

8.3 Homogeneous and heterogeneous catalysts

Name: _____ Class: _____ Date: _____

Total: 13 marks

KEY WORDS catalyst 催化剂 • heterogeneous catalyst 多相催化剂 • homogeneous 均相 • heterogeneous 多相
• mechanism 反应机理

Objective

Build the skills to answer exam questions on **catalysts** 催化剂 — how a catalyst works, and the difference between **homogeneous** 均相 and **heterogeneous** 多相 catalysts.

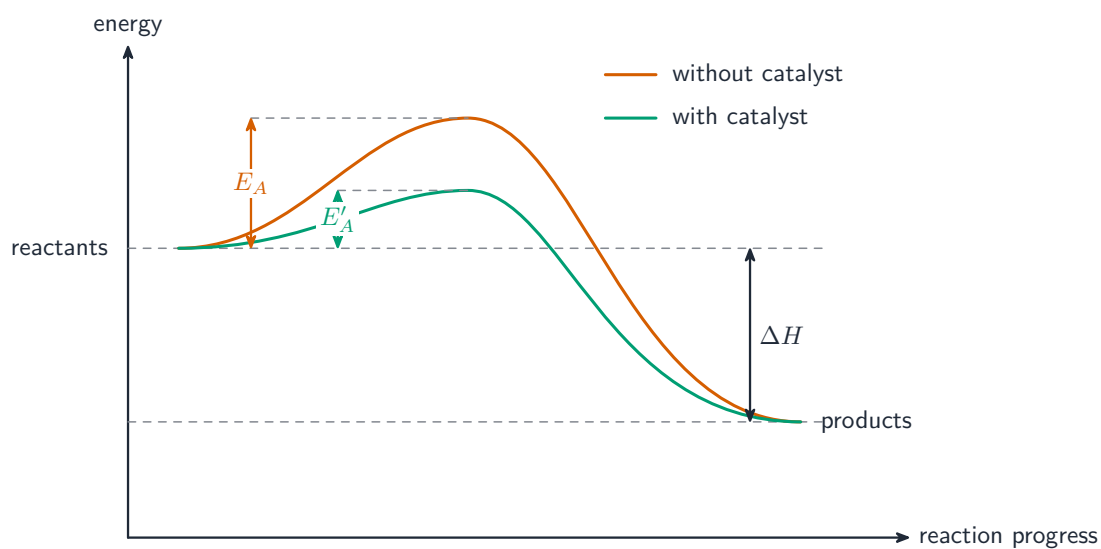
You must be able to:

- explain that a catalyst gives a different mechanism of lower activation energy
- explain the catalytic effect using the Boltzmann distribution
- construct and interpret reaction pathway diagrams with and without a catalyst

1 Worked examples

■ How a catalyst works

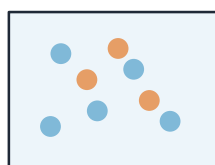
A **catalyst** speeds up a reaction without being used up. It provides a different **mechanism** 反应机理 with a **lower activation energy**.



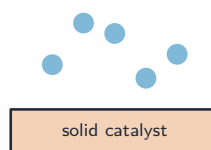
The catalysed route has a lower E_A ; ΔH is unchanged

On the Boltzmann distribution, lowering E_A moves the line left, so more molecules can react $\rightarrow$ faster rate.

■ Homogeneous vs heterogeneous



homogeneous
(same state,
mixed in)



heterogeneous
(different state,
a surface)

Homogeneous: same state as the reactants (e.g. acid in solution). Heterogeneous: a different state (e.g. solid iron with gases)

2 Practice

2.1 State what a catalyst does and what happens to it during the reaction. [2]

2.2 State the difference between a homogeneous and a heterogeneous catalyst. [2]

3 Exam-style questions

3.1 A catalyst increases the rate of a reaction by: [1]

- A increasing the activation energy
 - B providing a route with a lower activation energy
 - C making the reaction more exothermic
 - D raising the temperature
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3.2 Which property of a reaction is **not** changed by adding a catalyst? [1]

- A the rate
 - B the activation energy
 - C the enthalpy change, ΔH
 - D the mechanism
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3.3 (a) Explain, using the Boltzmann distribution, why a catalyst speeds up a reaction. [2]

(b) Sketch a reaction pathway diagram showing the catalysed and uncatalysed routes for an exothermic reaction. [3]

3.4 Iron is used in the Haber process. State whether it is a homogeneous or heterogeneous catalyst, and explain your answer. [2]

Solutions

2.1 it speeds up the reaction; it is not used up / is regenerated.

2.2 homogeneous — in the same physical state as the reactants; heterogeneous — in a different state.

3.1 B. A catalyst provides a route with lower activation energy.

3.2 C. The enthalpy change is unchanged by a catalyst.

3.3 (a) the catalyst lowers the activation energy; so a larger fraction of molecules now exceed E_A and can react — more effective collisions per second.

(b) reactants higher than products (exothermic); two activation-energy humps, the catalysed one lower; same ΔH marked between reactants and products.

3.4 heterogeneous; the iron is a solid while the reactants (N_2 and H_2) are gases — a different physical state.