

(Measuring rates (practicals))

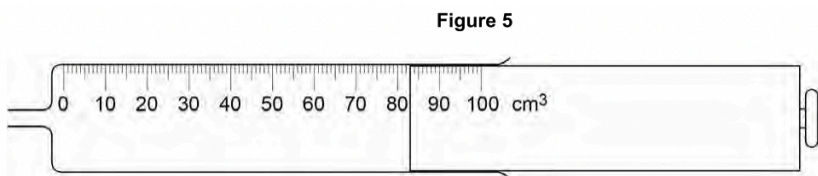
Q1.(2018)

A student investigated how concentration affects the rate of reaction between magnesium and hydrochloric acid.

This is the method used.

1. Place hydrochloric acid in a conical flask.
2. Add magnesium powder.
3. Collect the gas produced in a gas syringe.
4. Measure the volume of gas every 40 seconds for 160 seconds.
5. Repeat steps 1–4 three more times.
6. Repeat steps 1–5 with hydrochloric acid of a higher concentration.

Figure 5 shows a gas syringe.



What is the volume of gas in the syringe?

[1 mark]

Volume = _____ cm^3

Q2.a) (2018)

The Rate and Extent of Chemical Change

<http://www.pcfgstudy.com>

Table 5 shows the student's results for the experiment with hydrochloric acid of a lower concentration.

Table 5

Time in seconds	Volume of gas collected in cm ³				
	Test 1	Test 2	Test 3	Test 4	Mean
0	0	0	0	0	0
40	46	30	47	49	X
80	78	83	83	82	82
120	98	94	96	95	96
160	100	100	100	100	100

Calculate mean value **X** in **Table 5**.

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

Give your answer to 2 significant figures.

[2 marks]

X = _____ cm³

Q2.b) (2018)

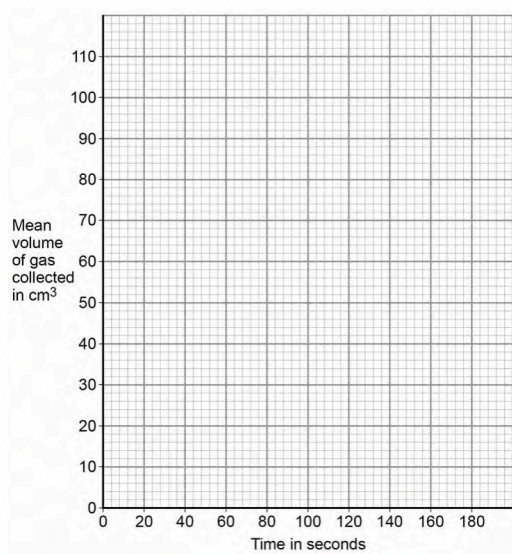
Plot the data from **Table 5** on **Figure 6**.

You should include your answer to Question **07.3**.

You do **not** need to draw a line of best fit.

[2 marks]

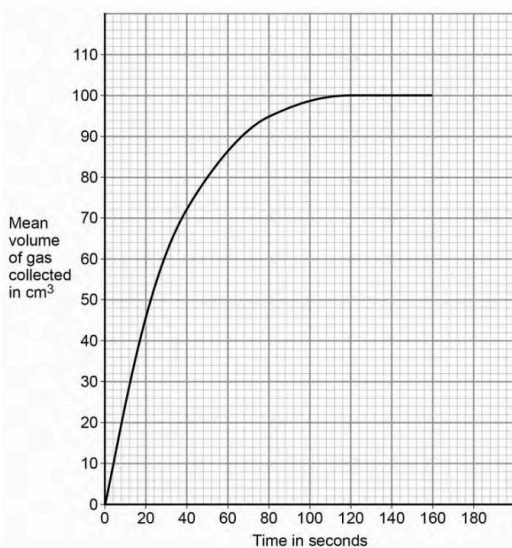
Figure 6



Q3.a)(2018)

Figure 7 shows results of the experiment with the hydrochloric acid of a higher concentration.

Figure 7



Calculate the mean rate of reaction between 0 and 50 seconds.

Use Figure 7 and the equation:

$$\text{mean rate of reaction} = \frac{\text{mean volume of gas collected}}{\text{time taken}}$$

[2 marks]

Mean rate of reaction = _____ cm³/s

Q3.b)(2018)

Describe how the **rate of reaction** changes between 0 and 160 seconds.

Use Figure 7.

[3 marks]

Q3.c)(2018)

The Rate and Extent of Chemical Change

<http://www.pcfgstudy.com>

The student concludes that the rate of reaction is greater when the concentration of hydrochloric acid is higher.

Why is the rate of reaction greater when the concentration of hydrochloric acid is higher?

[2 marks]

Tick **two** boxes.

