionation rxn

(1) $MnO_2 + O_2 + KOH \longrightarrow K_2MnO_4 + 2H_2O$

(2) $3K_2\overset{+6}{Mn}O_4 + 4H^+ \longrightarrow 2K\overset{+7}{Mn}O_4 + \overset{+4}{Mn}O_2 + H_2O$

reduction

oxidation

* In commercial purpose $KMnO_4$ makes by pyrolucite with rxn with fused KNO_3 & again electrolyte oxidation in alkaline medium

$MnO_2 \xrightarrow[KNO_3]{\text{fused with}} MnO_4^{-2}$

$MnO_4^{-2} \xrightarrow[\text{alkalined}]{\text{electrolyte oxidation in}} MnO_4^-$

⇒ Physical Properties

1. It is deep purple colour cluster with greenish shine it has become unshinny in presence of air.

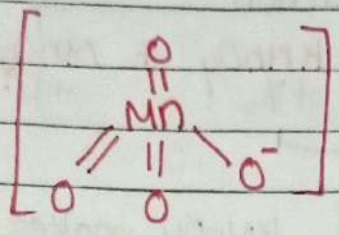
2. Solubility:
slightly soluble in water & more soluble in hot water.

3. In presence of heat they break into.

$KMnO_4 \xrightarrow{513\,K} K_2MnO_4 + MnO_2 + O_2$

3. They are good oxidizing agent. These chemical properties discussed later.

Structure - Tetrahydral



⇒ Chemical Properties

- In different medium they show diff. properties

– In acidic medium :-

– It converts into Mn^{+2} in acidic medium & equalent weight is 31.6 g

$$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{+2} + 4H_2O$$

$$\text{eq. wt.} = \frac{\text{Mw}}{\text{Val}} = \frac{158}{5} = 31.6\ g/l.$$

⇒ In basic / alkali medium

– In basic medium it converts into MnO_4^- & eq. weight is ~~###~~ 158 g.

$$MnO_4^- + 2OH^- + e^- \longrightarrow MnO_4^{-2} + H_2O + [O]$$

$$\text{eq. wt} = \frac{\text{mw}}{\text{Val}} = \frac{158}{1} = 158\ g/l$$

- In neutral medium

In neutral medium it gives MnO_2.

$MnO_4^- + 2H_2O + 3e^- \longrightarrow MnO_2 + 4OH^-$

eq. weight = $\frac{mw}{\text{valency}} = \frac{158}{3} = 52.67\ g$

Note: It is clarified by above rxn $KMnO_4$ are good in acidic & moderate in neutral medium. but in basic do not works with its 100% efficiency.

In acidic medium:

(1) $10I^- + 2MnO_4^- + 16H^+ \longrightarrow 2Mn^{+2} + 5I_2 + 8H_2O$

(2) $5Fe^{+2} + MnO_4^- + 8H^+ \longrightarrow Mn^{+2} + 5Fe^{+3} + 4H_2O$

(3) $5C_2O_4^{-2} + 2MnO_4^- + 16H^+ \longrightarrow 2Mn^{+2} + 10CO_2 + 8H_2O$

(4) $5S^{-2} + 2MnO_4^- + 16H^+ \longrightarrow 2Mn^{+2} + 5S + 8H_2O$

(5) $5NO_2^- + 2MnO_4^- + 6H^+ \longrightarrow 2Mn^{+2} + 5NO_3^- + 3H_2O$

(6) $5SO_3^- + 2MnO_4^- + 6H^+ \longrightarrow 2Mn^{+2} + 5SO_4 + 3H_2O$

In neutral medium:-

(1) $2MnO_4^- + H_2O + I^- \longrightarrow 2MnO_2 + 2OH^- + IO_3^-$

(2) $8MnO_4^- + 3S_2O_3^- + H_2O \rightarrow 8MnO_2 + 2OH^- + 6SO_4^{-2}$

(3) $2MnO_4^- + 3Mn^{+2} + 2H_2O \rightarrow 5MnO_2 + 4H^+$

Brice
Page:
Date: / /

⇒ Uses :-
- Used in analytical chemistry.
→ Used as bleaching of wool, cotton, silk, textile
→ decolorisation of oils etc.
→ Used as germicides & disinfectant.
→ A very dil. sol^n of $KMnO_4$ used as gargling for ~~moth~~ mouth sore
→ Also used in purifing water of stinking wells
→ In laboratory ^oH is called as Baeyers reagent

