1 Fatimah investigates the reaction between sodium hydrogencarbonate and dilute hydrochloric acid.

She always adds 0.5 g of sodium hydrogencarbonate to 20 cm^3 of dilute hydrochloric acid.

She measures the time it takes for the reaction mixture to stop bubbling.

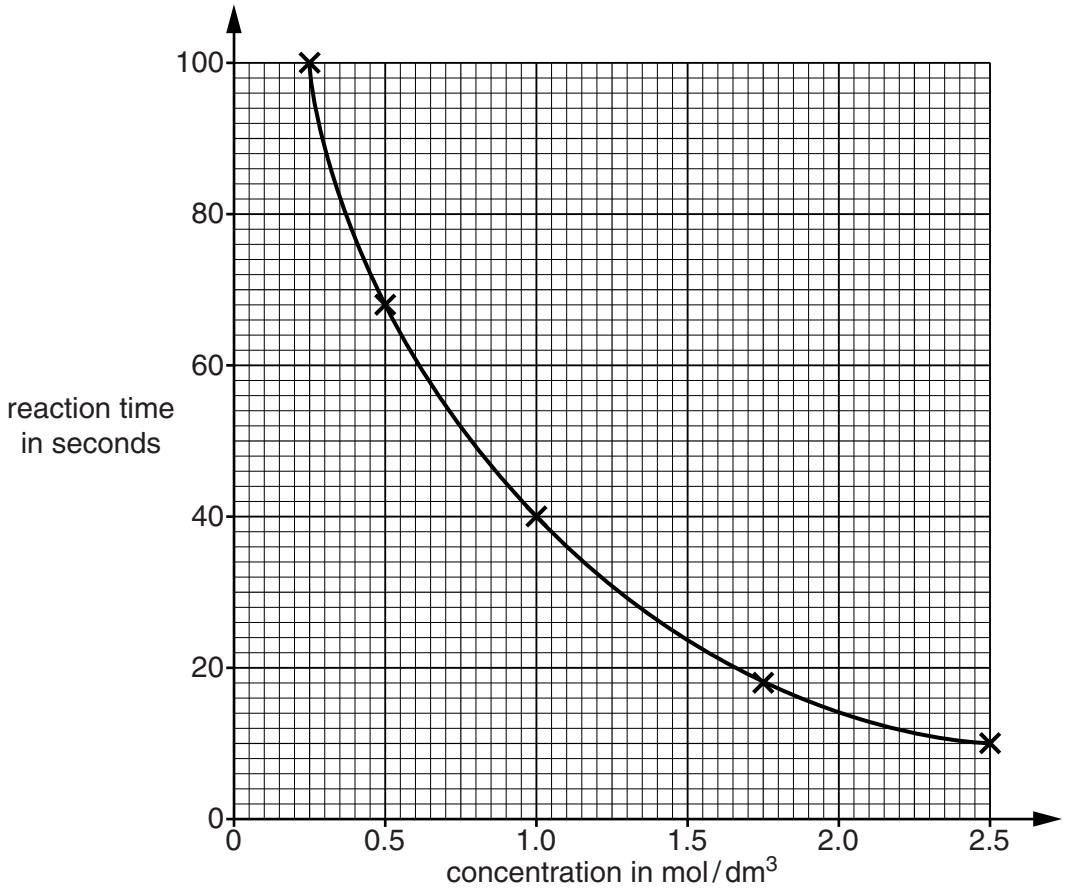
This is called the **reaction time**.

She does five different experiments.

She keeps the temperature the same.

Each experiment uses a **different concentration** of acid.

Look at a graph of her results.



Fatimah concludes that as the concentration of acid increases, the rate of reaction increases.

Explain, with a reason, whether the results support Fatimah's conclusion.

Use the reacting particle model to explain Fatimah's results.



The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

2 This question is about acids.

Nitric acid, HNO_3, is a strong acid and propanoic acid, C_2H_5COOH, is a weak acid.

David investigates the reaction of both of these acids with calcium carbonate.

David does two experiments

- the first with nitric acid
- the second with propanoic acid.

Each time he puts 50 cm^3 of 2.0 mol/dm^3 acid into a conical flask.

