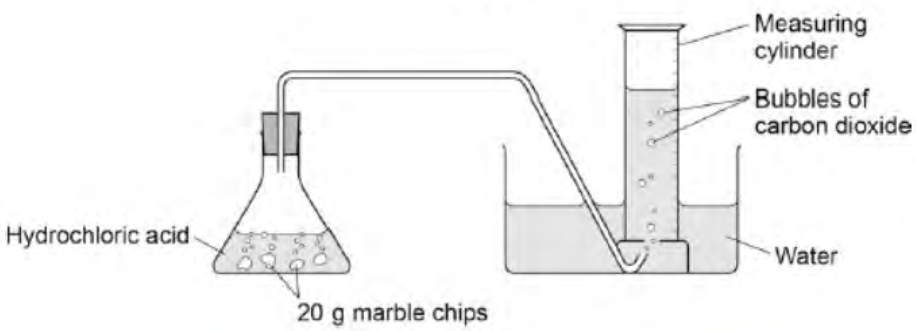
AQA Chemistry GCSE

Required Practical 5 - Rate of Reaction
Past Exam Questions

Q1. Marble chips are mainly calcium carbonate (CaCO3). A student investigated the rate of reaction between marble chips and hydrochloric acid (HCl).
Figure 1 shows the apparatus the student used.

Figure 1



(a) Complete and balance the equation for the reaction between marble chips and hydrochloric
acid.

..... + ... → CaCl2 + ... + ...

(2)

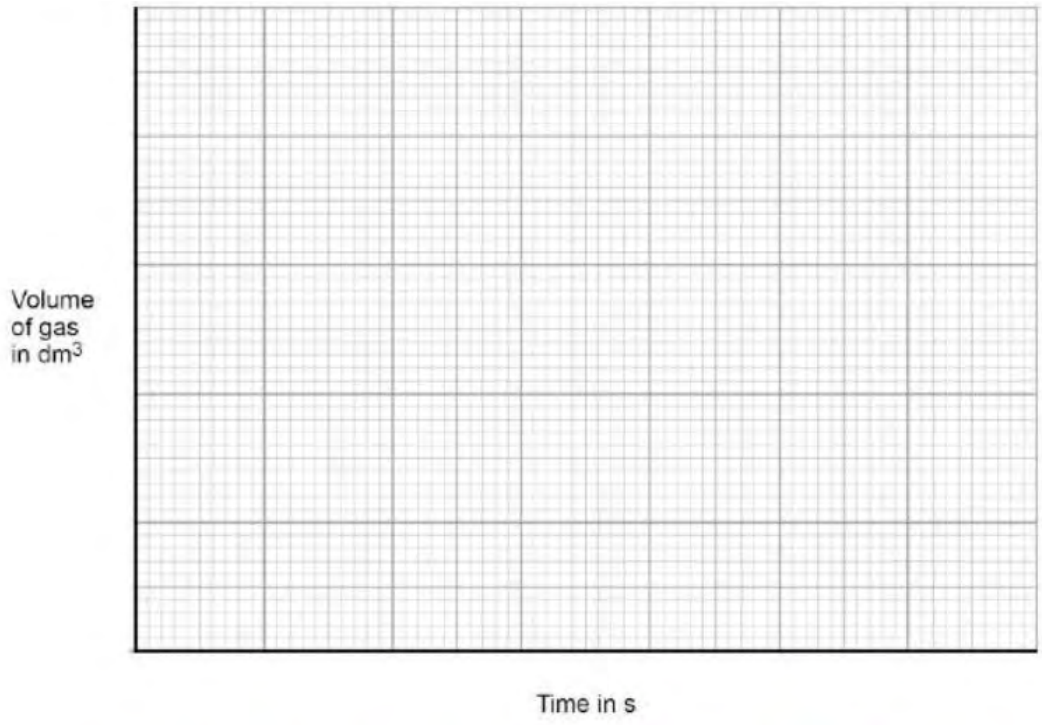
(b) The table below shows the student's results.

Time in s	Volume of gas in dm^3
0	0.000
30	0.030
60	0.046
90	0.052
120	0.065
150	0.070
180	0.076
210	0.079
240	0.080

On Figure 2:

- Plot these results on the grid.

- Draw a line of best fit.

