

d- and f-Block Elements: one-page cheat sheet

NEET Chemistry · Unit 11 · Inorganic Chemistry

1 • Transition elements

Definition partly filled d -orbitals in the atom or in a common ion

Not typical Zn, Cd, Hg (d^{10} always)
 $(n-1)d^{1-10}ns^{1-2}$

Exceptions Cr $3d^5 4s^1$; Cu $3d^{10} 4s^1$

Ions $4s$ electrons leave **before** $3d$

2 • Physical trends

Radius falls Sc to Cr, flat Fe to Ni, small rise Cu, Zn

m.p. peak near d^5 (Cr); Mn dips; Zn, Cd, Hg low (Hg liquid)

$4d \approx 5d$ equal radii from lanthanoid contraction

Cause metallic bonding by ns and unpaired $(n-1)d$ electrons

3 • Oxidation states & E°

Lowest number of s electrons

Highest $s + d$ electrons, up to Mn (+7)

Down a group higher states become more stable (Mo, W vs Cr)

Couple	E° (V)
$\text{Cr}^{3+}/\text{Cr}^{2+}$	-0.41
$\text{Fe}^{3+}/\text{Fe}^{2+}$	+0.77
$\text{Mn}^{3+}/\text{Mn}^{2+}$	+1.57
Cu^{2+}/Cu	+0.34

Mn^{3+} is a strong oxidant: it gains the stable d^5 . Cr^{2+} is a reductant: it gains t_{2g}^3 in Cr^{3+} .

4 • Magnetism & colour

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

n	μ (BM)	Ions
1	1.73	Ti^{3+} , Cu^{2+}
2	2.84	Ti^{2+} , Ni^{2+}
3	3.87	V^{2+} , Cr^{3+}
4	4.90	Cr^{2+} , Fe^{2+}
5	5.92	Mn^{2+} , Fe^{3+}

Colour $d-d$ transition; d^0 and d^{10} are colourless (Sc^{3+} , Zn^{2+})

5 • Catalysts

Catalyst	Process
V_2O_5	Contact process
Fe	Haber process
Ni	hydrogenation
PdCl_2	Wacker (ethene to ethanal)
$\text{TiCl}_4 + \text{Al}(\text{C}_2\text{H}_5)_3$	Ziegler-Natta

6 • Potassium dichromate

Step 1 roast chromite FeCr_2O_4 with Na_2CO_3 and air: Na_2CrO_4 (yellow)

Step 2 $2\text{CrO}_4^{2-} + 2\text{H}^+ \rightarrow \text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{O}$ (yellow to orange)

Step 3 $\text{Na}_2\text{Cr}_2\text{O}_7 + 2\text{KCl} \rightarrow \text{K}_2\text{Cr}_2\text{O}_7 + 2\text{NaCl}$
 $\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$

Oxidises Fe^{2+} , I^- , H_2S ; orange turns green. Structure: two tetrahedra sharing a corner, Cr–O–Cr 126° .

7 • Potassium permanganate

Prep. $2\text{MnO}_2 + 4\text{KOH} + \text{O}_2 \rightarrow 2\text{K}_2\text{MnO}_4 + 2\text{H}_2\text{O}$

Disprop. $3\text{MnO}_4^{2-} + 4\text{H}^+ \rightarrow 2\text{MnO}_4^- + \text{MnO}_2 + 2\text{H}_2\text{O}$

Medium	Product	e^-
Acidic	Mn^{2+}	5
Neutral / weak alkaline	MnO_2	3
Strong alkaline	MnO_4^{2-}	1

Equivalent mass = $M/5$, $M/3$, $M/1$. MnO_4^- is purple (d^0 , charge transfer).

8 • f-Block

	Lanthanoids	Actinoids
Filling	$4f$ (Z 58–71)	$5f$ (Z 90–103)
Main state	+3	+3 and higher (+4 to +7)
Shielding	$4f$ poor, buried	$5f$ extends further
Radioactive	only Pm	all

Ce^{4+} $4f^0$; also Eu^{2+} (f^7), Yb^{2+} (f^{14}), Tb^{4+} (f^7)

Contraction poor $4f$ shielding: basicity falls La to Lu

Seen in NEET 2026

Spin-only μ of Ti^{2+} ($3d^2$).

$$\mu = \sqrt{2(2+2)} = 2.84 \text{ BM}$$

Seen in NEET 2022

KMnO_4 oxidises I^- to IO_3^- in neutral medium. Change in Mn?

MnO_4^- to MnO_2 : **+7 to +4**.

Seen in NEET 2024

Why is E° ($\text{Mn}^{3+}/\text{Mn}^{2+}$) = +1.57 V so positive?

Mn^{3+} (d^4) gains an electron to reach the half-filled d^5 of Mn^{2+} .

Seen in NEET 2025

Strictly diamagnetic lanthanoid ions?

Ce^{4+} ($4f^0$) and Yb^{2+} ($4f^{14}$): no unpaired electrons.

Also in NEET 2022

Gd ($4f^7 5d^1 6s^2$) has a low third ionisation enthalpy: removing the $5d$ electron leaves stable $4f^7$.

Six traps to remember

- Zn, Cd and Hg are not true transition elements (d^{10}).
- Cr is $3d^5 4s^1$ and Cu is $3d^{10} 4s^1$, not $4s^2$.
- Cr^{2+} and Fe^{2+} both have 4 unpaired electrons: $\mu = 4.90 \text{ BM}$.

- $\text{Mn}^{3+}/\text{Mn}^{2+}$ is +1.57 V because $d^4 \rightarrow d^5$ is favoured.
- KMnO_4 : 5 electrons in acid, 3 in neutral or weakly alkaline medium.
- Ce^{4+} is stable as $4f^0$; Gd has a low third ionisation enthalpy for $4f^7$.