

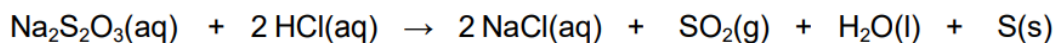
(Measuring rates (practicals))

Q1. (2018)

Sodium thiosulfate solution reacts with dilute hydrochloric acid.

The solution becomes cloudy as the reaction takes place.

The equation for the reaction is:



Explain why the solution becomes cloudy.

[2 marks]

Q2. (2018)

A student investigated how temperature affects the rate of reaction between magnesium carbonate and dilute hydrochloric acid.

This is the method used.

1. Heat hydrochloric acid to 30 °C in a conical flask.
2. Add magnesium carbonate powder to the conical flask.
3. Measure the loss in mass of the flask and contents every 20 seconds for 140 seconds.
4. Repeat steps 1-3 with hydrochloric acid heated to 50 °C

Explain why the contents of the conical flask lose mass.

[2 marks]

Q3. (2018)

Table 5 shows the student's results for hydrochloric acid at 30 °C

Table 5

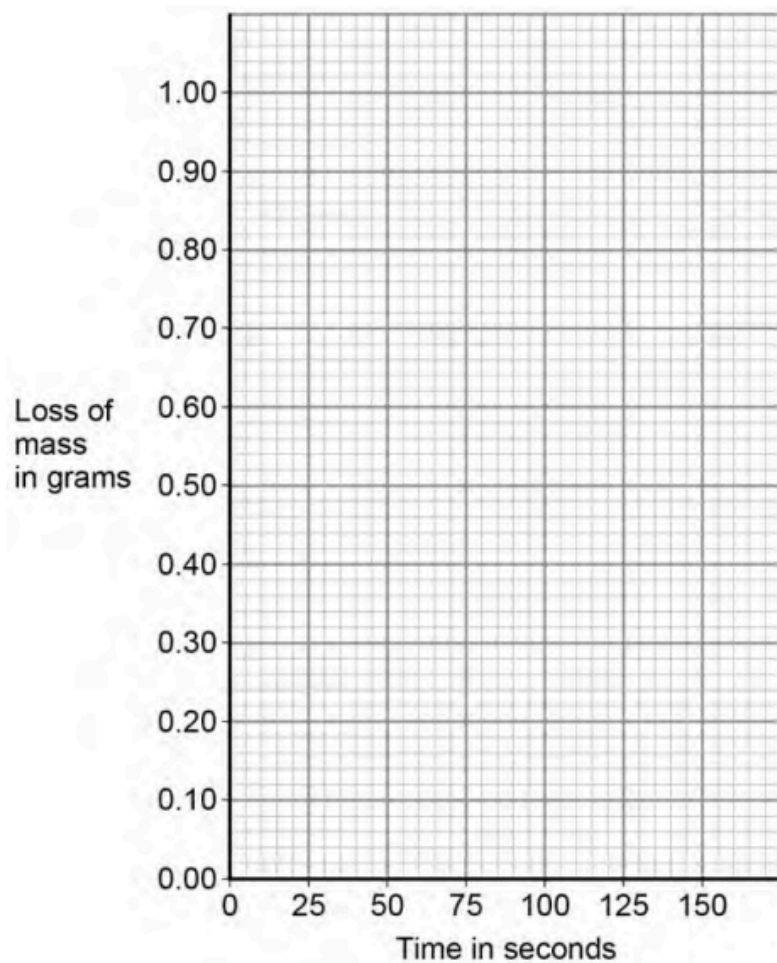
Time in seconds	Loss of mass in grams
0	0.00
20	0.26
40	0.48
60	0.67
80	0.82
100	0.91
120	0.96
140	0.99

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

Draw a line of best fit.

[3 marks]

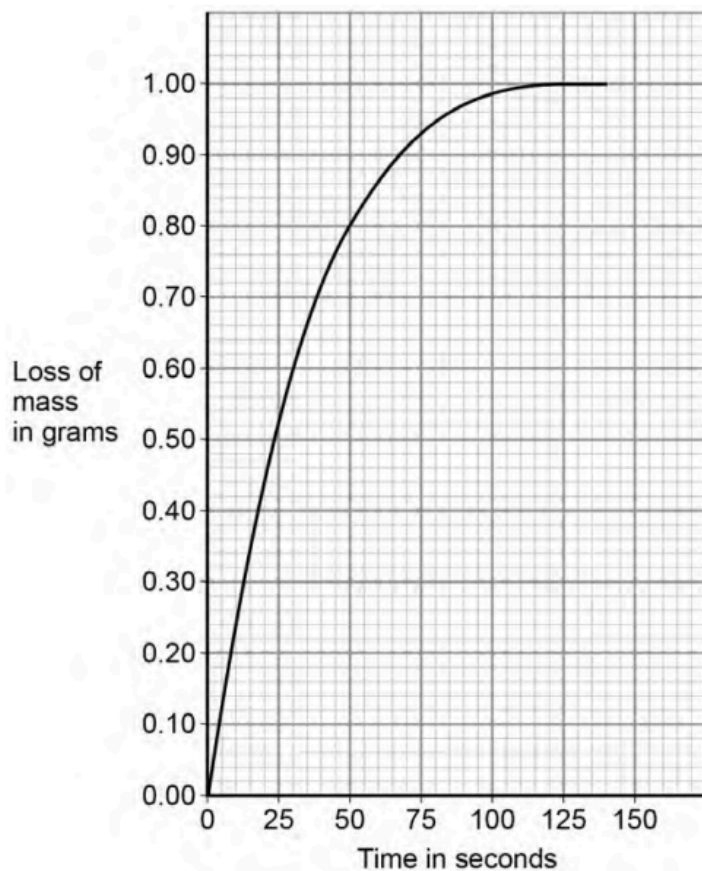
Figure 6



Q4. (2018)

Figure 7 shows the student's results for hydrochloric acid at 50 °C

Figure 7



Determine the rate of reaction at 50 °C when the loss of mass is 0.95 g

Show your working on **Figure 7**.

