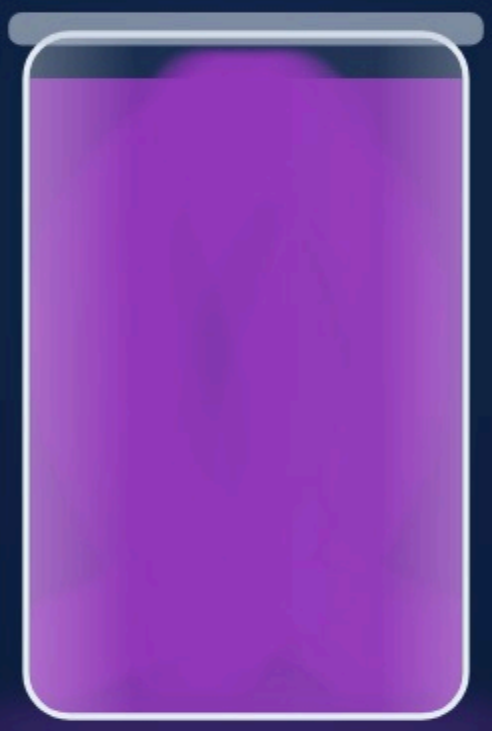
A tiny crystal, a deep colour



A pinch of $KMnO_4$ turns a whole jar of water **deep purple**.

Yet Mn in MnO_4^- has **no d electrons**.

