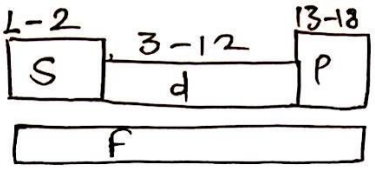
D - Block



→ Middle part of periodic table is 'd' block.

→ $_{21}Sc$ $_{22}Ti$ _ _ _ $_{28}Ni$ $_{29}Cu$ $_{30}Zn$ → 3d series

$_{39}Y$ $_{40}Zr$ $_{72}Hf$ (Almost same size.) $_{46}Pd$ $_{47}Ag$ $_{48}Cd$ → 4d series

$_{57}La$ $_{78}Pt$ $_{79}Au$ $_{80}Hg$ → 5d-series

$_{89}Ac$ 104 112

Lanthanoid

Actinoid

→ In 'd' block, last electron enter in $(n-1)d$.

→ $_{21}Sc$: _ _ _ $3s^2\ 3p^6\ 4s^2\ 3d^1$ (last e⁻ in $(n-1)d$)

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

$(n-1)d^{1-10}\ ns^{0,1,2}$

Q. Which d-block metal has ns^1 configuration?

(a) Cr → $4s^1$ (b) Cu → $4s^1$ (c) Au → ns^1 ~~(d) All~~

Q. Which d-block metal has ns^0 configuration? ★

(a) Cr (b) Cu (c) Ni ~~(d) Pd~~

→ Group → 3 to 12 , period → 4 to 7.

Ni $3d^8 4s^2$

Pd $4d^{10} 5s^0$

Pt $5d^9 6s^1$

IB/11 group IIB/12 group

Cu, Ag, Au — Coinage metals.

Zn, Cd, Hg — Volatile group

→ All d-block elements are not transition, but all transition elements are d-block.

Transition elements:- $(n-1)d$ incomplete either in atomic or ionic form.

→ gives colored compounds.

→ Cu: transition.

Cu → $[Ar]\ 4s^1\ 3d^{10}$ ×.

Cu^{+2} → $[Ar]\ 4s^0\ 3d^9$ ✓

→ IIB (Zn, Cd, Hg) are not transition metal because $(n-1)d$ is completely filled in atomic and in ionic form.

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→ $Zn \rightarrow 3d^{10} 4s^2$
$Zn^{+2} \rightarrow 3d^{10}$] – complete filled in atomic & ionic form

→ S – – – – Zn
– – – – Cd
– – – – Hg – not transition element.
– – – – 112

∴ Total transition element = 36
Total d block – 40.

→ Transition element → 3 to 11. group
12th group – not transition.

→ configuration of transition element → $(n-1)\, d^{1-10}\, ns^{1-2}$
└ same as d-block.

Atomic size:-

– Along 3d sereis

1st size ↓es, than almost same & at end size ↑es slightly.

3d series → Sc > Ti > V > Cr > Mn > Fe ≈ Co ≈ Ni < Cu < Zn

size ↓es, $Z_{eff} > \sigma$ shielding ef. | almost same $Z_{eff} = \sigma$ | size ↑es sli. $Z_{eff} < \sigma$.

Q. Zn is larger than:-
(a) Cd (b) Sc (c) K (d) Ca ~~(e)~~ Cu

Note: In divalent – 3d ion, size ↓es regular
Sc^{+2} Ti^{+2} V^{+2} – – – Co^{+2} Ni^{+2} Cu^{+2} Zn^{+2}
size ↓es, regular.

3d – 21 Sc 22 Ti
4d – 39 Y 40 Zr
5d – 57 La – 72 Hf
└ lanthanoid
└ 14e⁻ in f-subshell.
└ poor shielding
└ lanthanoid contraction

shell ↑es, size ↑es.
size Zr ≈ Hf
└ due to lanthanoid contraction.
4d ≈ 5d
└ except La > Y

→ $Zr^{+4} \simeq Hf^{+4}$

but $Zr^{+4} \simeq Hf^{+2}$ X.

$Zr \simeq Hf^{+2}$ X.