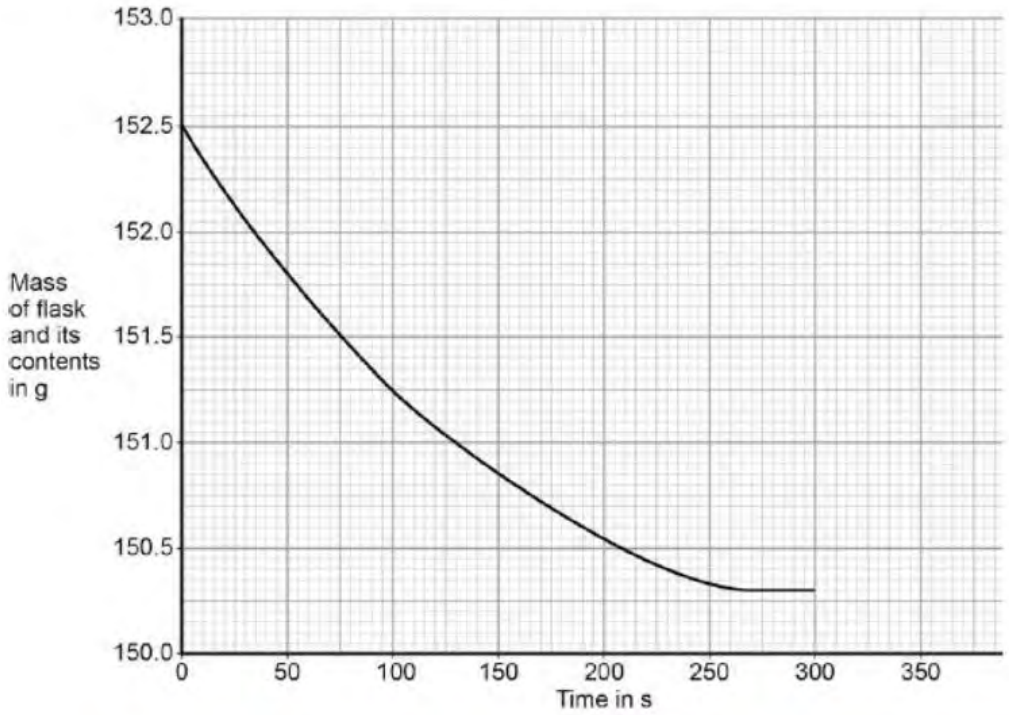


(4)

(c) Sketch a line on the grid in Figure 2 to show the results you would expect if the experiment was repeated using 20 g of smaller marble chips.
Label this line A.

(2)

(d) Another student investigated the rate of reaction by measuring the change in mass. Figure 3 shows the graph plotted from this student's results.



Use Figure 3 to calculate the mean rate of the reaction up to the time the reaction is complete. Give your answer to three significant figures.

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Mean rate of reaction = ... g / s

(4)

(e) Use Figure 3 to determine the rate of reaction at 150 seconds.
Show your working on Figure 3. Give your answer in standard form.

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Rate of reaction at 150 s = ... g / s

(4)

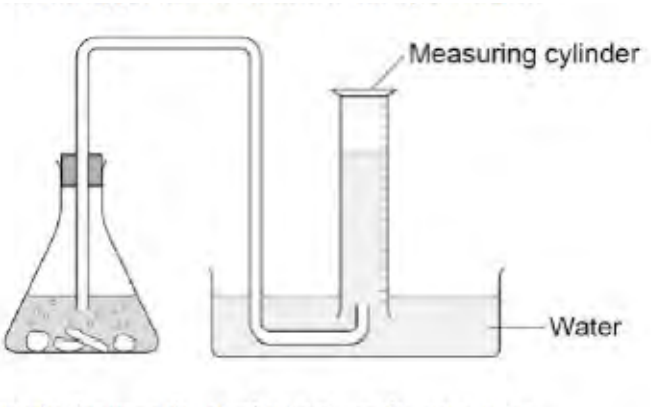
Q2. Sodium carbonate reacts with dilute hydrochloric acid:

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

A student investigated the volume of carbon dioxide produced when different masses of sodium carbonate were reacted with dilute hydrochloric acid. This is the method used:

1. Place a known mass of sodium carbonate in a conical flask.
2. Measure 10 cm^3 of dilute hydrochloric acid using a measuring cylinder.
3. Pour the acid into the conical flask.
4. Place a bung in the flask and collect the gas until the reaction is complete.

(a) The student set up the apparatus as shown in the figure below.



Identify the error in the way the student set up the apparatus. Describe what would happen if the student used the apparatus shown.

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..... (2)

(b) The student corrected the error. The student's results are shown in the table below.

Mass of sodium carbonate in g	Volume of carbon dioxide gas in cm3
0.7	16.0
0.12	27.5
0.23	52.0
0.29	12.5
0.34	77.0
0.54	95.0
0.59	95.0
0.65	95.0

The result for 0.29 g of sodium carbonate is anomalous. Suggest what may have happened to cause this anomalous result.

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..... (1)

(c) Why does the volume of carbon dioxide collected stop increasing at 95.0 cm3 ?

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..... (1)

(d) What further work could the student do to be more certain about the minimum mass of sodium carbonate needed to produce 95.0 cm3 of carbon dioxide?

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..... (1)

(e) The carbon dioxide was collected at room temperature and pressure. The volume of one mole of any gas at room temperature and pressure is 24.0 dm3. How many moles of carbon dioxide is 95.0 cm3? (Give your answer in three significant figures).

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..... mol (2)

(f) Suggest one improvement that could be made to the apparatus used that would give more accurate results. Give a reason for your answer.

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..... (2)

(g) One student said that the results of the experiment were wrong because the first few bubbles of gas collected were air. A second student said this would make no difference to the results. Explain why the second student was correct.

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..... (2)

Q3. A student investigated the rate of reaction between marble chips and hydrochloric acid. Figure 1 shows the apparatus the student used.

