PARISHRAM

2026

D & F Block Elements

CHEMISTRY LECTURE-1

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

- Electronic Configuration

Introduction and Electronic Configuration of d - Block Elements

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100/100 ✓ 95

1. Parishram batch ✓
2. Class notes. (NCERT) ✓
3. VIJETA ✓
4. MAHA MARATHON. ✓
5. Last Day Revision. ✓
6. U-Am Class

Reactions.

↓

Tough.

1. 11th Basic ✓
2. Electronics configuration.
3. NCERT Imp. points
   ↓
   Bishbhaiya Notes.
4. BKT
5. BKT*

1. d & f block.
2. coordination chemistry.

1. Class notes. (NCERT, Examples).
2. CBSE PYQ.
3. Test.
4. NCERT Questions.

100/100

Complete Solution

BKT → Brijendra kumar Trick.

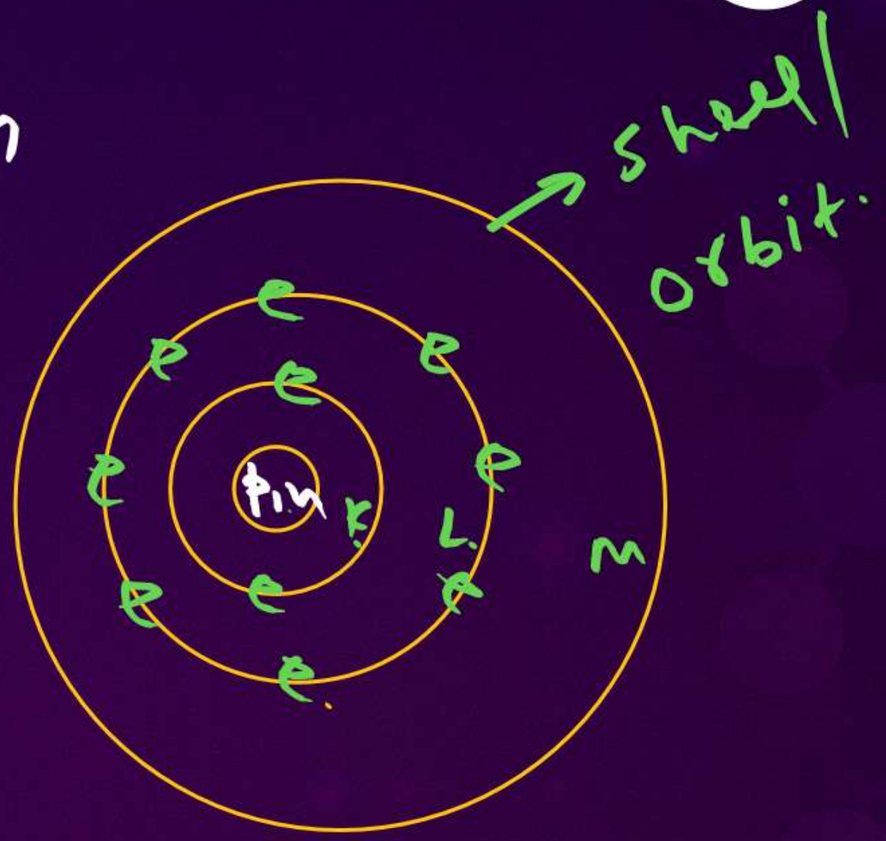
* concept of shell/subshell.

* Nucleus → proton & Neutron

↓

charge (+)ve zero

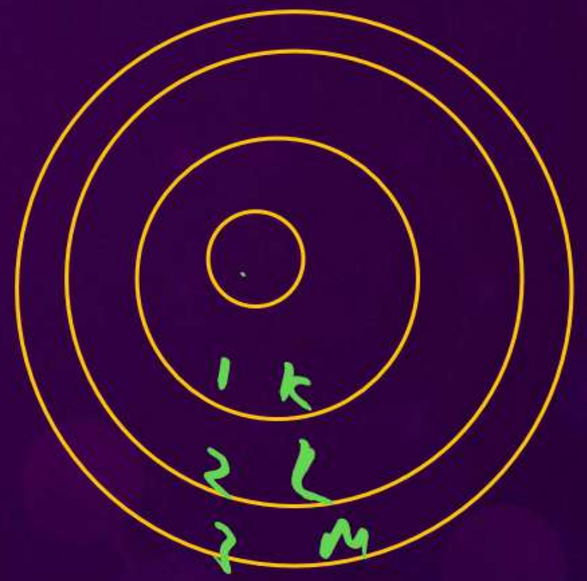
* electron → −ve charge



Shell/orbit	Subshell	orbital
colony	building	Room
KBR	ABC	420
N	P	p_x

K, L, M, N	s, p, d, f	p_x, p_y, p_z, d_{xy}, $d_{x^2-y^2}$
1, 2, 3, 4		

Shell/orbit	Sub shell	Orbital
$n=1$, K	s	
$n=2$, L	s, p	no. of sub shell = shell no.
$n=3$, M	s, p, d	
$n=4$ N	s, p, d, f	



10. No. of Sub shell in shell no = 7.

(a) 6

(b) 7

(c) 8

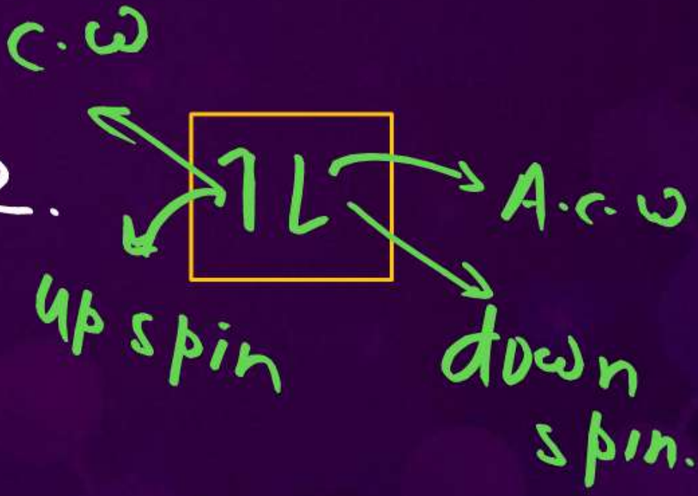
(d) none.

= 7

* s sub shell

→ shape → spherical s

→ no. of orbitals in s = 1

→ no. of electrons in an orbital = 2. 

electron ← shell sub shell orbital spin

→ s → shape → spherical.

* orbitals = 1

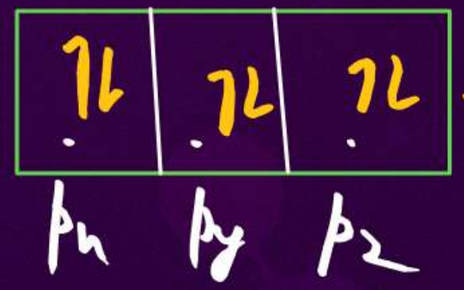
* no. of e in s = 2.

* P sub shell

* shape → dumbell.

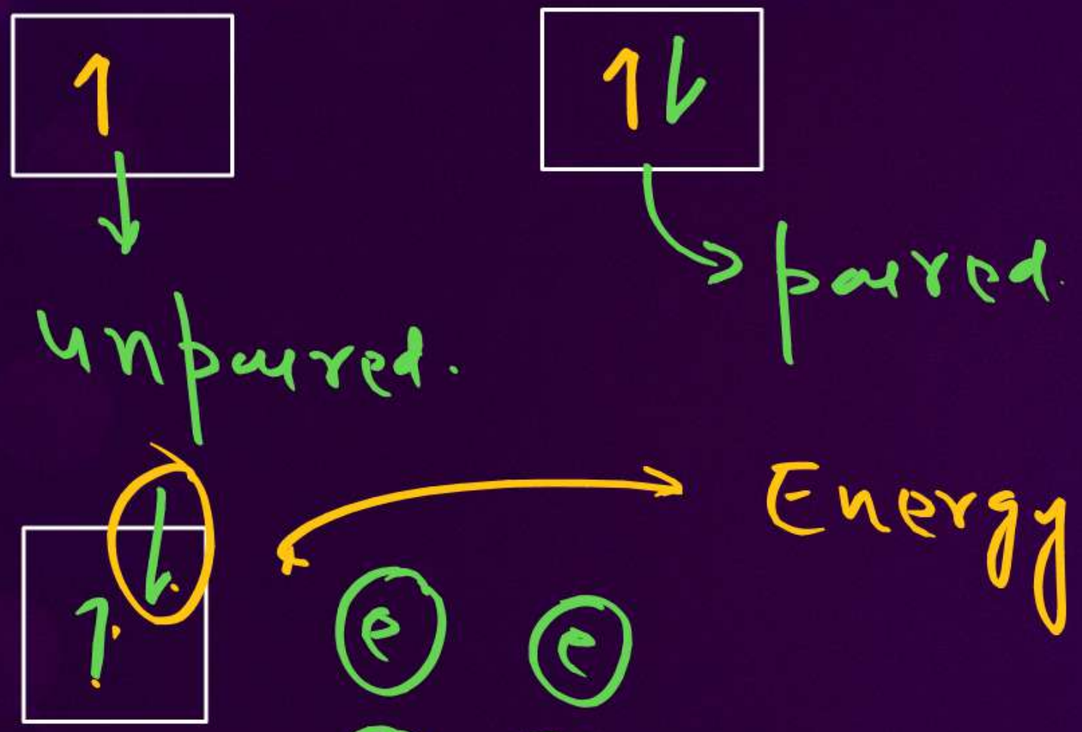
* no. of orbitals in P = 3

p_x, p_y, p_z



→ 6e.

* no. of electrons in p = 6e



Energy is always required for pairing → pairing Energy.

repulsive force.

p^1

1		

p^2

1	1	

✓

1		

✗

p^3

1	1	1

1	1	

✗

p^4

1	1	1

Attractive force

↓

Automic.

↓

Energy releases.

repulsive force

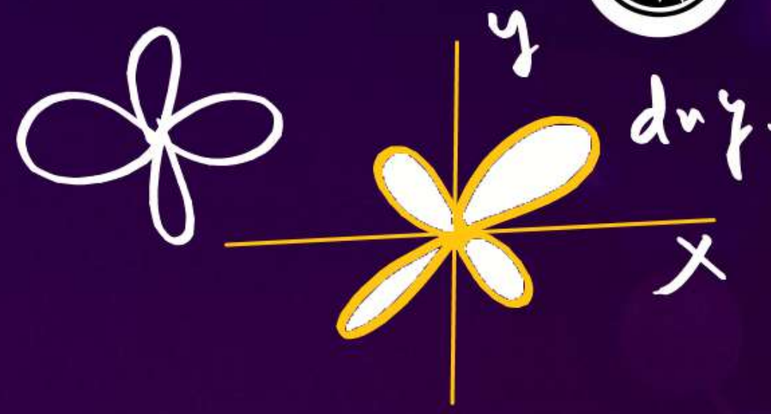
↓

Energy required.

Energy dena parega.

* d orbital

Shape → double dumbell



* no. of orbitals in d = 5
* no. of electrons in d = 5×2
= 10e

↑↓	↑↓	↑↓	↑↓	↑↓

d_{xy} d_{yz} d_{xz}

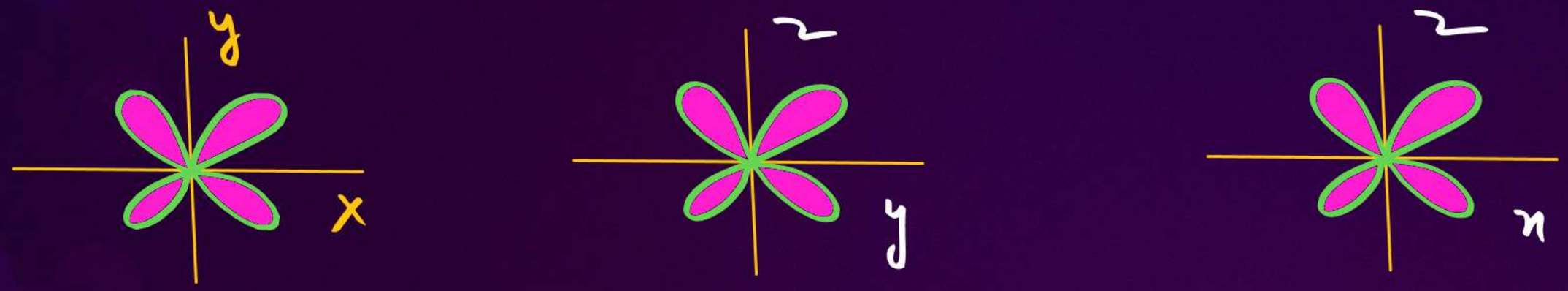
S → 1

p → 3

d → 5

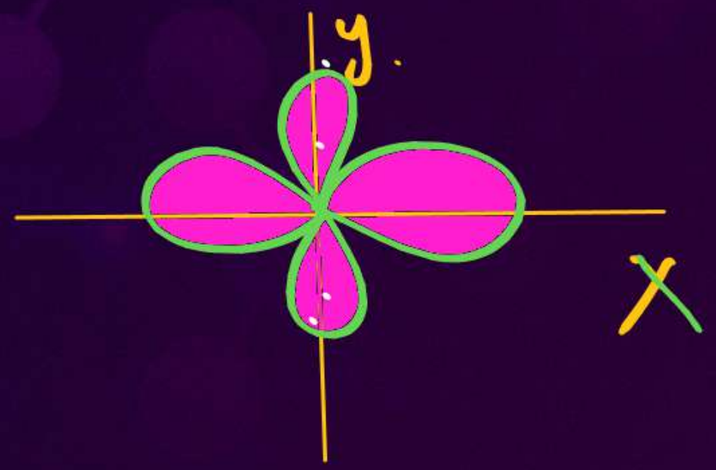
f → 7.

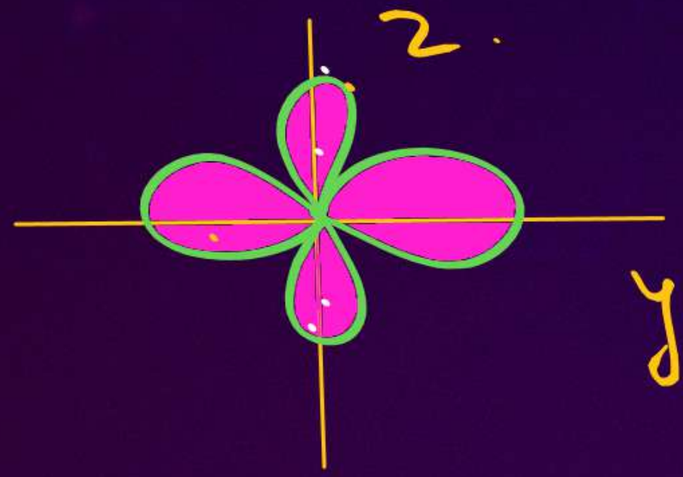
d_{xy} d_{yz} d_{xz}



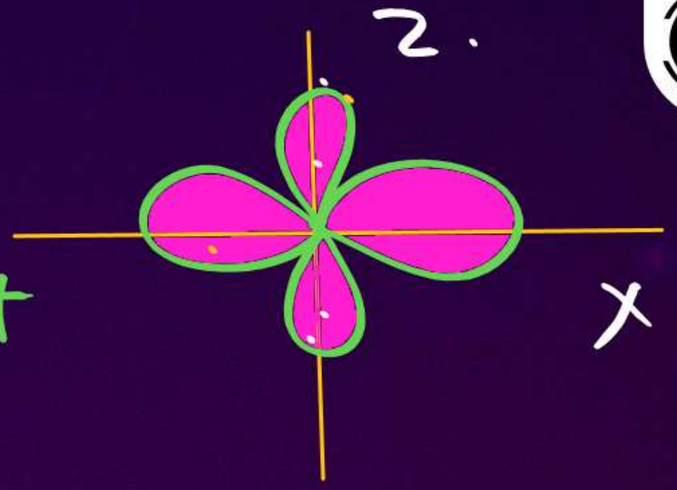
d_{xy}. d_{yz} d_{xz}

b/w the axis.





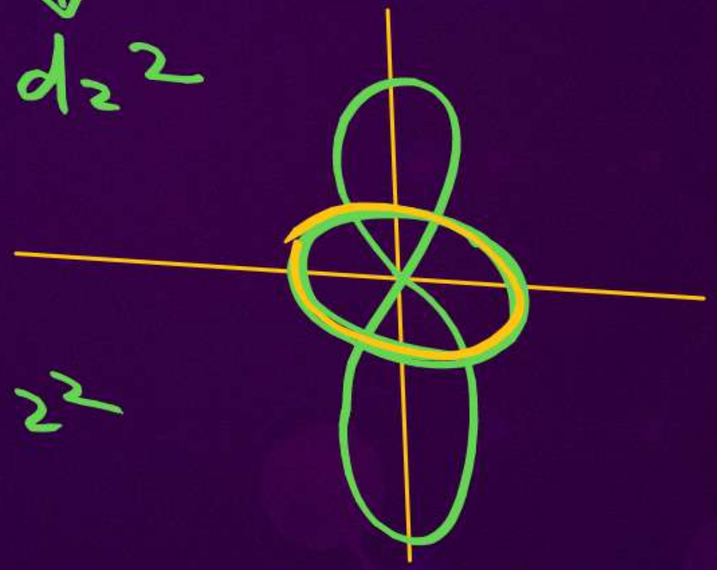
+



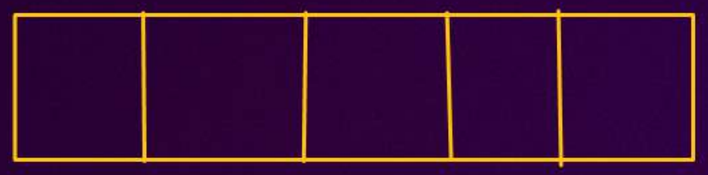
$d_{x^2-y^2}$ $\quad$ $d_{y^2-z^2}$ $\quad$ $d_{x^2-z^2}$

on the axis

d_{z^2}



$$d_{z^2} = d_{y^2-z^2} + d_{x^2-z^2}$$



d_{xy} d_{yz} d_{xz} $d_{x^2-y^2}$ d_{z^2}

b/w the axis

on the axis

t_{2g}

e_g

f sub shell

↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓

no of orbitals
= 7

no. of electrons = 14.

Home Work

→ Class notes.

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2026

D & F Block Elements

CHEMISTRY LECTURE-2

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Topic Covered

- **Electronic Configuration-**

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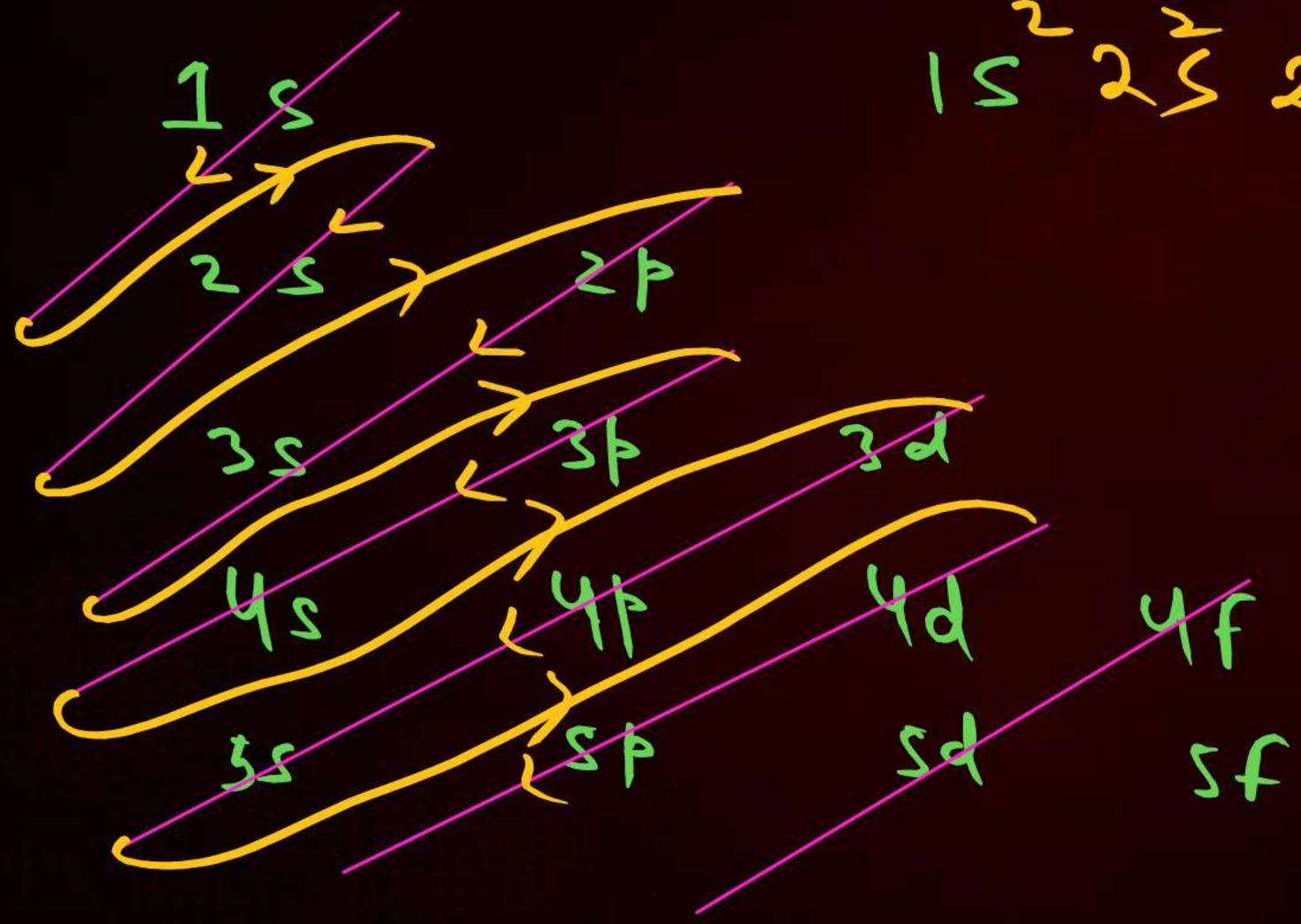
	orbitals	electron
s →	1	2
p →	3	6
d →	5	10
f →	7	14

Electronic configuration



$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}$

BKT for EC

1s 2s 2p 3s 3p 4s

3d 4p 5s 4d 5p 6s

4f 5d 6p 7s 5f 6d 7p 8s

s → 1
p → 2
d → 3
f → 4

$H_1 \rightarrow 1s^1$

$He^*_2 \rightarrow 1s^2$

$Li_3 \rightarrow 1s^2 2s^1$

$Be_4 \rightarrow 1s^2 2s^2$

$B_5 \rightarrow 1s^2 2s^2 2p^1$

$C_6 \rightarrow 1s^2 2s^2 2p^2$

$N_7 \rightarrow 1s^2 2s^2 2p^3$

$O_8 \rightarrow 1s^2 2s^2 2p^4$

$F_9 \rightarrow 1s^2 2s^2 \underline{2p^5}$

$Ne^*_{10} \rightarrow 1s^2 2s^2 \underline{2p^6}$.

$Na_{11} \rightarrow \boxed{1s^2 2s^2 2p^6} 3s^1$

[Ne] $3s^1$

$Mg_{12} \rightarrow 1s^2 2s^2 2p^6 3s^2$

$Al_{13} \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^1$

Si_{14} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

P_{15} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

S_{16} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

Cl_{17} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

Ar_{18}^{*} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

K_{19} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$

Ca_{20} $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

$[Ar]\ 4s^2$

Sc^{*}_{21} $[Ar]\ 4s^2\ 3d^1$

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ \underline{3d^1}$

BKT → last e Jis subshell me Jata hai → element usi block ka ho Jata hai

d → 10 e

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
21	22	23	24	25	26	27	28	29	30
Sano	Tum	Viyah	kar lo	Mujhse	fir	koi	Nhi	kahega	Zanu.

1st series.

2nd series.

Y Zr Nb Mo Tc Ru Rh Pd Ag Cd

Yar Zaroori Nhi Mohabbat Tujhe Rulati Rahe padhega Agar chemistry

3rd series.

La Hf Ta W Re Os Ir Pt Au Hg

La Hafta Warna Re Udhar Idhar pitay; Aur Hogi

Inert gas / Nobel gas / Rare gas.

He → Heen

Ne → Neeng

Ar → Aur

Kr → Karing

Xe → Ja

Rn → Re

Sc_{21} $[Ar]\ 4s^2\ 3d^1$

Ti_{22} $[Ar]\ 4s^2\ 3d^2$

V_{23} $[Ar]\ 4s^2\ 3d^3$

Cr^*_{24} $[Ar]\ 4s^2\ 3d^4$ ✗

$4s^1\ 3d^5$

Total e in d = 10

$10/2 = 5e$

Half filled

d^5 is more stable than d^4

↑	↑	↑	↑	

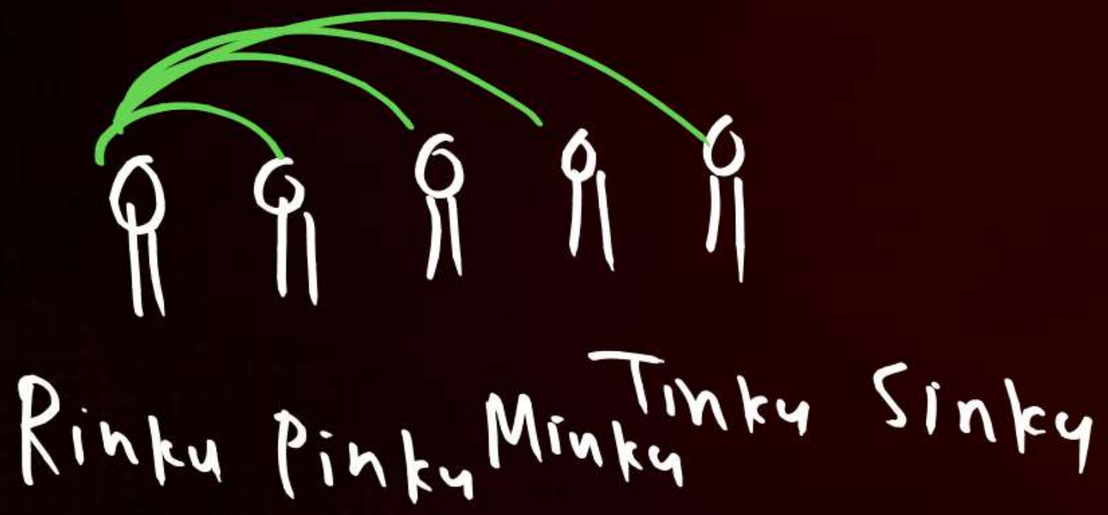
d^4

↑	↑	↑	↑	↑

d^5

Exchange energy.

$$\text{stability} \propto \frac{1}{\text{Energy}}$$



* Half filled is more stable because of more exchange energy.

$Cr^*_{24} \longrightarrow [Ar]\,4s^1\,3d^5$

Mn_{25} $[Ar]\,4s^2\,3d^5$

Fe_{26} $[Ar]\,4s^2\,3d^6$

Co_{27} $[Ar]\,4s^2\,3d^7$

Ni_{28} $[Ar]\,4s^2\,3d^8$

Cu^*_{29} $[Ar]\,4s^1\,3d^{10}$

↑↓	↑↓	↑↓	↑↓	↑↓

d^{10}

↓

fully filled is more stable.

Zn_{30} $4s^2\,3d^{10}$.

BKT → e hamesa last shell se Nikala Jata hai

* Fe^{+2}

$Fe_{26} \xrightarrow[-2e]{} Fe^{+2}$

$4s^2\ 3d^6$ → last shell

$4s^0\ 3d^6$

Fe^{+3} → $4s^0\ 3d^5$

Fe_{26}

$4s^2\ 3d^6$

① Sc^{+2} Sc_{21} $4s^2\ 3d^1$ $Sc^{+2}\ 4s^0\ 3d^1$

② Ti^{+3} Ti_{22} $4s^2\ 3d^2$ $Ti^{+3}\ 4s^0\ 3d^1$

③ V^{+2} V_{23} $4s^2\ 3d^3$ $V^{+2}\ 4s^0\ 3d^3$

④ Cr^{+3} Cr_{24} $4s^1\ 3d^5$ $Cr^{+3}\ 4s^0\ 3d^3$

⑤ Cr^{+} Cr_{24} $4s^1\ 3d^5$ $Cr^{+}\ 4s^0\ 3d^5$

⑥ Mn^{+2} Mn_{25} $4s^2\ 3d^5$ $Mn^{+2}\ 4s^0\ 3d^5$

(7) Mn^{+4} $\quad Mn_{25}$ $\quad 4s^2\ 3d^5 \longrightarrow 4s^0\ 3d^3$

(8) Mn^{+7} $\quad Mn_{25}$ $\quad 4s^2\ 3d^5 \longrightarrow [Ar]\ 4s^0\ 3d^0$

(9) Cu^{+} $\quad Cu_{29}$ $\quad 4s^1\ 3d^{10} \longrightarrow 4s^0\ 3d^{10}$

(10) Cu^{+2} $\quad \longrightarrow 4s^0\ 3d^9$.

(11) Ni^{+2} $\quad Ni_{28}$ $\quad 4s^2\ 3d^8 \rightarrow 4s^0\ 3d^8$

(12) Ni^{+4} $\quad \longrightarrow 4s^0\ 3d^6$

(13) Co^{+2} $\quad$ Co_{27} $\quad$ $4s^2\ 3d^7 \rightarrow 4s^0\ 3d^7$

(14) Co^{+3} $\quad$ $\longrightarrow 4s^0\ 3d^6$

(15) Fe^{+6} $\quad$ $Fe_{26} \rightarrow 4s^2\ 3d^6 \rightarrow 4s^0\ 3d^2$

(16) Zn^{+2} $\quad$ $Zn_{30} \rightarrow 4s^2\ 3d^{10} \rightarrow 4s^0\ 3d^{10}$

(17) Sc^{+3} $\quad$ $Sc_{21} \rightarrow 4s^2\ 3d^1 \rightarrow [Ar]\ 4s^0\ 3d^0$

(18) V^{+5} $\quad$ $V_{23} \rightarrow 4s^2\ 3d^3 \rightarrow [Ar]\ 4s^0\ 3d^0$

(19) Cr^{+4} $\quad Cr_{24}$ $\quad 4s^1\ 3d^5 \xrightarrow{-4e} 4s^0\ 3d^2$

(20) Ni^{+3} $\quad Ni_{28} \rightarrow 4s^2\ 3d^8 \rightarrow 4s^0\ 3d^7$

The last electron which enters the atom of transition element is

d block

A. s-electron

B. p-electron

C. f-electron

D. d-electron

Chromium has the electronic configuration :

A. $3s^2\ 3p^6\ 3d^4, 4s^2$

B. $3s^2\ 3p^6\ 3d^5, 4s^1$

$Cr_{24} \rightarrow$

C. $3s^2\ 3p^6\ 3d^6$

D. none of these

PhysicsWallah
सवाल से ही SELECTION होगा

The number of d electrons in Fe^{2+} (at no. of iron = 26) is equal to :

A → 5

B → 2

C → 4

D → 6

$Fe_{26} \rightarrow 4s^2\, 3d^6$

$Fe^{+2} \rightarrow 4s^0\, 3d^6$

PhysicsWallah
सवाल से ही SELECTION होगा

Which of the following has the maximum number of unpaired d electrons?

A Zn

B Fe^{2+}

C Ni^{3+}

D Cu^{+}

PhysicsWallah
सवाल से ही SELECTION होगा

The electronic configuration of copper is :

A [Ar]$3d^9$, $4s^2$

B [Ar]$3d^{10}$, $4s^1$

C [Ar]$3d^8$, $4s^2$

D [Ar]$3d^{10}$, $4s^2$

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

सवाल से ही SELECTION होगा

Which one of the following is the correct configuration of Fe^{3+} (Z = 26)?

A [Ar] $4s^2, 3d^6$

B [Ar] $4s^2, 3d^3$

C [Ar] $3d^5$

D [Ar] $4s^2, 3d^4$

$Fe_{26} \rightarrow 4s^2\ 3d^6$

$Fe^{+3} \rightarrow 4s^0\ 3d^5$

PhysicsWallah
सवाल से ही SELECTION होगा

The electronic configuration, $1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^6$ corresponds to

24

A. Mn^{2+}

B. Cr^{3+}

C. Fe^{2+}

$26 - 2e = 24$

Fe $4s^2\ 3d^6$

$4s^0\ 3d^6$

D. Fe^{3+}

सवाल से ही SELECTION होगा

Q no. of d electrons in Cr^{+3}?

(a) 5

(b) 6

(c) 3 ✓

(d) none.

Cr_{24} $4s^1 3d^5$

$4s^0 3d^3$

5 B.Tech + M.Tech.

60 subjects → 120 Assignments

180 exams.

JEE

↑

$\boxed{10950}$

3 sal JEE

730

365

1095 days → 10 hour

Unpaired electrons.

↓

single electron

d^1 | ↑ | | | | |

→ unpaired $n = 1$

d^2 | ↑ | ↑ | | | | $n = 2$

d^3 | ↑ | ↑ | ↑ | | | $n = 3$

paired electron

↓

2e in an orbital.

| ↑↓ |

↓

paired

d^4

1	1	1	1	

$n = 4$

d^5

1	1	1	1	1

$n = 5$

d^6

1	1	1	1	1

$n = 4$

d^7

1	1	1	1	1

$n = 3$.

d^8

1	1	1	1	1

$n = 2$.

d^9

1	1	1	1	1

$n = 1$

d^{10}

1	1	1	1	1

$n = 0$.