The particles are moving faster

☐

The particles have more energy

☐

The surface area of magnesium is smaller

☐

There are more particle collisions each second

☐

There are more particles in the same volume

☐

Q3.d)(2018)

The student tests the gas produced by bubbling it through limewater.

No change is seen in the limewater.

Give **one** conclusion the student can make about the gas.

[1 mark]

Q3.e)(2018)

The student tests the gas produced using a burning splint.

Name the gas the student is testing for.

Give the result of a positive test for this gas.

[2 marks]

Name of gas _____

Result _____

Q4.(2020)

This question is about the rate of the reaction between hydrochloric acid and calcium carbonate.

A student investigated the effect of changing the size of calcium carbonate lumps on the rate of this reaction.

This is the method used.

1. Pour hydrochloric acid into a conical flask up to the 50 cm³ line.
2. Add 10.0 g of small calcium carbonate lumps to the conical flask.
3. Attach a gas syringe to the conical flask.
4. Measure the volume of gas produced every 20 seconds for 100 seconds.
5. Repeat steps 1 to 4 using 10.0 g of large calcium carbonate lumps.

The student used the 50 cm³ line on the conical flask to measure the volume of hydrochloric acid.

Suggest a piece of equipment the student could use to make the measurement of volume more accurate.

[1 mark]

Q5.a)(2021)

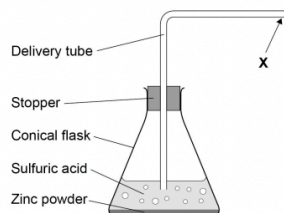
A student investigated the rate of the reaction between zinc and sulfuric acid.

This is the method used.

1. Pour 40 cm³ of sulfuric acid into a conical flask.
2. Add 2.0 g of zinc powder to the conical flask.
3. Put the stopper in the conical flask.
4. Measure the volume of hydrogen gas collected every 30 seconds for 5 minutes.

Figure 4 shows part of the apparatus used.

Figure 4



X shows where a piece of equipment is connected to measure the volume of hydrogen gas collected.

Complete **Figure 4** to show the equipment used.

[1 mark]

Q5.b)(2021)

The student made an error setting up the delivery tube shown in **Figure 4**.

Describe the error **and** the problem this error would cause.

[2 marks]

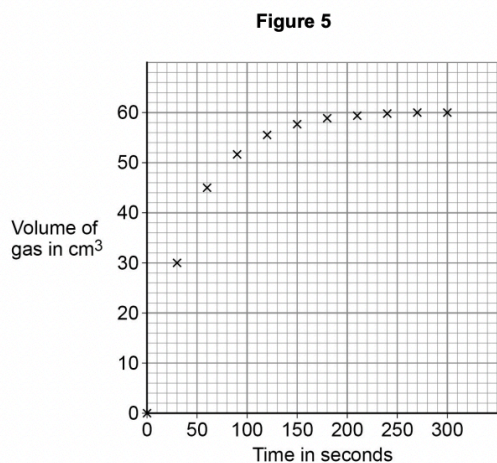
Error made _____

Problem caused _____

Q5.c)(2021)

The student then set up the apparatus correctly.

Figure 5 shows the student's results.



Complete **Figure 5** by drawing a line of best fit.

[1 mark]

Q5.d)(2021)

The Rate and Extent of Chemical Change

<http://www.pcfgstudy.com>

Determine the mean rate of reaction between 0 seconds and 60 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas formed}}{\text{time taken}}$$

Use data from **Figure 5**.

Give the unit.

Choose the answer from the box.

[4 marks]

cm^3/s	g/s	s/cm^3	s/g
------------------------	--------------	-----------------	--------------

Mean rate of reaction = _____ Unit _____

Q5.e)(2021)

The student repeated the investigation using sulfuric acid of a higher concentration.

The student plotted the results and drew a line of best fit.

How would the line of best fit for higher concentration compare with the line of best fit for lower concentration?

[1 mark]

Tick (✓) **one** box.

The line of best fit for higher concentration would have a less steep slope.

☐

The line of best fit for higher concentration would have a steeper slope.

☐

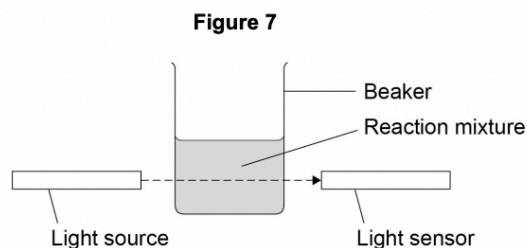
The lines of best fit would have slopes with the same steepness.

☐

Q6.a)(2022)

A student investigated the rate of reaction between sodium thiosulfate solution and hydrochloric acid.

Figure 7 shows the apparatus used.



When hydrochloric acid is added to sodium thiosulfate solution, the mixture gradually becomes cloudy.