→ F block elements

The inner transition elements, ~~&~~ f-block consist of the two series of 14-14 elements starts from Ce and end ~~from~~ at Lu. These series of element contains two important series which is called lanthanoids & actanoids

→ Lanthanum & Actinium does not put in f-block elements. They are truly d-block element which is from 3rd ~~gue~~ group.

→ Study of actanoids does not easier because they are highly radioactive, thats why after uranium are called Trans-uranium elements & used only in atomic bomb or nuclear energy ~~de~~ developing, fuel which is used in nuclear reactor, Breeder reactor.

Brice
Page :
Date : / /

• Lanthanoids

→ Lanthanoids are elements which are found between third & fourth group of d-block.

→ The name lanthanoids are given as because they are starting from lanthanum.

→ They are the elements which common electronic configration are $6s^{0-2}\ 5d^{0-1}\ 4f^{1-14}$

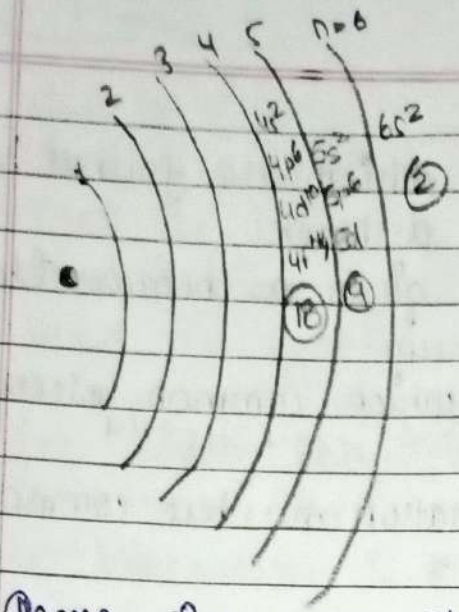
→ They show variable oxidation no. but common oxidation no. are +2 & +3.

→ Atomic & Ionic size:-

from going left to right in the series size are always decreases because from going left to right z-effective increases & net attraction force also increases thats why size decreases. One more reason the effect are called Lanthanoid contractions.

→ Lanthanoid contractions :-

1) It is a unique feature which only found in lanthanoid & actinoids. In this pubperty when electrons enter in f subshell, there d subshell are completely filled with $10e^-$ due to that reason there is a shield / screen of 18 electrons [extra 10 electrons of d-block or d-subshell] due to that reason there a layer of electrons directly attracted by the nucleous & the size will shrink and their effect on 6s & 5f are negligible.



$Z_{eff} = Z - \sigma$ ... rep. for by elec.
↓
att. force
by nucle.

2) There size are shrink up to thats why the size of Zr, Hf are approx. same

3) Oxidation state
They show $^{+2}$ & $^{+3}$ configuration but still some element show +4 configration.
eg:- Ce^{+4}
Some other element which is found in +4,
Tb, Pr, Nd, Dy.
Yb^{+2} have f^{14} but they show reducing property

3) General characteristic
2) All lathanoid are silvery white, soft metal & tarnishing rapidly in air.
2) from going left to right hardness increases, samarium (62) are steel hard.
2) Boiling point Melting point → 1000 − 12,00K
Sm has 1623K.
2) Good conductor of heat & electricity.
2) density increases from left to right
Eu - Yb ↑
Sm - Tm ↓

⇒ They are mostly colourless while they have f^0 & f^{14} configuration
La^{+3} & Ce^{+4} f^0
Yb^{+2} Lu^{+3} f^{14}] colourless

⇒ They all are paramagnetic.