BKT

$d^{1-5} \rightarrow$ unpaired e $n = d(e)$

d^{6-10} $n = 10 - d(e)$

d^1 $n = 1$

d^2 $n = 2$

d^3 $n = 3$

d^4 $n = 4$

$d^5 = 5$

$d^6 \rightarrow n = 10 - 6 = 4$

$d^7 \rightarrow n = 10 - 7 = 3$

$d^8 \rightarrow n = 10 - 8 = 2$

$d^9 \rightarrow n = 10 - 9 = 1$

$d^{10} \rightarrow n = 10 - 10 = 0$

JEE PYQ.

maximum no. of unpaired electrons.

d^{1-5} $n = d(e)$

d^{6-10} $n = 10 - d(e)$

(a) d^8 $10 - 8 = 2$

(b) d^7 $10 - 7 = 3$

✓ (c) d^6 $10 - 6 = 4$

(d) d^3 3

no of unpaired electron in d^4

$n = 4$

no of unpaired electron in d^6

$n = 10 - 6 = 4$

no of unpaired electron in d^9

no of unpaired electron in d^5

5

$\longrightarrow$ d^3 $n = \underline{\underline{3}}$

Home Work

→ unpaired electrons.

Sc ——— Zn.

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2026

D & F Block Elements

CHEMISTRY LECTURE-3

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

- Transition Metal
  Atomic Radius
- Lanthanoid Contraction

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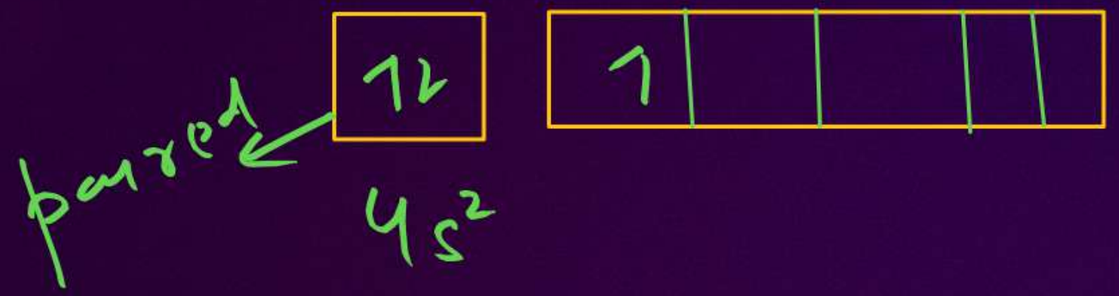
$Sc_{21} \longrightarrow 4s^2\ 3d^1 \longrightarrow n = 1$



Ti_{22} $\quad 4s^2\ 3d^2$

$0 + 2 = 2$

V_{23} $\quad 4s^2\ 3d^3$

$0 + 3 = 3$

BKT

d^{1-5} $\quad n = d(e)$

d^{6-10} $\quad n = 10 - d(e)$

Cr_{24} $4s^1\ 3d^5$

↑	↑	↑	↑	↑	↑

$1 + 5 = 6$

Mn_{25} $4s^2\ 3d^5$

$\downarrow$

$0 + 5 = 5$

Fe_{26} $4s^2\ 3d^6$

$0 + 10 - 6 = 4 = 4$

Co_{27} $4s^2\ 3d^7$

$\downarrow$

0 $10 - 7 = 3$

$3 + 0 = 3.$

Ni_{28} $4s^2\ 3d^8$ $\Longrightarrow 2$

$\downarrow$

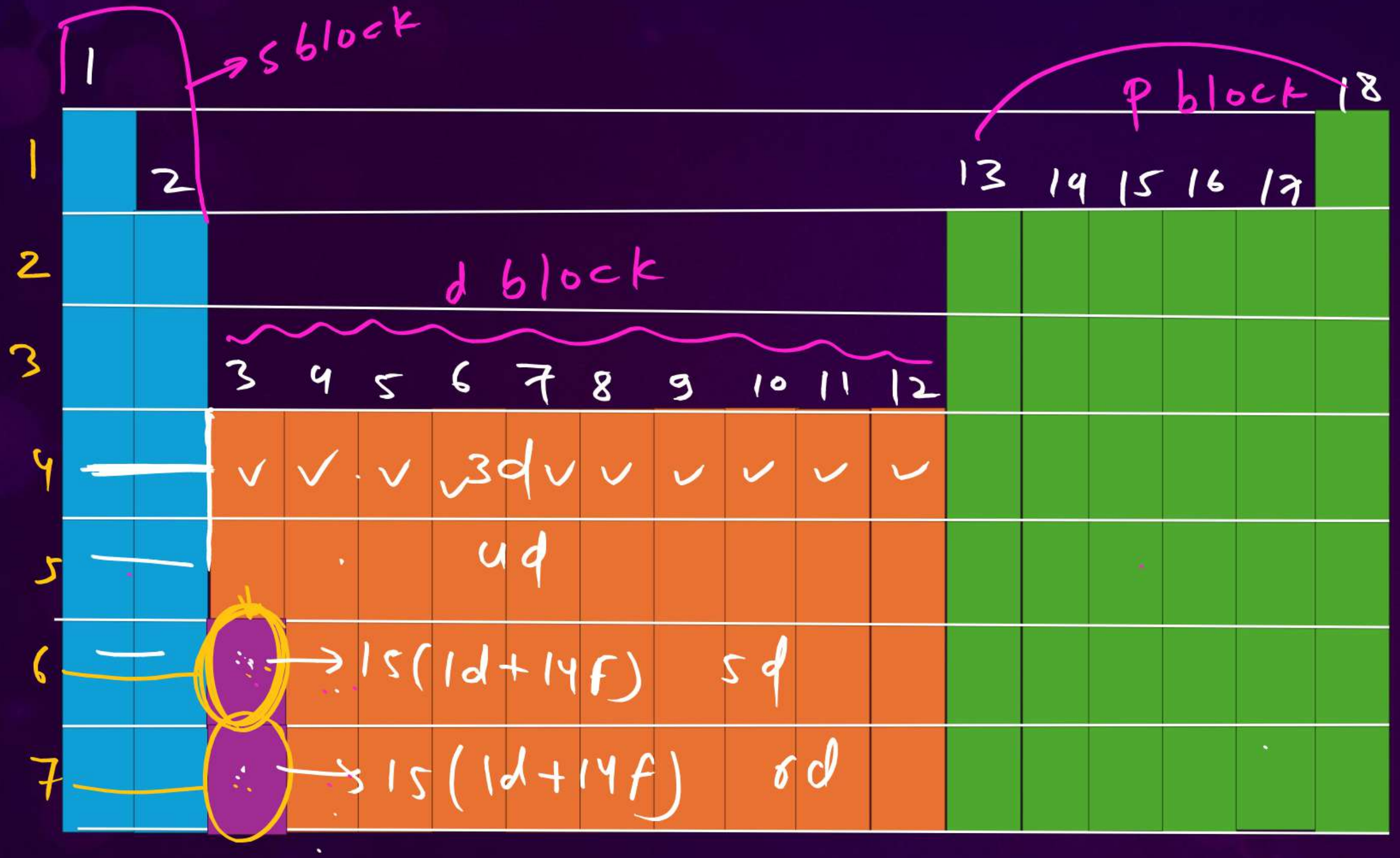
$0 + 10 - 8 = 2$

Cu_{29} $4s^1\ 3d^{10}$

$1 + 0 = 1$

Zn_{30} $4s^2\ 3d^{10} = 0$

Sc	1
Ti	2
V	3
Cr	6
Mn	5
Fe	4
Co	3
Ni	2
Cu	1
Zn	0


s block
p block
d block
1
2
3
4
5
6
7
1
2
3 4 5 6 7 8 9 10 11 12
13 14 15 16 17
18
3d
4d
1s(1d+14f) 5d
1s(1d+14f) 6d

s-1
p-2
d-3
f → 4

$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$

$3d^{10}$ $4p$ $5s$ $4d$ $5p$ $6s$

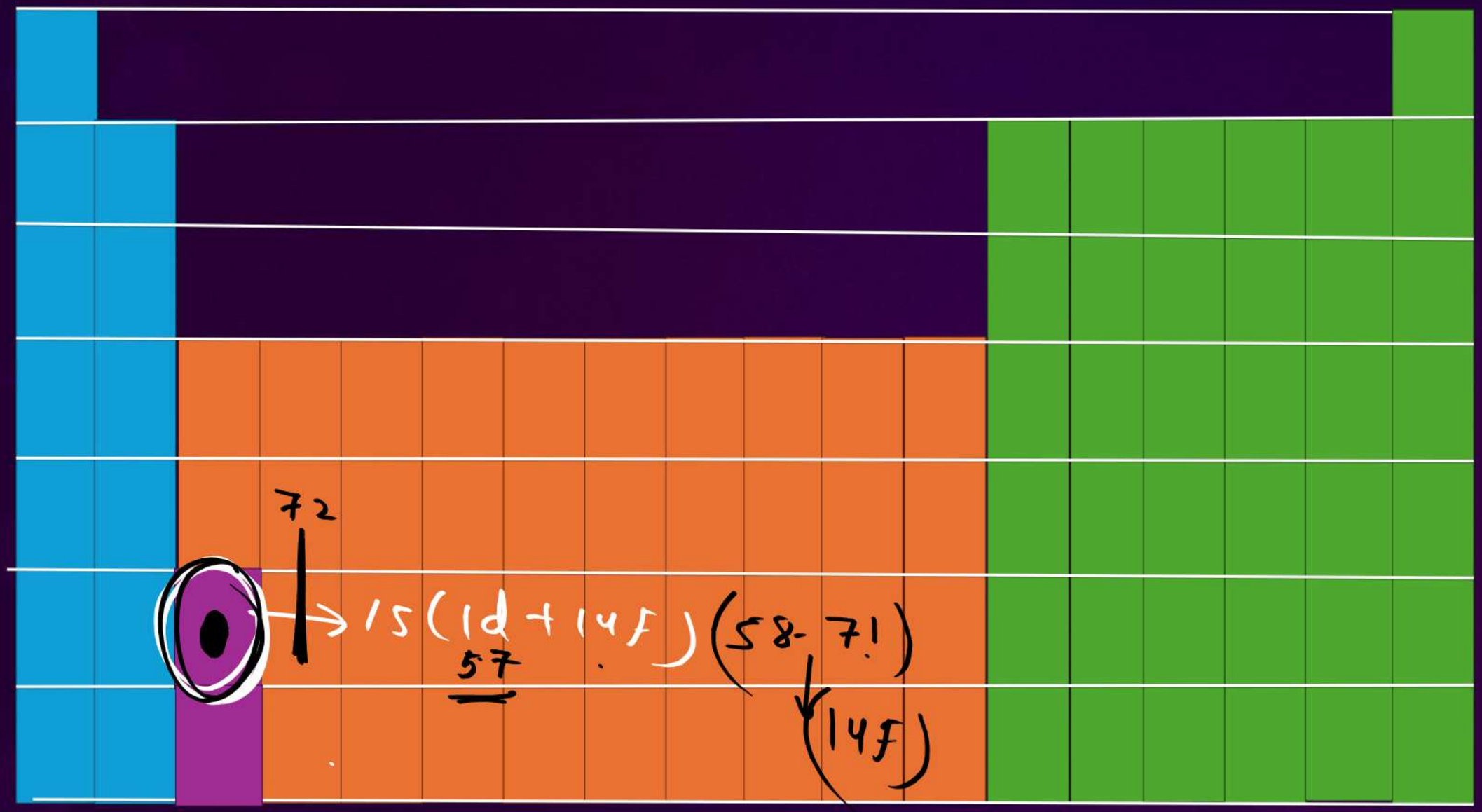
$4f$ $5d$ $6p$ $7s$ $5f$ $6d$ $7p$ $8s$

s block → 1, 2 → metal. (- H)

d block → 3 – 12 → metal.

f block → 3 → metal.

p block → 13 – 18 → Metal, Non metal, Metalloid.


72
15(1d + 14f)(58 - 71)
57
(14f)

Introduction

- There are four series in d block – 3d, 4d, 5d, 6d

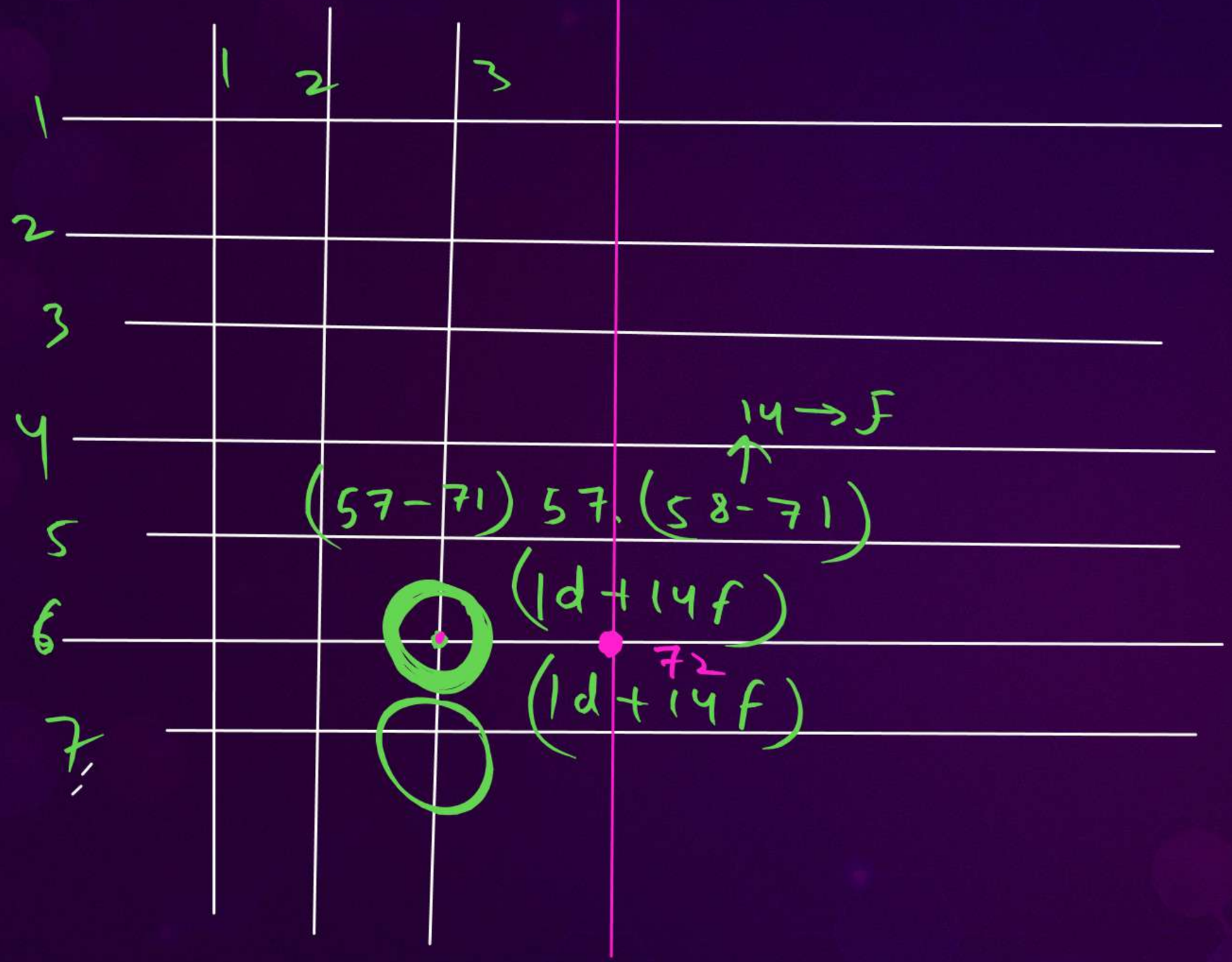
3d
4d
5d
6d

Transition Series

4th	1st	3d series	$Sc_{21} - Zn_{30}$	10
5th	2nd	4d series	$Y_{39} - Cd_{48}$	10
6th	3rd	5d series	$La_{57}, Hf_{72} - Hg_{80}$	9 + 1 =10
7th	4th	6d series	$Ac_{89}, Unq_{104} - Uub_{112}$	9 + 1 =10

18 18 18 32

d (90-103 14f)



(f → 14e)

Ugt (143)

3d → 1st → Sc_{21} — Zn_{30}

4d → 2nd → Y_{39} — Cd_{48}

18 18

(58-71) → Ce_{57}, Hf_{72} — Hg_{80}

↓

f (90-103) f

32 Ac_{89} Unq_{104} — Uub_{112}

Electronic Configuration

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

- Exceptions – $Cr = 4S^1\ 3d^5$
  $Cu = 4S^1\ 3d^{10}$
  $Pd = 5S^0\ 4d^{10}$

Sc $4s^2 3d^1$
Ti $4s^2 3d^2$
V $4s^2 3d^3$
Cr_{24} $4s^1 3d^5$

Sc_{21}

$4s^2 3d^1$

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

Zn

$4s^2 3d^{10}$

The general outer electronic configuration of transition elements is

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

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

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

D $(n-1)\,d^{5}\,ns^{1}$

PhysicsWallah
सवाल से ही SELECTION होगा

1st Series

साइंटिस्ट वेकेरमन फेकोनी कु जन

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

BKT

3d – 4, 9

4d- 3, 9

5d – 8

6d - 9

2nd Series

यश जरदार नवाब Mobile टेक्नोलॉजी Russia में रोहित प्रसाद अग्रवाल चौधरी के पास है

	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd*	Ag	Cd
Z	39	40	41	42	43	44	45	46	47	48
5s	2	2	1	1	1	1	1	0	1	2
4d	1	2	4	5	6	7	8	10	10	10
	1	2	3	4	5	6	7	8	9	10

3rd Series

का किया जिसने दिया

ललित हफ्ता वसूल रिटर्न उस आयरन प्रताप Au Hg

	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg
Z	57	72	73	74	75	76	77	78	79	80
6s	2	2	2	2	2	2	2	1	1	2
5d	1	2	3	4	5	6	7	9	10	10
	1	2	3	4	5	6	7	8	9	10

4th Series

	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn
Z	89	104	105	106	107	108	109	110	111	112
7s	2	2	2	2	2	2	2	2	1	2
6d	1	2	3	4	5	6	7	8	10	10

3d – 4, 9
4d- 3, 9
5d – 8
6d - 9

Transition Metal

→ d block

d^{10} → complety filled

- D Block elements having incompletely filled d orbitals (d^{1-9}) either in ground state or in most stable oxidation state are called transition elements

- All d-Block elements are transition elements. Except- Zn, Cd, Hg are not transition elements

BKT*

$Zn \rightarrow 4s^2\ 3d^{10}$ → complety filled; $Zn^{+2} \Rightarrow 4s^0\ 3d^{10}$

- Cu, Ag, Au are called coinage metal and they are transition metal also.

$Cu \rightarrow 4s^1\ 3d^{10}$ → Complety filled

$Cu^{+2} \rightarrow 4s^0\ 3d^9$ → Incompletly filled

PYQ

Q Why Zn is not transition metal but Cu is transition metal.

Ans

$Zn_{30} \rightarrow 4s^2\, 3d^{10}$ (completely filled)

$Zn^{+2} \rightarrow 4s^0\, 3d^{10}$

$Cu^{*}_{29} \rightarrow 4s^1\, 3d^{10}$

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

Atomic Size

e = p

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

Sc Ti V Cr Mn Fe Co Ni Cu Zn

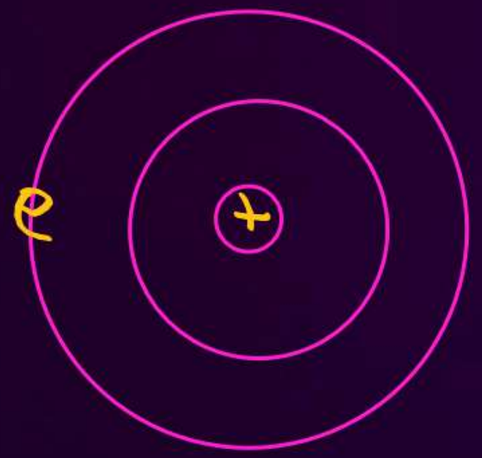
21 30

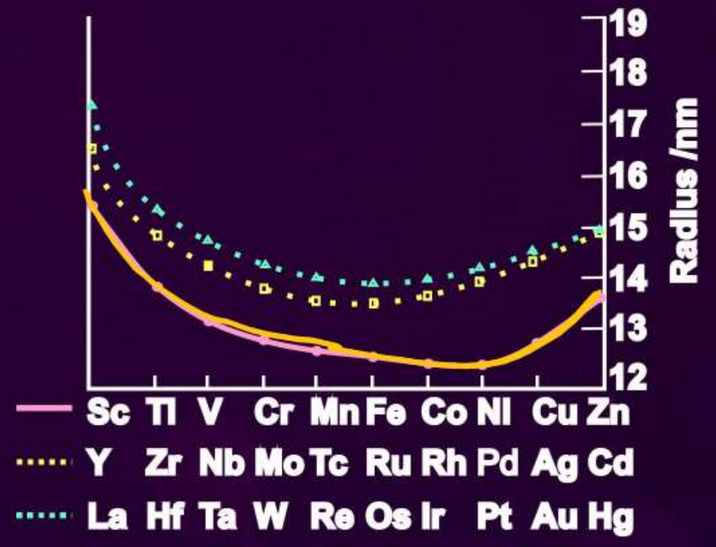
Radius decreases — Attractive force > Repulsive force

Radius Constant — Attractive force = Repulsive force

Radius Increases — Attractive force < Repulsive force

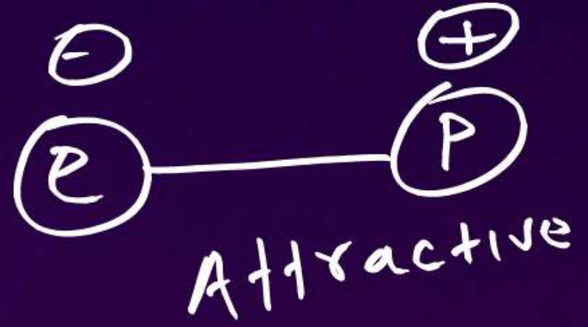
Nucleus
↓
proton → +ve
&
Neutron





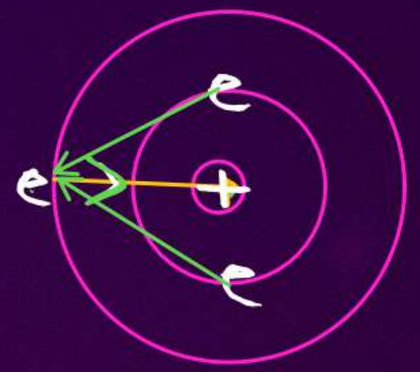
Atomic Radius

$$F = \frac{K q_1 q_2}{r^2}$$



Distance from centre of Nucleus to the outermost electron.

↳ last



① Radius $\propto \frac{1}{F_{attr}}$ ② Radius $\propto F_{rep}$

$\longrightarrow$ 3d, 4d, 5d, 6d.

$\longrightarrow$ 3d $\longrightarrow$ Sc_{21} — Zn_{30}

* All d block elements $\rightarrow$ Transition metal.
* Zn, Cd, Hg are not transition
* Cu, Ag, Au $\rightarrow$ coinage metal.

Sc Ti V Cr Mn Fe Co Ni Cu Zn.

Atomic Radius dec. → constant → increases.

Sc_{21}	$4s^2$	$3d^1$	Sc^{+2}	$4s^0$	$3d^1$
Ti_{22}	$4s^2$	$3d^2$	Ti^{+2}	$4s^0$	$3d^2$
V_{23}	$4s^2$	$3d^3$	V^{+2}	$4s^0$	$3d^3$
*Cr_{24}	$4s^1$	$3d^5$	Cr^{+2}	$4s^0$	$3d^4$
Mn_{25}	$4s^2$	$3d^5$	Mn^{+2}	$4s^0$	$3d^5$
Fe_{26}	$4s^2$	$3d^6$	Fe^{+2}	$4s^0$	$3d^6$
Co_{27}	$4s^2$	$3d^7$	Co^{+2}	$4s^0$	$3d^7$
Ni_{28}	$4s^2$	$3d^8$	Ni^{+2}	$4s^0$	$3d^8$
*Cu_{29}	$4s^1$	$3d^{10}$	Cu^{+2}	$4s^0$	$3d^9$
Zn_{30}	$4s^2$	$3d^{10}$	Zn^{+2}	$4s^0$	$3d^{10}$

Home Work

No DPP

PARISHRAM

2026

D & F Block Elements

CHEMISTRY LECTURE-4

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

- Metallic Character
- Melting Point & Boiling Point
- Enthalpy of Atomization

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QUESTION

The transition element with the lowest atomic number is

A. Scandium → Z = 21

B. Titanium

C. Zinc

D. Lanthanum

QUESTION

Transition elements are :

A s-block

B p-block

C d-block

D f-block

no. of unpaired electrons in Mn

(a) 4

(b) 5 ✓

(c) 6

(d) 3

concept.

Mn_{25} $4s^2\ 3d^5$

paired → ↑↓ → 2e

4s	3d			
↑↓	↑	↑	↑	↑

4s2 → 0

3d5 → 5

no. of unpaired electrons in Cr

(a) 4

(b) 5

(c) 6 ✓

(d) 3

Cr_{24} $4s^1$ $3d^5$

unpaired

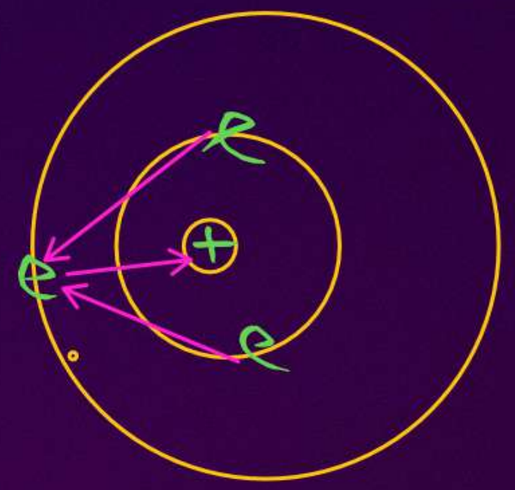
↑	↑	↑	↑	↑	↑

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

$1 + 5 = 6$

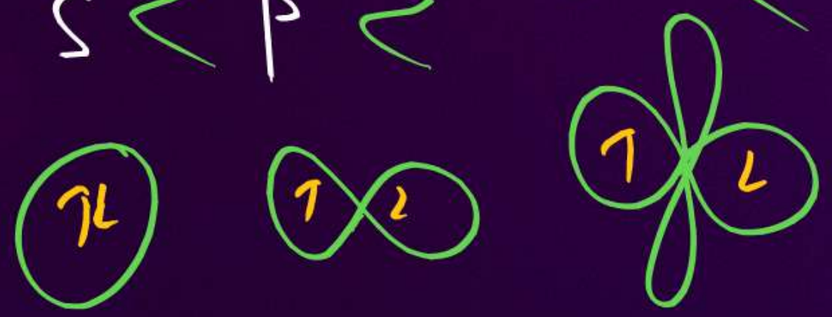
shielding | screening.

* repulsion b/w electrons.



order of size

$s < p < d < f$



order of shielding

$\boxed{s > p > d > f}$

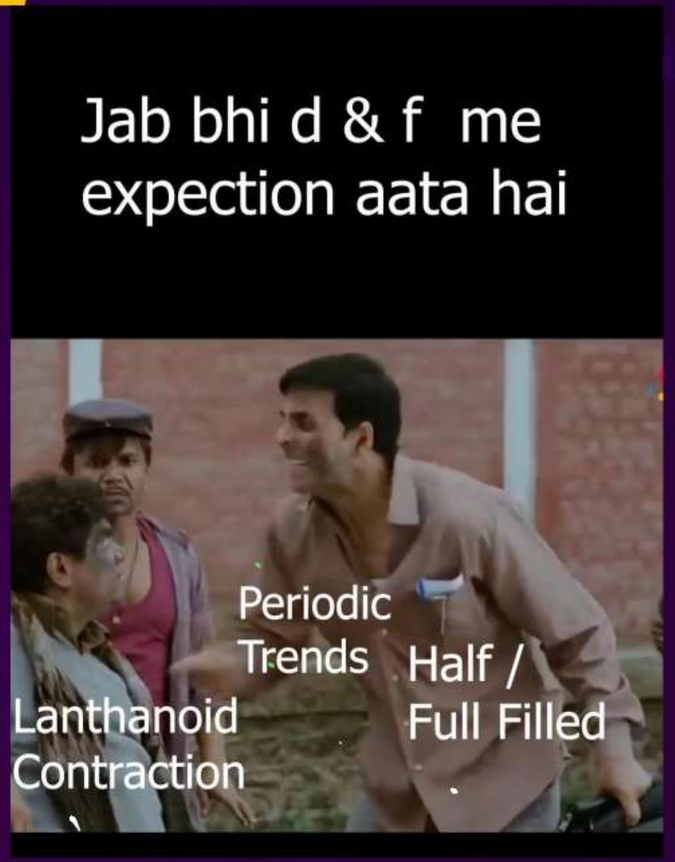
less repulsion

poor shielding

Lanthanoid Contraction

What is Lanthanoid contraction?

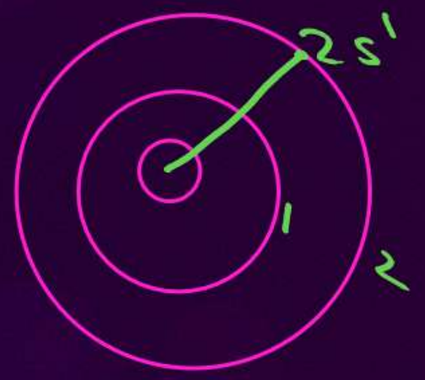
→ contration in Radius of 5d series element due to Lanthanoid.



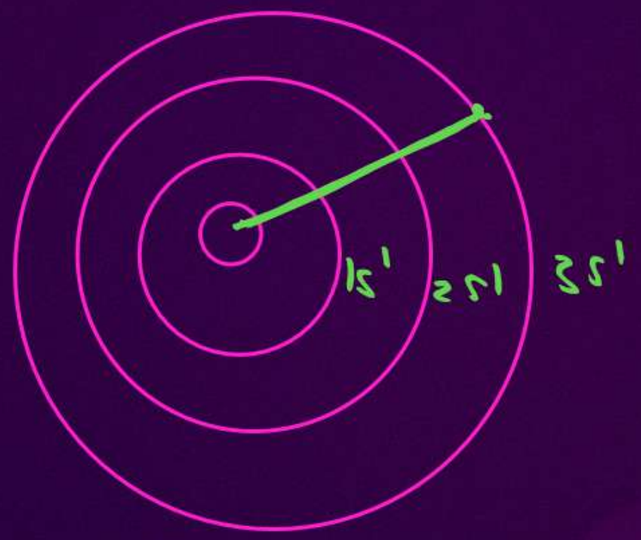
Radius $\propto$ shell no.

$Li_3 < Na_{11}$

$1s^2\ 2s^1$



$1s^2\ 2s^2\ 2p^6\ 3s^1$



Li	$2s^1$
Na	$3s^1$
K	$4s^1$
Rb	$5s^1$
Cs	$6s^1$
Fr	$7s^1$

Lanthanoid Contraction

	3	4			
4th.	Sc 21	Ti 22		Zn	3d
5th	Y 39	Zr 40		Cd	4d
		=		=	
6th.	La 57	Hf 72		Hg	5d

$Zr \approx Hf$

f^{14}

Lanthanoids (58–71)

$\boxed{La > Y > Sc}$

$s > p > d > f$ → less repulsion, poor shielding

Lanthanoid Contraction

Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	3d
Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	4d
La	=	=	=	=	=	=	=	=	=	
La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	5d

1st

2nd

3

lanthanoid

$R(4d) \simeq R(5d)$.

$Cd \simeq Hg$

WOF has same Radius?

(a) Cr, Mo

(b) Zr, Nf

(c) Zn, Hg

(d) Sc, Y.

$$\boxed{Zr^{+4} \simeq Hf^{+4}}$$

Lanthanoid Contraction

- The net result of the lanthanoid contraction is that the second and the third d series exhibit similar radii (e.g., Zr 160 pm, Hf 159 pm) and have very similar physical and chemical properties

BKT*

NCERT lines.

QUESTION- CBSE Sample Question Paper

Which of the following options give the correct arrangement of the atomic radii of the 3d, 4d, and 5d transition series of elements?

A. Atomic radii of 3d < atomic radii of 4d < atomic radii of 5d

B. Atomic radii of 3d < atomic radii of 4d = atomic radii of 5d

C. Atomic radii of 3d = atomic radii of 4d > atomic radii of 5d

D. Atomic radii of 3d > atomic radii of 4d > atomic radii of 5d

Ti 3d
Zr 4d
≈
Hf 5d
4d ≈ 5d

QUESTION CBSE 2024

Assertion (A): Zr and Hf are of almost similar radii.

Reason (R): This is due to Lanthanoid contraction.

(a) both A and R are correct and R is correct explanation of A

(b) both A and R are correct but R is not correct explanation of A

(c) both are incorrect

(d) A is correct R is incorrect

Density

$= \frac{\text{mass}}{\text{Volume}}$

Volume ∝ r

Element	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Density/g cm^{-3}	3.43	4.1	6.07	7.19	7.21	7.8	8.7	8.9	8.9	7.1

Radius Decreases → Constant → Increases

Mass Increases

Density Increases up to Cu

3d
4d
5d

Density in Group – 3d <4d<<5d

BKT*

1. 3d series EC (Ions)

2. unpaired electrons.

3. Lanthanoid contraction.

Home Work

DPP 2.

