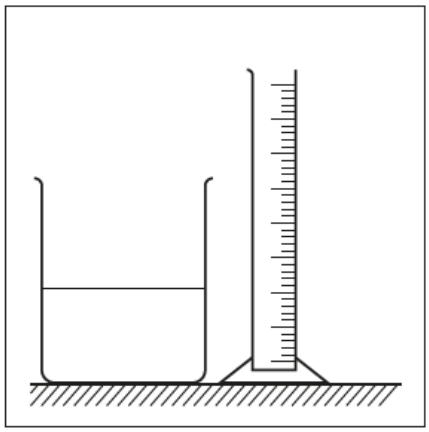
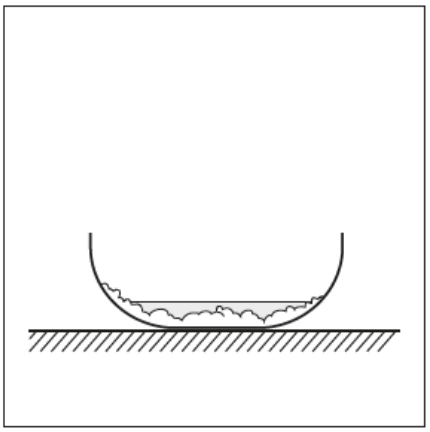
Making useful chemicals – 2021/20 GCSE 21st Chemistry Combined Science B

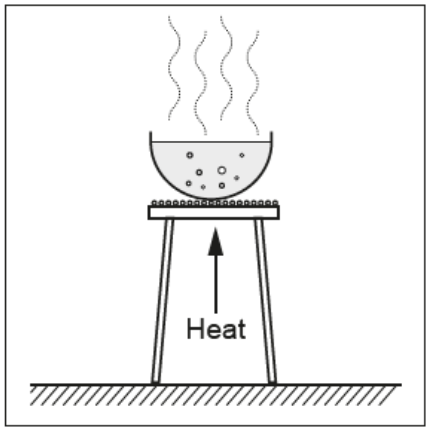
1. Nov/2021/Paper_ J260/02/No.5

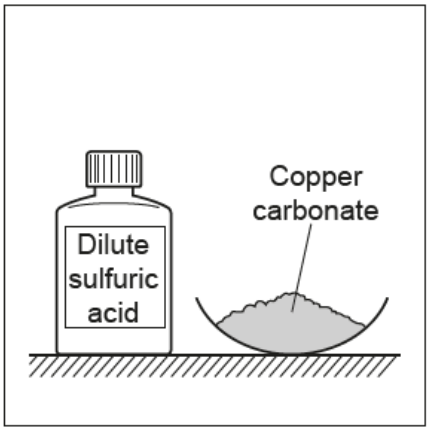
Kai makes some copper sulfate crystals. He uses solid copper carbonate and 20 cm^3 of dilute sulfuric acid.

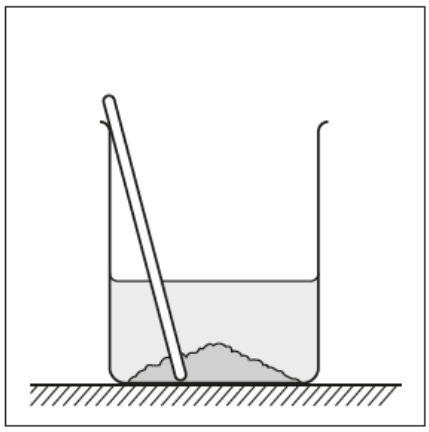
The pictures show some of the apparatus he uses. They are **not** in the correct order.

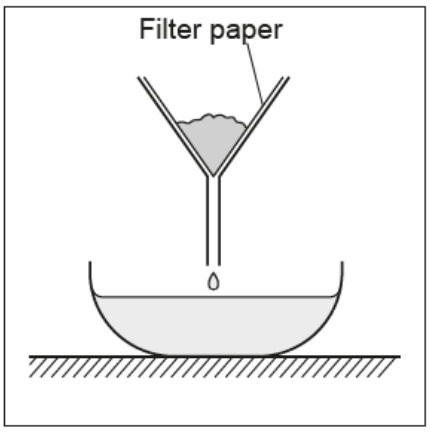












Describe how Kai produces a sample of dry copper sulfate crystals from solid copper carbonate and dilute sulfuric acid.