⇒ The first ionization enthalpy of lanthanoid are around 600 KJ/mol & 2nd are around 1200 KJ/mol which is approximately equal to Calcium & 3rd ionization enthalpy is higher than other 2 because electrons remove from 4S orbital but exceptionally some element have higher third Ip because of half filled and fulfilled f-orbital.

⇒ Oxidation no.
They show +3 configuration.

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

⇒ Chemical properties :—

(1) React with acid :

$$Ln + 3HCl \longrightarrow LnCl_3 + \frac{3}{2} H_2$$

(2) React with halogen :

$$Ln + X_2 \longrightarrow LnX_3$$

(3) Reaction with carbon : [Exception]

$$Ln + C \xrightarrow{2273K} \underset{(Ln)}{LnC_2}$$

4) React with N_2 :

$$2Ln + N_2 \longrightarrow 2LnN$$

(5) React with sulphur

$2Ln + 3S \longrightarrow Ln_2S_3$

(6) React with air

$Ln + O_2 \longrightarrow Ln_2O_3$

* These oxides are basic in nature that's why if they react with water they give-

$Ln + 3H_2O \rightarrow Ln(OH)_3 + 3/2\ H_2$

* Generally these all oxides are basic in nature

*

⇒ Alloy formation

Lanthanoid is very famous for production of alloy with steel for making of plates & pipes.

- Mish Misch metal

95% La, 5% Iron, trace amount of Si, C, Ca, Al

- It is used as magnesium based alloy which is used for making bullets, shell and lighter flint

Mixed oxides of lanthanoid are used as catalyst in petrolium cracking

- Some (Ln) oxides are used as phosphors in television screen and in ~~floro~~ fluorescing surface.

phosphors :- solid which ~~emit~~ emmited light
flourescing :- surface which are brighter then other

⇒ Actinoids.

- They contain 14 elements Th - Lr..
- They all radioactive & there half life are approximately many years to 3 minutes.

→ electronic configuration : $5f^{1-14}$ $7s^{1-2}$ $6d^{0-1}$ $5f^{1-14}$

- The study of actinoids as compared to lanthanoid are more tougher because there members are found in only nano-gram quantity & all are radioactive.
- $5f^0, 5f^7, 5f^{14}$ are stable configuration.
ex :- Am & Cm both have f^7 configuration

⇒ Ionic and atomic size

from going left to right ionic size decreases due to actinoids contraction

- Reasons :- Screening effect of 5f

⇒ In lanthanoid & actinoid, lanthanoid contract more due to the poor shelding effect of 4f.

⇒ The Ac contraction is more than La contraction coz 5f $e^{\ominus}$ are more poorly shelding than 4f.

Brice
Page :
Date : / /

⇒ Uses / Application of f-& d block

1. Iron & steel are most important for construction material.
2. There main use are making of alloy with Cr, Mn, Ni
3. TiO_2 are used as pigmentation industries & MnO_2 used as dry cell.
4. Zn, Ni/Cd are also used in battery industries.
5. Group 11 Cu, Ag & Au. used as making of coins by Taksar that's why they are called coinage metal.
6. V_2O_5, making of H_2SO_4 from SO_2.
7. $TiCl_4 + Al(CH_3)_3$ combine & called Ziegler nata catalyst which is used in making of polyethene.
8. Iron catalyst is used as convertion of ammonia from H_2 & N_2 that Habber's process.
9. PdCl2 convert ethyne to ethanal called Walker's process
10. Nickel complex used as polymerization of alkynes & benzene.
11. AgBr used ~~to~~ in making relies and light sensitive device in photography industries

Brice
Page
Date / /

Questions

Q. Match the catalyst with the process

CATALYST	PROCESS
1. V_2O_5	I. The oxidation of ethyne to ethanal
2. $TiCl_4 + Al(CH_3)_3$	II. Polymerisation of alkynes
3. $PdCl_2$	III. Oxidation of SO_2 in the manufacture of H_2SO_4
4. Nickel complexes	IV. Polymerisation of ethylene

Which of the following is the correct option:

Ans: 1-III, 2-IV, 3-I, 4-II

Que. The calculated spin only magnetic moment of Cr^{2+} ion is- [NEET (Sep.) 2020]

(a) 4.90 BM (b) 5.92 BM (c) 2.84 BM (d) 3.87 BM.