PARISHRAM

2026

D & F Block Elements

CHEMISTRY LECTURE-5

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

- **Metallic Character**
- **Oxidation State**

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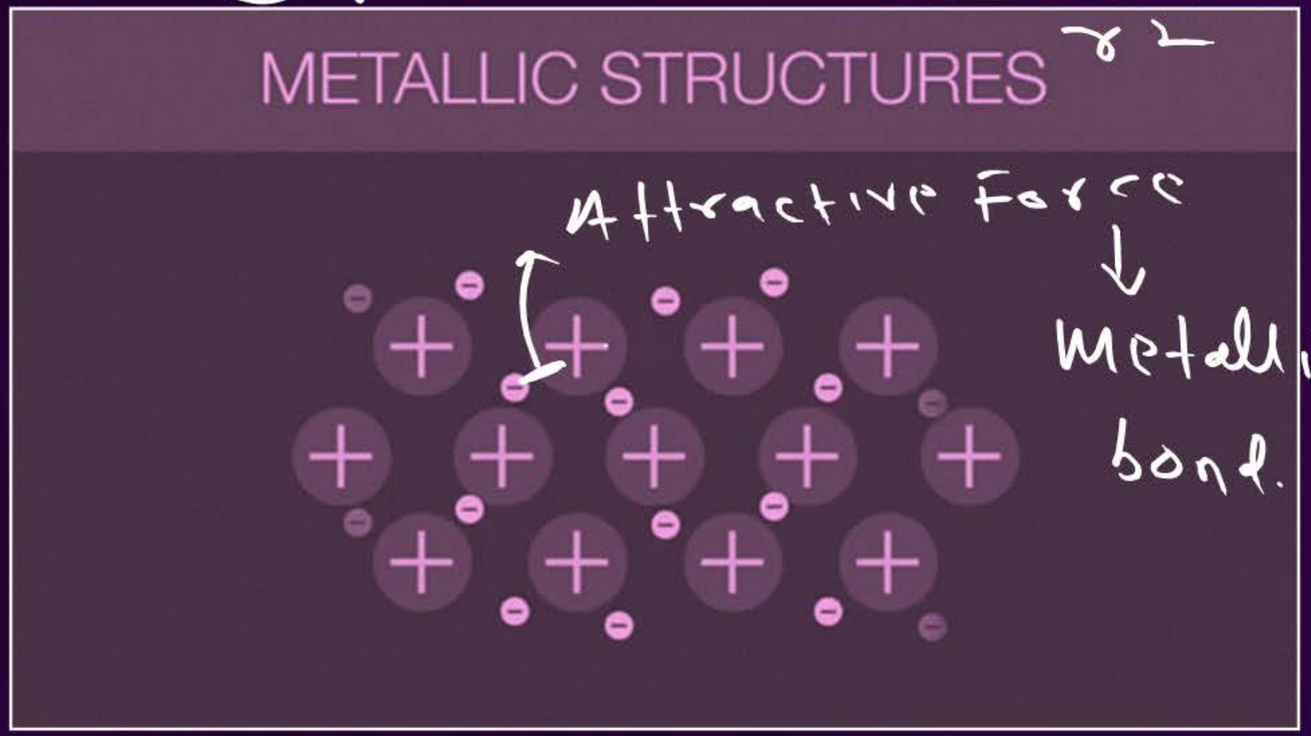
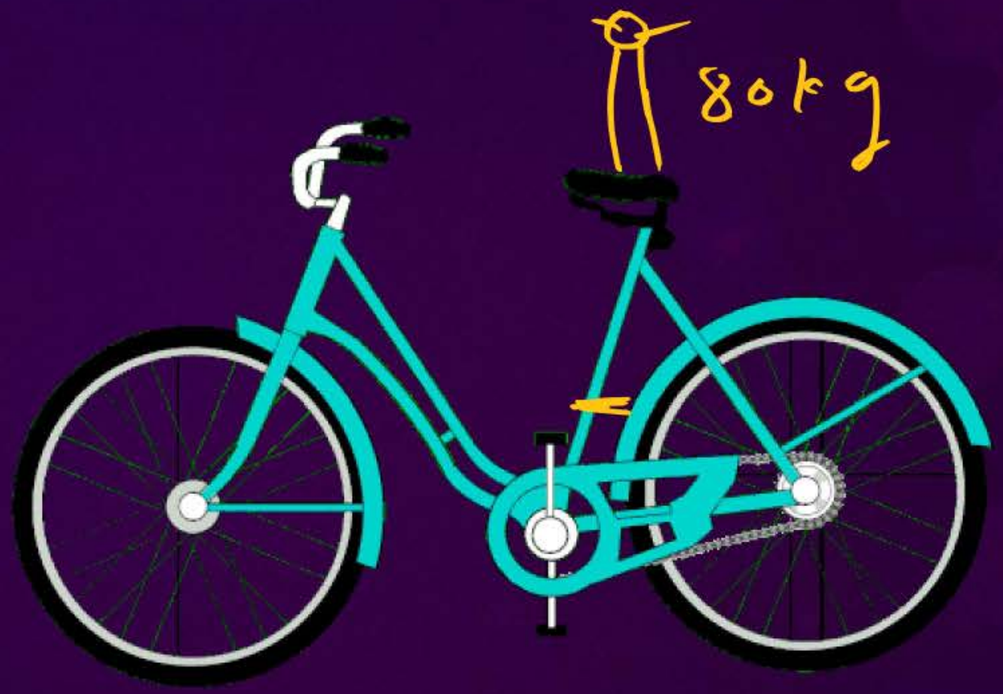
Metallic Bonding

- Metallic Bonding is Directly Proportional to Number of Unpaired Electron

q_1 q_2 r

$$F = \frac{k q_1 q_2}{r^2}$$





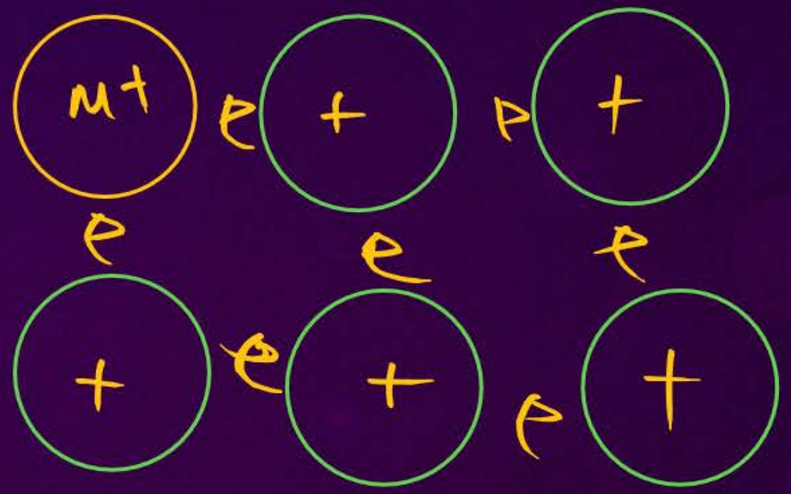
* Metal $\longrightarrow$ e donar

$$Mn \xrightarrow{-2e} Mn^{+2} + 2e.$$

$$Mg \xrightarrow{-2e} Mg^{+2} + 2e.$$

$$M \xrightarrow{-e} M^{+} + e$$

$$\left[\begin{array}{l} \underline{\underline{Al}} \xrightarrow{-3e} Al^{+3} + 3e \\ \underline{\underline{Na}} \xrightarrow{-e} Na^{+} + e. \end{array}\right]$$



Metallic Bonding

$F = \frac{k q_1 q_2}{r^2}$ $F \propto \frac{1}{r^2}$

$F \propto q_1$ $F \propto q_2$

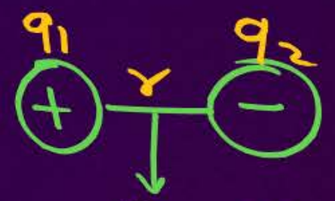
q_1 = charge on metal.

q_2 = charge on electron

q_2 = no. of +ve e.

$F = \frac{k q_1 q_2}{r^2}$

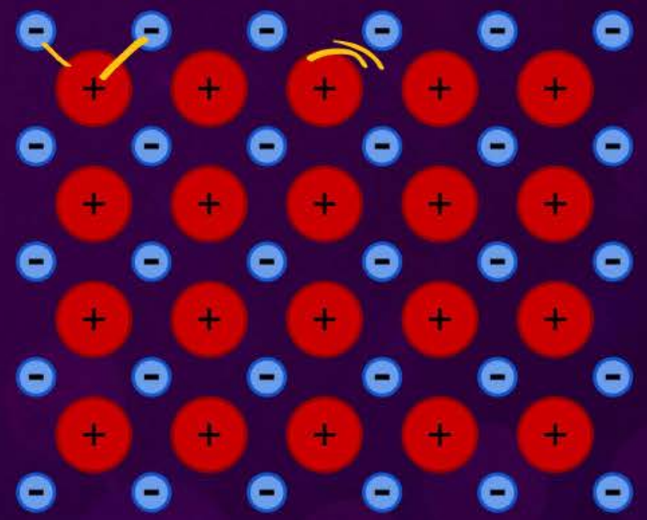
- Metallic bond, force that holds atoms together in a metallic substance
- Metallic bonding is a type of Chemical Bond that arises from the electrostatic attractive force between Conduction electrons and positively charged metal ions



Force → metallic bond.

Metallic Bond Strength is directly proportional to charge on [redacted] and Number of valence electron

Metallic Bond strength is inversely proportional to size of metal

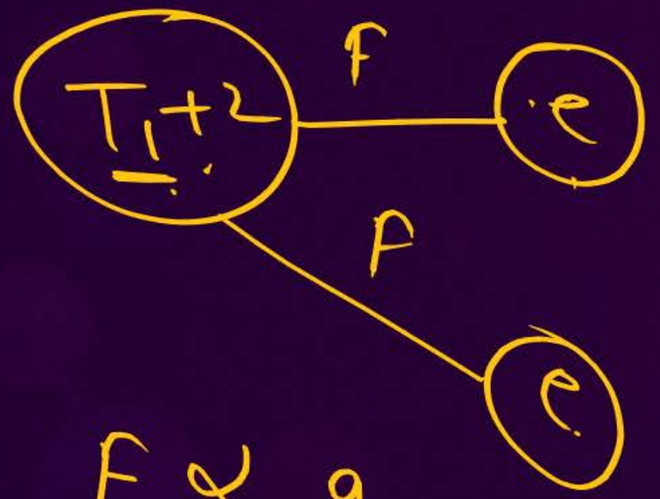


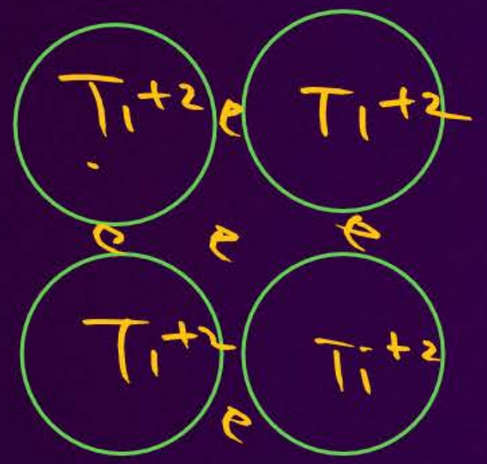
for d block

$Ti \Rightarrow 4s^2\, 3d^2$

$n = 2.$

$Ti \xrightarrow{-2e} Ti^{+2} + 2e$





$F \propto q_1$

$F \propto$ no. of e.

$Na \rightarrow 1s^2\, 2s^2\, 2p^6\, 3s^1$

$Na^+ + e$

$Na^+ + Cl^- \rightarrow \underline{\underline{NaCl}}$

Metallic Character

Cr → 4s1 3d5
↓
1 + 5 = 6

Sc	Ti	V	Cr*	Mn	Fe	Co	Ni	Cu	Zn
n ⇒ 1	2	3	6	5	4	3	2	1	0

Number of Unpaired electron increases → (Sc to Cr)

Number of Unpaired electron decreases → (Mn to Zn)

MBS inc.
↓
metallic bond strength.

MBS dec.

BKT**

$Zn \rightarrow 4s^2 3d^{10}$

unpaired electron = 0.

Metallic character / Metallic Bond Strength is directly proportional to number of Unpaired Electron

Hardness of Metal is directly proportional to Unpaired Electron

Zn, Cd, Hg are soft – Unpaired Electron = 0 **(PYQ)** BKT*

Hardness ∝ Metallic bond Strength.

QUESTION

In which of the following metallic bond is strongest?

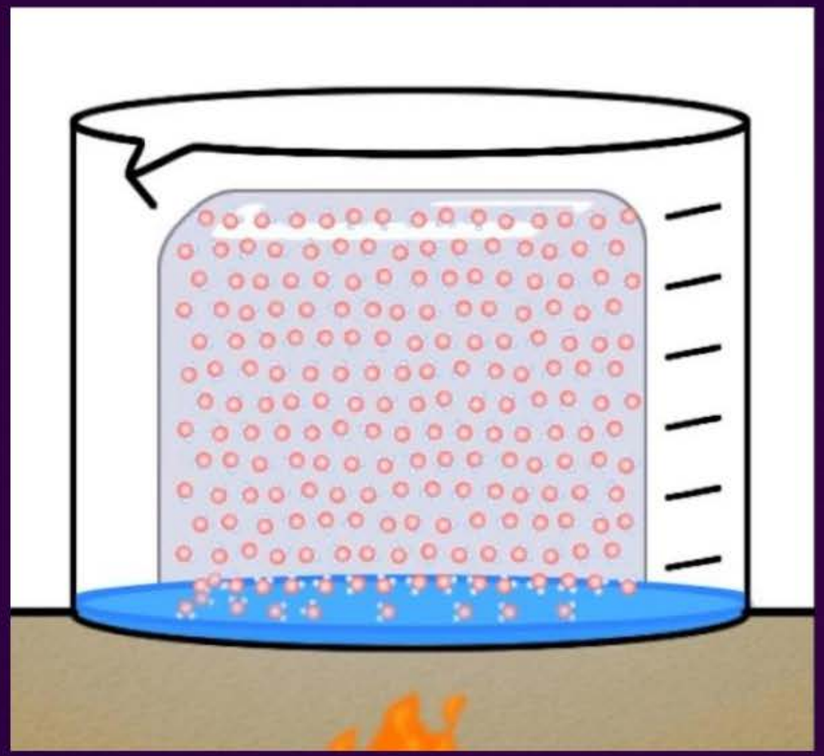
A V

B Fe

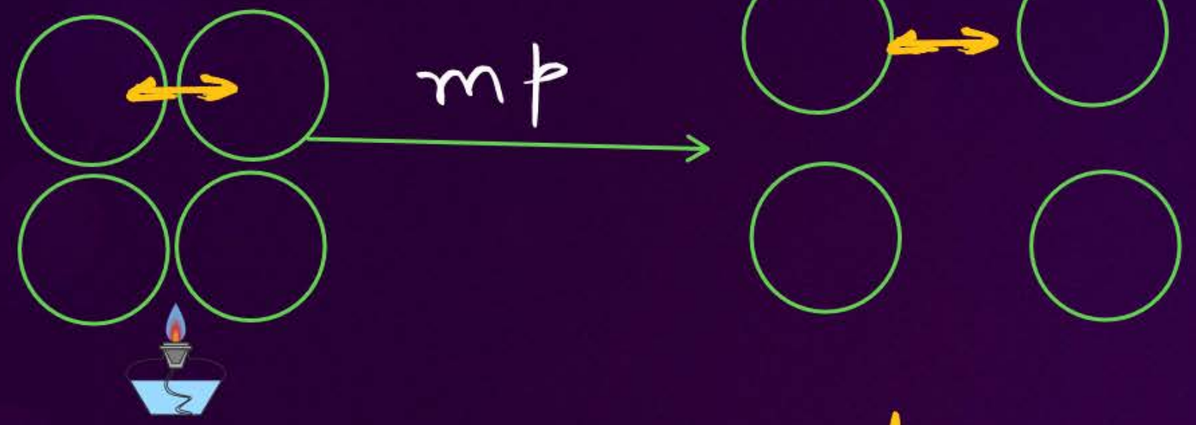
C Cr

D Sc

Melting & Boiling Point



Solid



liquid.

Intermolecular

Space → very low.

Force → strong.

liquid

Force → weak

Space → more.

mp ∝ I.m.F

Intermolecular force.

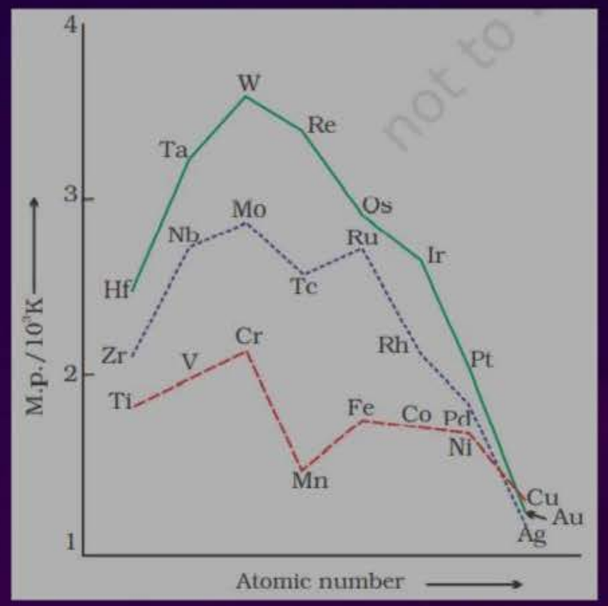
mp ∝ metallic bond

mp ∝ no. of unpaired e

Melting & Boiling Point

Melting & Boiling Point α Metallic Bond Strength

Melting & Boiling Point α Number of Unpaired Electron

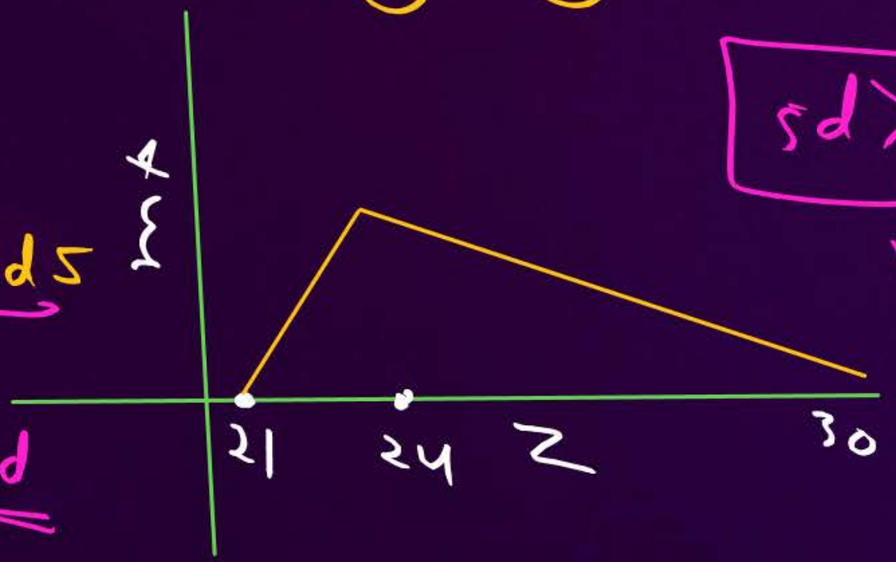


	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
n	1	2	3	6	5	4	3	2	1	0

BKT*

Mn → $4s^2 3d^5$

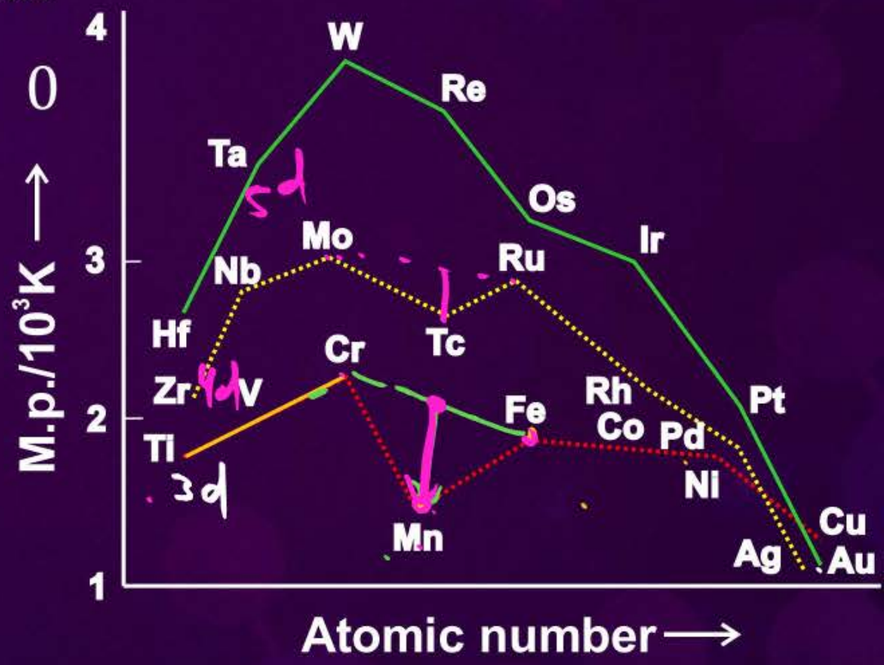
Half filled



$\boxed{5d > 4d > 3d}$

↓

MBS ins.



* Why Mn has less mp than expected?

BKT*

Ans → Mn_{25} → $4s^2\ 3d^5$

↓

half filled → stable.

metallic bond

↓

weak → mp low → Jaldi melt kar Jayega.

* why Zn has lowest mp ?

BKT*

$Zn \rightarrow 4s^2\ 3d^{10}$

unpaired e = 0

- fully Filled.
- stable
- MBS → low

Melting & Boiling Point

NCERT Line by Line

- Melting and boiling points of transition are high

Na → 3s¹
Mg → 3s²

- The high melting points of these metals are attributed to the involvement of greater number of electrons from (n-1)d in addition to the ns electrons in the interatomic metallic bonding.

BKT*

Cr → 4s¹ 3d⁵

- In any row the melting points of these metals rise to a maximum at d^5 except for anomalous values of Mn and Tc and fall regularly as the atomic number increases

BKT*

* mp $\propto$ no. of unpaired e.

* max mp $\Rightarrow$ Cr

* Mn $\rightarrow$ less than expected $\rightarrow$ $4s^2\,3d^5$
  $\rightarrow$ Half filled.

* lowest $\rightarrow$ Zn $\rightarrow$ $4s^2\,3d^{10}$ $\rightarrow$ unpaired electron = 0.

Energy Atom Formation (isolated gaseous)
Akela.

Enthalpy of Atomization

$M(s) \xrightarrow{\Delta} M(g)$

Enthalpy of Atomization – is Directly proportional to Unpaired Electron

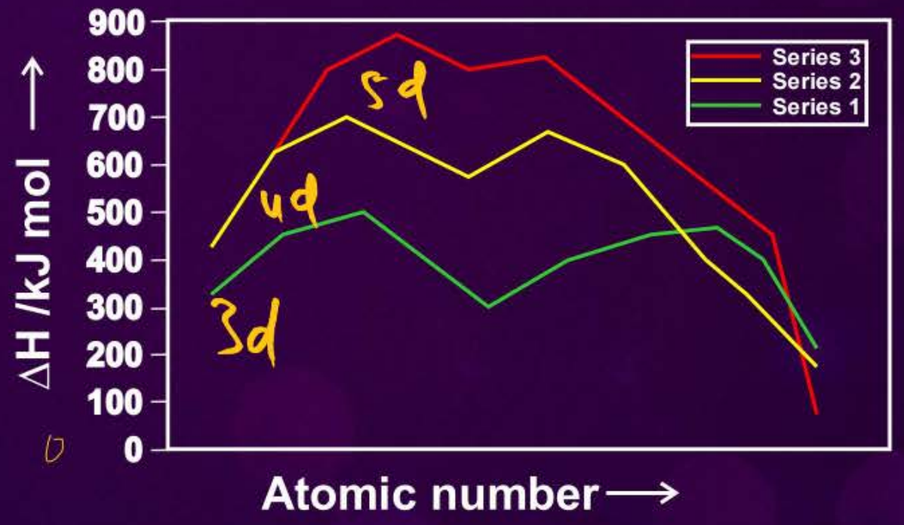
Transition Element has high Enthalpy of atomization – High Unpaired Electron - PYQ BKT*

3d Cr
4d Mo
5d W

$\boxed{5d > 4d > 3d}$

Zn has lowest Enthalpy of Atomization – Unpaired Electron = 0 (PYQ)

BKT*



$M(s) \longrightarrow M(g)$

✓ $m.p \propto$ no. of unpaired electron.

Enthalpy of Atomization $\propto$ no. of unpaired.

Enthalpy of Atomisation

NCERT Line by Line

high no. of unpaired electron.

- They have high enthalpies of atomization.
- The maxima at about the middle of each series indicate that one unpaired electron per d orbital is particularly favourable for strong interatomic interaction.
- In general, greater the number of valence electrons, stronger is the resultant bonding.

EA ∝ no. of unpaired electron.

unpaired electron.

QUESTION CBSE 2024

Attempt any five of the following:

(c) Which element of 3d series has lowest enthalpy of atomisation and why?

(e) Zn, Cd and Hg are soft metals. Why?

Zn → unpaired electron = 0.

→ unpaired electron = 0

↓

MBS lowest

QUESTION- Example 8.2

NCERT

Why do the transition elements exhibit higher enthalpies of atomisation?

Solution

Because of large number of unpaired electrons in their atoms they have stronger interatomic interaction and hence stronger bonding between atoms resulting in higher enthalpies of atomisation.

QUESTION- Intext Question

NCERT.

In the series Sc (Z = 21) to Zn (Z = 30), the enthalpy of atomisation of zinc is the lowest, i.e., 126 kJ mol^{-1}. Why?

Sc_{21} ——— Zn_{30}

$Zn \rightarrow 4s^2\ 3d^{10}$

unpaired electron = 0

Oxidation state / Number

↓

Charge per atom.

Mg^{+2} OS = +2

Cl^{-} OS = −1

SO_4^{-2}

group I +1

H He
Li Li
Na Na
K Ki
Rb Ruby
Cs Circus se
Fr Farar.

+1

Group 2

Be
Mg
Ca
Sr
Ba
Ra.

+2

O → −2

F
Cl
Br
I

→ −1

* $KMnO_4$

$+1 + x + 4 \times (-2) = 0$

$1 + x - 8 = 0 \quad x = 7.$

$Mn \longrightarrow x$

* MnO_4^{-2}

$x + 4(-2) = -2$

$x - 8 = -2$

$x = 6.$

* $\underset{x}{Cr_2}O_7^{-2}$

$2x + 7(-2) = -2$

$2x - 14 = -2$

$2x = 12$

$x = 6.$

* Fe_2O_3

$2x + 3(-2) = 0$

$2x - 6 = 0$

$x = 3$

* NO_2^-

$x + 2(-2) = -1$

$x - 4 = -1$

$x = 3.$

Question

Manganese exhibits lowest oxidation state in

A $KMnO_4$ (+7)

B K_2MnO_4 (+6)

$2 + x - 8 = 0$

C MnO_2 (+4)

$x - 4 = 0$

D MnO (+2)

$x - 2 = 0$

Home Work

→ DPP ✓

→ Do not attempt Today's DPP.

PARISHRAM

2026

D & F Block Elements

CHEMISTRY LECTURE-6

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

- Oxidation State
- Standard Electrode Potential

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* $S_2 \; 0 \; 7^{-2}$

$2x + 7(-2) = -2$

$2x - 14 = -2$

$2x = -2 + 14$

$\boxed{x = 6}$

No 3

$x + 3(-2) = -1$

$x - 6 = -1$

$x = -1 + 6$

$= 5$

* IO_3^-

$x + 3(-2) = -1$

$x - 6 = -1$

$x = 5$

* MnO_2

$x + 2 \times (-2) = 0$

$x - 4 = 0$

$x = 4$

* CO_3^{-2}

$x + 3 \times (-2) = -2$

$x - 6 = -2$

$x = 4$

EN → Ability to attract bonded pair electron.

Electron negativity.

$x \rightarrow 2.2$

1.0	1.5	2.0	2.5	3.0	3.5	4.0
Li	Be	B	C	N	O	F

				P	S	Cl
Na	Mg	Al	Si	2.1	2.5	3.0
0.9	1.2	1.5	1.8			

0.3 0.3 0.3 0.3 0.4 0.5

$\boxed{c+4}$ CO_2

$x - 4 = 0$

$x = 4$

$\overset{\delta+}{A} - \overset{\delta-}{B}$

$EN(B) > EN(A)$

$\overset{\delta+}{C} - \overset{\delta-}{O}$

2.5 3.5

Oxidation State

$Na \rightarrow 1s^2 2s^2 2p^6 3s^1$

$Na^+ \rightarrow \boxed{1s^2 2s^2 2p^6}$

[Ne] Inert gas

BKT*

✓ Due to less energy difference between 3d and 4s
d block elements show variable oxidation state / multiple oxidation state – **PYQ**

* **Zn and Sc do not show variable oxidation state - PYQ** BKT*

Most common oxidation state of d block elements is 2 except Sc - PYQ BKT*

maximum oxidation is +8 shown by Ru & Os

→ Sc^{+2} $Sc \rightarrow 4s^2 3d^1$

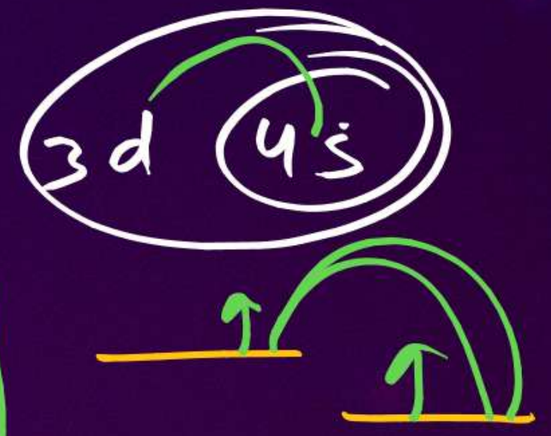
$Sc^{+2} \rightarrow [Ar]\, 4s^0 3d^1 \xrightarrow{-e} [Ar]\, 4s^0 3d^0$ (Sc^{+3})

BKT*

Q. Why 3d series element show multiple oxidation?

→ similar Energy.

→ less Energy difference



Q why Actinoids show many oxidation state

↳ 7s 6d 5f → bad me pardhaunga.

* maxm os = group no. ⟶ up to group no = 7

group 1 max os = +1
2 max os = +2] s

3 max os = +3
4 max os = +4
5 max os = +5
6 max os = +6
7 max os = +7] d

Oxidation State

Stable Oxidation State –

1. Nobel gas Configuration – [Ar] $4s^0\ 3d^0$
2. Fully Filled – d^{10} $4s^0\ 3d^{10}$
3. Half Filled – d^5
4. t_{2g} Half Filled – d^3

$Na \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^1$

$Mn \rightarrow +2$
$\rightarrow +3$
$\rightarrow +4$
$\rightarrow +5$
$\rightarrow +6$
$\rightarrow +7$

He
Ne
Ar
Kr
Xe
Rn.

(1)

$Sc_{21} \rightarrow 4s^2\ 3d^1$
$\rightarrow [Ar]\ 4s^2\ 3d^1$
$Sc^{+3} \rightarrow [Ar]\ 4s^0\ 3d^0$

2. Fully filled $\rightarrow d^{10}$

$4s^0\ 3d^{10}$

Ex $\longrightarrow$ $Zn_{30} \longrightarrow 4s^2\ 3d^{10}$

$\longrightarrow$ $Zn^{+2} \longrightarrow 4s^0\ 3d^{10}$

↑↓	↑↓	↑↓	↑↓	↑↓

fully filled

③ Half Filled $\longrightarrow d^5$

Ex $\longrightarrow$ Mn $\longrightarrow 4s^2\, 3d^5$

$Mn^{+2} \longrightarrow 4s^0\, 3d^5$

↑	↑	↑	↑	↑

$\downarrow$

Half Filled $\longrightarrow$ stable

(4) t_{2g} Half Filled $\longrightarrow$ $\underline{d^3}$

↑	↑	↑

t_{2g}

e_g.

$Cr_{24} \longrightarrow 4s^1\ 3d^5$

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

↓

Stable

↓

t_{2g} half filled.

orbitals = 3

electron = 3 × 2

= 6.

Half filled = 6/2 = (3)

(1) $4s^0\ 3d^0$ ✓

(2) $4s^0\ 3d^{10}$ ✓

(3) $4s^0\ 3d^5$ ✓

(4) $4s^0\ 3d^3$ ✓✓

Oxidation State

3	4	5	6	7	8	9	10	11	12
Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
	+2	+2	+2	+2	+2	+2	+2	+1	+2
+3	+3	+3	+3	+3	+3	+3	+3	+2	
	+4	+4	+4	+4	+4	+4	+4		
		+5	+5	+5					
			+6	+6	+6				
				+7					

$4s^2 3d^1$ $4s^2 3d^2$ $4s^2 3d^3$ $4s^1 3d^5$ $4s^2 3d^5$ $4s^0 3d^9$

$Zn^{+2} \rightarrow 4s^0 3d^{10}$

Max^m OS = (s + d) electron

$4s^2 3d^5 = 2 + 5 = 7$

- **Maximum oxidation state is shown by Mn in 3d Series = Mn^{+7}** PYQ (BBI) BKT*
- Fe^{+2} < Fe^{+3} PYQ

  $4s^0 3d^6$ $4s^0 3d^5$
- **Cu shows +1 Oxidation State** PYQ

  $4s^1 3d^{10} \xrightarrow{-e} 4s^0 3d^{10}$ fully filled.

1Q why Sc^{+3} is stable?

$Sc^{+3} \longrightarrow 4s^0 3d^0$ inert gas.

