AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.6.1.1

Calculating rates of reactions

Past-paper questions

Tier	**Foundation**
Question groups	**8**
Available paper years	**2018–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

5.6.1.1 Calculating rates of reactions

Question 01

June 2018 | 8464/C/2F | Original Q5

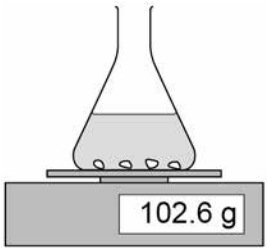
0 5 A student investigated the effect of the size of marble chips on the rate of the reaction between marble chips and hydrochloric acid.

This is the method used.

1. Add 10.0 g of marble chips into the flask.
2. Add 50 cm^3 of hydrochloric acid and start a timer.
3. Record the mass lost from the flask every 10 seconds.
4. Repeat steps 1 to 3 with different sizes of marble chips.

Figure 10 shows the apparatus.

Figure 10



0 5 . 1 Draw **one** line from each type of variable to the correct example of the variable.

[2 marks]

Type of variable	Example of variable
	Mass lost from flask
Independent	Size of flask
	Size of marble chips
Control	
	Time taken
	Volume of acid

5.6.1.1 Calculating rates of reactions

Question 01 · continued

0 5 . 2 The equation for the reaction is:

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

Name the **three** products.

[2 marks]

1 _____

2 _____

3 _____

0 5 . 3 Another student suggests putting some cotton wool in the top of the flask.

Suggest why this improves the investigation.

[1 mark]

_____

_____

0 5 . 4 The reaction produces 1.6 g of gas in 30 seconds.

Calculate the mean rate of the reaction in the first 30 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{mass of product produced in grams}}{\text{time in seconds}}$$

[1 mark]

_____

_____

Mean rate of reaction = _____

0 5 . 5 What is the unit for the mean rate of reaction calculated in question **05.4**?

[1 mark]

Tick **one** box.

g ☐ g/s ☐ s ☐ s/g ☐

5.6.1.1 Calculating rates of reactions

Question 01 · continued

0 5 . 6 **Table 5** shows the student's results.

Table 5

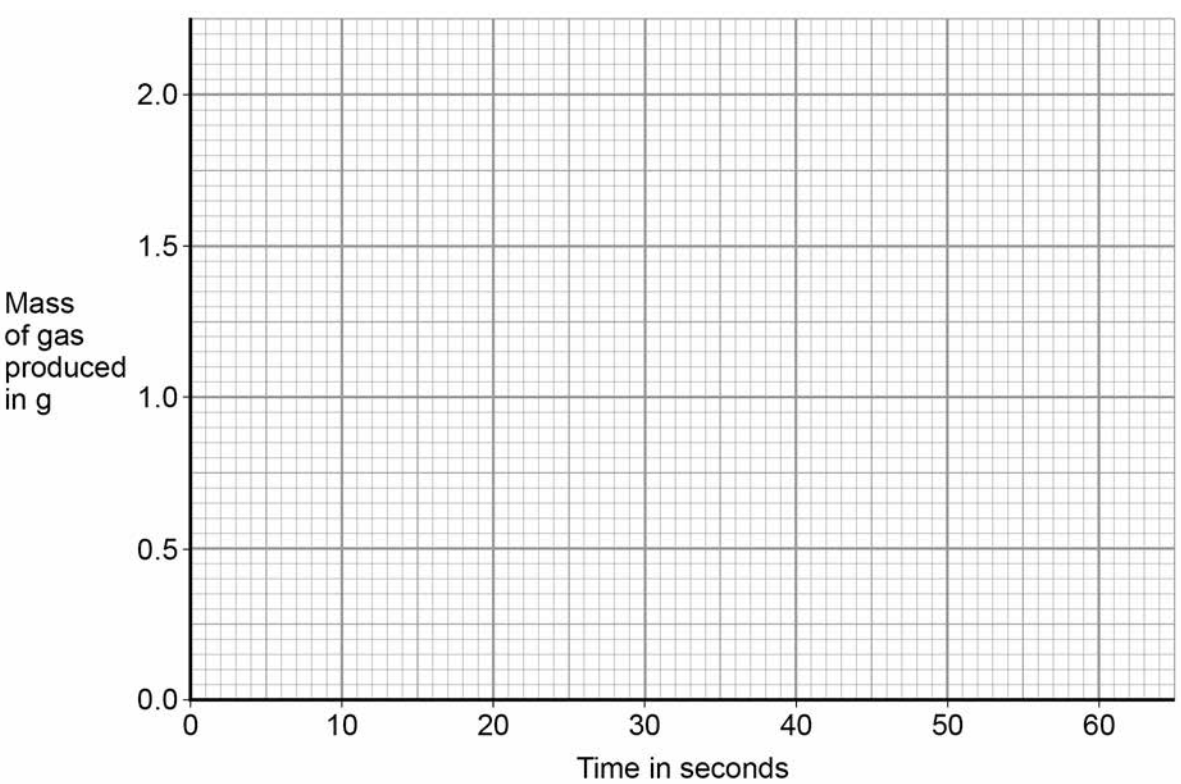
Time in seconds	Mass of gas produced in g
0	0.0
10	0.8
20	0.6
30	1.6
40	1.8
50	2.0
60	2.0

Plot the data from **Table 5** on **Figure 11**

Draw a line of best fit.