Mn is +7: $3d^0$

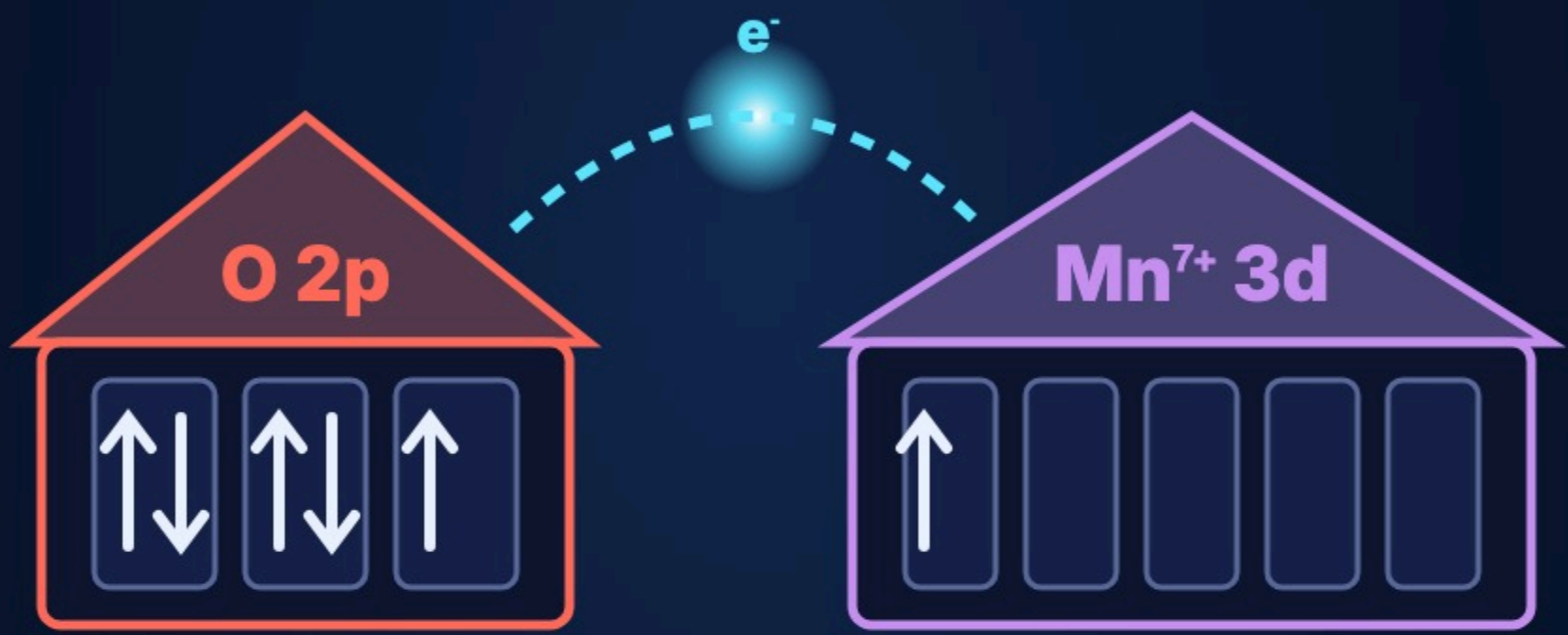


$Mn: 3d^5 4s^2 \rightarrow Mn^{7+}: 3d^0$

No d electron means **no d–d jump** is possible.

Other d^0 ions (Sc^{3+}, Ti^{4+}) are **colourless**.

The electron comes from O



Light makes an electron jump from **O (full 2p)** into **Mn's empty 3d**.

This is **ligand-to-metal charge transfer**.

Green-yellow absorbed → purple





The jump costs the energy of **green-yellow** light (≈ 525 nm).

Red + blue are left: we see **purple**.

Why so intense?



d → d: hard

charge transfer: easy

d–d jumps are **restricted** by nature, so few photons are absorbed.

Charge transfer is **allowed**: up to **hundreds of times** more light absorbed.

Same concentration, very different colour



Ti^{3+} (d–d)

MnO_4^- (CT)

Ti^{3+}(aq) (one d electron, d–d) is **pale**.

MnO_4^- (charge transfer) is **deep purple**.

The same family



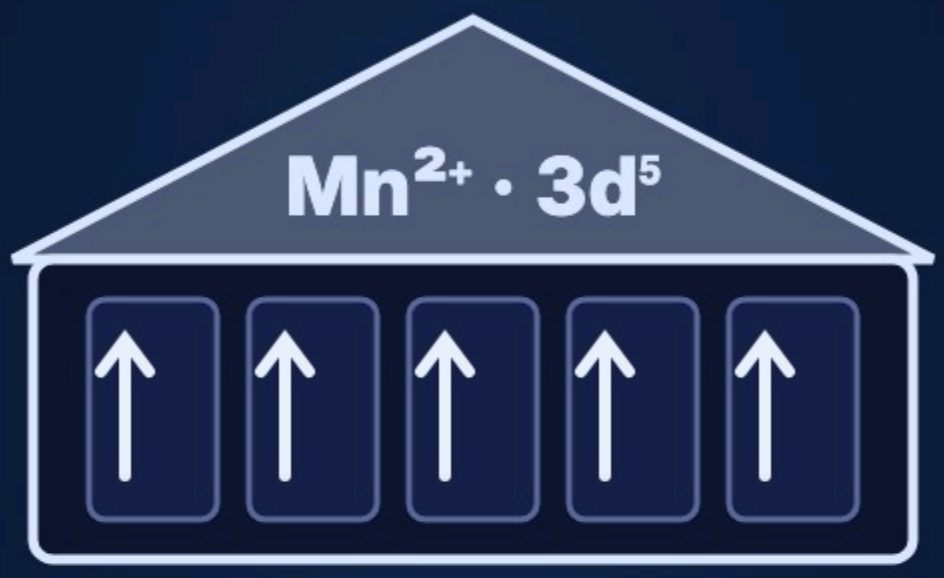
CrO_4^{2-} $Cr_2O_7^{2-}$

Cr +6 · d^0 · O → Cr

Chromate (yellow) and dichromate (orange) are also **d^0**.

Their colour is **O → Cr charge transfer** too.

Remember



almost colourless: why?

No d electrons, still coloured: **charge transfer** (O → Mn), and it is easy, so the colour is deep.

Your turn: Mn^{2+} has five d electrons yet is almost colourless. Why?