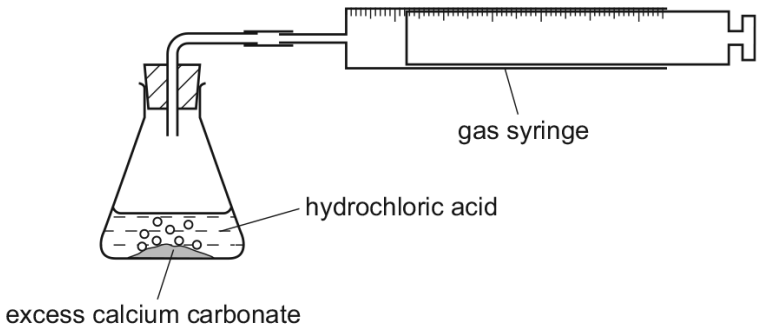
6.1 Rate (speed) of reaction

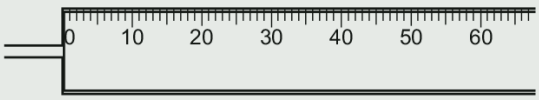
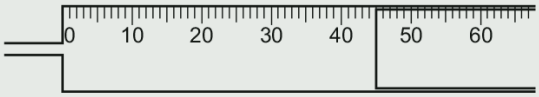
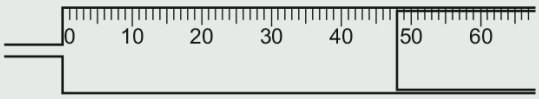
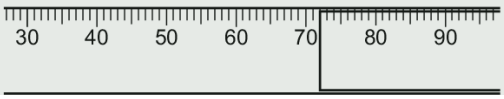
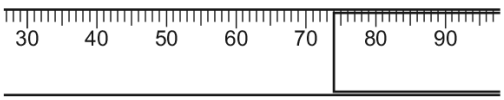
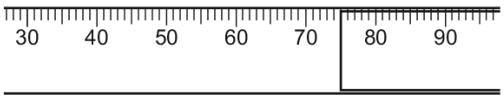
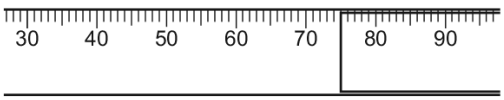
01. 0620_m15_qp_62 Q: 2

The rate of reaction between excess calcium carbonate and dilute hydrochloric acid was investigated using the apparatus shown below. The temperature of the hydrochloric acid was 25 °C.



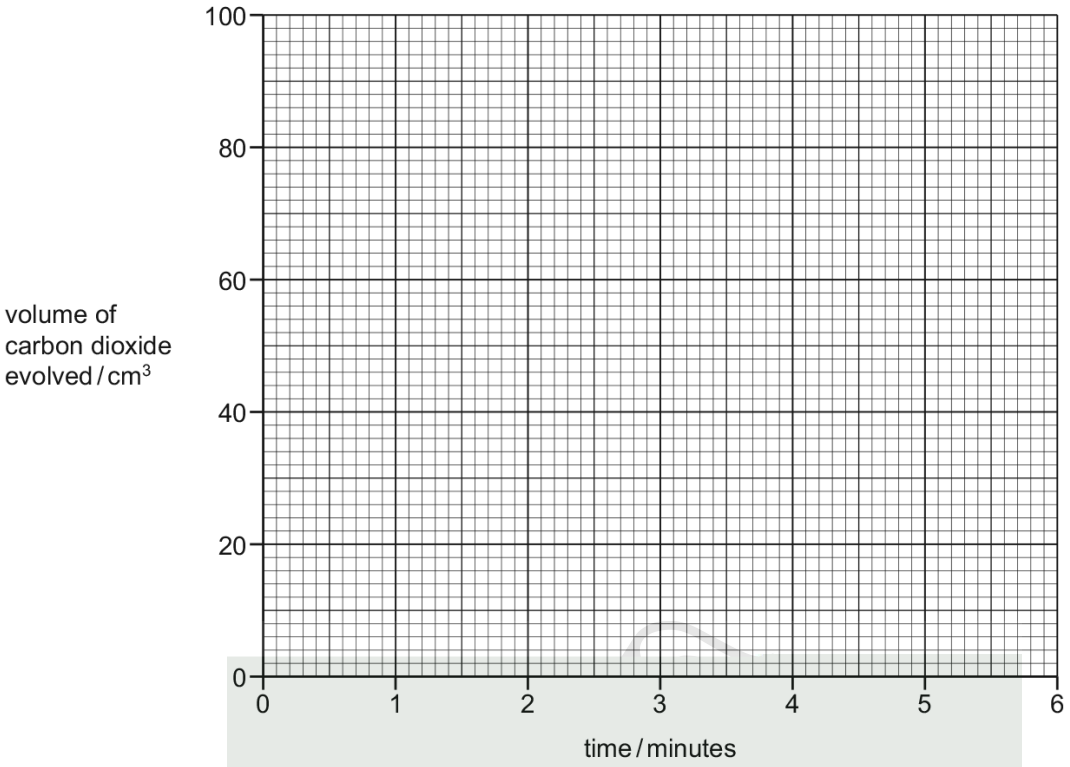
The volume of carbon dioxide evolved was measured every minute for six minutes.

(a) Use the gas syringe diagrams to complete the table of results.

time / minutes	gas syringe diagram	total volume of carbon dioxide evolved / cm^3
0		
1		
2		
3		
4		
5		
6		

[3]

(b) Plot the results on the grid below and draw a smooth line graph.



[4]

(c) (i) Which point appears to be inaccurate? Explain why.

.....

..... [2]

(ii) **Use your graph** to work out the volume of gas expected at that time. Show clearly **on the grid** how you worked out your answer.

..... [2]

(d) Sketch, **on the grid**, the graph you would expect if the experiment was repeated using hydrochloric acid at a temperature of 50 °C. [2]

[Total: 13]

02. 0620_m16_qp_62 Q: 2

A teacher investigated the rate of a reaction between two solutions, **J** and **K**, and sulfuric acid at different temperatures.

Four experiments were carried out.

(a) *Experiment 1*

A large measuring cylinder was used to pour 50 cm^3 of distilled water and 40 cm^3 of sulfuric acid into a 250 cm^3 conical flask.
A small measuring cylinder was used to add 2 cm^3 of methyl orange and 5 cm^3 of solution **J** to the mixture in the conical flask. The temperature of the mixture was measured.
The reaction was started by adding 5 cm^3 of solution **K** to the conical flask, immediately starting the timer and swirling the mixture.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 2

Experiment 1 was repeated but the mixture in the conical flask was heated to about 30 °C **before** adding the solution **K**. The temperature of the mixture was measured.
5 cm^3 of solution **K** was added to the conical flask. The timer was started and the mixture swirled.
The time taken for the mixture to turn pale yellow was measured. The final temperature of the mixture was measured.

Experiment 3

Experiment 1 was repeated but the mixture in the conical flask was heated to about 40 °C before adding the solution **K** to the flask. The same measurements were taken.

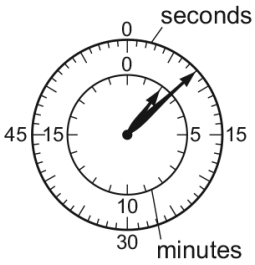
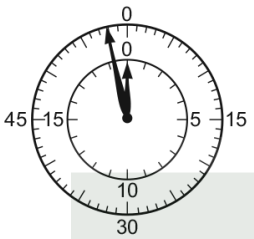
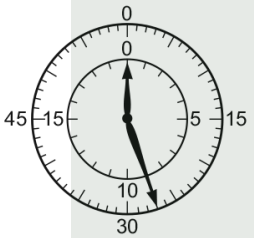
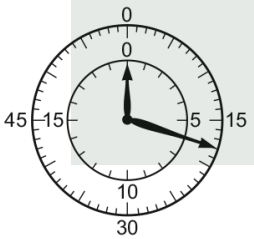
Experiment 4

Experiment 1 was repeated but the mixture in the conical flask was heated to about 50 °C before adding the solution **K** to the flask. The same measurements were taken.

Stop-clock diagrams for these experiments are on page 4.

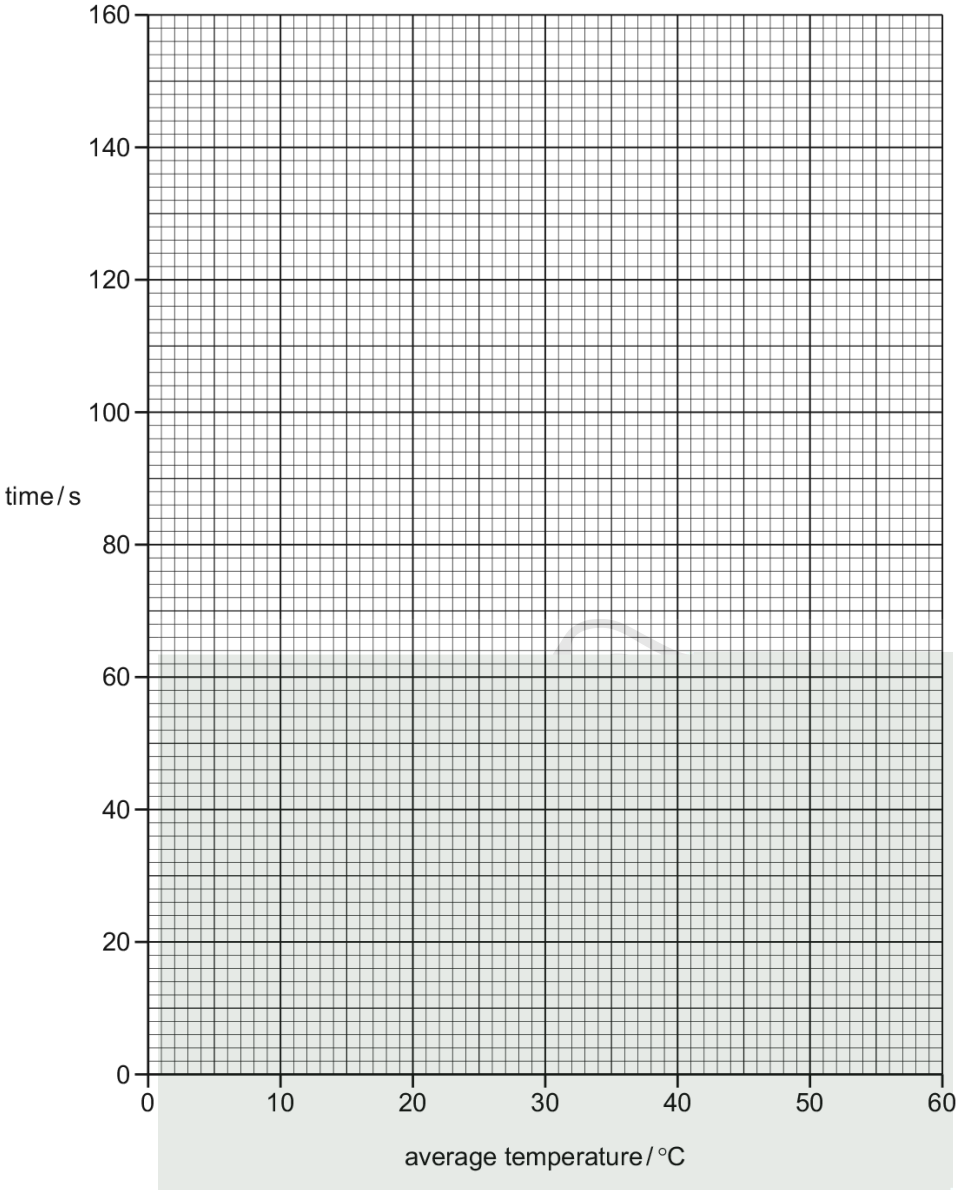
Use the stop-clock diagrams to record the times in the table.

Work out the average temperatures to complete the table.

experiment	stop-clock diagram	time taken for mixture to turn pale yellow / s	initial temperature / °C	final temperature / °C	average temperature / °C
1			17	15	
2			28	26	
3			42	40	
4			51	49	

[4]

(b) Plot the results on the grid and draw a smooth line graph.



[4]

(c) **From your graph** deduce the time taken for the mixture to turn pale yellow if Experiment 1 was repeated at an average temperature of 60 °C.
Show clearly **on the grid** how you worked out your answer.

..... [2]

(d) (i) In which experiment was the rate of reaction greatest?

..... [1]

(ii) Explain why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) (i) Suggest and explain the effect **on the results** of using a burette to measure the volume of solution **J**.

.....

..... [2]

(ii) Suggest and explain one **other** improvement to these experiments.

.....

..... [2]

[Total: 17]

03. 0620_m18_qp_62 Q: 4

Magnesium reacts with dilute sulfuric acid at room temperature to form hydrogen gas.

Plan an experiment to find the rate of reaction between magnesium ribbon and dilute sulfuric acid.

In your answer:
- include a diagram
- indicate how you could use the results obtained to find the rate of reaction.

You are provided with common laboratory apparatus, magnesium ribbon and dilute sulfuric acid.

.....

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..... [6]

[Total: 6]

04. 0620_m19_qp_62 Q: 4

The rate of reaction between magnesium and dilute hydrochloric acid can be followed by measuring the volume of hydrogen produced.

Plan an experiment to investigate the effect of decreasing the temperature on the rate of this reaction by measuring the volume of hydrogen produced.

You are provided with magnesium ribbon, dilute hydrochloric acid and common laboratory apparatus.
You are advised to draw a labelled diagram of the apparatus you would use in the space provided.

.....

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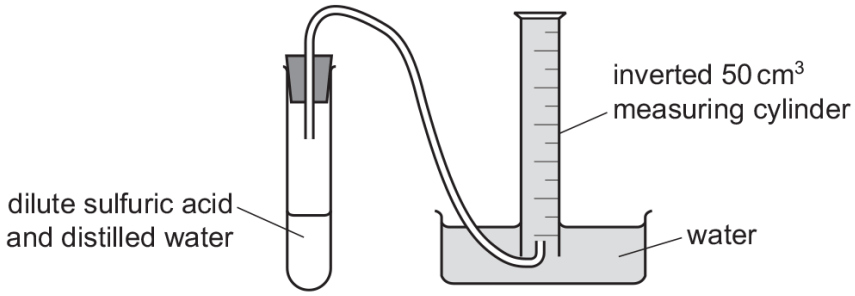
..... [6]

05. 0620_m20_qp_62 Q: 2

A student investigated the time taken to collect 40 cm^3 of hydrogen gas when magnesium reacts with dilute sulfuric acid.

Five experiments were done using the apparatus shown.



Experiment 1

- Using a measuring cylinder, 8 cm^3 of dilute sulfuric acid was poured into the boiling tube.
- Using a second measuring cylinder, 12 cm^3 of distilled water was added to the acid in the boiling tube.
- The apparatus was set up as shown in the diagram, ensuring the inverted measuring cylinder was full of water.
- The bung was removed from the boiling tube.
- A coiled length of magnesium ribbon was added to the boiling tube, the bung was immediately replaced and a timer started.
- The time taken for 40 cm^3 of gas to be collected was measured.
- The student felt the outside of the boiling tube.

(a) (i) The student noticed that the boiling tube was warm.

What does this tell you about the type of reaction?

..... [1]

(ii) Describe **one** change that could be made to the apparatus to help keep the temperature of the contents of the boiling tube constant during the reaction.

..... [1]

Experiment 2

- The boiling tube was rinsed out with distilled water.
- Experiment 1 was repeated using 10 cm^3 of dilute sulfuric acid and 10 cm^3 of distilled water.

Experiment 3

- Experiment 2 was repeated using 12 cm^3 of dilute sulfuric acid and 8 cm^3 of distilled water.

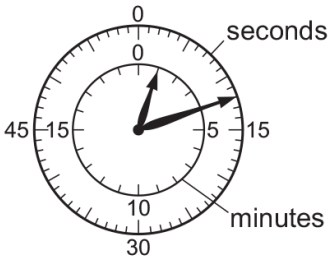
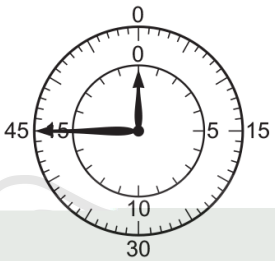
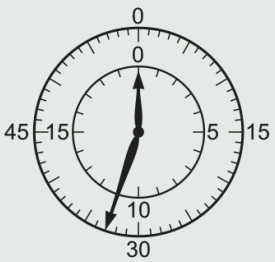
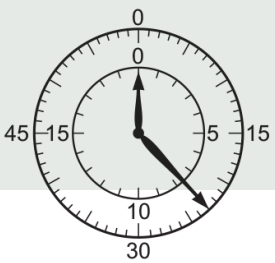
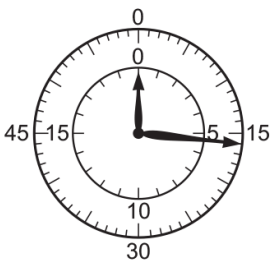
Experiment 4

- Experiment 2 was repeated using 16 cm^3 of dilute sulfuric acid and 4 cm^3 of distilled water.

Experiment 5

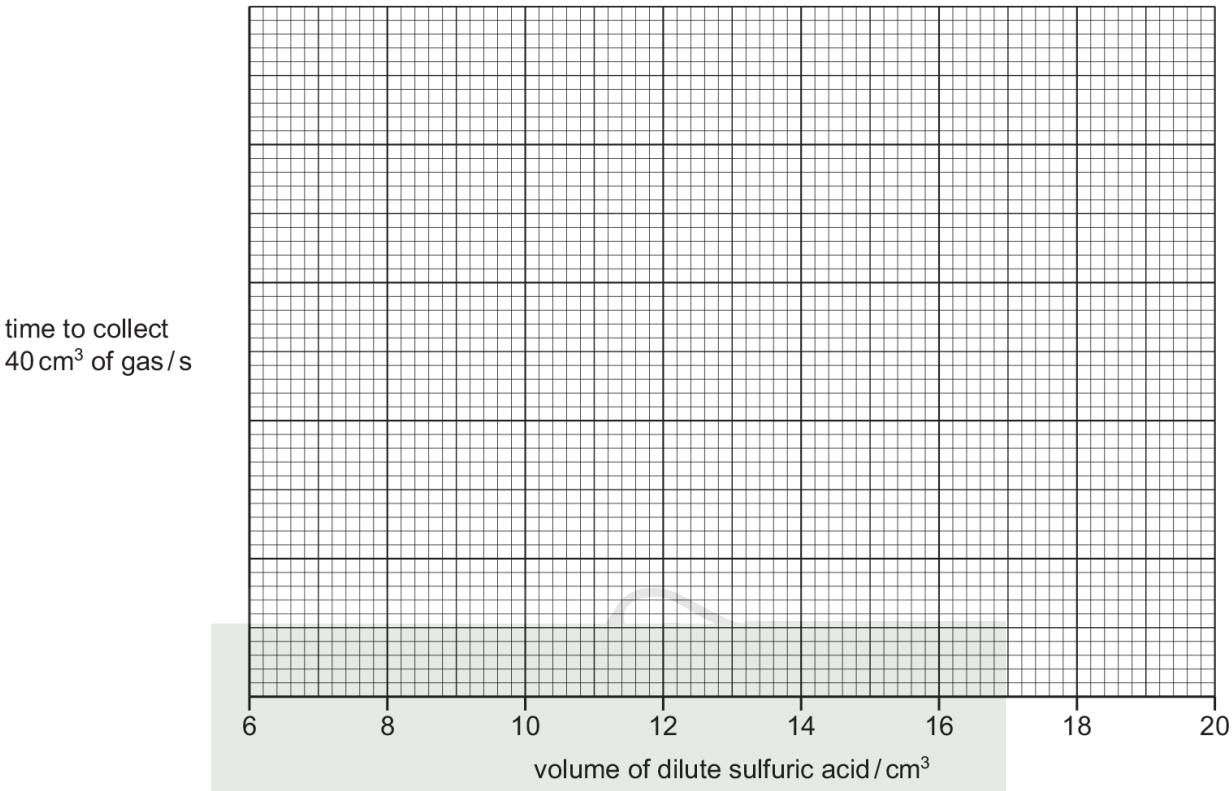
- Experiment 2 was repeated using 20 cm^3 of dilute sulfuric acid and no distilled water.

(b) Use the information in the description of the experiments and the timer diagrams to complete the table. Record the time in **seconds**.

experiment	volume of dilute sulfuric acid / cm^3	volume of distilled water / cm^3	timer diagram	time to collect 40 cm^3 of gas / s
1	8			
2	10			
3	12			
4	16			
5	20			

[4]

(c) Add a suitable scale to the *y*-axis and plot the results from Experiments 1 to 5 on the grid. Draw a smooth line graph.



[4]

(d) (i) **From your graph**, deduce the time taken to collect 40 cm^3 of gas if the experiment was repeated using 9 cm^3 of dilute sulfuric acid.

Show clearly **on the grid** how you worked out your answer.

..... s
[2]

(ii) What volume of distilled water would be needed if the experiment was repeated using 9 cm^3 of dilute sulfuric acid?

..... cm^3 [1]

(e) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{\text{volume of gas collected}}{\text{time taken to collect the gas}}$$

(i) Use this equation to calculate the rate of reaction in Experiment 1. Give the units for the rate of reaction you have calculated.

rate of reaction = ... units = ...

[2]

(ii) In which Experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(f) Why would measuring the volume of dilute sulfuric acid with a burette rather than a measuring cylinder be an improvement?

.....

..... [1]

(g) The magnesium starts to react with the dilute sulfuric acid as soon as it is added.

(i) Why does this decrease the accuracy of the investigation?

..... [1]

(ii) Describe **one** improvement that you could make to overcome this problem.

.....

.....

..... [1]

[Total: 19]

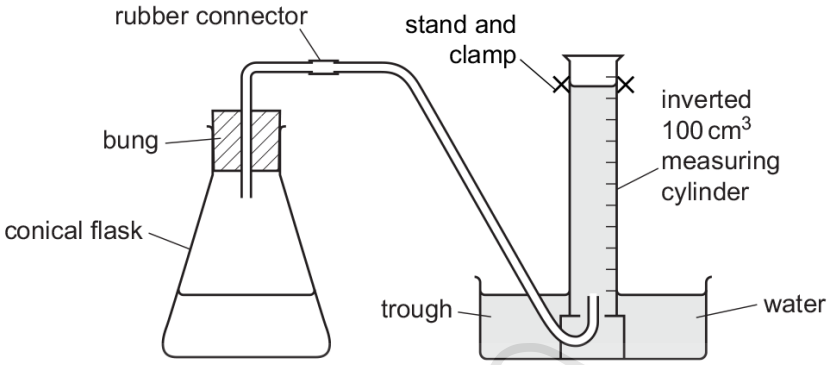
06. 0620_p20_qp_60 Q: 2

A student investigated the rate of reaction between excess magnesium and two different dilute acids, **X** and **Y**.

Two experiments were carried out.

Experiment 1

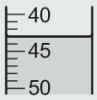
The apparatus was set up as shown in the diagram.



Using a measuring cylinder, 50 cm^3 of dilute acid **X** was poured into the conical flask.
0.5 g of magnesium ribbon was added to the conical flask and the bung added.

The timer was started and the volume of gas collected in the measuring cylinder was measured every 30 seconds for three minutes.

(a) Use the measuring cylinder diagrams to record the volumes of gas collected.

time / s	measuring cylinder diagram	total volume of gas collected / cm^3
0		
30		
60		
90		
120		
150		
180		

[2]

Experiment 2

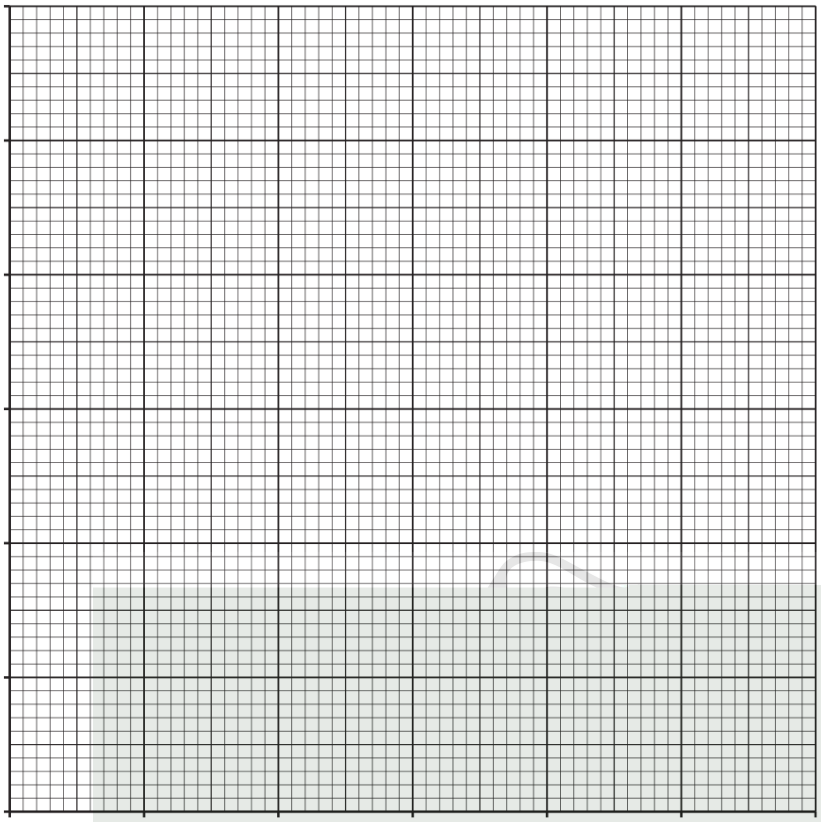
Experiment 1 was repeated using 50 cm^3 of dilute acid **Y**.

(b) Use the measuring cylinder diagrams to record the volumes of gas collected.

time / s	measuring cylinder diagram	total volume of gas collected / cm^3
0		
30		
60		
90		
120		
150		
180		

[2]

(c) Plot the results for both experiments on the grid below. For each set of results, draw a smooth line graph. Indicate clearly which line represents Experiment 1 and which line represents Experiment 2.



[4]

(d) State which experiment had the faster rate of reaction **and** suggest why the rate was faster in this experiment.

.....

..... [1]

(e) From your graph, deduce the time required to collect 25 cm^3 of gas in Experiment 1. Show clearly **on the graph** how you worked out your answer.

..... [1]

(f) The rate of this reaction can be calculated using:

$$\text{rate} = \frac{\text{volume of gas / cm}^3}{\text{time taken / s}}$$

For the experiment with the higher rate, calculate the rate of reaction for the first 30 seconds of the reaction. Deduce the units.

rate ..... [2]

(g) Give **one** advantage and **one** disadvantage of using a measuring cylinder to add the acids to the flask.

advantage .....

disadvantage ..... [2]

(h) Suggest **and** explain one improvement to this experiment.

.....

.....