Give your answer to 2 significant figures.

[4 marks]

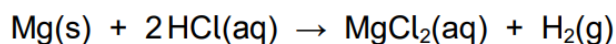
Rate of reaction = _____ g/s

Q5. a). (2019)

This question is about rate of reaction.

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

The equation for the reaction is:



Which state symbol in the equation for the reaction does **not** represent one of the three states of matter?

[1 mark]

Q5. b). (2019)

The student determined the rate of production of hydrogen gas.

What **two** pieces of measuring apparatus could the student use to find the rate of production of hydrogen gas?

[2 marks]

1

2

Q5. c). (2019)

Table 2 shows the results of the investigation.

Table 2

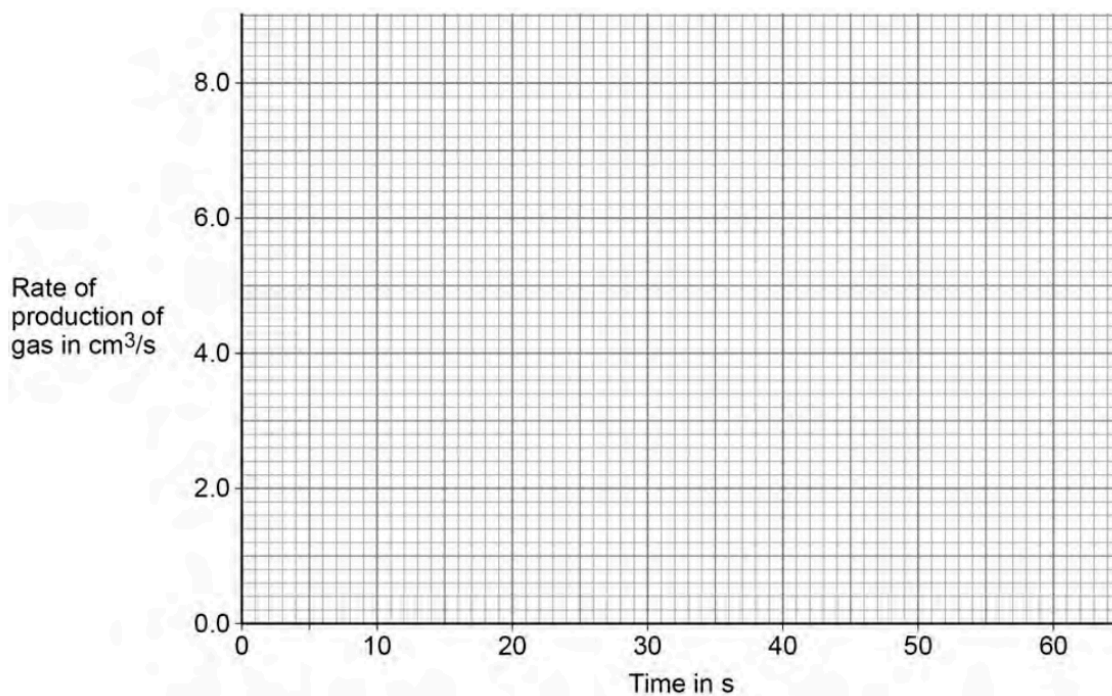
Time in s	Rate of production of gas in cm^3/s
10	6.9
20	3.9
30	2.0
40	0.9
50	0.3
60	0.0

Plot the data from **Table 2** on **Figure 3**.

You should draw a line of best fit.

[3 marks]

Figure 3



Q5. d). (2019)

Give **three** conclusions that can be drawn about the rate of reaction between magnesium and dilute hydrochloric acid in this investigation.

Use data from **Figure 3** and **Table 2**.

[3 marks]

1 _____

2 _____

3 _____

Q5. e). (2019)

The student repeated the investigation using dilute hydrochloric acid at a higher temperature.

All the other variables were kept the same.

Which **two** statements are correct?

[2 marks]

Tick (✓) **two** boxes.

More bubbles were produced in the first 10 seconds.

☐

The activation energy for the reaction was higher.

☐

The magnesium was used up more quickly.

☐

The reaction finished at the same time.

☐

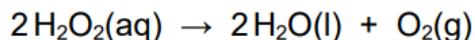
The total volume of gas collected was greater.

☐

Q6. (2019)

Some students investigated the rate of decomposition of hydrogen peroxide, H_2O_2

The equation for the reaction is:



The catalyst for the reaction is manganese dioxide.

Describe a test to identify the gas produced in the reaction.

Give the result of the test.

[2 marks]

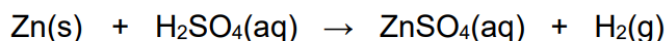
Test _____

Result _____

Q7. a). (2021)

A student investigated how a change in concentration affects the rate of the reaction between zinc powder and sulfuric acid.

The equation for the reaction is:

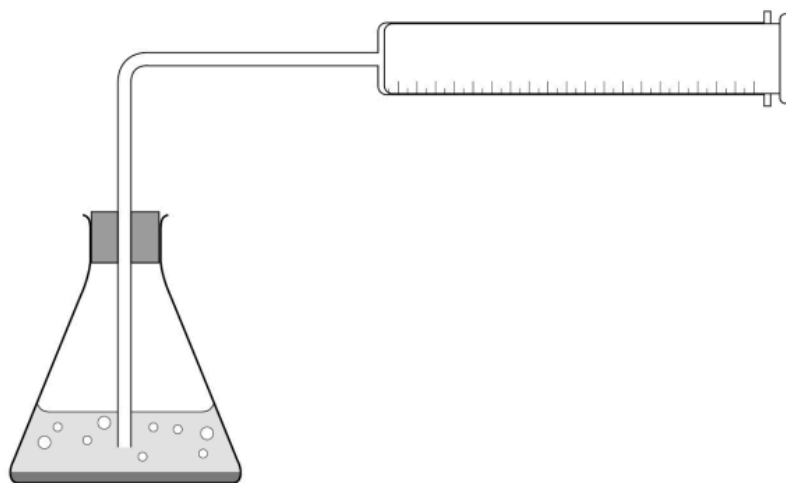


This is the method used.