$Cr^{+2} - 3d^5 4s^1$

$3d^4 -$ | 1 | 1 | 1 | 1 | |

$n = 4$

$\sqrt{4(4+2)}\,BM = \sqrt{24}\,BM = 5\,BM$ //

Que. In the following pair, the one in which both transition metal ions are colourless is:

(a) Sc^{3+}, Zn^{2+} (b) Ti^{3+}, Cu^{2+} [JEE Main P-II, 2022]

(c) V^{2+}, Ti^{3+} (d) Zn^{2+}, Mn^{2+}

Brice
Page :
Date : / /

Qu. Which of the following 3d- metal ion will give the lowest enthalpy of hydration ($\Delta_{hyd}H$) when dissolved in water? [JEE Main 2022]

(a) Cr^{2+} d^4 - 40p (b) Mn^{2+} d^5 50p

(c) Fe^{2+} d^6 - 40p (d) Co^{2+} d^7 30p

Que. Composition of gun metal is: [JEE Main P-I, 2021]

(a) Cu, Zn, Sn (b) Al, Mg, Mn, Cu

(c) Cu, Ni, Fe (d) Cu, Sn, Fe

Que. Cast iron is used for the manufacture of: [JEE Main P-II, 2020]

a) ~~W~~

b) Wrought iron & steel

c) Wrought iron, pig iron & steel.

d) Wrought iron & pig iron

e) pig iron, scrap iron & steel

Que The purest form of commercial iron is: [JEE Main P-II 2020]

a) Wrought iron

b) Scrap iron & pig iron

c) pig iron

d) Cast iron

Que. Atomic radius of Ag is similar to: [JEE M(P-I) 2020]

(a) Cu (b) Hg (c) Au (d) Ni

Que. Galvanization is applying a coating of: [JEE M 2016]

a) Pb b) Cr c) Cu d) Zn

Que. When neutral or faintly alkaline $KMnO_4$ is treated with potassium iodide, iodide ion is converted into 'X'. X is :- [Neet 2019]

a) I_2 (b) IO_4^- (c) IO_3^- (d) IO^-

$I^- \rightarrow KMnO_4$ — Acidic $- I_2$ (5e)

Neutral IO_3^- (3e)

Que. Match the ~~columns~~ metal ions given in column I with the spin magnetic moments of ion given in CII & assign the correct code [NEET 2018]

Column I	Column II
(1) $Co^{3+} \rightarrow d^6$ - 4 up.	(i) $\sqrt{8}$ BM
(2) $Cr^{3+} \rightarrow d^3$ - 3 up	(ii) $\sqrt{35}$ BM
(3) Fe^{3+} d^5 - 5 up	(iii) $\sqrt{3}$ BM
(4) Ni^{2+} d^8 - 2 up	(iv) $\sqrt{24}$ BM
	(v) $\sqrt{15}$ BM

or

	1	2	3	4
(a)	iv	i	ii	iii
(c)	iv	v	ii	i

	1	2	3	4
(b)	i	ii	iii	iv
(d)	iii	v	i	ii

U.P.