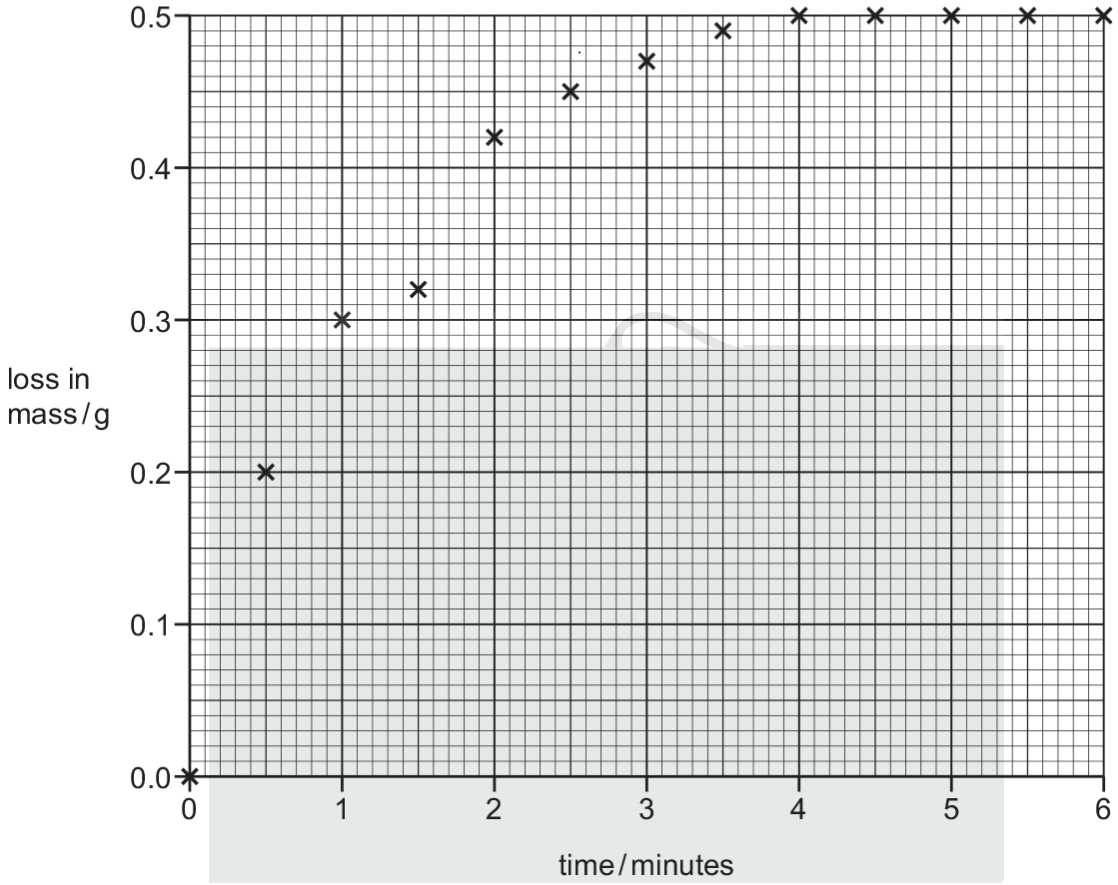
..... [1]

[Total: 15]

07. 0620_s12_qp_62 Q: 2

An experiment was carried out to measure the speed (rate) of reaction between magnesium carbonate and excess dilute nitric acid.
50 cm^3 of dilute nitric acid was poured into a conical flask and placed on a balance. 1.0 g of powdered magnesium carbonate was added to the flask. The mass of the flask and contents decreased as a gas was given off. The loss in mass was recorded every half minute for six minutes.

The results of the experiment are shown plotted on the grid below.



(a) Draw a smooth line graph through the points. [1]

(b) Which point appears to be inaccurate?

..... [1]

(c) Why does the curve level out? Explain your answer.

.....

..... [2]

(d) On the grid, sketch the graph you would expect if the reaction was repeated using 0.5 g of lumps of magnesium carbonate. [2]

[Total: 6]

08. 0620_s12_qp_62 Q: 4

A student investigated a reaction between a solid and a liquid. The reaction produced a gas. She wanted to know if any of the substances **W**, **X** and **Y** were catalysts for the reaction.
Firstly she carried out the reaction without any **W**, **X** or **Y**.
Then she repeated the reaction three times adding a small amount of **W**, **X** or **Y**. In each case she timed how long the reaction took to finish. The results are in the table.

substance added	time of reaction / s
none	277
W	266
X	279
Y	78

(a) How would the student know when the reaction had finished?

..... [1]

(b) **(i)** State the effect of each substance on the speed (rate) of the reaction.

W .....

X .....

Y ..... [3]

(ii) Which substance, **W**, **X** or **Y**, is the best catalyst for this reaction?

..... [1]

(c) How could the student check the reliability of her results?

.....

..... [2]

[Total: 7]

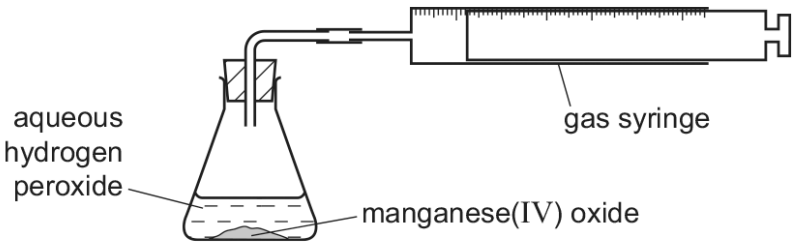
---

09. 0620_s12_qp_63 Q: 3

Hydrogen peroxide decomposes to form oxygen. Manganese(IV) oxide is a catalyst for this reaction.

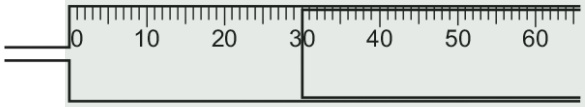
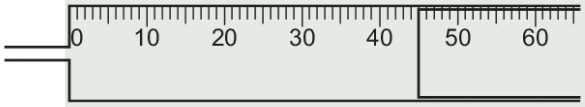
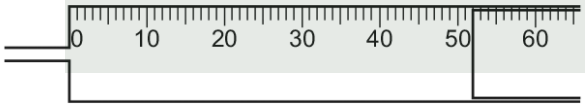
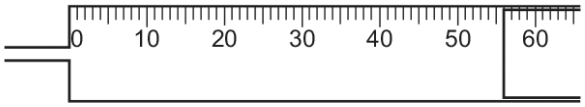
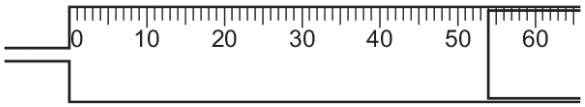
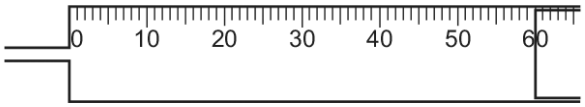
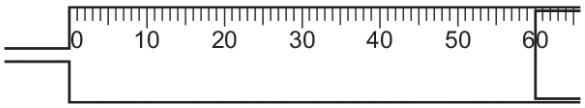
Two students investigated the speed of reaction using the apparatus below.

2 g of manganese(IV) oxide powder was added to 50 cm^3 of aqueous hydrogen peroxide at 20 °C.



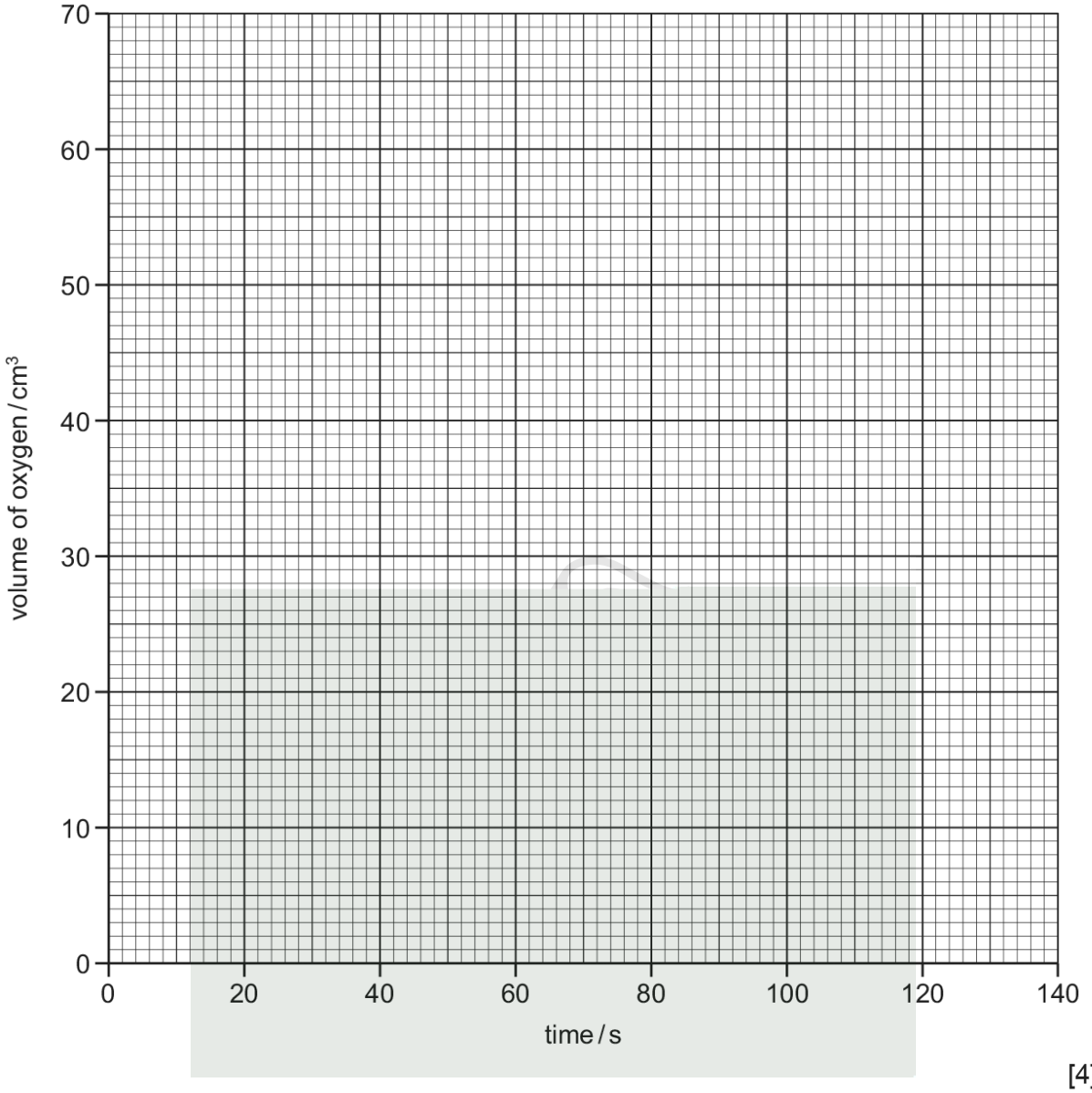
The volume of oxygen released was measured every 20 seconds.

(a) Use the gas syringe diagrams to record the volumes in the table.

time / s	gas syringe diagram	volume of oxygen / cm^3
0		
20		
40		
60		
80		
100		
120		
140		

[3]

(b) Plot the results on the grid below. Draw a smooth line graph.



[4]

(c) Which point appears to be inaccurate? Explain why.

.....

..... [2]

(d) **Use your graph** to find the volume of oxygen produced after 12 seconds. Show clearly how you used the graph.

..... [2]

(e) Why did the volume of oxygen level out after 120 seconds?

..... [1]

(f) The experiment was repeated but the hydrogen peroxide was cooled to 10 °C before starting.

(i) How could the hydrogen peroxide be cooled?

..... [1]

(ii) Sketch on the grid, on page 5, the graph you would expect for the results at 10 °C. [2]

[Total: 15]

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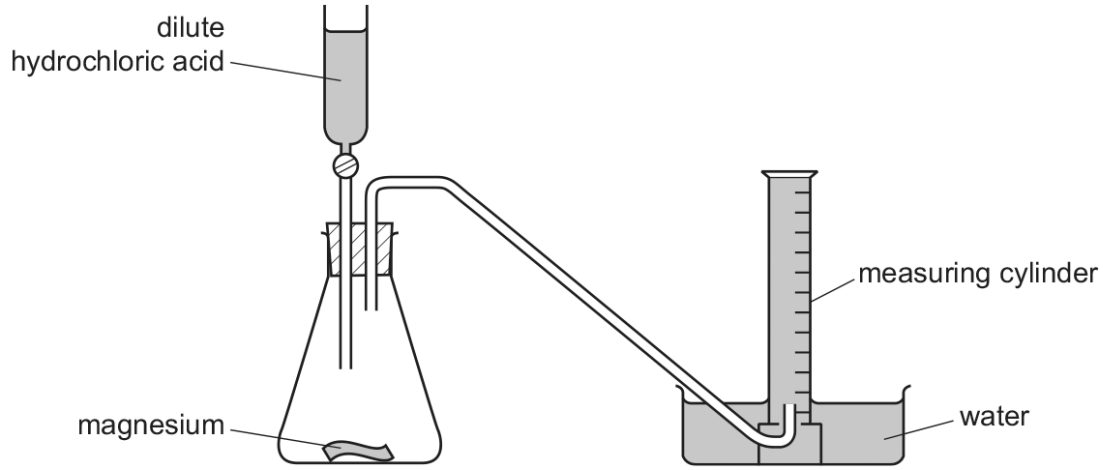
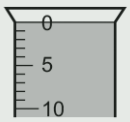
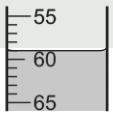
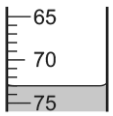
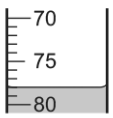
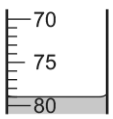
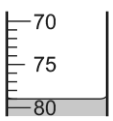
10. 0620_s13_qp_63 Q: 5

A student investigated the rate of reaction between magnesium and excess dilute hydrochloric acid at room temperature. The apparatus was set up as shown in the diagram.



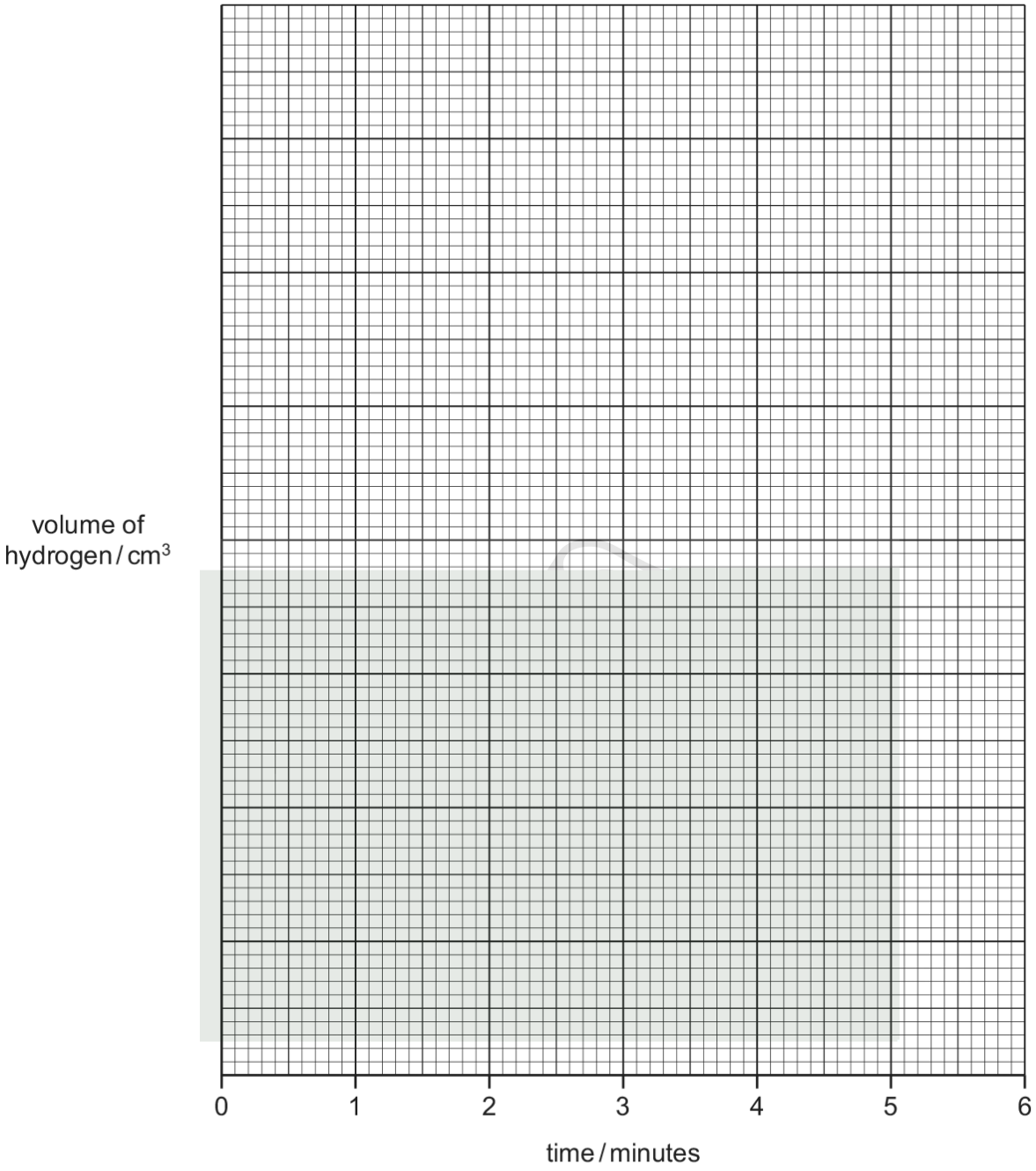
Using a tap funnel, 20 cm^3 of hydrochloric acid was added to 4 cm of magnesium ribbon. The volume of hydrogen produced was measured every minute for six minutes.

(a) Use the measuring cylinder diagrams to record the volumes of gas collected in the table of results.

time / min	measuring cylinder diagram	total volume of gas collected / cm^3
0		
1		
2		
3		
4		
5		
6		

[2]

(b) Plot the points on the grid and draw a smooth line graph.



[4]

(c) **From your graph**, find the time at which 50 cm^3 of gas was produced. Show clearly **on the graph** how you obtained your answer.

..... [2]

(d) Sketch **on the grid** the graph you would expect if the experiment was repeated using 2 cm of magnesium ribbon. [2]

(e) Explain why the rate of reaction would be lower if the hydrochloric acid was cooled to 5 °C before the reaction.

.....

.....

..... [2]

[Total: 12]

---

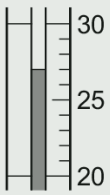
11. 0620_s14_qp_62 Q: 4

A student investigated the temperature rises produced when different lengths of magnesium ribbon reacted with excess dilute sulfuric acid.
Five experiments were carried out.

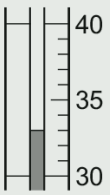
(a) *Experiment 1*

Using a measuring cylinder, 20 cm^3 of dilute sulfuric acid was added to a beaker. The initial temperature of the solution was measured. A 2 cm length of magnesium ribbon was added to the acid in the beaker and the mixture stirred with a thermometer. The highest temperature reached was measured.

Use the thermometer diagrams to record the initial and highest temperatures in the table on page 7.



initial temperature



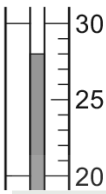
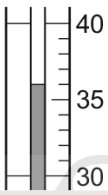
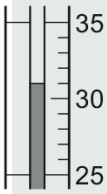
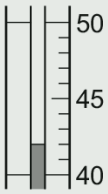
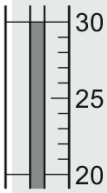
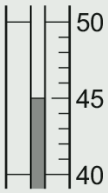
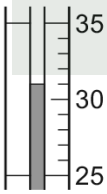
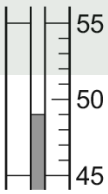
highest temperature

(b) *Experiment 2*

Experiment 1 was repeated, using a 3 cm length of magnesium ribbon. Use the thermometer diagrams to record the initial and highest temperatures in the table.

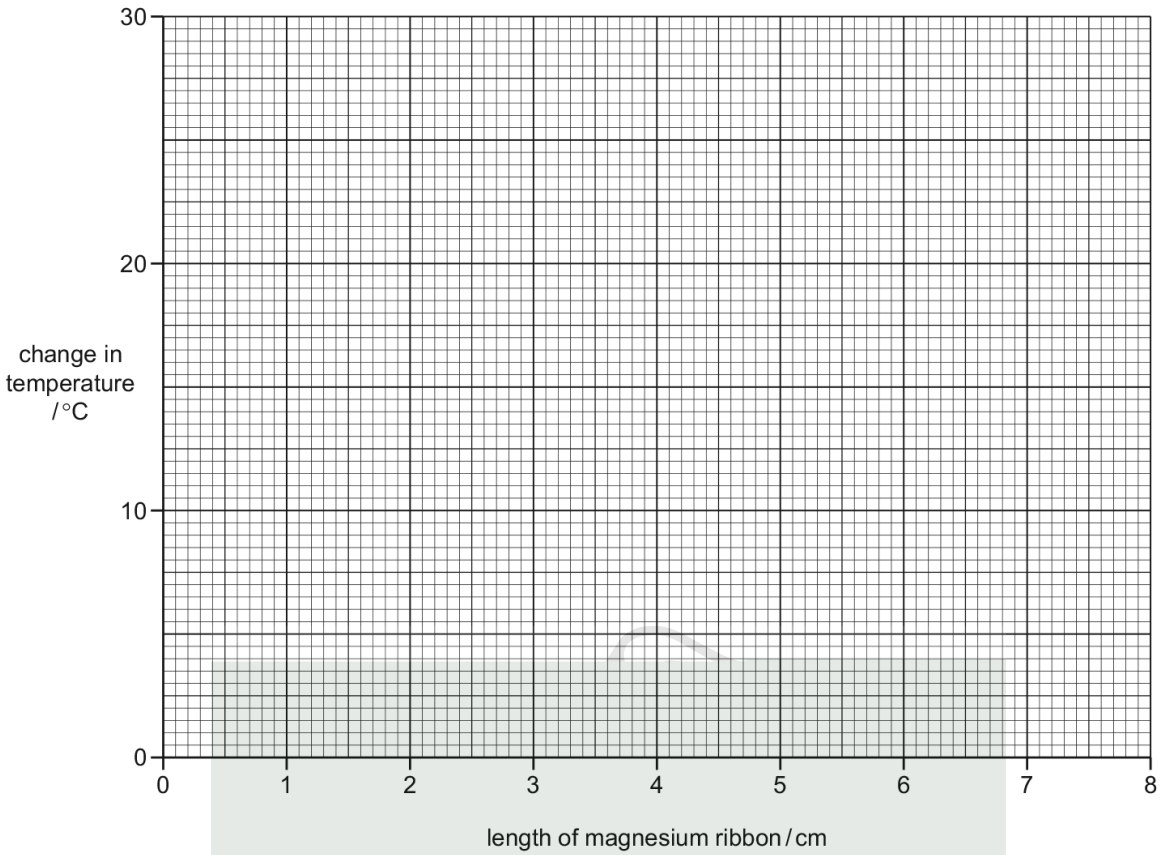
(c) *Experiments 3, 4 and 5*

Experiment 1 was repeated, using a 4 cm length, a 6 cm length and a 7 cm length of magnesium ribbon. Use the thermometer diagrams to record the temperatures in the table.
Complete the table of results.

Experiment	thermometer diagram	initial temperature / °C	thermometer diagram	highest temperature / °C	change in temperature / °C
1					
2					
3					
4					
5					

[5]

(d) Plot the results on the grid below. Draw a best fit straight line graph.



[4]

(e) **From your graph**, deduce the temperature change expected if Experiment 1 was repeated using an 8 cm length of magnesium ribbon.
Show clearly **on the grid** how you worked out your answer.

..... [3]

(f) Give **one** expected observation, other than temperature rise, when magnesium reacts with dilute sulfuric acid.

..... [1]

(g) (i) Which experiment gave the greatest change in temperature?

..... [1]

(ii) Suggest why the change in temperature was greatest in this experiment.

.....

..... [1]

(h) What difference would be observed if Experiment 1 was repeated using an equal mass of magnesium powder? Explain your answer.

.....

..... [2]

(i) Suggest the temperature change expected if Experiment 1 was repeated using 40 cm^3 of dilute sulfuric acid.

..... [1]

(j) Draw a diagram of apparatus you could use to collect and measure the volume of gas given off in the reaction.

[2]

(k) State **one** source of error in the results obtained in the experiments. Give **one** improvement to reduce this source of error.

error .....

improvement ..... [2]

[Total: 22]

12. 0620_s14_qp_63 Q: 2

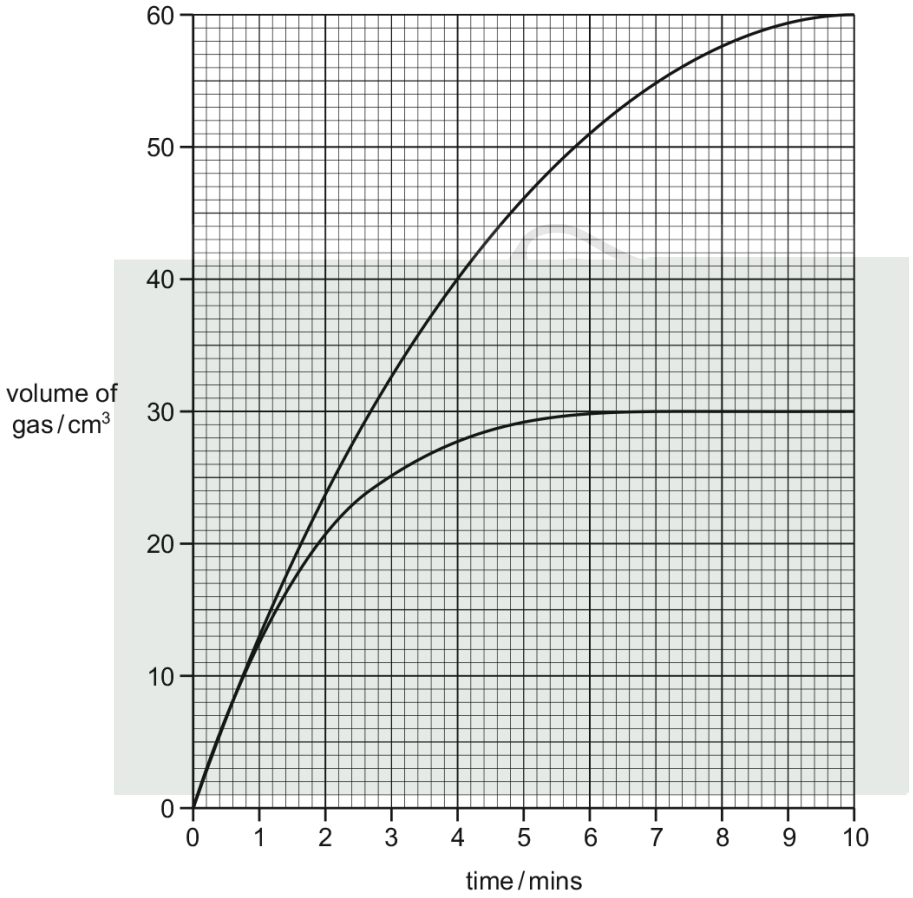
A student carried out three experiments to investigate the rate of reaction between dilute hydrochloric acid and zinc powder.

Experiment 1

50 cm^3 of dilute hydrochloric acid were reacted with excess zinc powder. The volume of gas produced was measured every minute for ten minutes.

Experiment 2

Experiment 1 was then repeated using 100 cm^3 of the dilute hydrochloric acid.
The results for these two experiments are shown below.



(a) Label the two lines to identify each experiment. [1]

Experiment 3

Experiment 1 was repeated using 50 cm^3 of dilute hydrochloric acid which was half as concentrated as in Experiment 1.

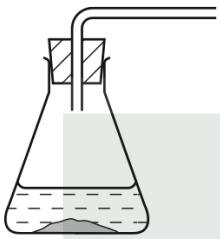
(b) (i) How could the student prepare a solution of dilute hydrochloric acid which was half as concentrated as the acid in Experiment 1?

.....

..... [2]

(ii) Sketch, on the grid on page 3, the result that would be expected in Experiment 3. [2]

(c) Complete the diagram to show how the gas could be collected and measured.



[2]

(d) Explain how the rate of reaction could be increased in Experiment 3 without changing the concentration of the dilute hydrochloric acid.

.....

.....

..... [3]

[Total: 10]

13. 0620_s15_qp_61 Q: 6

A catalyst is a substance that speeds up the rate of a chemical reaction and remains unchanged at the end of the reaction.
Hydrogen peroxide solution, H_2O_2, breaks down to form oxygen. This decomposition is very slow if a catalyst is not used.
Plan an investigation to show that copper(II) oxide is a suitable catalyst for this reaction.
You can use aqueous hydrogen peroxide and common laboratory apparatus.

Step 1 Show that copper(II) oxide catalyses the decomposition of hydrogen peroxide and measure the rate of the reaction.

.....

.....

.....

.....

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.....

Step 2 Show that the copper(II) oxide is unchanged at the end of the decomposition.

.....

.....

.....

.....

.....

.....