1. Pour 50 cm^3 of sulfuric acid of concentration 0.05 mol/dm^3 into a conical flask.
2. Add 0.2 g of zinc powder to the conical flask.
3. Put the stopper in the conical flask.
4. Measure the volume of gas collected every 30 seconds for 5 minutes.
5. Repeat steps 1 to 4 with sulfuric acid of concentration 0.10 mol/dm^3

Figure 8 shows the apparatus used.

Figure 8



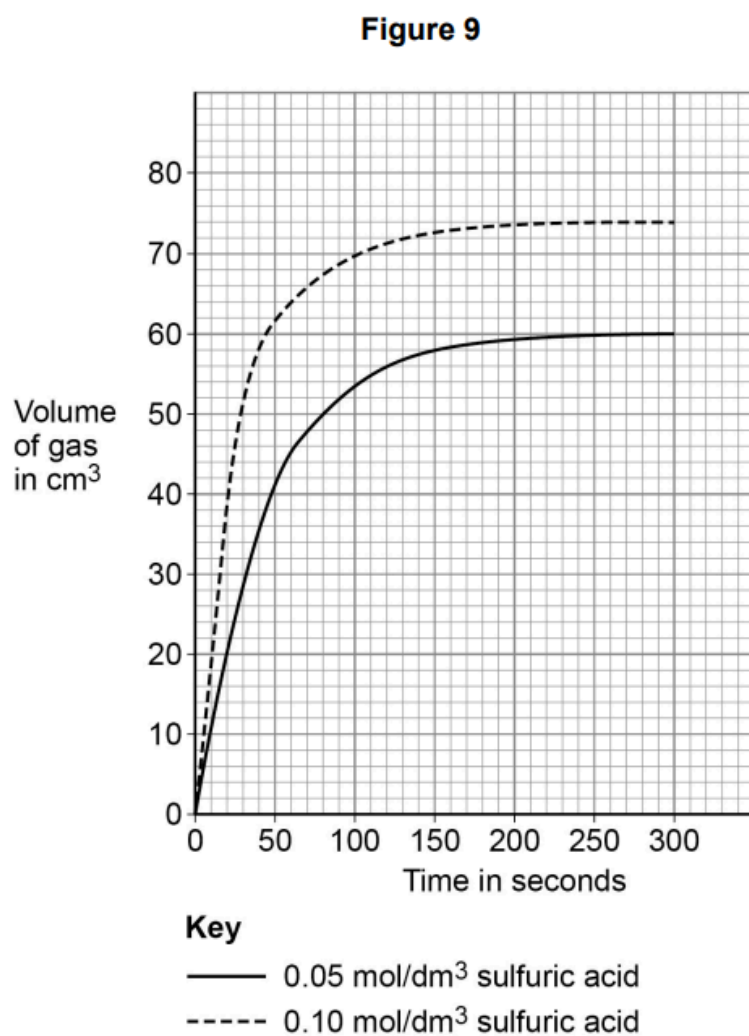
The student made an error in setting up the apparatus in **Figure 8**.

What error did the student make?

[1 mark]

The student corrected the error.

Figure 9 shows the student's results.



Explain why the lines of best fit on **Figure 9** become horizontal.

[2 marks]

How does **Figure 9** show that zinc powder reacts more slowly with 0.05 mol/dm³ sulfuric acid than with 0.10 mol/dm³ sulfuric acid?

[1 mark]

Q7. d). (2021)

Determine the rate of the reaction for 0.05 mol/dm³ sulfuric acid at 80 seconds.

Show your working on **Figure 9**.

Give your answer to 2 significant figures.

[5 marks]

Rate of reaction (2 significant figures) = _____ cm³/s

Q8. (2022)

Energy is taken in from the surroundings when hydrated cobalt chloride is heated.

When 238 g of hydrated cobalt chloride is heated until the mass does not change, 88.1 kJ of energy is taken in.

The student heated 2.00 g of hydrated cobalt chloride until the mass did not change.

Calculate the energy taken in during this reaction.

Give your answer to 3 significant figures.

[3 marks]

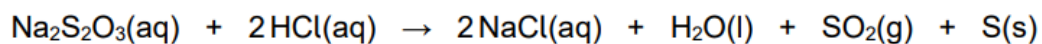
Energy taken in (3 significant figures) = _____ kJ

Q9. (2022)

This question is about the reaction between sodium thiosulfate solution and hydrochloric acid.

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

The equation for the reaction is:



Sulfur is produced in the reaction.

Why does the mixture become cloudy?

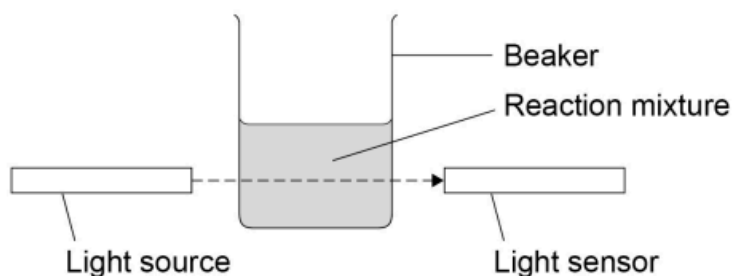
[1 mark]

Q10. a). (2022)

A student investigated the effect of changing the concentration of sodium thiosulfate solution on the rate of the reaction.

Figure 6 shows the apparatus used.

