

Questions are for both separate science and combined science students unless indicated in the question

Q1.

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

The equation for the reaction is

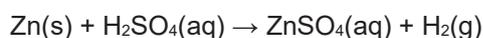
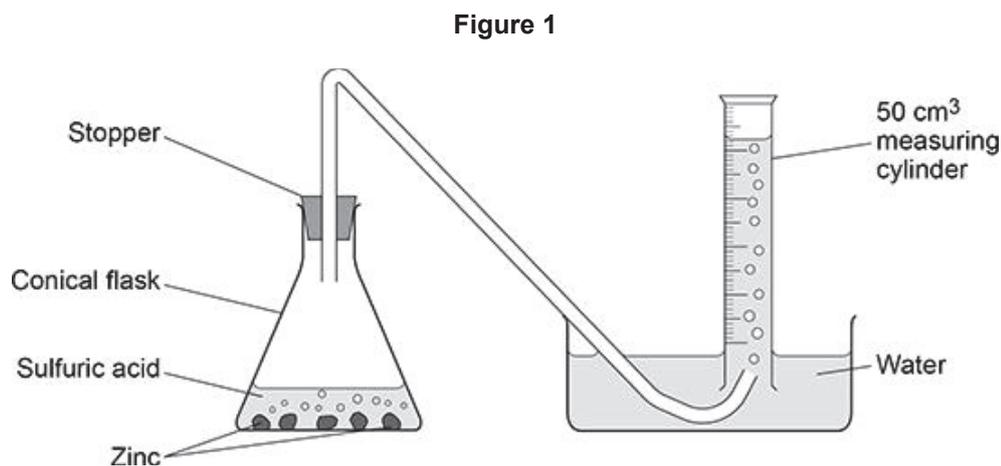


Figure 1 shows the apparatus.

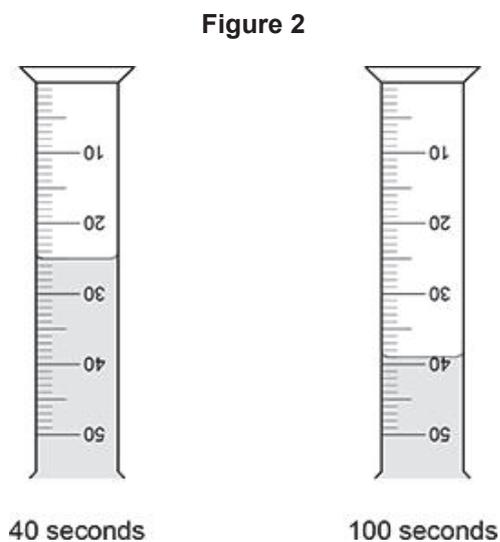


This is the method used.

1. Pour 50 cm³ 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 cm³ measuring cylinder every 20 seconds for 180 seconds.
- (a) Explain why the volume of hydrogen collected in the 50 cm³ measuring cylinder is less than the volume of hydrogen produced.

(2)

Figure 2 shows the volumes of hydrogen collected in the 50 cm³ measuring cylinder after 40 seconds and after 100 seconds.



- (b) Determine the number of moles of hydrogen collected between 40 seconds and 100 seconds. **(chemistry only) (HT only)**