Use the apparatus in the pictures to support your answer.

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

2. Nov/2021/Paper_ J260/02/No.6

Sarah does an experiment. She adds small pieces of zinc to 50 cm^3 of 0.1 mol/dm^3 sulfuric acid.

She measures the volume of hydrogen gas collected every 30 seconds.

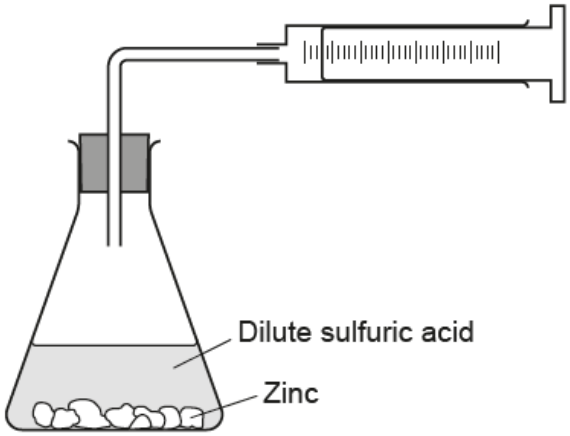


Fig. 6.1

(a) Sarah finds that the reaction is very slow.

Describe **two** ways in which Sarah could change her experiment to make the rate of reaction faster.

1 .....

2 .....

[2]

(b) Sarah plots a graph from her results, as shown in **Fig. 6.2**.

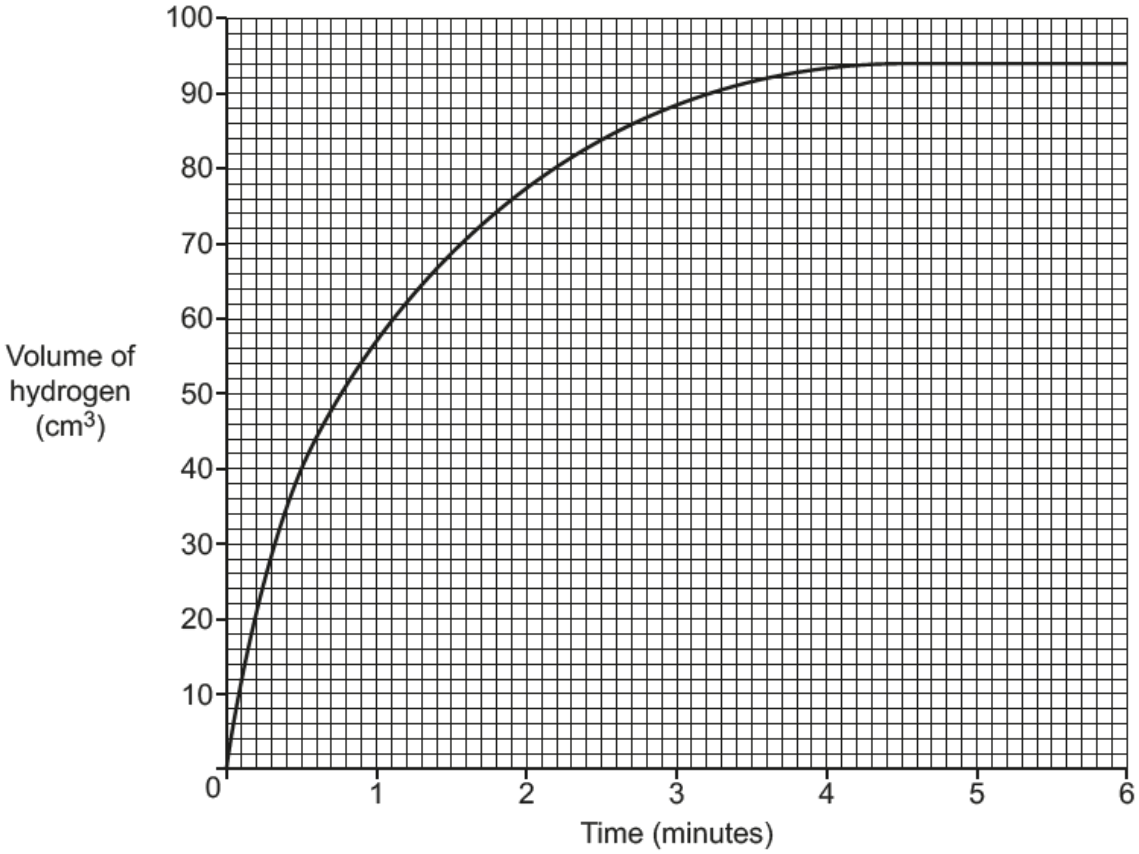


Fig. 6.2

(i) How many **seconds** does it take for 40 cm^3 of hydrogen to be collected?