Figure 6



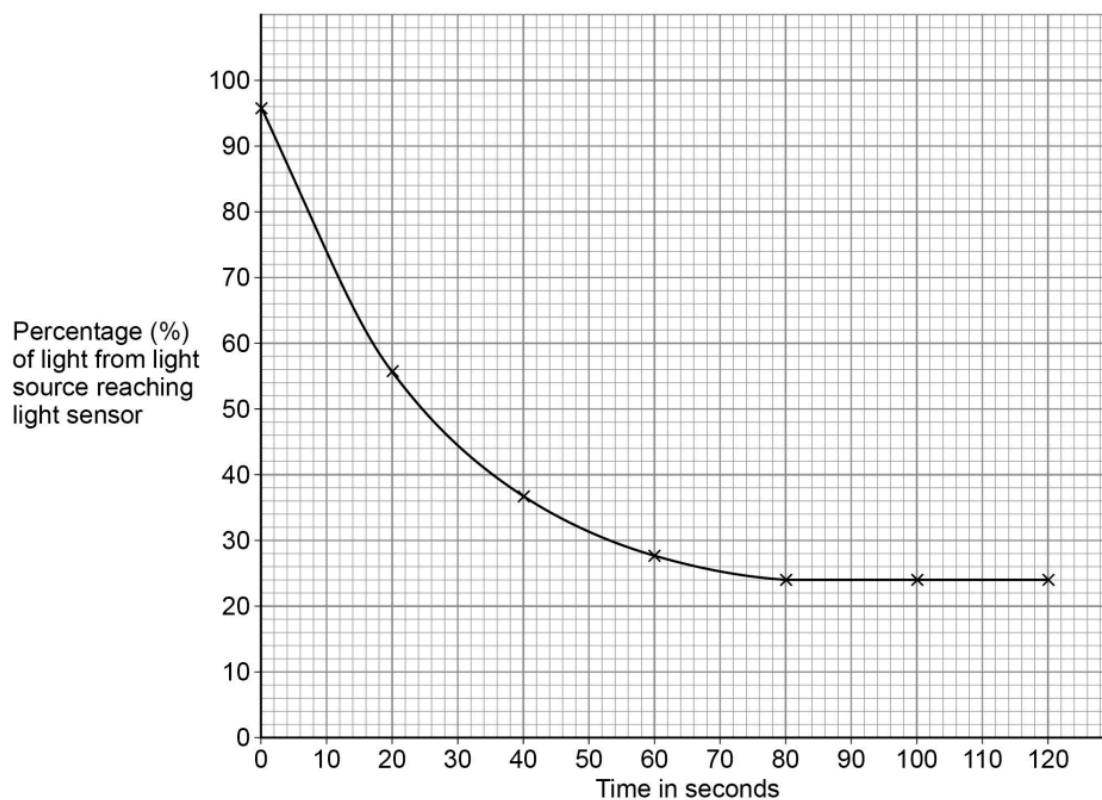
A smaller percentage of light from the light source reaches the light sensor as the mixture becomes more cloudy.

This is the method used.

1. Measure 50 cm³ of 0.10 mol/dm³ 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.
5. Repeat steps 1 to 4 using 0.20 mol/dm³ sodium thiosulfate solution.

Figure 7 shows the results for 0.10 mol/dm³ sodium thiosulfate solution.

Figure 7



The percentage of light reaching the light sensor decreases by 1% when 7.1×10^{-5} moles of sulfur is produced.

Determine the rate of reaction in mol/s for the production of sulfur at 30 seconds.

You should draw a tangent on **Figure 7**.

[5 marks]

Rate = _____ mol/s

Q10. b). (2022)

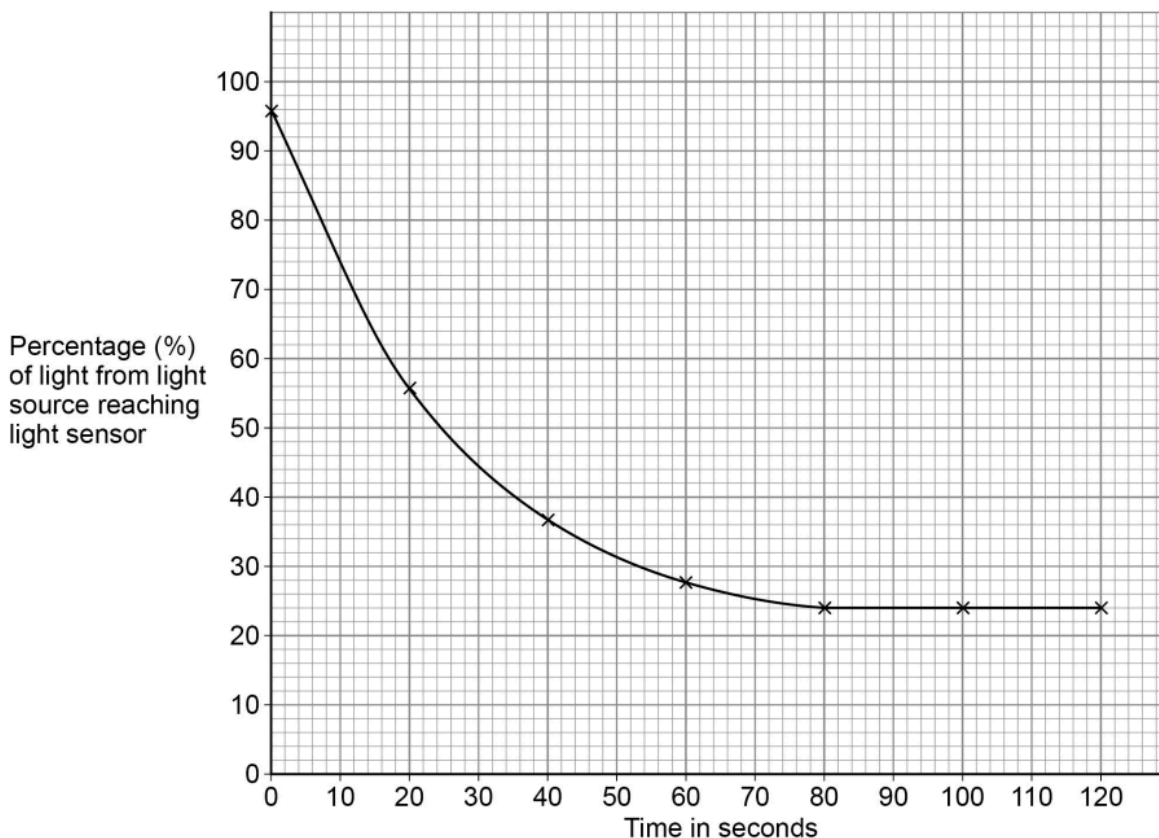
Explain why the rate of reaction changes between 0 and 60 seconds.

