

Exercise walk-through

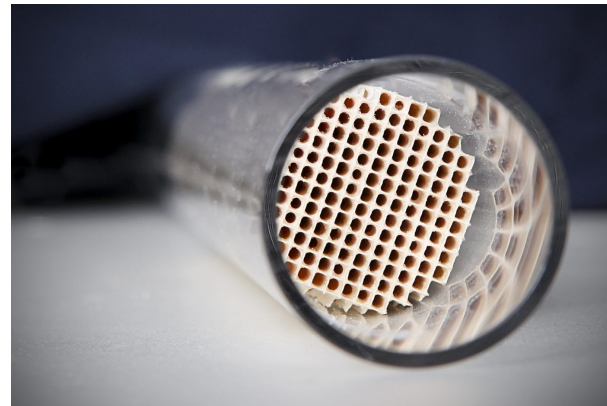
8.1

Rate of reaction

A-Level Chemistry

What we will cover

- 1 Rate & collisions
- 2 Concentration & pressure
- 3 The Boltzmann distribution
- 4 Catalysts
- 5 Types of catalyst



a catalyst speeds reactions

Measuring a rate, and what a catalyst does

the rate of reaction

how fast a reactant is used or a product is made, per unit time

measuring it

volume of gas made divided by the time taken; or mass lost, or a colour change

reading the graph

the rate is **fastest at the start** – the graph is steepest – because the reactants are most concentrated, and it slows as they are used

collision frequency

more particles per volume means more collisions per second

a non-effective collision

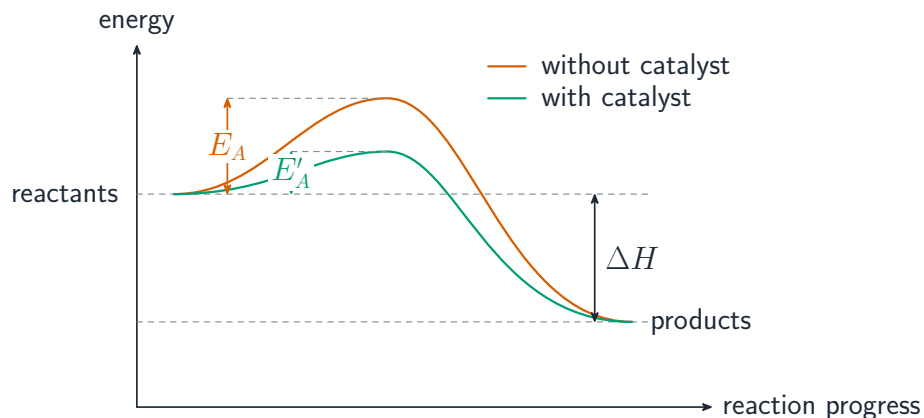
one with too little energy, or the wrong orientation – most collisions are these

a catalyst

speeds the reaction and is **not used up**; **catalysis** is the name for the action

A catalyst gives an alternative **reaction pathway** of **lower activation energy** – so a larger fraction of collisions is effective. It never changes the position of equilibrium.

Catalysts



A **catalyst** speeds a reaction without being used up: it offers a different **reaction mechanism** – a new route with a **lower** E_A . On a **reaction pathway diagram** the catalysed route has a lower hill.

More molecules now exceed E_A , so the rate rises – but the **enthalpy change** ΔH is **unchanged**.

Exercises 2.1·2.2

2.1 State the **two** things a collision needs to be effective. [2]

2.2 Explain why increasing the concentration of a reactant speeds up a reaction. [2]

Exercises 2.1·2.2

2.1 State the **two** things a collision needs to be effective. [2]

2.1

- enough energy (at least the activation energy); the correct orientation/direction
-

2.2 Explain why increasing the concentration of a reactant speeds up a reaction. [2]

2.2

- there are more particles in the same volume, so they collide more often – more effective collisions per second

Exercises 3.1·3.2

3.1 Increasing the pressure of a gas reaction increases the rate because:

[1]

☐

- A the particles gain activation energy
- B the particles are closer, so collide more often
- C the activation energy falls
- D the catalyst works better

3.2 A reaction produces 48 cm^3 of gas in 20 s. The mean rate of reaction is:

[1]

☐

- A $0.42 \text{ cm}^3 \text{ s}^{-1}$
- B $2.4 \text{ cm}^3 \text{ s}^{-1}$
- C $24 \text{ cm}^3 \text{ s}^{-1}$
- D $960 \text{ cm}^3 \text{ s}^{-1}$

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- A the particles gain activation energy
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- D the catalyst works better

3.1 B

- Higher pressure brings particles closer, so they collide more often

3.2 A reaction produces 48 cm^3 of gas in 20 s. The mean rate of reaction is:

[1]

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3.2 B

- $48/20 = 2.4 \text{ cm}^3 \text{ s}^{-1}$

Exercise 3.3 (a)

3.3 A reaction makes carbon dioxide. The volume collected is 30 cm^3 at 15 s and 54 cm^3 at 45 s.

(a) Calculate the mean rate of reaction between 15 s and 45 s. [2]

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(a)

- $\frac{54 - 30}{45 - 15} = \frac{24}{30} = 0.80 \text{ cm}^3 \text{ s}^{-1}$

Exercise 3.3 (b)

3.3 A reaction makes carbon dioxide. The volume collected is 30 cm^3 at 15 s and 54 cm^3 at 45 s.

(b) Explain why the rate is faster at the start of the reaction than near the end. [2]

Exercise 3.3 (b)

3.3 A reaction makes carbon dioxide. The volume collected is 30 cm^3 at 15 s and 54 cm^3 at 45 s.

(b) Explain why the rate is faster at the start of the reaction than near the end. [2]

(b)

- at the start the reactant concentration is highest, so collisions are more frequent and the rate is faster; as reactant is used up the rate falls