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

Moles of hydrogen = _____

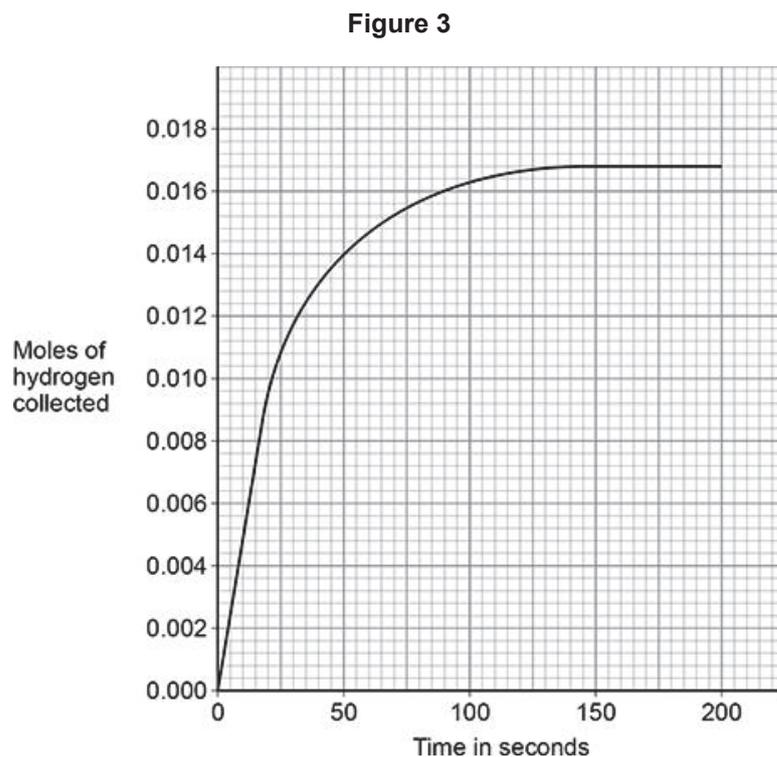
(4)

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

- (c) 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 3 shows the results.



Determine the rate of reaction at 45 seconds.

You should draw a tangent on **Figure 3**.

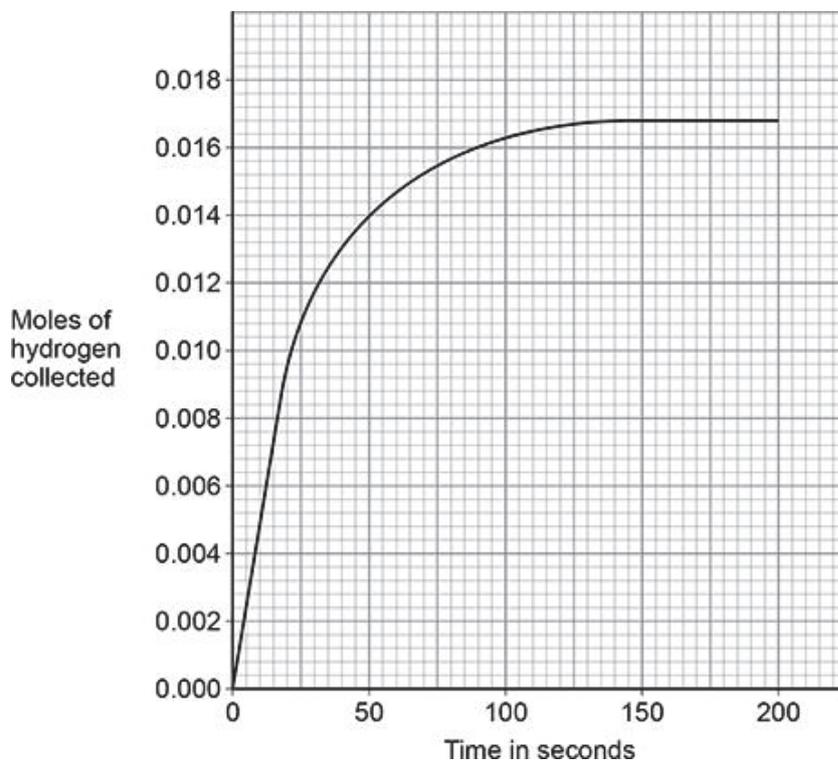
Give your answer in standard form. **(HT only)**

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

(5)

- (d) **Figure 4** shows the results for 0.40 mol/dm^3 sulfuric acid.

Figure 4



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 4** to show the results you would expect.

