Exercise walk-through

Reaction Rates ▪ 5.1

eXercise

You must be able to

- express **rate** 反应速率 as change in concentration per time
- list the factors that change rate (concentration, temperature, surface area, catalyst)
- explain each factor with collision ideas

Method — Rate as a change per time

The **rate** is how fast a reactant is used up or a product forms:

$$\text{rate} = \frac{\Delta[\text{concentration}]}{\Delta t},$$

usually in mol $\text{L}^{-1}\text{s}^{-1}$.

Method — Factors that speed up a reaction

- **Higher concentration** — more particles per volume more collisions.
- **Higher temperature** — faster particles, and more with enough energy.
- **Larger surface area** — more exposed particles to collide with.
- **A catalyst** — a lower-energy pathway.

Method — The collision picture

A reaction happens when particles **collide** with enough energy and the right orientation. Anything that increases the **frequency** or **energy** of successful collisions speeds the reaction.

Method — Reading a rate from a graph

On a concentration-vs-time graph, the rate is the **slope**. The reaction is fastest at the start (steepest) and slows as reactants run out.

Practice 2.1 ▪ 1 mark

Write the definition of reaction rate.

Solution 2.1

Method: Reading a rate from a graph

Worked steps

The change in concentration of a reactant or product per unit time B1.

Practice 2.2 ▪ 2 marks

State two factors that increase reaction rate.

Solution 2.2

Worked steps

Any two: higher concentration, higher temperature, larger surface area, a catalyst B1 B1.

Practice 2.3 ▪ 1 mark

Why does a powder react faster than a lump of the same mass?

Solution 2.3

Worked steps

A powder has a larger surface area, so more particles are exposed to collide B1.

Exam-style 3.1 ▪ 1 mark

Increasing the concentration of a reactant increases the rate because it

A lowers the activation energy

B increases the collision frequency

C changes the products

D cools the mixture

Solution 3.1

Method: Rate as a change per time

A lowers the activation energy

B increases the collision frequency ✓

C changes the products

D cools the mixture

Worked steps

B — more particles per volume means more frequent collisions.

Exam-style 3.2 ▪ 1 mark

A reaction is run at 20°C and again at 40°C.
(a) State which is faster.
(b) Give two reasons, in terms of particle collisions, why raising temperature speeds a reaction.

Solution 3.2

Method: Factors that speed up a reaction

Worked steps

(a) $40°C$ B1. (b) Particles move faster (more frequent collisions) and more of them have energy above the activation energy (more successful collisions) M1 A1.

Exam-style 3.3 ▪ 2 marks

Explain, using collision ideas, why a catalyst speeds up a reaction without being used up.

Solution 3.3

Method: The collision picture

Worked steps

A catalyst provides an alternative pathway with a lower activation energy, so more collisions succeed; it is regenerated at the end, so it is not consumed M1 A1.