Answer in terms of concentration.

Use **Figure 7**.

[2 marks]

Q10. c). (2022)

Figure 8 is a repeat of **Figure 7**.**Figure 8****Figure 8** shows the results for 0.10 mol/dm^3 sodium thiosulfate solution.

Sodium thiosulfate solution was in excess in the investigation.

The line of best fit on **Figure 8** is horizontal between 80 and 120 seconds because the reaction stopped.

Why did the reaction stop?

[1 mark]

Q10. d). (2022)

Sketch a line on **Figure 8** to show the results you would predict for 0.20 mol/dm³ sodium thiosulfate solution.

[2 marks]

Q10. e). (2022)

The same student did the investigation again the next day.

The student found that the same method produced different results for the percentage of light reaching the light sensor.

How could the student improve the method so that the same percentages of light reached the light sensor?

[1 mark]

Tick (✓) **one** box.

Record the percentage of light every 10 seconds.

☐

Stop light from other sources reaching the light sensor.

☐

Use a larger volume of sodium thiosulfate solution.

☐

Use a more sensitive light sensor.

☐

Q10. f). (2022)

The student improved the method so that similar results were obtained on different days.

What name is given to similar results obtained on different days under the same conditions by the same student?

[1 mark]

Tick (✓) **one** box.

Anomalous

☐

Precise

☐

Repeatable

☐

Reproducible

☐

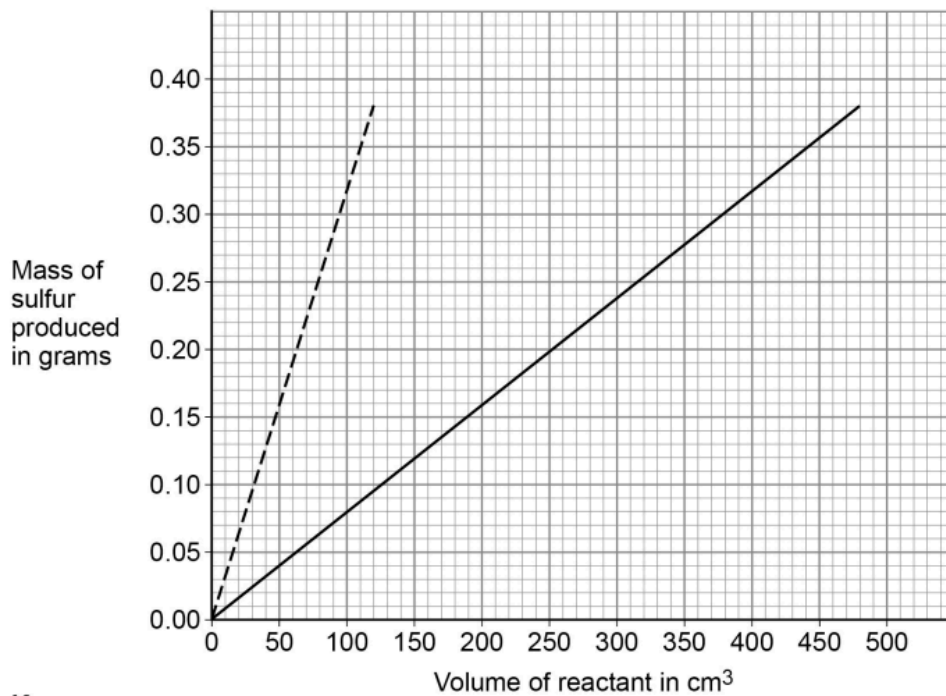
Q11. a). (2022)

Figure 9 shows the volumes of:

- sodium thiosulfate solution of concentration 0.10 mol/dm^3
- hydrochloric acid of concentration 0.05 mol/dm^3

which completely react to produce different masses of sulfur.

Figure 9



Key

- 0.10 mol/dm^3 sodium thiosulfate solution
- 0.05 mol/dm^3 hydrochloric acid

Which expression represents the relationship between the volume (V) of sodium thiosulfate solution used and the mass (m) of sulfur produced?

Use **Figure 9**.

[1 mark]

Tick (✓) **one** box.

$V \propto m$

☐

$V \sim m$

☐

$V \ll m$

☐

$V = m$

☐

Q11. b). (2022)

Determine the simplest whole number ratio of the volumes of

sodium thiosulfate solution : hydrochloric acid

which completely react with each other.

Use **Figure 9**.