2.Q. why Ti^{+4} is stable?

$Ti_{22} \rightarrow \underline{4s^2}\ \underline{3d^2}$

$Ti^{+4} \rightarrow [Ar]\,4s^0 3d^0$ nobel gas / Inert gas ✓

30. why V^{+5} is stable?

$V^{+5} = [Ar]\,4s^0\,3d^0$ nobel gas.

Cr

$+6 \longrightarrow 4s^1\,3d^5 \xrightarrow{-6} [Ar]\,4s^0\,3d^0$ nobel gas.

$+3 \longrightarrow \underline{4s^1}\,\underline{3d^5} \xrightarrow{-3} 4s^0\,3d^3$ for HF.

↑	↑	↑

Mn

$+7 \longrightarrow 4s^2\,3d^5 \xrightarrow{-7e} [Ar]\,4s^0\,3d^0$

noble gas.

$+2 \longrightarrow 4s^2\,3d^5 \xrightarrow{-2e} 4s^0\,3d^5$

Half Filled.

Fe

26

$4s^2\,3d^6$

$+2 \longrightarrow Fe^{+2}$ $4s^0\,3d^6$

$+3 \longrightarrow Fe^{+3}$ $4s^0\,3d^5$ Half filled.

$\boxed{Fe^{+3} > Fe^{+2}}$ Bkt ***

Oxidation State

- In the p–block the lower oxidation states are favoured by the heavier members (due to inert pair effect), the opposite is true in the groups of d-block

- For example, in group 6, Mo(VI) and W(VI) are found to be more stable than Cr(VI).

- Thus Cr(VI) in the form of dichromate in acidic medium is a strong oxidising agent, whereas MoO_3 and WO_3 are not.

+6 +6

+6

$K_2Cr_2O_7 \xrightarrow{[R]} Cr^{+3}$

OA

$2+2n-14=0$

$n=6$

	+3	+6
Cr	LOS	HOS
Mo		
W		

decreases ↓ | increases ↓

HOS = Higher oxidation state

LOS = Lower oxidation state.

$Cr^{+6} < Mo^{+6} < W^{+6}$

$Cr^{+3} > Mo^{+3} > W^{+3}$

$Cr^{+3} > Cr^{+6}$

oxidizing agent

$Cr^{+6} \xrightarrow{\text{Reduction}} Cr^{+3}$

Oxidation State

Low oxidation states are found when a complex compound has ligands capable of π-acceptor character in addition to the σ-bonding. For example, in $Ni(CO)_4$ and $Fe(CO)_5$, the oxidation state of nickel and iron is zero

Question – NCERT Exemplar

In the form of dichromate, Cr (VI) is a strong oxidising agent in acidic medium but Mo (VI) in MoO_3 and W (VI) in WO_3 are not because _____.

$Cr^{+6} < Mo^{+} < W^{+6}$

A Cr (VI) is more stable than Mo(VI) and W(VI).

B Mo(VI) and W(VI) are more stable than Cr(VI).

C Higher oxidation states of heavier members of group-6 of transition series are more stable.

D Lower oxidation states of heavier members of group-6 of transition series are more stable.

Question – NCERT Exemplar

Which of the following will not act as oxidising agents?

A CrO_3

$+6$

$x - 6 = 0$

B MoO_3

C WO_3

D CrO_4^{2-}

$+6$

$x - 8 = -2$

$x = 6$

$Cr^{+6} \longrightarrow Cr^{+3}$

OA

Mo^{+6} ✗

W^{+6} ✗

Question

Transitional elements exhibit variable valencies because they release electrons from the following orbits

A. ns orbit

B. ns and np orbits

C. (n–1)d orbit

D. (n–1)d and ns orbit

2 - 3

1 hours

Question

Zinc does not show variable valency like d–block elements because

A. it is low melting

B. d-orbital is complete

C. it is a soft metal

D. two electrons are present in the outer most orbit

$Zn \rightarrow 4s^2 3d^{10}$

Fully Filled

Question

Among the following outermost configurations of transition metals, which shows the highest oxidation state?

A $3d^5\ 4s^1$ Cr

B $3d^3\ 4s^2$ V

C $3d^5\ 4s^2$ Mn +7

D $3d^6\ 4s^2$ Fe +6

Question

The most stable oxidation state of Fe is

A. +2

B. +4

C. +3

D. +5

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

Question

Sc Zn K

Which one of the following does not show variable oxidation states?

A. Iron

B. Copper

C. Zinc

D. Manganese

$Fe^{+2} < Fe^{+3}$

$4s^0\ 3d^6$ $4s^0\ 3d^5$

HF

Question

Which one of the following transition metals shows highest oxidation states?

A. Sc

B. Ti

C. Os

D. Zn

Home Work

→ Class notes. Revision

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2026

D & F Block Elements

CHEMISTRY LECTURE-7

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

- Standard Electrode Potential
- Stability of Higher Oxidation State

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Energy.

Ionisation Enthalpies

There is an increase in ionisation enthalpy along each series of the transition elements from left to right

Cry

Zn>Fe>Co>Cu>Ni> Mn>Ti>Cr>V>Sc

BKT

Zan fir koi Nhi mai Tujhe rula V sKti hu.

2nd IE

3rd IE of Zn

Sc Ti V Cr Mn Fe Co Ni Cu Zn

IE increases.

Zn Fe Co Cu Ni Mn Ti Cr V Sc.

Ionization Enthalpy

↓

Energy

Ion ka formation.

cation ka formation

$$Na \xrightarrow[-e]{} Na^+ + e$$

$$Cr(s) \xrightarrow{-e} X$$

sublimation.

$$Cr(s) \xrightarrow{\Delta} Cr(g)$$

$$Cr(g) \xrightarrow[\Delta]{-e} Cr^+(g)$$

IE

* Energy required to remove an electron from isolated gaseous state.

akela.

$$M \xrightarrow[-e]{\text{IE high.}} M^+$$

stable — less stable.

A — IE_6

$$A^{+5} \xrightarrow[-e]{} A^{+6} + e$$

IE_6

* $Fe \xrightarrow[-e]{} Fe^+ + e$ — IE_1

$Fe^+ \xrightarrow[-e]{} Fe^{+2} + e$ — IE_2

$Fe^{+2} \xrightarrow[-e]{} Fe^{+3} + e$ — IE_3

$Zn \longrightarrow 3^{rd}\ IE \longrightarrow IE_3$ high.

$Zn^{+2} \xrightarrow[-e]{} Zn^{+3} + e$

$4s^0\ 3d^{10}$

fully filled

Stable.

Cr $\underline{\underline{IE_2}}$ — high / low

$Cr^{+1} \xrightarrow[-e]{} Cr^{+2} + e$

$4s^0\ 3d^5$

Half filled

Stable

IE_2 $\underline{\underline{\text{high}}}$

QUESTION

The correct order of decreasing second ionisation enthalpy of Ti (22), V(23), Cr(24) and Mn(25)

(A) Mn > Cr > Ti > V

(B) Ti > V > Cr > Mn

(C) Cr > Mn > V >Ti

(D) V > Mn > Cr > Ti

Ti_{22} V_{23} Cr_{24} Mn_{25}

$4s^2 3d^2$ $4s^2 3d^3$ $4s^1 3d^5$ $4s^2 3d^5$

Ti^+ V^+ Cr^+ Mn^+

$4s^1 3d^2$ $4s^1 3d^3$ $4s^0 3d^5$ $4s^1 3d^5$

HF

Oxidation

① Addition of oxygen.

$$\overset{0}{Mg} + \overset{0}{O_2} \longrightarrow \overset{+2}{Mg}\overset{-2}{O}$$

oxidation

RA

Add^n of oxygen

increase oxidation no.

Reduction.

① Removal of oxygen.

② Decrese in oxidation number.

$$* \quad \underset{(-1)}{A^{-1}} \longrightarrow \underset{(0)}{A^{0}}$$

Increases (oxidation)

$Mn^{+7} \longrightarrow Mn^{+2}$

oxidising agent

Decrease in ON

Reduction.

$Fe^{+2} \xrightarrow{+1} Fe^{+3}$

Reducing agent.

Oxidation.

oxidising agent.

$Cr^{+6} \longrightarrow Cr^{+3}$

Reduction.

RA.

$H_2S \longrightarrow S$

$2H^{+} / S^{-2} \longrightarrow S^{0}$

$(-2) \qquad 0$

inc → oxidation

$\overset{+7}{MnO_4^-} \xrightarrow{\text{reduction}} \overset{+4}{MnO_2}$

OA

$x + 4 \times (-2) = -1$

$x = 7$

$x - 4 = 0$

$x = 4$

$\overset{+3}{NO_2^-} \xrightarrow{[O]} \overset{+5}{NO_3^-}$

RA

$x - 4 = -1$

$x = 3$

$x - 6 = -1$

$x = 5$

$\overset{+4}{SO_2} \xrightarrow{\text{oxidation}} \overset{+6}{SO_4^{-2}}$

RA

$x + 2 \times (-2) = 0$

$x = 4$

$x + 4 \times (-2) = -2$

$x = 6$

$Cl^- \longrightarrow Cl_2^0$

RA

$(-1) \longrightarrow 0$

oxidation.

Oxidising agent	Reducing agent
→ oxides others.	→ Reduces others.
→ Jo kisi Aur ka oxidation karte	→ kisi aur ka reduction karte
→ khud ka Reduction.	→ khud ka oxidation.

* Metal $\longrightarrow$ e donar

* $M^0 \xrightarrow{[O]} M^+ + e$

RA

* $Zn \xrightarrow{[O]} Zn^{+2} + 2e$

RA

* $Cr \xrightarrow{[O]} Cr^{+2} + 2e$

RA

* Metals are Reducing agent

Sublimation Energy

① $M(s) \xrightarrow{\Delta} M(g)$

Enthalpy of Atomization

② $M(g) \xrightarrow[-e]{} M^+(g) + e$ IE

③ $M^+(g) \xrightarrow[H_2O]{} M^+(aq)$ HE

low ⟸ EA + IE + HE → high.

de rahe (supply) (+ve)

mil rha hai (releases) (−ve)

ΔH = Final Energy − Initial Energy.

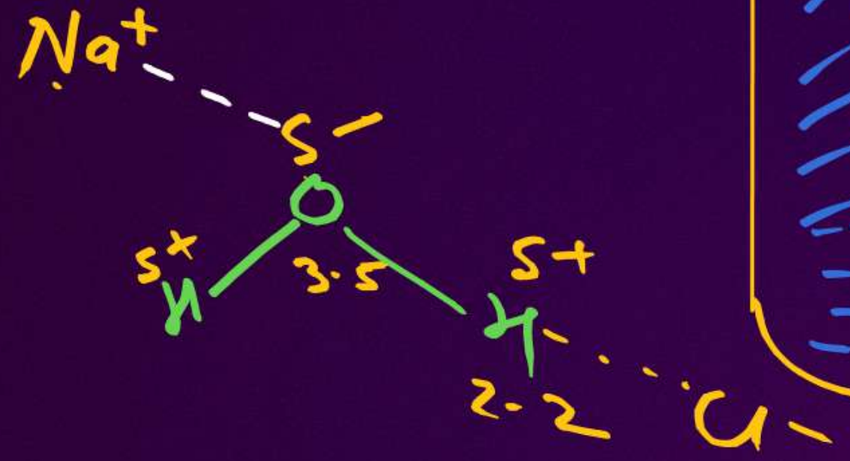
= +ve Endothermic

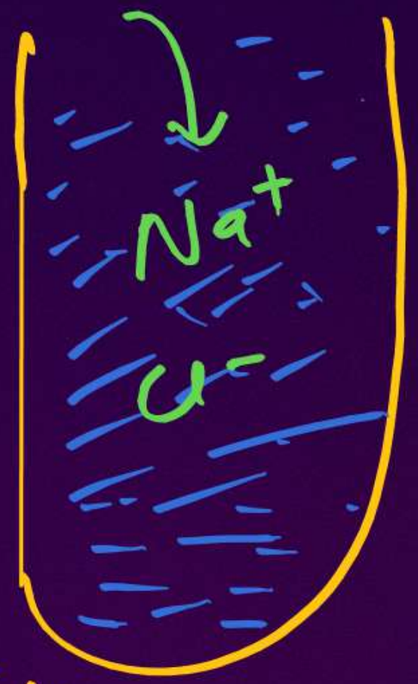
ΔH = −ve Exothermic rxn.

Hydration Energy/Enthalpy

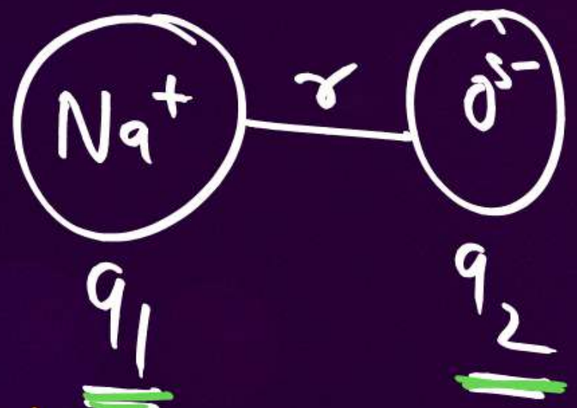
pani
H_2O

$$F = \frac{k q_1 q_2}{r^2}$$





C	N	O	F
2.5	3.0	3.5	4.0



Hydration Energy $\propto F$

$\propto \frac{k q_1 q_2}{r^2}$

$$\boxed{HE \propto \frac{Q}{r}}$$

> Fe^{+2}

> Cu^{+1}

Hydration Energy $\propto \frac{Q}{r}$

Q = charge

r = radius.

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

$Cu^{+2} > Cu^{+}$

M^{2+}/M Standard Electrode Potentials

$M^0 \longrightarrow M^{+2}$

ghar Sasural.

- $E^{\ominus}/V$ is negative this means that ion is not interested for reduction
- $E^{\ominus}/V$ is positive this means that ion is interested for reduction

$E^0_{M^{+2}/M} = -ve$ $M^{+2}[R] \longrightarrow M^0$ (−ve) No

stable

Nhi Jana chahti

$E^0_{M^{+2}/M} = +ve$ $M^{+2} \longrightarrow M^0$ +ve yes.

yes

Jana chahti hai

stable

$E^{o}_{M^{+2}/M} \Rightarrow +ve$

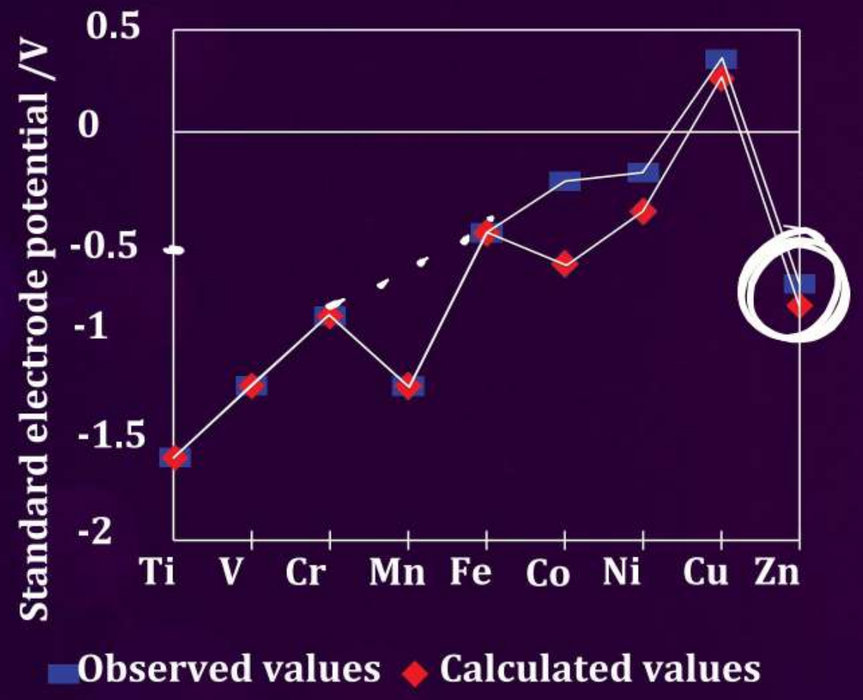
$M^{+2} \longrightarrow M^{0}$ → more stable

Jana chahti hai

$E^{o}_{M^{+2}/M^{0}} = -ve$ NO

$M^{+2} \longrightarrow M^{0}$ Nhi Jana chahti hai

M^{2+}/M Standard Electrode Potentials



Element (M)	$\Delta_a H^\ominus$ (M)	$\Delta_i H_1^\ominus$	$\Delta_1 H_2^\ominus$	$\Delta_{hyd} H^\ominus$ (M^{2+})	$E^\ominus/V$
Ti	469	656	1309	-1866	-1.63
V	515	650	1414	-1895	-1.18
Cr	398	653	1592	-1925	-0.90
Mn	279	717	1509	-1862	-1.18
Fe	418	762	1561	-1998	-0.44
Co	427	758	1644	-2079	-0.28
Ni	431	736	1752	-2121	-0.25
Cu	339	745	1958	-2121	0.34
Zn	130	906	1734	-2059	-0.76

* $E^0_{Mn^{+2}/Mn} = -ve$ (more -ve)

$Mn^{+2} \longrightarrow Mn^0$

No

$4s^0\,3d^5$ → Half filled → Stable

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

* $E^0_{Zn^{+2}/Zn} = -ve$

$Zn^{+2} \longrightarrow Zn$

$4s^0\,3d^{10}$ → fully filled → Stable

$4s^2\,3d^{10}$

Home Work

→ last DPP ✓

→ Today's DPP ✗

PARISHRAM

2026

D & F Block Elements

CHEMISTRY LECTURE-8

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

- Standard Electrode Potential
- Stability of Higher Oxidation State

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M^{2+}/M Standard Electrode Potentials

- $E^{\ominus}/V$ is negative this means that ion is not interested for reduction
- $E^{\ominus}/V$ is positive this means that ion is interested for reduction

$E^{\circ}_{M^{+2}/M} = -ve$

$M^{+2} \longrightarrow M^{0}$

Stable

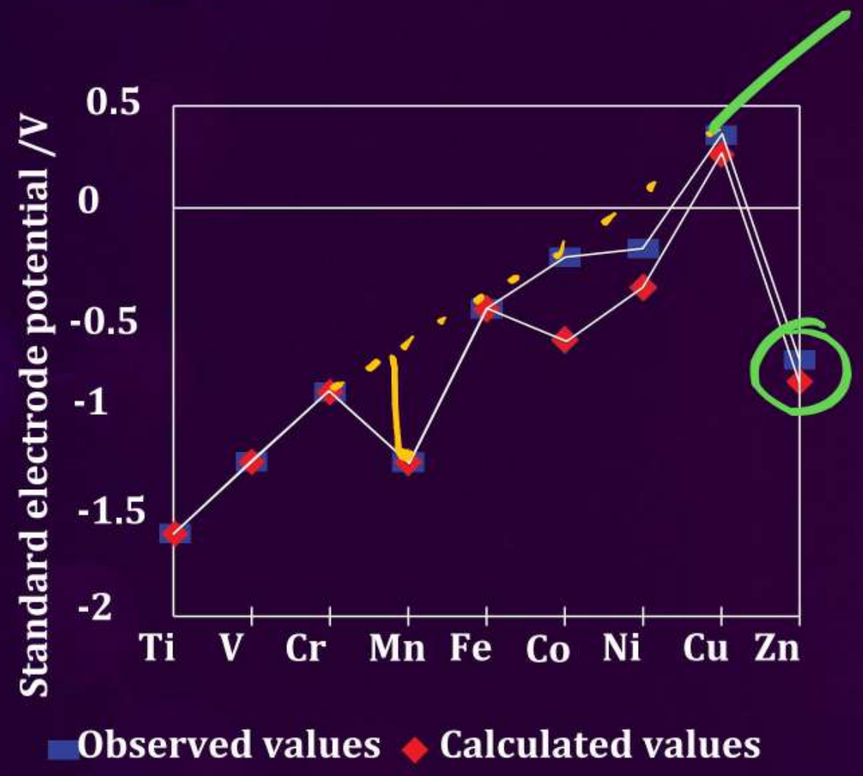
No.

$E^{\circ}_{M^{+2}/M} = +ve$

$M^{+2} \longrightarrow M^{0}$

Stable

M^{2+}/M Standard Electrode Potentials



Element (M)	$\Delta_a H^\ominus$ (M)	$\Delta_i H_1^\ominus$ IE	$\Delta_1 H_2^\ominus$ + IE2	$\Delta_{hyd} H^\ominus$ (M^{2+})	$E^\ominus$/V
Ti	469	656	1309	-1866	-1.63
V	515	650	1414	-1895	-1.18
Cr	398	653	1592	-1925	-0.90
Mn	279	717	1509	-1862	-1.18
Fe	418	762	1561	-1998	-0.44
Co	427	758	1644	-2079	-0.28
Ni	431	736	1752	-2121	-0.25
Cu	339	745	1958	-2121	0.34
Zn	130	906	1734	-2059	-0.76

$E^{\circ}_{Mn^{+2}/Mn}$ = more -ve

$Mn^{+2} \longrightarrow Mn$

$4s^0 3d^5$ $\qquad$ $4s^2 3d^5$

↓

Half filled

$E^{\circ}_{Zn^{+2}/Zn}$ = -ve

$Zn^{+2} \longrightarrow Zn$

$4s^0 3d^{10}$

fully filled.

Biju Bhaiya Magic of rxn.

$$\underset{RA}{M} + \text{dil } H^+Cl^- \xrightarrow{[R]} MCl + H_2^0(g)$$

$$M \xrightarrow{-e} M^+ + e$$

$$HCl \longrightarrow H^+ + Cl^-$$

$$M^+ + Cl^- \longrightarrow MCl.$$

$$H^+ + e \longrightarrow \frac{1}{2} H_2$$

BKT

$$\boxed{2H^+ + 2e \rightarrow H_2(g)}$$

M^{2+}/M Standard Electrode Potentials

NCERT

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

- The unique behaviour of Cu, having a positive $E^{\ominus}$, accounts for its inability to liberate H_2 from acids.

$E^{0}_{Cu^{+2}/Cu^{0}} = +ve$

- $Cu + HCl$ ——— $CuCl_2 + H_2$ Not Possible

- Only oxidising acids (nitric and hot concentrated sulphuric) react with Cu, the acids being reduced.

H_2SO_4

- The high energy to transform $Cu(s)$ to $Cu^{2+}(aq)$ is not balanced by its hydration enthalpy.

$Cu \rightarrow Cu^{+} + e$ IE_1 $Cu^{+} \rightarrow Cu^{+2}$ IE_2 high

$4s^1 3d^{10}$ $4s^0 3d^{10}$ $3d^9$

$Cu + dil\ HCl \longrightarrow CuCl_2 + H_2(g)$ ✗

$Cu^0 \xrightarrow[-2e]{[O]} Cu^{+2} + 2e$ ✗

$2HCl \longrightarrow 2H^+ + 2Cl^-$

$Cu^{+2} + 2Cl^- \rightarrow CuCl_2$

$2H^+ + 2e \longrightarrow H_2(g)$

$E^0_{Cu^{+2}|Cu} = +ve$ ✓

$Cu^{+2} \longrightarrow Cu$

Jana chahti hai

$$Cu^{0} + \text{conc } \underset{OA}{H_2SO_4} \longrightarrow Cu^{+2} + H_2(g)$$

$$Cu \longrightarrow Cu^{2+} + 2e$$

$$\boxed{2H^{+} + 2e \rightarrow H_2}$$

Q WOF rxn is/are possible?

(i) $Zn + dil\ HCl \longrightarrow Zn^{+2} + H_2(g)$

(ii) $Cu + conc\ H_2SO_4 \xrightarrow{hot} Cu^{+2} + H_2(g)$

(iii) $Fe + dil\ HCl \longrightarrow Fe^{+2} + H_2(g)$

(iv) $Cu + dil\ HCl \longrightarrow Cu^{+2} + H_2(g)$

(a) i & ii (b) i & iii (c) ii & iv (d) i, ii, iii

M + dil HCl $\longrightarrow H_2(g)$

Ti ✓
V ✓
Cr ✓
Mn ✓
Fe ✓
Co ✓
Ni ✓
Cnt

Zn ✓

M^{2+}/M Standard Electrode Potentials

NCERT

The general trend towards less negative E^{Θ} values across the series is related to the general increase in the sum of the first and second ionisation enthalpies.

✓ It is interesting to note that the value of E^{Θ} for Mn, Ni and Zn are more negative than expected from the trend.

- **The stability of the half-filled d sub-shell in Mn^{2+} and the completely filled d^{10} configuration in Zn^{2+} are related to their E^{Θ} values, whereas E^{Θ} for Ni is related to the highest negative $\Delta_{hyd}H^{\Theta}$.**

M^{3+}/M^{2+} Standard Electrode Potentials

$E^0_{Zn^{+3}/Zn^{+2}} = +ve$ f.f

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

$4s^0 3d^9$ $\quad$ $4s^0 3d^{10}$

Element	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Atomic number	21	22	23	24	25	26	27	28	29	30
electrode M^{2+}/M	-	-1.63	-1.18	-0.90	-1.18	-0.44	-0.28	-0.25	+0.34	-0.76
Potential $E^{\ominus}/V$ M^{3+}/M^{2+}	- -ve	-0.37	-0.26	-0.41	+1.57	+0.77	+1.97	-	-	- +ve

$E^0_{Mn^{+3}/Mn^{+2}}$ yes.

$E^0_{M^{+3}/M^{+2}}$ $\quad$ $M^{+3} \longrightarrow M^{+2}$

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

$4s^0 3d^4$ $\quad$ $4s^0 3d^5 \rightarrow$ nf

$E^0_{Sc^{+3}/Sc^{+2}} = -ve \rightarrow$ No, $Sc^{+3} \longrightarrow Sc^{+2}$

$[Ar]4s^0 3d^0$ $\quad$ $[Ar]4s^0 3d^1$

QUESTION CBSE 2024

3

Attempt any five of the following:

(b) $E^o(Mn^{2+}/Mn)$ is –1.18 V. Why is this value highly negative in comparison to neighbouring d block elements?

$E^o Mn^{+2}/Mn = -ve \rightarrow No$

$Mn^{+2} \longrightarrow Mn$

$4s^0 3d^5 \rightarrow$ Half filled.

give $\longrightarrow$

since value of

$E^o Mn^{+2}/Mn = -1.18V$

i.e negative this means that Mn^{+2} is not interested for reduction.

M^{3+}/M^{2+} Standard Electrode Potentials

- The highest value for Zn is due to the removal of an electron from the stable d^{10} configuration of Zn^{2+}.
- The comparatively high value for Mn shows that $Mn^{2+}(d^5)$ is particularly stable, whereas comparatively low value for Fe shows the extra stability of Fe^{3+} (d^5).
- The comparatively low value for V is related to the stability of V^{2+} (half-filled t_{2g} level)

$E^\circ_{V^{+3}/V^{+2}}$

$V_{23} = 4s^2 3d^3$

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

$3d^2$ $\quad$ $3d^3$ (t_{2g} HF)

Bk Tx**

- Cr^{+2} is Reducing while Mn+3 is Oxidising

- Mn^{+2} is more stable than Fe^{+2} towards its oxidation to +3 Oxidation state

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

$4s^0 3d^5$ $\quad$ $4s^0 3d^4$ $\quad$ $4s^0 3d^6$ $\quad$ $4s^0 3d^5$

HF $\quad$ HF

* Cr^{2+} is a stronger reducing agent than Fe^{2+}

- The E° value for the Mn^{3+}/Mn^{2+} couple is more positive than that of the Fe^{3+}/Fe^{2+} couple or Cr^{3+}/Cr^{2+} because Mn^{2+} is more stable than Fe^{2+}

$Mn^{+3} \longrightarrow Mn^{+2}$ $\quad$ $Fe^{+3} \longrightarrow Fe^{+2}$ $\quad$ $Cr^{+3} \longrightarrow Cr^{+2}$

$4s^0 3d^4$ $\quad$ $4s^0 3d^5$ $\quad$ $4s^0 3d^5$ $\quad$ $4s^0 3d^6$ $\quad$ $3d^3$ $\quad$ $3d^4$

BKT **

Cr^{+2} is reducing agent while Mn^{+3} is oxidising agent?

↓ oxidation.

Reduction.

$Cr = 4s^1 3d^5$

$Cr^{+2} \xrightarrow{[O]} Cr^{+3}$

$4s^0 3d^4$

$4s^0 3d^3$

t_{2g} half filled

↑	↑	↑		
t_{2g}			e_g	

$Mn^{+3} \xrightarrow{[R]} Mn^{+2}$

$4s^0 3d^4$

$4s^0 3d^5$

half filled.

Cr^{+2} is stronger Reducing agent than Fe^{+2}.

oxidation

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

$4s^0 3d^4$ $\quad$ $4s^0 3d^3$ $(t_{2g}\ hf)$

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

$4s^0 3d^6$ $\quad$ $4s^0 3d^5$ (hf)

* $t_{2g}\ hf > hf$

*

↑	↑	↑

↑	↑	↑	↑	↑

Home Work

DPPs ✓

PARISHRAM

2026

D & F Block Elements

CHEMISTRY LECTURE-9

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

- Catalytic Properties
- Interstitial Compounds
- Alloy Formation

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Stability of Higher Oxidation States

F
Cl
Br
I

size inc

Blc T*

- D block elements form bond in higher oxidation state only with Oxygen & fluorine

- The ability of fluorine to stabilise the highest oxidation state is due to either higher lattice, or higher bond enthalpy.

V — F V — I

- Oxygen stabilizes the higher oxidation state by forming multiple bonds.

Mn = O

Blc T**

The +7 state for Mn is not represented in simple halides but MnO3F is known – PYQ

Highest fluoride of Mn is MnF4 whereas the highest oxide is Mn2O7. - PYQ

2n − 14 = 0 n = 7

Sc	Ti	V	Cr	Mn
3	4	5	6	7

WOF is maximum O.S of Mn

(a) 6

(b) 7

(c) 8

(d) 5

Mn

$4s^2\ 3d^5$

$2+5^- = 7$

WOF is maximum O.S of Cr

(a) 6

(b) 7

(c) 8

(d) 5

Cr_{24} $4s^1$ $3d^5$

$\boxed{1+5=6}$

WOF is maximum O.S of V

(a) 6

(b) 7

(c) 8

(d) 5

V_{23} $4s^2\ 3d^3$

$2+3=5$

Stability of Higher Oxidation States

Formulas of Halides of 3d Metals

Oxidation Number									
+6			CrF_6						
+5		VF_5	CrF_5						
+4	TiX_4	VX_4^{I}	CrX_4	MnF_4					
+3	TiX_3	VX_3	CrX_3	MnF_3	FeX_3^{I}	CoF_3			
+2	TiX_2^{III}	VX_2	CrX_2	MnX_2	FeX_2	CoX_2	NiX_2	CuX_2^{II}	ZnX_2
+1								CuX^{III}	

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

The +7 state for Mn is not represented in simple halides but MnO_3F is known

MnF_7 ✗ $\longrightarrow$ does not exist.

MnF_4 ✓ $\longrightarrow$ yes.

MnO_3F $\longrightarrow$ yes.

Mn_2O_7 $\longrightarrow$ yes.

Stability of Higher Oxidation States

BKT*

CuF_2 ✓ $CuCl_2$ ✓ $CuBr_2$ ✓ CuI_2 ✗

- All Cu^{ii} halides are known except the iodide. In this case, Cu^{2+} oxidises I^- to I_2

$$2Cu^{2+} + 4I^- \rightarrow Cu_2^{+1}I_2^{-1}(s) + I_2^{0}$$

OA [O]

*Many copper (i) compounds are unstable in aqueous solution and undergo disproportionation because of hydration energy

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

Copper (I) ion (Cu^+) is not known in aqueous solution - PYQ

$$Cu^{+2} + 4I^- \rightarrow Cu_2I_2 + I_2$$

$$Cu^{+2} \longrightarrow Cu^+ + I^-$$

$$Cu^+ \quad I^-$$

$$\rightarrow Cu_2I_2$$

wof reaction is not correct?
rxn

(a) $Cu^{+2} + F^- \longrightarrow CuF_2$

(b) $Cu^{+2} + I^- \longrightarrow Cu_2I_2 + I_2$

(c) $Cu^{+2} + I^- \longrightarrow CuI_2$

(d) $Cu^{+2} + Cl^- \longrightarrow CuCl_2$

✓ $Cu^{+2} + F^- \longrightarrow Cu^{+}/CuI_2 + F_2$

$Cu^{+2} + F^- \longrightarrow CuF_2$

OA

$Cu^{+2} + Cl^- \longrightarrow CuCl_2$

$Cu \xrightarrow{2} F$, $Cu \xrightarrow{1} F$

OA

Cu^{+2}

$\downarrow [R]$

Cu^{+1}

$Cu^{+2} + Br^- \longrightarrow CuBr_2$

$Cu^{+2} + I^- \longrightarrow CuI_2$ X

Cu^{+1}

$Cu^{+2} + I^- \longrightarrow Cu_2^{+1}I_2 + I_2$

OA

$2n - 2 = 0$

$n = 1$

$F_2 \quad Cl_2 \quad Br_2 \quad I_2$

order of oxidising agent

$F_2 > Cl_2 > Br_2 > I_2$

QUESTION- NCERT Exemplar

Highest oxidation state of manganese in fluoride is +4 (MnF_4) but highest oxidation state in oxides is +7 (Mn_2O_7) because _____.

A fluorine is more electronegative than oxygen.

B fluorine does not possess d-orbitals.

C fluorine stabilises lower oxidation state.

D in covalent compounds fluorine can form single bond only while oxygen forms double bond.