(2)

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

(3)

(Total 16 marks)

Q2.

Manganese dioxide catalyses the decomposition of hydrogen peroxide solution.

Oxygen and water are produced.

- (a) Explain how a manganese dioxide catalyst increases the rate of decomposition of hydrogen peroxide.

(2)

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.

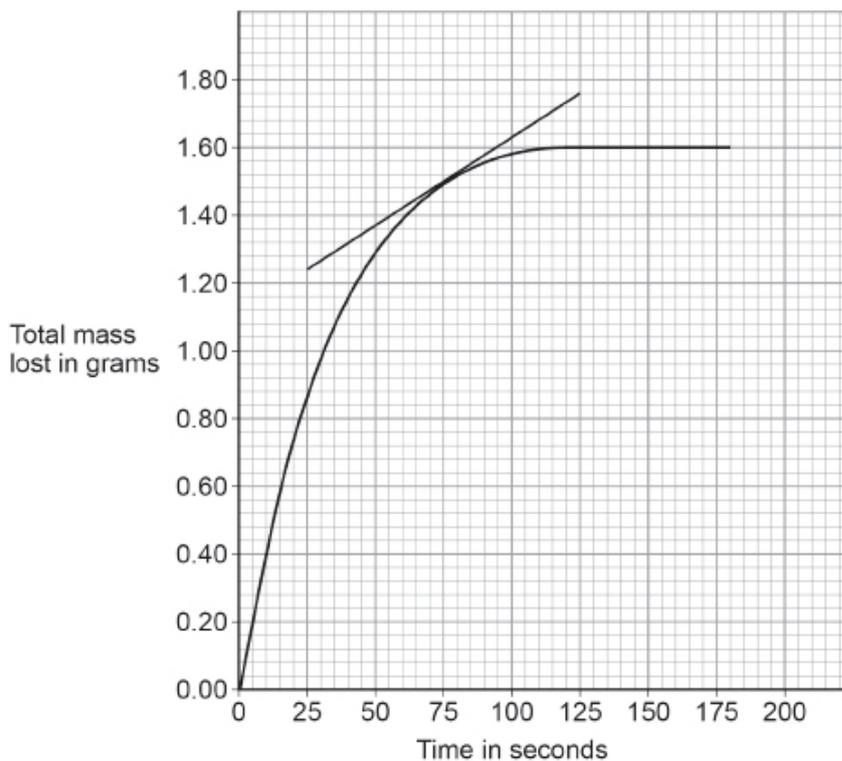
- (b) Explain why the mass of the conical flask and contents decreased.

(2)

- (c) **Figure 1** 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 1



Determine the rate of reaction when the time was 75 seconds. **(HT only)**

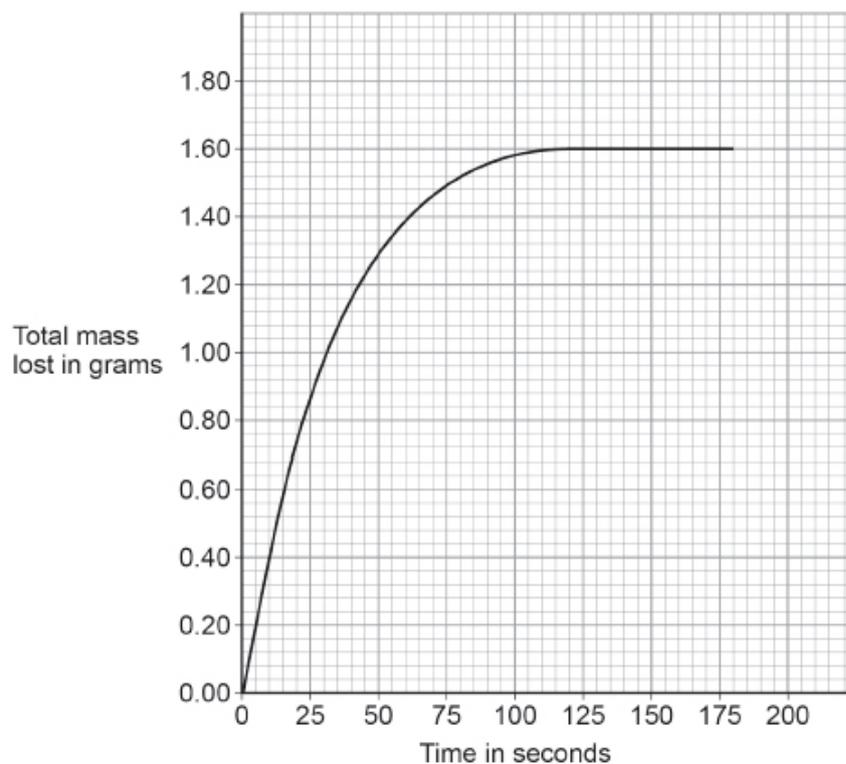
Give your answer to 2 significant figures.