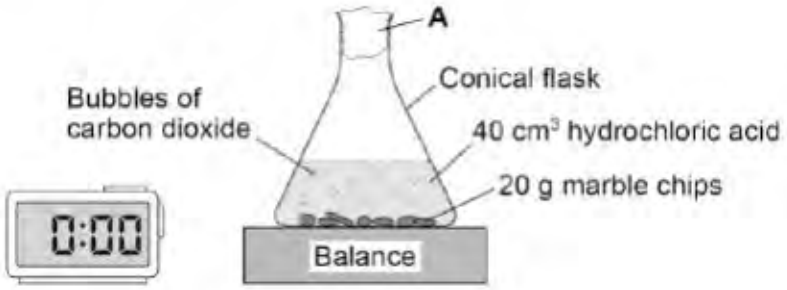


Figure 1 (a) What is A? Tick one box.

cotton wool	☐
limestone	☐
poly(ethene)	☐
rubber bung	☐

(1)

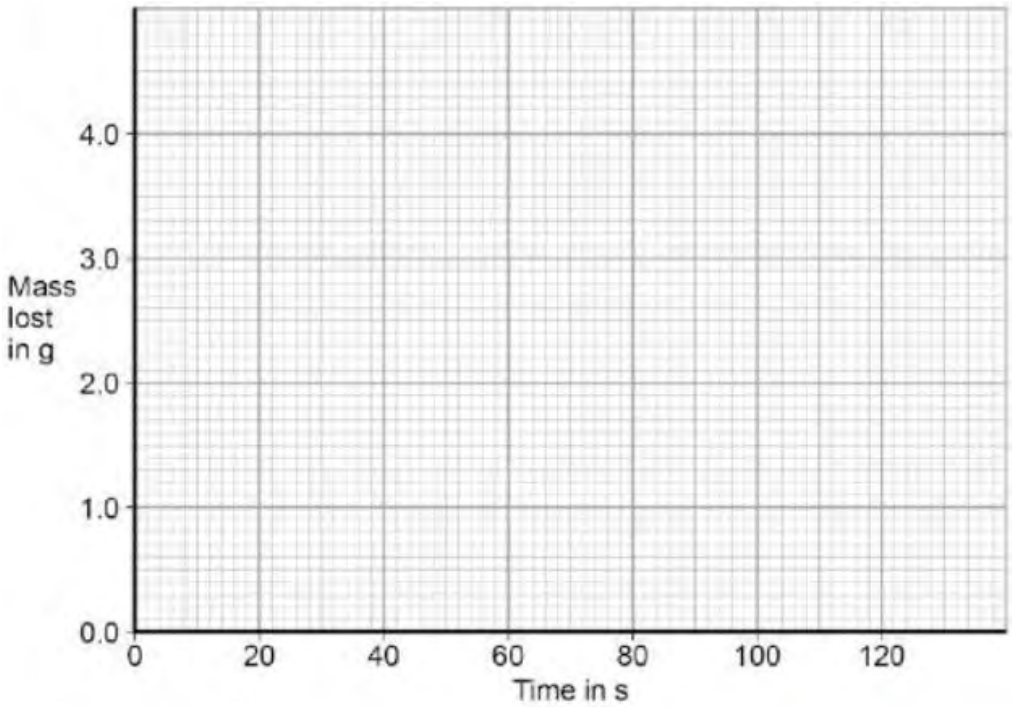
(b) Table 1 shows the student's results for one investigation.

Time in s	Mass lost in g
0	0.0
20	1.6
40	2.6
60	2.9
80	3.7
100	4.0
120	4.0

(3)

(a) Plot these results on the grid.

(b) Draw a line of best fit.



(c) Use the grid to complete Table 2.

Mass lost after 0.5 minutes	..... g
Time taken to complete the reaction	..... s

(2)

(d) The equation for the reaction is:

$2HCl(aq) + CaCO3(s) \rightarrow CaCl2(aq) + H2O(l) + CO2(g)$

Explain why there is a loss in mass in this investigation.

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(2)

(e) Another student investigated the rate of a different reaction. Table 3 shows the results from the different reaction.

Mass lost when the reaction was complete	9.85 g
Time taken to complete the reaction	2 minutes 30 seconds

Calculate the mean rate of the reaction using Table 3 and the equation:

$$\text{mean rate of reaction} = \frac{\text{mass lost in g}}{\text{time taken in s}}$$

Give your answer to two decimal places.

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Mean rate of reaction = ... g / s (2)

(f) The student measured the change in mass of the reactants.

Describe another method, other than measuring the change in mass of the reactions, that the student could have used to find the rate of the reaction between marble chips and hydrochloric acid.

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(2)

Q4. Lithium carbonate reacts with dilute hydrochloric acid.
A group of students investigated the volume of gas produced.

This is the method used:
1. Place a known mass of lithium carbonate in a conical flask.
2. Measure 10cm^3 of dilute hydrochloric acid using a measuring cylinder.
3. Pour the acid into the conical flask.
4. Place a bung in the flask and collect the gas as shown in Figure 1.

Fig. 1

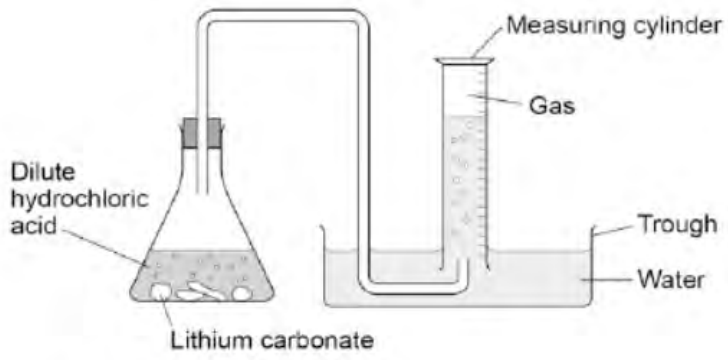


Figure 2 shows the measuring cylinder

Figure 2

What volume of gas has been collected?