Stability of Higher Oxidation States

- Many copper (i) compounds are unstable in aqueous solution and undergo disproportionation because of hydration energy

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

Copper (I) ion (Cu^{+}) is not known in aqueous solution - PYQ

* $Cu^{+2} > Cu^{+1}$ Hydration Energy.

✓ Hydration Energy $\propto \frac{Q}{r}$

Q = charge.

Cu^{+}	<	Cu^{+2}	→ HE
$4s^0 3d^{10}$		$4s^0 3d^9$	

Cu^{+2} is more stable than Cu^{+} in water due to HE.

$$Cu^{+}(aq) \xrightarrow{H_2O} Cu^{+2} + Cu^{0}$$

oxidation

Reduction

$\longrightarrow$ Disproportionation rxn.

$\downarrow$

DPP rxn.

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

$$Cu^{+} + e \longrightarrow Cu$$

$$A + B \longrightarrow C + D$$

Home Work

→ Do not solve Todays DPP.

* NCERT Reading.

PARISHRAM

2026

D & F Block Elements

CHEMISTRY LECTURE-10

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

- Catalytic Properties
- Interstitial Compounds
- Alloy Formation
- Magnetic Properties
- Formation of Coloured Ions
- Metallic Character

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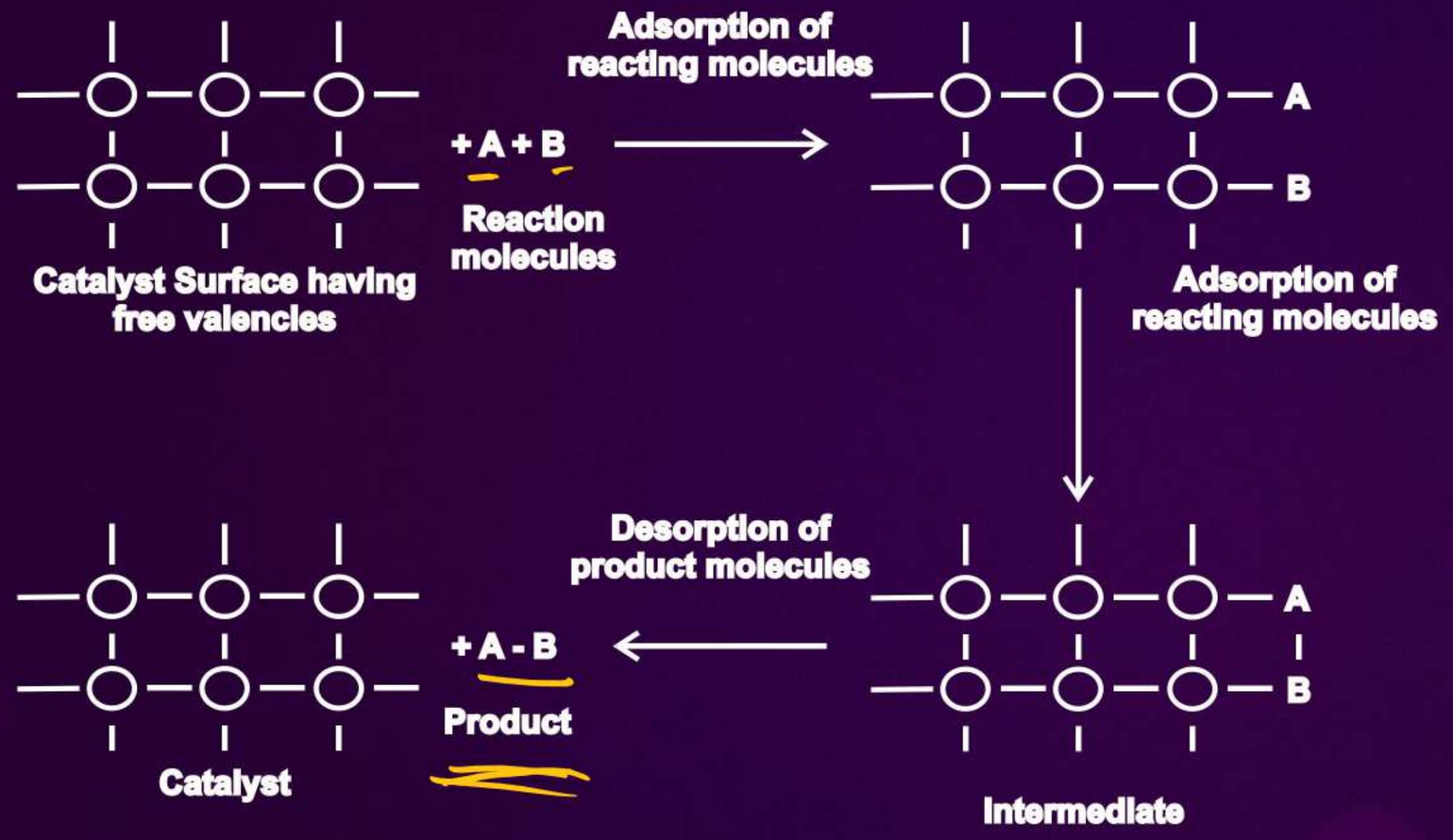
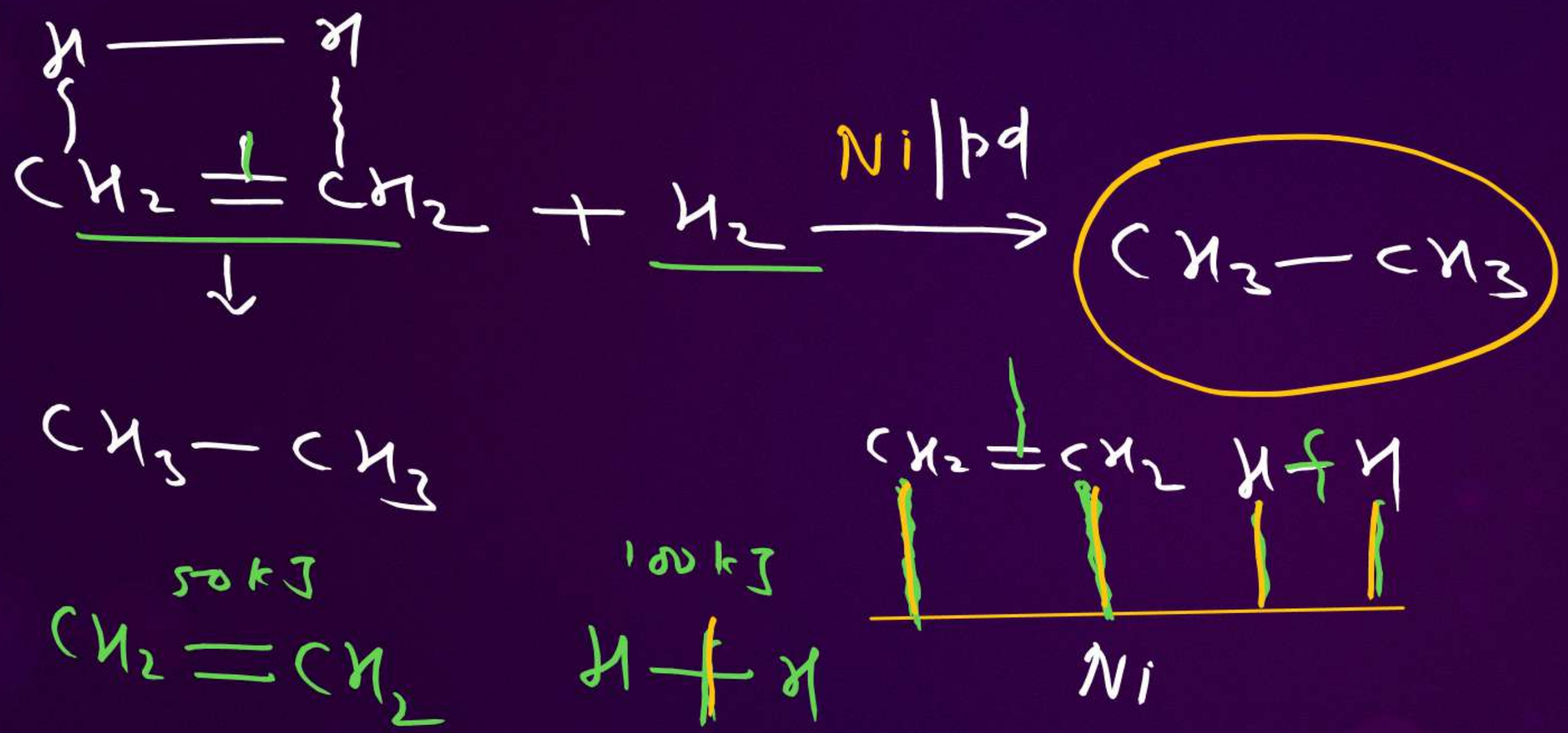
Catalytic Properties



Catalyst.


H — H
CH2 = CH2
+ H2
Ni|Pd
CH3 — CH3
CH3 — CH3
CH2 = CH2
H — H
Ni
50 kJ
CH2 = CH2
100 kJ
H — H

Biju
Bhaiya
Akky
pinki
sinki
Biju
Bhaiy

Catalytic Properties

NCERT

BKT

- The transition metals and their compounds are known for their catalytic activity. This activity is ascribed to their ability to adopt multiple oxidation states and to form complexes

- Catalysts at a solid surface involve the formation of bonds between reactant molecules and atoms of the surface of the catalyst

- **This has the effect of increasing the concentration of the reactants at the catalyst surface and also weakening of the bonds in the reacting molecules (the activation energy is lowering).**

$CH_2 = CH_2 + H_2 (H + H)(H \; H$

Catalytic Properties

Because the transition metal ions can change their oxidation states, they become more effective as catalysts :-

Iron(III) catalyses the reaction between iodide and persulphate ions.

$$2\,I^- + S_2O_8^{2-} \rightarrow I_2 + 2\,SO_4^{2-}$$

An explanation of this catalytic action can be given as:

$$2\,Fe^{3+} + 2\,I^- \rightarrow 2\,Fe^{2+} + I_2$$

$$2\,Fe^{2+} + S_2O_8^{2-} \rightarrow 2\,Fe^{3+} + 2SO_4^{2-}$$

$$\underset{OA}{Fe^{+3}} + I^- \longrightarrow I_2 + Fe^{+2}$$

$$\underset{RA}{Fe^{+2}} + \underset{OA}{S_2O_8^{-2}} \longrightarrow SO_4^{-2} + Fe^{+3}$$

$$I^- + S_2O_8^{-2} \longrightarrow I_2 + SO_4^{-2}$$

OA

BKT → −ve OS + OA → zero OS

$$I^- + OA \longrightarrow I_2$$

(−1)

$2x = 0$

$x = 0$

$Cl^- + OA \longrightarrow Cl_2^0$

$Br^- + OA \longrightarrow Br_2$

$I^- + OA \longrightarrow I_2$

$S^{-2} + OA \longrightarrow S$

(-2)

$S_2O_8^{-2}$

x

oxidation no =

$2x + 8 \times (-2) = -2$

$2x - 16 = -2$

$\boxed{x = 7}$

Ans = 6

Trick

for p block

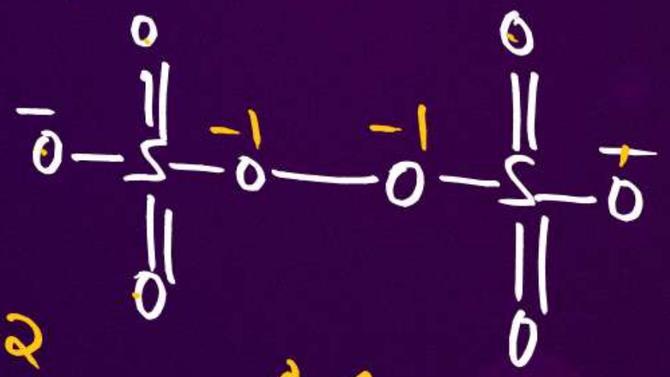
maximum OS = group no − 10

= 16 − 10

= 6

16
- O
- S
- Se
- Te
- Po

$S_2O_8^{-2}$ (OA)



OA

$O^{-1} \xrightarrow{[R]} O^{-2}$

OA

O_2^{-2}

$2x = -2$

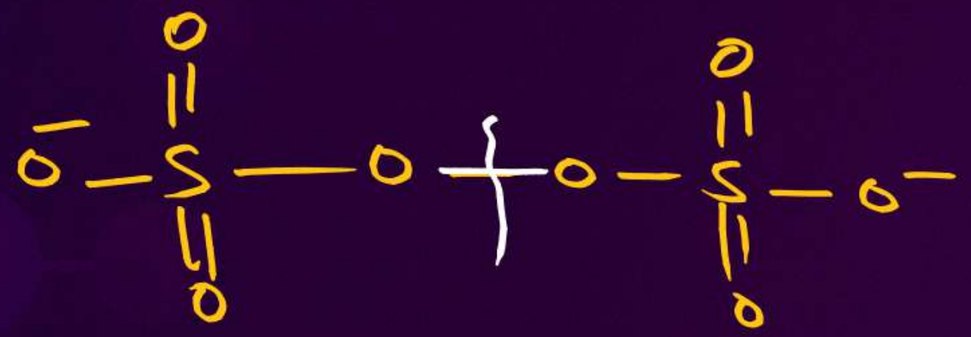
$x = -1$

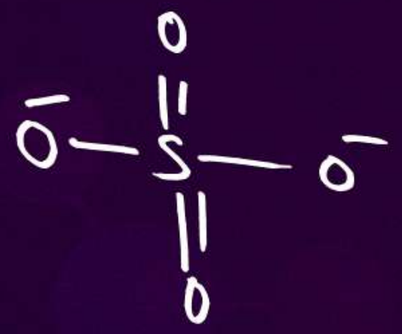
peroxide bond.

$S_2O_8^{-2} \longrightarrow SO_4^{-2}$

$O\ A$

$O^{-1} \longrightarrow O^{-2}$

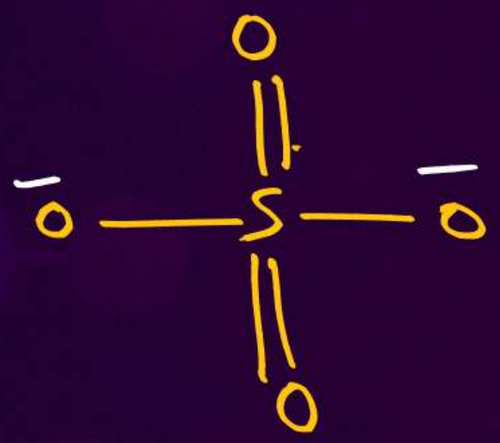




structure

Jadu → BKT

SO_4^{-2}



SO_3^{-2}

CO_3^{-2}

O → stable

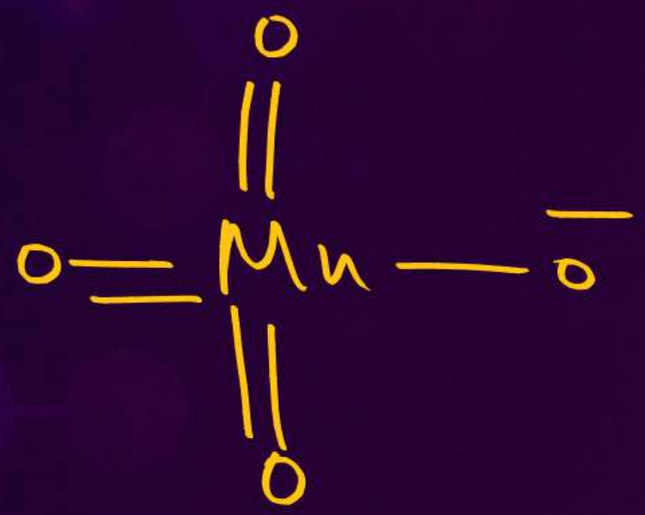
VE = 6 + 2 = 8e

O = A, A—O—A

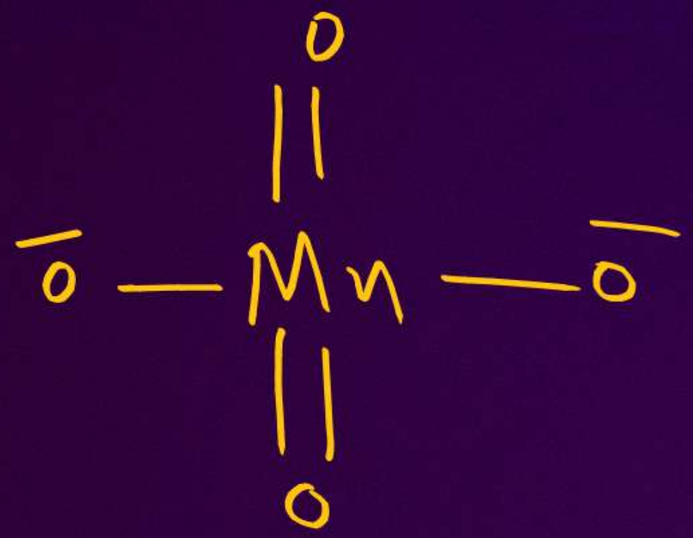
O + e = O⁻

6e + e = 7e $\bar{O}$—A

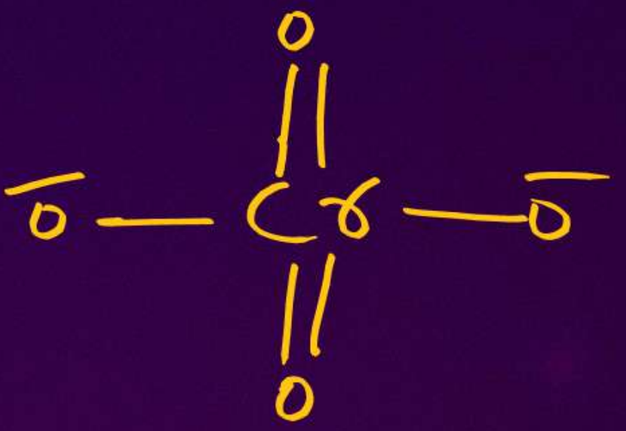
MnO_4^-



MnO_4^{-2}



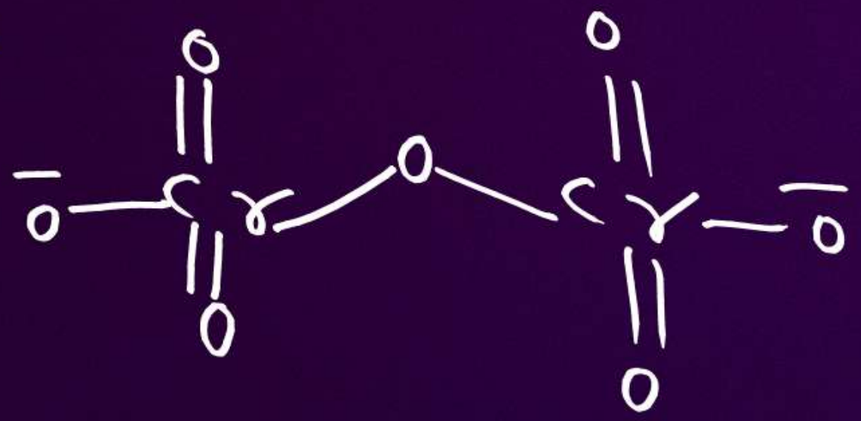
CrO_4^{-2}



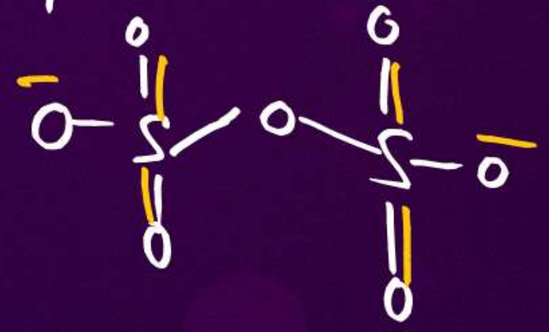
$Cr_2O_7^{-2}$

2Cr 7O

Cr 3.5



$S_2O_7^{-2}$



Catalytic Properties

Some Important Catalyst

Contact Process – V_2O_5 (SO_2 to SO_3) (H_2SO_4)
Haber's Process – Fe_2O_3, Al_2O_3, K_2O (NH_3)
Ostwald's Process – Pt/Rh (HNO_3)
Zeigler Natta – $TiCl_4 + (C_2H_5)_3Al$ (Polymerization of Alkene)

Hydrogenation of Alkene – Ni/Pd
Wilkinson's Catalyst – RhCl + PPh_3

Question

The catalytic activity of the transition metals and their compounds is ascribed to their

A. magnetic behaviour

B. chemical reactivity

C. unfilled d-orbitals

D. ability to adopt multiple oxidation states and their complexing ability

Question

In the manufacture of H_2SO_4 by contact process, the catalyst used is/are

A. Pt

B. MnO_2

C. V_2O_5

D. both Ni and Pd

Formation of Complex Compounds

The transition metals form a large number of complex compounds. This is due to

1. Comparatively smaller sizes of the metal ions,
2. High ionic charges
3. The availability of d orbitals for bond formation.

$[Fe(CN)_6]^{3-}$, $[Fe(CN)_6]^{4-}$, $[Cu(NH_3)_4]^{2+}$ and $[PtCl_4]^{2-}$

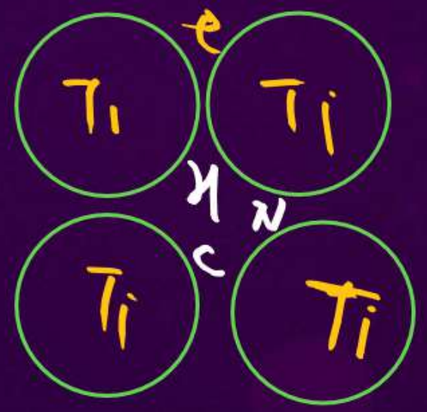
Formation of Interstitial Compounds

- Interstitial compounds are those which are formed when small atoms like H, C or N are trapped inside the crystal lattices of metals.

- They are usually non stoichiometric and are neither typically ionic nor covalent, for example, TiC, Mn_4N, Fe_3H, $VH_{0.56}$ and $TiH_{1.7}$, etc.

$$Ti + C \rightarrow TiC$$

$$Mn + N \rightarrow Mn_4N$$



The principal physical and chemical characteristics of these compounds are as follows:

(i) They have high melting points, higher than those of pure metals.

(ii) They are very hard, some borides approach diamond in hardness.

(iii) They retain metallic conductivity.

(iv) They are chemically inert.

$Ti + C \longrightarrow TiC$

① They have high m.p.

② They are very hard.

③ retain metallic conductivity.

④ Chemically inert

QUESTION

CBSE 2024

Tranisition metals are known to make interstitial compounds. Formation of interstitial compounds makes the transition metal.

A More hard

B More soft

C More ductile

D More metallic

QUESTION- All India 2020, NCERT Exemplars

Interstitial compounds are formed when small atoms are trapped inside the crystal lattice of metals. Which of the following is not the characteristics property of interstitial compounds?

A. They have high melting points in comparison to pure metals

B. They are very hard

C. They retain metallic conductivity

D. The are chemically very reactive

Alloy Formation

- Alloys are formed by atoms with metallic radii that are within about 15 percent of each other.

- Because of similar radii and other characteristics of transition metals, alloys are readily formed by these metals

Brass (copper-zinc) and
bronze (copper-tin),
German Silver Cu , Zn , Ni

Magnetic Properties

- Diamagnetic substances are repelled by the applied field while the paramagnetic substances are attracted.
- Substances which are attracted very strongly are said to be ferromagnetic.
- In fact, ferromagnetism is an extreme form of paramagnetism.

If no. of unpaired electron $n = 0$ Diamagnetic.
If no. of unpaired electron $n \neq 0$ paramagnetic.

$\mu \longrightarrow$ magnetic moment

spin only magnetic moment

$$\mu = \sqrt{n(n+2)} \quad B.M$$

n = no. of unpaired electron

$n = 1 \quad \mu = \sqrt{1 \times (1+2)} = \sqrt{3} = 1.73.$

BKT

$n = 1 \quad \mu = 1.73$

$n = 2 \quad \mu = 2.\ldots \qquad n = 5 \quad \mu = 5.\ldots$

$n = 3 \quad \mu = 3.\ldots$

$n = 4 \quad \mu = 4.\ldots$

Magnetic Properties

Calculated and Observed Magnetic Moments (BM)

Ion	Configuration	Unpaired electron(s)	Magnetic moment	
			Calculated	Observed
Sc^{3+}	$3d^0$	0	0	0
Ti^{3+}	$3d^1$	1	1.73	1.75
Tl^{2+}	$3d^2$	2	2.84	2.76
V^{2+}	$3d^3$	3	3.87	3.86
Cr^{2+}	$3d^4$	4	4.90	4.80
Mn^{2+}	$3d^5$	5	5.92	5.96
Fe^{2+}	$3d^6$	4	4.90	5.3 – 5.5
Co^{2+}	$3d^7$	3	3.87	4.4 – 5.2
Ni^{2+}	$3d^8$	2	2.84	2.9 – 3, 4
Cu^{2+}	$3d^9$	1	1.73	1.8 – 2.2
Zn^{2+}	$3d^{10}$	0	0	

Question

The highest magnetic moment is shown by the transition metal ion with the outer electronic configuration

A $3d^2$

2

B $3d^7$

3

C $3d^5$ ✓

5

D $3d^9$

1

↑↓	↑↓	↑↓	↑↓	↑

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

Question

Which of the following has highest magnetic moment?

A Ti^{3+} $4s^2 3d^2 \longrightarrow 4s^0 3d^1 = 1$

B Sc^{3+} $Sc_{23} = 4s^2 3d^1 = 4s^0 3d^0$ $n=0$

C Mn^{2+} $4s^2 3d^5 = 4s^0 3d^5 = 5$

D Zn^{2+} $4s^0 3d^{10}$ $n=0$.

Question

Electrons in a paramagnetic compound are

$n \neq 0$

- **A** unpaired
- **B** shared
- **C** paired
- **D** donated

Diamagnetic

$n = 0$

paired.

Question

Which of the following has lowest magnetic moment

A. $3d^2$ 2

B. $3d^7$ 10 - 7 = 3

C. $3d^9$ 1

D. $3d^3$ 3

Question

μ_m

Which of the following ions has the least magnetic moment?

A Cu^{+2}

B Ni^{+2}

C Co^{+3}

D Fe^{+2}

Formation of Coloured Ions

Ions in M^{+2} state

V^{2+} → Violet → V → Very
Cr^{2+} → Blue → B → Beautiful
Mn^{2+} → Pink → P → Pink
Fe^{2+} → Green → G → Girl
Co^{2+} → Pink → P → Pinky
Ni^{2+} → Green → G → G
Cu^{2+} → Blue → B → Bhut
Zn^{2+} → Colourless → C → Cute hai

Ions in M^{3+} state

Sc^{3+} → Colourless → C → Cute
Ti^{3+} → Purple → P → Purple
V^{3+} → Green → G → Girl
Cr^{3+} → Violet → V → Vinni
Mn^{3+} → Violet → V → Very
Fe^{3+} → Yellow → Y → Young

$n = 0$ colourless
$n \neq 0$ coloured

Configuration	Example	Colour
$3d^0$	Sc^{3+}	colourless
$3d^0$	Ti^{4+}	colourless
$3d^1$	Ti^{3+}	purple
$3d^1$	V^{4+}	blue
$3d^2$	V^{3+}	green
$3d^3$	V^{2+}	violet
$3d^3$	Cr^{3+}	violet
$3d^4$	Mn^{3+}	violet
$3d^4$	Cr^{2+}	blue
$3d^5$	Mn^{2+}	pink
$3d^5$	Fe^{3+}	yellow
$3d^6$	Fe^{2+}	green
$3d^6 3d^7$	$Co^{3+} Co^{2+}$	bluepink
$3d^8$	Ni^{2+}	green
$3d^9$	Cu^{2+}	blue
$3d^{10}$	Zn^{2+}	colourless

Question

Which ion gives coloured solution?

A Cu^{1+} $4s^1 3d^{10}$ $Cu^{+1} = 4s^0 3d^{10}$ $n = 0$

→ colourless

B Zn^{2+}

C Ag^{1+}

D Fe^{2+} → $4s^2 3d^6$

$4s^0 3d^6$ $n = 4$

Coloured.

Question

Which one of the following ions is colourless?

A. Mn^{3+}

B. V^{3+}

C. Ni^{2+}

D. Zn^{2+}

$4s^0 3d^{10}$ $n=0$

Question

In which of the following pairs are both ions are coloured in aqueous solution?

A. Sc^{3+}, Ti^{3+} Sc+3 4s°3d° n=0

B. Sc^{3+} Co^{2+}

C. Ni^{2+}, Cu^{1+} 4s°3d¹⁰ n=0

D. Ni^{2+}, Ti^{3+}

Question

no

Which of the following set has all the coloured ions

A Cu^{+}, Cu^{2+}, Ni^{2+}

B $Cu^{2+}, Co^{2+}, Sc^{3+}$

C $Cu^{2+}, Fe^{2+}, Co^{2+}$

D Na^{+}, Mg^{2+}, Al^{3+}

Home Work

→ DPP

PARISHRAM

2026

D & F Block Elements

CHEMISTRY LECTURE-11

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

Compounds of D Block
Preparation and Reaction of $K_2Cr_2O_7$

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* If no. of unpaired electron $n = 0$

Colourless.

* If no. of unpaired electrons $n \neq 0$

Coloured.

1. wof is coloured?

(a) $Sc^{+3} \longrightarrow 4s^0 3d^0$ $n=0$

(b) Fe^{+2} $4s^0 3d^6$ $n=4$

(c) Zn^{+2} $4s^0 3d^{10}$ $n=0$

(d) V^{+5} $4s^0 3d^0$ $n=0$

2. WOF is colourless?

(a) Fe^{+3} $4s^0 3d^5 = 5$

(b) Cu^{+2} $4s^0 3d^9 = 1$

(c) Cu^{+1} $4s^0 3d^{10} = 0$

(d) Cr^{+2} $4s^0 3d^4 = 4$

Formation of Coloured Ions

Ions in M^{+2} state

V^{2+} → Violet → V → Very

Cr^{2+} → Blue → B → Beautiful

Mn^{2+} → Pink → P → Pink

Fe^{2+} → Green → G → Girl

Co^{2+} → Pink → P → Pinky

Ni^{2+} → Green → G → G

Cu^{2+} → Blue → B → Bhut

Zn^{2+} → Colourless → C → Cute hai

Ions in M^{3+} state

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V^{3+} → Green → G → Girl

Cr^{3+} → Violet → V → Vinni

Mn^{3+} → Violet → V → Very

Fe^{3+} → Yellow → Y → Young

Configuration	Example	Colour
$3d^0$	Sc^{3+}	colourless
$3d^0$	Ti^{4+}	colourless
$3d^1$	Ti^{3+}	purple
$3d^1$	V^{4+}	blue
$3d^2$	V^{3+}	green
$3d^3$	V^{2+}	violet
$3d^3$	Cr^{3+}	violet
$3d^4$	Mn^{3+}	violet
$3d^4$	Cr^{2+}	blue
$3d^5$	Mn^{2+}	pink
$3d^5$	Fe^{3+}	yellow
$3d^6$	Fe^{2+}	green
$3d^6 3d^7$	$Co^{3+} Co^{2+}$	bluepink
$3d^8$	Ni^{2+}	green
$3d^9$	Cu^{2+}	blue
$3d^{10}$	Zn^{2+}	colourless

What is color of Co^{+2}.

(a) Red

(b) pink

(c) green

(d) yellow

V^{+2}	Voilet
Cr^{+2}	blue
Mn^{+2}	pink
Fe^{+2}	green
Co^{+2}	pink

What is colour of Fe^{+3}

(a) pink

(b) Red pink

(c) yellow

(d) green

DPP-9

Coloured ?

$Ag^+ \rightarrow n=0$

SO_4^{-2}

(a) $Ag_2(SO_4)$

$2n-2=0 \quad 2n=2 \quad n=1$

(b) $\overset{+2}{Cu}F_2$ $\quad Cu^{+2} \longrightarrow Cu_{29}$

$4s^1 3d^{10}$

$\longrightarrow Cu^{+2}$

$\boxed{n=1}$ $\quad 4s^0 3d^9$

(c) $\overset{+2}{Zn}F_2$

(d) $\overset{+1}{Cu_2}F_2$

$2n-2=0$

$n=1$

$CoCl_2$

Co^{+2}

→ wof is coloured.