Rate (2 significant figures) = _____ g/s

(4)

- (d) 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 2**.

Figure 2



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 2**.

(2)

(Total 10 marks)

Q3.

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:



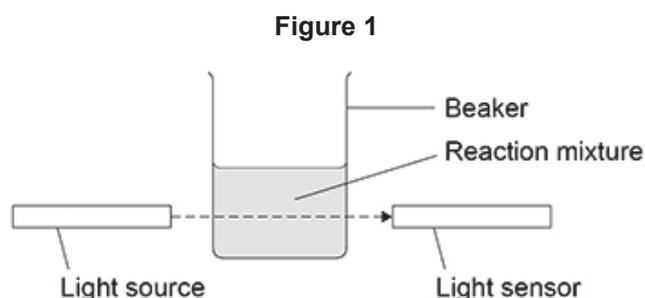
- (a) Sulfur is produced in the reaction.

Why does the mixture become cloudy?

(1)

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

Figure 1 shows the apparatus used.



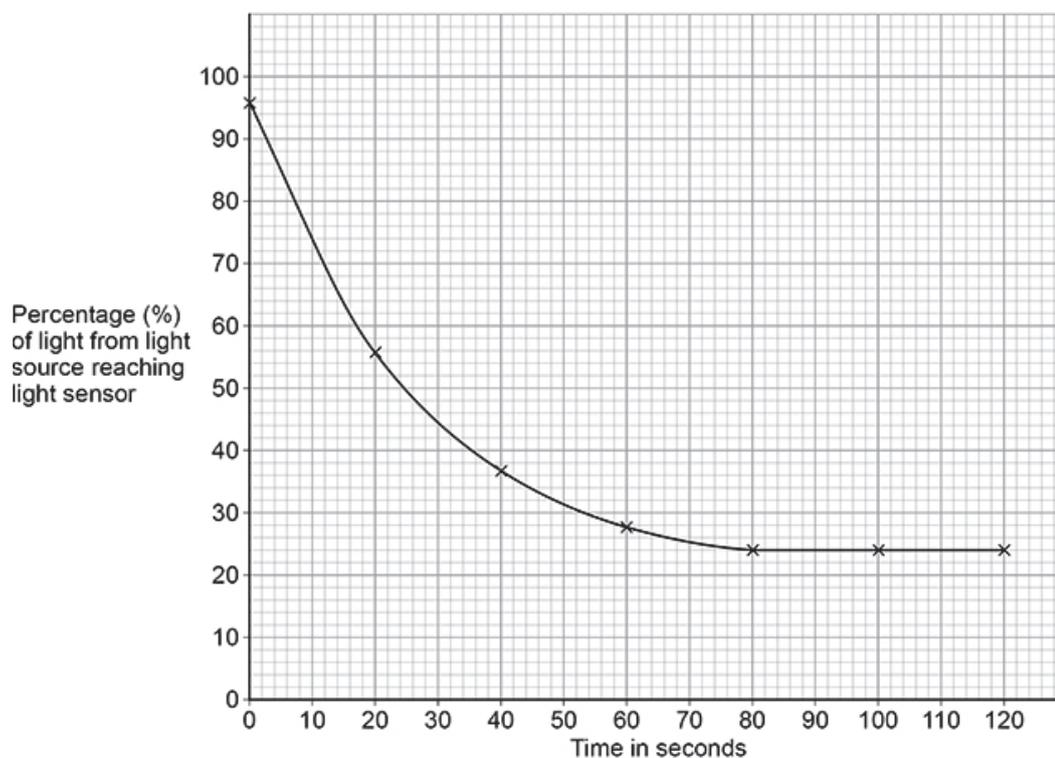
A smaller percentage of light from the light source reaches the light sensor as the mixture becomes more cloudy.