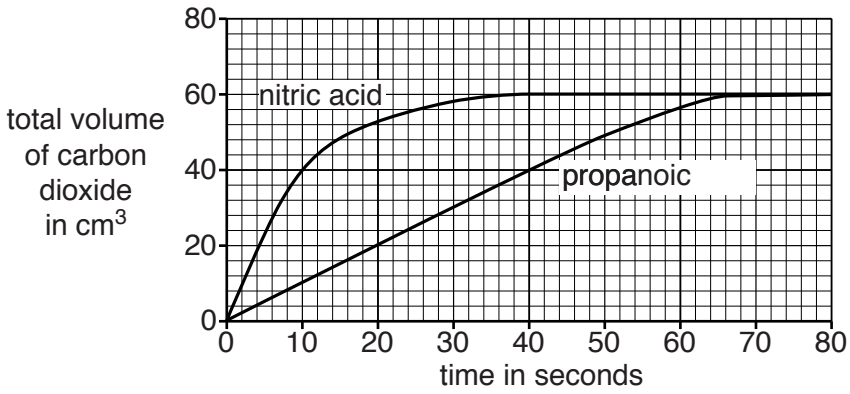
He then adds the same mass of calcium carbonate to each acid.

David measures the total volume of carbon dioxide made every 10 seconds.

(a) Draw a labelled diagram of the apparatus David can use in these experiments.

[2]

(b) Look at the graph of David's results.



The two lines are different shapes because the strength of each acid is different.

Write about the difference between a strong and a weak acid and explain why the two lines are different.

The quality of written communication will be assessed in your answer to this question.

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(c) Look at the balanced symbol equation for the reaction of calcium carbonate with nitric acid.

$$CaCO_3 + 2HNO_3 \rightarrow Ca(NO_3)_2 + CO_2 + H_2O$$

(i) David's experiment with nitric acid makes 60 cm^3 of carbon dioxide at room temperature and pressure.

How many moles of carbon dioxide are made at the end of the reaction?

One mole of carbon dioxide has a volume of 24 000 cm^3 at room temperature and pressure.

moles of carbon dioxide = ... **[1]**

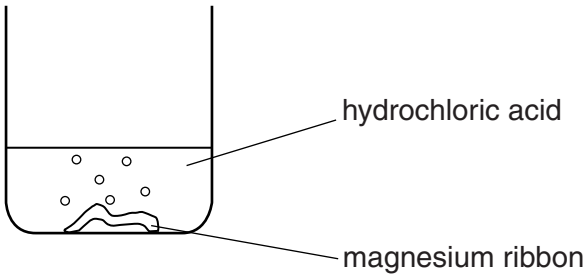
(ii) Calculate the mass of calcium carbonate needed to make this amount of carbon dioxide.

The relative formula mass, M_r, of calcium carbonate, $CaCO_3$, is 100.

mass of calcium carbonate = …….. g **[1]**

3 Rachel investigates the reaction between magnesium and hydrochloric acid.

She adds a piece of magnesium ribbon to hydrochloric acid in a beaker.

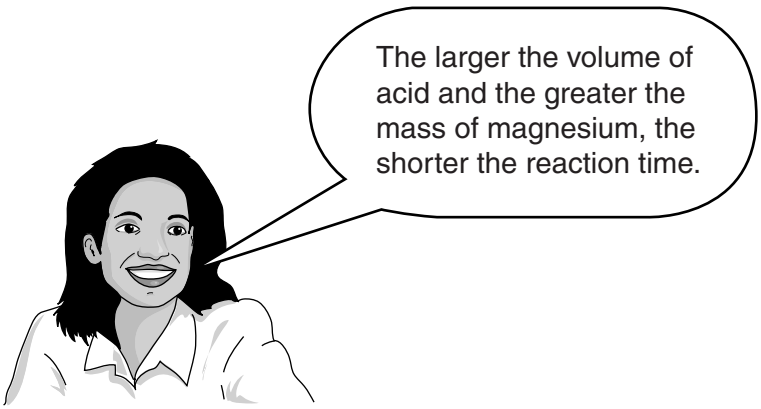


Rachel measures the time it takes for all the magnesium ribbon to react.