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

(ii) What happens to the rate of the reaction during the first 4 minutes?

Tick (✓) **one** box.

It slows down ☐

It speeds up ☐

It stays constant ☐

[1]

(iii) What is the total volume of hydrogen collected after 4.5 minutes?

..... cm^3 **[1]**

(iv) Why does the graph level out after 4.5 minutes?

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

(c) Sarah repeats the experiment using 50 cm^3 of **0.05** mol/dm^3 sulfuric acid instead of 50 cm^3 of **0.1** mol/dm^3 sulfuric acid.

The table shows her results:

Time (minutes)	1	2	3	4	5	6
Volume of hydrogen (cm^3)	24	40	46	48	48	48

(i) Plot the results in the table on **Fig. 6.2 and** draw a line of best fit. **[2]**

(ii) What happens when she uses 50 cm^3 of 0.05 mol/dm^3 sulfuric acid instead of 50 cm^3 of 0.1 mol/dm^3 sulfuric acid?

Put a (ring) around the correct answers.

The rate of the reaction at the start is **faster** / **slower** / **the same**.

The total volume of hydrogen produced is **less** / **more** / **the same**.

[2]

3. Nov/2020/Paper_ J260/02/No.5

(a) When acids react with alkalis, a salt is formed.

Different salts can be made by reacting different acids and alkalis together.

(i) Draw lines to connect each **salt** with the acid **and** alkali that are used to make it.

Acid	Salt	Alkali
Hydrochloric acid	**Calcium sulfate**	Sodium hydroxide
Nitric acid	**Sodium chloride**	Potassium hydroxide
Sulfuric acid	**Potassium nitrate**	Calcium hydroxide

[3]

(ii) Complete the table of information about **three** other salts.

Use the Data Sheet.

Name	Ions	Formula	Relative formula mass
Potassium bromide	K^+ and Br^-	KBr	119
Calcium chloride	..... and	$CaCl_2$	.....
Calcium nitrate	Ca^{2+} and NO_3^-	.....	164.1

[3]

4. Nov/2020/Paper_ J260/02/No.8

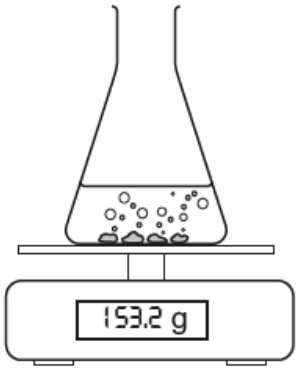
Sundip investigates the rate of reaction between calcium carbonate and hydrochloric acid.

This is the symbol equation for the reaction.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

She adds 50 cm^3 of 1 mol / dm^3 hydrochloric acid to a flask and puts the flask on a balance.

She adds 10 g of calcium carbonate pieces to the acid.



She measures the mass of the flask and its contents at the start, and again after 1 minute.

Results

Mass of flask and contents at the start = 153.2 g
Mass of flask and contents after 1 minute = 152.5 g

(a) (i) Why does the mass of the flask and its contents decrease after 1 minute?

Tick (✓) **one** box.

- Gases are lighter than liquids. ☐
- Gas particles leave the flask. ☐
- The products have less total mass than the reactants. ☐
- The reactants have less total mass than the products. ☐

[1]

(ii) Calculate the rate of reaction for this experiment.

Use the equation: rate of reaction (g/s) = $\frac{\text{change in mass (g)}}{\text{time (s)}}$

Give your answer to **2** significant figures.

Rate of reaction = ... g/s

[3]

(b) What can Sundip do to make the reaction faster?