- $Cu < Ag \simeq Au$.
- $Ni < Pd \simeq Pt$
- $Ti^{+4} < Zr^{+4} \simeq Hf^{+4}$.

] size.

Ionization Energy

$$I.E \propto \frac{1}{size}$$

- stable configuration has high I.E.

→ Sc Ti V Cr

size ↓es, I.E ↑es.

- $(I.E)_1$ → Cu < Zn
  $3d^{10}4s^1$ $3d^{10}4s^2$
- $(I.E)_2$ → $Cu^+ > Zn^+$
  $3d^{10}$ $3d^{10}4s^1$

→ $(I.E)_1$ → K < Cu
$4s^1$ $4s^1$

$(I.E)_2$ → $K^+ > Cu^+$
$3s^2 3p^6$ (Noble gas config.) $3d^{10}$

$(I.E)_2$ → Cu > Cr
$3d^{10}$ $3d^5$

Q. Which metal has maximum $(I.E)_3$?

(a) V ($3d^3$) (b) Cr ($3d^4$) (c) Mn ($-2e^-$ → Mn^{+2} → $3d^5$ half filled.) (d) Fe ($3d^6$)

→ $(I.E)_2$ of ↓es → Ti V Cr Mn

$(I.E)_2$ → Ti ($3d^2 4s^1$) V ($3d^3 4s^1$) Cr ($3d^5$) Mn ($3d^5 4s^1$)

→ **Cr > Mn > V > Ti**

Q. Which coinage metal has minimum I.E?

(a) Cu (b) Ag (c) Au max. (d) Hg not coinage

Au > Cu > Ag

Coinage 3d Cu, 4d Ag, 5d Au — size ↑es, I.E ↓es.

but I.E of 5d > 4d

5d > 3d > 4d

Note:-

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Melting point

→ d-block metal > s-block metal - mpt

Fe > Ca
Ti > Ca.] - metal.

→ mpt. ∝ no. of unpaired e⁻

→ metallic bond strength ∝ no. of unpaired e⁻

but $FeCl_2$ (covalent) < $CaCl_2$ (ionic) → m.pt (compound)

→ Melting point, Hardness, enthalpy of atomization of d-block metal is greater than s-block e⁻ because large no. of (n-1)d unpaired e⁻ involve in metallic bonding.

$M_{(s)} \longrightarrow M_{(g)}$

enthalpy of atomization → sublimation energy

3d series

Sc Ti V Cr Mn Fe Co Ni Cu Zn

(Cr: 6 | VIB. max unpaired e⁻)

4d series

Y Zr Nb Mo Tc

(Mo: m.pt max.)

Q. Which of the following element can be used as a filament in X-ray tube?

(a) Sc (b) Fe (c) Ni ~~(d)~~ Mo

Cr Mo W (Tungsten)
↳ 6 | VIB.

Q. Which of the following group of d-block has higher m.pt?

(a) IVB (b) VB ~~(c)~~ VIB (d) VIIB

→ Along the 3d series, m.pt ↑es upto middle & then ↓es because pairing start.

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

unpaired e⁻ ↑. → unpaired e⁻ ↓es
m.pt ↑es → m.pt ↓es

→ Max. melting point metal → Tungsten (W)

→ Max. melting point of element → C (diamond).

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- Min. m.pt metal → Hg
- Min. m.pt element → He

→ In each series, last metal [Zn, Cd, Hg] has min. m.pt or min. enthalpy of atomisation because all d e^- are paired.

Q. Which 3d transition metal has minimum enthalpy of atomisation?

(a) Sc (b) Ti (c) Cu (d) Zn — not transition

Q. Which property of (Mn) is max. in 3d series?

(a) m.pt (b) density (c) size (d) Oxidation state

Q. Which group has maximum m.pt?

(a) IA (b) IIA (c) IIIB (d) IIB — volatile, least.

IA, IIA → s. IIIB, IIB → d-block

Density

→ 'D' block > 's' block → loose packing
- low efficiency of packing.
- due to close packing
- packing efficiency high

• Fe > Ca → density

Cu > K → density

$d = \frac{m}{V}$ — m: group, V: period

3d series — min density in 3d-series

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

volume ↓es, density ↑. — except.

mas ↑es. density ↑es

4d series

Y Zr.

