Transition Metals Map

Edexcel International A Level Chemistry · Unit 5 · Topic 17A Transition Metals and Complexes

1 What is a transition metal?

17.1

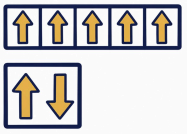
- A d-block element
- Forms a **stable ion**
- With **incomplete d orbitals**
- Sc^{3+} and Zn^{2+} have none: not transition metals



2 Configurations

17.2

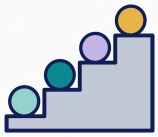
- **4s fills before 3d**
- **4s is lost first**
- Cr $3d^5\ 4s^1$; Cu $3d^{10}\ 4s^1$
- Fe^{3+} is [Ar] $3d^5$

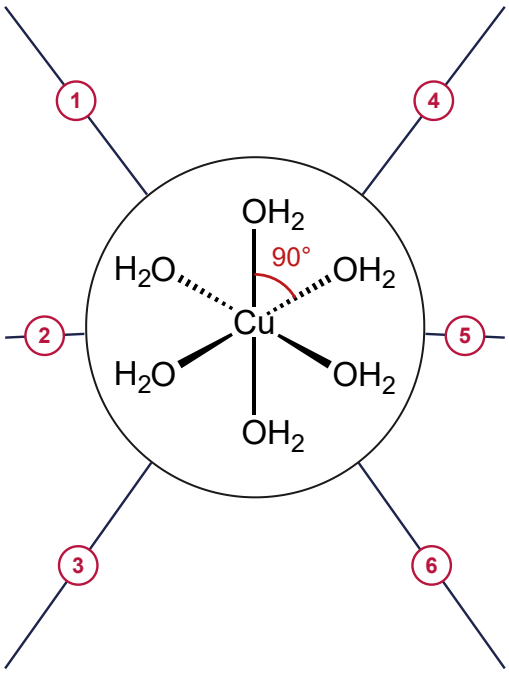


3 Oxidation numbers

17.3

- 3d and 4s are **close in energy**
- Bonding **repays** the energy
- Most: all 3d + 4s electrons
- Cr +6, Mn +7





4 Ligands and complexes

17.4–17.6, 17.10, 17.12

- Ligand: a **lone pair** to donate
- **Dative** bond to the metal ion
- Coordination number: dative bonds
- H_2O, NH_3, OH^-: monodentate



5 Multidentate ligands

17.16

- en, $H_2NCH_2CH_2NH_2$: **bidentate**
- $C_2O_4^{2-}$: bidentate
- $EDTA^{4-}$: **hexadentate**
- $[Ni(en)_3]^{2+}$: coordination number 6



6 Medical complexes

17.15, 17.17

- Cisplatin: square planar, Cl adjacent
- Supplied as a **single isomer**
- Haemoglobin: Fe^{2+}, polydentate
- **CO replaces O_2**: ligand exchange



Shapes of complexes

coordination number (CN), shape, angle

Example	CN	Shape	Angle
$[Cu(H_2O)_6]^{2+}$	6	Octahedral	90°
$[Co(NH_3)_6]^{3+}$	6	Octahedral	90°
$[CuCl_4]^{2-}$	4	Tetrahedral (large Cl^-)	109.5°
$[CoCl_4]^{2-}$	4	Tetrahedral	109.5°
$[Pt(NH_3)_2Cl_2]$	4	Square planar	90°

Worked examples

Configuration

- V [Ar] $3d^3\ 4s^2$
- Lose 4s, then 3d
- **V^{3+} [Ar] $3d^2$**

Charge

- $Co^{3+} + 5NH_3 + Cl^-$
- +3 + 0 − 1
- **$[Co(NH_3)_5Cl]^{2+}$**

Coordination number

- $[Cr(C_2O_4)_3]^{3-}$
- Three bidentate ligands
- **3 × 2 = 6**

Colour and the reactions of the aqueous ions follow in Topic 17B; ligand exchange and catalysis in Topic 17C.

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