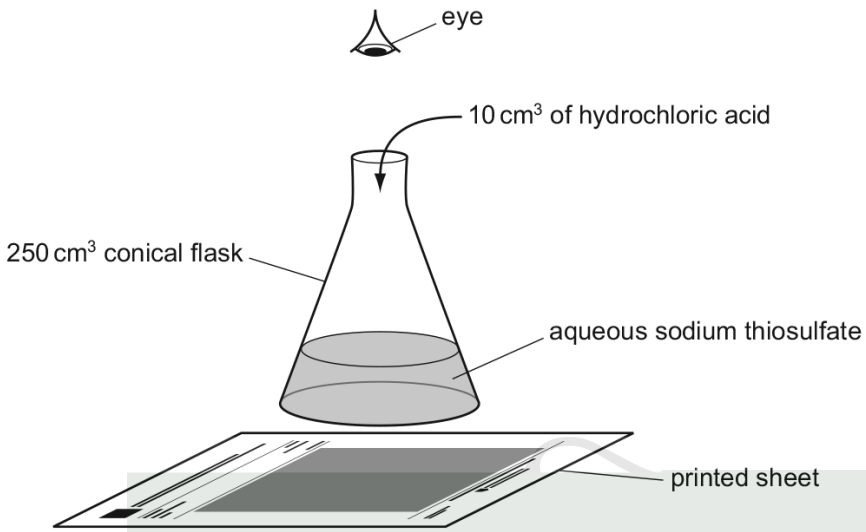
.....

[Total: 8]

14. 0620_s15_qp_62 Q: 4

A student investigated the rate of reaction between hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Five experiments were done using the apparatus shown below.



(a) *Experiment 1*

Using a measuring cylinder, 50 cm^3 of aqueous sodium thiosulfate was poured into a conical flask. The conical flask was placed on a printed sheet of paper.
10 cm^3 of the hydrochloric acid was added to the solution in the conical flask and the stop clock started.
The time taken for the printed words to disappear from view was measured.

(b) *Experiment 2*

Using a measuring cylinder, 40 cm^3 of aqueous sodium thiosulfate was poured into a conical flask, followed by 10 cm^3 of distilled water. The conical flask was placed on the printed sheet.
10 cm^3 of the hydrochloric acid was added to the solution in the conical flask and the stop clock started.
The time taken for the printed words to disappear from view was measured.

(c) *Experiment 3*

Experiment 2 was repeated using 35 cm^3 of aqueous sodium thiosulfate and 15 cm^3 of distilled water.

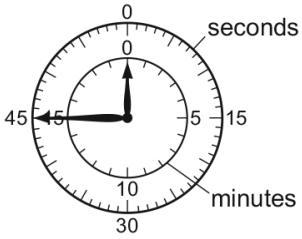
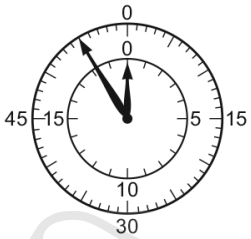
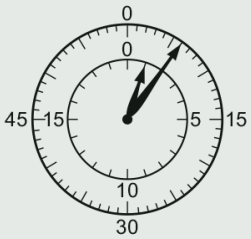
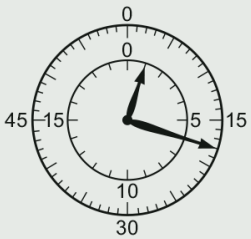
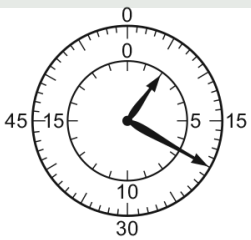
(d) *Experiment 4*

Experiment 2 was repeated using 30 cm^3 of aqueous sodium thiosulfate and 20 cm^3 of distilled water.

(e) *Experiment 5*

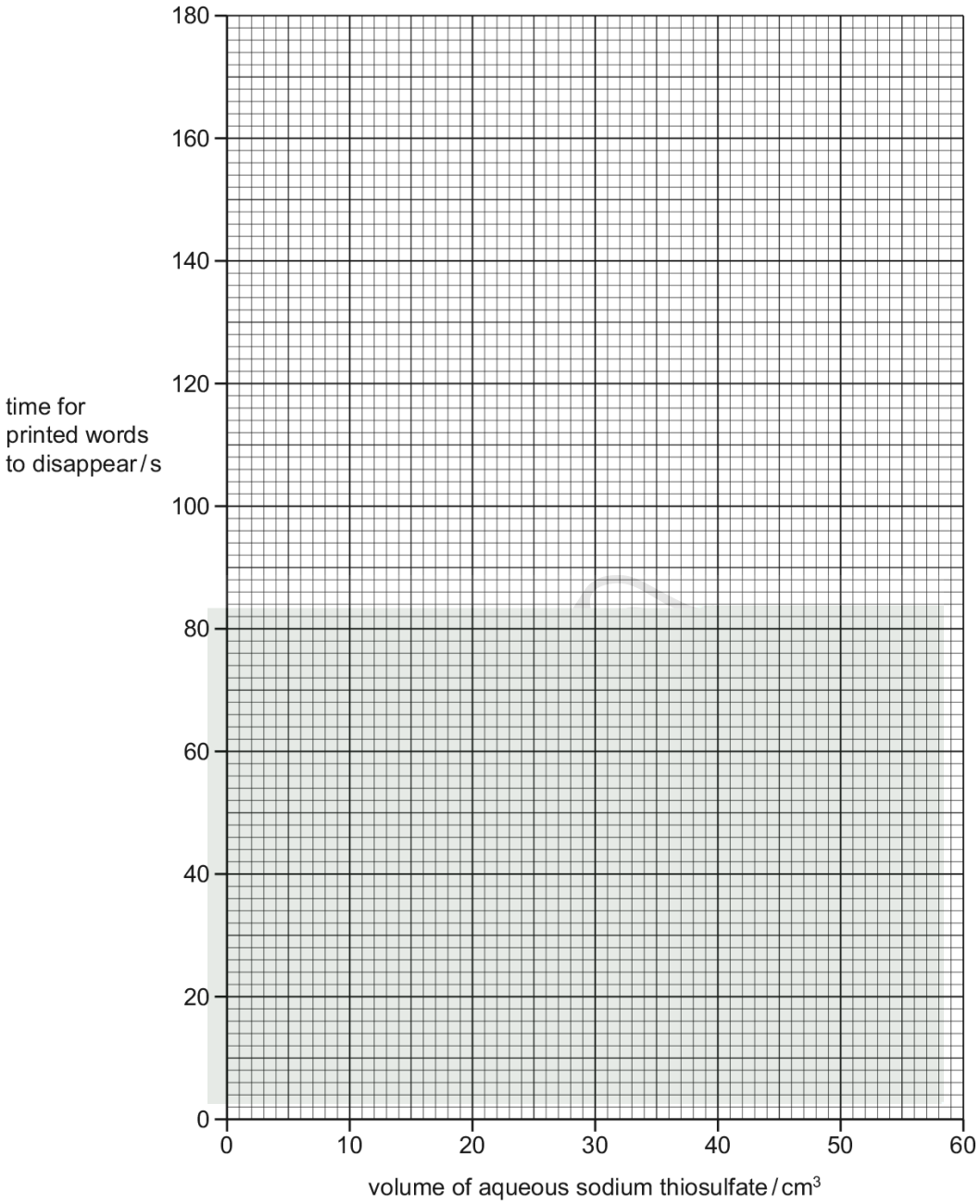
Experiment 2 was repeated using 20 cm^3 of aqueous sodium thiosulfate and 30 cm^3 of distilled water.

(f) Use the stop clock diagrams to record the times in the table.
Complete the table.

Experiment number	volume of aqueous sodium thiosulfate / cm^3	volume of distilled water / cm^3	stop clock diagram	time for printed words to disappear / s
1				
2				
3				
4				
5				

[4]

(g) Plot the results on the grid and draw a smooth line graph.



[3]

(h) (i) **From your graph**, deduce the time for the printed words to disappear if Experiment 2 was repeated using 25 cm^3 of aqueous sodium thiosulfate and 25 cm^3 of distilled water. Show clearly **on the grid** how you worked out your answer.

..... [3]

(ii) Sketch **on the grid** the curve you would expect if the experiments were repeated at a lower temperature. Label this curve 'lower temperature'. [1]

(i) **(i)** In which experiment was the rate of reaction greatest?

..... [1]

(ii) Explain why the rate of reaction was greatest in this experiment.

.....

..... [1]

(j) A student did a sixth experiment using 60 cm^3 of aqueous sodium thiosulfate.

Why would this not be an appropriate volume to use in this series of experiments?

.....

..... [2]

(k) Suggest and explain the effect of

(i) using a burette to measure the volume of the hydrochloric acid,

.....

..... [2]

(ii) using a 100 cm^3 conical flask.

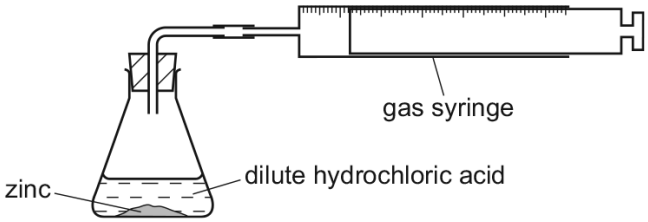
.....

..... [2]

[Total: 19]

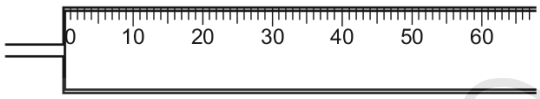
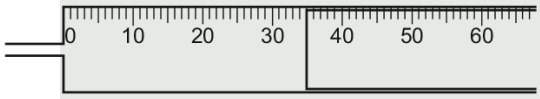
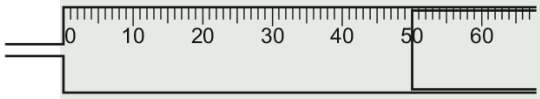
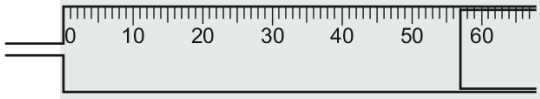
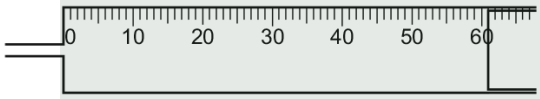
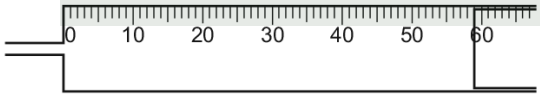
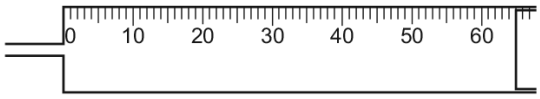
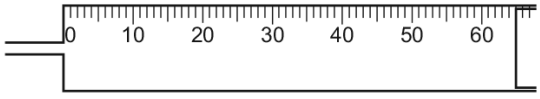
15. 0620_s15_qp_63 Q: 2

A student investigated the rate of reaction between zinc and excess hydrochloric acid, at 20 °C.
2 g of zinc powder was added to 50 cm^3 of dilute hydrochloric acid.



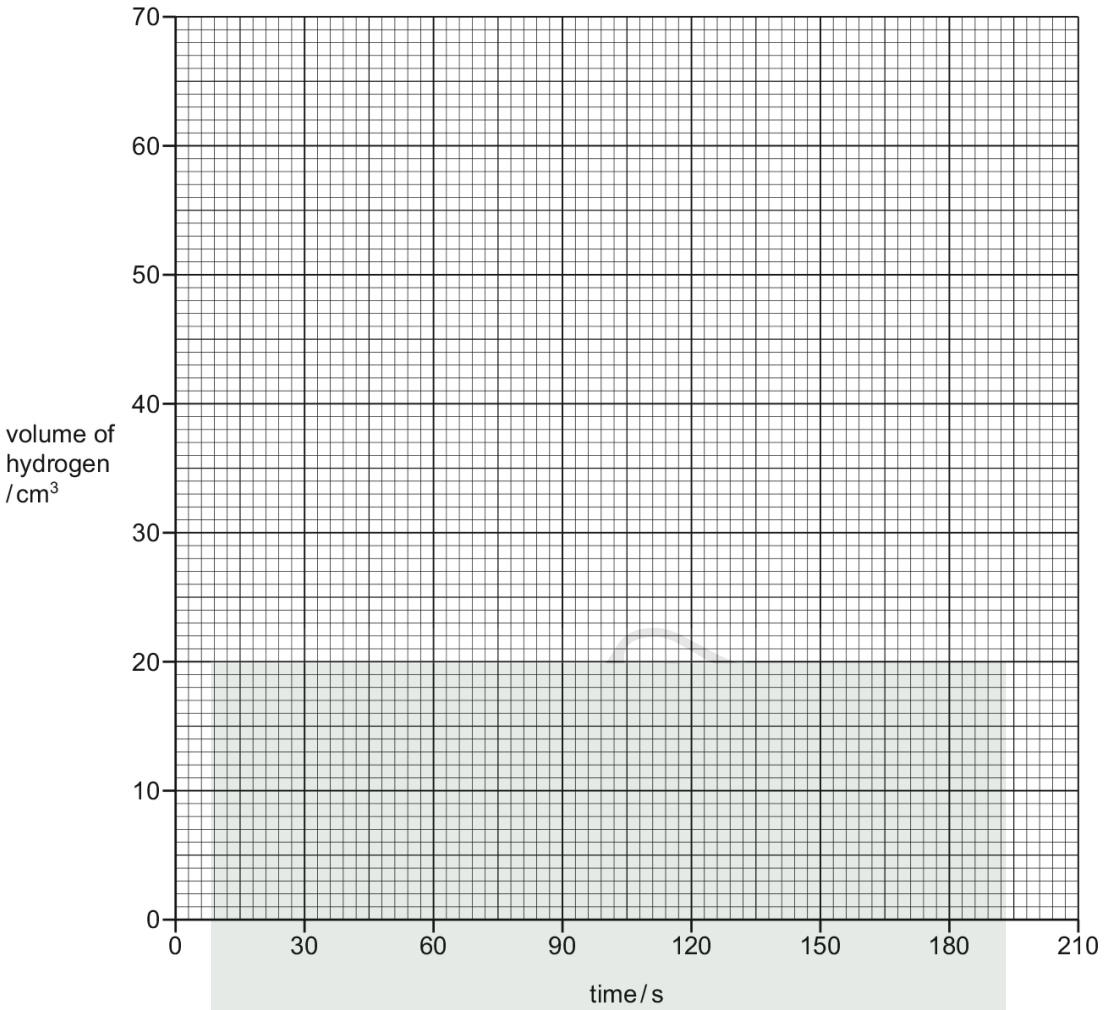
The volume of hydrogen released was measured every 30 seconds.

(a) Use the gas syringe diagrams to record the volumes in the table.

time / s	gas syringe diagram	volume of hydrogen / cm^3
0		
30		
60		
90		
120		
150		
180		
210		

[3]

(b) Plot the points on the grid. Draw a smooth line graph.



[4]

(c) **(i)** At which time interval does the point appear to be inaccurate?

..... [1]

(ii) **Use your graph** to find the volume of gas that would be expected at this time.

..... [2]

(d) The experiment was repeated but the hydrochloric acid was cooled to 5 °C before adding the zinc.

(i) How could the hydrochloric acid be cooled?

..... [1]

(ii) Sketch **on the grid** the graph you would expect for the results at 5 °C. Label your graph 'lower temperature'. [2]

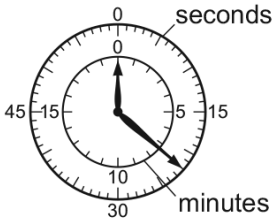
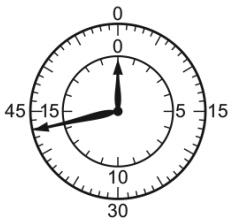
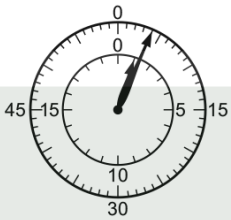
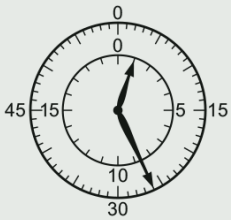
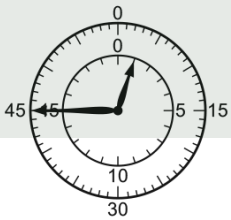
[Total: 13]

16. 0620_s16_qp_62 Q: 2

A student investigated the rate of reaction between hydrogen peroxide and aqueous potassium iodide. When these chemicals react they form iodine. Sodium thiosulfate solution reacts with iodine and can be used to show how fast the reaction proceeds.

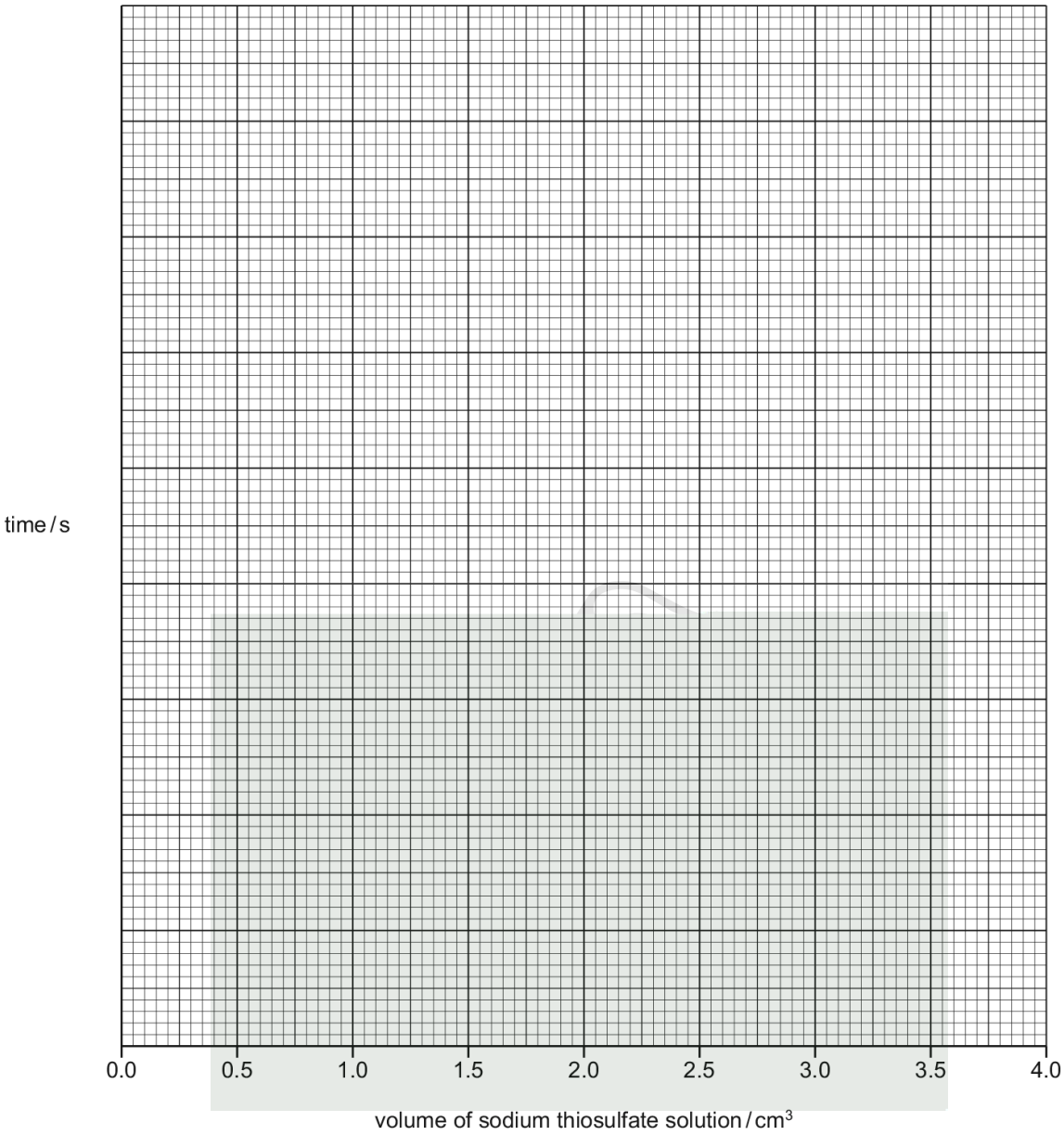
(a) A burette was filled up to the 0.0 cm^3 mark with sodium thiosulfate solution.
Using a large measuring cylinder, 100 cm^3 of distilled water were poured into a conical flask.
Using a small measuring cylinder, 6 cm^3 of sulfuric acid, 1 cm^3 of starch solution and 4 cm^3 of aqueous potassium iodide were added to the flask.
0.5 cm^3 of sodium thiosulfate solution was added from the burette to the mixture in the flask and swirled to mix.
The reaction was then started by adding 3 cm^3 of hydrogen peroxide solution to the mixture, and the timer started.
The time taken for a blue colour to appear was noted.
A further 0.5 cm^3 of sodium thiosulfate solution was added to the mixture in the conical flask, swirled and the blue colour disappeared. The time when the blue colour reappeared was noted.
The experiment continued by adding further 0.5 cm^3 portions of sodium thiosulfate solution until a total of 3.0 cm^3 of sodium thiosulfate solution had been added, noting the times at which the blue colour reappeared.

Use the timer diagrams on page 4 to record the times in seconds in the table.

total volume of sodium thiosulfate solution added / cm^3	timer diagram	time at which blue colour appeared / s
0.5		
1.0		
1.5		
2.0		
2.5		
3.0		

[3]

(b) Plot the results you have obtained on the grid and draw a best-fit straight-line graph.



[5]

(c) (i) **From your graph** deduce the time at which the blue colour would appear if a total of 4.0 cm^3 of sodium thiosulfate solution were added to the mixture in the conical flask.
Show clearly **on the grid** how you worked out your answer.

..... [3]

(ii) Sketch **on the grid** the graph you would expect if the experiment was repeated at a higher temperature. [1]

(d) Suggest the purpose of the starch solution.

..... [1]

(e) **(i)** Suggest **one** advantage of using a pipette to measure the volume of the hydrogen peroxide.

..... [1]

(ii) Suggest and explain **one** disadvantage of using a pipette to measure the volume of the hydrogen peroxide.

.....

..... [2]

(f) Explain **one** disadvantage of using a beaker instead of a conical flask.

.....

..... [1]

[Total: 17]

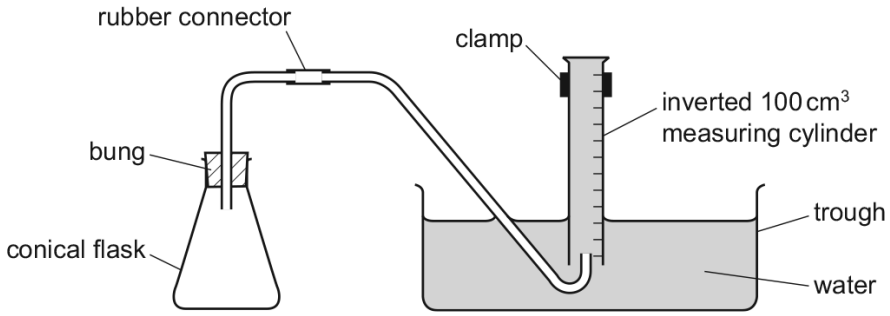
17. 0620_s17_qp_63 Q: 2

A student investigated the rate of reaction between magnesium ribbon and two different solutions of dilute sulfuric acid, solution **G** and solution **H**. The acid was in excess in both experiments.

Two experiments were carried out.

Experiment 1

- The apparatus was set up as shown in the diagram.

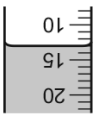
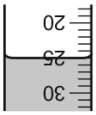
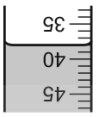
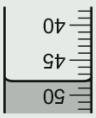
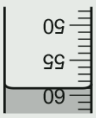
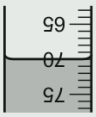
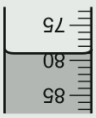
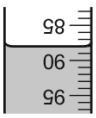
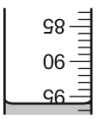


- Using a measuring cylinder, 50 cm^3 of solution **G** were poured into the conical flask. A piece of magnesium ribbon was added to the conical flask and the bung replaced.
- The timer was started immediately and the total volume of gas collected in the measuring cylinder was measured every 20 seconds for 180 seconds (3 minutes).

Experiment 2

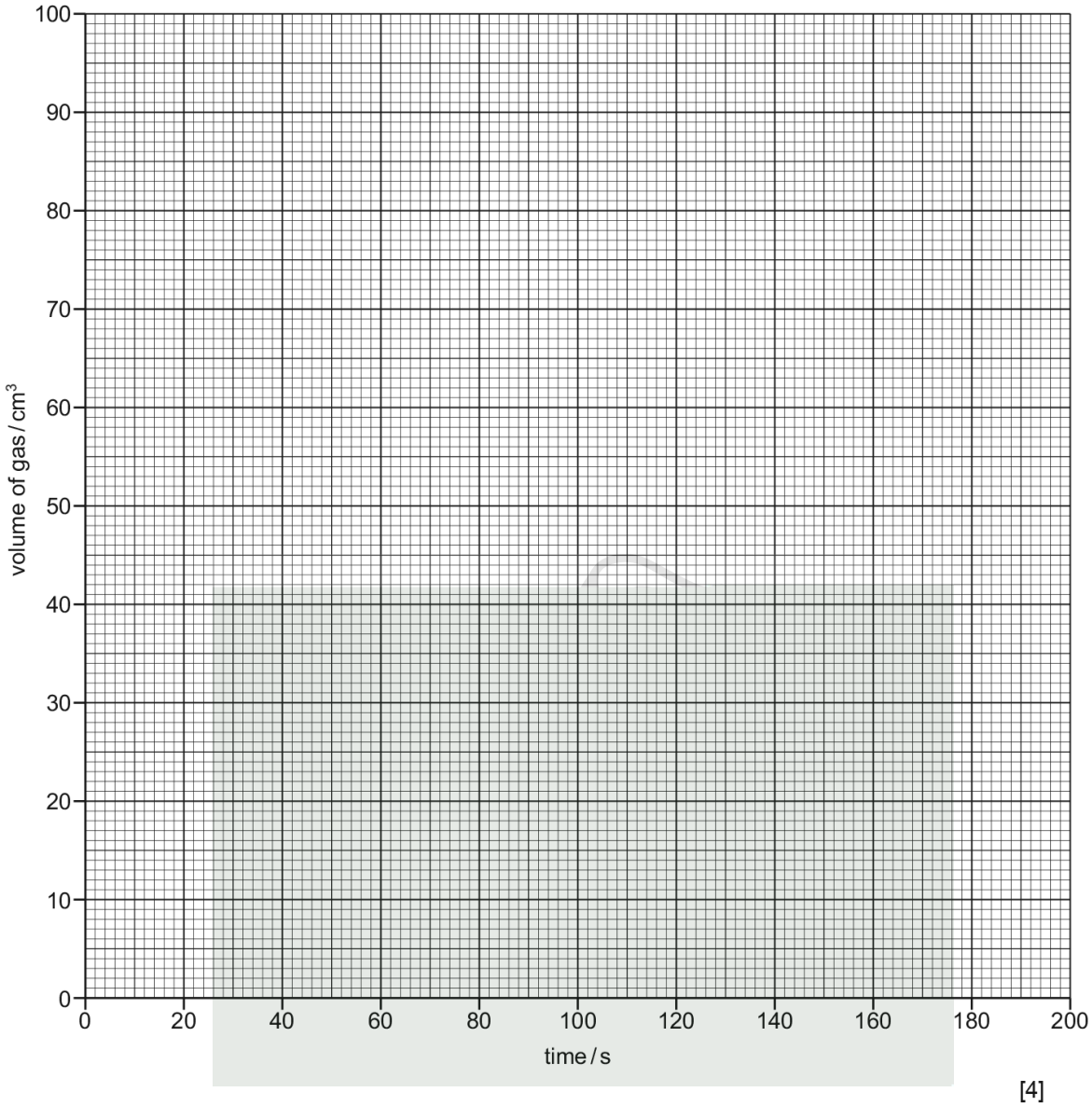
- Experiment 1 was repeated using 50 cm^3 of solution **H** instead of solution **G**.

(a) Use the measuring cylinder diagrams to record the volumes of gas collected in Experiment 1.

	Experiment 1		Experiment 2
time / s	measuring cylinder diagram	volume of gas / cm^3	volume of gas / cm^3
0			0
20			8
40			14
60			21
80			27
100			33
120			39
140			45
160			50
180			55

[3]

(b) Plot the results for Experiments 1 and 2 on the grid and draw **two** smooth line graphs. Clearly label your graphs.



[4]

(c) Which experiment had the faster rate of reaction? Suggest a reason why the rate was faster in this experiment.