[3 marks]

Simplest whole number ratio = _____ : _____

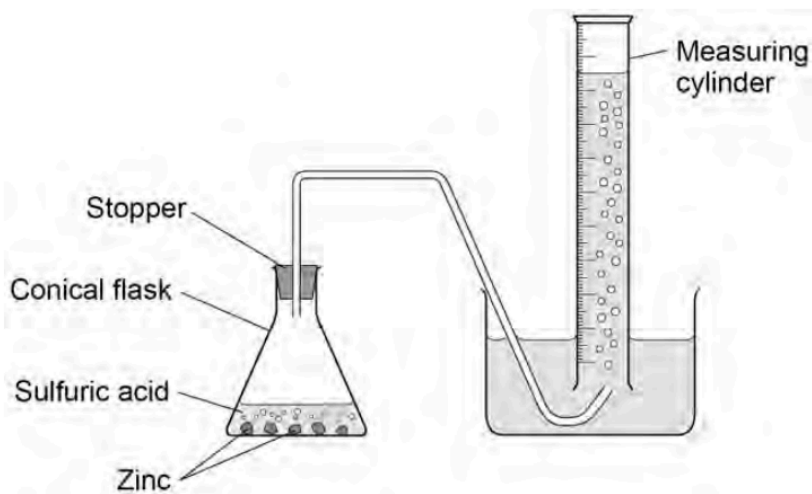
Q12. a). (2023)

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

Hydrogen gas is produced during this reaction.

Figure 1 shows the apparatus.

Figure 1



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]

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

Table 1 shows the results of the calculations.

Table 1

	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

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

☐

Q12. 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 _____

Q13. (2023)

A student investigated the rate of this reaction.

This is the method used.

1. Add 50 cm³ of 2.0 mol/dm³ hydrogen peroxide solution to a conical flask.
2. Add 1.0 g of manganese dioxide to the conical flask.
3. Place the conical flask on a balance and start a timer.
4. Record the total mass lost from the conical flask every 20 seconds for 180 seconds.

Explain why the mass of the conical flask and contents decreased.

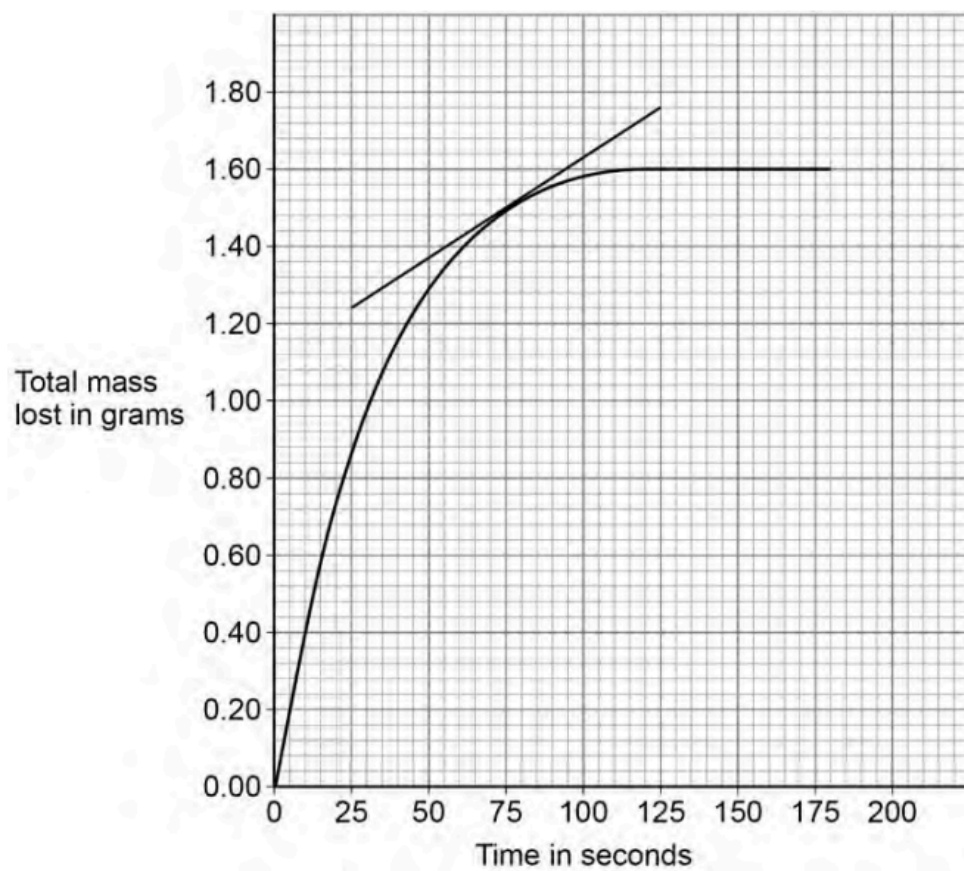
[2 marks]

Q14. a). (2023)

Figure 4 shows the results for 50 cm³ of 2.0 mol/dm³ hydrogen peroxide solution and 1.0 g of manganese dioxide.

A tangent to the line has been drawn at 75 seconds.

Figure 4



Determine the rate of reaction when the time was 75 seconds.

Give your answer to 2 significant figures.

