

Measuring Rates

Q1. (2018) – 1c

- 1 Students are investigating exothermic and endothermic reactions. They are finding the temperature change in 50 cm^3 water when a solid dissolves in it. The apparatus is shown in Figure 1.

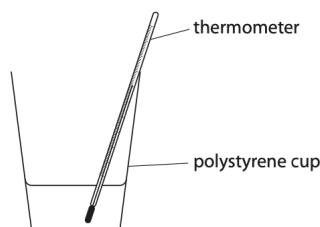


Figure 1

- (c) State how step **R** could be changed to measure the volume of water more accurately. (1)

Q2. (2018) – 3a, 3c (ii)

- 3 Hydrogen peroxide decomposes to form water and oxygen.

The rate of this reaction can be found by measuring the volume of oxygen formed after different time intervals.

Hydrogen peroxide solution is placed in a conical flask. The apparatus is set up as shown in Figure 5.

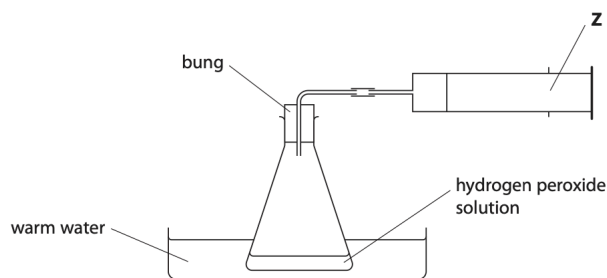


Figure 5

A)

- (a) State the name of the piece of apparatus labelled **Z** in Figure 5. (1)

B)

- (c) A solid catalyst can be used for this reaction.

- (ii) At the end of the experiment with the catalyst added, the mass of the catalyst remaining is found.

The method used to find the mass of the catalyst remaining is
filter the mixture of products and catalyst
determine the mass of the filter paper and solid catalyst
subtract the mass of a filter paper from the mass of filter paper and solid catalyst.

This method would not give the accurate mass of catalyst remaining.

Which of the following needs to be done to give a more accurate mass? (1)

- ☐ **A** dry the filter paper and catalyst before finding their mass
☐ **B** scrape the catalyst off the filter paper and find the mass of the catalyst
☐ **C** find the mass of the filtrate and not the filter paper and catalyst
☐ **D** repeat the experiment

Q3. (2019)

- 6 The word equation for the reaction between magnesium and dilute hydrochloric acid is



The reaction was carried out using the apparatus shown in Figure 11.

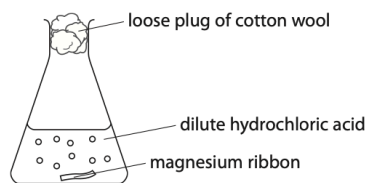


Figure 11

A strip of magnesium ribbon was placed in the conical flask.
100 cm³ of dilute hydrochloric acid was added to the conical flask.

The mass of the flask and contents was measured at regular intervals.
The loss in mass was calculated.

Figure 12 shows a graph of the results.

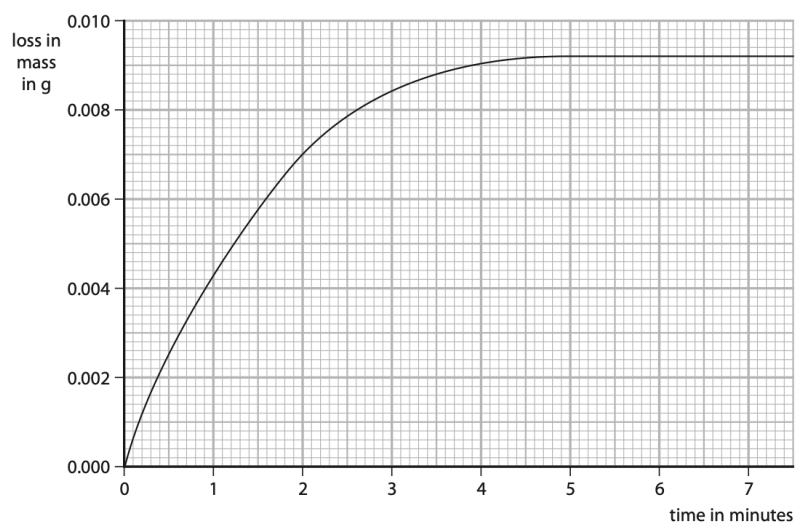


Figure 12

A)

- (a) Name the apparatus that could be used to measure out 100 cm³ of dilute hydrochloric acid.
(1)

B)

- (b) Explain why there is a loss in mass of the flask and contents.
(2)

Q4. (2019) – 10c

A)

- (c) (i) The apparatus in Figure 16 can be used to investigate the temperature rise produced in a known mass of water when a sample of ethanol is burned.