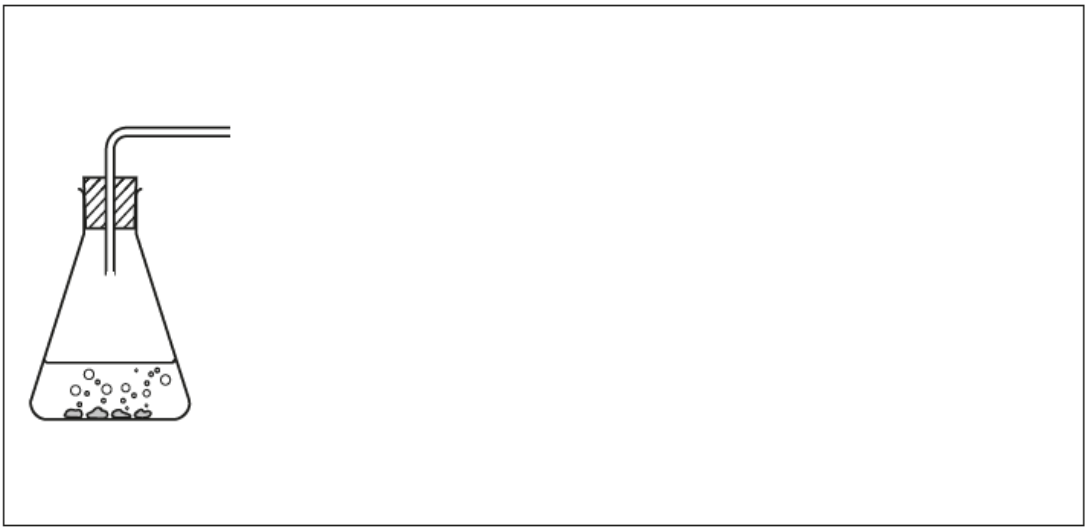
Tick (✓) **two** boxes.

- Use a smaller volume of acid. ☐
- Use larger pieces of calcium carbonate. ☐
- Use a lower temperature. ☐
- Use more concentrated acid. ☐
- Use powdered calcium carbonate instead of pieces. ☐

[2]

(c) Sundip also collects and measures the volume of gas given off during the reaction.

(i) Complete the diagram to show how she could measure the volume of gas given off.



[2]

(ii) Sundip measures the volume of gas given off after 1 minute.

She repeats the experiment at different temperatures. Here are her results.

Temperature (°C)	20	30	40	50
Volume of gas given off after 1 minute (cm^3)	11	22	44	88

Sundip looks at her results and writes this relationship.

rate of reaction ∝ temperature

Do Sundip's results agree with this relationship?

Yes ☐

No ☐

Use Sundip's results to explain your answer.

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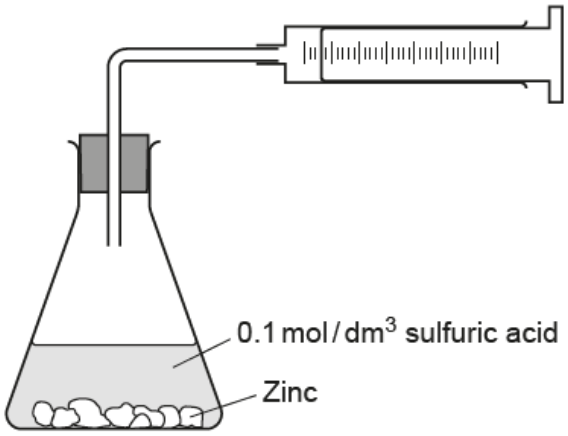
..... **[2]**

5. Nov/2021/Paper_ J260/06/No.4

Sarah investigates the rate of reaction when zinc reacts with dilute sulfuric acid.

She adds small pieces of zinc to 50 cm^3 of 0.1 mol / dm^3 sulfuric acid. She measures the volume of hydrogen gas collected every 30 seconds.



(a) Sarah finds that the reaction is very slow and so she increases the temperature.

(i) Explain why increasing the temperature increases the rate of a reaction.

Use ideas about collisions of particles in your answer.

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.....