This is the reaction time.

She does five different experiments.

Look at Rachel's prediction.



Look at Rachel's results.

Experiment number	Mass of magnesium used in g	Volume of acid used in cm^3	Concentration of acid in mol/dm^3	Reaction time in seconds
1	0.05	25	1.0	30
2	0.10	25	1.0	30
3	0.05	50	1.0	30
4	0.05	50	2.0	15
5	0.10	50	2.0	15

(a) Explain if Rachel's results support her prediction. Use the reacting particle model to explain the difference between the reaction time in experiments **3** and **4**.



The quality of written communication will be assessed in your answer to this question.

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..... **[6]**

(b) Rachel repeats experiment **1**. This time she uses acid at a **higher** temperature.

Explain, using the reacting particle model, what happens to the rate of reaction.

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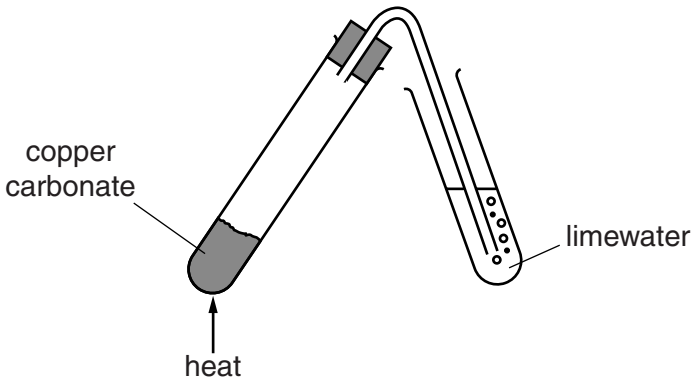
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..... **[2]**

[Total: 8]

4 (a (i) Sam investigates the action of heat on copper carbonate.

Look at the diagram. It shows the apparatus he uses.



Look at the word equation for the reaction

copper carbonate → copper oxide + xide

This is a **thermal decomposition** reaction.

Explain why.

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..... **[1]**

(ii) Sam makes some copper.

Sam heats copper oxide, CuO, with carbon, C.

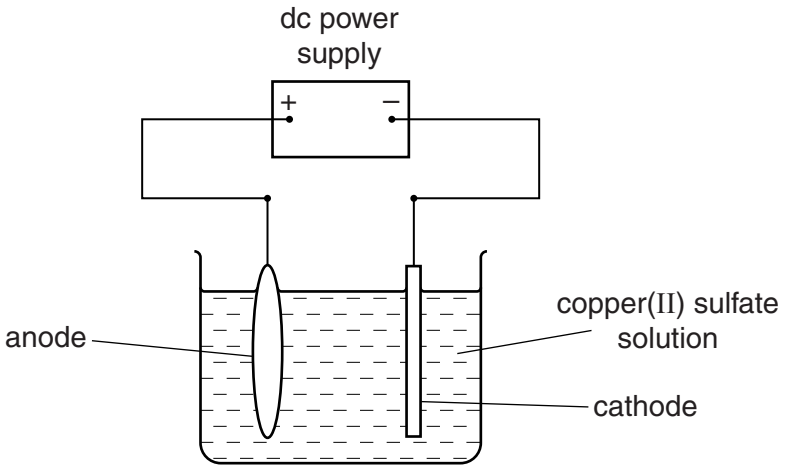
Copper, Cu, and carbon dioxide, CO_2, are made.

Write a **balanced symbol** equation for this reaction.

..... **[2]**

(b) The copper Sam makes is impure.

Look at the diagram. It shows the apparatus he uses to purify copper.



Look at the equations below for the electrode reactions.

The anode: $Cu - 2e^- \longrightarrow Cu^{2+}$

The cathode: $Cu^{2+} + 2e^- \longrightarrow Cu$

(i) Which reaction is oxidation and which is reduction?

Explain why.

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..... **[2]**

(ii) Use the electrode reactions to explain why the anode **loses** mass and the cathode **gains** mass.

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..... **[2]**

(c) Explain one **advantage** and one **problem** of recycling copper.