.....

..... [2]

(d) The average rate of this reaction can be calculated using the equation shown.

$$\text{average rate} = \frac{\text{volume of gas / cm}^3}{\text{time taken / s}}$$

For Experiment 1, calculate the average rate of reaction for the first 30 seconds of the reaction. Include the units.

rate = ...

units = ...
[3]

(e) Why, eventually, will no more gas be produced?

..... [1]

(f) Suggest the effect on the rate of reaction of using the same mass of magnesium powder instead of magnesium ribbon. Explain your answer.

.....

.....

..... [2]

(g) Give **one** advantage and **one** disadvantage of using a measuring cylinder to measure the volumes of solution **G** and solution **H**.

advantage .....

disadvantage .....
[2]

(h) Suggest **one** improvement to these experiments.

.....

..... [1]

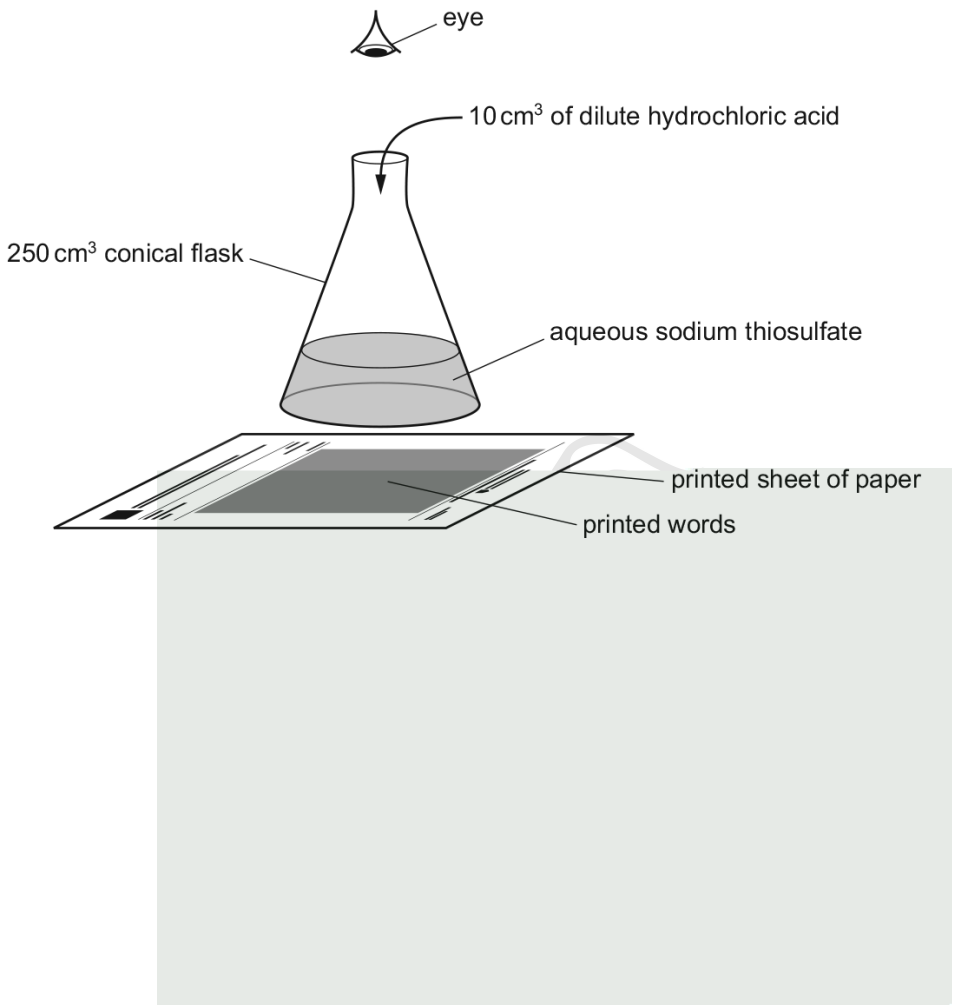
[Total: 18]

---

18. 0620_s18_qp_61 Q: 2

A student investigated the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Five experiments were done using the apparatus shown.



Experiment 1

- A large measuring cylinder was used to pour 50 cm^3 of aqueous sodium thiosulfate into a 250 cm^3 conical flask. The conical flask was placed on a printed sheet of paper.
- 10 cm^3 of dilute hydrochloric acid was added to the solution in the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the printed words to disappear from view was measured.

Experiment 2

- The large measuring cylinder was used to pour 40 cm^3 of aqueous sodium thiosulfate into a conical flask, followed by 10 cm^3 of distilled water. The conical flask was placed on the printed sheet of paper.
- 10 cm^3 of dilute hydrochloric acid was added to the solution in the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the printed words to disappear from view was measured.

Experiment 3

- Experiment 2 was repeated but using 35 cm^3 of aqueous sodium thiosulfate and 15 cm^3 of distilled water.

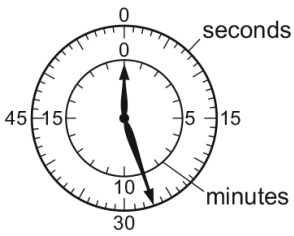
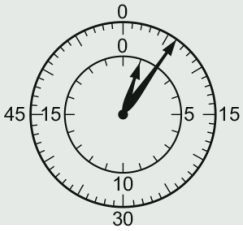
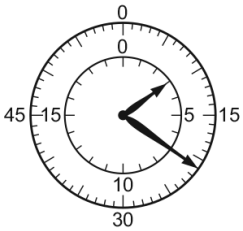
Experiment 4

- Experiment 2 was repeated but using 30 cm^3 of aqueous sodium thiosulfate and 20 cm^3 of distilled water.

Experiment 5

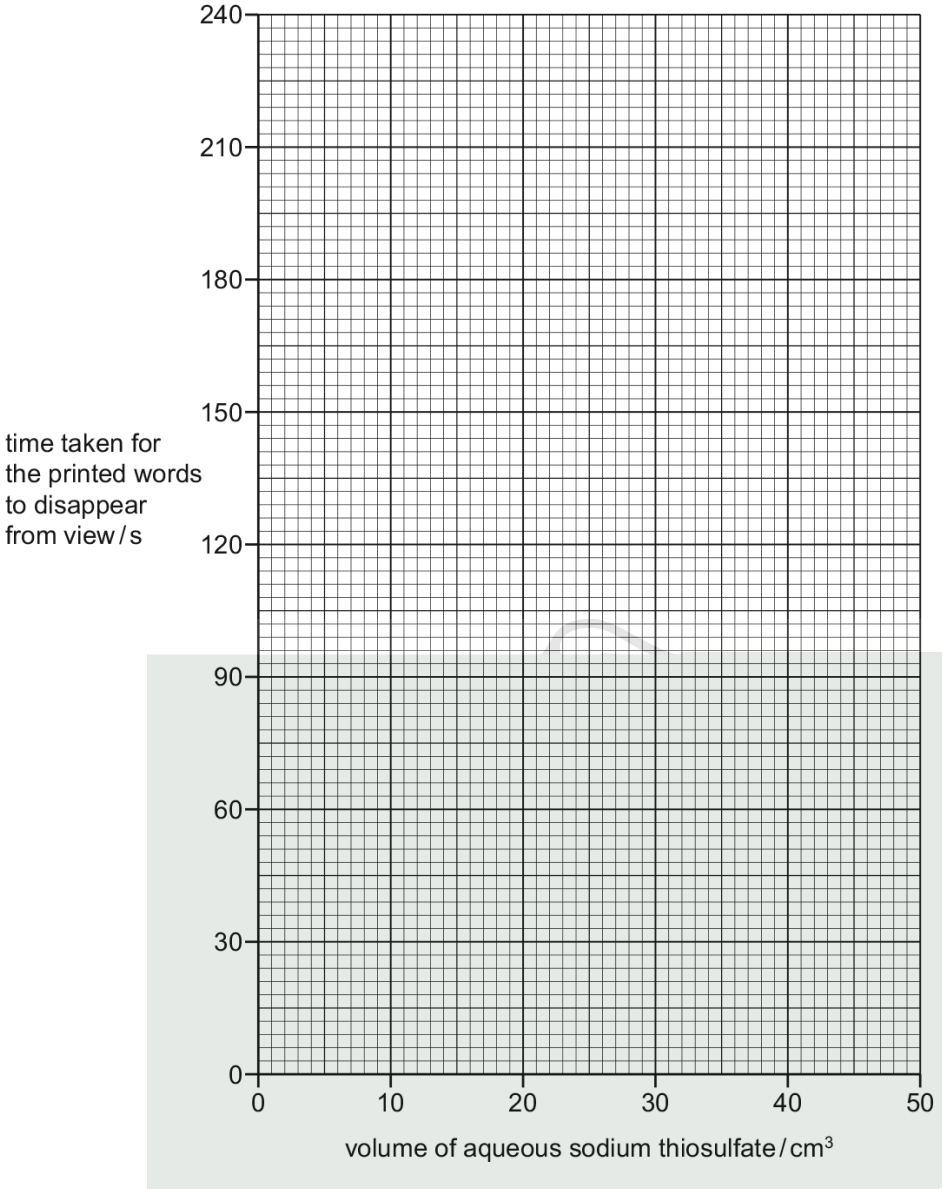
- Experiment 2 was repeated but using 10 cm^3 of aqueous sodium thiosulfate and 40 cm^3 of distilled water.

(a) Record the volumes of distilled water used in the table. Use the stop-clock diagrams to record the results in the table.

experiment	volume of aqueous sodium thiosulfate / cm^3	volume of distilled water / cm^3	stop-clock diagram	time taken for the printed words to disappear from view / s
1	50			
2	40			
3	35			
4	30			
5	10			

[3]

(b) Plot the results from Experiments 1–5 on the grid. Draw a smooth line graph.



[3]

(c) (i) **From your graph**, deduce the time taken for the printed words to disappear from view if Experiment 2 were repeated using 20 cm^3 of aqueous sodium thiosulfate and 30 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... **s** [2]

(ii) The rate of reaction can be calculated using the equation shown.

$$\text{rate of reaction} = \frac{1}{\text{time taken}}$$

Calculate the rate of reaction using your answer from **(c)(i)**.

..... [1]

(d) (i) In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) Give the name of a more accurate piece of apparatus for measuring volumes than a measuring cylinder.

..... [1]

(f) Suggest the effect on the results of using a 100 cm^3 conical flask instead of a 250 cm^3 conical flask. Explain your answer.

.....

..... [2]

(g) Sketch **on the grid** the graph you would expect if all of the experiments were repeated at a **lower** temperature. Clearly label your graph. [1]

[Total: 16]

19. 0620_s19_qp_63 Q: 2

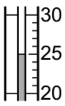
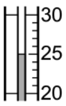
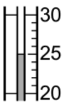
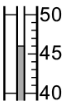
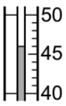
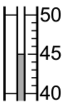
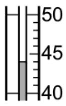
A student investigated the temperature changes when two different metals, zinc and magnesium, reacted with aqueous copper(II) sulfate.

Three experiments were done.

Experiment 1

- A measuring cylinder was used to pour 25 cm^3 aqueous copper(II) sulfate into a polystyrene cup.
- The initial temperature of the solution was measured and the timer was started.
- The temperature of the solution was measured at 30 seconds and at 60 seconds.
- At 60 seconds, 5 g of zinc powder was added to the aqueous copper(II) sulfate. The mixture was stirred with a thermometer.
- The temperature of the mixture was measured every 30 seconds for 210 seconds. The mixture was stirred continuously.

(a) Use the thermometer diagrams to record the temperatures in the table.

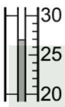
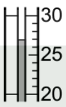
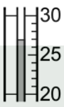
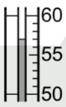
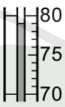
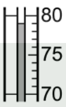
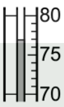
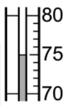
time / s	0	30	60	90	120	150	180	210
thermometer diagram								
temperature of mixture / °C								

[2]

Experiment 2

- Experiment 1 was repeated using 5 g of magnesium powder instead of zinc powder.

(b) Use the thermometer diagrams to record the temperatures in the table.

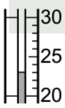
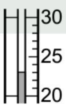
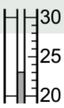
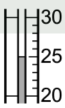
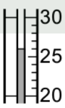
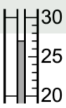
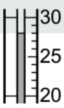
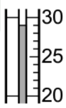
time / s	0	30	60	90	120	150	180	210
thermometer diagram								
temperature of mixture / °C								

[1]

Experiment 3

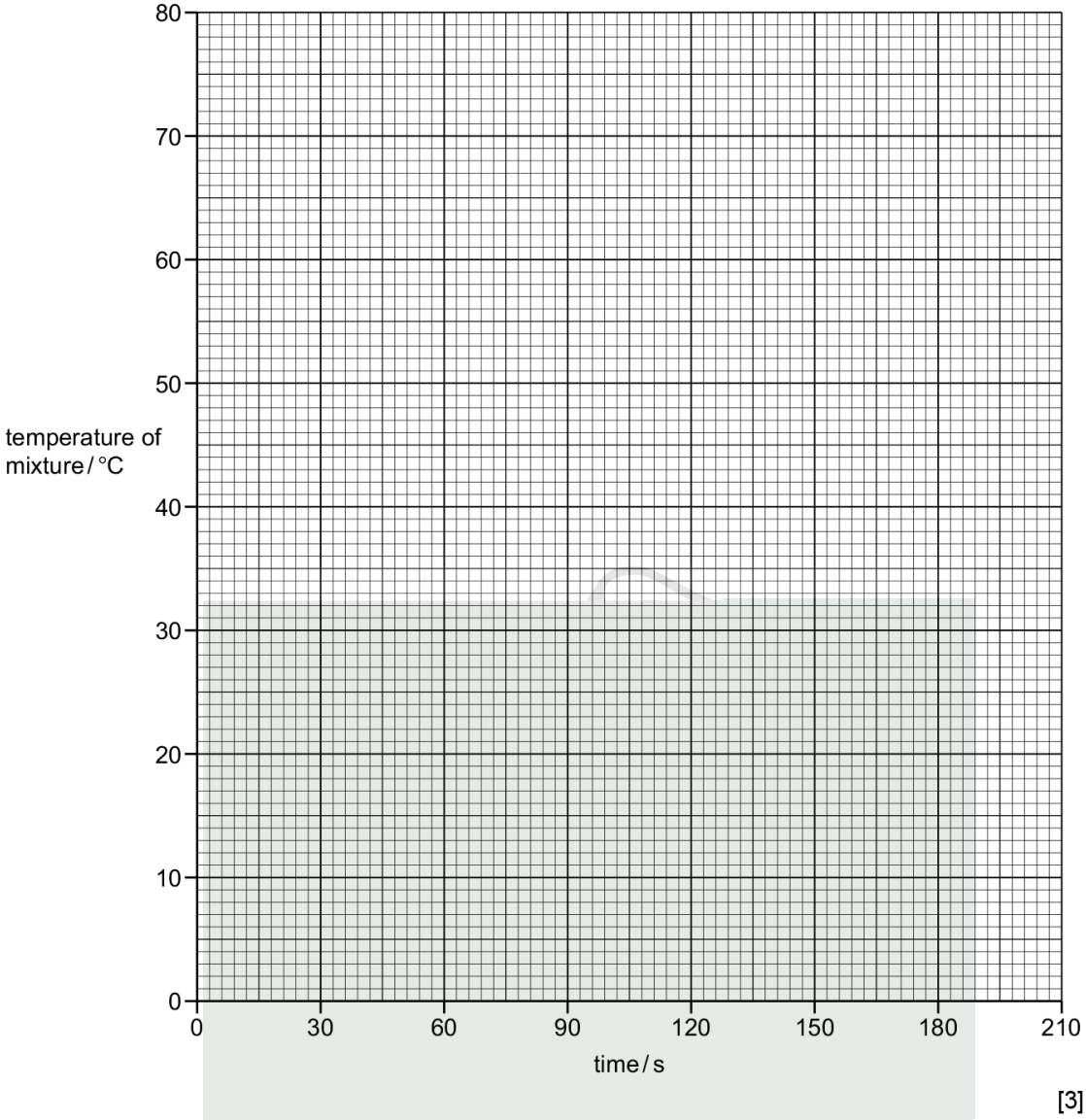
- Experiment 1 was repeated using 5 g of zinc granules instead of zinc powder.

(c) Use the thermometer diagrams to record the temperatures in the table.

time / s	0	30	60	90	120	150	180	210
thermometer diagram								
temperature of mixture / °C								

[1]

(d) Plot the results for Experiments 1–3 on the grid and draw **three** smooth line graphs. Clearly label your lines.



[3]

(e) **From your graph**, deduce the temperature of the mixture in Experiment 2 after 75 seconds.

Show clearly **on the grid** how you worked out your answer.

..... °C [2]

(f) **(i)** From the results, which Experiment was the most exothermic? Explain your answer.

.....

..... [2]

(ii) Compare the rates of reaction in Experiments 1 and 3. Explain why the rates of reaction are different.

.....

.....

..... [2]

(g) Predict the temperature of the mixture in Experiment 2 after 2 hours. Explain your answer.

.....

..... [2]

(h) When doing the experiments, what would be the advantage of taking the temperature readings every 15 seconds?

.....

..... [2]

(i) Explain why a copper can should **not** be used in place of the polystyrene cup in these experiments.

.....

.....

..... [2]

[Total: 19]

20. 0620_s20_qp_62 Q: 2

A student investigated the temperature change when magnesium ribbon reacts with dilute sulfuric acid.

Five experiments were done.

Experiment 1

- Using a measuring cylinder, 20 cm^3 of dilute sulfuric acid were poured into a boiling tube.
- A thermometer was used to measure the initial temperature of the acid.
- A 1 cm length of magnesium ribbon was added to the acid in the boiling tube.
- The acid and magnesium ribbon in the boiling tube were stirred continuously using a thermometer.
- The highest temperature reached by the mixture was measured.
- The boiling tube was rinsed out with distilled water.

Experiment 2

- Experiment 1 was repeated using a 2 cm length of magnesium ribbon instead of the 1 cm length.

Experiment 3

- Experiment 1 was repeated using a 3 cm length of magnesium ribbon instead of the 1 cm length.

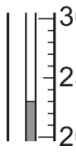
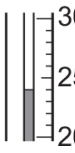
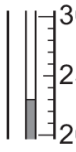
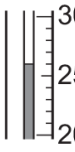
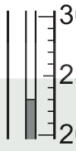
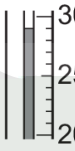
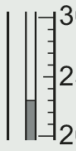
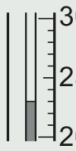
Experiment 4

- Experiment 1 was repeated using a 5 cm length of magnesium ribbon instead of the 1 cm length.

Experiment 5

- Experiment 1 was repeated using a 6 cm length of magnesium ribbon instead of the 1 cm length.

(a) Use the information in the description of the experiments and the thermometer diagrams to complete the table.

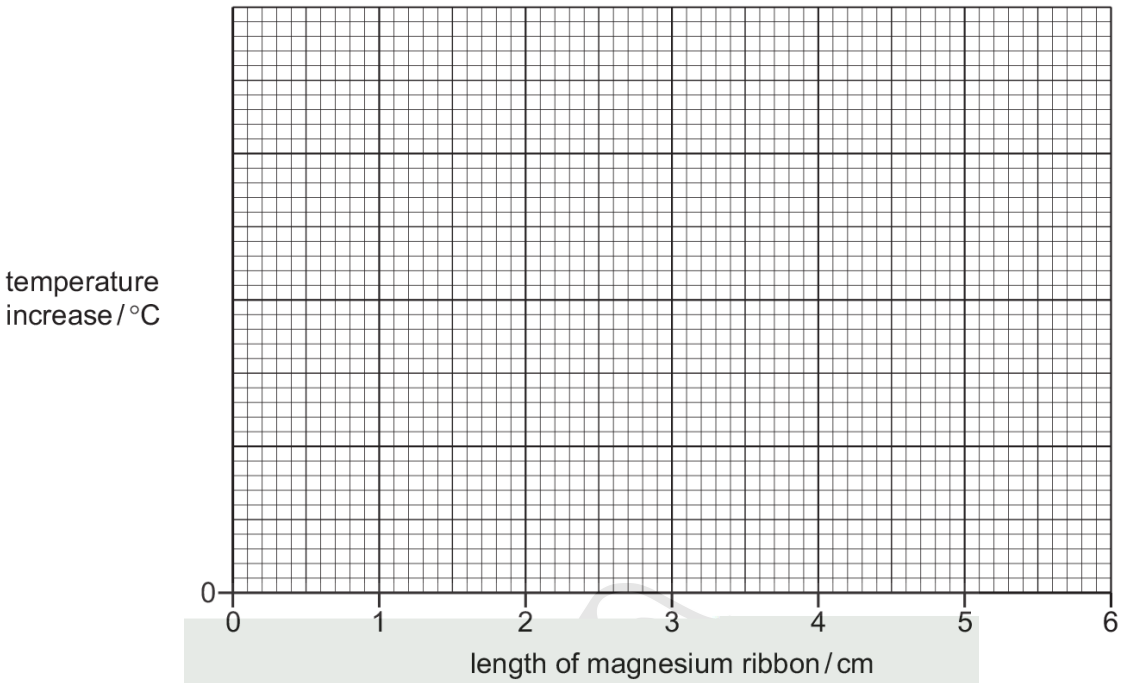
experiment	length of magnesium ribbon / cm	initial temperature		highest temperature		temperature increase / °C
		thermometer diagram	initial temperature of acid / °C	thermometer diagram	highest temperature of acid / °C	
1						
2						
3						
4						
5						

[4]

(b) In which experiment, 1, 2, 3, 4 or 5, was the temperature increase the largest?

..... [1]

(c) Add a suitable scale to the *y*-axis and plot the results from Experiments 1 to 5 on the grid. Draw a smooth line graph, making sure that your line passes through (0,0).



[5]

(d) Explain why the graph line must pass through (0,0).

.....

..... [1]

(e) **From your graph**, deduce the temperature increase if Experiment 1 is repeated using a 4 cm length of magnesium ribbon.

Show clearly **on the grid** how you worked out your answer.

.....
[3]

(f) **(i)** Why would carrying out the experiment in a polystyrene cup rather than a boiling tube improve the accuracy of the results?

.....

..... [1]

(ii) Sketch **on the grid** the graph you would expect if the experiment was repeated using a polystyrene cup instead of a boiling tube. [1]

(g) The volume of dilute sulfuric acid could be measured with a 20 cm^3 pipette.

(i) State **one** advantage of using a pipette rather than a measuring cylinder.

.....

..... [1]

(ii) State **one** disadvantage of using a pipette rather than a measuring cylinder.

.....

..... [1]

[Total: 18]

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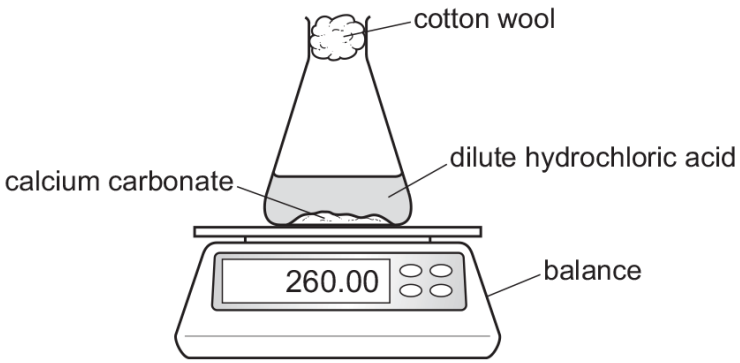
21. 0620_s21_qp_61 Q: 4

Dilute hydrochloric acid reacts with calcium carbonate to make carbon dioxide gas. The apparatus shown in the diagram can be used to follow the progress of the reaction. The carbon dioxide gas leaves the flask causing the mass shown on the balance to decrease.



Plan an investigation, using the apparatus shown in the diagram, to find out how the temperature of the dilute hydrochloric acid affects the rate of the reaction. Your plan should include how your results will show how the temperature of the dilute hydrochloric acid affects the rate of the reaction.

You are provided with dilute hydrochloric acid, calcium carbonate and common laboratory apparatus.

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..... [6]

22. 0620_w12_qp_61 Q: 4

A student investigated the speed of reaction when iodine was produced by the reaction of solution **L** with potassium iodide at different temperatures.

Five experiments were carried out.

Experiment 1

A burette was filled with the aqueous solution **L** to the 0.0 cm^3 mark.
10.0 cm^3 of solution **L** was added from the burette into a boiling tube and the initial temperature of the solution was measured.

Using a measuring cylinder, 5 cm^3 of aqueous potassium iodide and 3 cm^3 of aqueous sodium thiosulfate were poured into a second boiling tube. Starch solution was added to this boiling tube and the mixture shaken.

The mixture in the second boiling tube was added to the solution **L**, shaken and the clock started. These chemicals reacted to form iodine which reacted with the starch. When a blue colour appeared, the clock was stopped and the time measured and recorded in the table. The final temperature of the mixture was measured.

Experiment 2

Experiment 1 was repeated but solution **L** was heated to about 40 °C. The temperature of the solution was measured before adding the mixture in the second boiling tube.
When a blue colour appeared, the clock was stopped and the time measured and recorded in the table. The final temperature of the mixture was measured.

Experiment 3

Experiment 2 was repeated, heating solution **L** to about 50 °C.

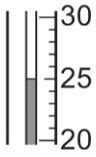
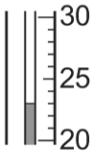
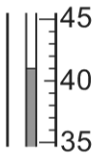
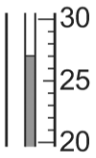
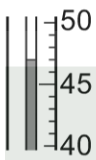
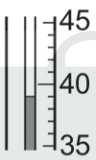
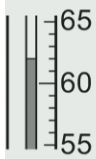
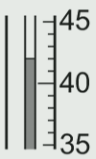
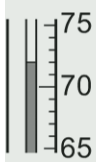
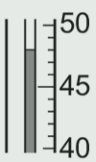
Experiment 4

Experiment 2 was repeated, heating solution **L** to about 60 °C.

Experiment 5

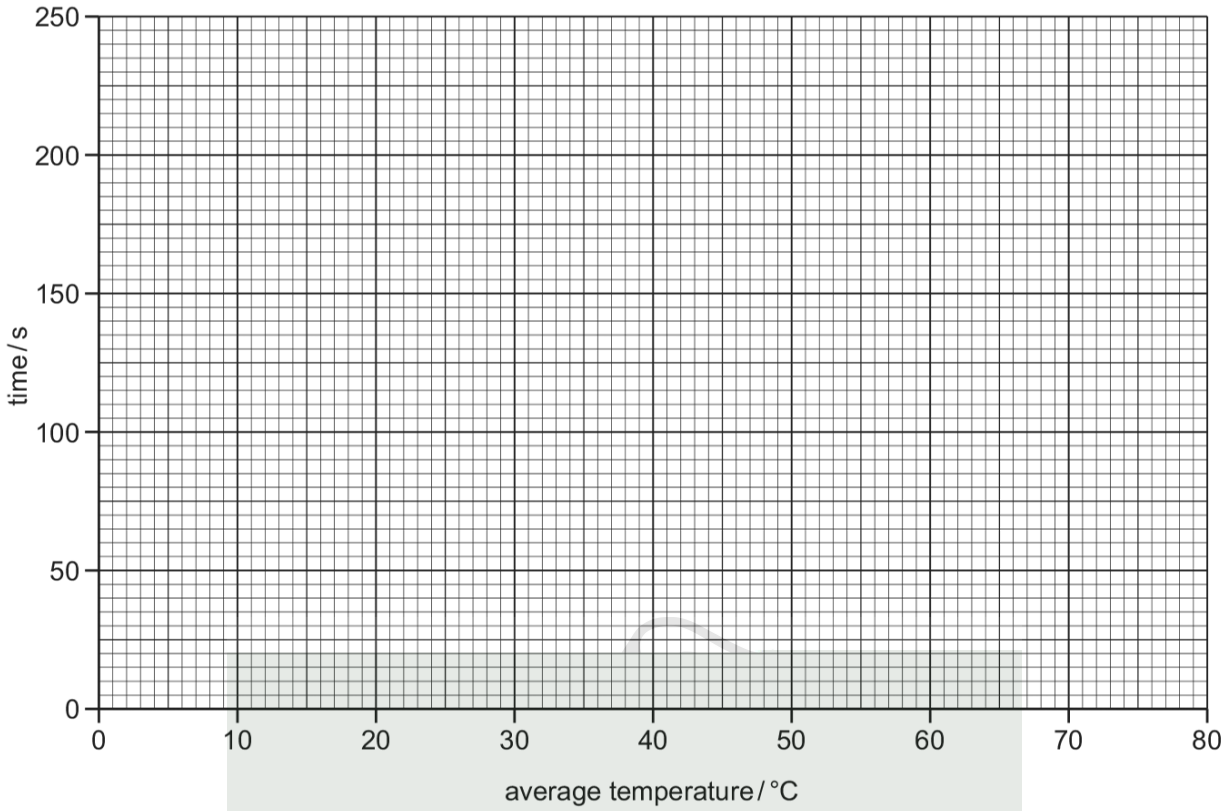
Experiment 2 was repeated, heating solution **L** to about 70 °C.