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

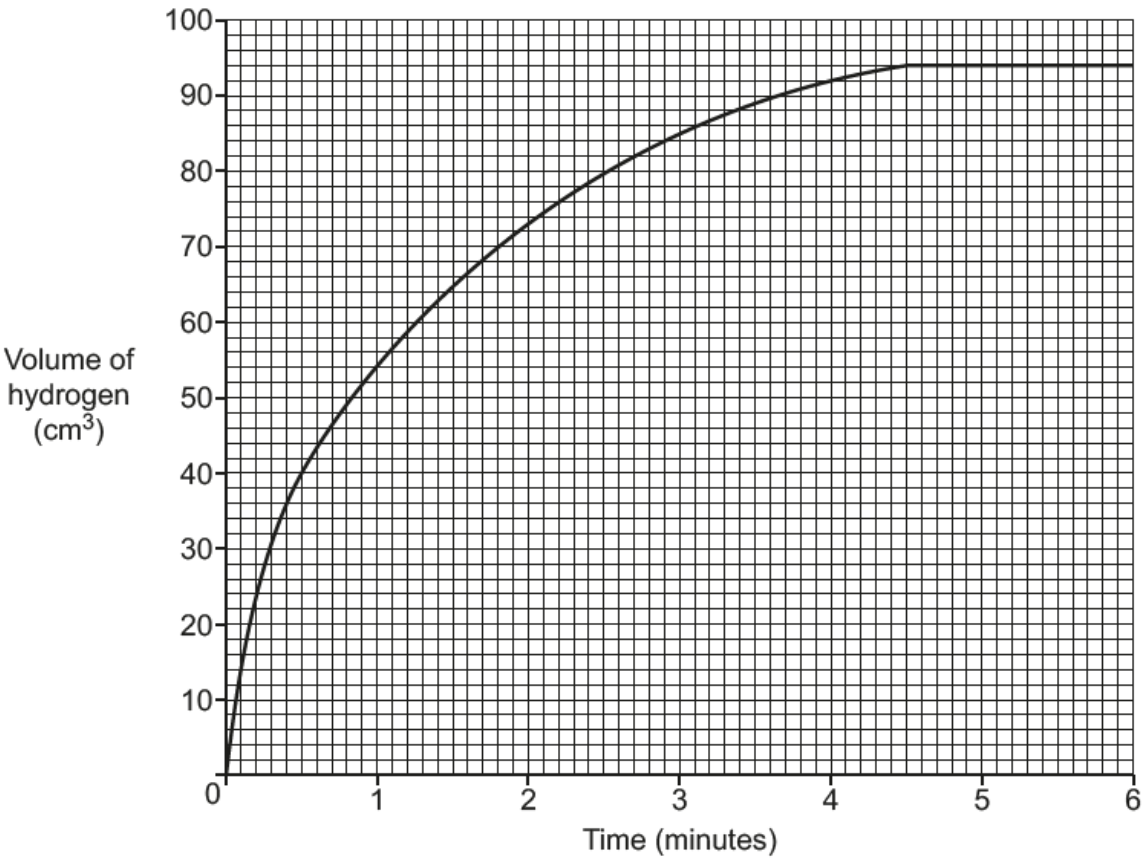
(ii) Give **two** other ways that she could speed up the reaction.

1 .....

2 .....

[1]

(b) Sarah plots a graph from her results.



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

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

(ii) What volume of hydrogen is given off by the end of the reaction?

..... cm^3 **[1]**

(iii) Calculate the average volume of hydrogen given off **per second**.

..... cm^3/s **[2]**

(iv) Draw a tangent on the graph **and** use it to calculate the **initial rate** of the reaction in **cm^3/s**.

Initial rate = ... cm^3/s **[3]**

(v) Some zinc pieces are left behind when the reaction ends.

Explain how and why the rate of reaction changes during the first **two** minutes of the reaction.

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

6. Nov/2020/Paper_ J260/06/No.1

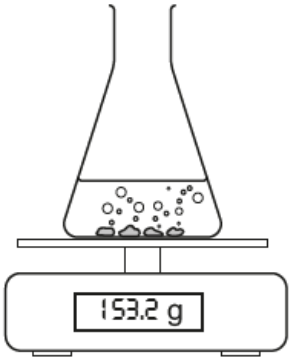
Sundip investigates the rate of reaction between calcium carbonate and hydrochloric acid.

This is the symbol equation for the reaction.

$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

She adds 50 cm^3 of 1 mol / dm^3 hydrochloric acid to a flask and puts the flask on a balance.

She adds 10 g of calcium carbonate pieces to the acid.



She measures the mass of the flask and its contents at the start, and again after 1 minute.