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..... **[2]**

(d) Look at the table. It shows some properties of three metals.

	Density in g/cm^3	**Relative electrical conductivity (0 = low, 100 = high)**	**Relative strength (0 = weak, 1000 = very strong)**	**Corrosion in moist air**	**Cost per tonne in £**
Aluminium	2.7	40	300	does not corrode	770
Copper	8.9	64	400	corrodes slowly	5900
Iron	7.9	11	600	corrodes	200

Look at the picture. It shows overhead power cables used by electric trains.



Which metal would you choose to make the overhead power cables?

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Justify your answer.

Use the data in the table.

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..... **[2]**

[Total: 11]

5 Hilary investigates the reaction between magnesium, Mg, and hydrochloric acid, HC*l*.

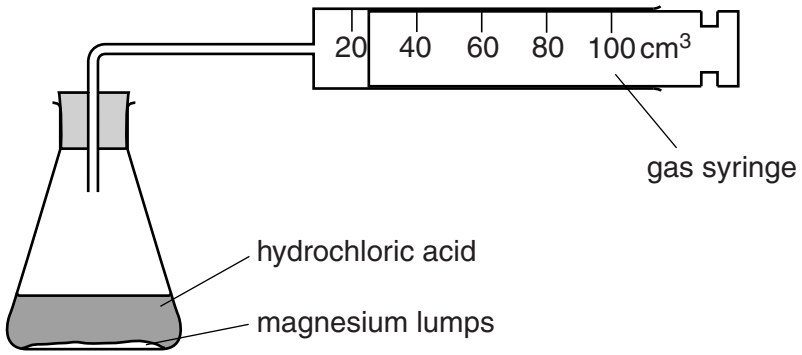
Magnesium chloride, $MgCl_2$, and hydrogen, H_2, are made.

(a) Construct the **balanced symbol** equation for this reaction.

..... **[2]**

(b) Look at the diagram.

It shows the apparatus she uses.



Hilary measures the total volume of gas in the syringe every 10 seconds.

Look at the graph opposite. It shows her results.

(i) How long does it take for the reaction to stop?

answer ..... seconds **[1]**

(ii) Calculate the **rate of reaction** during the first **10 seconds** of this experiment.