Volume = ... cm3

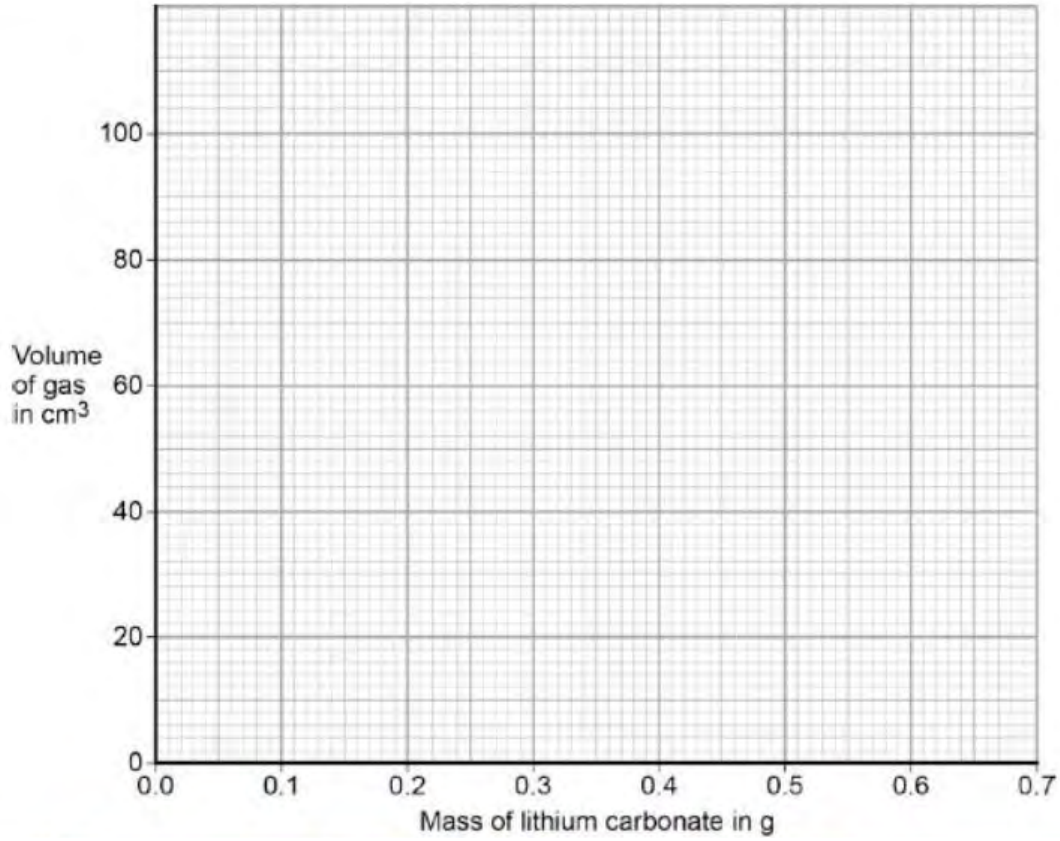
(b) The table below shows the students' results.

Mass of lithium carbonate in g	Volume of gas in cm^3
0.0	0
0.1	22
0.2	44
0.3	50
0.4	88
0.5	96
0.6	96
0.7	96

On Figure 3:

•Plot these results on the grid.

•Complete the graph by drawing two straight lines of best fit.



(c) What are two possible reasons for the anomalous result?

Tick **two** boxes.

Too much lithium carbonate was added. ☐

The bung was not pushed in firmly enough. ☐

There was too much water in the trough. ☐

The measuring cylinder was not completely over the delivery ☐

The conical flask was too small. ☐

(2)

(d) Describe the pattern the graph shows up to 0.4 g of lithium carbonate added.

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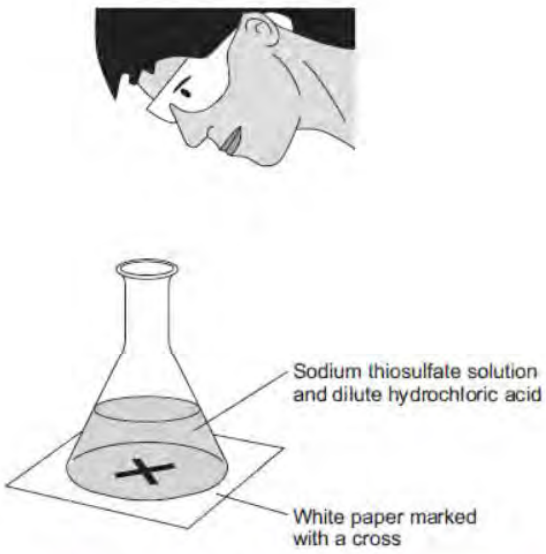
(2)

Q5. A student investigated the rate of reaction between sodium thiosulfate solution and dilute hydrochloric acid, as shown in Figure 1.

Figure 1



The reaction produced a precipitate, which made the mixture turn cloudy.
The student timed how long it took until she could no longer see the cross.