(a) $Ag_2(SO_4) \longrightarrow 2Ag^+ + SO_4^{-2}$ ✗

(b) $CuCl \longrightarrow Cu^+ + Cl^-$ ✗

(c) $CuF_2 \longrightarrow Cu^{+2} + F^-$

$4s^0 3d^9$ $n=1$

(d) $ZnF_2 \longrightarrow Zn^{+2} + F^-$

$4s^0 3d^{10}$ $n=0$

Cu $4s^1 3d^{10}$

Ag

Au

Cu^+ $4s^0 3d^{10}$

Ag^+ $5s^0 4d^{10}$

$n=0$

Formation of Coloured Ions

$KMnO_4$ Purple

$K_2Cr_2O_7$ Orange

$2 + 2n - 14 = 0$

$n = 6$

Cr^{+6} $4s^0 3d^0$ $n = 0$

$KMnO_4$

$1 + n - 8 = 0$

$n = 7$

$K^+ | MnO_4^-$

Mn^{+7} $4s^0 3d^0$

$n = 0$

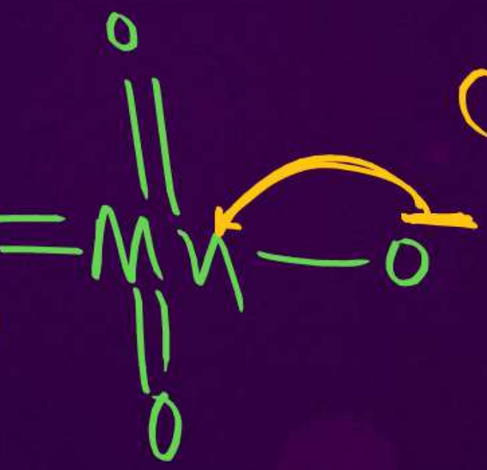
colourless ✗

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

$Mn^{+6} = 4s^0 3d^1$

$Mn^{+7} + e \rightarrow Mn^{+6}$

$4s^0 3d^1$ $n = 1$

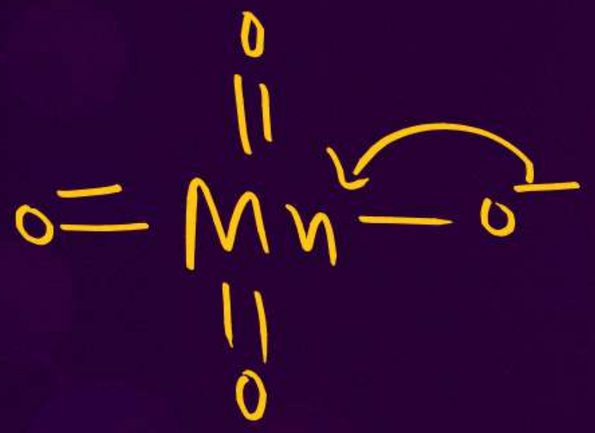


Charge Transfer

$KMnO_4$

Mn^{+7} $\quad Mn_{25} \longrightarrow 4s^2\, 3d^5$

$Mn^{+7} \longrightarrow 4s^0\, 3d^0 \quad n=0$



$Mn^{+7} + (-ve) = Mn^{+6} \longrightarrow 4s^0\, 3d^1$

$n = 1$

$K_2Cr_2O_7$

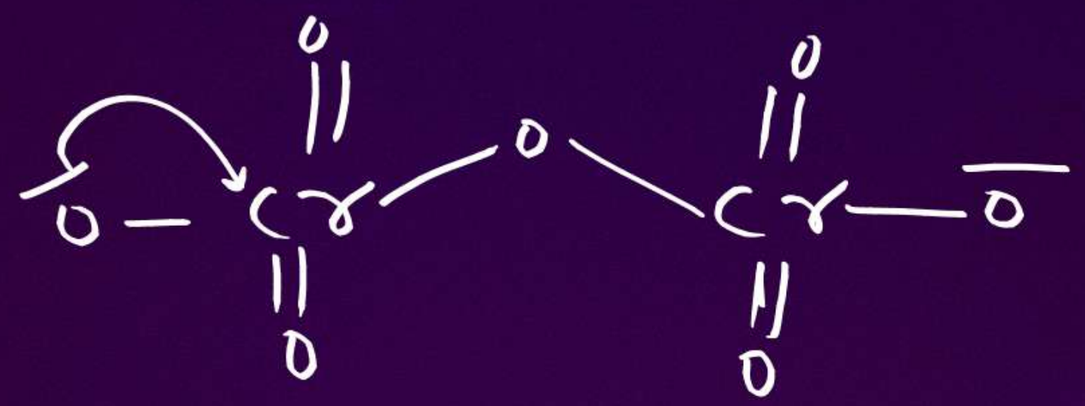
$2 + 2n - 14 = 0$

$\boxed{n = 6}$

$Cr^{+6} \Rightarrow 4s^0\, 3d^0$

$n = 0$

$2K^+ \mid Cr_2O_7^{-2}$



$\boxed{\text{Charge Transfer}}$

Question

Which ion gives coloured solution?

A. Cu^{1+}

B. Zn^{2+}

C. Ag^{1+}

D. Fe^{2+}

$Fe_{26} = 4s^2\ 3d^6$

$4s^0\ 3d^6$ $\boxed{n = 4}$

Question

Which one of the following ions is colourless?

A. Mn^{3+}

B. V^{3+}

C. Ni^{2+}

D. Zn^{2+}

Zn_{30} $4s^2$ $3d^{10}$

$4s^0$ $3d^{10}$ $n=0$

Question

In which of the following pairs are both ions are coloured in aqueous solution?

A. Sc^{3+}, Ti^{3+}

B. Sc^{3+} Co^{2+}

C. Ni^{2+}, Cu^{1+}

D. Ni^{2+}, Ti^{3+}

Sc^{+3}

Sc_{21} $4s^2 3d^1$

Sc^{+3} $4s^0 3d^0$

$n=0$

Cu^+

$Cu = 4s^1 3d^{10}$

$Cu^+ = 4s^0 3d^{10}$.

Question

Which of the following set has all the coloured ions

A. Cu^{+}, Cu^{2+}, Ni^{2+}

B. Cu^{2+}, Co^{2+}, Sc^{3+}

C. Cu^{2+}, Fe^{2+} , Co^{2+}

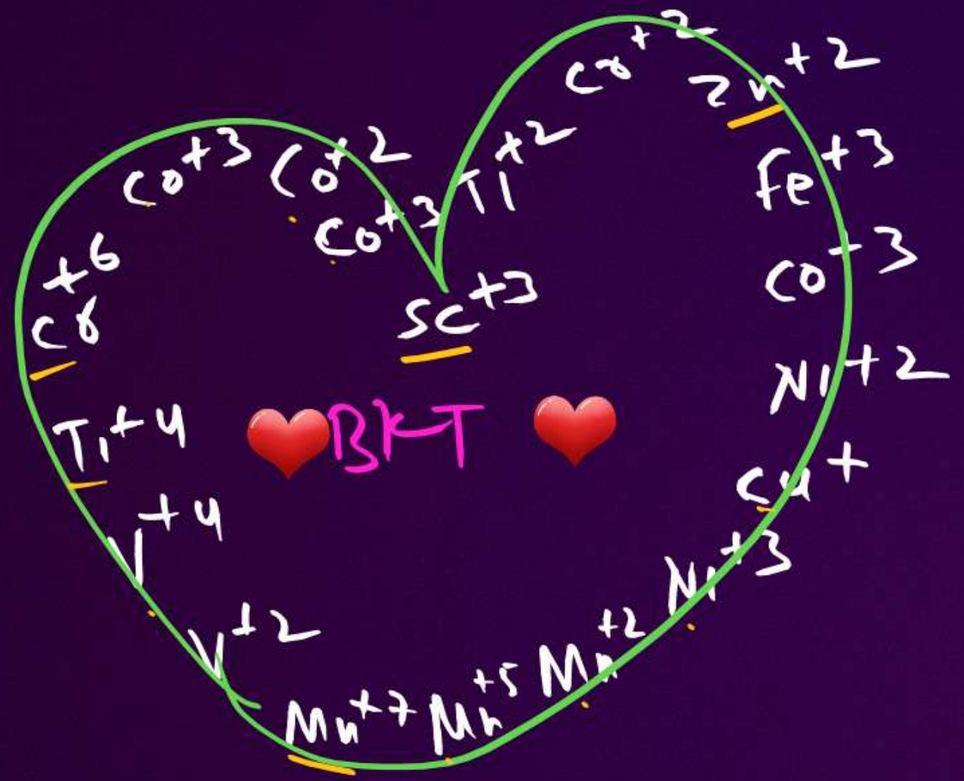
D. Na^{+}, Mg^{2+}, Al^{3+}

How many are colourless.

$Co^{+3} \longrightarrow 4s^0 3d^6$.

Bijy Bhaiya

Creation For BKT Army



- Sc^{+3} $4s^0 3d^0$ (0)
- Zn^{+2} $4s^0 3d^{10}$ (0)
- Cu^{+} $4s^0 3d^{10}$ n=0
- Mn^{+7} $4s^0 3d^0$ n=0
- Ti^{+4} $4s^0 3d^0$ n=0
- Cr^{+6} $4s^0 3d^0$ n=0

Important Compounds of Transition Elements

Oxides and Oxoanions of Metals

- These oxides are generally formed by the reaction of metals with oxygen at high temperatures

- All the metals except scandium form MO oxides which are ionic
- As the oxidation number of a metal increases, ionic character decreases. In the case of Mn, Mn_2O_7 is a covalent green oil
-

Mn_2O_7

$2n - 14 = 0 \quad n = +7$

$Mn^{+7} \rightarrow$ covalent

$M + O_2 \xrightarrow{\Delta.T.} MO$

oxide

(Ti —— Zn)

Common OS = +2

$M_2 O_2 \rightarrow \boxed{MO}$

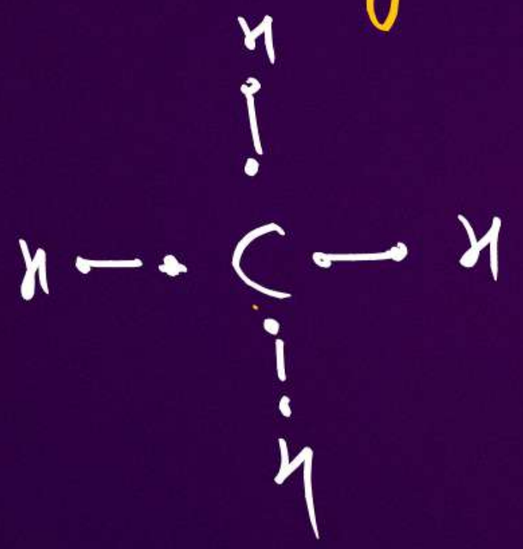
$Ti + O_2 \longrightarrow \overset{+2}{TiO}$

$Zn + O_2 \longrightarrow \overset{+2}{ZnO}$

$M + O_2 \longrightarrow \overset{+2}{MO}$

$\longrightarrow$ OS $\rightarrow$ +1 | +2 | +3 $\rightarrow$ Ionic

Covalent character ∝ OS

Ionic	Covalent
Transfer of e	Sharing of e.
NaCl | $Na \rightarrow 1s^2\ 2s^2\ 2p^6\ 3s^1$	
$Na \xrightarrow{-e} Na^+ + e$	$C \rightarrow 1s^2\ 2s^2\ 2p^2$
$Cl + e \rightarrow Cl^-$	VE = 4
	$C \rightarrow 1s^2\ 2s^2\ 2p^2$
	VE = 4

Nature of oxides.

Acid	Base	Amphoteric
H^+ donar	OH^- donar	Behaves as both Acid/Base
e acceptor	e donar	
Acidic Character $\propto$ e accepting tendency		
Acidic $\propto$ +ve OS		

Non metal oxide → Acid in nature

↓

e acceptor

metal oxide → Basic in Nature.

↓

e donar

Metal oxide →

- +1 / +2 / +3 → Basic
- +4 → Amphoteric.
  - TiO_2 ✓
  - V_2O_4 (+4 → Basic)
- +5 / +6 / +7 → Acid

- In these higher oxides, the acidic character is predominant.

Amphoteric Trick

ZnO BeO Al_2O_3 PbO PbO_2 Ga_2O_3 SnO SnO_2

Zn Be Al Pb Ga Sn

Zanabe Ali Punjabi Gana Suna

+3 Cr_2O_3 ✓ +3 Cr 3 As 3 Sb 5 V +5

+6 CrO_3 ✗ As_2O_3 Sb_2O_3 V_2O_5

kar Ashwanya Savita ko impress kiye

Important Compounds of Transition Elements

⇒ V_2O_3 V_2O_4 V_2O_5
Basic Basic Amphoteric

⇒ CrO Cr_2O_3 CrO_3
Basic Amphoteric Acidic

⇒ MnO MnO_2 Mn_2O_7
Basic Amphoteric Acidic

+3 V_2O_3 Basic

+4 V_2O_4 Basic

+5 V_2O_5 Amphoter

+2 CrO Basic

+3 Cr_2O_3 Amphoteric

+6 CrO_3 Acid

+2 MnO Basic

+4 MnO_2 Amphoteric

+7 Mn_2O_7 Acidic

Cr_2O_3 is

(a) Acidic

(b) Basic

(c) Amphoteric

(d) Neutral.

$\boxed{{}^{3}Cr \quad {}^{3}As \quad {}^{3}Sb \quad {}^{5}V}$

$\overset{+7}{Mn_2}O_7$ is.

(a) Acidic

(b) Basic

(c) Amphoteric

(d) Neutral.

metal → 1/2/3 Basic
→ +4 Amphe
→ +5/+6/+7 Acidic

$Mn^{+2}O$

(a) Acidic

(b) Basic

(c) Amphoteric

(d) Neutral.

CrO_3 is.

(a) Acidic

(b) Basic

(c) Amphoteric

(d) Neutral.

Home Work

→ NCERT example

→ Intext Question.

PARISHRAM

2026

D & F Block Elements

CHEMISTRY LECTURE-12

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

Reactions of d Block Elements

KMnO4 & K2CR2O7

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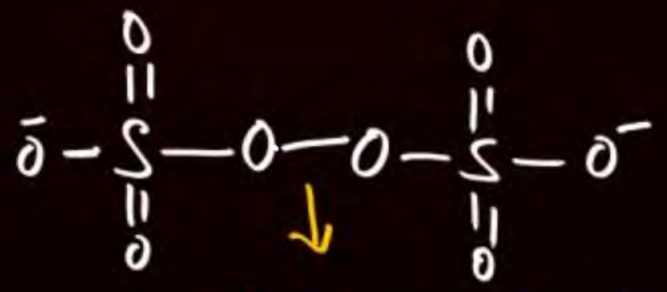
Oxidising Agent

- O_2
- $K\overset{+5}{N}O_3$
- $K_2\overset{+6}{Cr}_2O_7$
- $K\overset{+7}{Mn}O_4$
- $S_2O_8^{-2}$ ⟶ 

$\overset{-1}{O}-\overset{-1}{O}$

$O^{-1} \longrightarrow O^{-2}$

peroxide linkage

- Oxidising agent Jisse Reaction karta hai uska oxidation no. increase karta hai ⟶ oxidation karta hai

- $Fe^{+2} \xrightarrow[OA]{} Fe^{+3}$

★ Maximum oxidation number = group no (1-7)
or
group no - 10 (13-18)

* For Group 1 → maxm OS = +1

* For Group 15 → maxm OS = group no - 10
= 15 - 10
= 5

* If Element in maximum OS ⇒ oxidising agent
* If Element in minimum OS ⇒ Reducing agent

$KNO_3 \longrightarrow$ OA

$1 + n - 6 = 0$

$\boxed{n = 5}$

$N \longrightarrow +5$

Maxm OS $= 15 - 10$

$= 5$

$O_2^0 \longrightarrow O^{-2}$ [R]

OA

$KMnO_4 \xrightarrow{[R]} Mn^{+2}$

OA

$1 + n - 8 = 0$

$n = 7$

$Mn \rightarrow$ maxm OS $= +7$

How many of following are OA?

oxidising agent?

O_2, KNO_3, $K_2Cr_2O_7$, $KMnO_4$

$O_2^0 \longrightarrow O^{-2}$

[R]

OA

$Fe^0 + O_2 \longrightarrow Fe^{+2}O^{-2}$

OA

$\longrightarrow Fe_2O_3$

$Mg + O_2 \longrightarrow MgO$

$$Fe^{+2} + \overset{OA}{O_2} \longrightarrow Fe_2O_3$$

$$O_2^{0} \longrightarrow Fe^{+3} / O^{-2}$$

OA

Disproportination rxn → DPP rxn

* gf Element is in intermediate oxidation state.

* $Cu^{+} \xrightarrow{} Cu^{+2} + Cu^{0}$

[O]

→ DPP rxn

[R]

$Cu^{+2} > Cu^{+1}$

hydration Energy.

* $Mn^{+6} \xrightarrow{\mu^{+}} Mn^{+7} + MnO_2^{+4}$

[O]

→ DPP rxn.

[R]

★ Cu^{+2} (OA) + I^- ⟶ $\overset{+1}{Cu_2I_2}$ + $\overset{0}{I_2}$

CuI_2 ✗

★ Cu^{+2} + F^- ⟶ CuF_2.

★ Cu^{+2} + Cl^- ⟶ $CuCl_2$

★ Cu^{+2} + Br^- ⟶ $CuBr_2$

★ Cu + dil HCl ⟶ No rxn

$E^0_{Cu^{+2}/Cu} = +ve$ $\quad Cu^{+2} \longrightarrow Cu^0$

order of oxidising Agent

$F_2 > Cl_2 > Br_2 > I_2$

$Cu_2X_1 \xrightarrow{F} CuF_2$

Pani Nikalo H_2O → BKT

Heating rkn.

* $H_2CO_3 \xrightarrow{-H_2O} H_2O + CO_2$

* $H_2SO_4 \xrightarrow{-H_2O} H_2O + SO_3$

* $H_2SO_3 \xrightarrow{-H_2O} H_2O + SO_2$

✓ * $H_2Cr_2O_8^{-2} \xrightarrow[-H_2O]{} Cr_2O_7^{-2} + H_2O$

84

* $(NH_4)_2Cr_2O_7$

$\downarrow \Delta$, $-4H_2O$

$N_2 + 4H_2O + Cr_2O_3$

$$H_2CO_3 \xrightarrow[\Delta]{-H_2O} H_2O + CO_2$$

$$H_2SO_4 \xrightarrow[\Delta]{-H_2O} SO_3 + H_2O$$

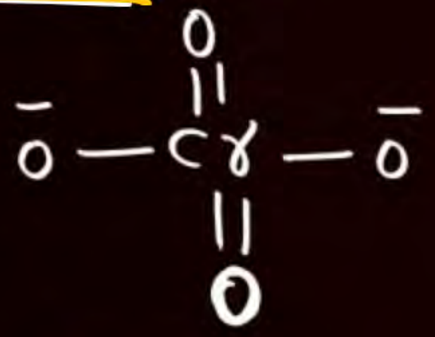
$$H_2SO_3 \xrightarrow[\Delta]{-H_2O} SO_2 + H_2O$$

$$H_2Cr_2O_8^{-2} \xrightarrow[\Delta]{-H_2O} H_2O + Cr_2O_7^{-2}$$

Preparation of $K_2Cr_2O_7$

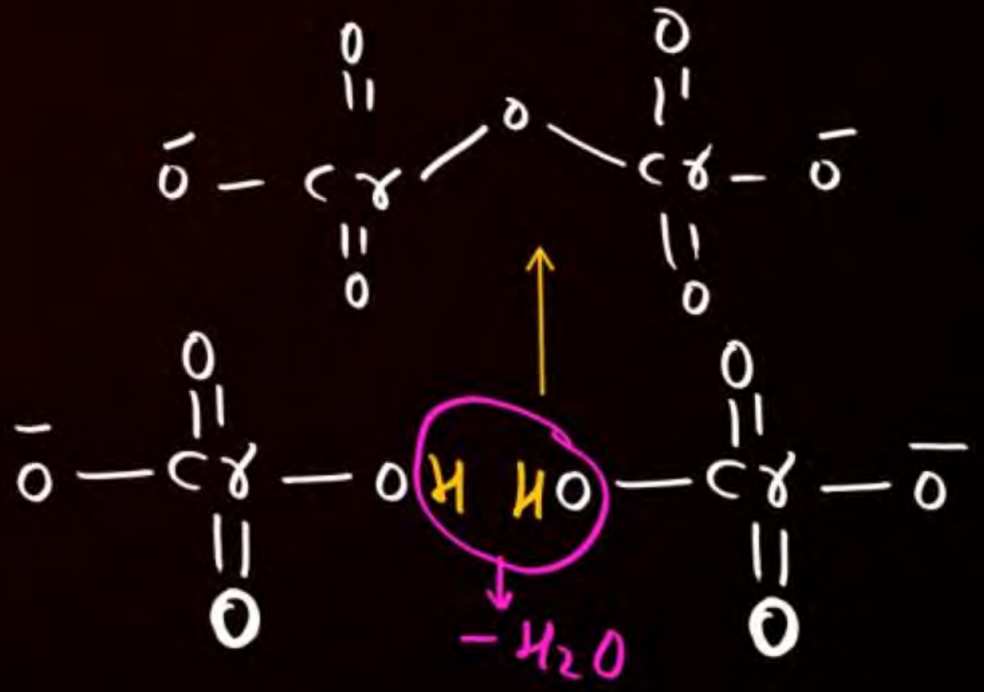
* K_2CrO_4 / $\overset{+6}{Cr}O_4^{-2}$

Chromate



* $Cr_2O_7^{-2}$ / $\overset{+6}{Cr_2}O_7$ *

Dichromate



- $CrO_4^{-2} + H^+ \rightarrow HCrO_4^-$
- $HCrO_4^- + HCrO_4^- \rightarrow H_2Cr_2O_8^{-2}$
- $H_2Cr_2O_8^{-2} \xrightarrow[-H_2O]{} Cr_2O_7^{-2} + H_2O$

$\overset{+6}{Cr}O_4^{-2}$ chromate

$x + 4 \times (-2) = -2$

$x - 8 = -2$

$x = 6.$

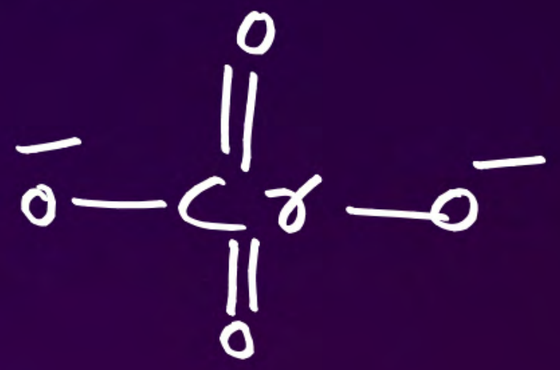
$\overset{+6}{Cr}_2O_7^{-2}$ dichromate

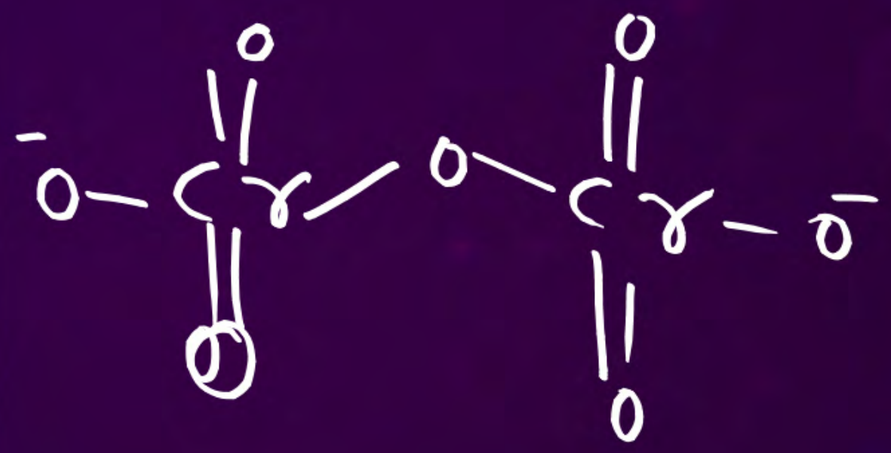
$2x + 7(-2) = -2$

$2x = 12$

$x = 6$

CrO_4^{-2}





$$CrO_4^{-2} + H^+ \longrightarrow HCrO_4$$

$$HCrO_4^- + HCrO_4^- \longrightarrow H_2Cr_2O_8^{-2} \xrightarrow[-H_2O]{} Cr_2O_7^{-2}$$

$$\boxed{2CrO_4^{-2} + 2H^+ \longrightarrow Cr_2O_7^{-2} + H_2O}$$

Ore of Chromium

Chromite ore

$FeCr_2O_4$

$\overset{+2}{Fe}O \cdot \overset{+3}{Cr_2}O_3$

$x-2=0$ | $2y-6=0$

$x=2$ | $y=3$

oxidising agent

oxidation

$Fe\overset{+3}{Cr_2}O_4 + O_2 \longrightarrow \overset{+6}{Cr}O_4^{-2}$

OA

$2CrO_4^{-2} + 2H^+ \longrightarrow Cr_2O_7^{-2} + H_2O$

* complete rxn

$\overset{+2}{Fe}O\overset{+3}{Cr_2}O_3 + Na_2CO_3 + O_2 \longrightarrow Na_2CrO_4 + CO_2 + \overset{+3}{Fe_2}O_3$

OA

$2Na^+ / CrO_4^{-2}$

$2Na_2CrO_4 + 2H^+ \longrightarrow Na_2Cr_2O_7 + H_2O + 2Na^+$

$Na_2Cr_2O_7 + KCl \longrightarrow K_2Cr_2O_7 + NaCl$

oxidising agent → kisi Aur ka oxidation karta hai

↓

(khud ka Reduction)

Chromite ore

$FeCr_2O_4$

$[FeO \cdot \underline{Cr_2O_3}]$

$$FeO \cdot \overset{+3}{Cr_2}O_3 + \underset{OA}{O_2} \longrightarrow \overset{+6}{Cr}O_4^{-2}$$

oxidation

$$\underset{\text{chromate}}{2CrO_4^{-2}} + 2H^+ \xrightarrow{-H_2O} \underset{\text{dichromate.}}{\underline{\underline{Cr_2O_7^{-2}}}} + H_2O$$

$$\overset{+2}{FeO} \cdot \overset{+3}{Cr_2O_3} + O_2 + Na_2CO_3$$

$$Fe^{+3} \quad O^{-2}$$

$$3 \quad 2$$

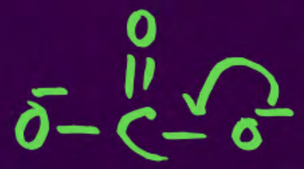
$$Fe_2O_3$$

$$Na_2CrO_4 + Fe_2O_3 + CO_2$$

$$2Na_2CrO_4 + 2H^+ \longrightarrow Na_2Cr_2O_7 + H_2O + 2Na^+$$

$$Na_2Cr_2O_7 + KCl \rightarrow K_2Cr_2O_7 + NaCl.$$

$$Na_2CO_3 \longrightarrow 2Na^+ + CO_3^{-2}$$



$$\downarrow$$

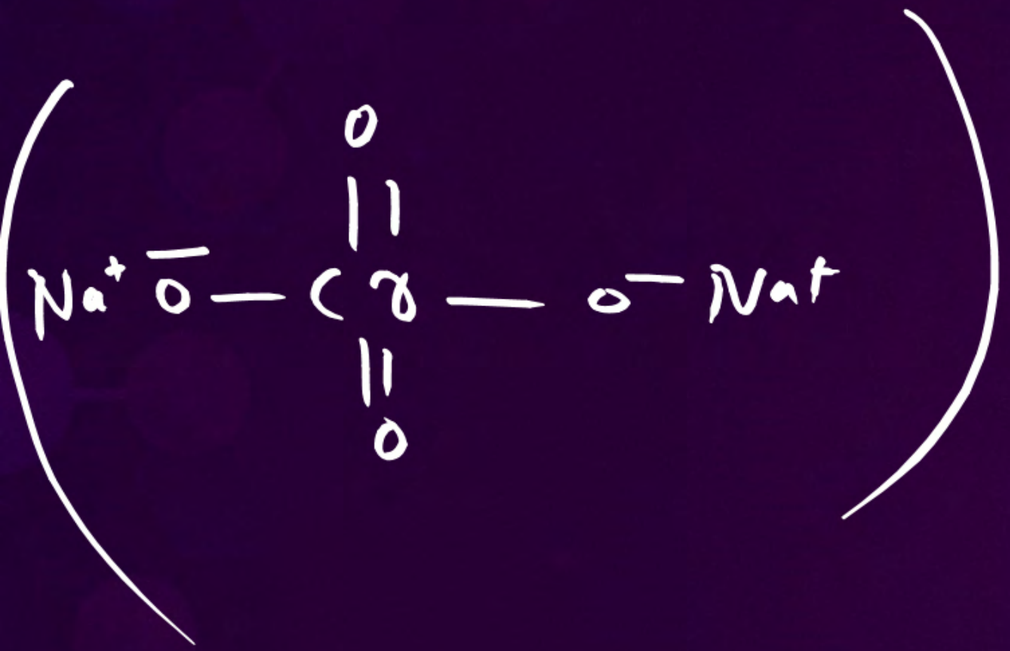
$$CO_2$$

$$FeO.Cr_2O_3 + O_2 + Na_2CO_3 \longrightarrow Na_2CrO_4 + Fe_2O_3 + CO_2$$

$$2\,Na_2CrO_4 + 2H^+ \longrightarrow Na_2Cr_2O_7 + H_2O + 2Na^+$$

$$Na_2Cr_2O_7 + KCl \longrightarrow K_2Cr_2O_7 + NaCl.$$

$$CrO_4^{-2} + 2Na^+ \longrightarrow$$



Action of pH

$$\underset{\text{yellow}}{CrO_4^{-2}} \underset{OH^-}{\overset{H^+}{\rightleftharpoons}} \underset{\text{orange}}{Cr_2O_7^{-2}}$$

* $2CrO_4^{-2} + 2H^+ \longrightarrow Cr_2O_7^{-2} + H_2O$

* $Cr_2O_7^{-2} + 2OH^- \longrightarrow 2CrO_4^{-2} + H_2O$

* (OA) $\underline{\underline{Cr_2O_7^{-2}}}$ (Cr^{+6}) $+ 14H^+ + 6e \xrightarrow{[R]} \underline{2Cr^{+3}} + 7H_2O$

$\boxed{Cr^{+3} > Cr^{+6}}$

* $K_2Cr_2O_7$ Acts as oxidising agent in Acidic medium

BKT

★ (−ve) oxidation state + OA ⟶ Zero oxidation state

★ I^- + $K_2Cr_2O_7$ ⟶ I_2^0 + Cr^{+3}

(−1) OA

★ Cl^- + $K_2Cr_2O_7$ ⟶ Cl_2 + Cr^{+3}

OA

★ H_2S + $K_2Cr_2O_7$ ⟶ S + Cr^{+3}

S^{-2} OA

Br^- + $K_2Cr_2O_7$ ⟶ Br_2 + Cr^{+3}

BKT

gf Element E is from d block

$$E^{n} + OA \xrightarrow{+1} E^{n+1}$$

gf Element E is from p block

$$E^{n} + OA \xrightarrow{+2} E^{n+2}$$

- $Fe^{+2} + K_2Cr_2O_7 \xrightarrow{+1} Fe^{+3} + Cr^{+3}$
- $Sn^{+2} + K_2Cr_2O_7 \xrightarrow{+2} Sn^{+4} + Cr^{+3}$
- $\overset{+4}{S}O_2 + K_2Cr_2O_7 \xrightarrow{+2} \overset{+6}{S}O_4^{-2} + Cr^{+3}$

  $x - 8 = -2$
- $\overset{+4}{S}O_3^{-2} + K_2Cr_2O_7 \xrightarrow{+2} \overset{+6}{S}O_4^{-2} + Cr^{+3}$
- $\overset{+3}{N}O_2^{-} + K_2Cr_2O_7 \xrightarrow{+2} \overset{+5}{N}O_3^{-} + Cr^{+3}$

  $x - 6 = -1$
- $C_2H_5OH + K_2Cr_2O_7 \longrightarrow CH_3COOH + Cr^{+3}$

$$S^{-2} + K_2Cr_2O_7 \longrightarrow S + Cr^{+3}$$

(-2)

$$Sn^{+2} + K_2Cr_2O_7 \xrightarrow{+2} Sn^{+4} + Cr^{+3}$$

$$\overset{+4}{SO_3^{-2}} + K_2Cr_2O_7 \xrightarrow{+2} \overset{+6}{SO_4^{-2}} + Cr^{+3}$$

$x - 6 = -2$

$x = 4$

$$Fe^{+2} + K_2Cr_2O_7 \xrightarrow{+1} Fe^{+3} + Cr^{+3}$$

$$\underset{(-1)}{Cl^-} + K_2Cr_2O_7 \longrightarrow Cl_2 + Cr^{+3}$$

$$\overset{+3}{N}O_2^- + \underset{OA}{K_2Cr_2O_7} \xrightarrow{+2} \overset{+5}{N}O_3^- + Cr^{+3}$$

$x - 4 = -1$

$x = 3$

$x - 6 = -1$

$x = 5$

Home Work

$\longrightarrow$ HW

$H_2CO_3 \xrightarrow[\Delta]{}$

$CrO_4^{-2} + H^+ \longrightarrow$

$Fe^{+2} + Cr_2O_7^{-2} \longrightarrow$

OA

$Sn^{+2} + K_2Cr_2O_7 \longrightarrow$

$H_2S + K_2Cr_2O_7 \longrightarrow$

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2026

D & F Block Elements

CHEMISTRY LECTURE-13

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

Reactions of d Block Elements

Preparation and Properties of KMnO4

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$$Fe^{+2} + K_2Cr_2O_7 \xrightarrow{+1} Fe^{+3} + Cr^{+3}$$

$$Sn^{+2} + Cr_2O_7^{-2} \xrightarrow{+2} Sn^{+4} + Cr^{+3}$$

$$SO_3^{-2} + Cr_2O_7^{-2} \longrightarrow SO_4^{-2} + Cr^{+3}$$

$$SO_2 + Cr_2O_7^{-2} \longrightarrow SO_4^{-2} + Cr^{+3}$$

$KMnO_4$ → Potassium permanganate (+7)

* $KMnO_4 \rightarrow 1 + n - 8 = 0$ $\quad n = +7$

$1 + n - 8 = 0$

* $K_2MnO_4 \rightarrow 2 + n - 8 = 0$ $\quad n = +6$

↓

Potassium manganate

* $KMnO_4 = K^+ / MnO_4^-$

* $K_2MnO_4 = 2K^+ / MnO_4^{-2}$

$\overset{+6}{MnO_4^{-2}} \xrightarrow{[O]} \overset{+7}{MnO_4^-}$

oxidation

MnO_4^{-2}

$x - 8 = -2$

$x = +6$

Manganate

MnO_4^{-}

$x - 8 = -1$

$x = +7$

permanganate ✓

Preparation of $KMnO_4$

* $\overset{+4}{MnO_2} + O_2 \,|\, KNO_3 + KOH \longrightarrow \overset{+6}{K_2MnO_4} + 2H_2O$

* $\overset{+6}{MnO_4^{-2}} + 4H^+ \longrightarrow \overset{+7}{MnO_4^-} + \overset{+4}{MnO_2} + 2H_2O$

[O]

[R]

DPP rxn

* $K_2MnO_4 \rightarrow$ dark green.

$$\overset{+4}{MnO_2} + \underset{OA}{O_2} \longrightarrow \overset{+6}{MnO_4^{-2}}$$

$$\overset{+6}{MnO_4^{-2}} \xrightarrow{H^+} \overset{+7}{MnO_4^-} + \overset{+4}{MnO_2}$$

[O]

[R]

DPP

Commercial Method

* $\overset{+4}{MnO_2} \xrightarrow[KNO_3/O_2]{KOH} \overset{+6}{MnO_4^{-2}}$

Manganate Ion

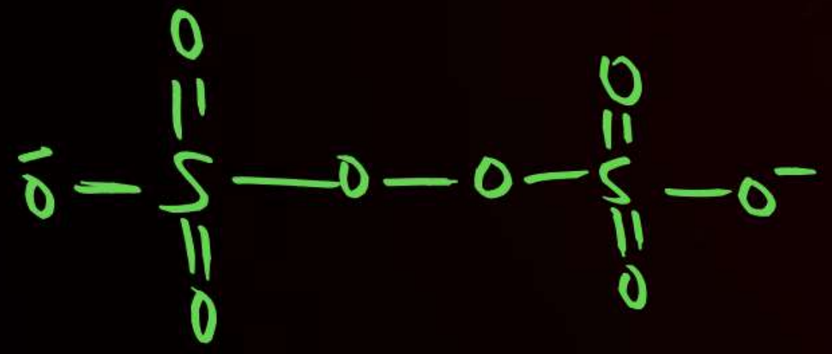
* $\overset{+6}{MnO_4^{-2}} \xrightarrow[\text{Oxidation}]{\text{Electrolytic}} \overset{+7}{MnO_4^{-}}$

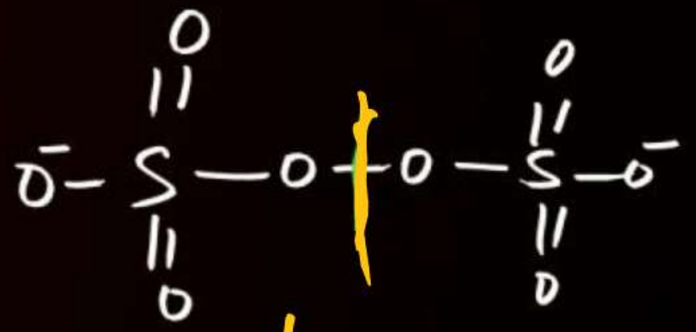
Basic Medium

Lab Method

$$Mn^{+2} + S_2O_8^{-2} \longrightarrow \overset{+7}{MnO_4^-} + SO_4^{-2}$$

OA





peroxide bond

① $\overset{+4}{MnO_2} + O_2 \,|\, KNO_3 \xrightarrow{KOH} K_2MnO_4$

$\overset{+6}{MnO_4^{-2}} \xrightarrow{H^+} \overset{+7}{MnO_4^-} + MnO_2.$

② $MnO_2 + O_2 \,|\, KNO_3 \xrightarrow{KOH} K_2MnO_4 \,|\, MnO_4^{-2}$

$MnO_2^{-2} \xrightarrow[\text{oxidation}]{\text{Electro}} MnO_4^-$

Basic

③ $Mn^{+2} + S_2O_8^{-2} \longrightarrow MnO_4^- + SO_4^{-2}$ ✓

Rxn of $KMnO_4$

* $\overset{+7}{KMnO_4}$ is an strong oxidising agent in Acidic, Neutral and basic.