(a) Use the thermometer diagrams in the table to record the temperatures and complete the table.

experiment	thermometer diagram	initial temperature / °C	thermometer diagram	final temperature / °C	average temperature / °C	time / s
1						215
2						105
3						60
4						40
5						35

[5]

(b) Plot the results on the grid below and draw a smooth line graph.



[5]

(c) **From your graph**, work out the time taken for the blue colour to appear if solution **L** was heated to 80 °C. The final temperature of the reaction mixture was 64 °C.
Show clearly **on the grid** how you obtained your answer.

..... [2]

(d) Suggest the purpose of the starch solution in the experiments.

..... [1]

(e) **(i)** In which experiment was the reaction speed fastest?

..... [1]

(ii) Explain, using ideas about particles, why this experiment was the fastest.

.....

..... [2]

(f) Predict the effect on the time and speed of the reaction in Experiment 5 if it was repeated using a less concentrated solution of **L**.

time .....

speed ..... [2]

(g) Why was a burette used to measure solution **L** instead of a measuring cylinder?

.....

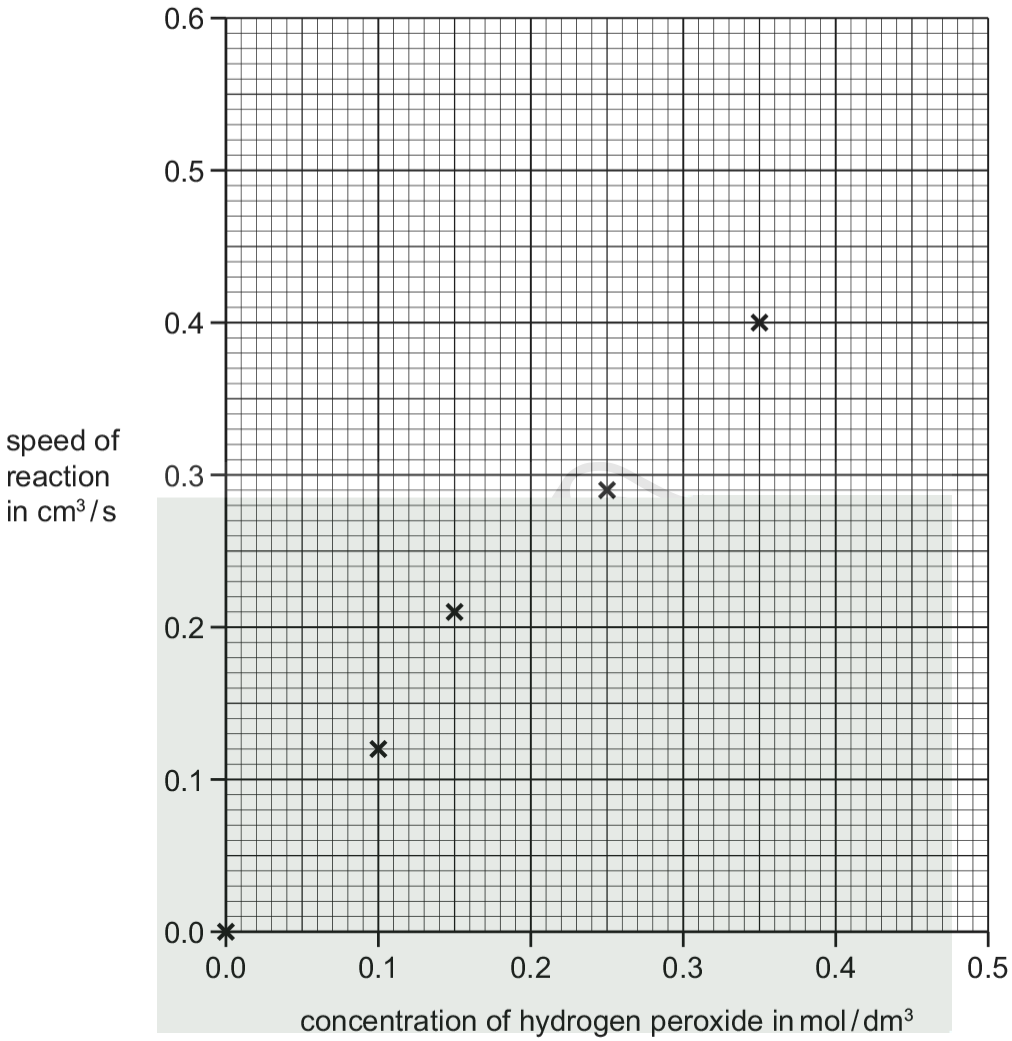
..... [1]

[Total: 19]

---

23. 0620_w12_qp_62 Q: 2

Hydrogen peroxide breaks down to form oxygen. A student investigated the speed of the breakdown of aqueous solutions of hydrogen peroxide of different concentrations, using 1 g of powdered manganese(IV) oxide. The temperature was kept constant at 25 °C. She plotted her results on the grid below.



(a) Draw a straight line graph on the grid. [2]

(b) **From your graph**, work out the speed of the reaction when the concentration of hydrogen peroxide is 0.5 mol/dm³. Show clearly **on the grid** how you obtained your answer.

..... [2]

(c) Sketch on the grid the graph you would expect if the experiments were repeated at 10 °C. [1]

(d) **(i)** What is the function of the manganese(IV) oxide?

..... [1]

(ii) Suggest the effect of repeating the investigation using 1 g of lumps of manganese(IV) oxide. Explain your answer.

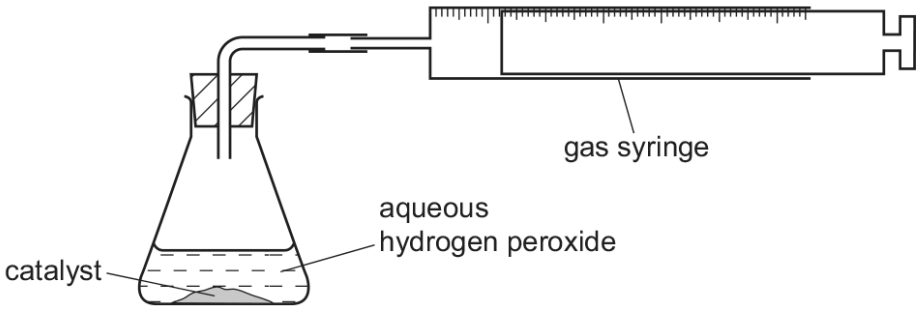
effect .....

explanation ..... [2]

[Total: 8]

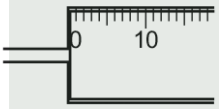
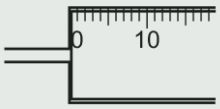
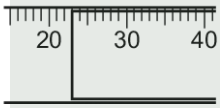
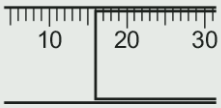
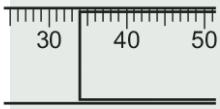
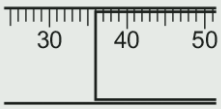
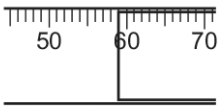
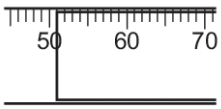
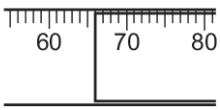
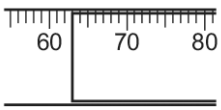
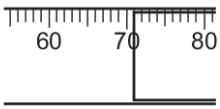
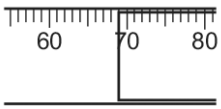
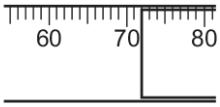
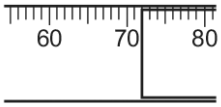
24. 0620_w13_qp_61 Q: 5

Two experiments using catalysts were carried out. Catalysts **R** and **S** were used to break down 50 cm^3 of aqueous hydrogen peroxide at a temperature of 20 °C. The volume of oxygen given off was measured using the apparatus shown.



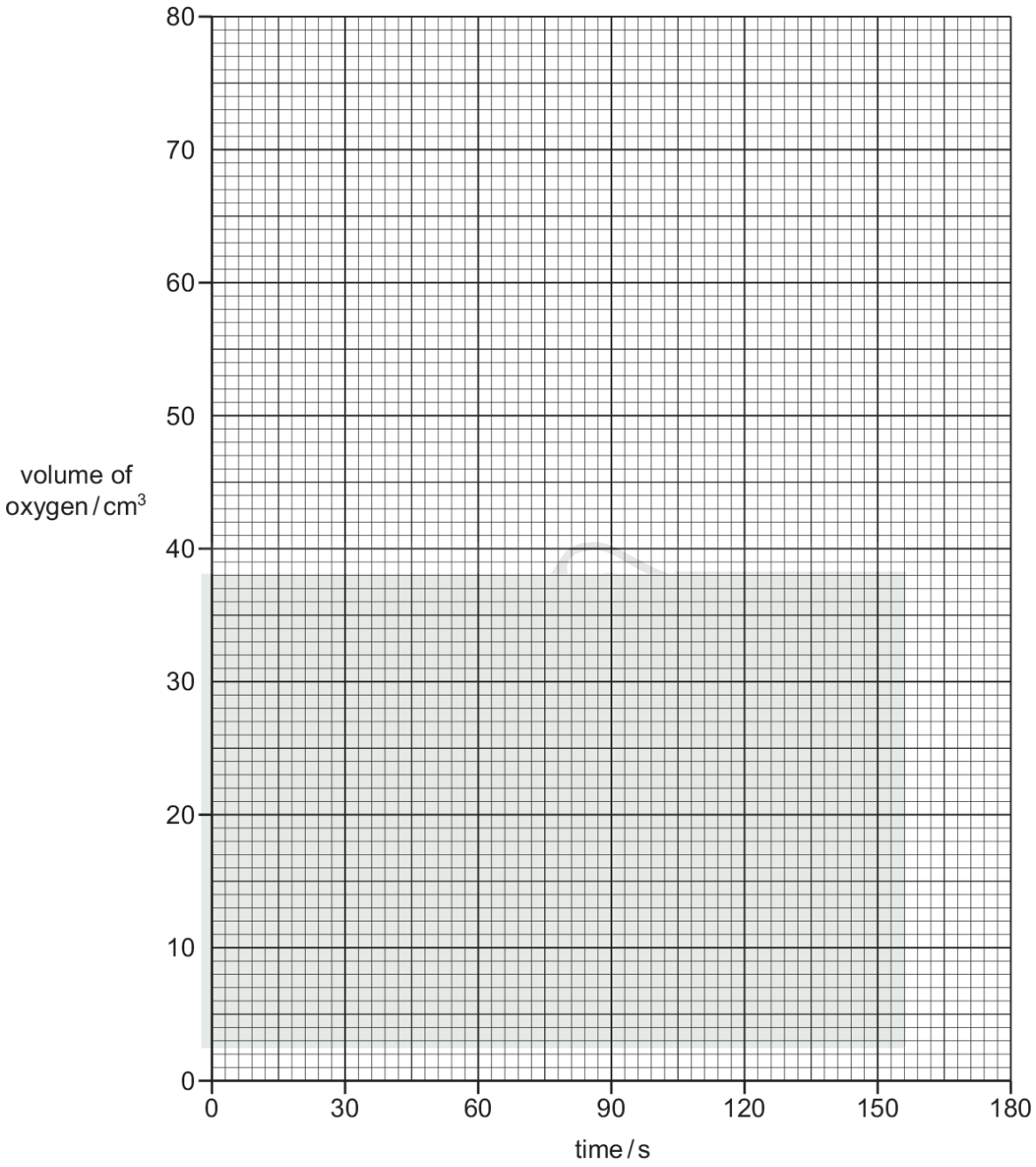
The gas syringe diagrams show the volume of oxygen formed every 30 seconds in each experiment.

(a) Use the syringe diagrams to complete the volumes in the table.

time / s	using catalyst **R**		using catalyst **S**	
	syringe diagram	volume / cm^3	syringe diagram	volume / cm^3
0				
30				
60				
90				
120				
150				
180				

[4]

(b) Plot a graph to show each set of results. Clearly label the graphs **R** and **S**.



[6]

(c) Which result using catalyst **R** was inaccurate?

..... [1]

(d) Which is the better catalyst in this reaction? Explain your answer.

.....

..... [2]

(e) Sketch a line on the grid to show the graph you would expect if the reaction with catalyst **R** was repeated at 50 °C. [2]

[Total: 15]

25. 0620_w13_qp_62 Q: 6

Hair bleach

A solution of hydrogen peroxide can be used to bleach hair. Hairdressers buy '20 volume' hydrogen peroxide. One volume of this solution breaks down to form 20 volumes of oxygen. For example 10 cm^3 of 20 volume hydrogen peroxide will break down to produce 200 cm^3 of oxygen.

Old solutions of hydrogen peroxide will produce less oxygen than expected.

Plan an experiment to find out which of two solutions of hydrogen peroxide, **H** and **J**, is new and which is old. You are provided with common laboratory apparatus and the catalyst manganese(IV) oxide which speeds up the break down of hydrogen peroxide.

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..... [5]

[Total: 5]

26. 0620_w14_qp_61 Q: 2

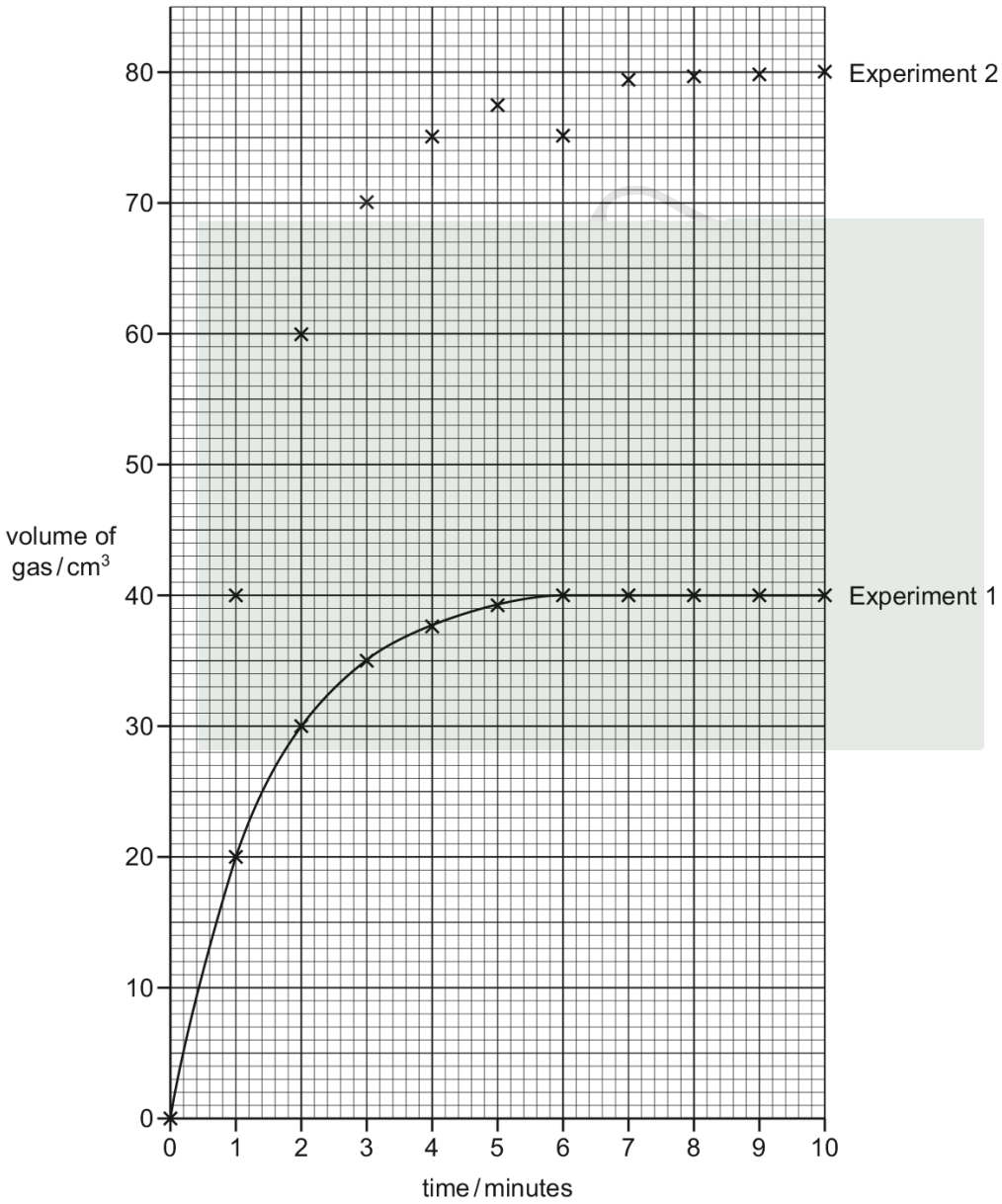
Two experiments were carried out to show what factors affect the rate of decomposition of hydrogen peroxide, H_2O_2.
In each experiment the volume of gas produced was measured every minute for ten minutes.

Experiment 1

The student used a mixture of 50 cm^3 of hydrogen peroxide, 50 cm^3 of water and 1 g of manganese(IV) oxide at a room temperature of 20 °C.
The results were plotted to obtain the graph shown.

Experiment 2

The student repeated Experiment 1 but did not record how much of each substance was used. The points were plotted on the grid.



(a) Complete the graph for Experiment 2. [1]

(b) Suggest the composition of the mixture used in Experiment 2. Explain your suggestion.

composition .....

.....

explanation .....

..... [4]

(c) What is the function of the manganese(IV) oxide?

..... [1]

(d) Sketch on the grid the curve that you would expect if Experiment 1 was repeated at 10 °C. [2]

[Total: 8]

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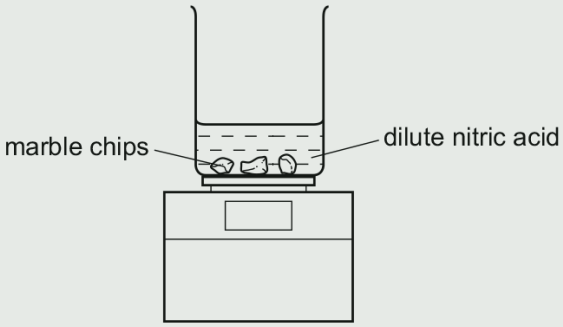
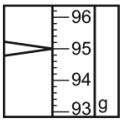
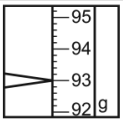
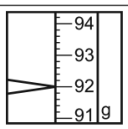
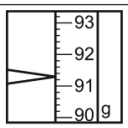
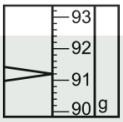
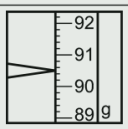
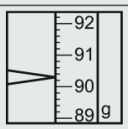
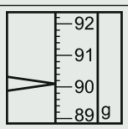
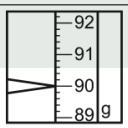
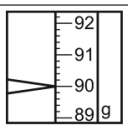
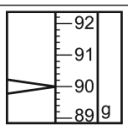
27. 0620_w14_qp_63 Q: 2

A student investigated the rate of reaction between dilute nitric acid and marble chips (calcium carbonate). The apparatus below was used.



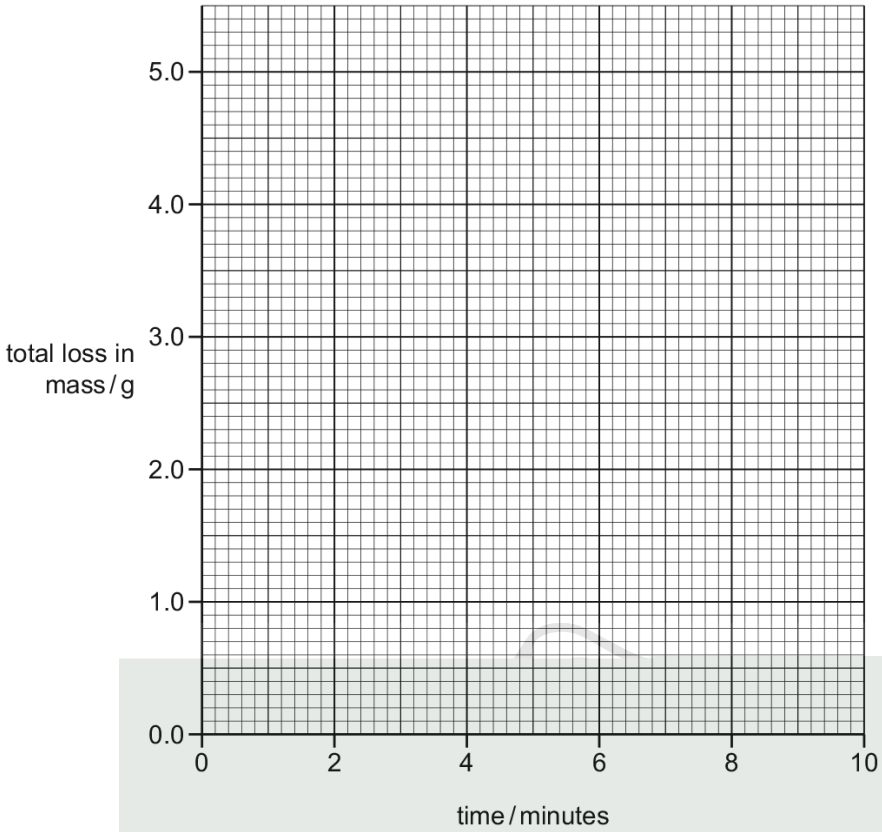
50 cm^3 of dilute nitric acid, an excess, was poured into a beaker. The beaker was placed on a balance and the marble chips added to the beaker. The apparatus was weighed immediately and a timer started. The mass of the beaker and contents was measured every minute for ten minutes.

(a) Use the balance diagrams to record the mass of the beaker and contents in the table. Complete the table to work out the total loss in mass of the beaker and contents.

time / minutes	balance diagram	mass of beaker and contents / g	total loss in mass / g
0		95.0	0.0
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

[3]

(b) Plot the results on the grid and draw a smooth line graph.



[3]

(c) Why does the mass of the beaker and contents decrease?

..... [1]

(d) **(i)** Which result appears to be inaccurate?

..... [1]

(ii) Use your graph to work out the loss in mass expected at that time.

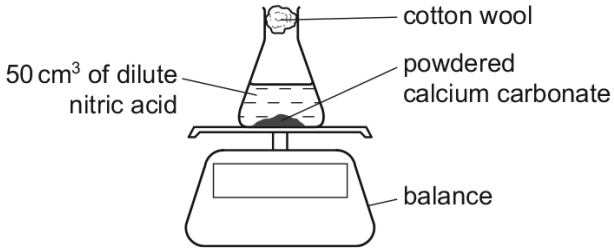
..... [1]

(e) Sketch on the grid the graph you would expect if the experiment was repeated using the same mass of smaller marble chips. [2]

[Total: 11]

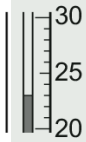
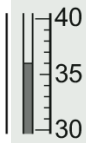
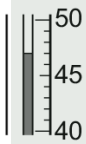
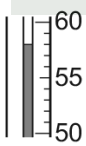
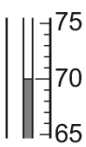
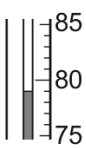
28. 0620_w15_qp_62 Q: 3

A teacher demonstrated the rate of reaction of dilute nitric acid with powdered calcium carbonate at different temperatures.
50 cm^3 of dilute nitric acid was heated to a known temperature and placed on a balance.



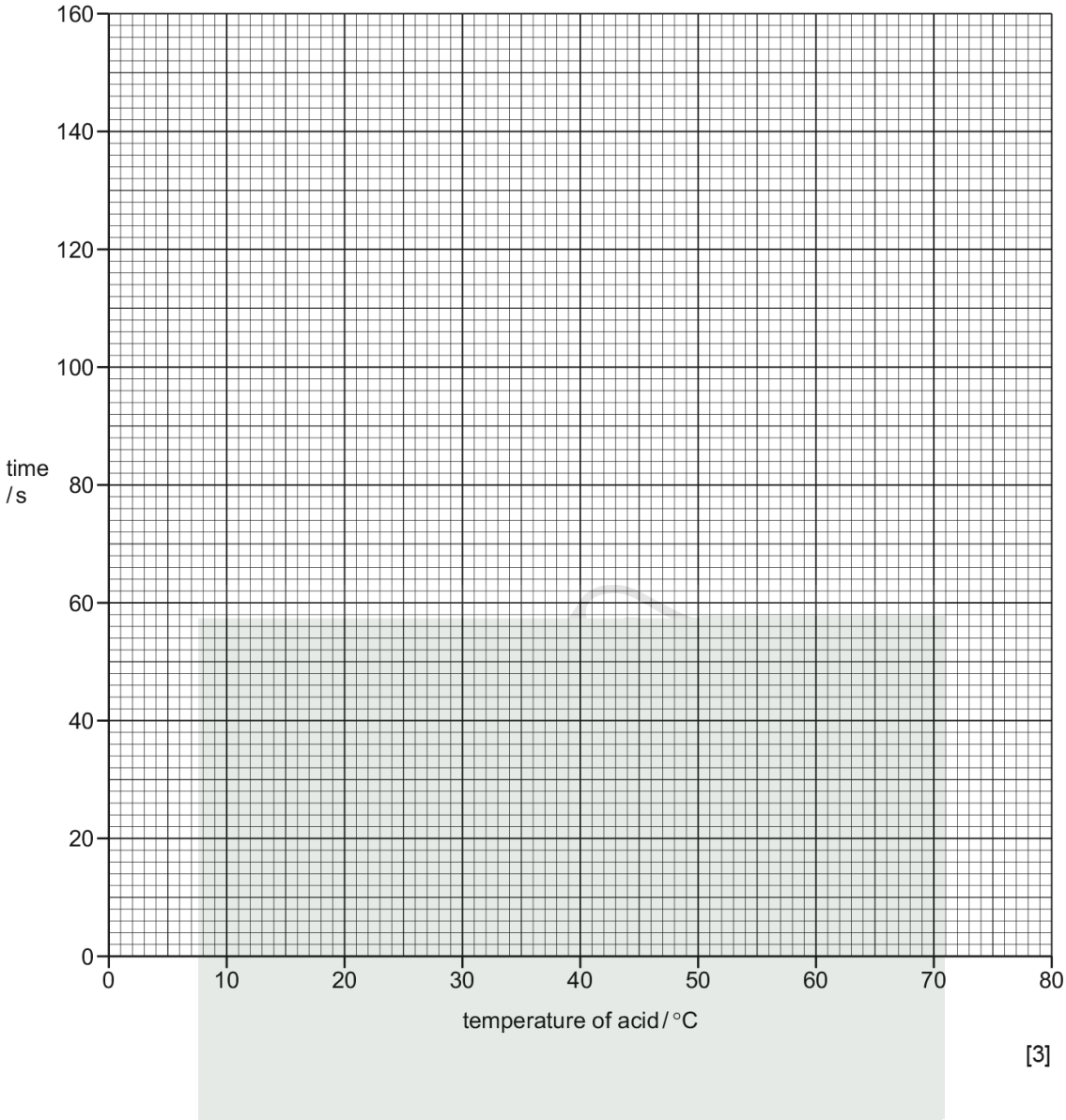
Excess powdered calcium carbonate was added to the nitric acid and the mass of the beaker and contents recorded. The time taken for the mass to decrease by 1 g was measured. The experiment was repeated at different temperatures.

(a) Using the thermometer diagrams, record the temperatures in the table.

thermometer diagram	temperature of nitric acid / °C	time for mass to decrease by 1 g in seconds
		139
		102
		99
		60
		45
		38

[3]

(b) Plot the results on the grid and draw a smooth line graph.