[3 marks]

Figure 11

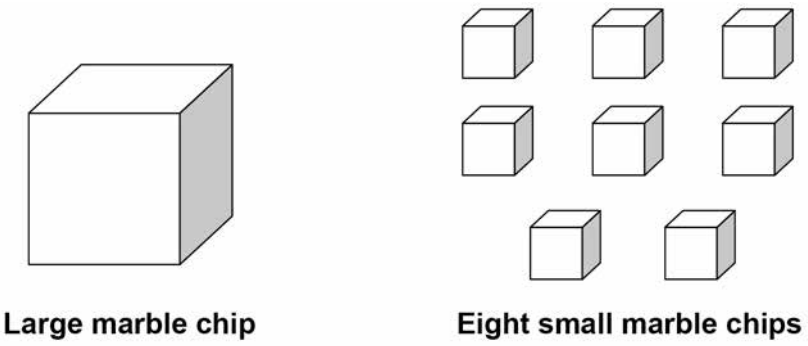


5.6.1.1 Calculating rates of reactions

Question 01 · continued

0 5 . 7 **Figure 12** shows a large marble chip and eight small marble chips.

Figure 12



The large marble chip has the same total volume as the eight small marble chips, but a different surface area.

Why do the eight small marble chips react faster than the large marble chip?

[1 mark]

Tick **one** box.

- The eight small marble chips have a larger surface area, so less frequent collisions. ☐
- The eight small marble chips have a larger surface area, so more frequent collisions. ☐
- The eight small marble chips have a smaller surface area, so less frequent collisions. ☐
- The eight small marble chips have a smaller surface area, so more frequent collisions. ☐

11

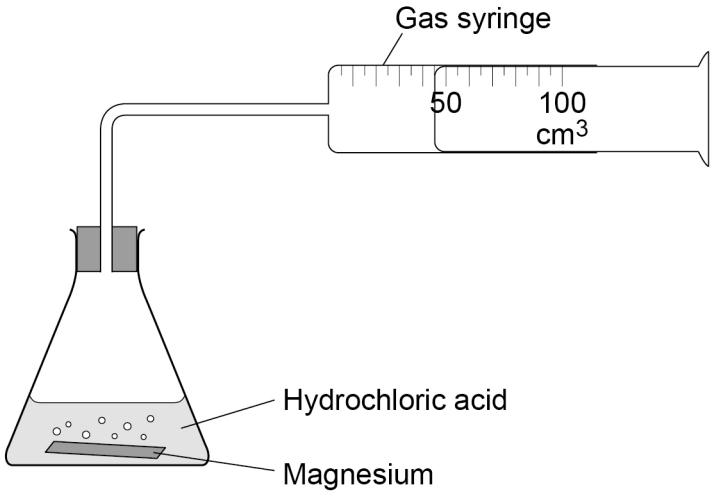
5.6.1.1 Calculating rates of reactions

Question 02

0 3 A student investigated the rate of the reaction between magnesium and hydrochloric acid.

Figure 4 shows the apparatus the student used.

Figure 4



0 3 . 1 Balance the equation for the reaction.

[1 mark]

$$Mg + ____ HCl \rightarrow MgCl_2 + H_2$$

0 3 . 2 The student used 50 cm^3 of hydrochloric acid.

Which apparatus would measure 50 cm^3 of hydrochloric acid with the greatest accuracy?

[1 mark]

Tick (✓) **one** box.

50 cm^3 beaker ☐

50 cm^3 conical flask ☐

50 cm^3 measuring cylinder ☐

5.6.1.1 Calculating rates of reactions

Question 02 · continued

0 3 . 3 The student measured the volume of gas produced every 20 seconds for 2 minutes.

The volume of gas was zero at the start of the experiment.

The measured volumes of gas were:

26 cm^3 38 cm^3 47 cm^3 55 cm^3 59 cm^3 60 cm^3

Complete **Table 2** to show these results.

[4 marks]

Table 2

0	0

0 3 . 4 The volumes of gas were lower than expected.

Suggest **one** reason.

[1 mark]

_____

_____

0 3 . 5 The student repeated the experiment using different concentrations of hydrochloric acid.

Give **two** variables the student should keep the same.

[2 marks]

1 _____

2 _____

5.6.1.1 Calculating rates of reactions

Question 02 · continued

0 3 . 6 Complete the sentences.

[3 marks]

As the concentration of the hydrochloric acid increased, the rate of the reaction _____ .

This is because there were more acid _____ in each cubic centimetre (cm^3).

So the collisions happened more _____ .

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5.6.1.1 Calculating rates of reactions

Question 03

November 2020 | 8464/C/2F | Original Q4

0 4 This question is about hydrogen peroxide.

0 4 . 1 The symbol equation for the decomposition of hydrogen peroxide (H_2O_2) is:

$$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$$

Complete the word equation for the decomposition of hydrogen peroxide.

[2 marks]

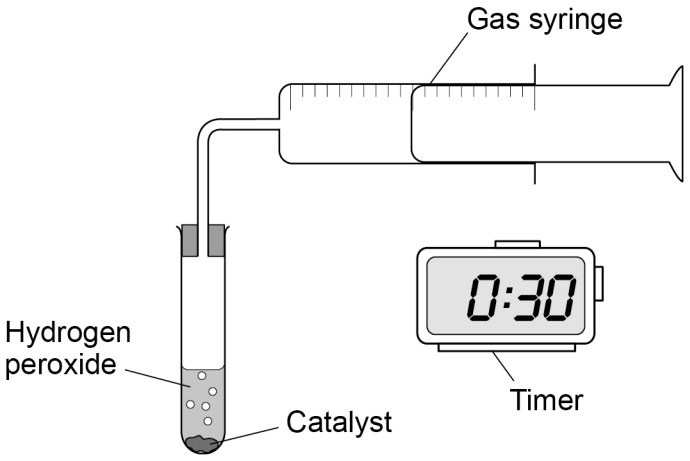
hydrogen peroxide → _____ + _____

A student investigated the effect of different catalysts on the decomposition of hydrogen peroxide.

The student measured the volume of gas collected every 30 seconds for 5 minutes.

Figure 5 shows the apparatus used.