A smaller percentage of light from the light source reaches the light sensor as the mixture becomes more cloudy.

This is the method used.

1. Measure 50 cm³ of sodium thiosulfate solution into the beaker.
2. Add 10 cm³ of hydrochloric acid to the sodium thiosulfate solution.
3. Immediately start a timer.
4. Record the percentage of light from the light source that reaches the light sensor every 20 seconds for 120 seconds.

Balance the equation for this reaction.

[1 mark]



Q6.b)(2022)

The mixture becomes cloudy because the sulfur produced is a solid.

What is the state symbol for a solid?

[1 mark]

Tick (✓) **one** box.

(aq)	☐
(g)	☐
(l)	☐
(s)	☐

Q6.c)(2022)

The student monitored the cloudiness of the reaction mixture using a light sensor.

What other piece of equipment could be used to monitor the cloudiness of the reaction mixture?

[1 mark]

Tick (✓) **one** box.

A balance

☐

A cross on a piece of paper

☐

A gas syringe

☐

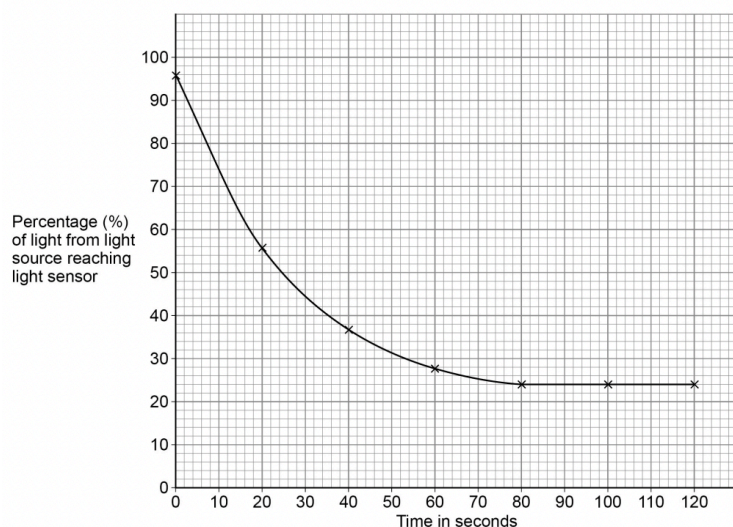
A thermometer

☐

Q6.d)(2022)

Figure 8 shows the results.

Figure 8



What happened to the rate of reaction between 40 and 60 seconds?

Use **Figure 8**.

[1 mark]

Tick (✓) **one** box.

The rate of reaction decreased.

☐

The rate of reaction stayed at zero.

☐

The rate of reaction increased.

☐

Q6.e)(2022)

The student stopped taking measurements after 120 seconds because the percentage of light reaching the sensor stayed constant.

Why did the percentage of light reaching the sensor stay constant?

[1 mark]

Tick (✓) **one** box.

No light was reaching the sensor.

☐

One of the reactants was used up.

☐

The reaction was too vigorous.

☐

Q6.f)(2022)

The student repeated the experiment using sodium thiosulfate solution of a higher concentration.

How would the line of best fit for sodium thiosulfate solution of a higher concentration compare with the line of best fit on **Figure 8**?

[1 mark]

Tick (✓) **one** box.

Initially the line of best fit would be less steep.

☐

Initially the line of best fit would be the same steepness.

☐

Initially the line of best fit would be steeper.

☐

Q6.g)(2022)

The student then investigated the effect of changing the temperature on the rate of reaction.

The student used sodium thiosulfate solution and hydrochloric acid which had been kept in an ice bath.

Which are **two** effects of using reactants kept in an ice bath rather than at room temperature?

[2 marks]

Tick (✓) **two** boxes.

Fewer reactant particles have the activation energy.

☐

The reactant particles collide more frequently.

☐

The reactant particles have more energy.

☐

The reactant particles move more slowly.

☐

There are fewer reactant particles in the same volume.

☐

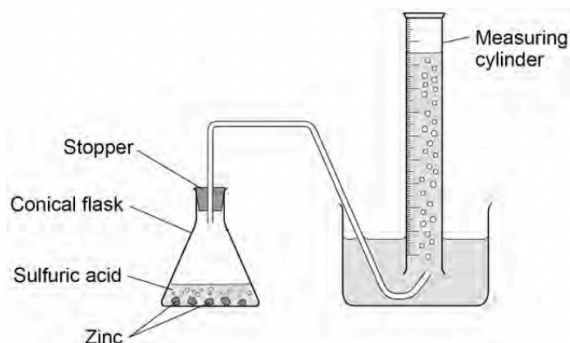
Q7.a)(2023)

A student investigated the rate of the reaction between zinc and sulfuric acid.

Hydrogen gas is produced during this reaction.

Figure 7 shows the apparatus.

Figure 7



This is the method used.