$\sqrt{3}$ BM = 1

$\sqrt{8}$ BM = 2

$\sqrt{15}$ BM = 3

$\sqrt{24}$ BM = 4

$\sqrt{35}$ BM = 5

Bricc
Page
Date / /

Que. Which one of the following ions exhibits d-d transition & paramagnetism as well? [NEET 2018]

(a) MnO_4^- (b) $Cr_2O_7^{2-}$ (c) CrO_4^{2-} (d) MnO_4^{2-}

(a) MnO_4^- ↓ $+7, d^0$ (b) $Cr_2O_7^{2-}$ ↓ $+6; d^0$ (c) CrO_4^{2-} ↓ $+6, d^0$ (d) MnO_4^{2-} ↓ $+6, d^1$

Que. Magnetic moment 2.84 BM is given by [At. no. Ni = 28, Ti = 22, Cr = 24, Co = 27). (AIPMT 2015, 14)

(a) Ni^{2+} (b) Ti^{3+} (c) Cr^{3+} (d) Co^{2+}

(a) Ni^{2+} $d^8 s^2$ 2 up. $\sqrt{8} = 2.4$ BM

Que. For the 4 successive transition elements (Cr, Mn, Fe & Co) the stability of +2 oxidation state will be there in which of the following order? [AIPMT 2011] (At. no. Cr = 24, Mn = 25, Fe = 26, Co = 27)

(a) Fe > Mn > Co > Cr

(b) Co > Mn > Fe > Cr

(c) Cr > Mn > Co > Fe

(d) Mn > Fe > Cr > Co

Fe → $d^6 s^2$ → d^6

Mn → $d^5 s^2$ → d^5

Co → $d^7 s^2$ → d^7

Cr → $d^5 s^1$ → d^4

Brice
Page:
Date: / /

Que. Which one of the following ions has e⊖ config. $[Ar]\,3d^6$?
[At no Mn = 25, Fe = 26, Co = 27, Ni = 28]
[AIPMT 2010]

(a) Ni^{3+} ↓ $d^6 s^2$ or d^7
(b) Mn^{3+} ↓ $d^4 s^2$ or d^5
(c) Fe^{3+} ↓ $d^5 s^2$ or d^4
(d) ~~Co^{3+}~~ ↓ $d^7 s^2 \rightarrow d^6$

Que. Which of the following pairs both the ions coloured in aqueous soln?
At no. - Sc = 21, Ti = 22, Ni = 28, Cu = 29, Co = 27
(a) Ni^{2+}, Ti^{3+}
(b) Sc^{3+}, Ti^{3+}
(c) Sc^{3+}, Co^{2+}
(d) Ni^{2+}, Cu^{+}

Que. On what ground can you say that scandium (Z = 21) is transition element but zinc (Z = 30) is not.
$\{Sc^{+2}, Sc^{+3}\}$ - multiple O.no. ⇒ Transition
Zn^{+2} → only one O.no. ⇒ Non Transition

Zn^{2+} salts are white while Cu^{2+} salts are coloured why?
$Zn^{2+} \rightarrow d^{10} \rightarrow$ paired — colourless
$Cu^{2+} \rightarrow d^9 \rightarrow$ unpaired — colourfull

Brice
Page
Date : / /

Que. Explain giving reasons:
Transition metals & their compounds generally exhibit a paramagnetic behaviour.

Ans:- d^0 - d^{10} - only condition of dimagnetic rest all are paramagnetic.

Que. What is meant by disproportion? Give example of a disproportion rxn in aqueous soln.

Ans:- $MnO_4^{-2} \longrightarrow MnO_2 + MnO_4^{-}$

+6 (red. → +4) (oxidation → +7)

= when one element has 3 oxidation no. & the same element's oxidation & reduction will take place that is disproportion rxn.

Que. Assign a reason for each of the following
(i) Transition metals (with the exception of Zn, Cd & Hg) are hard & high melting & boiling point.
due to lot of unpaired electrons in d-orbital
(ii) The ionization enthalpies (1st & 2nd) in the first series of the transition elements are found to vary irregularly.
= d^5 & d^{10} configration
size → ↓Mn → Fe — Ni same, Cu-same Zn↑

Que. Assign ~~the~~ reasons
(i) Cu(I) ion is not known to exist in aqueous sol'n.