* $\overset{+7}{MnO_4^-} \xrightarrow{H^+} Mn^{+2}$

  OA

* $\overset{+7}{MnO_4^-} \xrightarrow{\overset{-}{OH}} \overset{+4}{MnO_2}$

  OA

$KMnO_4 \xrightarrow{\Delta} K_2MnO_4 + MnO_2 + O_2$

★ Rk^n of $KMnO_4$ in Acidic Medium

* $Fe^{+2} + \underset{OA}{KMnO_4} \longrightarrow Fe^{+3} + Mn^{+2}$

* $Sn^{+2} + \underset{OA}{KMnO_4} \xrightarrow{+2} Sn^{+4} + Mn^{+2}$

* $\overset{+3}{N}O_2^- + KMnO_4 \xrightarrow{+2} \overset{+5}{N}O_3^- + Mn^{+2}$

* $\overset{+4}{S}O_3^{-2} + KMnO_4 \longrightarrow \overset{+6}{S}O_4^{-2} + Mn^{+2}$

* $\overset{+4}{S}O_2 + KMnO_4 \longrightarrow \overset{+6}{S}O_4^{-2} + Mn^{+2}$

BKT

$E^n + OA \rightarrow E^{n+1}$

$E \in$ d block

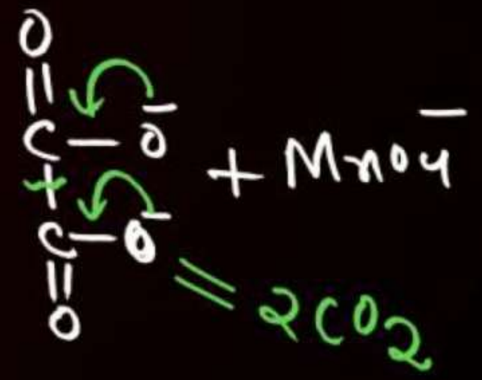
BKT

$E^n + OA \rightarrow E^{n+2}$

$E \in$ p block

★ Rk^n of $KMnO_4$ in Acidic Medium

* $I^- + KMnO_4 \longrightarrow I_2^0 + Mn^{+2}$
* $Cl^- + KMnO_4 \longrightarrow Cl_2^0 + Mn^{+2}$
* $Br^- + KMnO_4 \longrightarrow Br_2^0 + Mn^{+2}$
* $H_2S/S^{-2} + KMnO_4 \longrightarrow S^0 + Mn^{+2}$
* $C_2O_4^{-2} + KMnO_4 \longrightarrow CO_2 + Mn^{+2}$



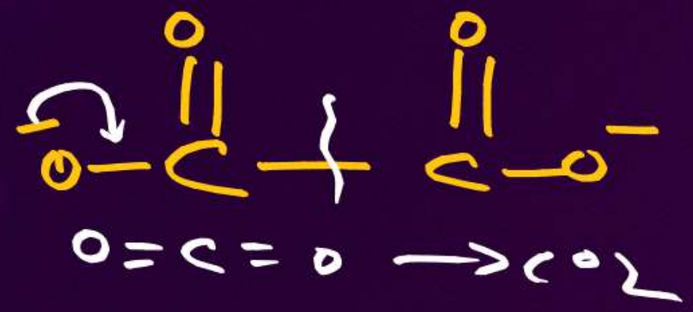
* $C_2H_5OH + KMnO_4 \longrightarrow CH_3-COOH$

BKT

$\boxed{-ve\ OS + OA \rightarrow zero\ OS}$

$C_2O_4^{-2} + MnO_4^- \longrightarrow 2CO_2 + Mn^{+2}$

(Oxalte ion)



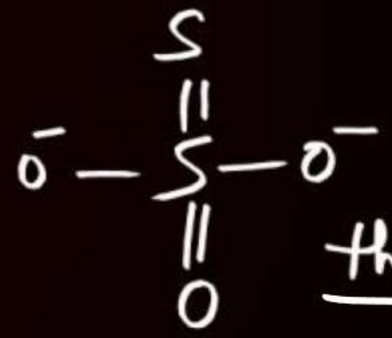
★ Rk^n of $KMnO_4$ in Basic/Neutral medium

* $I^- + MnO_4^- \longrightarrow \overset{+5}{I}O_3^- + \overset{+4}{MnO_2}$

  $x - 6 = -1$

* $S_2O_3^{-2} + MnO_4^- \longrightarrow \overset{+6}{SO_4^{-2}} + \overset{+4}{MnO_2}$

* $Mn^{+2} + MnO_4^- \longrightarrow \overset{+4}{MnO_2}$



thiosulphate

$Cr_2O_7^{-2}$ (orange)

$I^- \rightarrow I_2$

$Cl^- \rightarrow Cl_2$

$Br^- \rightarrow Br_2$

$H_2S \rightarrow S$ (S^{-2})

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

$Sn^{+2} \rightarrow Sn^{+4}$

NO_2^- ($+3$) $\rightarrow NO_3^-$ ($+5$)

SO_3^{-2} ($+4$) $\rightarrow SO_4^{-2}$ ($+6$)

SO_2 ($+4$) $\rightarrow SO_4^{-2}$ ($+6$)

$C_2H_5OH \rightarrow CH_3COOH$

Cr^{+3}

BKT

$Mn O_4^-$

$C_2O_4^{-2} \rightarrow CO_2$

$I^- \rightarrow I_2$

$Cl^- \rightarrow Cl_2$

$Br^- \rightarrow Br_2$

$H_2S \rightarrow S$ (S^{-2})

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

$Sn^{+2} \rightarrow Sn^{+4}$

$NO_2^- \rightarrow NO_3^-$

$SO_3^{-2} \rightarrow SO_4^{-2}$

$SO_2 \rightarrow SO_4^{-2}$

$C_2H_5OH \rightarrow CH_3COOH$

Mn^{+2}

Acidic

(purple)

$Mn O_4^-$

$I^- \rightarrow IO_3^-$

$S_2O_3^{-2} \rightarrow SO_4^{-2}$

$Mn^{+2} \rightarrow MnO_2$

$CH_2=CH_2 \rightarrow CH_2(OH)-CH_2(OH)$

MnO_2

(Brown Ppt)

BKT Basic or Neutral

Q. Find correct product

$$I^- + MnO_4^- \xrightarrow{OH^-}$$

(a) I_2

(b) IO_3^-

(c) IO_4^-

(d) none.

$$\overset{+3}{NO_2^-} + MnO_4^- \xrightarrow[+2]{x^+} \overset{+5}{NO_3^-}$$

(a) N_2

(b) NO_3^-

(c) NO

(d) none.

$C_2O_4^{-2} + MnO_4^- \longrightarrow CO_2.$

(a) CO_2

(b) CO_3^{-2}

(c) both

(d) none.

Sum of oxidation states of Iodide in products of reactions given below.

(a) $I^- + MnO_4^- \xrightarrow{H^+} (I_2^0)$ ✓ → n

(b) $I^- + MnO_4^- \xrightarrow{\bar{O}H} (IO_3^-)$ (+5) → y

n + y

5 + 0 = 5

F block

Lanthanoids.

Ce	Pr	Nd	Pm	Sm	Eu	Gd
cine	par	Nadiya	prem ki	samaji	Eun	gadgad

Tb	Dy	Ho	Er	Tm	Yb	Lu.
Tab	Dil	Hua	Arre	tum	Yunhi	Lajabab ho.

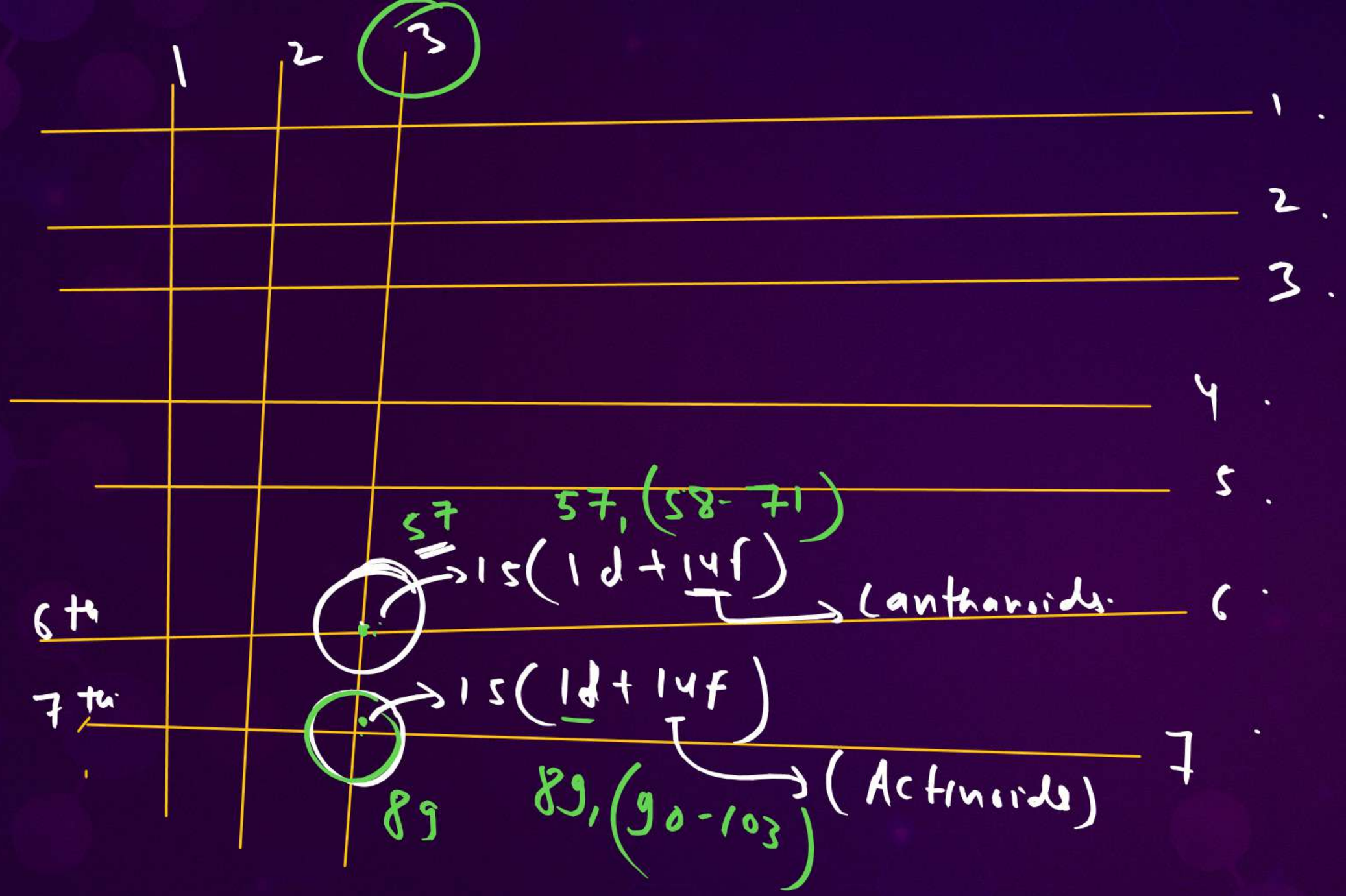
Actinoids.

Th Pa U Np Pu Am Cm Bk

Thapa ne Usma ko Napa pure American Camera Beka gya.

Cf Es Fm Md No Lr

California ne Einstein ke form ko modi Nagar Number lagwaya.


1
2
3
1.
2.
3.
4.
5.
6.
7.
6th
7th
57
57, (58-71)
1s(1d+14f)
Lanthanoids.
1s(1d+14f)
(Actinoids)
89
89, (90-103)

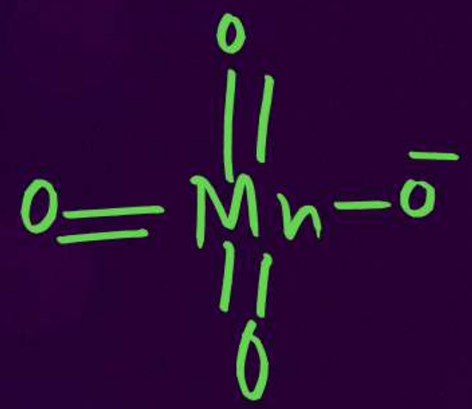
Lanthanoids.

- period → 6th.
- group 3
- Atomic no → (58 – 71)

Actinoids.

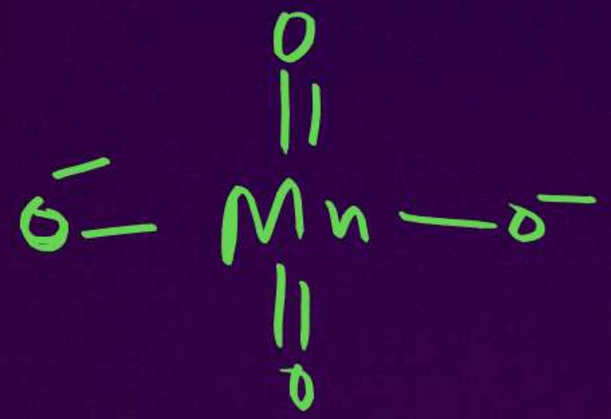
- period → 7
- group → 3
- Atomic no → (90-103)
  ↓
  14

$\overset{+7}{Mn}O_4^-$



$n = 0$ Diamagnetic

$\overset{+6}{Mn}O_4^{-2}$



$n = 1$ paramagnetic

Home Work

→ DPP

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2026

D & F Block Elements

CHEMISTRY LECTURE-14

BY – BIJENDRA SIR (Biju Bhaiya)

Topic Covered

F Block Elements
PYQ Session

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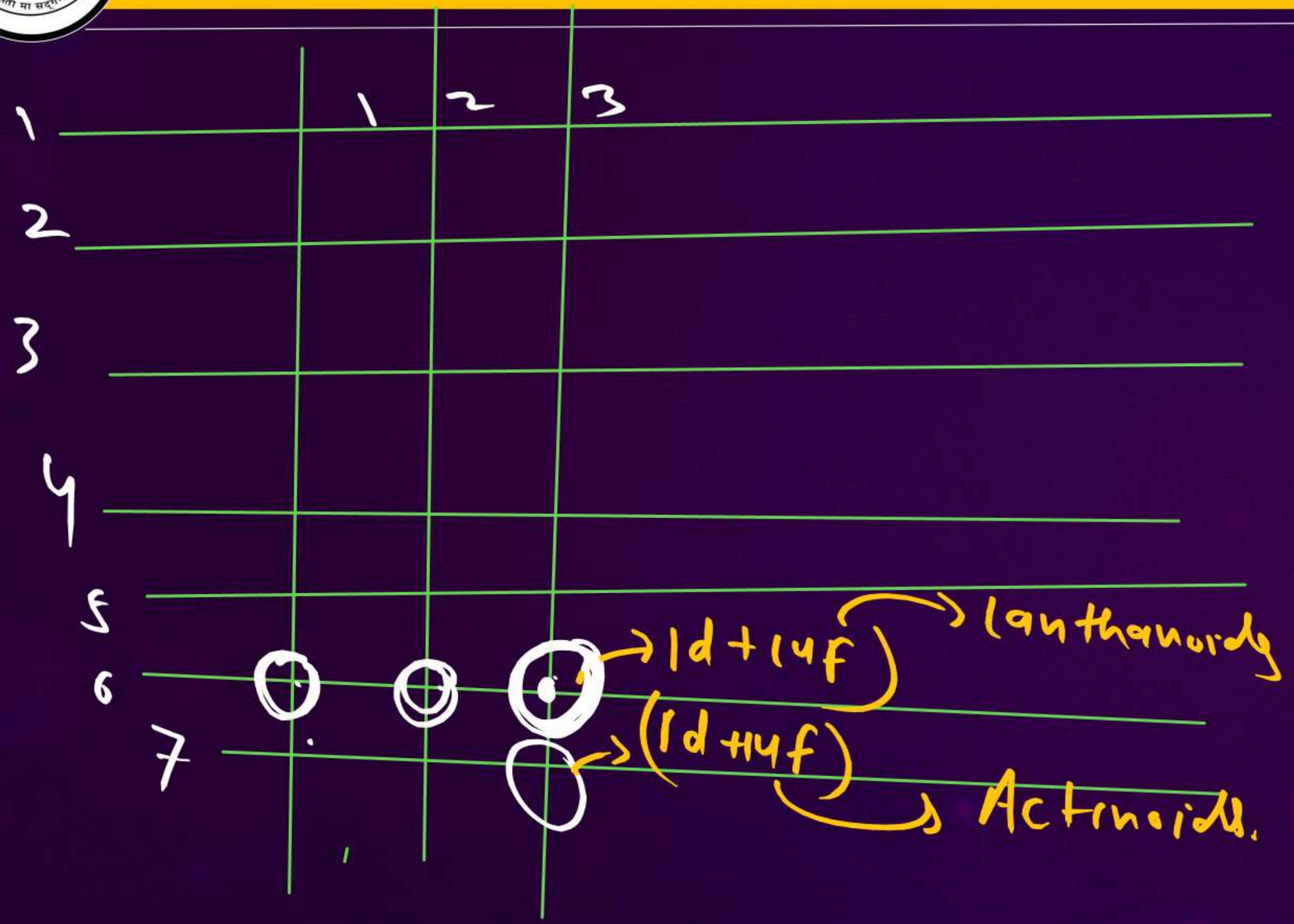
F Block Elements



① Lanthanoids → 14 elements.
(58-71)

② Actinoids → 14 elements
(90-103)

Question

The total number of elements present in f block of the periodic table is

A. 20

B. 28

C. 30

D. 26

14 + 14

= 28

F Block Elements

Yb Lu

yubko ko lata.

Lanthanoids

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm
सड़क	पर	नंदू	पमार	स्मार्ट	यूरोप का	गधा	तब	Dyanium	Hocker	ने यूरोप के	तमाम युवकों को लूटा
Sadak	par	Nandu	pamar	Smart	Europe ka	gadha	Tab	Dyanium	Hocker Ne	Europe ke	Tam

Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	M
थापा ने	ऊष्मा को	नापा	Pure	American	कैमरा	बेका गया	कैलिफोर्निया ने	आइंस्टीन के	फॉर्म को	मोदीनगर पर नंबर पर लगवाया	

Actinods

Lanthanoids

Ce Pr Nd Pm Sm Eu Gd Tb Dy Ho

Er Tm Yb Lu

Actinoids.

Th Pa U Np Pu Am Cm Bk Cf Es Fm Md

No Lr.

Question

The last element in Lanthanides and Actinides are

A. La, Ac

B. Ce, Th

C. Lu, Lr

D. Th, Lr

Question

Lutetium and Lawrencium are

Lu Lr

A. Actinide and Lanthanide respectively

B. Lanthanide and Actinide respectively

C. Both Actinides

D. Both Lanthanides

Question

Atomic number of Einstenium is

A. 96

B. 97

C. 98

D. 99

Th	Pa	U	Np	Pu	Am	Cm	Bk
90	91	92	93	94	95	96	97

Cf	Es
98	99

F Block Elements

Electronic Configurations & Radii of Lanthanum & Lanthanoids

Atomic Number	Name	Symbol	Electronic Configurations			Radii/pm		
			Ln	Ln^{2+}	Ln^{3+}	Ln^{4+}	Ln	Ln^{3+}
57	Lanthanum	La	$5d^1 6s^2$	$5d^1$	$4f^0$		187	106
58	Cerium	Ce	$4f^1 5d^1 6s^2$	$4f^2$	$4f^1$	$4f^0$	183	103
59	Praseodymium	Pr	$4f^3 6s^2$	$4f^3$	$4f^2$	$4f^1$	182	101
60	Neodymium	Nd	$4f^4 6s^2$	$4f^4$	$4f^3$	$4f^2$	181	99
61	Promethium	Pm	$4f^5 6s^2$	$4f^5$	$4f^4$		181	98
62	Samarium	Sm	$4f^6 6^5$	$4f^6$	$4f^5$		180	96
63	Europium	Eu	$4f^7 6s^2$	$4f^7$	$4f^6$		199	95
64	Gadolinium	Gd	$4f^7 5d^1 6s^2$	$4f^7 5d^1$	$4f^7$		180	94
65	Terbium	Tb	$4f^9 6s^2$	$4f^9$	$4f^8$	$4f^7$	178	92
66	Dysprosium	Dy	$4f^{10} 6s^2$	$4f^{10}$	$4f^9$	$4f^8$	177	91
67	Holmium	Ho	$4f^{11} 6s^2$	$4f^{11}$	$4f^{10}$		176	89
68	Erbium	Er	$4f^{12} 6s^2$	$4f^{12}$	$4f^{11}$		175	88
69	Thulium	Tm	$4f^{13} 6s^2$	$4f^{13}$	$4f^{12}$		174	87
70	Ytterbium	Yb	$4f^{14} 6s^2$	$4f^{14}$	$4f^{13}$		173	86
71	Lutetium	Lu	$4f^{14} 5d^1 6s^2$	$4f^{14} 5d^1$	$4f^{14}$	-	-	-

BKT For E.C of Lanthanoids.

Lanthanoids $\longrightarrow$ period $\longrightarrow$ 6th

EC $\longrightarrow$ $6s^2$ $5d$ $4f$

BKT $5d \longrightarrow 5d^0$ For all (– except)

$5d^1 \longrightarrow$ Ist, Last, Gd

$5d^1 \longrightarrow$ Ce, Lu, Gd

4f

$f \rightarrow 2, 8 \times$

$f \rightarrow \frac{14}{2} = 7$

$f \rightarrow 7, 7$

$f \rightarrow 14, 14.$

Ce $6s^2\ 5d^1 4f^1$

Pr $6s^2\ 5d^0 4f^3$

Nd $6s^2\ 5d^0 4f^4$

Pm $6s^2\ 5d^0 4f^5$

Sm $6s^2\ 5d^0 4f^6$

Eu $6s^2\ 5d^0 4f^7$ → hf

Gd $6s^2\ 5d^1 4f^7$

Tb $6s^2\ 5d^0 4f^9$

Dy $6s^2\ 5d^0 4f^{10}$

Ho $6s^2\ 5d^0 4f^{11}$

Er $6s^2\ 5d^0 4f^{12}$

Tm $6s^2\ 5d^0 4f^{13}$

Yb $6s^2\ 5d^0\ 4f^{14}$

Lu $6s^2\ 5d^1 4f^{14}$

→ F.F

BKT* BBI

Half Filled

Eu $6s^2\ 5d^0\ 4f^7$

Gd $6s^2\ 5d^1\ 4f^7$

Fully filled

Yb $6s^2\ 5d^0\ 4f^{14}$

Lu $6s^2\ 5d^1\ 4f^{14}$.

$f \rightarrow$

1	1	1	1	1	1	1

✓ $f^7 \longrightarrow$ half Filled

✓ $f^{14} \longrightarrow$ Fully Filled

$_{64}Gd^{+3}$

$_{64}Gd \xrightarrow{-3e}$ $6s^0\ 5d^0\ 4f^7$

$6s^2\ 5d^1\ 4f^7$

6 5 4

last shell

F Block Elements

Some Properties of Actinium and Actinoids

Atomic Number	Name	Symbol	Electronic Configurations			Radii/pm	
			M	M^{3+}	M^{4+}	M^{3+}	M^{4+}
89	Actinium	Ac	$6d^1 7s^2$	$5f^0$		111	
90	Thorium	Th	$6d^2 7s^2$	$5f^1$	$5f^0$		99
91	Protactinium	Pa	$5f^2 6d^1 7s^2$	$5f^2$	$5f^1$		96
92	Uranium	U	$5f^3 6d^1 7s^2$	$5f^3$	$5f^2$	103	93
93	Neptunium	Np	$5f^4 6d^1 7s^2$	$5f^4$	$5f^3$	101	92
94	Plutonium	Pu	$5f^6 7s^2$	$5f^5$	$5f^4$	100	90
95	Americium	Am	$5f^7 7s^2$	$5f^6$	$5f^5$	99	89
96	Curium	Cm	$5f^7 6d^1 7s^2$	$5f^7$	$5f^6$	99	88
97	Berkelium	Bk	$5f^9 7s^2$	$5f^8$	$5f^7$	98	87
98	Californium	Cf	$5f^{10} 7s^2$	$5f^9$	$5f^8$	98	86
99	Einstenium	Es	$5f^{11} 7s^2$	$5f^{10}$	$5f^9$	-	-
100	Fermium	Fm	$5f^{12} 7s^2$	$5f^{11}$	$5f^{10}$	-	-
101	Mendelevium	Md	$5f^{13} 7s^2$	$5f^{12}$	$5f^{11}$	-	-
102	Nobelium	No	$5f^{14} 7s^2$	$5f^{13}$	$5f^{12}$	-	-
103	Lawrencium	Lr	$5f^{14} 6d^1 7s^2$	$5f^{14}$	$5f^{13}$	-	-

BKT for EC of Actinoids

period $\longrightarrow$ 7

EC $\longrightarrow$ $7s^2\ 6d\ 5f$

f $\longrightarrow$ 1, 5, 8 ✗

$[Rn]\ 7s^2\ 6d\ 5f^0$

$86+2+0=88$

$*\ Th_{90}\ 7s^2\ 6d^2\ 5f^0$

$Pa_{91}\ 7s^2\ 6d^1\ 5f^2$

$U_{92}\ 7s^2\ 6d^1\ 5f^3$

$86 + 2 + 2 = 90$

$Np_{93}\ 7s^2\ 6d^1\ 5f^4$

$Pu_{94}\ 7s^2\ 6d^0\ 5f^6$

$Am_{95}\ 7s^2\ 6d^0\ 5f^7$

$Cm_{96}\ 7s^2\ 6d^1\ 5f^7$

$BK_{97}\ 7s^2\ 6d^0\ 5f^9$

$Cf_{98}\ 7s^2\ 6d^0\ 5f^{10}$

$Es_{99}\ 7s^2\ 6d^0\ 5f^{11}$

$Fm_{100}\ 7s^2\ 6d^0\ 5f^{12}$

$Md_{101}\ 7s^2\ 6d^0\ 5f^{13}$

$No_{102}\ 7s^2\ 6d^0\ 5f^{14}$

$Lr_{103}\ 7s^2\ 6d^1\ 5f^{14}$

$f \rightarrow 1, 5, 8X \quad f \rightarrow 7, 7, \quad f \rightarrow 14, 14$

BKT* BBI

HF

Am $7s^2\ 6d^0\ 5f^7$

Cm $7s^2\ 6d^1\ 5f^7$

F.F

No $7s^2\ 6d^0\ 5f^{14}$

Lr $7s^2\ 6d^1\ 5f^{14}$

Question

The electronic configuration of gadolinium (At. No. 64) is

A [Xe] $4f^8\ 5d^9\ 6s^2$

B [Xe] $4f^7\ 5d^1\ 6s^2$

C [Xe] $4f^3\ 5d^5\ 6s^2$

D [Xe] $4f^6\ 5d^2\ 6s^2$

Eu $6s^2$ $5d^0$ $4f^7$

Gd $6s^2$ $5d^1$ $4f^7$

Question

The number of 4f electrons in Eu (63) and Gd (64) are

A. 6, 7

B. 7, 6

C. 7, 7

D. 6, 6

$4f^7$ $4f^7$

Question

Electronic configuration of Lawrencium is

Lr

Lr

A. $5f^{14}\ 6d^{2}\ 7s^{2}$

B. $5f^{14}\ 6d^{1}\ 7s^{2}$

C. $5f^{13}\ 6d^{2}\ 7s^{2}$

D. $5f^{14}\ 6d^{3}\ 7s^{0}$

No $7s^2$ $6d^0$ $5f^{14}$

Lr $7s$ $6d^1$ $5f^{14}$

Question

Which actinoid does not have any electron in 5f-subshell?

A. Ac(z = 89)

B. Th(z = 90)

C. Pa(z = 91)

D. All of these

$f \rightarrow 1, 5, 8$ X

Th $7s^2\ 6d^2\ 5f^0$

Atomic and Ionic Sizes

- The overall decrease in atomic and ionic radii from lanthanum to lutetium (the lanthanoid contraction) is a unique feature in the chemistry of the lanthanoids.

order of shielding

s > p > d > f.

poor shielding

max.

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
58													71
f^1	f^3	f^4	f^5	f^6	f^7	f^7	f^9	f^{10}	f^{11}	f^{12}	f^{13}	f^{14}	f^{14}

Radius decreases.

Question

Which element among the lanthanides has the smallest atomic radius?