She calculated the rate of the reaction.

(a) The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\,HCl(aq) \longrightarrow 2\,NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$$

Name the product that made the mixture go cloudy.

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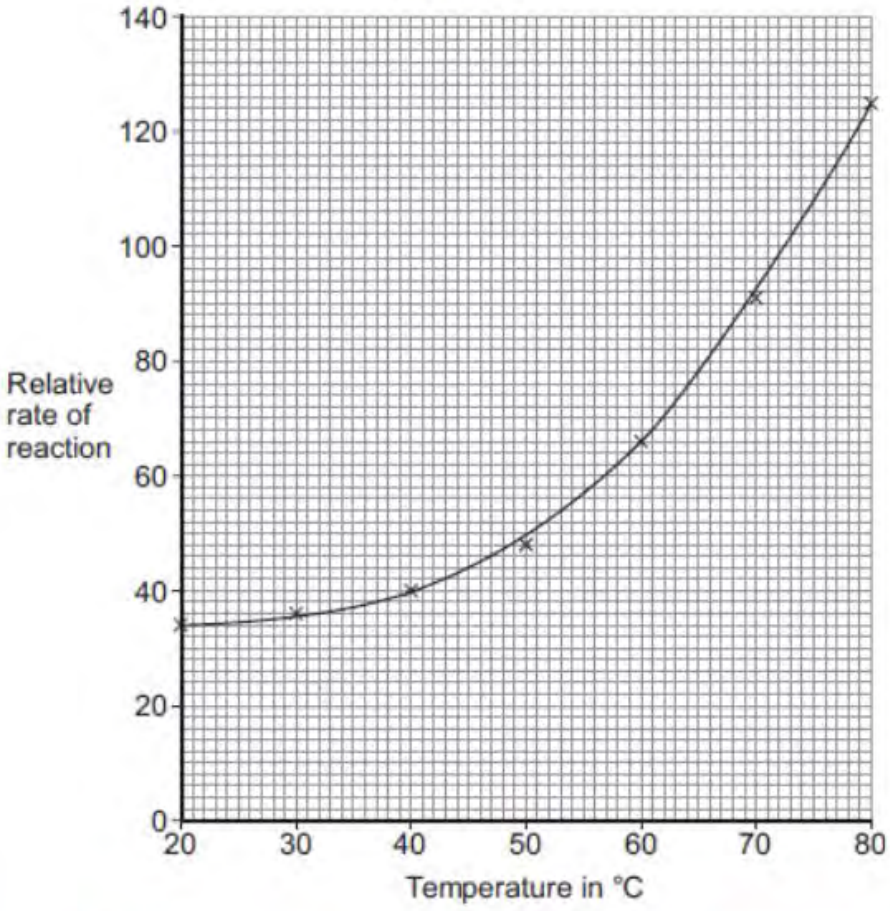
(1)

(b) The student investigated the effect of changing the temperature of the sodium thiosulfate solution on the rate of reaction.
She plotted her results on a graph, as shown in Figure 2.



Describe the trends shown in the student's results.

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(2)

(c) The student then investigated the effect of changing the concentration of sodium thiosulfate solution on the rate of the reaction.

(i) Suggest two variables the student would need to control to make sure that her results were valid.

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(2)

(ii) From this investigation the student correctly concluded:

‘As the concentration of sodium thiosulfate solution doubles, the rate of reaction doubles.’

Explain the student’s conclusion in terms of particles.

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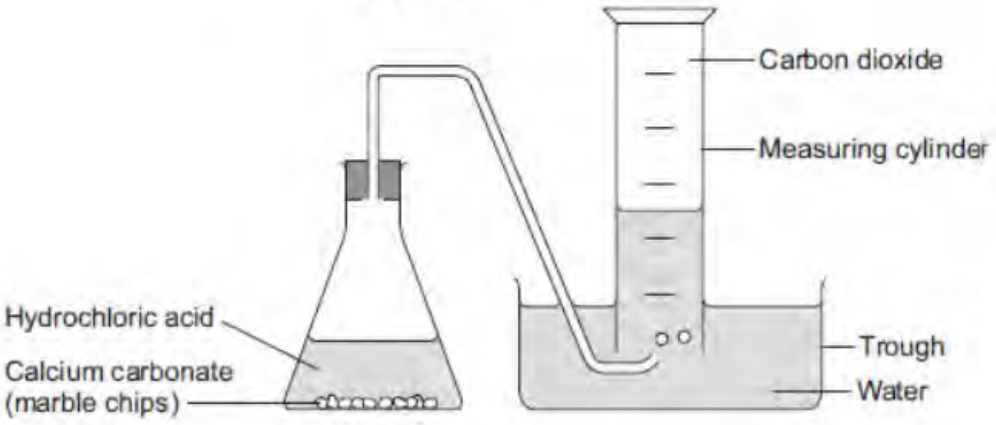
(3)

Q6. A student investigated the rate of reaction between calcium carbonate (marble chips) and hydrochloric acid. The student used the apparatus shown in Figure 1.