5d series La Hf — 14 element

Density - 5d >>> 4d

almost 5d is double of 4d (density) due to lanthanoid contraction

Q. Which metal sink in Hg liq:-

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

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Magnetic Property

→ paramagnetic substance attracted by magnetic field & paramagnetism arises due to unpaired e^- (d^1 to d^9) ($\mu \neq 0$).

$$\mu = \sqrt{n(n+2)}$$ n → unpaired e^-.

$\mu = 1.73$, $n = 1$.
$\mu = 3.88$, $n = 3$.

- Magnetic property or paramgnetism $\propto n$ (unpaired e^-)

Q. Cr^{+2}, $\mu = ?$
($n = 4$)
(a) 5.83 (b) 4.88 (c) 3.72 (d) 2.9.

$\mu = \sqrt{n(n+1)} = \sqrt{4 \times 5} = \sqrt{20} = 4.88$

$\mu = 8.32$, $n = 8$.

$\mu = x.y$, $n = x$.

Q. Which divalent 3d ion contain maximum unpaired e^-?
(a) Cr^{+2} $4s^0 3d^4$ (4)
(b) Mn^{+2} $4s^0 3d^5$ (5)
(c) Fe^{+2} $4s^0 3d^6$ (4)
(d) Ca^{+2} $4s^0 4d^?$ ($\frac{1}{3}$).

Q. Max unpaired present in:-
(a) V^{+3} (b) Cr^{+3} (c) Mn^{+3} (d) Fe^{+3} ($3d^5$) (e) Co^{+3}

→ Along 3d series, paramagnetism increases upto middle & then decreases because pairing start.

Q. Which aqua complex show maximum paramagnetism?
(a) $[Ni(H_2O)_6]^{+2}$ ($3d^8$, $2n$)
(b) $[Fe(H_2O)_6]^{+2}$ ($3d^6$, $4n$)
(c) $[Mn(H_2O)_6]^{+2}$ ($3d^5$, $5n$)
(d) $[Cu(H_2O)_6]^{+2}$ ($3d^9$, $1n$).

$c > b > a > d$

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Q. Fe^{+x}, $\mu = \sqrt{24}$, $x = ?$

$\therefore \mu = 4.8$ .. $\therefore x = 2$.

Fe^{+2} → $3d^6$ → $n = 4$.

- **Diamagnetism:-** Diamagnetic substance repel by magnetic field.
  - ↳ unpaired e^- $(n) = 0$.
    - ↳ d^0 | d^{10}

– In each series, 1st & last metal ion is diamagnetic & colorless.

$Sc^{+3} \rightarrow 3d^0$ — — — $Zn^{+2} \rightarrow 3d^{10}$

$Y^{+3} \rightarrow 4d^0$ $Cd^{+2} \rightarrow 4d^{10}$

$La^{+3} \rightarrow 5d^0$ $Hg^{+2} \rightarrow 5d^{10}$

Q. Which metal ion is diamagnetic?

(a) Sc^{+3} ($3d^0$) (b) Ti^{+4} ($3d^0$) (c) Cu^{+} ($3d^{10}$) (d) Zn^{+2} ($3d^{10}$) ~~(e)~~ All

Q. Which pair is diamagnetic?

(a) Cu^{+} ($n=0$), Cu^{+2} ($n=1$) (b) Fe^{+2} ($n=4$), Fe^{+3} ($n=5$)

~~(c)~~ Hg^{+2}, Hg_2^{+2} (d) None

Hg_2^{+2} → Hg^{+} & Hg^{+}.

↳ always diamagnetic.

$5d^{10}$ ~~6s⁰~~ $5d^{10}6s^1$ but exist in dimer → $Hg_2^{+2} \rightarrow 5d^{10}$.

↳ mercurous ion

* $[Mn(CN)_6]^{-3}$, $n = ?$

(a) 4 (b) 0 ~~(c)~~ 2 (d) 3.

$Mn^{+3} \rightarrow 3d^4 4s^2$

↳ 2 unpaired e.