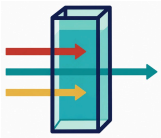
Transition Metal Reactions Map

Edexcel International A Level Chemistry · Unit 5 · Topic 17B Colour, Redox and Reactions of Ions

1 Why ions are coloured

17.7–17.9

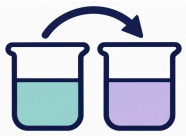
- Ligands **split** the 3d orbitals
- An electron absorbs light: ΔE
- We see the **complementary** colour
- $3d^0$ and $3d^{10}$: colourless



2 Changing the colour

17.11

- Oxidation number: $Fe^{2+} \rightarrow Fe^{3+}$
- Ligand: $H_2O \rightarrow NH_3$
- Coordination number: 6 → 4
- Each changes the **size of ΔE**

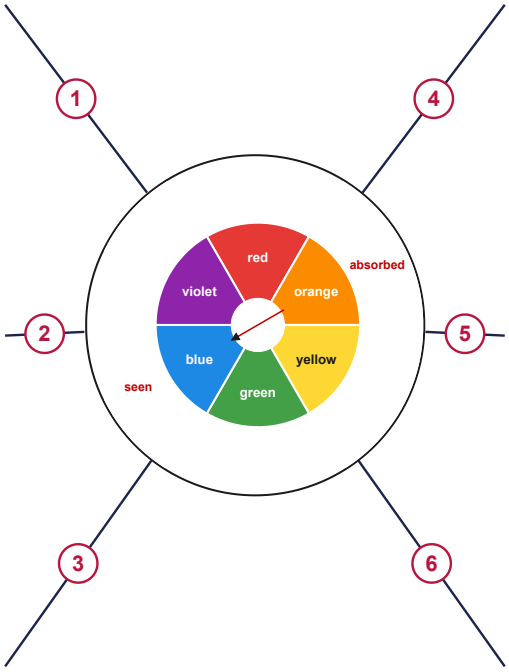


3 Vanadium

17.18, 17.19

- +5 yellow, +4 blue
- +3 green, +2 violet
- Zinc in acid reaches V^{2+}
- Tin stops at V^{3+}





4 Chromium

17.20, 17.21

- $Cr_2O_7^{2-}$ orange; Cr^{3+} green
- Zinc: on to **blue Cr^{2+}**
- H_2O_2 + alkali: yellow CrO_4^{2-}
- Acid: orange again (not redox)



5 Hydroxide precipitates

17.22, 17.23

- OH^- and NH_3 remove H^+
- Neutral complex: a **precipitate**
- $Fe(OH)_2$, $Mn(OH)_2$ darken in air
- Cr, Zn: **amphoteric**



6 Excess ammonia; CP14

17.24, 17.33

- NH_3 replaces H_2O: **exchange**
- Cu: deep blue ammine complex
- Cr, Co, Ni, Zn also dissolve
- CP14: crystals of the ammine



Metal ions with aqueous hydroxide and ammonia

precipitate, then in excess

Ion	Precipitate	Excess OH^-	Excess NH_3
Cr^{3+}	green	dark green solution	violet solution
Mn^{2+}	pale brown	stays	stays
Fe^{2+}	dirty green	stays	stays
Fe^{3+}	orange-brown	stays	stays
Co^{2+}	blue	stays	pale brown solution
Ni^{2+}	green	stays	blue solution
Cu^{2+}	pale blue	stays	deep blue solution
Zn^{2+}	white	colourless solution	colourless solution

Worked examples

Absorbing light

- $[Cu(H_2O)_6]^{2+}$ absorbs orange
- Complement: blue
- **Looks blue**

Feasibility

- $Zn + 2V^{3+} \rightarrow Zn^{2+} + 2V^{2+}$
- −0.26 − (−0.76)
- **+0.50 V: feasible**

Deprotonation

- $[Fe(H_2O)_6]^{3+} + 3OH^-$
- $\rightarrow [Fe(OH)_3(H_2O)_3]$
- **+ $3H_2O$**

Half-cell values come from Topic 16; ligand exchange with chloride and the chelate effect follow in Topic 17C.

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