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

Figure 2



- (b) 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 2**. (HT only)

Rate = _____ mol/s

(5)

- (c) Explain why the rate of reaction changes between 0 and 60 seconds.

Answer in terms of concentration.

Use **Figure 2**.

(2)

Figure 3 is a repeat of **Figure 2**.

Figure 3

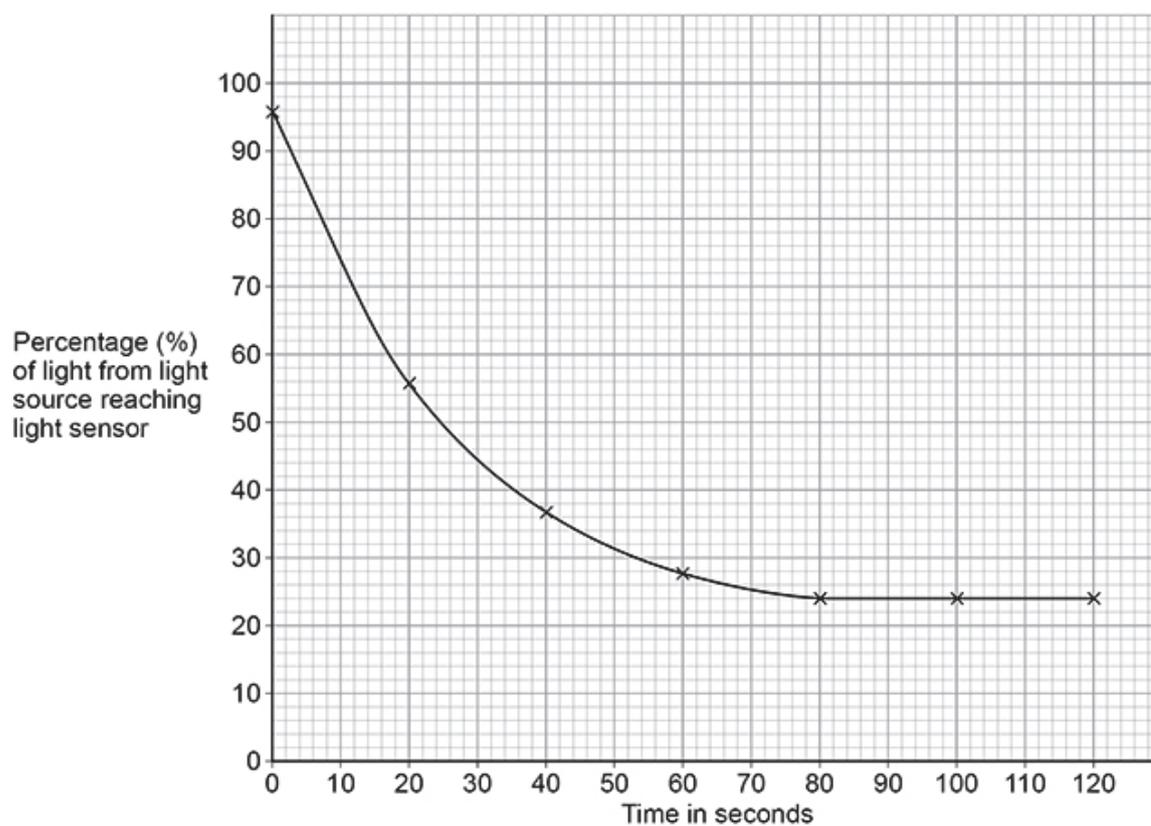


Figure 3 shows the results for 0.10 mol/dm³ sodium thiosulfate solution.

Sodium thiosulfate solution was in excess in the investigation.

- (d) The line of best fit on **Figure 3** is horizontal between 80 and 120 seconds because the reaction stopped.

Why did the reaction stop?

(1)

- (e) Sketch a line on **Figure 3** to show the results you would predict for 0.20 mol/dm³ sodium thiosulfate solution.

(2)

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.