Figure 5



5.6.1.1 Calculating rates of reactions

Question 03 · continued

0 4 . 2 Which **two** variables should the student keep the same to make the investigation a fair test?

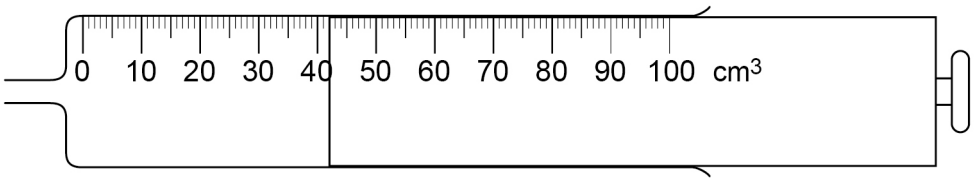
[2 marks]

Tick (✓) **two** boxes.

- Concentration of hydrogen peroxide ☐
- Mass of catalyst ☐
- Size of gas syringe ☐
- Type of catalyst ☐
- Volume of gas collected ☐

0 4 . 3 **Figure 6** shows a gas syringe.

Figure 6



What is the volume of gas in the syringe?

[1 mark]

Volume = _____ cm^3

Question 4 continues on the next page

5.6.1.1 Calculating rates of reactions

Question 03 · continued

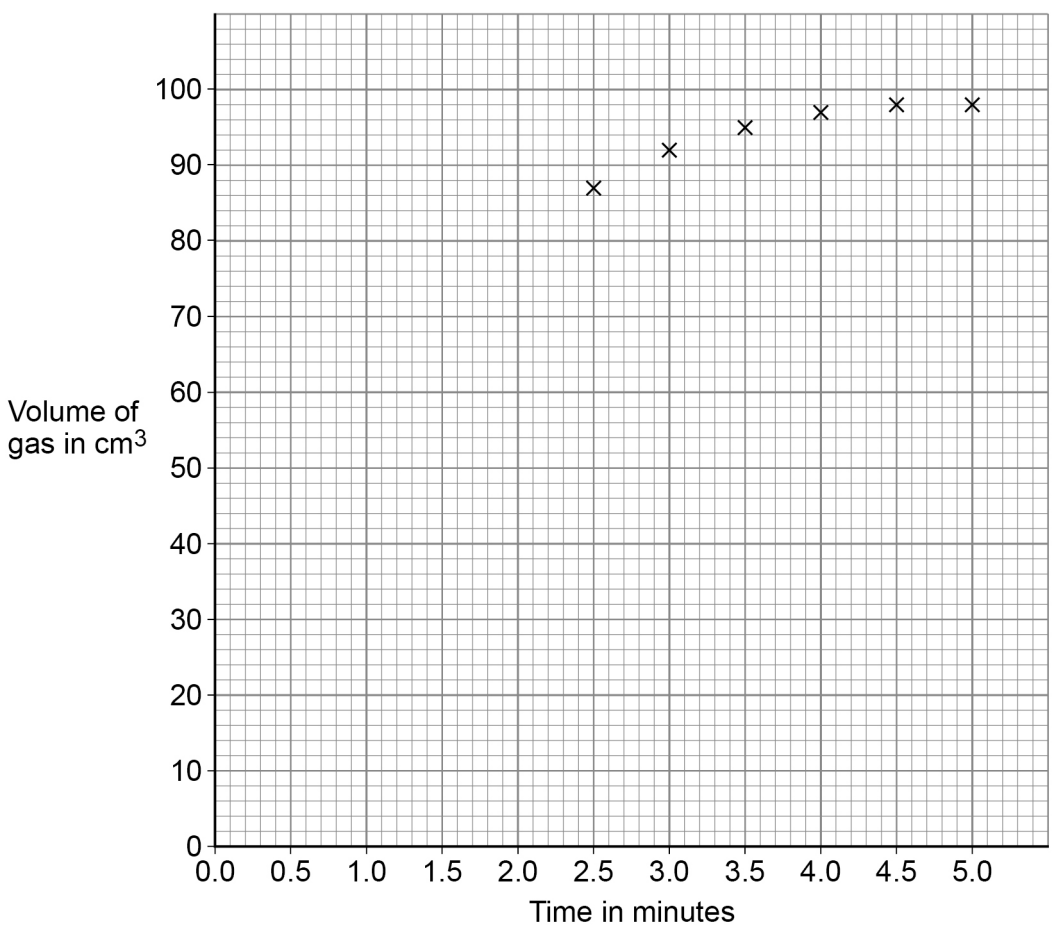
Table 3 shows the student's results for one catalyst.

Table 3

Time in minutes	0.0	0.5	1.0	1.5	2.0
Volume of gas in cm^3	0	34	54	68	78

0 4 . 4 Six of the other results have been plotted on **Figure 7**.

Figure 7



Complete the graph in **Figure 7**.

You should:

- plot the results from **Table 3**
- draw a line of best fit for all of the results.

[3 marks]

5.6.1.1 Calculating rates of reactions

Question 03 · continued

The student repeated the experiment with other catalysts and plotted a graph for each of the catalysts used.

0 4 . 5 Suggest how the student could use these graphs to identify the best catalyst.

[1 mark]

0 4 . 6 All the graphs level off at the same volume of gas.

Suggest why.

[1 mark]

0 4 . 7 In another investigation, a student increased the temperature of the hydrogen peroxide.

Why is the rate of reaction faster when the temperature of the hydrogen peroxide is increased?

[2 marks]

Tick (✓) **two** boxes.

- The concentration of hydrogen peroxide decreases. ☐
- The particles are moving more slowly. ☐
- The particles have more energy. ☐
- There are more particle collisions per second. ☐
- There are more particles per unit volume. ☐

12

5.6.1.1 Calculating rates of reactions

Question 04

November 2020 | 8464/C/2F | Original Q7

0 7 Some students investigated the effect of temperature on the rate of reaction.