Figure 1



The student:

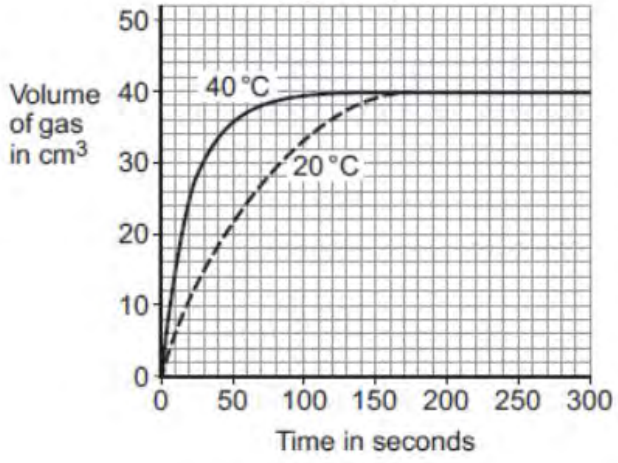
- Recorded the volume of gas collected every 5 seconds
- Repeated the experiment using hydrochloric acid at different temperatures.

The equation for the reaction is:

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

(a) The student plotted results for the hydrochloric acid at 20 °C and 40 °C on a graph. Figure 2 shows the student's graph.

Figure 2



Use information from Figure 2 to answer these questions.

(i) State one conclusion the student could make about the effect of temperature on the rate of the reaction.

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(1)

(ii) Give one reason why the student could make this conclusion.

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(1)

(iii) For the hydrochloric acid at 60 °C the student had collected 30 cm3 after 15 seconds.

Calculate the average rate of reaction from 0 to 15 seconds.

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Rate of reaction = ... cm3 per second

(1)

(b) The student then investigated how the surface area of marble chips affected the rate of reaction.

(i) Which two variables should the student keep constant?

Tick (✓) **two** boxes.

Amount of water in the trough	☐
Concentration of acid	☐
Mass of marble chips	☐

(2)

(ii) Explain, in terms of particles and collisions, the effect that increasing the surface area of the marble chips has on the rate of reaction.

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(2)

(c) Calcium carbonate is a catalyst for the industrial production of biodiesel.
Give one reason why using a catalyst reduces costs.

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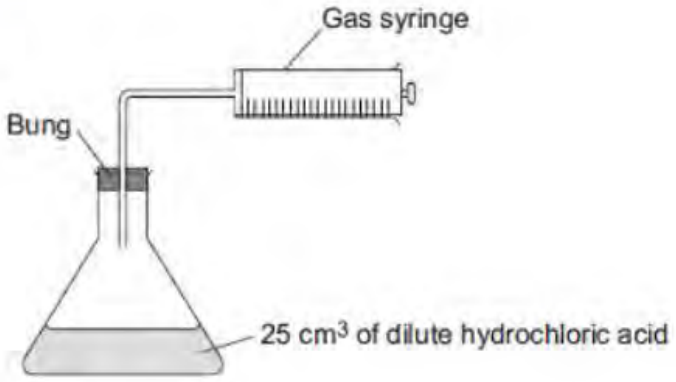
(1)

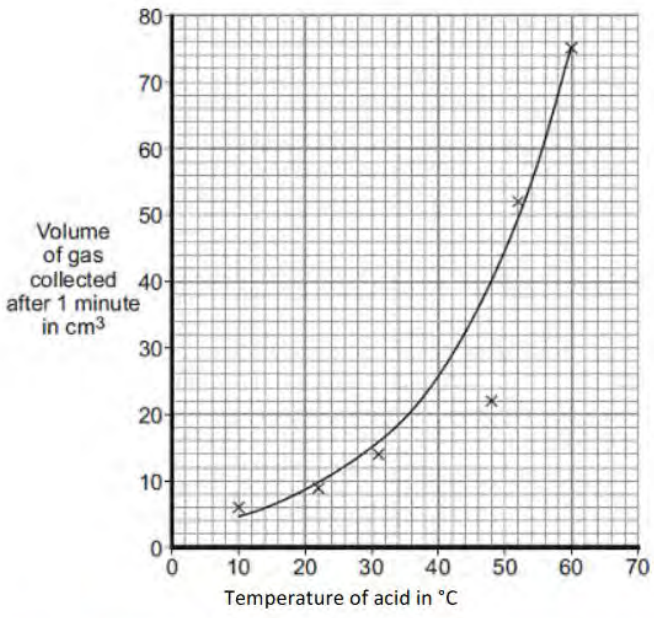
Q7. A student investigated the reaction between magnesium metal and dilute hydrochloric acid.
The student placed 25 cm3 of dilute hydrochloric acid in a conical flask and set up the apparatus as shown in the diagram.



The student:

- Took the bung out of the flask and added a single piece of magnesium ribbon 8 cm long
- Put the bung back in the flask and started a stopwatch
- Recorded the volume of gas collected after 1 minute
- Repeated the experiment using different temperatures of acid.

The student plotted his results on a graph.

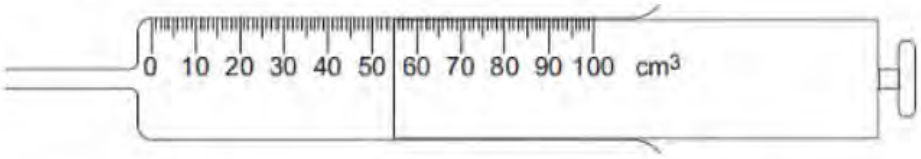


(a) Write the correct state symbols in the equation.
Choose from (s) for solid, (l) for liquid, (g) for gas and (aq) for aqueous.

$$Mg\ (....) + 2\ HCl\ (....) \longrightarrow MgCl_2\ (....) + H_2\ (....)$$

(2)

(b) The diagram shows a gas syringe after 1 minute.



