

26.2 Homogeneous and heterogeneous catalysts

Name: _____ Class: _____ Date: _____

Total: 23 marks

KEY WORDS catalyst 催化剂 • heterogeneous 多相 • heterogeneous catalyst 多相催化剂
• homogeneous 均相 • homogeneous catalyst 均相催化剂

Objective

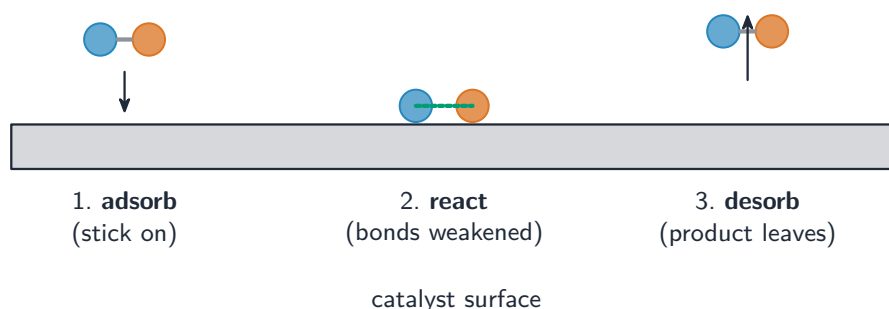
Build the skills to answer exam questions on the **mode of action of catalysts** 催化剂作用方式 — **heterogeneous** 多相 and **homogeneous** 均相 catalysis.

You must be able to:

- describe heterogeneous catalysis (adsorption, bond weakening, desorption)
- describe homogeneous catalysis (used in one step, reformed in a later step)
- give the examples in the syllabus

1 Worked examples

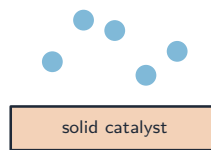
■ Heterogeneous catalysis



*A heterogeneous catalyst works at its surface: **adsorption** of reactants → **bond weakening** → reaction → **desorption** of products*



homogeneous
(same state,
mixed in)



heterogeneous
(different state,
a surface)

Homogeneous versus heterogeneous catalysis

Examples: **iron** in the Haber process; **Pt/Pd/Rh** in catalytic converters (removing NO_x).

■ Homogeneous catalysis

A homogeneous catalyst (same state as the reactants) is **used in one step and reformed in a later step**. Examples: oxides of nitrogen catalysing $\text{SO}_2 \rightarrow \text{SO}_3$ in the atmosphere; $\text{Fe}^{2+}/\text{Fe}^{3+}$ catalysing the $\text{I}^-/\text{S}_2\text{O}_8^{2-}$ reaction (the Fe ion is regenerated, so it is a catalyst not a reactant).

2 Practice

2.1 State the three stages of heterogeneous catalysis.

[3]

2.2 State what “homogeneous” means for a catalyst.

[1]

3 Exam-style questions

3.1 In heterogeneous catalysis, the reactant molecules first:

[1]

A	B
C	D

- A desorb from the surface
- B adsorb onto the catalyst surface
- C dissolve in the catalyst
- D evaporate

3.2 The iron catalyst in the Haber process is an example of a: [1]

A	B
C	D

A homogeneous catalyst

B heterogeneous catalyst

C reactant

D product

3.3 Explain how a heterogeneous catalyst speeds up a reaction at its surface. [3]

3.4 Fe^{2+} catalyses the reaction between iodide ions and peroxodisulfate ions. Explain why it is described as a homogeneous catalyst, not a reactant. [2]

3.5 Two industrial reactions use catalysts.

- Reaction 1: $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$ over solid iron.
- Reaction 2: $\text{S}_2\text{O}_8^{2-}(\text{aq}) + 2\text{I}^-(\text{aq}) \rightarrow 2\text{SO}_4^{2-}(\text{aq}) + \text{I}_2(\text{aq})$, catalysed by $\text{Fe}^{3+}(\text{aq})$.

(a) Classify each as homogeneous or heterogeneous, giving your reason. [2]

(b) Describe, in three stages, how the iron catalyst speeds up Reaction 1. [3]

(c) Write the two equations that show how Fe^{3+} catalyses Reaction 2, and state what the pair of equations shows about the catalyst. [4]

(d) Explain, with reference to the Boltzmann distribution, why a catalyst increases the rate but not the yield at equilibrium. [3]