0 7 . 1 The students reacted sodium thiosulfate solution with hydrochloric acid.

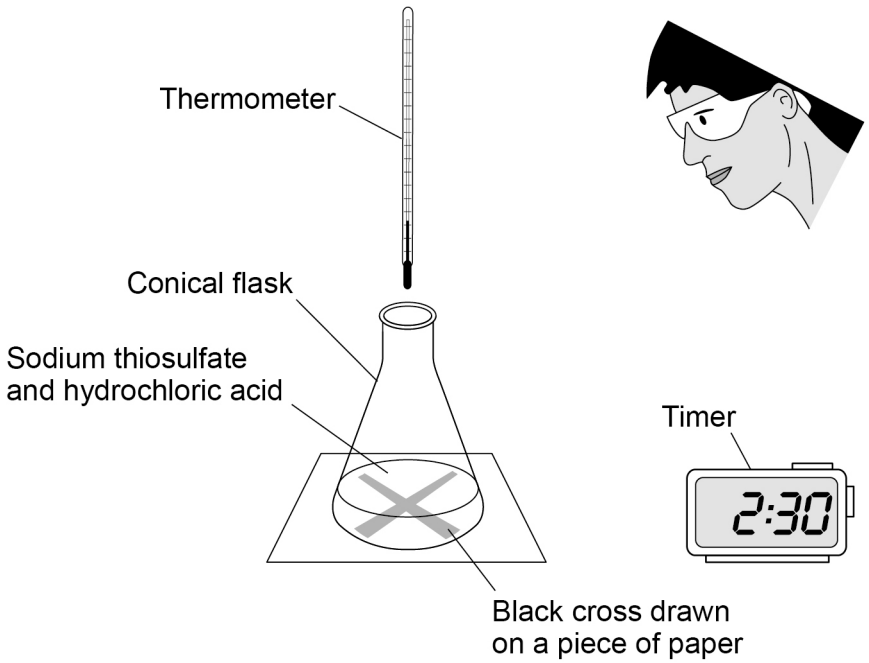
This is the method used.

1. Use a beaker to measure 50 cm^3 of heated sodium thiosulfate solution into a conical flask.
2. Measure the temperature of the room.
3. Put the conical flask on a black cross drawn on a piece of paper.
4. Start a timer.
5. Use the same beaker to measure 10 cm^3 of hydrochloric acid into the conical flask.
6. Stop the timer when the cross is no longer visible.

The students repeated the experiment at a different room temperature.

Figure 10 shows the apparatus.

Figure 10



5.6.1.1 Calculating rates of reactions

Question 04 · continued

The method contains errors and does **not** produce accurate results.

Describe a method the students should use to produce accurate results.

You do **not** need to write about safety precautions.

[6 marks]

Question 7 continues on the next page

5.6.1.1 Calculating rates of reactions

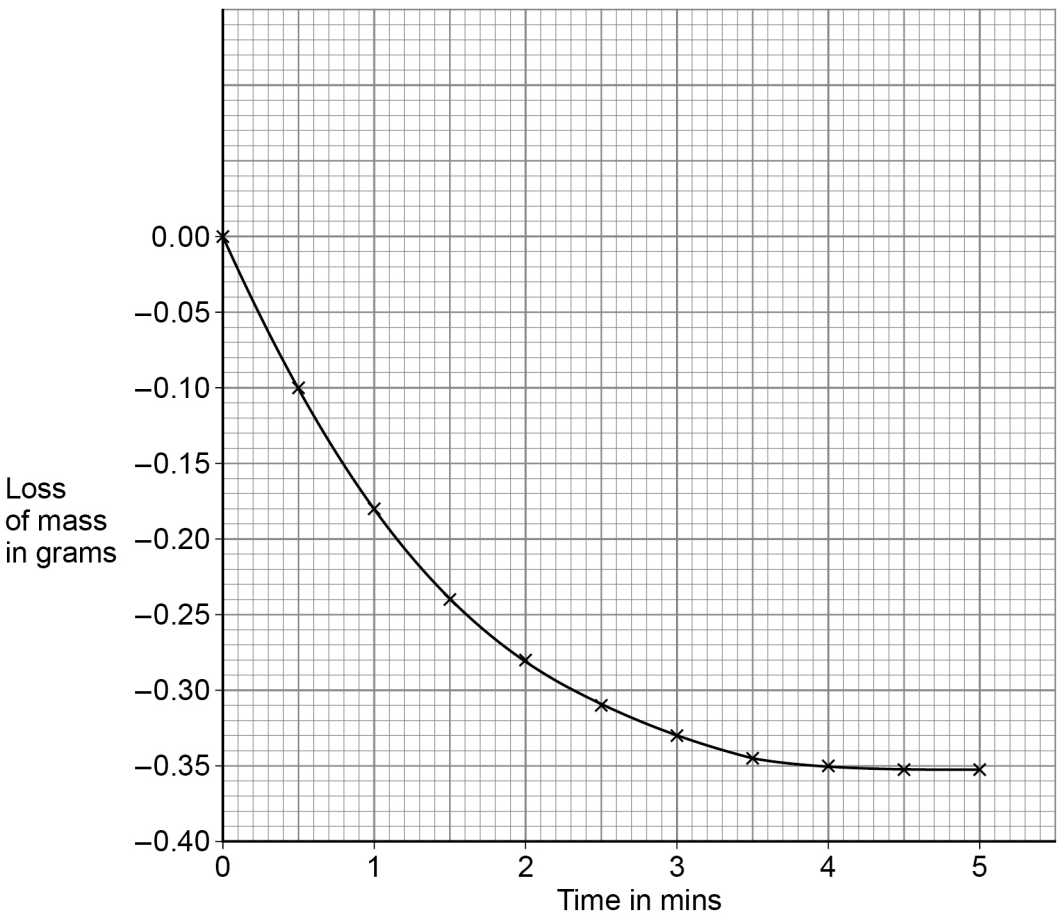
Question 04 · continued

Some students investigated the effect of temperature on the rate of a different reaction.