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answer ..... cm^3/s **[1]**

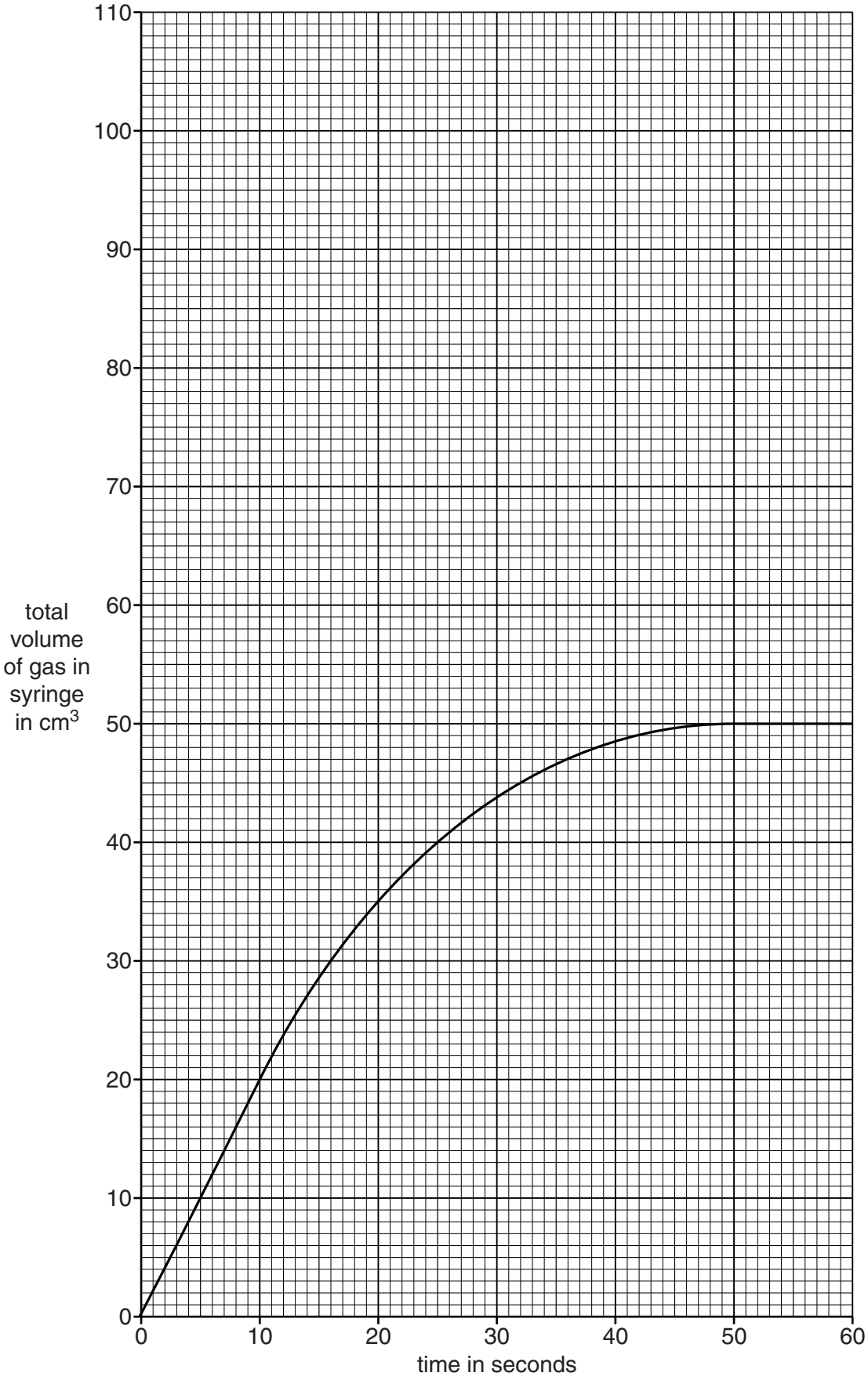
(iii) Hilary repeats the experiment.

She uses the same mass of magnesium and the same volume and concentration of acid.

This time she uses magnesium **powder**.

On the **grid** sketch the curve she gets. **[2]**

[Total: 6]


110
100
90
80
70
60
50
40
30
20
10
0
total volume of gas in syringe in cm3
0
10
20
30
40
50
60
time in seconds

6 Hydrochloric acid is a **strong** acid.

Ethanoic acid is a **weak** acid.

Both acids contain hydrogen ions, H^+.

(a) Explain why hydrochloric acid is a strong acid and ethanoic acid is a weak acid.

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..... **[2]**

(b) An excess of both acids react with 0.1 g of magnesium to make hydrogen gas.

Both acids have a concentration of 1 mol / dm^3.

(i) Ethanoic acid reacts more slowly with magnesium than hydrochloric acid.

Explain why.

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..... **[2]**

(ii) Both reactions make the same volume of hydrogen.

Explain why.

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..... **[1]**

[Total: 5]

7 An acid reacts with a base to make a salt and water.

$$\text{acid} + \text{base} \longrightarrow \text{salt} + \text{water}$$

Look at the table. It shows some acids, bases and the salts made from them.

Acid	Base	Salt
sulfuric acid	copper oxide	copper sulfate
nitric acid	sodium carbonate	.....
.....	zinc oxide	zinc chloride
sulfuric acid	.....	magnesium sulfate

(a) Complete the table. **[3]**

(b) Hydrochloric acid, HCl, reacts with calcium carbonate, $CaCO_3$.

Calcium chloride, $CaCl_2$, carbon dioxide and water are made.

Write a **balanced symbol** equation for this reaction.

..... **[2]**

(c) Acids contain hydrogen ions, H^+. Alkalis contain hydroxide ions, OH^-.

Write the **ionic** equation for neutralisation.

..... **[1]**

(d) Many fertilisers are made by neutralisation.

Fertilisers can cause **eutrophication**.

Explain what happens during eutrophication.

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..... **[3]**

[Total: 9]

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8 Antacid tablets are used to stop indigestion.