Results

Mass of flask and contents at the start = 153.2 g
Mass of flask and contents after 1 minute = 152.5 g

(a) (i) Why does the mass of the flask and its contents decrease after 1 minute?

Tick (✓) **one** box.

- Gases are lighter than liquids. ☐
- Gas particles leave the flask. ☐
- The products have less total mass than the reactants. ☐
- The reactants have less total mass than the products. ☐

[1]

(ii) Calculate the rate of reaction for this experiment.

Use the equation: rate of reaction (g/s) = $\frac{\text{change in mass (g)}}{\text{time (s)}}$

Give your answer to **2** significant figures.

Rate of reaction = ... g/s

[3]

(b) What can Sundip do to make the reaction faster?

Tick (✓) **two** boxes.

Use a smaller volume of acid. ☐

Use larger pieces of calcium carbonate. ☐

Use a lower temperature. ☐

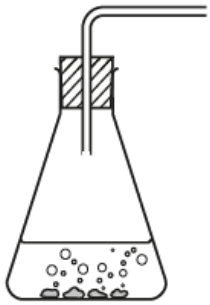
Use more concentrated acid. ☐

Use powdered calcium carbonate instead of pieces ☐

[2]

(c) Sundip also collects and measures the volume of gas given off during the reaction.

(i) Complete the diagram to show how she could measure the volume of gas given off.



[2]

(ii) Sundip measures the volume of gas given off after 1 minute.

She repeats the experiment at different temperatures. Here are her results.

Temperature (°C)	20	30	40	50
Volume of gas given off after 1 minute (cm^3)	11	22	44	88

Sundip looks at her results and writes this relationship.

rate of reaction ∝ temperature

Do Sundip's results agree with this relationship?

Yes ☐

No ☐

Use Sundip's results to explain your answer.

.....

.....

.....

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

7. Nov/2020/Paper_ J260/06/No.9

Beth has **four** solutions, **A**, **B**, **C** and **D**, two of which contain dilute hydrochloric acid, and two of which contain dilute ethanoic acid, as shown in **Table 9.1**.

	Hydrochloric acid		Ethanoic acid	
	Solution A	**Solution B**	**Solution C**	**Solution D**
Concentration (mol/dm^3)	0.1	0.01	1.0	0.1
Concentration of H^+ ions (mol/dm^3)	1×10^{-1}	1×10^{-2}	1×10^{-2}	1×10^{-3}
pH	1	2	2	3

Table 9.1

(a) (i) Give **two** ways in which **Table 9.1** shows that ethanoic acid and hydrochloric acid are both acids.

1 .....

2 .....

[2]

(ii) Predict the pH and concentration of hydrogen ions for a solution of $0.001\,mol/dm^3$ hydrochloric acid.

pH = ...

Concentration of hydrogen ions = ... mol/dm^3

[2]

(b) Hydrochloric acid is a strong acid. Ethanoic acid is a weak acid.

(i) Explain what is meant by a strong acid and a weak acid.

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

(ii) How does the information in **Table 9.1** show that hydrochloric acid is a strong acid and ethanoic acid is a weak acid?

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

(c) Magnesium reacts with hydrogen ions in dilute acid to form magnesium ions and hydrogen gas.

(i) Write the **ionic** equation for this reaction.

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

(ii) Beth adds 10 g of magnesium ribbon to 100 cm^3 of the four solutions.

She measures how long it takes to collect 10 cm^3 of hydrogen for each acid.

Her results are shown in **Table 9.2**.

	Hydrochloric acid		**Ethanoic acid**	
	Solution A	**Solution B**	**Solution C**	**Solution D**
Concentration (mol/dm^3)	0.1	0.01	1.0	0.1
Concentration of H^+ ions (mol/dm^3)	1×10^{-1}	1×10^{-2}	1×10^{-2}	1×10^{-3}
Time taken to collect 10 cm^3 hydrogen (s)	39	388	392	More than 1 hour

Table 9.2

Compare the rates of reaction for solutions **A**, **B** and **C**.

Use data from **Table 9.2** to support your answer.

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

(iii) Solutions **A** and **D** both have concentrations of 0.1 mol/dm^3.

Explain why solution **D** takes much longer to react than solution **A**.

Use data from **Table 9.2** to support your answer.

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