A. Cerium

B. Lutetium ✓

C. Europium

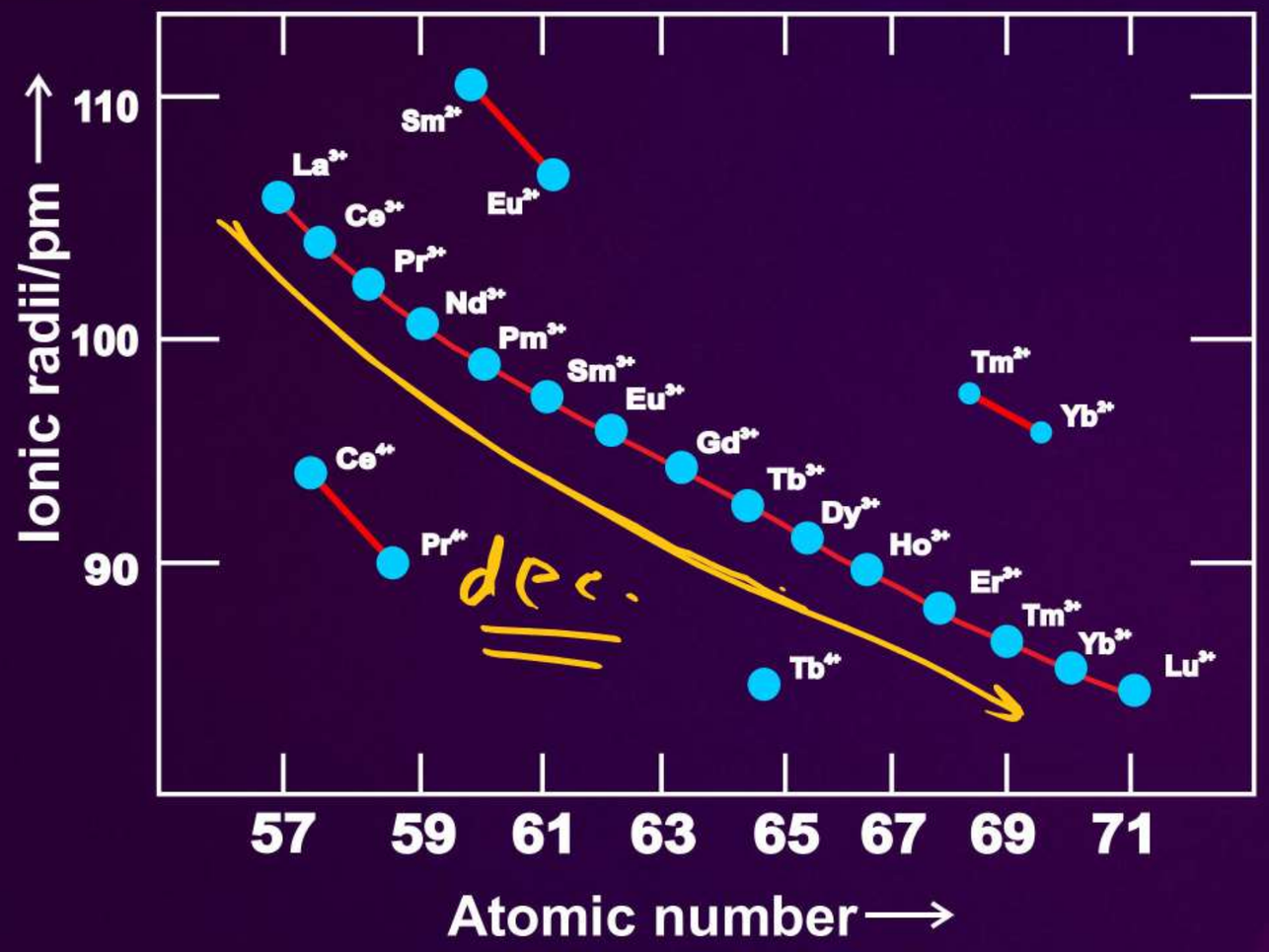
D. Gadolinium

Ce — Lu

decreases.

Atomic and Ionic Sizes

Ln +3



Trends in ionic radii of lanthanoids

Question

The radius of La^{3+} (At. No. of La = 57) is 1.06 Å. Which one of the following given values will be closet to the radius of Lu^{3+} (At. No. of Lu = 71)

A 1.40 Å ✗

B 1.06 Å ✗

C 0.85 Å ✓

D 1.60 Å ✗

$La^{+3} \longrightarrow Lu^{+3}$

1.06 A°

R dec.

Oxidation state (Ln)

common OS = +3

- In the lanthanoids, Ln(III) compounds are predominant species. However, they also exhibits +2 and +4
- Thus, the formation of Ce^{IV} is favoured by its noble gas configuration, but it is a strong oxidant reverting to the common +3 state

Ce $6s^2$ $5d^1$ $4f^1$

Ce^{+4} $6s^0$ $5d^0$ $4f^0$

Inert gas.

$Ce^{+4} \longrightarrow Ce^{+3}$

BKT*

oxidising reduction.

Oxidation state (Ln)

Ce

Pr, Nd, Tb and Dy also exhibit +4 state but only in oxides, MO_2

Eu^{2+} (f7 configuration) is a strong reducing agent changing to the common +3 state

$Eu \xrightarrow{-2} Eu^{+2}$ RA $Eu^{+2} \longrightarrow Eu^{+3}$

$6s^2 5d^0 4f^7$ $6s^0 5d^0 4f^7$ (4f) (oxidation)

Yb^{2+} which has f^{14} configuration is a reductant.

$Yb \xrightarrow{-2e} Yb^{+2}$ (F.F)

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

RA $Yb^{+2} \longrightarrow Yb^{+3}$

Tb^{IV} has half-filled f-orbitals and is an oxidant

OA $Tb^{+4} \longrightarrow Tb^{+3}$

✓**The behaviour of samarium is very much like europium, exhibiting both +2 and +3 oxidation states.** Sm

$$Ln^{+2} \xrightarrow{[U]} Ln^{+3}$$

RA

$$Ln^{+4} \xrightarrow{[R]} Ln^{+3}$$

OA

$$\left[\begin{array}{l} +2 \longrightarrow RA \\ +4 \longrightarrow OA \end{array}\right] \text{Bk T*}$$

Question

The most common oxidation state of lanthanides is

(A) + 4

(B) + 3

(C) + 6

(D) + 2

+3

Looser

failure

winner

Question

Most common oxidation states shown by Ce are

Ce → +3, +4

- **A** +2, +4
- **B** +3, +4
- **C** +3, +5
- **D** +2, +3

Question

Choose the correct statement

A. Eu(63) exhibits +2 oxidation state

B. Yb(70) exhibits +2 oxidation state

C. Ce(58) exhibits +4 oxidation state

D. all of these

Eu^{+2}

Yb^{+2}

Question

The reason for the stability of Gd^{3+} ion is

A. 4f–subshell–half filled

B. 4f subshell – completely filled

C. possesses the general electronic configuration of noble gases

D. 4f subshell–empty

Gd $6s^2$ $5d^1$ $4f^7$

Gd^{+3} $6s^0$ $5d^0$ $4f^7$

HP

Oxidation state (Ac)

The actinoids show in general +3 oxidation state.

3d
4s

Oxidation States of Actinium and Actinoids

Npbu

Ac	Th	Pb	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	NO	Lr
3		3	3	3	3	3	3	3	3	3	3	3	3	3
	4	4	4	4	4	4	4	4						
		5	5	5	5	5								
			6	6	6	6								
				7	7									

$7s^2\ 6d\ 5f$

General Characteristics of Lanthanoid → metals

- All the lanthanoids are silvery white soft metals.
- The hardness increases with increasing atomic number, samarium being steel hard.
- Their melting points range between 1000 to 1200 K but samarium melts at 1623 K.
- They have typical metallic structure and are good conductors of heat and electricity.

- Neither La^{3+} nor Lu^{3+} ion shows any colour but the rest do so → Ce^{+3} Eu^{+3}

- **The lanthanoid ions other than the f^0 type (La^{3+} and Ce^{4+}) and the f^{14} type (Yb^{2+} and Lu^{3+}) are all paramagnetic.**

BK T*

- A well known alloy is mischmetall which consists of a lanthanoid metal (~ 95%) and iron (~ 5%) and traces of S, C, Ca and Al. A good deal of mischmetall is used in Mg-based alloy to produce bullets, shell and lighter flint

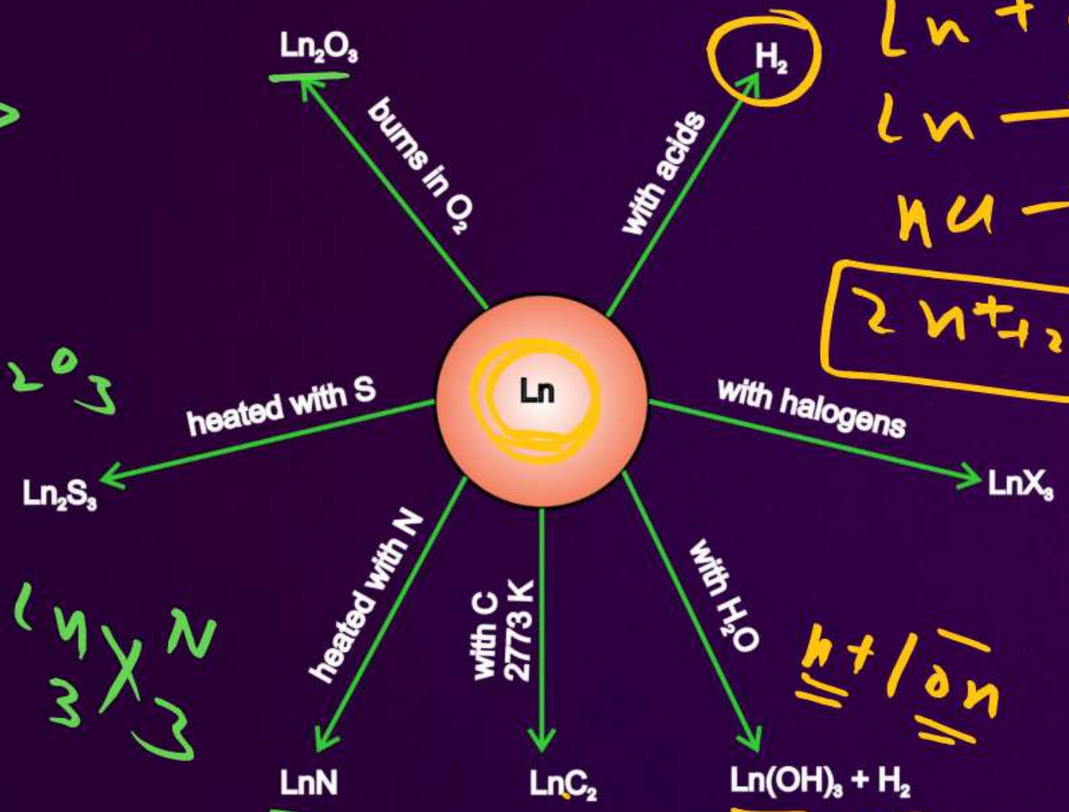
→ Lu^{+3}

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

Lu^{+3} $6s^0$ $5d^0$ $4f^{14}$

$n=0$

- In their chemical behaviour, in general, the earlier members of the series are quite reactive similar to calcium but, with increasing atomic number, they behave more like aluminium



$Ln + O_2 \rightarrow$

$Ln_3X_2^{O} \rightarrow Ln_2O_3$

$Ln + S \rightarrow Ln_3X_3^{N}$

$Ln_3X_2^{S} \rightarrow Ln_2S_3$

$Ln + N_2 \rightarrow$

$Ln + C \rightarrow LnC_2$

$Ln + HCl \rightarrow$

$Ln \rightarrow Ln^{+3} + 3e$

$HCl \rightarrow H^+ + Cl^-$

$X^- = F, Cl, Br, I$

$\boxed{2H^+ + 2e \rightarrow H_2}$

$Ln + X_2 \rightarrow$

$Ln_3X_1^{X} \rightarrow LnX_3$

H^+ / OH^-

General Characteristics of Actinoid

- The actinoids are radioactive elements and the earlier members have relatively long half-lives, the latter ones have half-life values ranging from a day to 3 minutes for lawrencium (Z =103).

BKTU

- Transuranic elements are members of the actinide series beyond uranium, beginning with neptunium (atomic number 93).

- There is a gradual decrease in the size of atoms or M^{3+} ions across the series

Yaanram ke bad.

Question

Which elements are called transuranics?

A. elements of 1st and 2nd group

B. elements of 4d & 5d series

C. elements after atomic number 92

D. elements of actinide series, prior to uranium

Which one among the following metals of 3d series has the lowest melting point ?

A. Fe

B. Mn

C. Zn

D. Cu

Which of the following is not considered a transition element?

A. Scandium

B. Silver

C. Vanadium

D. Zinc

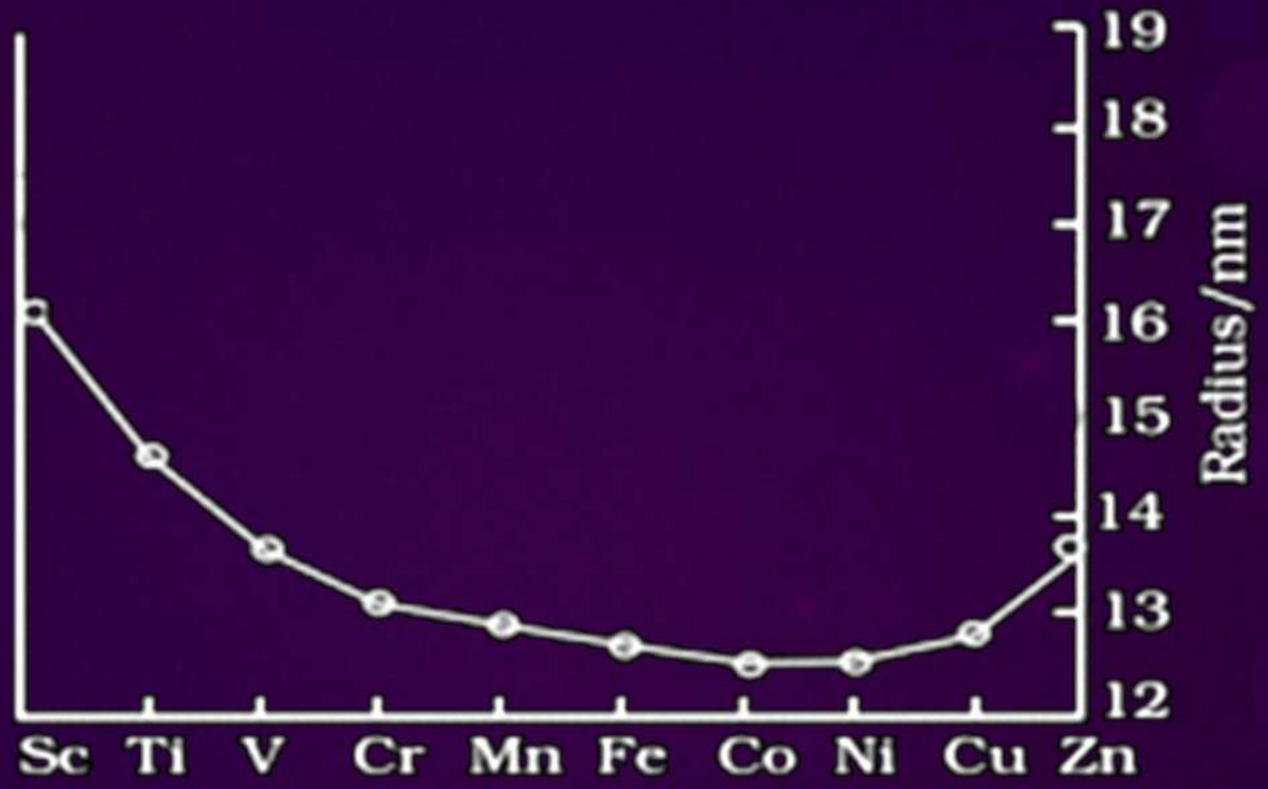
The trend of which property is represented by the following graph?

A ionization enthalpy

B atomic radii

C enthalpy of atomization

D melting point



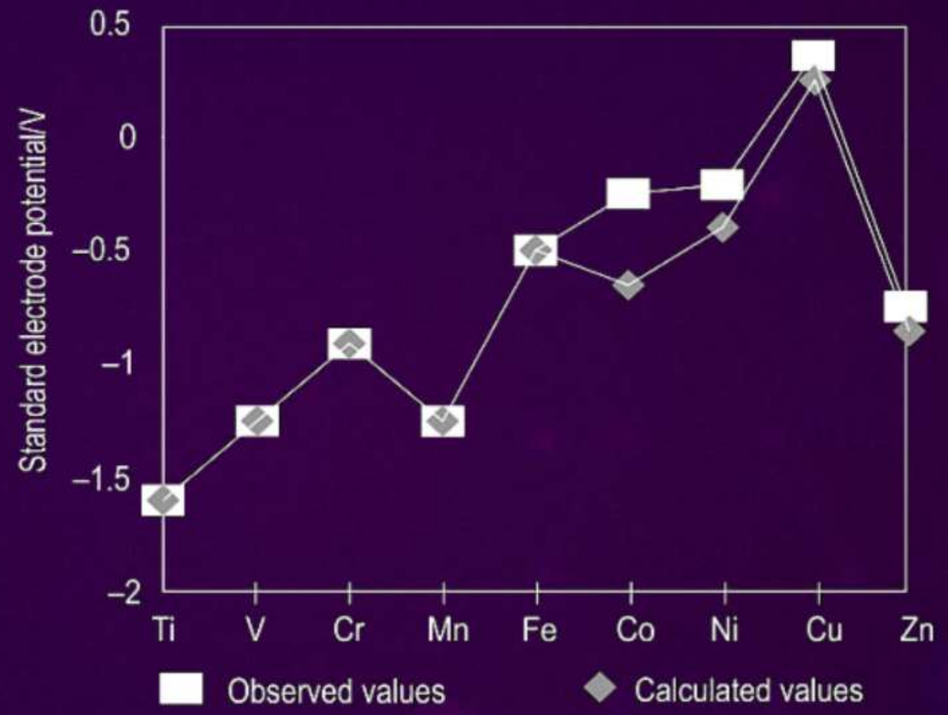
Study the graph given below.
Based on the graph given, which element will MOST LIKELY be involved in the following reaction?
Metal + conc. sulphuric acid → Metal sulphate + sulphur dioxide + water

A. Cu

B. Co

C. Ti

D. Zn



Observed and calculated values for the standard electrode potentials

($M^{2+} \rightarrow M^{0}$) of the elements Ti to Zn

Which of the following options give the correct arrangement of the atomic radii of the 3d, 4d and 5d transition series of elements?

A. Atomic radii of 3d < atomic radii of 4d < atomic radii of 5d

B. Atomic radii of 3d < atomic radii of 4d = atomic radii of 5d

C. Atomic radii of 3d = atomic radii of 4d > atomic radii of 5d

D. Atomic radii of 3d > atomic radii of 4d > atomic radii of 5d

If a strip of Cu metal is placed in a solution of ferrous sulphate

A. Copper will precipitate out

B. Iron will precipitate out

C. Copper will dissolve

D. No reaction will take place

Which ion has maximum magnetic moment?

A. V^{+3}

B. Mn^{+3}

C. Fe^{+3}

D. Cu^{+2}

When $KMnO_4$ is reduced with oxalic acid in acidic solution, the oxidation number of Mn Changes from

A. 7 to 4

B. 6 to 4

C. 7 to 2

D. 4 to 2

Select the correct statement :

A. When d-block elements from ions, (n – 1) d electrons are lost before ns electrons.

B. When d-block elements form ions, ns electrons are lost before (n – 1) d electrons.

C. When d-block elements form ions, (n – 1) f electrons are lost before ns electrons

D. None of these

In acidic solution, oxidizing action of potassium dichromate can be represented as

(A) $Cr_2O_7^{2-} + 3H^+ + Mn^{2+} \rightarrow 2Cr^{2+} + NH_3$

(B) $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

(C) $Cr_2O_7^{2-} + 18H^+ + 6Fe^{2+} \rightarrow 4Cr^{3+} + Cr_2O_5$

(D) $CrO_4^{2-} + 14H^+ + 5Cl_2 \rightarrow 2Cr^{3+} + Mn^{2+} + 7H_2O$

The number of unpaired electrons present, as per accepted electronic configuration in Yb(70) is/are :

(A) 0

(B) 1

(C) 2

(D) 7

Which of the following is paramagnetic?

A. Ni^{++}

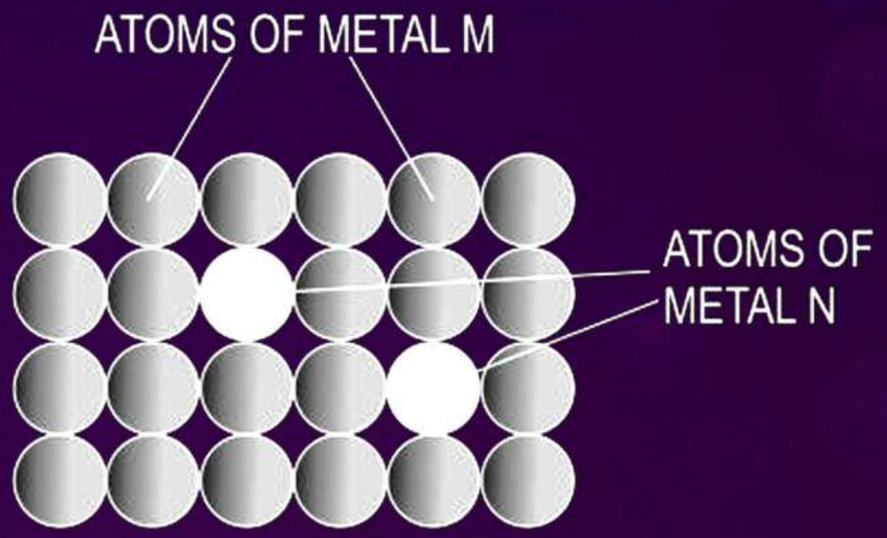
B. Cu^{+}

C. Zn^{++}

D. Sc^{++}

Given below is an image showing a specific property of transition metals.

Which property of transition metals is shown in the image?



A. Catalytic action

B. Formation of alloy

C. Coloured complex formation

D. Interstitial compound formation

The highest oxidation state which is shown by transition metals is :

A. +3

B. +8

C. +7

D. +5

Which of the given options gives the correct magnetic properties of the given ions?
[At no. of : La = 57, Ce = 58, Yb = 70, Lu = 71]

(A) Both La and La^{+3} is paramagnetic in nature.

(B) Both La^{+3} and Lu^{+3} are repelled by the applied magnetic field

(C) Ce^{+2} is diamagnetic in nature.

(D) Yb^{+2} has a magnetic moment of 2.76 BM.

Which of the following is not an element of first transition series?

A. Fe

B. Co

C. Ni

D. Ag

Priya listed 4 uses of $KMnO_4$ as follows :

P. It is used in volumetric analysis.

Q. It is used in the Chromyl Chloride test to detect cation.

R. It is used as a germicide

S. It is used in Baeyer's test, the test for unsaturated hydrocarbon.

Which of the used are CORRECTLY listed by Priya?

A. Only P, R and S

B. Only Q, R and S

C. Only S and R

D. Only P and Q

Which of the following statements is not correct

A. Copper liberates hydrogen from acids

B. In its higher oxidation states, manganese forms stable compounds with oxygen and fluorine

C. Mn^{3+} and Co^{3+} are oxidizing agents in aqueous solution are reducing agents in aqueous solution

D. Ti^{2+} and Cr^{2+} are reducing agents in aqueous solution

Which of the following characteristics make transition elements good catalysts?

P. Their tendency to form reaction intermediates with the reactants, thereby reducing the activation energy

Q. Their ability to have multiple oxidation states

R. Their ability to form complex compounds

A. Only P

B. Only Q

C. Only Q and R

D. All P, Q and R

$KMnO_4$ acts as an oxidizing agent in acidic medium. The number of moles of $KMnO_4$ that will be needed to react with one mole of sulphide ions in acidic solution is :

A $\frac{2}{5}$

B $\frac{3}{5}$

C $\frac{4}{5}$

D $\frac{1}{5}$

Assertion (A) : Transition metals have low melting points.
Reason (R) : The involvement of greater number of (n – 1)d and ns electrons in the interatomic metallic bonding.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

Assertion (A) : Copper does not form copper (II) sulphate on reaction with dil. sulphuric acid.

Reason (R) : The standard potential for Cu^{+2}/Cu electrode is negative.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

Assertion (A) : The highest oxidation state of osmium is +8.
Reason (R) : Osmium is a 5d-block element.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

Assertion (A) : Actinoids form relatively less stable complexes as compared to lanthanoids.
Reason (R) : Actinoids can utilize their 5f orbitals along with 6d orbitals in bonding but lanthanoids do not use their 4f orbital for bonding.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

Assertion (A) : Cu^{2+} iodide is not known.
Reason (R) : Cu^{2+} oxidises I^- to iodine.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

Assertion (A) : Cuprous ion(Cu^{+}) is colourless whereas cupric ion (Cu^{++}) is blue in the aqueous solution.
Reason (R) : Cuprous ion(Cu^{+}) has unpaired electrons while cupric ion (Cu^{++}) does not.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

Assertion (A) : Most of the trivalent lanthanide ions are coloured both in the solid state and in aqueous solution.
Reason (R) : The elements with xf electrons have a similar colour to those of (14 – x) f electrons.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

Assertion (A) : Mn^{2+} is a colourless ion
Reason (R) : Ti shows +2, +3 and +4 oxidation states due to $4s^2$ and $3d^2$ electrons.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

Assertion (A) : Fe^{3+} is more stable than Fe^{2+}.
Reason (R) : Half filled and completely filled subshells are more stable.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

Assertion (A) : The atomic density of copper is less than that of chromium.
Reason (R) : The atomic mass of copper is more than that of chromium.

A. Both A and R are true, and R is the correct explanation of A.

B. Both A and R are true, but R is not the correct explanation of A.

C. A is true, but R is false

D. A is false, but R is true.

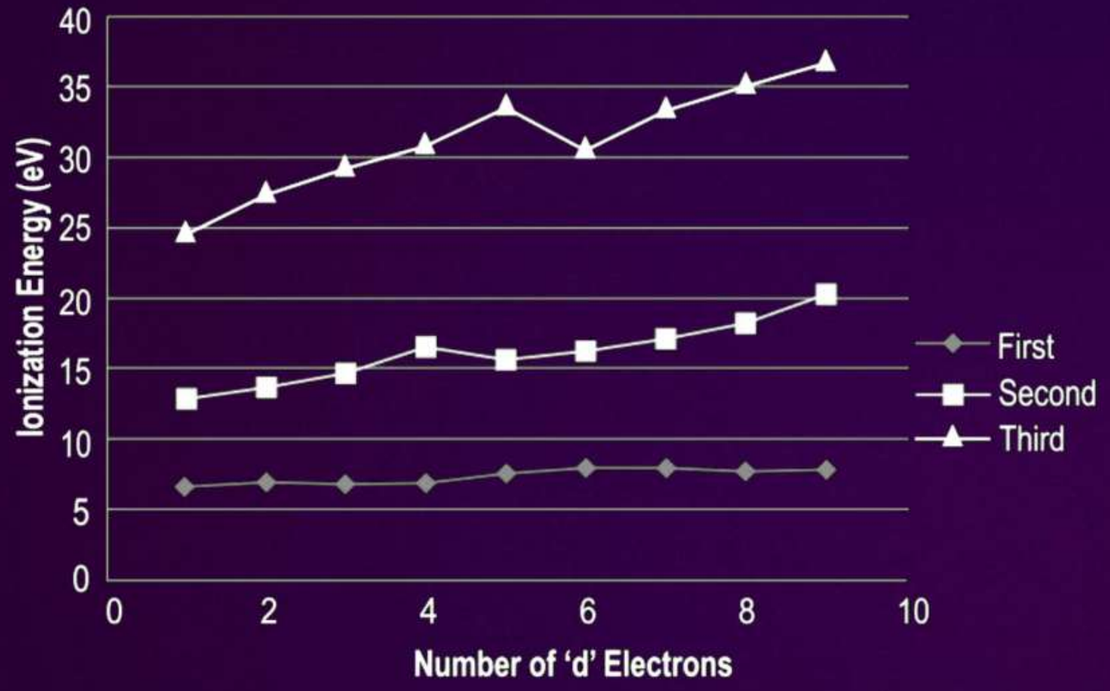
In the series Sc (Z = 21) to Zn (Z = 30), the enthalpy of atomization of zinc is the lowest, i.e., 126 kJ/mol. Why?

Explain why Cu^+ ion is not stable in aqueous solutions?

Explain briefly how +2 state becomes more and more stable in the first half of the first row transition elements with increasing atomic number?

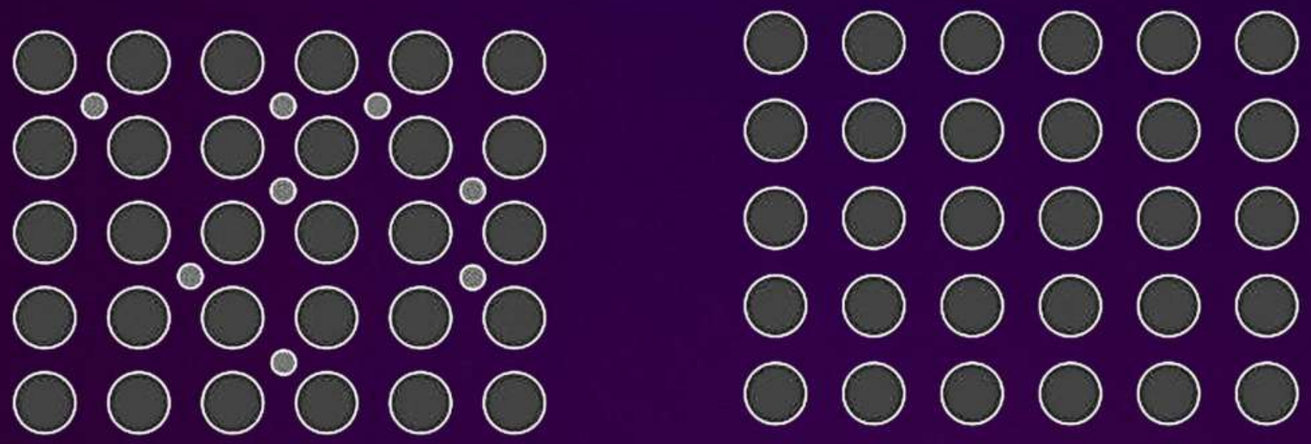
To what extent do the electronic configuration decide the stability of oxidation states in the first series of the transition elements? Illustrate your answer with examples.

The graph below shows the first, second and third ionization energies of a set of elements.



In the graph, we can see a deviation in the fifth eleemtn in the trend for second ionization energy and a deviation in the sixth element in the trend for third ionization energy. Idetnify the elements ands explain why the deviation occurs.

The structure of two different samples of the same metal is shown below:



Sample I

Sample II

Complete the table with respect to the samples given above with the given information:
[1668°C, 3160°C, chemically reactive, chemically inert]

	Sample I	Sample II
Melting point		
Chemical reactivity		

Compare between lanthanoids and actinoids.

Why actinoid contraction is greater than lanthanoid contraction?

Explain why Sm^{3+} is paramagnetic ?

Give two similarities in the properties of Sc and Zn.

Defined transition metals. Why are Zn, Cd and Hg not called transition metals? How is the variablility in oxidation states of transition metals different from that of p-block elements?

Write the balanced chemical equations involved in the preparation of $KMnO_4$ from pyrilusite ore MnO_2?

Write the balanced ionic equations showing the oxidizing action of acidified dichromate ($Cr_2O_7^{2-}$) solution with (i) Tin (II) ion, and (ii) Iron (II) ion

Following ions are given :

Cr^{2+}, Cu^{2+}, Cu^{+}, Fe^{2+}, Fe^{3+}, Mn^{3+}

Identify the ion which is

(i) A strong reducing agent

(ii) Unstable in aqueous solution

(iii) A strong oxidizing agent

Give suitable reason in each.

Given reasons for the following :

(i) The transition metals generally form coloured compounds.

(ii) E^0 value for Mn^{3+} / Mn^{2+} is highly positive than that for Cr^{3+} / Cr^{2+} couple.

(iii) The chemistry of actinoids elements is not so smooth as that of the lanthanoids.

When $FeCr_2O_4$ is fused with Na_2CO_3 in the presence of air it gives a yellow solution of compound (A). Compound (A) on acidification gives compound (B). Compound (B) on reaction with KCl forms an orange coloured compound (C). An acidified solution of compound (C) oxidises Na_2SO_3 to (D). Identify (A), (B), (C) and (D).

(a) Why Eu^{2+} acts as a strong reducing agent?

(b) Write the electronic configuration of Yb^{3+} ion and calculate its magnetic moment.

A solution of $KMnO_4$ on reduction yields either a colourless solution or a brown precipitate or a green solution depending on pH of the solution. What different stages of the reduction do these represent and how are they carried out?

(a) What are inner transition elements? Decide which of the following atomic numbers are the atomic numbers of the inner transition element : 29, 59, 74, 95, 102, 104.

(b) Name the members of the lanthanoid series which exhibit +4 oxidation states and those which exhibit +2 oxidation states. Try to correlate this type of behaviour with the electronic configuration of these elements.

How would you account for the following:

(i) Of the d^4 species, Cr^{2+} is strongly reducing while manganese (III) is strongly oxidizing.

(ii) Cobalt (II) is stable in aqueous solution but in the presence of complexing reagents it is easily oxidized.

(iii) The d^1 configuration is very unstable in ions.

What are alloys? Name an important alloy which contains some of the lanthanoid metals. Mention its uses.

(a) (I) Account for the following :

(i) E° value for Mn^{3+} / Mn^{2+} couple is much more positive than that for Cr^{3+} / Cr^{2+}.

(ii) Sc^{3+} is colourless whereas Ti^{3+} is coloured in an aqueous solution.

(II) Write the chemical equations for the preparation of $KMnO_4$ from MnO_2.

(b) (I) Account for the following :

(i) Transition metals form alloys.

(ii) Ce^{4+} is a strong oxidizing agent.

(II) Write one similarity and one difference between chemistry of Lanthanoids and Actionids.

(III) Complete the following ionic equation :

$Cr_2O_7^{2-} + 2OH^- \rightarrow$

(a) Give reason for the following observations related to the transition metals.

(i) Higher enthalpies of atomization

(ii) Formation of coloured compounds

(iii) Formation of complexes

(b) Complete the following reaction :

(i) $NO_2^- + MnO_4^- + H^+ \rightarrow$

(ii) $MnO_4^-(aq) + C_2O_4^{2-}(aq) + H^+(aq) \rightarrow$

(a) Why are all copper halides known except that copper iodide?

(b) Why is the $E°(V^{3+}/V^{2+})$ value for vanadium comparatively low?

(c) Why HCl should not be used for potassium permanganate titrations?

(d) Explain the observation, at the end of each period, there is a slight increase in the atomic radius of d block elements.

(e) What is the effect of pH on dichromate ion solution?

(*) Next lecture.

↓

New chapter

↓

coordination compound.

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starting → 20 minutes → Revision. PYQ d & f block.

Home Work

Pyo → HW

DPP