1. Add 50 cm³ of sulfuric acid to a conical flask.
2. Add 2.0 g of zinc to the conical flask.
3. Quickly put a stopper in the conical flask and start a timer.
4. Measure the time taken to collect 20 cm³ of gas.
5. Repeat steps 1 to 4 three more times.

Suggest why the stopper must be put in the conical flask as quickly as possible in **step 3**.

[1 mark]

Q7.b)(2023)

The student calculated the rate of the reaction for each trial.

Table 7 shows the results of the calculations.

Table 7

	Trial 1	Trial 2	Trial 3	Trial 4
Rate of reaction in cm ³ /s	0.78	0.81	0.68	0.81

Determine the mean time taken to collect 20 cm³ of gas.

Do **not** include any anomalous results.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{volume of gas collected}}{\text{mean time taken}}$$

[5 marks]

Mean time taken = _____ s

Q7.c)(2023)

The student changed the investigation so that the mean time taken to collect 20 cm³ of gas was greater.

Which **two** changes would increase the mean time taken to collect 20 cm³ of gas?

[2 marks]

Tick (✓) **two** boxes.

Use a catalyst

☐

Use a larger conical flask

☐

Use a lower temperature

☐

Use smaller pieces of zinc

☐

Use sulfuric acid of a lower concentration

☐

Q7.d)(2023)

Hydrogen gas is produced during this reaction.

Describe the test for hydrogen gas.

Give the result of the test.

[2 marks]

Test _____

Result _____

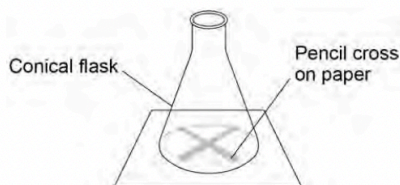
Q8.a)(2024)

A student investigated the rate of the reaction of sodium thiosulfate solution with hydrochloric acid.

When sodium thiosulfate solution reacts with hydrochloric acid, the mixture becomes cloudy.

Figure 6 shows the apparatus.

Figure 6



This is the method used.

1. Put 75 cm³ of sodium thiosulfate solution in a conical flask.
2. Draw a pencil cross on paper.
3. Put the conical flask on the pencil cross.
4. Add 15 cm³ of hydrochloric acid to the contents of the conical flask.
5. Swirl the conical flask to mix the contents and immediately start a timer.
6. Stop the timer when the pencil cross is no longer visible through the reaction mixture.
7. Repeat steps 1 to 6 using different concentrations of sodium thiosulfate solution.

Explain why a 50 cm³ conical flask is unsuitable to use in this method.

[2 marks]

Q8.b)(2024)

Name a piece of equipment suitable for measuring the volume of sodium thiosulfate solution.

[1 mark]

Q8.c)(2024)

The student measured the time taken for the pencil cross to be no longer visible for different concentrations of sodium thiosulfate solution.

Draw **one** line from each type of variable to the variable in this investigation.

[2 marks]

Type of variable	Variable in this investigation
	Concentration of sodium thiosulfate solution
Dependent variable	Size of conical flask
	Temperature of sodium thiosulfate solution
Independent variable	Time for pencil cross to become no longer visible
	Volume of hydrochloric acid

Q8.d)(2024)

What effect will using a darker pencil cross have on the time taken for the cross to be no longer visible?

[1 mark]

Tick (✓) **one** box.

The time taken will decrease.

☐

The time taken will be the same.

☐

The time taken will increase.

☐

Q8.e)(2024)

Table 2 shows the results.

Table 2

Concentration of sodium thiosulfate solution in g/dm ³	Time for cross to become no longer visible in seconds
8	120
16	60
24	40
32	30

Which concentration of sodium thiosulfate solution had the highest rate of reaction?

[1 mark]

Tick (✓) **one** box.

8 g/dm³ ☐ 16 g/dm³ ☐ 24 g/dm³ ☐ 32 g/dm³ ☐

Q8.f)(2024)

Increasing the concentration of sodium thiosulfate solution changes the rate of the reaction with hydrochloric acid.

Which **two** statements explain the effect of increasing the concentration?

[2 marks]

Tick (✓) **two** boxes.

The particles are closer together.

☐

The particles are further apart.

☐

The particles collide less frequently.

☐

The particles collide more frequently.

☐

The particles move faster.

☐

The particles move slower.

☐

Q8.g)(2024)

The effect on the time taken for the cross to disappear can also be investigated by:

- changing the temperature of the hydrochloric acid
- changing the concentration of the hydrochloric acid.

Complete the sentences.

Choose the answers from the box.

[2 marks]

decreases	stays the same	increases
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If the temperature of the hydrochloric acid is **increased**, the time taken for the cross to disappear _____.

If the concentration of the hydrochloric acid is **decreased**, the time taken for the cross to disappear _____.