$Cu^{+} \longrightarrow Cu + Cu^{+2}$ — very high hydration energy

+1 (red. → 0, ox. → +2)

(2) Transition elements are much harder than the alkali metals.

volume ↓ density ↑

Que (i) which metal in first transition series (3d - series) exhibits +1 oxidation state most frequently & why?

⇒ $Cu^+ \rightarrow d^{10}s^1 \rightarrow d^{10}$ - stable configration.

(ii) which of the following cations are coloured in aqueous soln & why?

Sc^{3+}, V^{3+}, Ti^{4+}, Mn^{2+}

d^0 d^1 d^0 d^5 of

C.L. C.F. C.L

Que. Give reason

(1) Sc (21) is transition element but Ca (20) is not.

(1) d^1 last electron / d end

(2) Ca d not present, Sc $\begin{matrix} +2 \\ +8 \end{matrix}$

I +2

(ii) The Fe^{2+} is much more easily oxidised to Fe^{3+} than Mn^{2+} to Mn^{3+}

d^5 stable

Brice
Page
Date : / /

Que. Compare the chemistry of the actinoids with that of lanthanoids with reference to
(1) electronic configration
(2) oxidation states
(3) chemical reactivity

Ans:- (1) La → $6s^{0-2}\ 5d^{0-1}\ 4f^{1-14}$ → $4f^{1-14}, 5d^{0-1}, 6s^{0-2}$
Ac → $7s^{0-2}\ 6d^{0-1}\ 5f^{1-14}$ → $5f^{1-4}\ 6d^{0-1}\ 7s^{0-2}$

(2) La :- +2, +3, +4
Ac :- +3, +4

(3) Both are highly reactive.

Que. Why do actinoids show wide range of oxidation states? Write one similarity between the chemistry of lanthanoids and actinoids.

Ans:- The actinoid contraction is more than lanthanoid contraction coz 5f electron are more poorly shielding than 4f electron.
Only magnetic property & colour property are same in lanthanoid & actinoid.

Que. Explain giving reasons:
The chemistry of actinoids is not smooth that of lanthanoids.

Ans:- (1) Actinoid are radioactive.
(2) They are found in very trace amount in nature.
(3) They show very high oxidation number.

Brice
Page
Date / /

Que. How would you account for the following:
Actinoid contraction is greater than lanthanoid contraction.
The actinoid contraction is more than lanthanoid contraction because 5f electron are more poorly shielding than 4f.

Que. Name an important alloy which contains some of the lanthanoid metals. Mention its two uses.
→ Misch metal → 95% La, 5% Iron, trace of C, S, Al, Ca
→ Uses:-
a) Magnesium based alloy which is used for making bullet, shield, lighter flint.

Que. What is lanthanoid contraction? What is its effect on the chemistry of the elements which follow the lanthanoid?
Ans: The steady decreases in the atomic & ionic radius of lanthanoid with increase in atomic no. is called lanthanoid contraction. It is caused due to the imperfect sheilding of nuclear charge by 4f electrons.
The effect of on the chemistry of the lanthanoid contraction are size of (Zr), (Hf) are approximately same.

Brice
Page
Date

Que:- Explain the following observations:
La^{3+} (Z=57) & Lu^{3+} (Z=71) do not show any colour in solutions.
La^{3+} → f^0 configration — all are pair
Lu^{3+} → f^{14} configration — all are pair
[colourless]

Que. Account for the following:
Zr & Hf have almost similar atomic radii.
Ans. due to the lanthanoid contraction.