Antacid tablets contain calcium carbonate, $CaCO_3$.

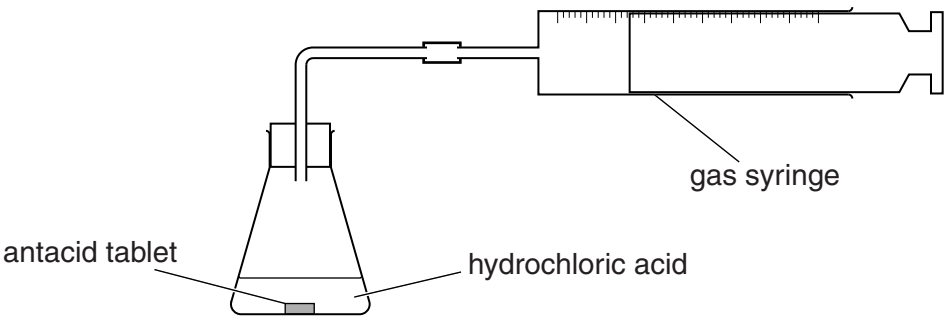
Jennie and Gary investigate the reaction of antacid tablets with hydrochloric acid.

Calcium chloride, $CaCl_2$, water and carbon dioxide are made.

(a) Write a **balanced symbol** equation for this reaction.

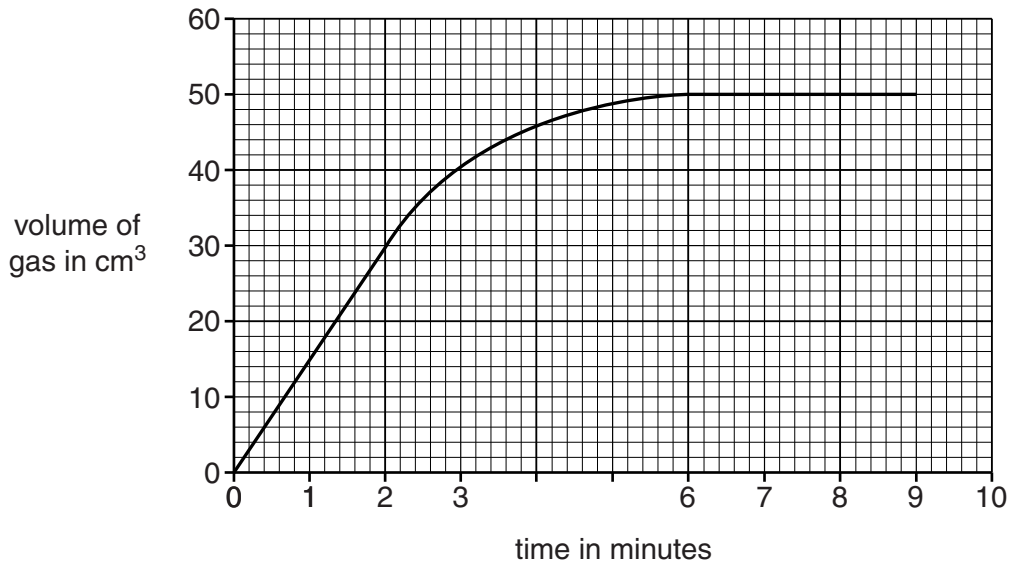
..... **[2]**

(b) Look at the diagram. It shows the apparatus they use.



Jennie and Gary react an antacid tablet with 100 cm^3 of hydrochloric acid.

Look at the graph. It shows their results.



(i) How long does it take for the reaction to stop?

answer ..... minutes **[1]**

(ii) Calculate the average rate of this reaction during the first 2 minutes of the experiment.

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answer ..... unit ..... **[2]**

(iii) The rate of reaction for the first 2 minutes is different to the rate of reaction between 2 and 4 minutes.

Describe how.

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..... **[1]**

(c) The rate of reaction between an antacid tablet and hydrochloric acid can be increased by

- increasing the concentration of the hydrochloric acid
- crushing the tablet.

Explain, using ideas about collisions between reacting particles, why these methods increase the rate of this reaction.



The quality of written communication will be assessed in your answer to this question.

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[Total: 12]