They recorded the loss of mass from their apparatus at 40 °C

Figure 11 shows the results.

Figure 11



5.6.1.1 Calculating rates of reactions

Question 04 · continued

0 7 . 2 Calculate the mean rate of reaction between 1 minute and 3 minutes at 40 °C

Use **Figure 11** and the equation:

$$\text{Mean rate of reaction} = \frac{\text{change in mass of gas in g}}{\text{time in mins}}$$

[3 marks]

Mean rate of reaction = _____ g/min

0 7 . 3 Draw a curve on **Figure 11** for the results you would expect at a temperature of 50 °C instead of 40 °C

[2 marks]

11

5.6.1.1 Calculating rates of reactions

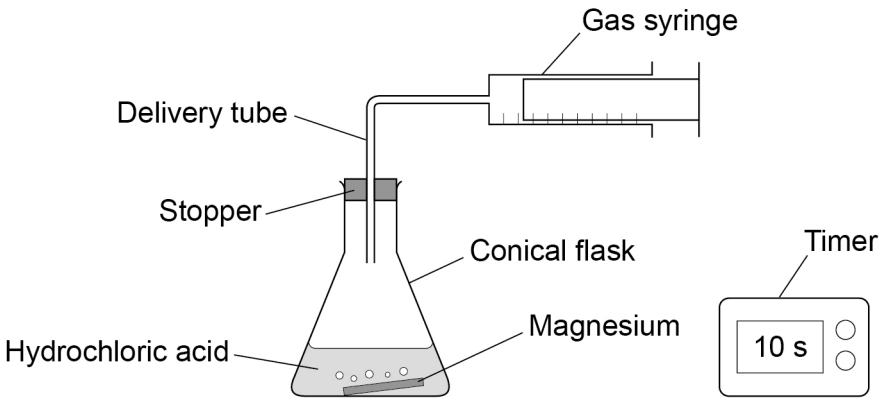
Question 05

November 2021 | 8464/C/2F | Original Q6

0 6 A student investigated the reaction between magnesium and excess hydrochloric acid.

Figure 5 shows the apparatus.

Figure 5



This is the method used.

1. Pour 50 cm^3 of hydrochloric acid into a conical flask.
2. Add a piece of magnesium.
3. Insert stopper and delivery tube and start a timer.
4. Collect the gas produced in a gas syringe.
5. Record the volume of gas produced every 20 seconds for 2 minutes.
6. Repeat steps 1 to 5 with higher concentrations of hydrochloric acid.

0 6 . 1 Give the independent variable and **one** control variable in this investigation.

[2 marks]

Independent variable _____

Control variable _____

Question 6 continues on the next page

Question 05 · continued

Table 3 shows the results from the first experiment using hydrochloric acid with a low concentration.

Table 3

Time in seconds	0	20	40	60	80	100	120
Volume of gas in cm^3	0	48	72	90	97	98	98

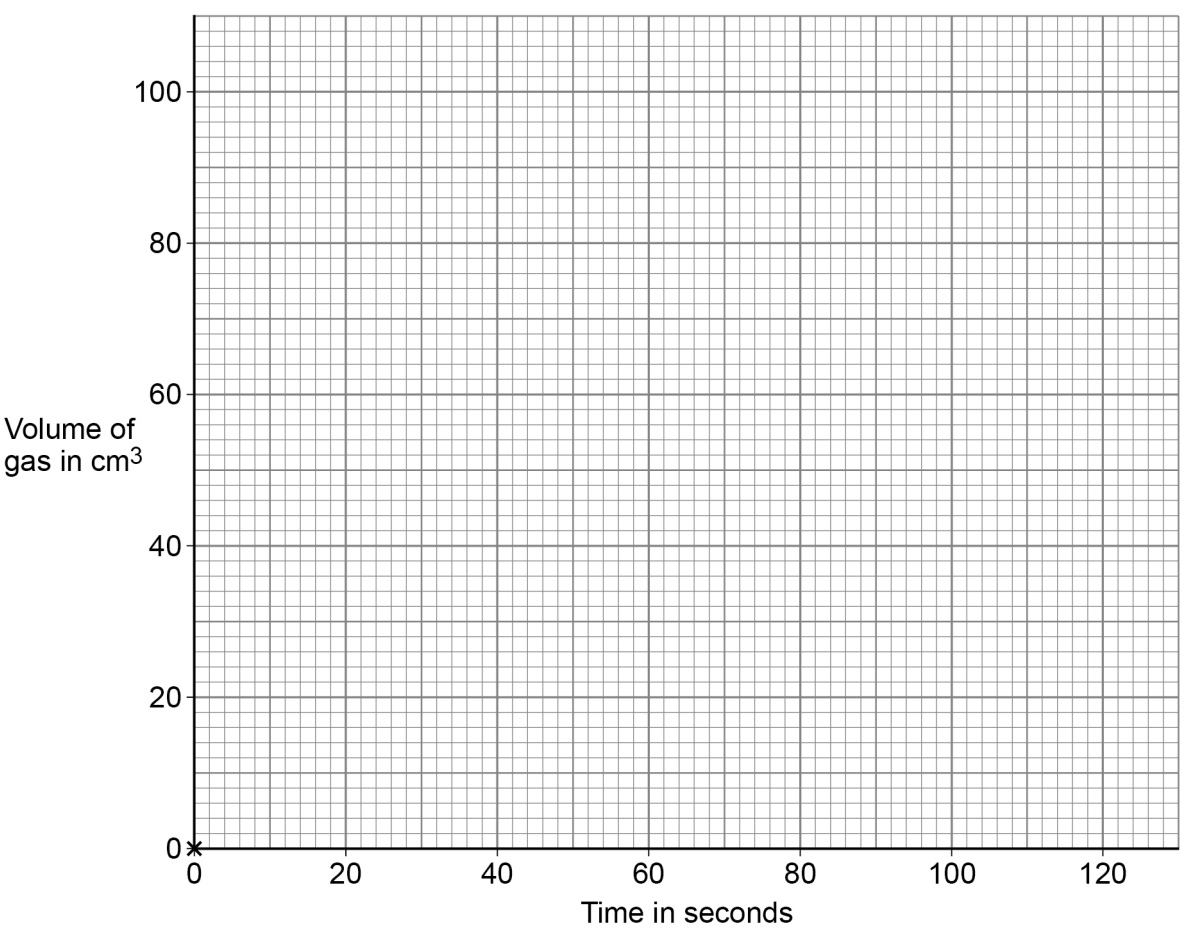
0 6 . 2 Complete **Figure 6**.

