Exercise walk-through

Catalysis ▪ 5.11

eXercise

You must be able to

- explain that a **catalyst** 催化剂 provides a lower-E_a pathway
- state that a catalyst is **not consumed** and does not change ΔH
- distinguish **homogeneous** and **heterogeneous** catalysts

Method — How a catalyst works

A **catalyst** provides an **alternative pathway** with a **lower activation energy**, so a larger fraction of collisions succeed and the reaction speeds up.

Method — Not used up; ΔH unchanged

A catalyst is **regenerated** at the end (used in an early step, released in a later one), so it is not consumed. It lowers E_a but **does not change** ΔH — the reactant and product energies are the same.

Method — Effect on both directions

Because it lowers the same barrier, a catalyst speeds up the **forward and reverse** reactions equally — it helps reach equilibrium faster, without shifting it.

Method — Homogeneous vs heterogeneous

- **Homogeneous** — same phase as the reactants (e.g. an aqueous catalyst in solution).
- **Heterogeneous** — a different phase (e.g. a solid catalyst with gaseous reactants adsorbing on its surface).

Practice 2.1 ▪ 1 mark

How does a catalyst speed up a reaction?

Solution 2.1

Worked steps

By providing an alternative pathway with a lower activation energy B1.

Practice 2.2 ▪ 1 mark

Does a catalyst change ΔH?

Solution 2.2

Method: Not used up; ΔH unchanged

Worked steps

No B1.

Practice 2.3 ▪ 2 marks

Distinguish a homogeneous from a heterogeneous catalyst.

Solution 2.3

Method: Homogeneous vs heterogeneous

Worked steps

Homogeneous — same phase as the reactants; heterogeneous — a different phase (e.g. solid catalyst, gas reactants) B1 B1.

Exam-style 3.1 ▪ 1 mark

A catalyst increases the rate by

A raising the temperature

B providing a pathway with lower activation energy

C increasing ΔH

D removing products

Solution 3.1

A raising the temperature

B providing a pathway with lower activation energy ✓

C increasing ΔH

D removing products

Worked steps

B — a lower-activation-energy pathway.

Exam-style 3.2 ▪ 2 marks

On an energy profile, a catalyst is added.
(a) State what changes and what stays the same.
(b) Explain why the catalyst is not consumed.

Solution 3.2

Method: Not used up; ΔH unchanged

Worked steps

(a) The activation energy (peak) is lowered; ΔH (reactant and product energies) is unchanged M1 A1. (b) It is used in an early step and regenerated in a later step, so it is not consumed overall M1 A1.

Exam-style 3.3 ▪ 2 marks

Explain why a catalyst speeds up the forward and reverse reactions equally and therefore does not shift the equilibrium position.

Solution 3.3

Method: Effect on both directions

Worked steps

The catalyst lowers the **same** barrier for both directions, so both the forward and reverse rates rise by the same factor; equilibrium (which depends on their ratio) is reached sooner but not shifted M1 A1.