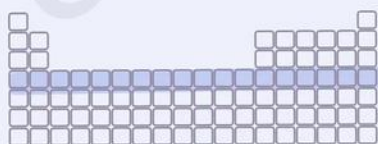


an inner shell fills while the outer one barely changes, and that's the whole personality

What makes a transition element *

- IUPAC: an element whose atom (or a common ion) has a **partly filled d subshell**
- Zn, Cd, Hg (full d^{10} in every common state) are d-block by position, not transition elements
- general configuration $(n-1)d^{1-10}ns^{0-2}$; 4s fills before 3d (lower $n+l$) but empties first on ionisation
- so a transition metal cation loses its ns electrons before any $(n-1)d$ electron
- four transition series sit in periods 4–7 (3d, 4d, 5d, 6d), across groups 3–12



period 4, the row where the first transition series (3d) appears, sitting across groups 3 to 12 of this row

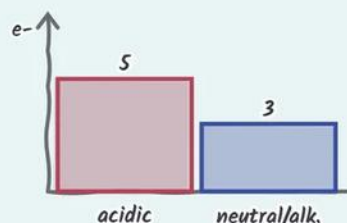
General properties, the trends worth knowing

- atomic/ionic radii fall across a period, but far more gently than the s- or p-block
- each added d electron partly shields the extra nuclear charge from the outer ns electrons
- variable oxidation states**: $(n-1)d$ and ns electrons are close in energy, several can be lost together
- +2 is common for most transition metals
- highest oxidation state often equals the group number for earlier members (Mn: up to +7)
- catalytic activity** comes from variable oxidation state (alternative path) plus adsorbing reactants on the surface
- colour** in aqueous ions comes from d-d transitions, needing an incomplete d subshell
- Sc^{3+} (d^0) and Zn^{2+} (d^{10}) are both colourless for exactly that reason

*almost every headline property here traces back to one fact: the d subshell is **INCOMPLETE**, so it has electrons free to move, absorb light, or be lost in more than one count*

$KMnO_4$: preparation and its two acid-dependent faces *

- made from pyrolusite (MnO_2): fused with KOH and an oxidiser (KNO_3 /air) gives green manganate, K_2MnO_4
- manganate disproportionates on acidification or electrolytic oxidation to purple permanganate, MnO_4^-
- in acid, MnO_4^- is reduced all the way to Mn^{2+} , a 5-electron change
- in neutral or faintly alkaline solution, only to MnO_2 , a 3-electron change: pH picks the job
- used to estimate Fe^{2+} , oxalate, iodide by titration: MnO_4^- is its own indicator at the endpoint



MnO_4^- gains 5 electrons in acid (going to Mn^{2+}) but only 3 in neutral or faintly alkaline solution (going to MnO_2)

Manganate to permanganate *