[3]

(c) Which point is inaccurate? Explain why you chose this point.

.....

..... [2]

(d) **Use your graph** to find out the time of reaction at a temperature of 30 °C. Show clearly on the grid how you obtained your answer.

..... [3]

(e) (i) How does the rate of this reaction vary with the change in temperature?

..... [1]

(ii) Explain why.

.....

.....

..... [2]

(f) (i) What would be the effect of repeating the experiments using lumps of calcium carbonate instead of powdered calcium carbonate? Explain your answer.

.....

..... [2]

(ii) Sketch on the grid the curve you would expect. [1]

(g) Explain why cotton wool was used in the neck of the conical flask.

.....

..... [2]

[Total: 19]

29. 0620_w15_qp_63 Q: 6

Dilute sulfuric acid reacts rapidly with magnesium ribbon. The magnesium ribbon gets smaller and eventually disappears.

Plan an investigation to show how the rate of this reaction changes using different concentrations of sulfuric acid.
You are provided with common laboratory apparatus, sulfuric acid, water and magnesium ribbon.

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.....

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.....

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.....

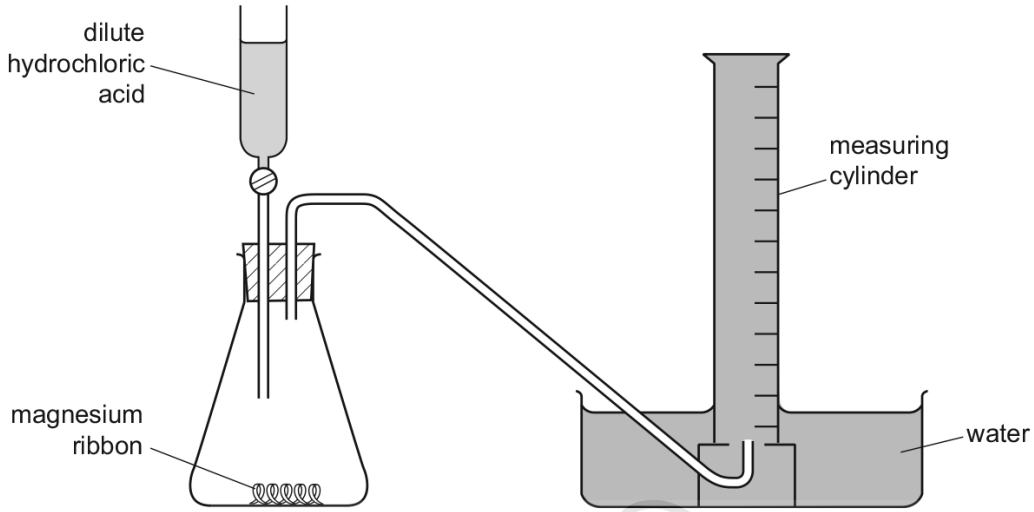
.....

..... [6]

[Total: 6]

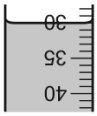
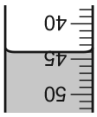
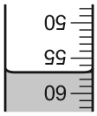
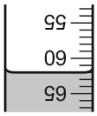
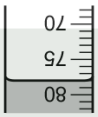
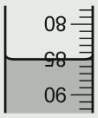
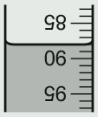
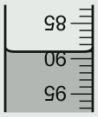
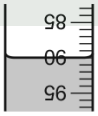
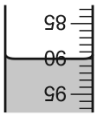
30. 0620_w16_qp_62 Q: 2

A student investigated the rate of reaction between dilute hydrochloric acid and excess magnesium at room temperature.
The apparatus was set up as shown in the diagram.



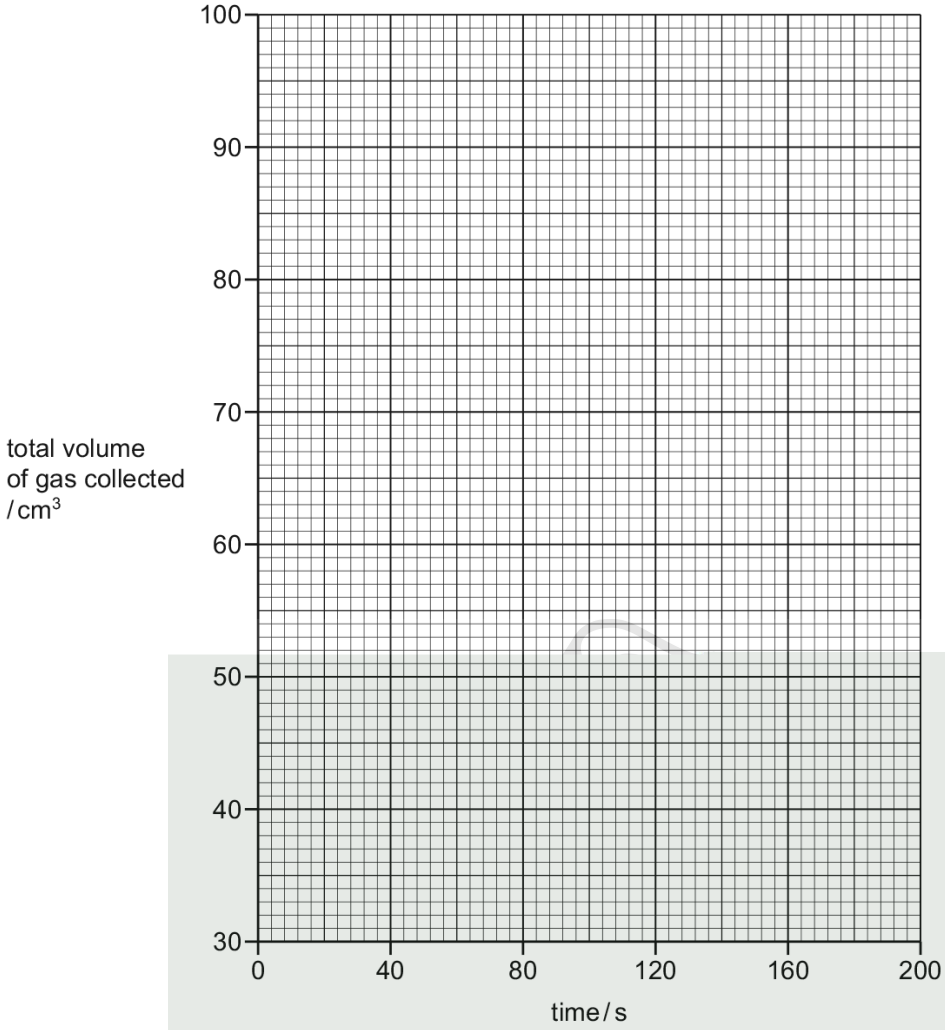
30 cm^3 of dilute hydrochloric acid were added to the conical flask containing magnesium ribbon. The timer was then started and the volume of gas collected in the measuring cylinder was measured every 20 seconds for 180 seconds (3 minutes).

(a) Use the measuring cylinder diagrams to record the total volume of gas collected in the table.

time / s	measuring cylinder diagram	total volume of gas collected / cm^3
0		30
20		
40		
60		
80		
100		
120		
140		
160		
180		

[2]

(b) Plot the results on the grid and draw a smooth line graph.



[3]

(c) (i) Which result is anomalous?

..... [1]

(ii) Suggest a possible reason for this anomalous result.

..... [1]

(iii) **Use your graph** to deduce the total volume of gas that you would have expected to collect instead of this anomalous volume.
Show clearly **on the grid** how you worked out your answer.

..... cm^3 [2]

(d) Explain why the total volume of gas collected does **not** increase after 160 seconds.

.....

..... [2]

(e) The average rate of the reaction can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{volume of gas collected / cm}^3}{\text{time / s}}$$

(i) Calculate the volume of gas collected between 20 seconds and 40 seconds.

..... [1]

(ii) Calculate the average rate of reaction between 20 seconds and 40 seconds.
Include the unit.

average rate of reaction = ... [2]

(f) Room temperature was 20 °C.

Sketch **on the grid** the graph you would expect if the experiment were repeated at 30 °C. [2]

(g) Suggest why the reading on the measuring cylinder was 30 cm^3 after the acid had been added and before the timer had been started.

.....

..... [1]

(h) Suggest and explain **one** improvement to this experiment.

.....

.....

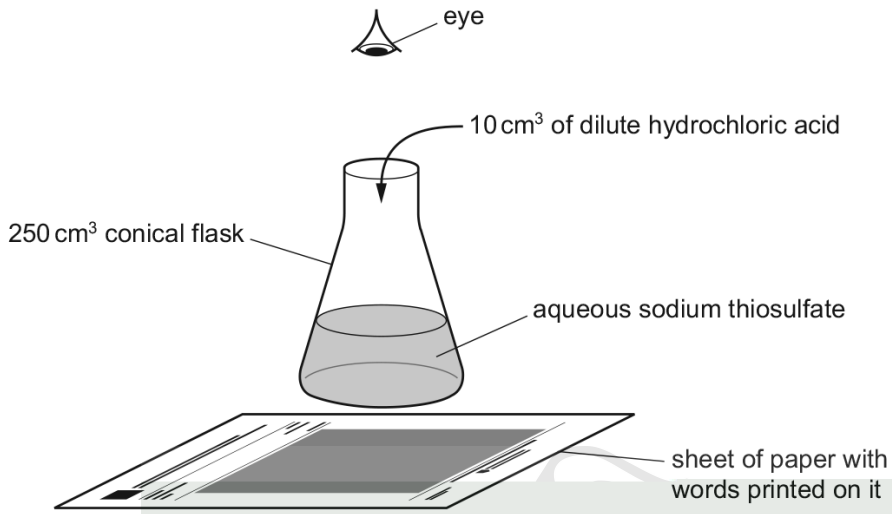
..... [2]

[Total: 19]

31. 0620_w17_qp_61 Q: 2

A student investigated the rate of reaction between dilute hydrochloric acid and aqueous sodium thiosulfate. When these chemicals react they form a precipitate which makes the solution go cloudy. The formation of this precipitate can be used to show how fast the reaction proceeds.

Five experiments were carried out using the apparatus shown.



Experiment 1

- Using a measuring cylinder, 50 cm^3 of aqueous sodium thiosulfate were poured into a conical flask. The initial temperature of the solution was measured. The conical flask was placed on a sheet of paper with words printed on it.
- Using a measuring cylinder, 10 cm^3 of dilute hydrochloric acid were added to the solution in the conical flask and a stopclock was started.
- The time taken for the printed words to disappear from view was measured.
- The final temperature of the mixture was measured.

Experiment 2

- Using a measuring cylinder, 50 cm^3 of aqueous sodium thiosulfate were poured into a conical flask. The solution was heated to about **30 °C** and the temperature was measured. The conical flask was placed on a sheet of paper with words printed on it.
- Using a measuring cylinder, 10 cm^3 of dilute hydrochloric acid were added to the solution in the conical flask and a stopclock was started.
- The time taken for the printed words to disappear from view was measured.
- The final temperature of the mixture was measured.

Experiment 3

- Experiment 2 was repeated but the 50 cm^3 of aqueous sodium thiosulfate were heated to about **40 °C** before adding the dilute hydrochloric acid.

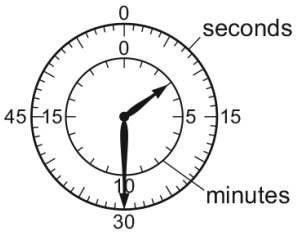
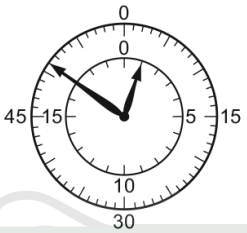
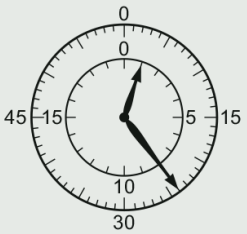
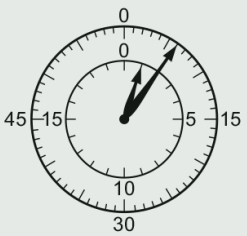
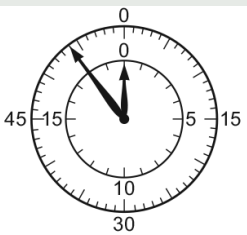
Experiment 4

- Experiment 2 was repeated but the 50 cm^3 of aqueous sodium thiosulfate were heated to about **50 °C** before adding the dilute hydrochloric acid.

Experiment 5

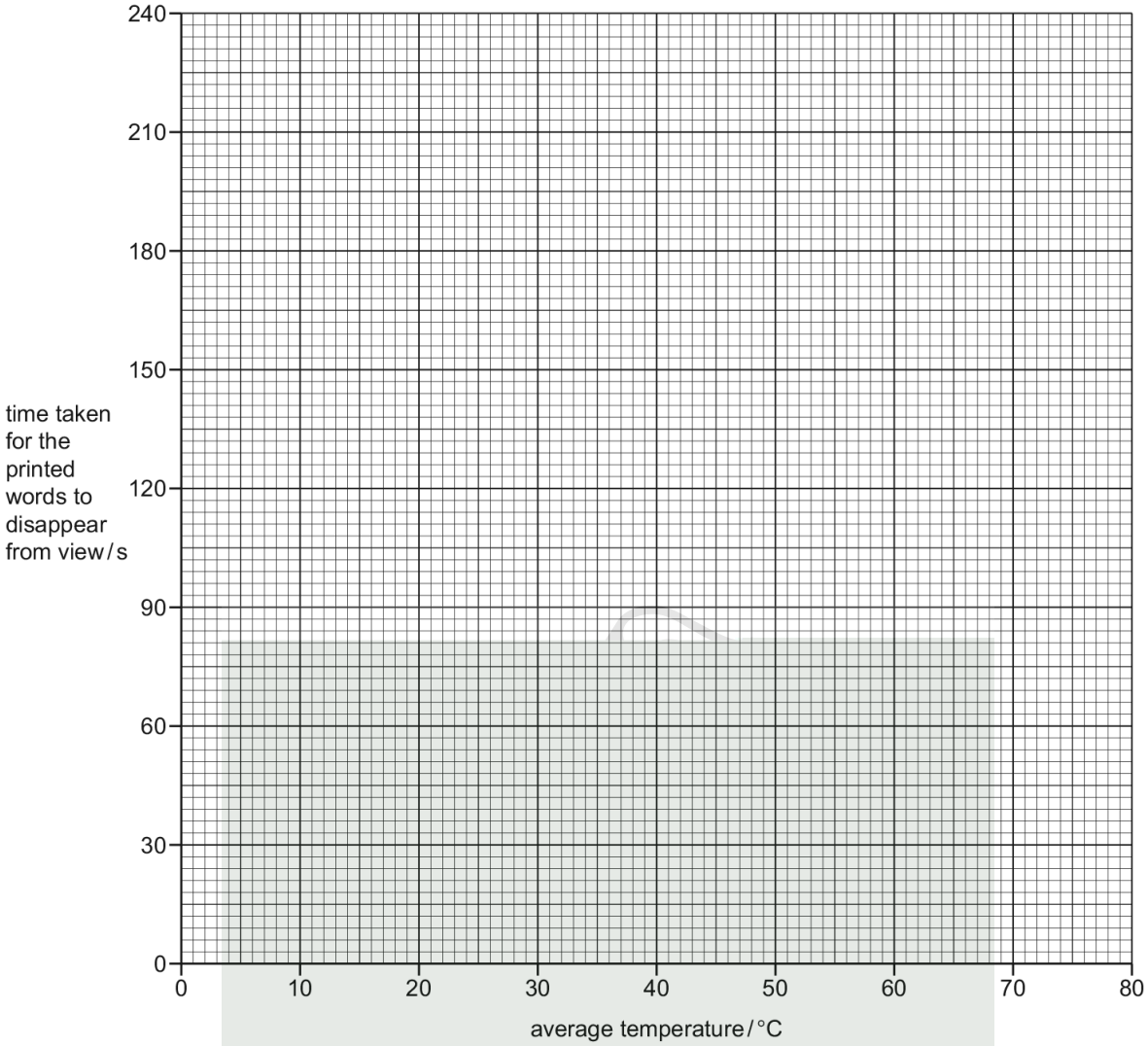
- Experiment 2 was repeated but the 50 cm^3 of aqueous sodium thiosulfate were heated to about **60 °C** before adding the dilute hydrochloric acid.

(a) Calculate the average temperatures and record them in the table.
Use the stopclock diagrams to record the times in the table.

experiment number	initial temperature of the solution / °C	final temperature of the mixture / °C	average temperature / °C	stopclock diagram	time taken for the printed words to disappear from view / s
1	19	17			
2	32	30			
3	42	40			
4	54	52			
5	65	61			

[3]

(b) Plot the results of Experiments 1–5 on the grid. Draw a smooth line graph.



[4]

(c) **From your graph**, deduce the time taken for the printed words to disappear from view when Experiment 2 was repeated at an initial temperature of 73 °C. The final temperature of the mixture was 71 °C.

Show clearly **on the grid** how you worked out your answer.

..... [3]

(d) Sketch **on the grid** the graph you would expect if all of the experiments were repeated using a more dilute solution of aqueous sodium thiosulfate. [1]

(e) **(i)** In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

.....

..... [2]

(f) Suggest and explain the effect on the results of using

(i) a burette to measure the volumes,

.....

.....

..... [2]

(ii) a 100 cm^3 conical flask instead of a 250 cm^3 conical flask.

.....

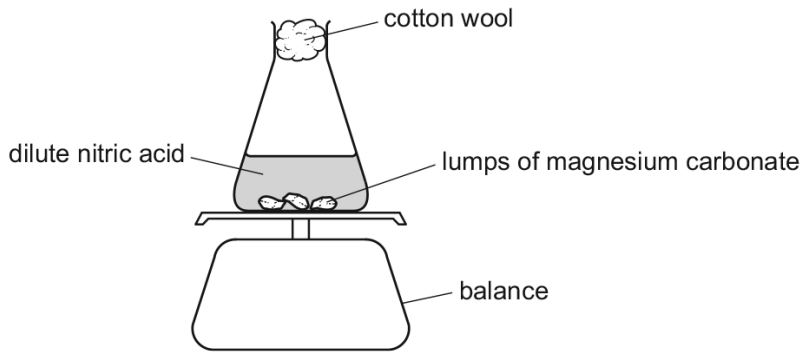
.....

..... [2]

[Total: 18]

32. 0620_w18_qp_61 Q: 2

A student investigated the rate of reaction between dilute nitric acid and lumps of magnesium carbonate. The apparatus shown was used.

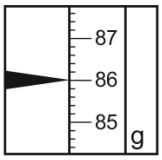
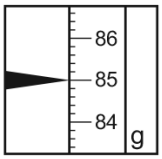
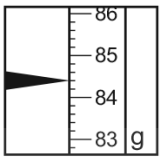
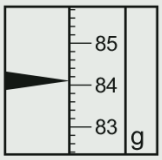
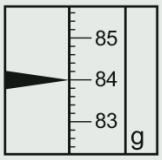
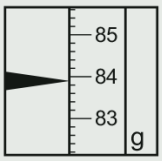
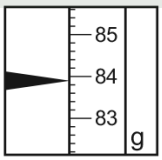
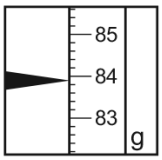


Lumps of magnesium carbonate were added to a conical flask. 40 cm^3 of dilute nitric acid was then poured into the conical flask using a measuring cylinder. The magnesium carbonate was in **excess**.

The conical flask was placed on a balance. Cotton wool was placed in the top of the conical flask.

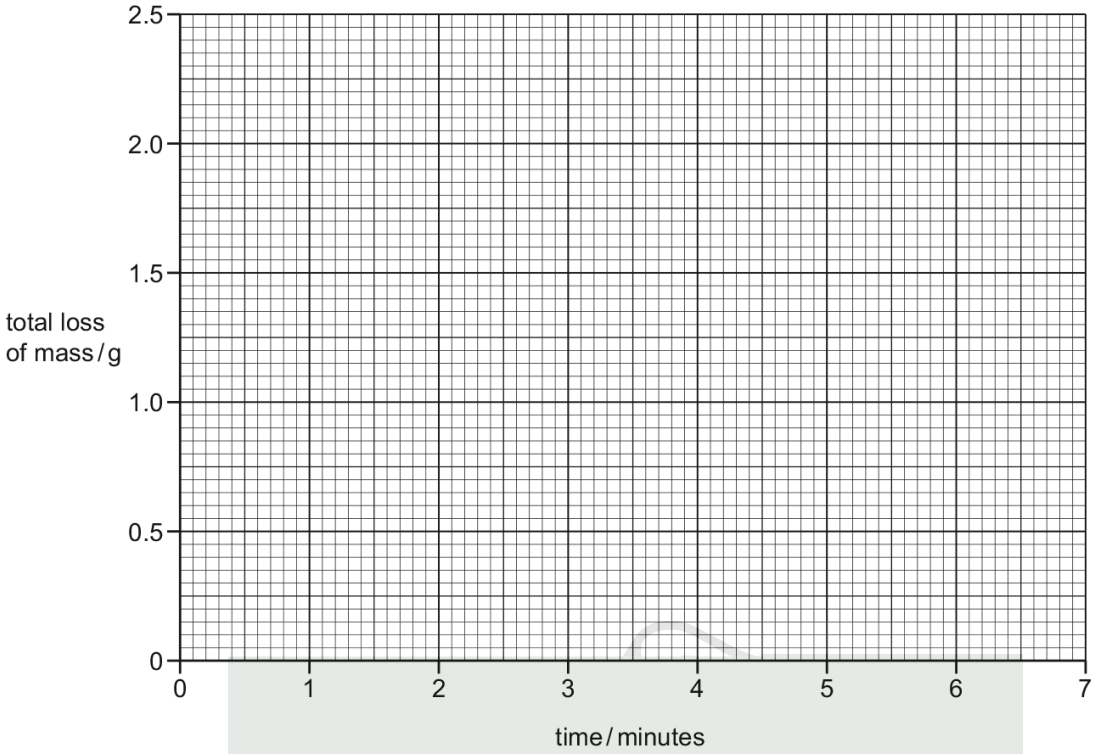
The mass of the conical flask and its contents was measured and a timer was started. The mass of the conical flask and its contents was measured every minute for 7 minutes.

(a) Use the balance diagrams to record the mass of the conical flask and its contents in the table. Complete the table to work out the total loss of mass of the conical flask and its contents since the start of the experiment.

time / minutes	balance diagram	mass of conical flask and its contents / g	total loss of mass / g
0			
1			
2			
3			
4			
5			
6			
7			

[3]

(b) Plot the results on the grid. Draw a smooth line graph.



[3]

(c) The average rate of reaction can be calculated using the equation shown.

$$\text{average rate of reaction} = \frac{\text{total loss of mass / g}}{\text{time taken / s}}$$

Calculate the average rate of reaction for the first 30 **seconds** of the reaction.
Deduce the unit.

rate = ...

unit = ...

[3]

(d) The experiment is repeated using an excess of powdered magnesium carbonate. All other conditions are kept the same.

Sketch on the grid the graph you would expect. [2]

(e) (i) Why does the mass of the conical flask and its contents decrease?

.....

..... [1]

(ii) Suggest the purpose of the cotton wool.

.....

.....

..... [2]

(iii) Why does the graph level off? Explain your answer.

.....

..... [2]

(f) Give **one** advantage and **one** disadvantage of using a burette instead of a measuring cylinder to add the dilute nitric acid to the conical flask.

advantage .....

disadvantage .....

[2]

[Total: 18]

33. 0620_w18_qp_62 Q: 2

A student investigated the rate of reaction between solution **L**, solution **M** and hydrochloric acid. When these chemicals react they form iodine. Sodium thiosulfate solution and starch solution were used to show how fast the reaction proceeded.

Five experiments were done.

Experiment 1

- A measuring cylinder was used to add 10 cm^3 of solution **L** to a conical flask.
- 10 cm^3 of dilute hydrochloric acid, 10 cm^3 of sodium thiosulfate solution and 1 cm^3 of starch solution were then added to the conical flask.
- The reaction was started by using a measuring cylinder to add 10 cm^3 of solution **M** to the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The conical flask was emptied and rinsed with distilled water.

Experiment 2

- A measuring cylinder was used to add 8 cm^3 of solution **L** and 2 cm^3 of distilled water to the conical flask.
- 10 cm^3 of dilute hydrochloric acid, 10 cm^3 of sodium thiosulfate solution and 1 cm^3 of starch solution were then added to the conical flask.
- The reaction was started by using a measuring cylinder to add 10 cm^3 of solution **M** to the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The conical flask was emptied and rinsed with distilled water.

Experiment 3

- Experiment 2 was repeated but 6 cm^3 of solution **L** and 4 cm^3 of distilled water were added to the conical flask before adding the other reagents.

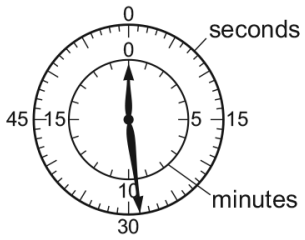
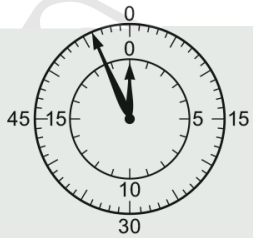
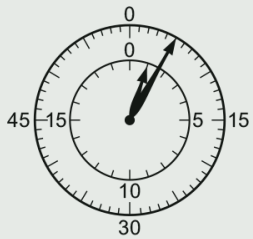
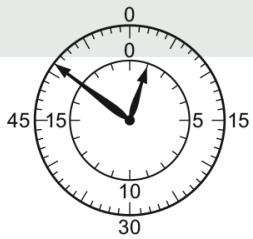
Experiment 4

- Experiment 2 was repeated but 5 cm^3 of solution **L** and 5 cm^3 of distilled water were added to the conical flask before adding the other reagents.

Experiment 5

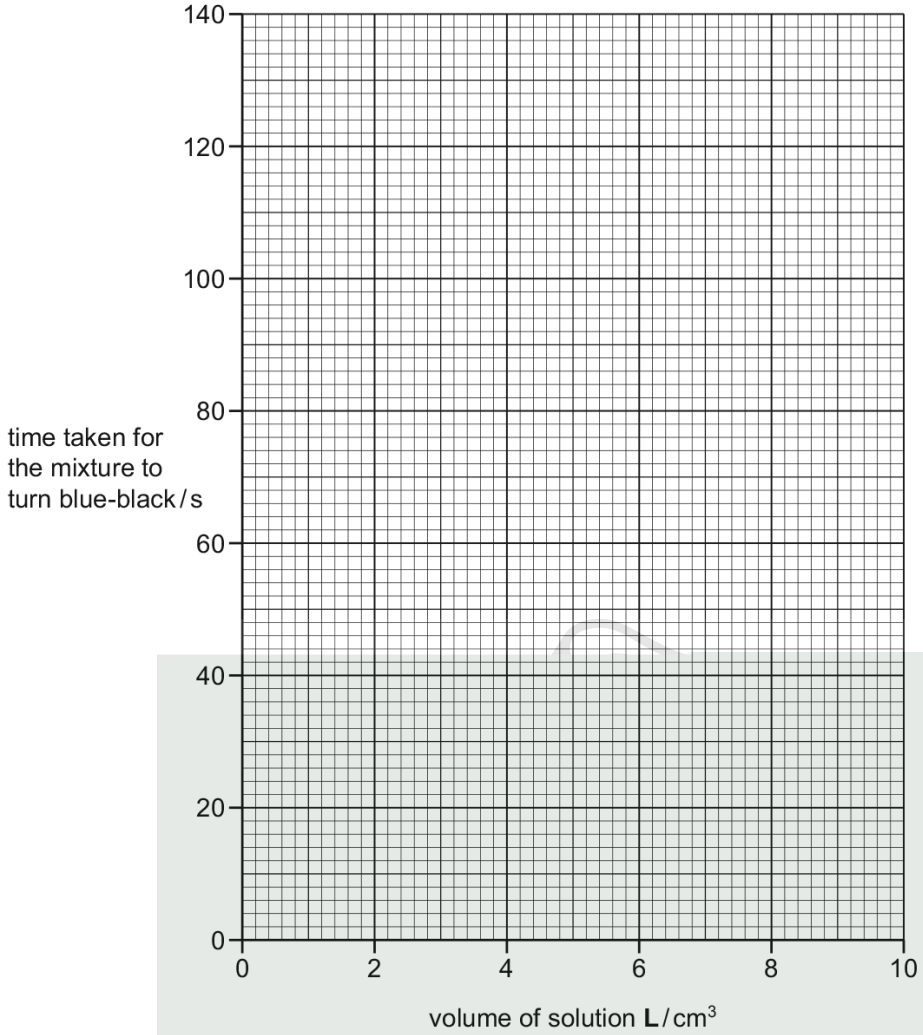
- Experiment 2 was repeated but 3 cm^3 of solution **L** and 7 cm^3 of distilled water were added to the conical flask before adding the other reagents.

