Exercise walk-through

6.1
Rate of reaction (4.6.1.1–4.6.1.5)

AQA · GCSE · Chemistry

Measuring the rate of a reaction

- The **rate of reaction** tells you how fast reactants are used up or products are made.
- The **mean rate** over a period of time is:
- The quantity can be a mass (rate in g/s) or a gas volume (cm^3/s); at higher tier it can also be an amount in moles (mol/s).
- **Worked example 1.** The volume of gas rises from 12 cm^3 at 10 s to 36 cm^3 at 30 s.

$$\text{mean rate} = \frac{\text{quantity of reactant used or product formed}}{\text{time taken}}$$

Required practical: concentration and rate

- Before you start, write a **hypothesis** , for example: "If the acid is more concentrated, the reaction will be faster, because there will be more frequent collisions."
- **Method 1: measuring a gas.** Add a 3 cm length of cleaned **magnesium ribbon** to 50 cm^3 of **dilute hydrochloric acid** in a conical flask.
- Quickly fit a bung with a **delivery tube** that leads into an upside-down **measuring cylinder** full of water (or use a **gas syringe**).
- Record the volume of hydrogen every 10 seconds until it stops changing.

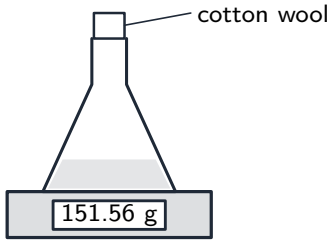
Reversible reactions

- In a **reversible reaction** , the products can react to form the original reactants again.
- The symbol $\rightleftharpoons$ shows this:
- Heating **ammonium chloride** breaks it down into two gases; when they cool, they join to form **ammonium chloride** again.
- If a reaction is exothermic in one direction, it is endothermic in the other, and the same amount of energy is transferred. **Hydrated copper sulfate** is blue.

$$\text{ammonium chloride} \rightleftharpoons \text{ammonia} + \text{hydrogen chloride}$$

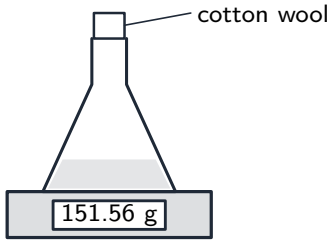
Exercise 2.1

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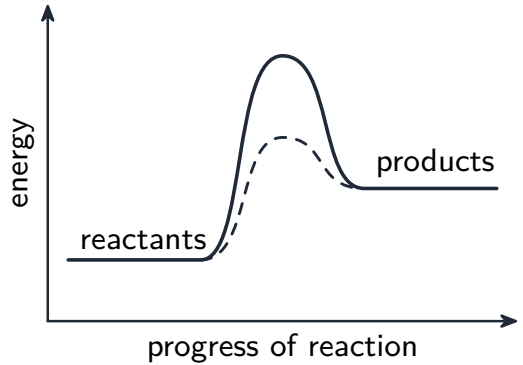


2.1

- $0.84 \div 120 = \mathbf{0.0070}$ g/s

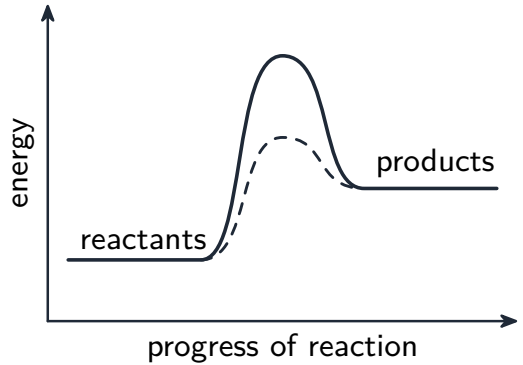
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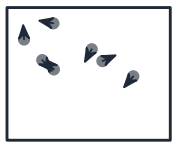


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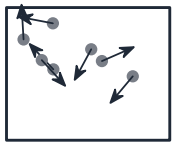
- it speeds up the reaction without being used up; it gives a different pathway with a lower activation energy

Exercise 3.1

3.1 Explain why a reaction is faster at a higher temperature. [3]



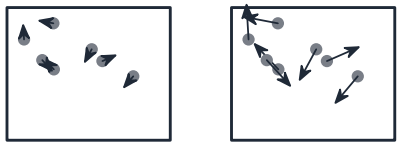
low temperature



high temperature

Exercise 3.1

3.1 Explain why a reaction is faster at a higher temperature. [3]



low temperature high temperature

3.1

- the particles move faster, so they collide more often
- more of the particles have energy equal to or greater than the activation energy
- so there are more successful collisions per second

