Exchange and Catalysis Map

Edexcel A Level Chemistry · Topic 15 Ligand Exchange and Catalysis

1 Ligand exchange

15B.26, 15B.27

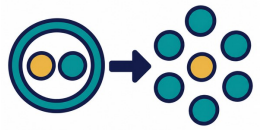
- NH_3 for H_2O: CN stays 6
- Cl^- for H_2O: CN falls to 4
- $[CuCl_4]^{2-}$ yellow; $[CoCl_4]^{2-}$ blue
- Add water: it **reverses**



2 The chelate effect

15B.28

- Bidentate for monodentate
- **More particles** on the right
- **ΔS_{system} positive**
- A more stable complex

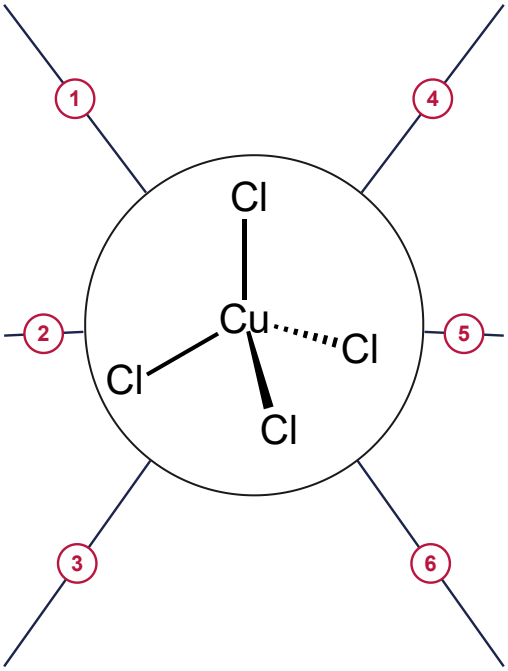


3 Catalysts

15B.29, 15B.30

- Heterogeneous: **different phase**
- Homogeneous: **same phase**
- A route of lower activation energy
- Variable oxidation number





4 V_2O_5 and the Contact process

15B.31

- $SO_2 + V_2O_5 \rightarrow SO_3 + V_2O_4$
- V +5 to +4
- $V_2O_4 + ½O_2 \rightarrow V_2O_5$
- V +4 back to +5



5 Catalytic converters

15B.32

- **Adsorption** of CO and NO
- Bonds weaken; reaction
- **Desorption** of CO_2 and N_2
- Pt or Rh surface



6 Homogeneous catalysis

15B.33–15B.35

- Fe^{2+} with $S_2O_8^{2-}$ and I^-
- Both steps: **opposite charges**
- Mn^{2+} in $MnO_4^-/C_2O_4^{2-}$
- Product catalyses: **autocatalysis**



Ligand exchange equations with colour changes

From	Reagent	To	Colour change
$[Cu(H_2O)_6]^{2+}$	excess NH_3	$[Cu(NH_3)_4(H_2O)_2]^{2+}$	blue to deep blue
$[Cu(H_2O)_6]^{2+}$	conc HCl	$[CuCl_4]^{2-}$	blue to yellow
$[Co(H_2O)_6]^{2+}$	conc HCl	$[CoCl_4]^{2-}$	pink to blue
$[Cu(H_2O)_6]^{2+}$	$EDTA^{4-}$	$[Cu(EDTA)]^{2-}$	blue to deeper blue

Worked examples

Chelate effect

- $[Cu(H_2O)_6]^{2+} + EDTA^{4-}$
- 2 particles → 7 particles
- **ΔS_{system} positive**

Fe^{2+} catalyst

- $S_2O_8^{2-} + 2Fe^{2+} \rightarrow 2SO_4^{2-} + 2Fe^{3+}$
- $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$
- **Fe^{2+} regenerated**

Autocatalysis

- Colour fades slowly at first
- Mn^{2+} forms: faster
- **S-shaped curve**

$E^\ominus$ values show why Fe^{2+} fits between $S_2O_8^{2-}$ and I^-: see Topic 14.

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