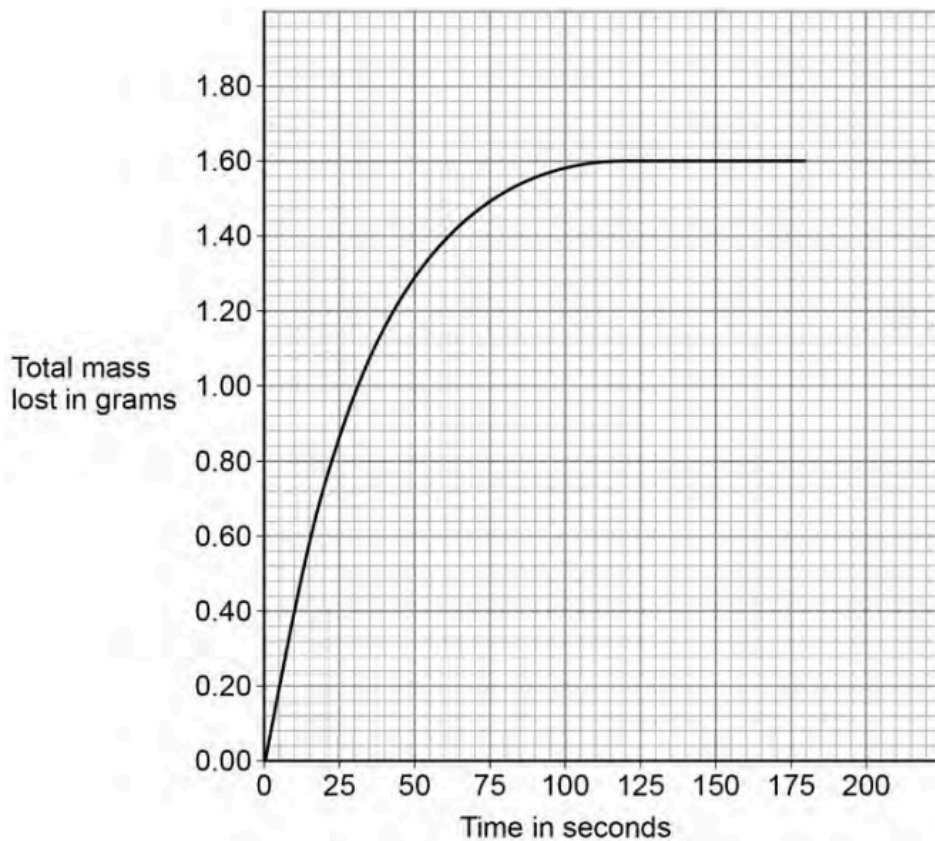
[4 marks]

Rate (2 significant figures) = _____ g/s

Q14. b). (2023)

The results for 50 cm³ of 2.0 mol/dm³ hydrogen peroxide solution and 1.0 g of manganese dioxide are shown again on **Figure 5**.

Figure 5



The student repeated the investigation using 50 cm³ of 1.0 mol/dm³ hydrogen peroxide solution and 1.0 g of manganese dioxide.

Sketch the expected results for 1.0 mol/dm³ hydrogen peroxide solution on **Figure 5**.
[2 marks]

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

The equation for the reaction is

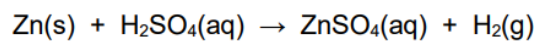
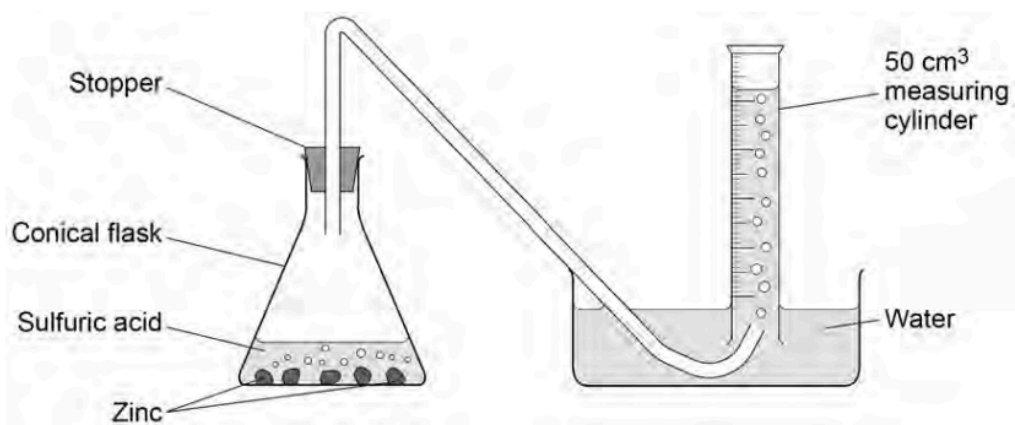


Figure 10 shows the apparatus.

Figure 10



This is the method used.

1. Pour 50 cm^3 of sulfuric acid into the conical flask.
2. Add excess zinc to the conical flask.
3. Insert the stopper and start a timer.
4. Measure the volume of hydrogen collected in the 50 cm^3 measuring cylinder every 20 seconds for 180 seconds.

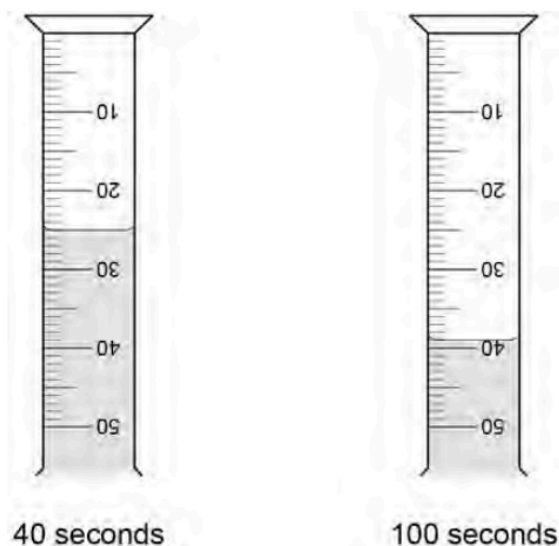
Explain why the volume of hydrogen collected in the 50 cm^3 measuring cylinder is less than the volume of hydrogen produced.

[2 marks]

Q15. b). (2024)

Figure 11 shows the volumes of hydrogen collected in the 50 cm³ measuring cylinder after 40 seconds and after 100 seconds.

Figure 11



Determine the number of moles of hydrogen collected between 40 seconds and 100 seconds.

The volume of one mole of any gas at room temperature and pressure is 24 dm³.