(a) Use the stop-clock diagrams to record the time taken for each experiment in the table.

experiment number	volume of solution **L** / cm^3	volume of distilled water / cm^3	stop-clock diagram	time taken for the mixture to turn blue-black / s
1	10	0		
2	8	2		
3	6	4		
4	5	5		
5	3	7		

[4]

(b) Plot the results for Experiments 1–5 on the grid. Draw a smooth line graph.



[4]

(c) **From your graph**, deduce the time taken for the mixture to turn blue-black if Experiment 2 were repeated using 4 cm^3 of solution **L** and 6 cm^3 of distilled water.

Show clearly **on the grid** how you worked out your answer.

..... [3]

(d) (i) In which experiment, 1, 2, 3, 4 or 5, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) (i) Suggest an advantage of using a graduated pipette instead of a measuring cylinder to measure solution **L**.

..... [1]

(ii) Suggest and explain a disadvantage of using a graduated pipette instead of a measuring cylinder to measure solution **M**.

.....

..... [2]

(f) Suggest **one** way to improve the reliability of the results of these experiments.

..... [1]

[Total: 18]

34. 0620_w18_qp_63 Q: 2

A student investigated the rate of reaction between solution **S** and solution **T** at different temperatures. When these chemicals react they form iodine. Sodium thiosulfate solution and starch solution were used to show how fast the reaction proceeded.

Four experiments were done.

Experiment 1

- A measuring cylinder was used to add 10 cm^3 of solution **S** and 10 cm^3 of sodium thiosulfate solution to a conical flask.
- A teat pipette was then used to add 1 cm^3 of starch solution to the mixture.
- The temperature of the mixture was measured and recorded in the table.
- The reaction was started by using a measuring cylinder to add 10 cm^3 of solution **T** to the conical flask. A timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The final temperature of the mixture was measured and recorded.
- The conical flask was emptied and rinsed with distilled water.

Experiment 2

- A measuring cylinder was used to add 10 cm^3 of solution **S** and 10 cm^3 of sodium thiosulfate solution to the conical flask.
- A teat pipette was then used to add 1 cm^3 of starch solution to the mixture.
- The mixture was then heated to about 30 °C.
- The temperature of the mixture was measured and recorded in the table.
- The reaction was started by using a measuring cylinder to add 10 cm^3 of solution **T** to the conical flask. The timer was started immediately and the mixture was swirled.
- The time taken for the mixture to turn blue-black was measured.
- The final temperature of the mixture was measured and recorded.
- The conical flask was emptied and rinsed with distilled water.

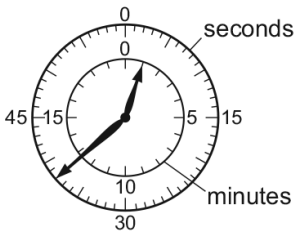
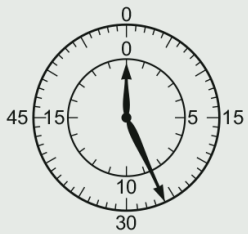
Experiment 3

- Experiment 2 was repeated but the mixture of solution **S**, sodium thiosulfate solution and starch solution in the conical flask was heated to about 40 °C before adding solution **T**.

Experiment 4

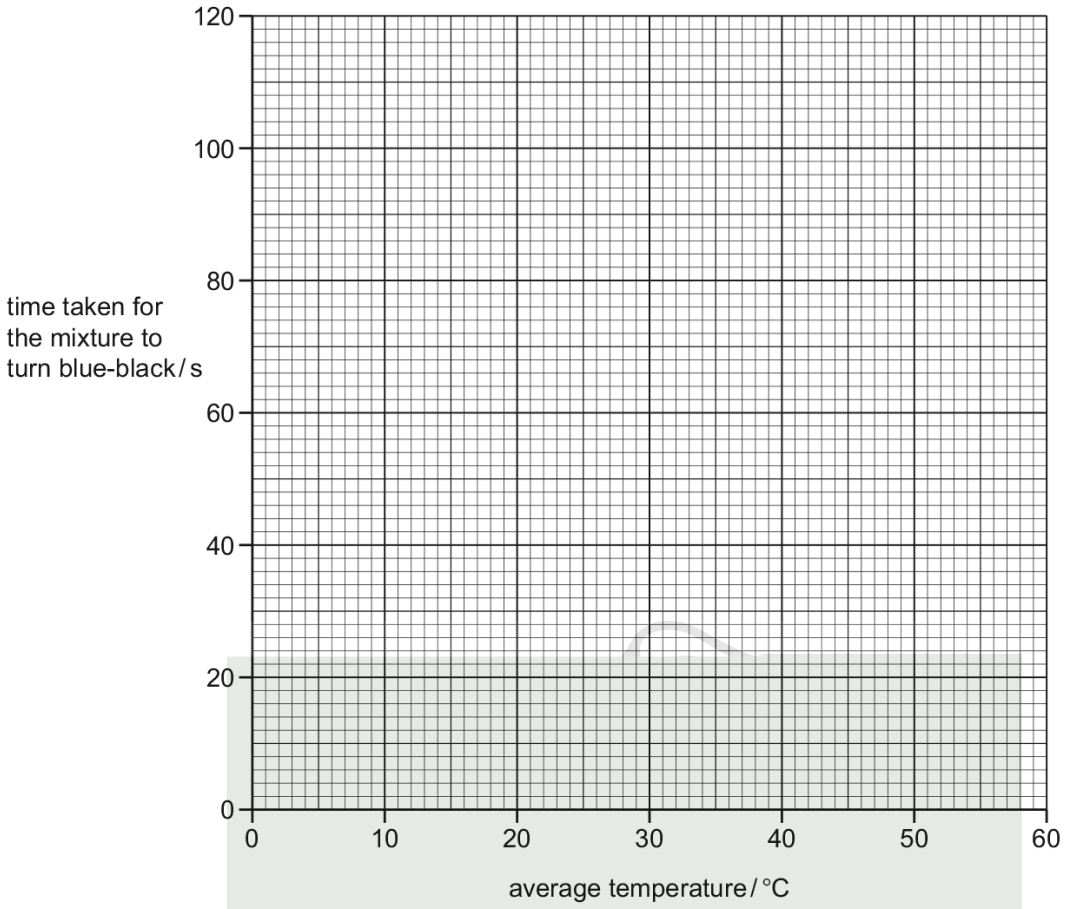
- Experiment 2 was repeated but the mixture of solution **S**, sodium thiosulfate solution and starch solution in the conical flask was heated to about 50 °C before adding solution **T**.

(a) Calculate the average temperatures in the table.
Use the stop-clock diagrams to record the time taken for each experiment in the table.

experiment number	initial temperature / °C	final temperature / °C	average temperature / °C	stop-clock diagram	time taken for the mixture to turn blue-black / s
1	22	22			
2	31	29			
3	41	37			
4	51	45			

[4]

(b) Plot the results for Experiments 1–4 on the grid. Draw a smooth line graph.



[4]

(c) **From your graph**, deduce the average temperature needed for the mixture to turn blue-black in 60 s.

Show clearly **on the grid** how you worked out your answer.

..... [3]

(d) **(i)** In which experiment, 1, 2, 3 or 4, was the rate of reaction greatest?

..... [1]

(ii) Explain, in terms of particles, why the rate of reaction was greatest in this experiment.

.....

.....

..... [2]

(e) Pipettes or burettes could be used to measure the volumes of solution **S** and the sodium thiosulfate solution more accurately.

State and explain **one other** way to improve the accuracy of the results of these experiments.

way to improve the accuracy .....

explanation .....

.....

[2]

(f) A student predicted that using a burette to add solution **T** would improve the accuracy of the results of these experiments.

Suggest why the student's prediction would **not** improve the accuracy of the results of these experiments.

.....

..... [2]

[Total: 18]

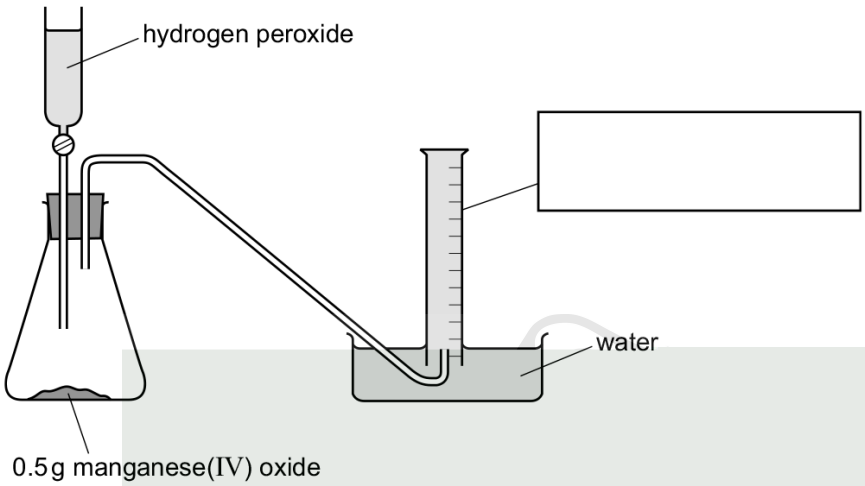
35. 0620_w19_qp_63 Q: 1

Hydrogen peroxide, $H_2O_2(aq)$, decomposes slowly to form water and oxygen.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

The addition of 0.5 g of manganese(IV) oxide speeds up this decomposition. Manganese(IV) oxide is an insoluble solid.

The apparatus shown was used to follow the rate of decomposition of hydrogen peroxide. The hydrogen peroxide was added to the conical flask and a stop-watch was started.



(a) Complete the box to name the apparatus. [1]

(b) What measurements should be taken to follow the rate of the reaction?

.....

..... [2]

(c) The rate of the reaction decreases over time. After 5 minutes the rate of reaction is zero.

(i) Why does the rate of reaction decrease?

..... [1]

(ii) Explain why the rate of reaction is zero after 5 minutes.

..... [1]

(d) (i) The manganese(IV) oxide acts as a catalyst.

How could a student separate the catalyst from the reaction mixture at the end of the reaction?

..... [1]

(ii) Suggest how the student could show that the catalyst separated in **(d)(i)** is unchanged at the end of the reaction.

.....

.....

.....

..... [3]

[Total: 9]

---

36. 0620_w20_qp_62 Q: 2

A student investigated the rate of a reaction between sodium metabisulfite and potassium iodate. In the reaction, starch was used as an indicator. At first the reacting mixture remained colourless but then suddenly changed to a blue-black colour.

Five experiments were done. In each experiment the total volume of liquid was 45 cm^3.

Experiment 1

- Using a 10 cm^3 measuring cylinder, 5 cm^3 of aqueous sodium metabisulfite was poured into a beaker.
- Using another 10 cm^3 measuring cylinder, 5 cm^3 of aqueous starch was poured into the beaker.
- Using a 25 cm^3 measuring cylinder, 15 cm^3 of distilled water was poured into the beaker.
- Using another 25 cm^3 measuring cylinder, 20 cm^3 of aqueous potassium iodate was poured into the beaker. At the same time a stop-clock was started.
- The mixture in the beaker was stirred until a sudden colour change was seen.
- The stop-clock was immediately stopped and the time recorded.
- The beaker was rinsed with water.

Experiment 2

- Experiment 1 was repeated using 17 cm^3 of distilled water and 18 cm^3 of aqueous potassium iodate.

Experiment 3

- Experiment 1 was repeated using 21 cm^3 of distilled water and 14 cm^3 of aqueous potassium iodate.

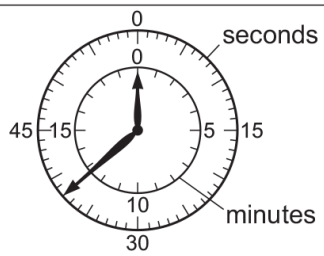
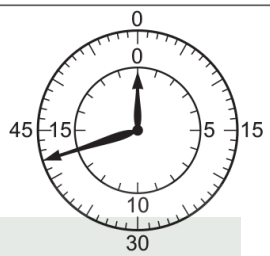
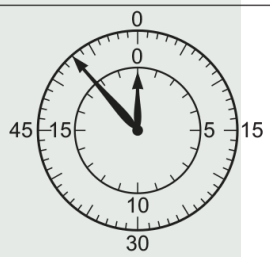
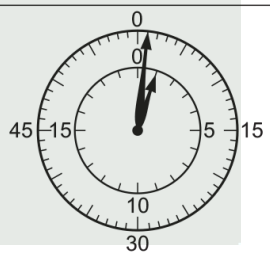
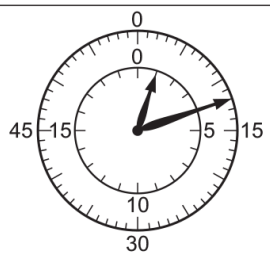
Experiment 4

- Experiment 1 was repeated using 23 cm^3 of distilled water and 12 cm^3 of aqueous potassium iodate.

Experiment 5

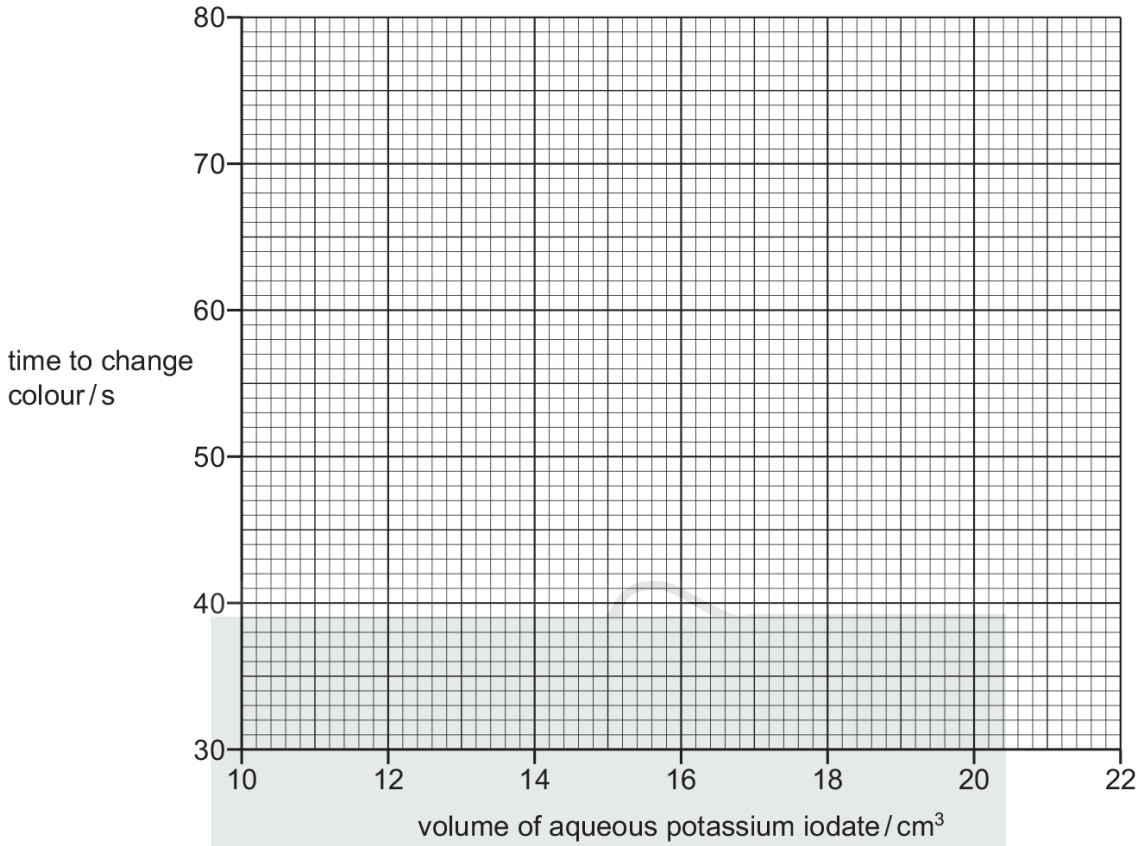
- Experiment 1 was repeated using 25 cm^3 of distilled water and 10 cm^3 of aqueous potassium iodate.

(a) Use the information in the description of the experiments and the stop-clock diagrams to complete the table. Record the times in **seconds**.

experiment	volume of aqueous sodium metabisulfite / cm^3	volume of distilled water / cm^3	volume of aqueous potassium iodate / cm^3	stop-clock diagram	time to change colour / s
1			20		
2			18		
3			14		
4			12		
5			10		

[5]

(b) Plot the results from Experiments 1 to 5 on the grid.
Draw a smooth curve of best fit.



[3]

(c) (i) **From your graph**, predict the time to change colour if 16 cm^3 of aqueous potassium iodate was used.
Show clearly **on the grid** how you worked out your answer.

time to change colour = ... s [2]

(ii) Calculate the volume of distilled water required if 16 cm^3 of aqueous potassium iodate was used.

volume of distilled water = ... cm^3 [1]

(d) Sketch **on the grid** the graph you would expect if Experiments 1 to 5 were repeated at a higher temperature. [1]

(e) The concentration of potassium iodate in the reaction mixture in each experiment can be calculated using the equation shown.

$$\text{concentration} = \frac{0.05 \times \text{volume of aqueous potassium iodate}}{45}$$

(i) Calculate the concentration of potassium iodate in the reaction mixture in Experiment 2.

concentration = ... mol/dm^3 [1]

(ii) State which experiment, 1, 2, 3, 4 or 5, had the fastest rate of reaction.

..... [1]

(f) Suggest why the volume of distilled water added to each experiment was increased as the volume of aqueous potassium iodate was decreased.

.....

..... [1]

(g) Give **one** change you could make to the apparatus used which would improve the results. Explain your answer.

change to apparatus .....

.....

explanation .....

.....

[2]

(h) How could the reliability of the results of this investigation be checked?

.....

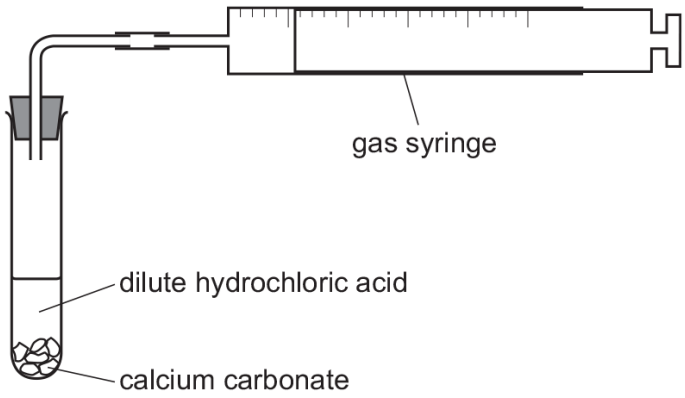
..... [1]

[Total: 18]

37. 0620_w21_qp_61 Q: 2

A student investigated the rate of reaction between small lumps of calcium carbonate and dilute hydrochloric acid.

The experiment was done at two different temperatures using the apparatus shown in the diagram. All other conditions were kept the same.



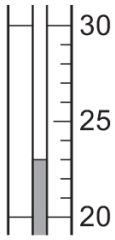
Experiment 1

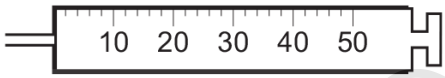
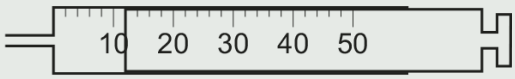
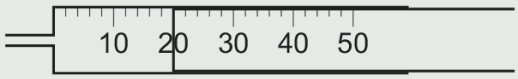
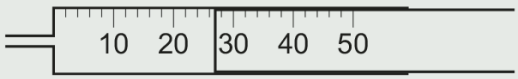
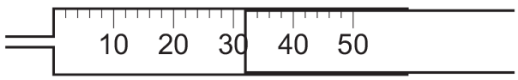
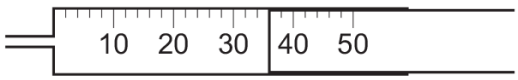
- Using a 50 cm^3 measuring cylinder, 25 cm^3 of dilute hydrochloric acid was poured into a boiling tube.
- The temperature of the dilute hydrochloric acid was measured using a thermometer.
- 10 g of lumps of calcium carbonate were added to the boiling tube, the bung replaced and the stop-watch started.
- The volume of gas collected in the gas syringe was measured every 50 seconds for 250 seconds.

Experiment 2

- Using a 50 cm^3 measuring cylinder, 25 cm^3 of dilute hydrochloric acid was poured into a boiling tube.
- The dilute hydrochloric acid in the boiling tube was warmed using a Bunsen burner.
- The temperature of the dilute hydrochloric acid was measured using a thermometer.
- 10 g of lumps of calcium carbonate were added to the boiling tube, the bung replaced and the stop-watch started.
- The volume of gas collected in the gas syringe was measured every 50 seconds for 250 seconds.

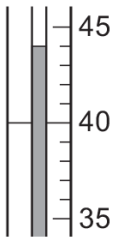
(a) Use the diagrams to complete the tables for Experiment 1.

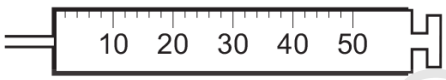
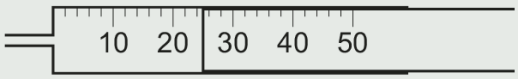
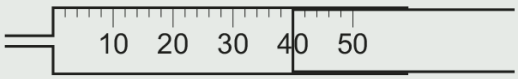
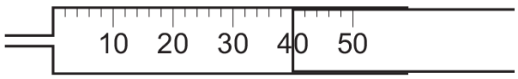
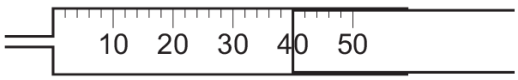
thermometer diagram	temperature of dilute hydrochloric acid / °C
	

time / s	gas syringe diagram	volume of gas collected / cm^3
0		
50		
100		
150		
200		
250		

[2]

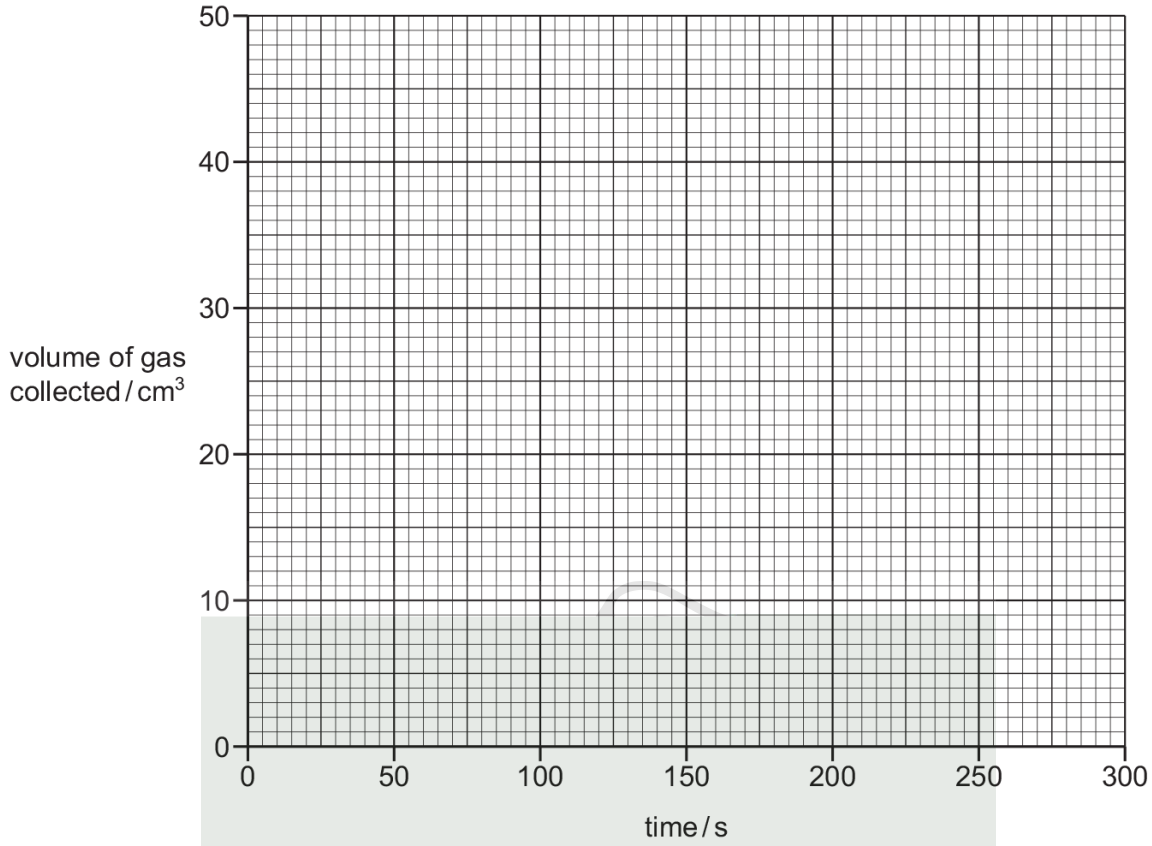
(b) Use the diagrams to complete the tables for Experiment 2.

thermometer diagram	temperature of dilute hydrochloric acid / °C
	

time / s	gas syringe diagram	volume of gas collected / cm^3
0		
50		
100		
150		
200		
250		

[2]

(c) Plot the results from Experiment 1 and Experiment 2 on the grid.
Draw a curve of best fit for each experiment. Label your curves.



[5]

(d) **From your graph**, deduce the volume of gas collected in Experiment 2 after 120 seconds.

Show clearly **on the grid** how you worked out your answer.

..... cm^3
[2]

(e) Explain how the results show that the reaction in Experiment 2 has stopped.

.....

..... [1]

(f) Predict the volume of gas that would be collected in Experiment 1 after 800 seconds.
Explain your answer.

volume of gas collected after 800 seconds ..... cm^3

explanation .....

.....
[2]

(g) A student stated it would be an improvement to measure the volume of gas collected every 25 seconds.

Explain why this is an improvement.

.....

.....

..... [2]

(h) State **two** changes to the apparatus to improve the accuracy of the results obtained if the experiment is repeated using the same thermometer.

change 1 .....

.....

change 2 .....

.....

[2]

(i) Describe how the method used in Experiment 2 could be changed so that results can be obtained using dilute hydrochloric acid at 1 °C.

.....

..... [1]

[Total: 19]

38. 0620_w21_qp_63 Q: 4

Catalysts are substances which increase the rate of a reaction but are unchanged at the end of the reaction.

Aqueous hydrogen peroxide decomposes slowly to form water and oxygen.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

Copper(II) oxide is an insoluble solid.