- (f) How could the student improve the method so that the same percentages of light reached the light sensor?

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.

(1)

- (g) 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?

Tick (✓) **one** box.

Anomalous

Precise

Repeatable

Reproducible

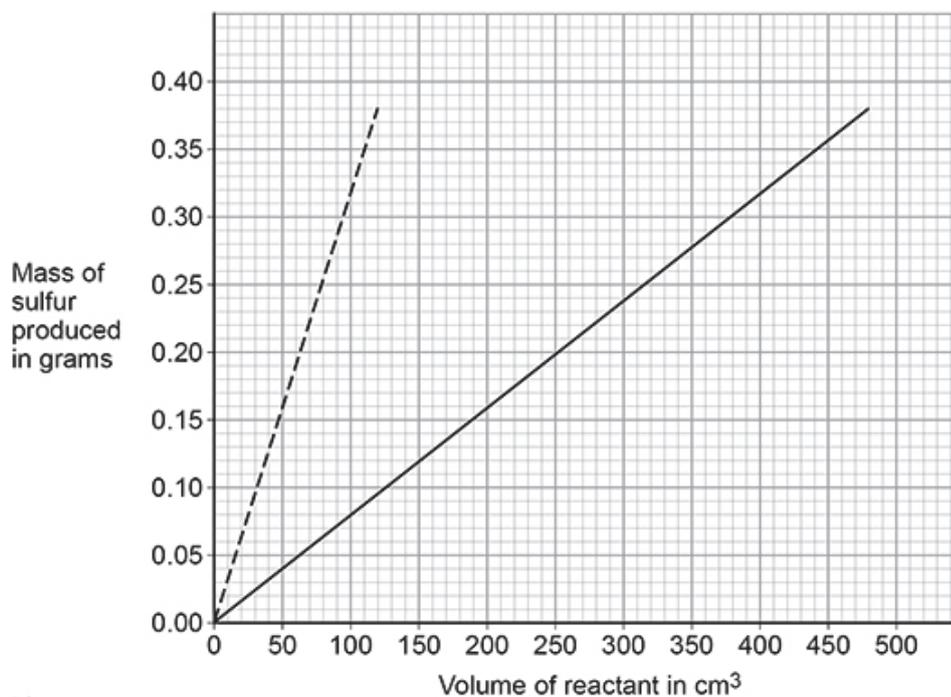
(1)

Figure 4 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 4



Key

--- 0.10 mol/dm^3 sodium thiosulfate solution

— 0.05 mol/dm^3 hydrochloric acid

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

Use **Figure 4**.

Tick (✓) **one** box.

$V \propto m$

$V \sim m$

$V \ll m$

$V = m$

(1)

- (i) Determine the simplest whole number ratio of the volumes of
sodium thiosulfate solution : hydrochloric acid
which completely react with each other.

Use **Figure 4**.

Simplest whole number ratio = _____ : _____

(3)

(Total 17 marks)