[4 marks]

Moles of hydrogen = _____

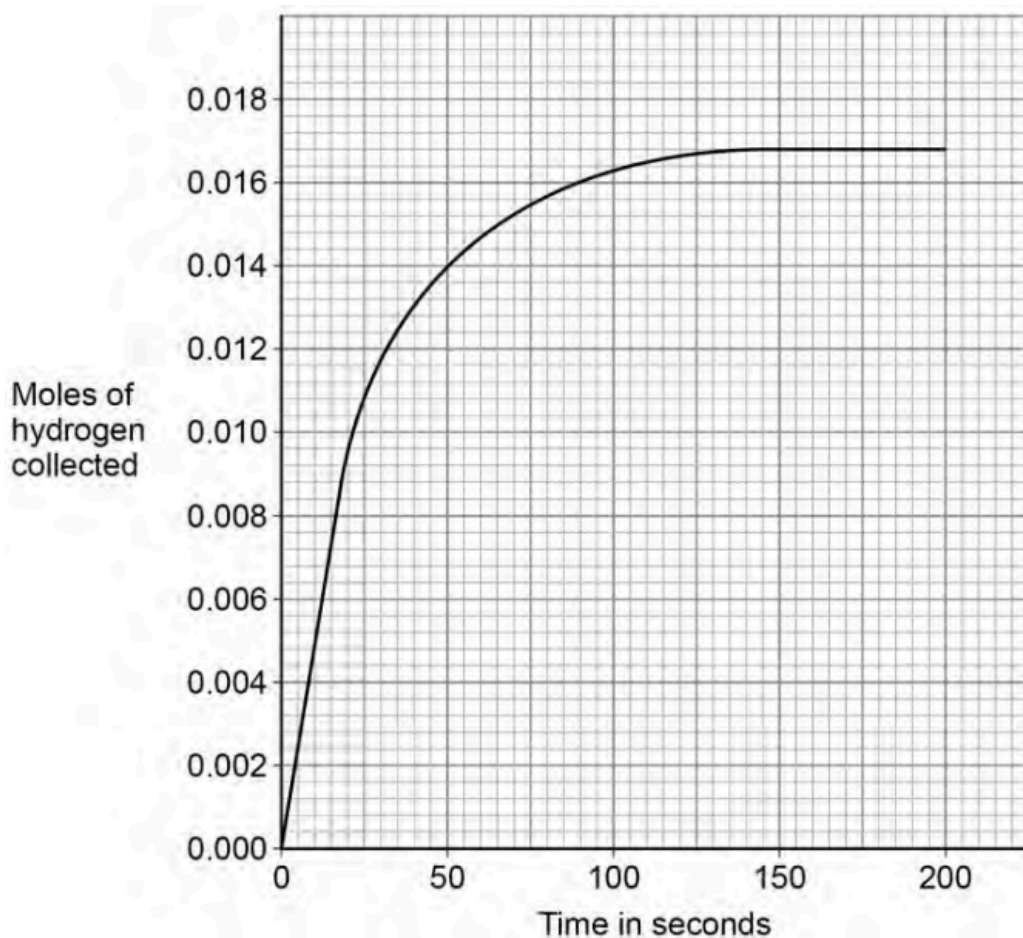
A different student investigated how the concentration of sulfuric acid affected the rate of the reaction.

The student did a different experiment using sulfuric acid of concentration 0.40 mol/dm^3 .

The student calculated the number of moles of hydrogen collected after every 20 seconds.

Figure 12 shows the results.

Figure 12



Determine the rate of reaction at 45 seconds.

You should draw a tangent on **Figure 12**.

Give your answer in standard form.

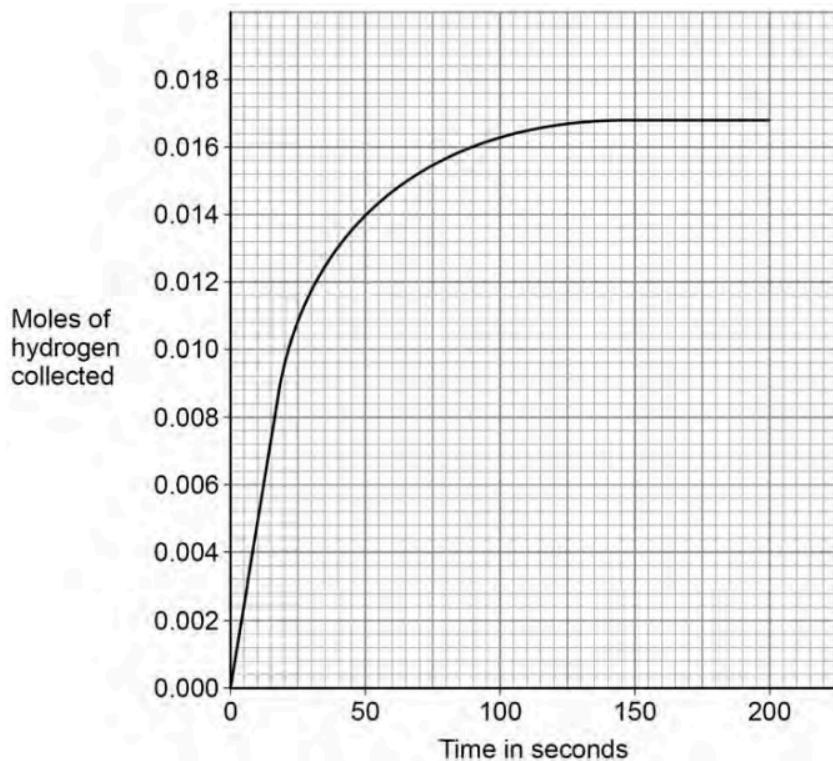
[5 marks]

Rate of reaction (in standard form) = _____ mol/s

Q15. d). (2024)

Figure 13 shows the results for 0.40 mol/dm^3 sulfuric acid.

Figure 13



The student repeated the experiment using 0.20 mol/dm^3 sulfuric acid instead of 0.40 mol/dm^3 sulfuric acid.

Excess zinc was used in each experiment.

Sketch a line on **Figure 13** to show the results you would expect.

[2 marks]

Explain how increasing the temperature would affect the rate of reaction between zinc and sulfuric acid.

[3 marks]