(i) What volume of gas has been collected in the gas syringe after 1 minute?

Volume = ... cm3

(1)

(ii) Use the graph to determine the temperature of the acid used in this experiment.

Temperature = ... °C

(1)

(iii) Calculate the average rate of reaction, in cm3 of hydrogen made per second (cm3/s), for this experiment.

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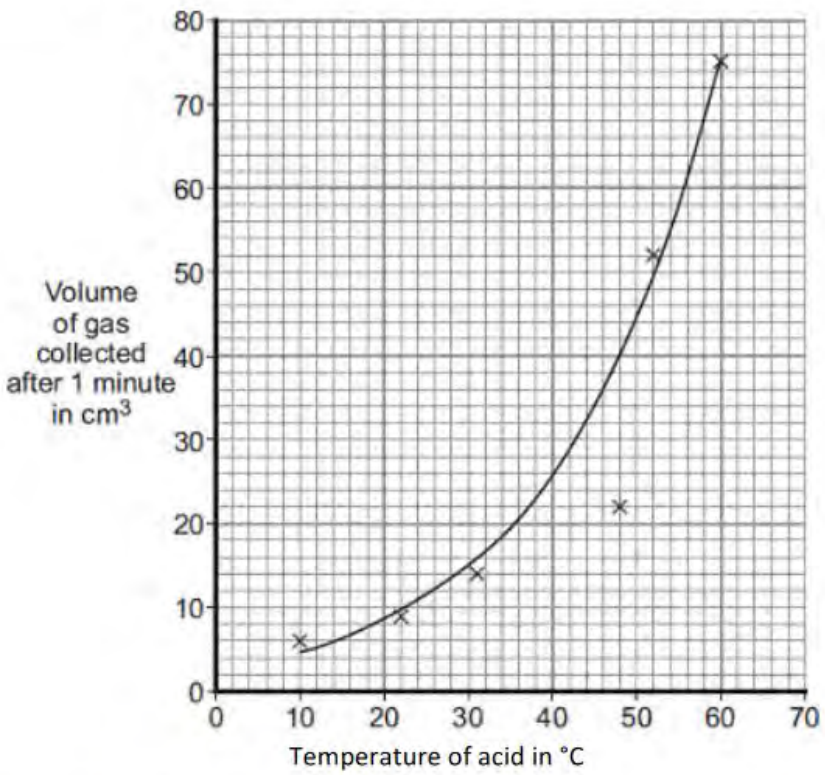
Rate of reaction = ... cm3/s

(2)

(c) The student's graph has been reprinted to help you answer this question.



One of the results on the graph is anomalous.

(i) Draw a circle on the graph around the anomalous point.

(1)

(ii) Suggest what may have happened to cause this anomalous result.
Explain your answer.

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(2)

(d) Explain how the student could improve the accuracy of the volume of gas recorded at each temperature.

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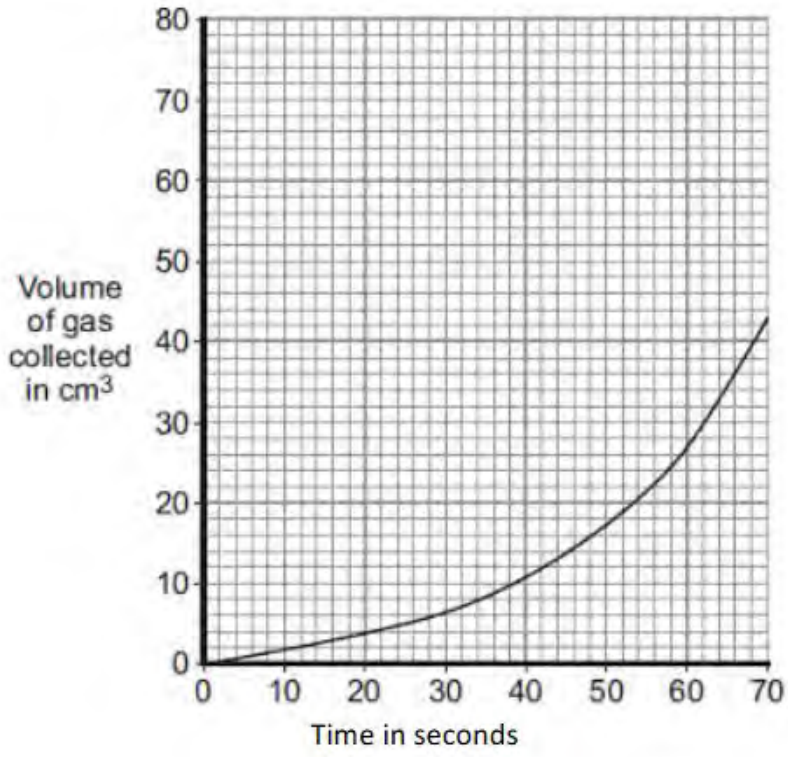
(3)

(e) The student then used the same apparatus to measure the volume of gas produced every 10 seconds at 40 °C.