You should:

- plot the data from **Table 3** (the point 0,0 has been plotted for you)
- draw a line of best fit.

[3 marks]

Figure 6



5.6.1.1 Calculating rates of reactions

Question 05 · continued

0 6 . 3 How does the **rate** of this reaction change with time?

Use **Table 3**.

[1 mark]

Tick (✓) **one** box.

The rate decreases. ☐

The rate stays the same. ☐

The rate increases. ☐

0 6 . 4 The student repeated the experiment using hydrochloric acid with a higher concentration.

Which statement is correct?

[1 mark]

Tick (✓) **one** box.

The activation energy for the reaction was higher. ☐

The magnesium reacted more quickly. ☐

The reaction finished at the same time. ☐

The total volume of gas collected was smaller. ☐

Question 6 continues on the next page

5.6.1.1 Calculating rates of reactions

Question 05 · continued

0 6 . 5 Temperature also affects the rate of the reaction.

Explain how increasing the temperature affects the **rate** of the reaction.

You should refer to particles and collisions.

[3 marks]

10

5.6.1.1 Calculating rates of reactions

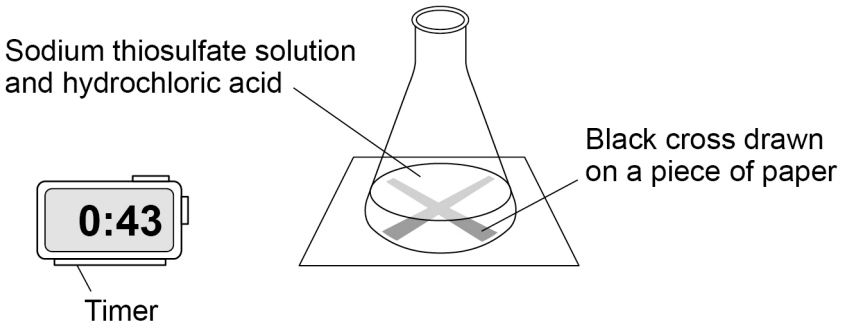
Question 06

0 4 A student investigates the effect of concentration on the rate of the reaction between sodium thiosulfate solution and hydrochloric acid.

Figure 6 shows the experiment.

The experiment was done in a fume cupboard.

Figure 6



This is the method used.

1. Pour 50 cm^3 of sodium thiosulfate solution into a conical flask.
2. Put the conical flask on a black cross drawn on a piece of paper.
3. Pour 10 cm^3 of hydrochloric acid into the conical flask and start a timer.
4. Stop the timer when the cross can no longer be seen.
5. Repeat the experiment with different concentrations of sodium thiosulfate solution.

5.6.1.1 Calculating rates of reactions

Question 06 · continued

0 4 . 1 Draw **one** line from each type of variable to the correct example of the variable in this investigation.

[2 marks]

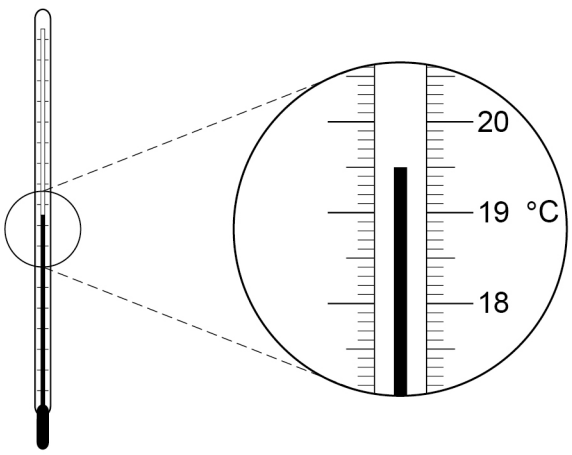
Type of variable	Example of variable
	Concentration of sodium thiosulfate solution
Dependent	
	Temperature of reaction mixture
	Time taken for the cross to no longer be seen
Independent	
	Volume of acid
	Volume of the flask

Question 4 continues on the next page

Question 06 · continued

0 4 . 2 The experiment is done at room temperature.

Figure 7



What is the temperature shown on the thermometer in **Figure 7**?

[1 mark]

Temperature = _____ °C

Table 1 shows the student's results.

