Transition Elements Map

Cambridge International AS & A Level Chemistry · Topic 28 Transition elements and complexes

1 Transition elements

28.1.1, 28.1.3

- A d-block element
- A stable ion with **incomplete d orbitals**
- Variable oxidation states; catalysts
- Complex ions; coloured compounds



2 3d orbitals

28.1.2

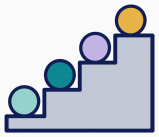
- Sketch $3d_{xy}$: four lobes between axes
- Sketch $3d_{z^2}$: two lobes and a ring
- Vacant d orbitals accept lone pairs
- Energetically accessible

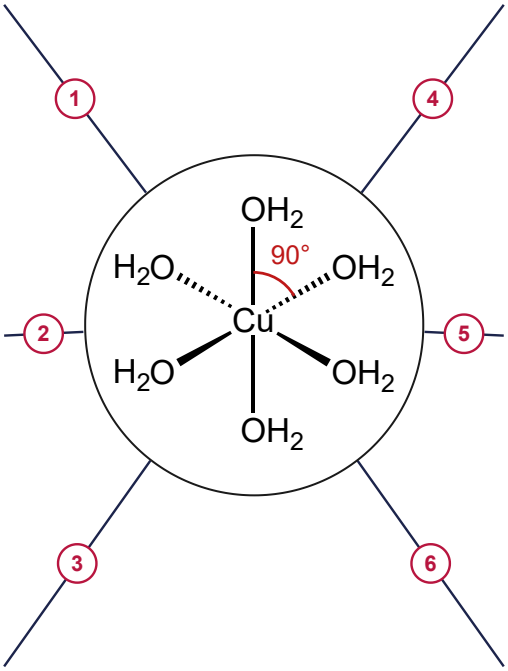


3 Oxidation states

28.1.4, 28.1.5

- 3d and 4s are **similar in energy**
- Several numbers of electrons can be lost
- More than one stable state: catalysts
- Vacant d orbitals: dative bonds

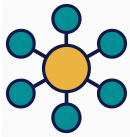




4 Ligands

28.2.2–28.2.4, 28.2.6

- A **lone pair** to donate
- Monodentate: H_2O, NH_3, Cl^-, CN^-
- Bidentate: en, $C_2O_4^{2-}$
- Polydentate: $EDTA^{4-}$



5 Geometry

28.2.5

- Octahedral 90°; tetrahedral 109.5°
- Square planar 90°
- Linear 180°
- Predict from the coordination number



6 Isomers and polarity

28.4

- Geometrical (cis/trans)
- Optical: with bidentate ligands
- Cis polar; trans dipoles cancel
- $[Ni(en)_2(H_2O)_2]^{2+}$: both



Geometry of complexes

coordination number (CN), shape, angle

Example	CN	Shape	Angle
$[Cu(H_2O)_6]^{2+}$	6	Octahedral	90°
$[CoCl_4]^{2-}$	4	Tetrahedral	109.5°
$[Pt(NH_3)_2Cl_2]$	4	Square planar	90°
$[Ag(NH_3)_2]^+$	2	Linear	180°

Worked examples

Formula

- Co^{2+} + four Cl^-
- +2 − 4
- **$[CoCl_4]^{2-}$**

Coordination number

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

Polarity

- Trans-$[Pt(NH_3)_2Cl_2]$
- Bond dipoles oppose
- **Non-polar overall**

Ligand exchange, colour, Kstab and redox feasibility follow in the next section.

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