The student's results are shown on the graph.



The rate at which the gas was produced got faster over the first 60 seconds.
The student's teacher gave two possible explanations of why the reaction got faster.

Explanation 1
There was a layer of magnesium oxide on the surface of the magnesium.
The layer of magnesium oxide prevented the magnesium reacting with the acid. As the magnesium oxide reacted slowly with the acid, the magnesium was exposed to the acid and hydrogen gas was produced.

Explanation 2
The reaction is exothermic, and so the temperature of the acid increased during the reaction.

(i) Describe further experimental work the student could do to see if explanation 1 is correct.

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(2)

(ii) Describe further experimental work the student could do to see if Explanation 2 is correct.

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(2)

Q8. Hydrogen peroxide, H_2O_2 , is often used as a bleach. It decomposes forming water and oxygen.

(a) (i) Write the balanced chemical equation for the decomposition of hydrogen peroxide.

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(3)

(ii) Give a test for oxygen.

Test .....

Result of test

.....

.....

(2)

(b) The rate of decomposition of hydrogen peroxide at room temperature is very slow. Manganese oxide is a catalyst which can be used to speed up the decomposition. Complete the sentence.

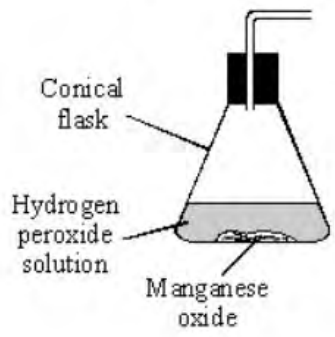
A catalyst is a substance which speeds up a chemical reaction. At the end of the reaction, the catalyst is

.....

(1)

(c) Two experiments were carried out to test if the amount of manganese oxide, MnO2 affected the rate at which the hydrogen peroxide decomposed.

(i) Complete the diagram to show how you could measure the volume of oxygen formed during the decomposition.

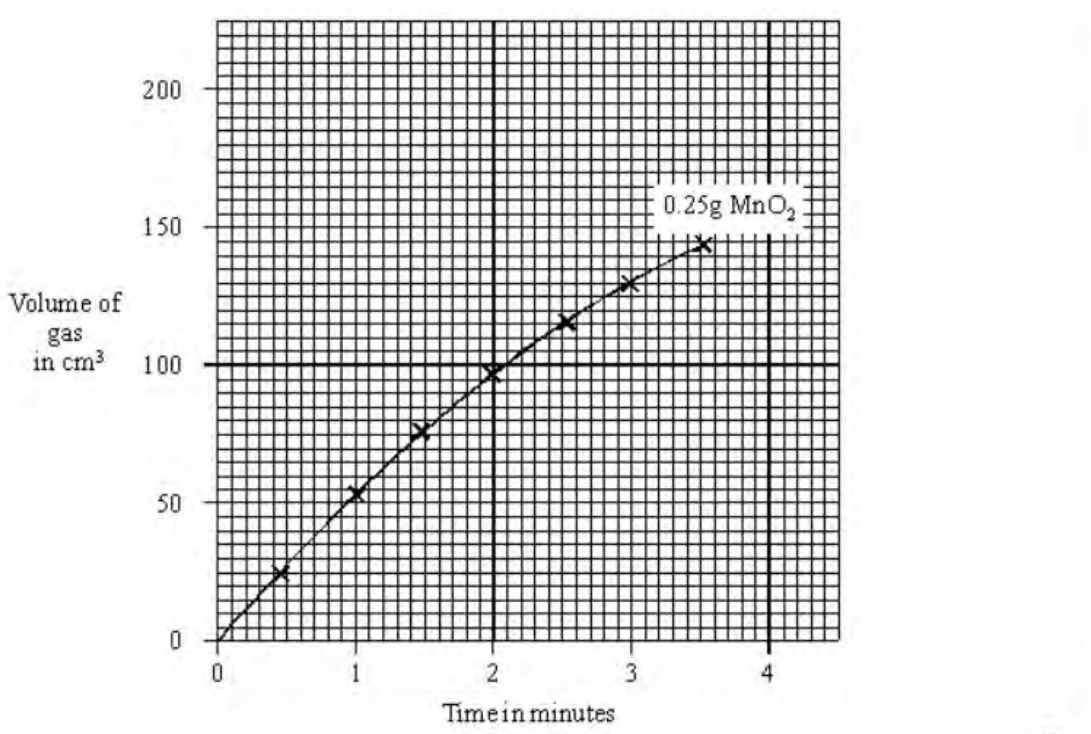


(2)

(ii) The results are shown in the table.

Time in minutes	0	0.5	1	1.5	2	2.5	3	3.5
Volume of gas in cm^3 using 0.25 g MnO_2	0	29	55	77	98	116	132	144
Volume of gas in cm^3 using 2.5 g MnO_2	0	45	84	118	145	162	174	182

Draw a graph of these results. The graph for 0.25 g MnO2 has been drawn for you.



(3)

(iii) Explain why the slopes of the graphs become less steep during the reaction.

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(2)

(iv) The same volume and concentration of hydrogen peroxide solution was used for both experiments. What two other factors must be kept the same to make it a fair test?

1

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(2)

(Total 15 marks)