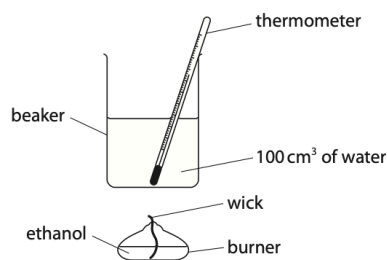


Figure 16

The first steps of the method are

1. put 100 cm^3 of water into a beaker
2. determine the mass of the burner containing ethanol
3. measure the initial temperature of the water
4. place the burner under the beaker of water
5. light the wick

Describe the remaining steps of the method that are needed to determine the mass of ethanol required to raise the temperature of the water by 30°C .

(3)

B)

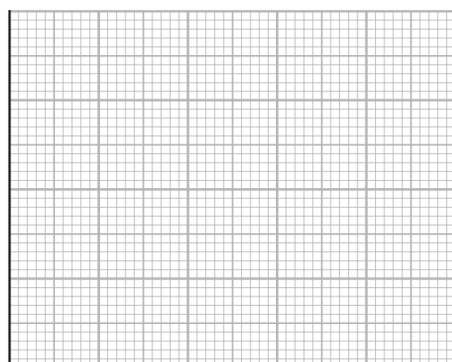
- (ii) In a different experiment, separate samples of the alcohols methanol, ethanol, propanol, butanol and pentanol were burned to determine the mass of each alcohol that needs to be burned to raise the temperature of 100 cm^3 water by 10°C .

alcohol	number of carbon atoms in one molecule of alcohol	mass of alcohol burned in g
methanol	1	0.37
ethanol	2	0.28
propanol	3	0.25
butanol	4	0.23
pentanol	5	0.22

Draw a graph of the mass of each alcohol required to raise the temperature of 100 cm^3 of water by 10°C against the number of carbon atoms in one molecule of that alcohol.

(3)

mass of alcohol
burned in g



number of carbon atoms in
one molecule of alcohol

Q5. (2020) – 3b

- 3 (a) A student investigated the reaction between potassium iodide and lead nitrate.
- (b) In another experiment, a student investigated the temperature decrease when different amounts of ammonium nitrate crystals were dissolved in 100 cm³ of water.
- The apparatus used is shown in Figure 5.

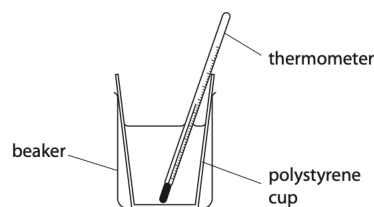


Figure 5

The student used the following method.

- step 1** pour 100 cm³ of water into the polystyrene cup
- step 2** add one spatula of ammonium nitrate crystals to the water
- step 3** stir the mixture
- step 4** use the thermometer to record the lowest temperature reached by the mixture
- step 5** repeat steps 1 to 4 using different amounts of ammonium nitrate

Question:

A)

- (i) Name a piece of apparatus that should be used to measure the 100 cm³ of water in **step 1**.

(1)

B)

- (ii) The student cannot work out the temperature decrease using the method described.

State what the student must do before **step 2** to be able to work out the temperature decrease.

(1)

C)

- (iii) State why a polystyrene cup is used in this experiment.

(1)

Q6. (2020) – 9a (ii)

- 9 (a) Calcium carbonate reacts with dilute hydrochloric acid to produce carbon dioxide gas.

The rate of reaction between calcium carbonate and dilute hydrochloric acid at room temperature was investigated.

- (ii) The calcium carbonate powder produced 90 cm³ of carbon dioxide in five minutes.

Calculate the average rate of reaction in cm³ s⁻¹.

(3)

Q7. (2021) – 2b, 2c, 2e

- 2 Magnesium reacts with dilute sulfuric acid to form magnesium sulfate and hydrogen gas.

A student wants to find out the effect of temperature on the rate of this reaction.

The student used the following method.

step 1 pour 25 cm³ of dilute sulfuric acid into a conical flask

step 2 warm the acid until its temperature is 30 °C

step 3 add a piece of magnesium to the acid

step 4 start a stopwatch

step 5 wait until the reaction has finished

step 6 stop the stopwatch

step 7 repeat steps 1–6 but at 50 °C.

A)

- (b) Which piece of equipment can be used to find the volume of 25 cm³ of sulfuric acid? (1)

- ☐ A balance
- ☐ B measuring cylinder
- ☐ C ruler
- ☐ D thermometer

B)

- (c) State how the student will know that the reaction has finished. (1)

C)

- (e) At 50 °C, 15.0 cm³ of gas was produced during the first 60 seconds of the reaction.

Calculate the average rate of reaction, in cm³ s⁻¹, for the first 60 seconds of the reaction.

(2)

Q8. (2021) – 6d (i, iii)

- 6 Figure 9 shows a sample of hydrogen peroxide solution decomposing to form water and oxygen gas.

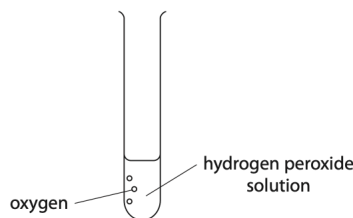


Figure 9

- (d) Liver contains the enzyme catalase.