Table 1

Concentration of sodium thiosulfate solution in mol/dm^3	Time in seconds
0.1	82
0.2	40
0.3	20
0.4	13
0.5	10
0.6	8

5.6.1.1 Calculating rates of reactions

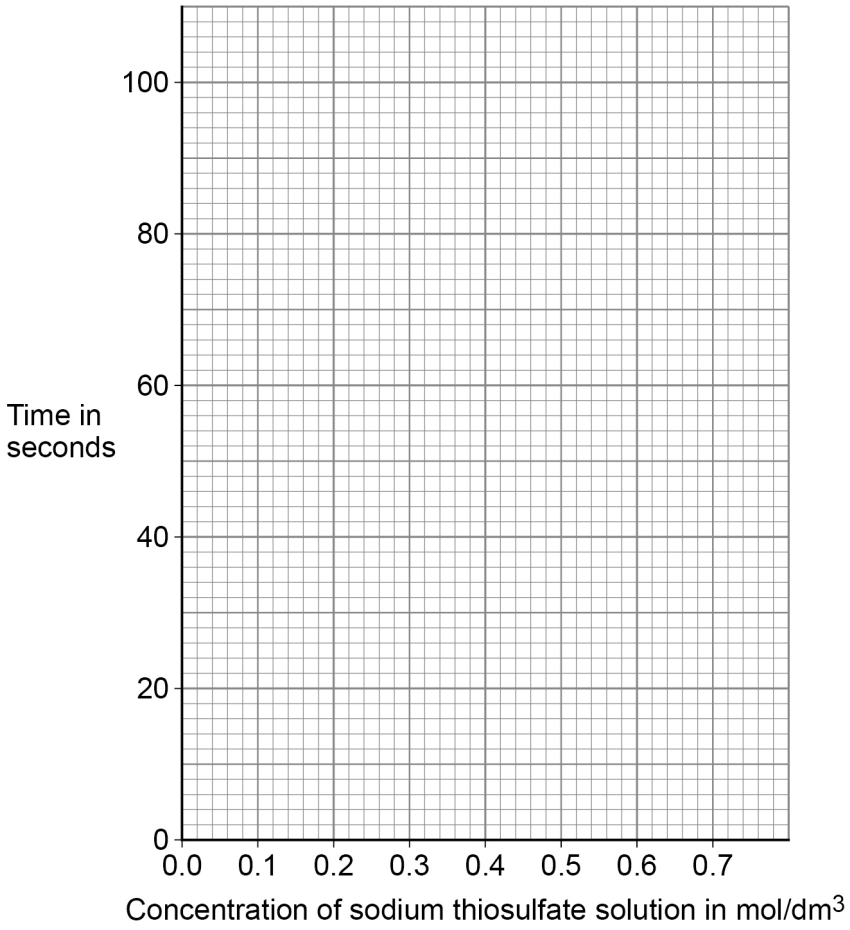
Question 06 · continued

0 4 . 3 Plot the data from **Table 1** on **Figure 8**.

Draw a line of best fit.

[3 marks]

Figure 8



0 4 . 4 Predict the time taken for the cross to no longer be seen at a concentration of 0.7 mol/dm^3

Use your graph in **Figure 8**.

[1 mark]

Time = _____ s

0 4 . 5 Complete the sentence.

[1 mark]

As the concentration of sodium thiosulfate solution increases, the time taken for the cross to no longer be seen _____ .

5.6.1.1 Calculating rates of reactions

Question 06 · continued

0 4 . 6 In one experiment 0.725 g of sulfur is produced in 20 seconds.

Calculate the mean rate of the reaction from 0 to 20 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{mass of sulfur produced in grams}}{\text{time in seconds}}$$

[2 marks]

Mean rate of reaction = _____

0 4 . 7 What is the unit for the mean rate of reaction calculated in Question **04.6**?

[1 mark]

Tick (✓) **one** box.

g ☐ g/s ☐ s ☐ s/g ☐

5.6.1.1 Calculating rates of reactions

Question 06 · continued

0 4 . 8 The student did the experiment with 0.15 mol/dm^3 sodium thiosulfate solution and repeated the experiment three more times.

Table 2 shows the results.

Table 2

	Test 1	Test 2	Test 3	Test 4
Time in seconds for the cross to no longer be seen	60.5	63.2	82.3	65.7

Calculate the mean time for this reaction.

Do **not** include the anomalous result in your calculation.

Give your answer to 3 significant figures.

[3 marks]

Mean time for the reaction (3 significant figures) = _____ s

14

5.6.1.1 Calculating rates of reactions

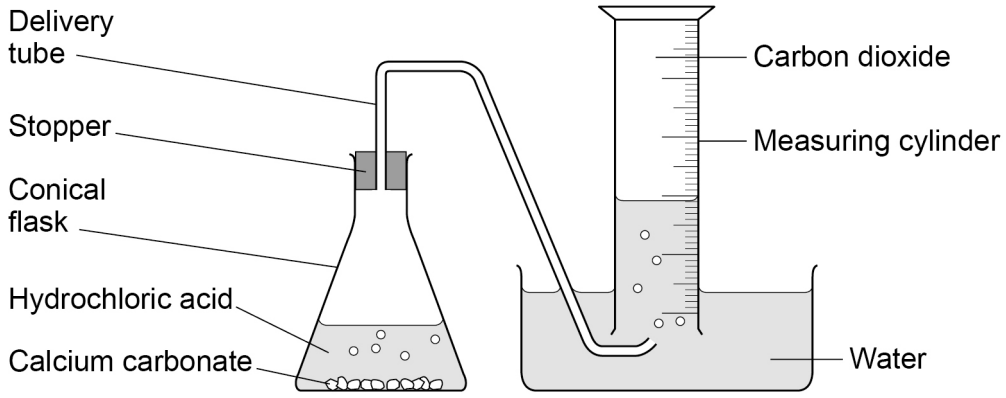
Question 07

0 7 Some factors affect the rates of chemical reactions.

0 7 . 1 A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

Figure 6 shows the apparatus.