Que. Complete the following eq^{n}s:-
(1) $Cr_2O_7^{2-} + 2OH^- \longrightarrow 2CrO_4^{-2} + H_2O$
(2) $MnO_4^- + 4H^+ + 3e^- \longrightarrow MnO_2 + 2H_2O$

Que. Complete the eq^{n}s:-
(1) $2MnO_4^- + 5S^{2-} + 16H^+ \longrightarrow 5S + 2Mn^{+2} + 8H_2O$
(2) $Cr_2O_7^{2-} + 2OH^- \longrightarrow 2CrO_4^{-2} + H_2O$

Que. Complete the equations:-
(1) $2CrO_4^{2-} + 2H^+ \longrightarrow Cr_2O_7^{-2} + H_2O$
(2) $2KMnO_4 \xrightarrow{\Delta} K_2MnO_4 + MnO_2 + O_2$

Que. Complete the following chemical reactions:
(1) $8MnO_4^- + 3S_2O_3^{2-} + H_2O \longrightarrow 8MnO_2 + 2OH^- + 6SO_4^{-2}$
(2) $Cr_2O_7^{2-} + 3Sn^{2+} + 14H^+ \longrightarrow 2Cr^{3+} + 3Sn^{4+} + 7H_2O$

Brice
Page:
Date: / /

Que: Complete the following equations:-

$2MnO_4^- + 6H^+ + 5NO_2^- \rightarrow 5NO_3^- + 3H_2O + 2Mn^{+2}$

Que: Complete the following eq^ns :-

$3MnO_4^{2-} + 4H^+ \rightarrow Mn^{+2} + 2MnO_4^- + 2H_2O + O_2$

Que:- Complete the following eq^n —

$MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{+2} + 4H_2O$

Que. Complete the following

$SO_2 + MnO_4^- + 2H_2O \rightarrow 2SO_4^{-2} + Mn^{+2} + 4H^+$

Que. Explain the following:

(1) Copper(I) ion is not stable in an aqueous soln.

(2) With same d^4 configration Cr(II) is reducing whereas Mn(III) is oxidising.

(3) Transition metals in general act as good catalyst.

(1) $Cu^+ \longrightarrow Cu^{+2} + Cu$

+1 +2 0

ox

red.

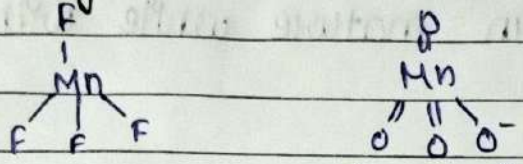
(2) Cr(II) – E° = -ve, ∴ reducing agent, Mn(III) is oxidizing agent

(3) catalyst — variable oxidation no.
— provide surface to reactent.

Que. Account for the following:-

(a) Mn shows the highest oxidation state of +7 with oxygen but with flourine, it shows the highest oxidation state of +4.

Ans.



- The valancey of F is 1 & max. capacity to hold element by Mn are 4.
- The valancy of O are 2. Thats why Mn show +7 oxidation state oxygen & with +4 with F.

(2) Cr^{2+} is strong reducing agent.

(2) Cr^{+2} are strong reducing agent coz its $E^{\ominus}$ is -ve

(3) Cu^{2+} salts are produced coloured, while Zn^{+2} are white.

(3) Cu^{2+} have d^9 configration with one unpaired $e^{\ominus}$ thats why its is colourfull d^{10} configration of Zn^{+2} thats why it is colourless.

Que Account the following:

(1) Mn^{+2} compounds are more stable than Fe^{2+} compound towards oxidation to thier +3 state.

Ans.

$Fe^{+3} \longrightarrow Fe^{+2}$

$d^5 \qquad d^6$

$Mn^{+3} \longrightarrow Mn^{+2}$

$d^4 \qquad d^5$

(2) Cr^{2+} is reducing & Mn^{3+} oxidizing when both have d^4 configration

$Cr^{2+} \Rightarrow E^\circ = -ve$, $Mn^{3+} \Rightarrow E^\circ = +ve$

Que. Cr^{2+} is reducing in nature while with the same d-orbital configration (d^4) Mn^{3+} is an oxidizing agent

Que: In transition series of metal, the metal which exhibits states occurs in the middle of the series Middle element contain lot of u.p. electron that's why they show max. O.S

eg:- Mn, Os, Ru