Plan an investigation to find out if copper(II) oxide is a catalyst for the decomposition of hydrogen peroxide. You must include how your results will tell you if copper(II) oxide is a catalyst. You have access to copper(II) oxide, aqueous hydrogen peroxide and all normal laboratory apparatus.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [6]

01. 0620_m15_ms_62 Q: 2

(a) Table of results

volume boxes completed correctly (3),
all 7 correct (3)
6 correct (2)
5 correct (1)
4 or fewer correct (0)

0, 45, 48, 72, 74, 75, 75 [3]

(b) points plotted correctly, including origin (3),
all 7 correct (3)
6 correct (2)
5 correct (1)
4 or fewer correct (0)

Smooth line graph(1) [4]

(c) (i) point at 2 min / 3rd point / 48 cm^3 (1)

off curve (1) [2]

(ii) reading from graph, 62–64 (cm^3) (1)

indication (1) [2]

(d) curve to left of original (1)

to same level (1) [2]

---

02. 0620_m16_ms_62 Q: 2

(a)	In each column: 4 correct = [2] 3 correct = [1] average temperature boxes completed correctly: 16, 27, 41, 50; times completed in seconds correctly: 128, 58, 27, 18;	**4**
(b)	all points plotted correctly = [3] smooth line graph;	**4**
(c)	value from graph: 12–13 s; extrapolation;	**2**
(d)(i)	Experiment 4;	**1**
(d)(ii)	any **2** from: highest temperature; more energy; more (chance of) collisions;	**2**
(e)(i)	more accurate; than a measuring cylinder;	**2**

(e)(ii)	insulation / use a lid; to reduce heat losses; OR repeats; average results; OR measure water or sulphuric acid or methyl orange using a burette / use a 2 d.p. stopwatch / digital thermometer; reference to accuracy;	**2**

03. 0620_m18_ms_62 Q: 4

			max 6

	gas volume	*mass loss*
M1	Mg added to sulfuric acid	Mg added to sulfuric acid
M2	in a suitable container with ability to have a bung	in a suitable container
M3	methods of measuring gas volume (gas syringe, downward displacement of water using a measuring cylinder)	on a balance
M4	start timer / timing (when added together)	start timer / timing (when added together)
M5	measure volume of gas	measure mass loss
M6	at set time / at end of experiment / at (regular) known intervals	at set time / time to end of experiment / at (regular) known intervals
M7	rate = volume ÷ time	rate = mass loss ÷ time

04. 0620_m19_ms_62 Q: 4

4	6 from: Weighed amount / x gram of magnesium Add known volume of dilute hydrochloric acid gas syringe / measuring cylinder over water Use of stop-clock / timer Measure volume of hydrogen at fixed time or time for a fixed volume to be made Repeat using different temperatures Compare results / conclusion	**6**

05. 0620_m20_ms_62 Q: 2

Question	Answer	Marks
(a)(i)	exothermic	**1**
(a)(ii)	use a water bath	**1**
(b)	all volumes of distilled water completed correctly (12, 10, 8, 4, zero / 0 / none / –)	**1**
	all times completed correctly, all five correct scores 2, four correct scores 1 (72, 45, 33, 23, 16)	**2**
	all times to number of seconds only	**1**
(c)	suitable *y*-axis scale	**1**
	plotting – all five correct scores 2, four correct scores 1	**2**
	suitable best fit line	**1**

Question	Answer	Marks
(d)(i)	correct reading from graph (expected 54–56)	1
	working shown on graph	1
(d)(ii)	11 (cm^3)	1
(e)(i)	0.56 ecf from results table (correct calculation of 40 / time for experiment 1)	1
	cm^3 / s	1
(e)(ii)	5	1
(f)	more accurate	1
(g)(i)	gas escapes (before bung inserted) / gas not collected	1
(g)(ii)	any description of method that prevents gas loss such as partitioned container, suspend magnesium on thread, etc.	1

06. 0620_p20_ms_60 Q: 2

(a) volume boxes completed correctly 0, 13, 22, 30, 36, 43, 49
note: all 7 correct = 2, 6 correct = 1, <6 correct = 0 [2]

(b) volume boxes completed correctly 0, 5, 10, 13, 17, 20, 23
note: all 7 correct = 2, 6 correct = 1, <6 correct = 0 [2]

(c) appropriate scale on *x*-axis and *y*-axis **and** labels **and** units; [1]
note: scale should cover at least half of grid
points plotted to ± half a small square accuracy;; [2]
note: >12 correct = 2, 10–12 correct = 1, <10 correct = 0
two labelled smooth line graphs **and** must plot volume at t = 0; [1]

(d) Experiment 1 / acid **X and** statement that acid **X** is stronger or more concentrated / ora [1]

(e) 71–73 s **and** indication shown on graph; [1]
allow: ecf from incorrect graph

(f) 13 □ 30 = 0.43; [1]
allow: 0.4
allow: ecf on plotting
cm^3 / s / $cm^3 s^{-1}$ / cm^3 per s; [1]
allow: sec

(g) advantage: convenient / easy / quick to use; [1]
disadvantage: reference to inaccurate measurement; [1]

(h) graduated pipette / burette / gas syringe / mass of magnesium rather than strips / repeats and take average / take more frequent readings / suitable method for reducing initial loss of gas **and** any suitable comment on improved accuracy; [1]
note: explanation must relate to reason

07. 0620_s12_ms_62 Q: 2

(a) smooth curve starting at origin and missing anomalous point (1) [1]

(b) point at 1.5 min/4th point/0.32 g (1) **ignore**: 3rd point [1]

(c) reaction finished/no more gas (1)
magnesium carbonate used up (1) [2]

(d) rising part of sketch curve below the original/less steep (1)
to half final level/0.25 g (1) [2]

[Total: 6]

---

08. 0620_s12_ms_62 Q: 4

(a) fizzing/bubbles stopped/no more gas produced (1) [1]

(b) **(i)** W little/no effect/slight increase (1)
X no effect/(slight) decrease (1)
Y speeds up reaction (1) [3]
note: The question is about rate, if candidates quote three different time differences, penalise first then allow the 'correct' answers (–11 s, +2 s, –199 s).
It must be clear that the increase in rate is less for W than Y for these 2 marks.

(ii) Y (1) [1]

(c) repeat experiments (1) take average/compare results/see if there is a difference (1) [2]

[Total: 7]

---

09. 0620_s12_ms_63 Q: 3

(a) volumes completed correctly
0, 30, 45, 52, 56, 54, 60, 60 –1 for each incorrect [3]

(b) points plotted correctly (3) –1 for each incorrect
smooth curve (1) [4]

(c) point at 100 seconds/54 cm^3/point 6 (1) off curve/owtte (1) [2]

(d) 20 cm^3 ±½ small square (1) indication on graph (1) [2]

(e) reaction finished/all peroxide decomposed owtte (1) [1]

(f) **(i)** in an ice bath (1) **allow**: in a refrigerator [1]

(ii) curve less steep (1) to same level (1) [2]

[Total: 15]

---

10. 0620_s13_ms_63 Q: 5

(a) volumes completed correctly in table (2), –1 each incorrect

0, 38, 59, 73, 78, 79, 79 [2]

(b) appropriate scale for *y*-axis (1)

points plotted correctly including origin (2)

smooth curve (1) [4]

(c) 90 s (1) indication (1) [2]

(d) sketch to right of graph (1) levelling out at 39–40 cm^3 (1) [2]

(e) particles moving slower / have less energy (1) fewer collisions (1) [2]

---

11. 0620_s14_ms_62 Q: 4

(c) Experiment 1: Table of results

initial temperature boxes completed correctly (2) 27, 28, 31, 30, 31

highest temperature boxes completed correctly (2) 33, 36, 42, 45, 49

temperature changes correct (1) 6, 8, 11, 15, 18 [5]

(d) All points correctly plotted (3)
guidance: 5 correct (3); 4 correct (2); 3 correct (1); 2 or fewer correct (0)

best fit straight line graph drawn with a ruler (1) [4]
note: does not need to go through origin

(e) value from graph (1), e.g. 21

°C (1)

extrapolation to 8 cm / indication shown (1) [3]

(f) magnesium smaller / disappears / fizzing / bubbles / effervescence (1) [1]
ignore: gas

(g) **(i)** Experiment 5 (1) [1]
allow: 7 cm

(ii) more / most / longest / 7 cm magnesium used (1) [1]
ignore: reactant / sulfuric acid / surface area

(h) temperature change / reaction faster (1)
ignore: temperature rise

more surface area (1) [2]

(i) 3 (°C)
allow: 2–5

(j) shows gas collected over water (1)

in labelled measuring cylinder / graduations shown on collection vessel (1)

OR

shows gas collected in a gas syringe (1)

in labelled (gas) syringe / graduations shown (1) [2]

(k) error…heat losses / using measuring cylinder / oxide layer (1)
ignore: initial temperature

improvement…insulation / use burette or pipette / clean / repeat (1) [2]

---

12. 0620_s14_ms_63 Q: 2

(a) labels on both graphs, i.e. Experiment 2 on that levelling at 60 and Experiment 1 on graph levelling at 30 (1) [1]

(b) **(i)** water (1)

25 cm^3 of dilute acid + 25 cm^3 of water / equal volumes (1) [2]

(ii) graph less steep than others (1)

levelling at 15 (1) [2]

(c) gas syringe **or** measuring cylinder inverted in trough of water (1)

labelled collection vessel / graduations shown on collection vessel (1) [2]

(d) heat / increase temperature (1)

particles have more energy / move faster (1)

more frequent / more successful / more collisions(1)

OR

catalyst (1)

lowers activation energy (1)

more successful collisions (1) [3]

---

13. 0620_s15_ms_61 Q: 6

	step 1
	add copper oxide or catalyst to hydrogen peroxide;
	measure volume of gas / mass loss / collect gas / count bubbles;
	over time;
	known volume of hydrogen peroxide;
	compare to hydrogen peroxide on its own;
	test gas with glowing splint;
	splint relights;
	
	step 2
	filter copper(II) oxide;
	dry;
	weigh;
	compare to original mass;
	OR
	filter (copper(II) oxide) / evaporate to dryness;
	add to hydrogen peroxide;
	measure rate of reaction;
	compare to first experiment;
		max 8	

14. 0620_s15_ms_62 Q: 4

(f)	volume of sodium thiosulfate: 50, 40, 35, 30, 20 volume of water: 0, 10, 15, 20, 30 all 10 correct = 1 mark; time: 45, 55, 66, 78, 140 all 5 correct for 2 marks 4 correct =1 mark; **all** times in seconds;	**4**	**I** decimal places **A** '–' for '0'
(g)	all 5 points plotted correctly (2 marks); smooth line graph;	**3**	

(h)(i)	correct value from graph, 90-110; units; indication shown on graph;	**3**	**A** s / sec / seconds
(h)(ii)	line must be above original;	**1**	the lines must **not** meet at any point
(i)(i)	experiment 1 / 50 cm^3 sodium thiosulfate / 45 s / no water;	**1**	
(i)(ii)	more particles of thiosulfate / particles closer together / more concentrated / no water / more (frequent) collisions;	**1**	
(j)	volume over 50 cm^3 / changing total volume; so not a fair test / so depth greater / cannot compare with other results;	**2**	**A** (result) not valid
(k)(i)	*any two from:* • more accurate (measurement of volume); • comparison to measuring cylinder; • less accurate measurement of time; • as it takes longer to add the acid;	**2**	**A** more precise
(k)(ii)	time shorter / cross disappears faster; depth greater;	**2**	**R** reacts faster

15. 0620_s15_ms_63 Q: 2

(a)	0, 35, 50, 57, 61, 59, 65, 65 All 8 = 3 marks 7 = 2 marks 6 = 1 mark;	**3**	
(b)	all 8 points plotted within half a small square = 3 marks 7 points plotted within half a small square = 2 marks 6 points plotted within half a small square = 1 mark; best fit smooth line;	**4**	
(c)(i)	at 150 s / 59 cm^3 of hydrogen;	**1**	
(c)(ii)	63–65; cm^3;	**2**	
(d)(i)	use a fridge / ice bath;	**1**	**A** freezer
(d)(ii)	curve below original; towards same final level;	**2**	

16. 0620_s16_ms_62 Q: 2

(a)	all 6 times completed correctly (2 marks) (22, 43, 64, 86, 105, 126) 5 times completed correctly (1 mark); in seconds;	**3** 2 1
(b)	appropriate scale for *y*-axis / increasing at 20 s per large square; *y*-axis is a linear scale; all 6 points plotted correctly ± half a small square (2 marks); 5 points plotted correctly ± half a small square (1 marks); best-fit straight-line graph;	**5** 1 1 2 1
(c)(i)	value from graph ± half a small square (typically 167–170); units / s; extrapolation;	**3** 1 1 1
(c)(ii)	sketch line below original line and diverging;	**1**
(d)	as an indicator;	**1**
(e)(i)	(more) accurate;	**1**
(e)(ii)	solution slow to run out of pipette; difficult to know when to start timer / reaction does not start at once / inaccurate time measurement owtte;	**2** 1 1
(f)	difficulty in swirling / mixing / shaking;	**1**

17. 0620_s17_ms_63 Q: 2

(a)	all volume boxes completed correctly: 0, 13, 25, 38, 48, 59, 70, 79, 88, 96	**3**
(b)	origin plotted	**1**
	other points correctly plotted	**1**
	two smooth lines	**1**
	labelled	**1**
(c)	Experiment 1	**1**
	more concentrated / stronger acid / the acid has a lower pH	**1**

(d)	volume of gas at 30 s	1
	correct calculation of rate	1
	unit: cm^3/s **OR** $cm^3 s^{-1}$	1
(e)	all the magnesium will have reacted	1
(f)	faster reaction / increased rate	1
	magnesium powder has a higher surface area	1
(g)	advantage: easy to use / quick	1
	disadvantage: not accurate	1
(h)	use of burette / pipette / gas syringe / weighed amount of magnesium / repeat experiment (and average) / clean the magnesium / remove oxide layer	1

18. 0620_s18_ms_61 Q: 2

(a)	volume boxes completed correctly in seconds 0, 10, 15, 20, 40	1
	time boxes completed correctly 27, 33, 45, 66, 201	2
(b)	all points plotted correctly (□ half a small square)	2
	smooth line graph	1
(c)(i)	value from graph	1
	with clear indication	1
(c)(ii)	1 □ value from **(c)(i)**	1
(d)(i)	experiment 1	1

(d)(ii)	more particles of thiosulfate (in a given volume)	1
	more chance of collision	1
(e)	use a pipette / burette	1
(f)	times would be shorter	1
	idea of depth of solution is greater	1
(g)	sketch curve roughly same shape and above original	1

19. 0620_s19_ms_63 Q: 2

(a)	temperature boxes completed: 25, 25, 25, 41,46, 46, 45, 44	2
(b)	temperature boxes completed: 27, 27, 27, 57, 79, 79, 77, 75	1
(c)	temperature boxes completed: 23, 23, 23, 25, 26, 27, 28, 29	1
(d)	all points plotted correctly	1
	3 best fit smooth line graphs	1
	axes labelled	1

(e)	working shown clearly on graph for Experiment 2 at 75 seconds	1
	reading taken from graph	1
(f)(i)	Experiment 2	1
	temperature (change) is greatest	1
(f)(ii)	Experiment 1 is faster (than Experiment 3)	1
	because surface area greater / more (frequent) collisions	1
(g)	initial temperature from table / room temperature	1
	reaction finished	1
(h)	more readings / points	1
	better / smoother graph	1
(i)	copper is a (good) conductor (of heat)	1
	(high) heat loss (to surroundings) / lower temperatures	1

20. 0620_s20_ms_62 Q: 2

Question	Answer	Marks
(a)	lengths completed correctly (1, 2, 3, 5, 6)	1
	10 correct thermometer readings (23 × 5, 24, 26, 29, 36, 40)	2
	All temperature increases worked out correctly (1, 3, 6, 13, 17)	1
(b)	5	1
(c)	scale has one big square = 5	1
	all five points plotted correctly	2
	best fit line through points	1
	which passes within half a small square of (0, 0)	1
(d)	there is no reaction (with no magnesium)	1

Question	Answer	Marks
(e)	working shown on graph	1
	correct reading	1
	units of °C shown	1
(f)(i)	(polystyrene is a better) insulator	1
(f)(ii)	sketch line starts at same point as plotted line for 0 cm magnesium and then is above plotted line at all non-zero lengths of magnesium.	1
(g)(i)	more accurate	1
(g)(ii)	slower	1

21. 0620_s21_ms_61 Q: 4

Question	Answer	Marks
	Any 6 from: • stated / set / same / measured volume of acid • stated / set / same / measured mass of calcium carbonate • add / combine / put together **and** start timing • Repeat (with acid) at higher / lower temperature **then:** • graphical method: • measure / record mass at known / regular / specified times • plot graph • steepest line is fastest **OR** mass loss in a set time • measure / record mass at a specified time • calculate / measure mass lost • largest mass loss is fastest or calculates rate by mass loss ÷ time **OR** time to end of reaction • react until mass stops changing / reaction stops • record time • shortest time is fastest or calculates rate by mass loss ÷ time **OR** time to lose a set mass • react until it reaches / loses a certain mass • record time • shortest time is fastest or calculates rate by mass loss ÷ time **OR** mass of calcium carbonate left after a set time • filter after a set time • find mass of calcium carbonate left • lower mass of calcium carbonate is fastest or calculates rate by mass **loss** ÷ time	6

22. 0620_w12_ms_61 Q: 4

(a) Table of results for Experiments [5]

all initial temperature boxes completed correctly (2)

25 41 47 62 72

all final temperature boxes completed correctly (2)

23 27 39 42 48

average temperatures completed correctly (1)

24 34 43 52 60

(b) points plotted correctly (4) [5]

smooth line graph (1)

(c) value from graph at 72 °C (1) ≈ 30–35 s [2]

extrapolation shown on grid (1)

(d) as an indicator owtte/check iodine present (1) [1]

(e) **(i)** experiment 5 (1) [1]

(ii) highest temperature (1) [2]

particles have more energy/more collisions/move faster (1)

(f) time longer/more/increase (1) [2]

speed slower/decrease (1)

(g) more accurate (1) [1]

23. 0620_w12_ms_62 Q: 2

(a) straight line drawn with a ruler missing point at concentration 0.15 (1)
through origin (1) [2]

(b) 0.56/0.57/0.58 (1)
extrapolation shown (1) [2]

(c) line to right hand side of original and goes through origin (1) [1]

(d) **(i)** catalyst/to speed up the reaction (1) [1]

(ii) slower/owtte (1)
less surface area (1) [2]

---

24. 0620_w13_ms_61 Q: 5

(a) volumes completed correctly (4), –1 each incorrect [4]

time / s	catalyst R	catalyst S
0	0	0
30	23	16
60	34	36
90	59	51
120	66	63
150	71	69
180	72	72

(b) points plotted correctly (3) smooth curves (2) labels (1) [6]

(c) result at 60s / volume 34 / third result (1) [1]

(d) R (1) rate faster (1) [2]

(e) sketch to left of R graph / steeper (1) to same level (1) [2]

---

25. 0620_w13_ms_62 Q: 6

x cm^3 of hydrogen peroxide / solution H (1)
add MnO_2 (1)
method to collect gas that works (1)
measurement of (total) volume of gas produced / counting bubbles in time interval (1)
repeat using solution J (1)
comparison / conclusion (1) max [5]
ignore: reference to heat
not: speed of relighting a glowing splint

---

26. 0620_w14_ms_61 Q: 2

(a) smooth curve missing anomalous point (1) [1]

(b) **composition of mixture**
double volume / 100 cm^3 of hydrogen peroxide (1)
more than 1 g of manganese(IV) oxide / powdered (1) [2]
ignore: references to water
note: double the concentration is valid for (2)

explanation
double volume of gas (1)
faster reaction (1) [2]

(c) catalyst / increase the rate of the reaction (1) [1]

(d) sketch graph less steep than original for Experiment 1 (1)
to same level (1) [2]

---

27. 0620_w14_ms_63 Q: 2

(a) mass of beaker + contents column completed correctly
all 11 correct (2)
10 correct (1)
9 or fewer correct (0)
total loss column correct (1) [3]
note: if all readings are not to 1dp, max 2

time / min	mass / g	total loss / g
0	95.0	0.0
1	93.0	2.0
2	92.0	3.0
3	91.3	3.7
4	91.2	3.8
5	90.5	4.5
6	90.3	4.7
7	90.1	4.9
8	90.0	5.0
9	90.0	5.0
10	90.0	5.0

(b) points plotted correctly including origin (2)
smooth curve missing anomalous point (1) [3]

(c) gas / carbon dioxide evolved / formed / escapes / given off (1) [1]

(d) **(i)** result at 4 minutes / fifth point / 91.2 / 3.8 g [1]

(ii) 4.2 (g) ± 0.1 (1) [1]

(e) sketch with steeper graph than original (1)
starting at origin levelling at same height (1) [2]

---

28. 0620_w15_ms_62 Q: 3

(a)	all temperatures correctly recorded: 23, 36, 47, 58, 70, 79 6 correct = 3 5 correct = 2 4 correct = 1 3 or fewer correct = 0	**3**	
(b)	all points correctly plotted: 23, 36, 47, 58, 70, 79 6 correct = 2 5 correct = 1 4 correct = 0 smooth curve;	**2** **1**	
(c)	third point / at 47 °C or 99 s; not on smooth line / curve;	**1** **1**	
(d)	118; seconds / sec / s; indication on the graph;	**1** **1** **1**	
(e)(i)	(it) increases / higher the temperature faster reaction;	**1**	**I:** references to time (rather than rate)

(e)(ii)	particles have more energy / move faster; more (chance of / successful) collisions;	1 1	
(f)(i)	slower reaction / longer time; smaller surface area;	1 1	
(f)(ii)	sketch above the curve not touching the original at any point;	1	**A:** curve above but touching the anomalous point
(g)	to prevent escape of / splash of acid; to allow carbon dioxide / gas to escape;	1 1	**R:** prevent spillages

29. 0620_w15_ms_63 Q: 6

	6 from: • uses different (at least two) concentrations of sulfuric acid; • made by diluting with water; • same total volume of (diluted) sulfuric acid; • same mass / amount / size / length / surface area of magnesium (ribbon); • measure time (or run at the same time); • for magnesium to dissolve or react or disappear / y cm^3 gas to collect / volume collected (set time) / bubbles to stop / mass to decrease by x g / mass to stop decreasing; • compare times of reaction / results;	6	**A:** implication of this last two marking points are dependent on measuring time

30. 0620_w16_ms_62 Q: 2

(a)	table of results volume boxes completed correctly (30), 44, 57, 62, 78, 85, 88, 89, 90, 90	2
(b)	all points correctly plotted smooth line graph	2 1
(c)(i)	point at 60 s / 62 cm^3 / fourth point / measurement 4	1
(c)(ii)	misread measuring cylinder / read too early	1
(c)(iii)	value from graph (68–70) shown clearly	1 1
(d)	the Reaction has finished all the acid has reacted / HCl is the limiting factor	1 1
(e)(i)	value from graph or table (57–44 = 13 cm^3)	1
(e)(ii)	13 / 20 = 0.65 cm^3 / s	1 1

(f)	steeper curve to same level	1 1
(g)	air is displaced (when the acid is added)	1
(h)	improvement explanation use a burette / graduated pipette / gas syringe improves accuracy **OR** use cotton thread to hold a test-tube (containing the acid) in the flask no air is collected **OR** repeat the experiment take average / more frequent readings	1 1

31. 0620_w17_ms_61 Q: 2

(a)	average temperatures completed for all five experiments: 18, 31, 41, 53, 63	1
	times completed for all five experiments: 210, 111, 84, 66, 54	1
	all times in seconds	1
(b)	all five points plotted	3
	smooth line graph	1
(c)	value from graph for average temperature 72 °C	1
	unit (s)	1
	shown clearly	1
(d)	line above experimental line	1
(e)(i)	Experiment 5	1
(e)(ii)	particles move faster / particles have more energy	1
	more (frequent) collisions / greater chance of collisions	1
(f)(i)	more accurate	1
	comparison to measuring cylinder	1
(f)(ii)	time shorter / cross disappears faster	1
	depth greater	1

32. 0620_w18_ms_61 Q: 2

(a)	mass boxes correctly completed to 1 dp 86.0, 85.0, 84.4, 84.1,84.0, 83.9, 83.9, 83.9	2
	Loss in mass boxes correctly completed 0.0, 1.0, 1.6, 1.9, 2.0, 2.1, 2.1, 2.1	1
(b)	points correctly plotted:	2
	smooth line graph;	1
(c)	**M1** mass loss from graph at 30 seconds (0.5)	1
	M2 mass in M1 / 30 calculated (= 0.017)	1
	M3 g / s;	1
(d)	Sketch steeper than original graph	1
	To same level	1

(e)(i)	gas / carbon dioxide given off	1
(e)(ii)	Allow gas to escape	1
	Prevent loss of acid;	1
(e)(iii)	Reaction finished	1
	All nitric acid has reacted	1
(f)	Advantage: more accurate;	1
	Disadvantage: slow	1

33. 0620_w18_ms_62 Q: 2

(a)	Table of results for experiments 1–5 Times completed 29, 39, 56, 65, 111	3
	in seconds	1
(b)	All points plotted correctly	3
	Smooth line graph	1
(c)	Value from graph	1
	indication on graph	1
	unit	1

(d)(i)	Experiment 1	1
(d)(ii)	More particles (of solution L present per unit volume)	1
	more frequent collisions / particles collide more often / higher collision rate	1
(e)(i)	More accurate	1
(e)(ii)	Too slow / slower addition of solution / takes longer to add	1
	Measuring time taken less accurate / results less accurate	1
(f)	Repeat **and** average / compare results	1

34. 0620_w18_ms_63 Q: 2

(a)	Table of results for experiments 1–4 average temperature boxes completed correctly 22, 30, 39, 48	1
	Time boxes completed correctly 98, 42, 26, 22	2
	Times completed in seconds	1
(b)	All points plotted correctly	3
	Smooth line graph (curve)	1

(c)	indication on graph	1
	Value from graph	1
	°C	1
(d)(i)	Experiment 4	1
(d)(ii)	**M1** particles (of solution L) have more / most (kinetic) energy / move faster	1
	M2 more frequent collisions / particles collide more often	1
(e)	**M1** Insulation / use a lid	1
	M2 To reduce heat losses	1
(f)	**M1** Too slow / slower addition of solution	1
	M2 Measuring time-taken / results less accurate	1

35. 0620_w19_ms_63 Q: 1

(a)	measuring cylinder	1
(b)	volume of gas / oxygen	1
	time	1
(c)(i)	concentration of hydrogen peroxide / reactant decreases	1
(c)(ii)	all hydrogen peroxide / reactant decomposed	1
(d)(i)	filtration	1
(d)(ii)	**method 1** □ dry / evaporate water □ (re-)weigh (the manganese(IV) oxide / catalyst after the reaction) □ mass should be unchanged / 0.5 g **OR** **method 2** □ use same sample MnO_2 / dry MnO_2 □ repeat experiment □ results would be the same	3

36. 0620_w20_ms_62 Q: 2

Question	Answer	Marks
(a)	all volumes of sodium metabisulfite completed as 5	1
	all volumes of water (15, 17, 21, 23, 25) correct.	1
	all times recorded correctly (38, 42, 53, 61, 72)	2
	all five times in seconds only	1
(b)	all 5 points plotted correctly	2
	suitable best fit curve drawn. Line must go through / within half a square of correctly plotted points	1
(c)(i)	correct working shown on graph	1
	time correct for their working	1
(c)(ii)	19	1
(d)	line is below plotted line and does not meet / touch plotted line.	1
(e)(i)	0.02	1

Question	Answer	Marks
(e)(ii)	1	1
(f)	to keep total volume constant / so concentration of sodium metabisulphite does not change	1
(g)	change: use a pipette / burette (in place of a measuring cylinder)	1
	explanation: more accurate / precise (than a measuring cylinder)	1
(h)	repeat **and** compare the results	1

37. 0620_w21_ms_61 Q: 2

Question	Answer	Marks
(a)	mark syringe diagrams only. 0, 12, 20, 27, 32, 36	2
(b)	thermometer diagrams Experiment 1: 23 **and** Experiment 2: 44	1
	syringe diagrams 0, 25, 35, 40,40,40	1
(c)	all 12 points plotted correctly	2
	smooth curve for Experiment 1	1
	smooth curve for Experiment 2, must level off	1
	lines labelled either with Experiment 1/2, (a)/(b) or temperature	1
(d)	correct indication/construction shown on graph	1
	correct reading for their indication/construction	1
(e)	gas volume constant / stays at 40 cm^3	1

Question	Answer	Marks
(f)	40	1
	same amount of reactants/acid as Experiment 2	1
(g)	more data / more points	1
	can plot a better graph / see trend more clearly	1
(h)	any two from • insulate the tube / use a waterbath • use a pipette/burette in place of the measuring cylinder • use a divided flask / description of this **max 2**	2
(i)	description of how the acid would be cooled, such as place acid in fridge or freezer / stand tube in ice bath	1

38. 0620_w21_ms_63 Q: 4

Question	Answer	Marks
	Any 6 from: **MP1** weigh copper(II) oxide / stated mass copper oxide **MP2** add to known volume of hydrogen peroxide / stated volume of hydrogen peroxide **MP3** measure volume of gas made in set time **MP4** filter off copper(II) oxide **MP5** dry and weigh **MP6** repeat experiment with no copper oxide added **OR** compare gas volume to with no copper oxide added **MP7** bigger volume **AND** catalyst mass the same means it is a catalyst max 6	6