Exercise 3.2

3.2 Sodium thiosulfate solution reacts with hydrochloric acid to make a cloudy solution. Describe how a student could use this reaction to find the effect of temperature on the rate. [3]



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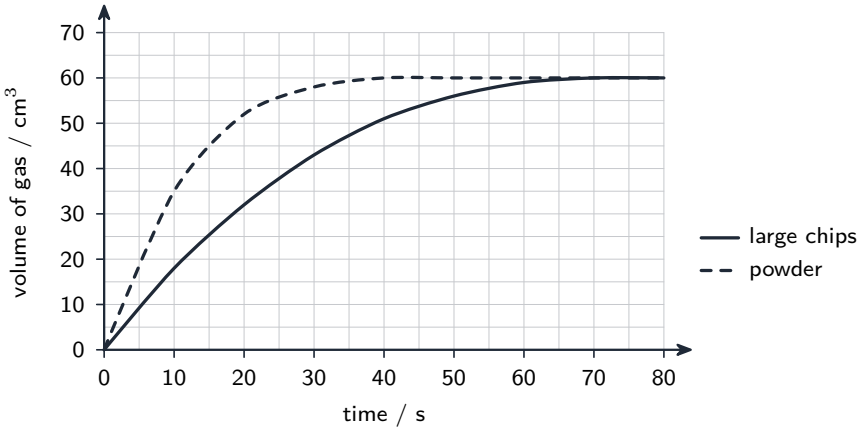
3.2

- put the same volume of sodium thiosulfate in a flask on a paper cross and warm it to a measured temperature
- add the same volume of acid and start a timer; stop it when the cross can no longer be seen
- repeat at several different temperatures

Exercise 3.3 (a)

3.3 A student reacts 2.0 g of marble chips with excess hydrochloric acid and measures the volume of gas. The student then repeats this with 2.0 g of marble powder.

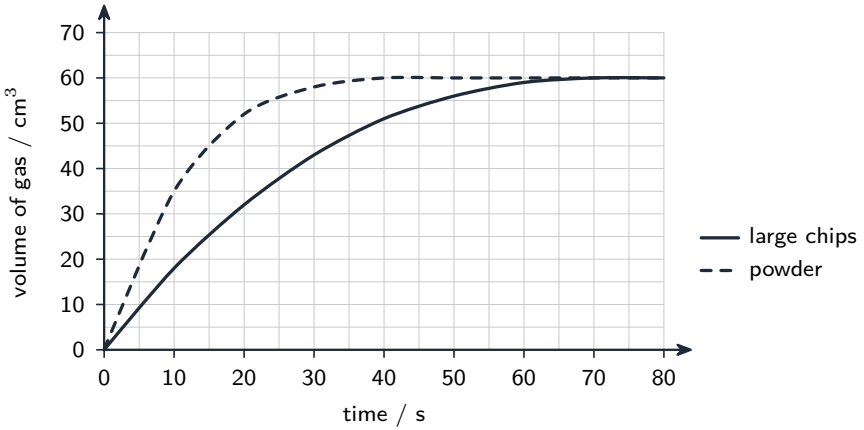
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(a) Use the graph to calculate the mean rate for the large chips in the first 40 s. [3]



(a) 51 cm^3 read at 40 s; $51 \div 40 = \mathbf{1.3}$ cm^3/s

Exercise 3.3 (b)

3.3 A student reacts 2.0 g of marble chips with excess hydrochloric acid and measures the volume of gas. The student then repeats this with 2.0 g of marble powder.

(b) Use the graph to find the time when the reaction with the powder finished. Explain why both reactions give the same final volume. [3]

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(b) Use the graph to find the time when the reaction with the powder finished. Explain why both reactions give the same final volume. [3]

(b) about 40 s; the same mass of calcium carbonate was used; the acid is in excess, so all of the carbonate reacts in both

Exercise 3.3 (c)

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(c) Explain why the curve for the powder is steeper at the start. [3]

(c) the powder has a larger surface area; more particles of the solid are exposed to the acid; so there are more frequent collisions

Exercise 3.3 (d)

3.3 A student reacts 2.0 g of marble chips with excess hydrochloric acid and measures the volume of gas. The student then repeats this with 2.0 g of marble powder.

(d) Describe how the student could carry out this investigation to measure the volume of gas over time. [6]

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(d) Describe how the student could carry out this investigation to measure the volume of gas over time. [6]

(d) points to include:

- put a measured volume of acid in a conical flask joined by a bung and tube to a gas syringe
- add 2.0 g of large chips, put the bung in quickly and start the timer
- record the volume of gas every 10 s until no more gas is made
- repeat with 2.0 g of powder, the same volume and concentration of acid, at the same temperature
- plot volume against time for both

Levels: **5–6** a full, logical answer with correct chemistry and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.