Figure 6



Describe a method the student could use to produce valid results.

[6 marks]

5.6.1.1 Calculating rates of reactions

Question 07 · continued

June 2024 | 8464/C/2F | Original Q7

0 7 . 2 The student investigated the effect of increasing the temperature on the rate of a reaction.

Explain the effect of increasing the temperature on the rate of a reaction.

Refer to particles and collisions in your answer.

[3 marks]

5.6.1.1 Calculating rates of reactions

Question 07 · continued

Catalysts affect the rate of reactions.

0 7 . 3 What is meant by a 'catalyst'?

[2 marks]

0 7 . 4 What are catalysts in biological systems called?

[1 mark]

12

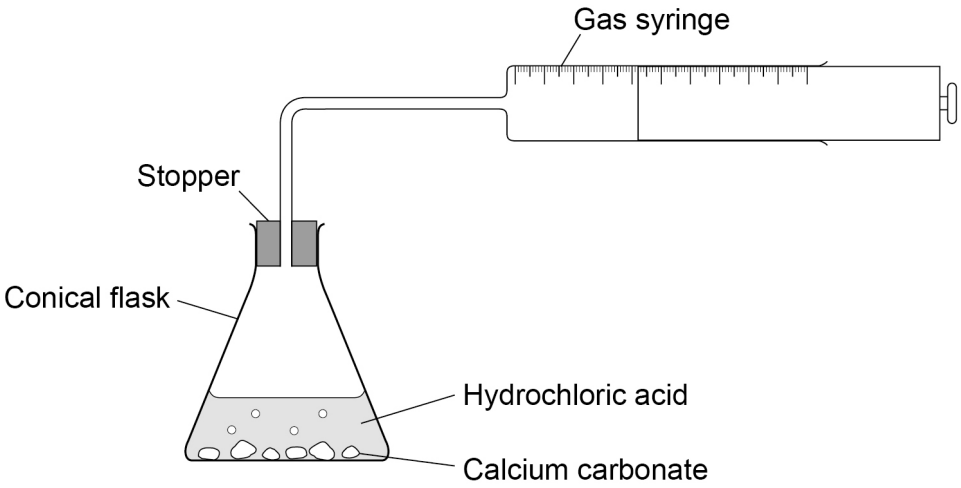
5.6.1.1 Calculating rates of reactions

Question 08

0 2 A student investigated the reaction of calcium carbonate with hydrochloric acid.

Figure 2 shows the apparatus.

Figure 2



This is the method used.

1. Measure 50 cm^3 of hydrochloric acid into a conical flask.
2. Add 4.0 g of calcium carbonate to the conical flask.
3. Insert the stopper into the conical flask as quickly as possible.
4. Start a timer.
5. Measure the volume of gas collected every 30 seconds for 3 minutes.
6. Repeat steps 1 to 5 using different concentrations of hydrochloric acid.

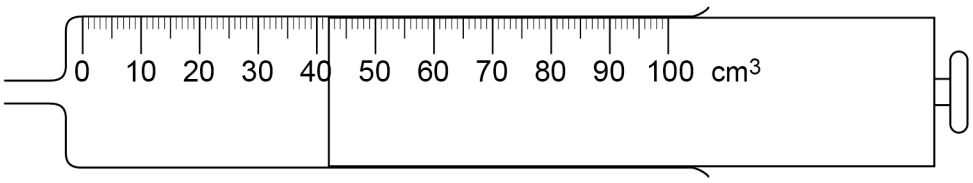
0 2 . 1 Name a suitable piece of equipment to measure 4.0 g of calcium carbonate.

[1 mark]

Question 08 · continued

0 2 . 2 **Figure 3** shows the gas syringe during the investigation.

Figure 3



What is the reading on the gas syringe?

[1 mark]

_____ cm^3

0 2 . 3 What is the independent variable in the investigation?

[1 mark]

Tick (✓) **one** box.

Concentration of hydrochloric acid ☐

Mass of calcium carbonate ☐

Temperature of the room ☐

0 2 . 4 Why did the student insert the stopper into the conical flask as quickly as possible in step 3?

[1 mark]

_____

_____

Question 2 continues on the next page

5.6.1.1 Calculating rates of reactions

Question 08 · continued

0 2 . 5 The gas produced during the investigation is carbon dioxide.

The test for carbon dioxide uses limewater.

What is the chemical name for limewater?

[1 mark]

Tick (✓) **one** box.

Calcium hydroxide solution ☐

Potassium carbonate solution ☐

Sodium chloride solution ☐

5.6.1.1 Calculating rates of reactions

Question 08 · continued

0 2 . 6 The student measured the volume of gas collected every 30 seconds for 3 minutes.

The volume of gas was zero at the start.

For one concentration of hydrochloric acid, the volumes of gas collected were:

43 cm^3 66 cm^3 78 cm^3 83 cm^3 84 cm^3 85 cm^3

Complete **Table 3**.

You should:

- add headings to each column
- add units
- add all of the results to the table.

[4 marks]

Table 3

0	0

Question 08 · continued

0 2 . 7 The student used a different concentration of hydrochloric acid.

18 cm^3 of gas was collected in the first 30 seconds.

Calculate the mean rate of reaction for the first 30 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas collected in cm}^3}{\text{time taken in seconds}}$$

Choose the unit from the box.

[3 marks]

cm^3	**cm^3/s**	**s**	**s/cm^3**

Mean rate of reaction = _____ Unit _____

0 2 . 8 Increasing the concentration of hydrochloric acid increases the rate of the reaction.

What are **two** reasons why?

[2 marks]

Tick (✓) **two** boxes.

- The particles are closer together. ☐
- The particles collide more frequently. ☐
- The particles have a lower surface area. ☐
- The particles have less energy. ☐
- The particles move faster. ☐

14