A piece of liver was added to another sample of hydrogen peroxide solution.

Figure 12 shows the results.

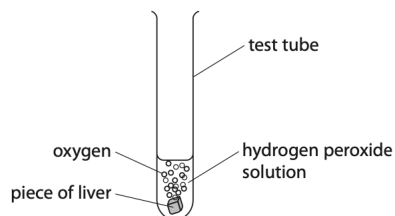


Figure 12

Figure 13 shows a graph of the volume of oxygen produced from the hydrogen peroxide with and without liver.

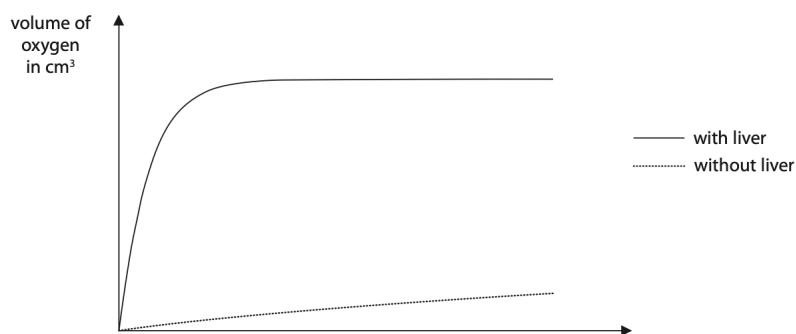


Figure 13

A)

- (i) Complete the missing label on the axis of the graph.

(1)

B)

- (iii) Describe how the apparatus in Figure 12 could be modified to find the volume of gas produced when the liver is added to the hydrogen peroxide.

(2)

Q9. (2021) – 7b

- (b) A student used an alcohol burner to find the mass of different alcohols needed to raise the temperature of 100 cm³ of water by 20 °C.

Figure 15 shows their results.

alcohol	initial mass of alcohol burner and alcohol in g	final mass of alcohol burner and alcohol in g	mass of alcohol used in g
ethanol	122.51	122.02	0.49
propanol	168.55	168.13	0.42
butanol	152.62	152.23	
pentanol	67.22	66.86	0.36

Figure 15

A)

- (i) Calculate the mass of butanol used.

(1)

mass of butanol = ... g

B)

- *(ii) Figure 16 shows equipment that can be used to obtain the results shown in Figure 15.

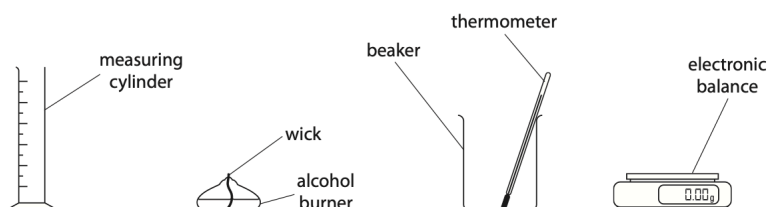


Figure 16

Describe an experiment, using the equipment in Figure 16, that could be used to obtain results like those shown in Figure 15.

(6)

C)

- (iii) The results show that 0.36 g of pentanol was needed to raise the temperature of the water by 20°C.

Calculate the mass of pentanol needed to raise the temperature of water by 1°C.

Give your answer to 2 decimal places.

Show your working.

(2)

Q10. (2022) – 4b

- (b) In an experiment, a solid is mixed with a liquid.
The temperature change of the mixture is measured.

Figure 6 shows the apparatus that is used.

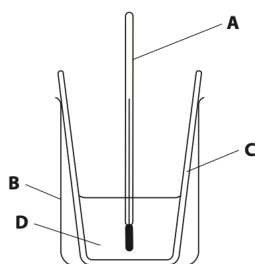


Figure 6

A)

- (i) Give the letter of the piece of apparatus, **A**, **B**, **C** or **D**, in Figure 6 that is used to measure the temperature.

(1)

B)

- (ii) Give the name of the piece of apparatus **B** shown in Figure 6.

(1)

C)

- (iii) The piece of apparatus labelled **C** is made from polystyrene.

State why polystyrene is a better material than glass for this piece of apparatus.

(1)

Q11. (2022)

- 8 A student used the apparatus in Figure 13 to investigate the rate of the reaction between a metal and dilute hydrochloric acid.

Pieces of the metal were placed in dilute hydrochloric acid in the flask, and the total volume of gas produced was measured every minute.

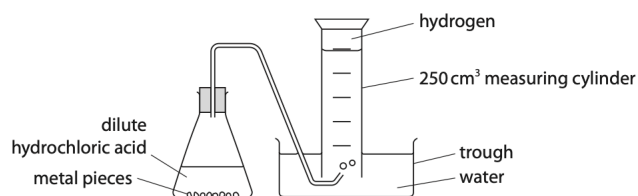


Figure 13

- (a) Figure 14 shows a graph of the student's results.

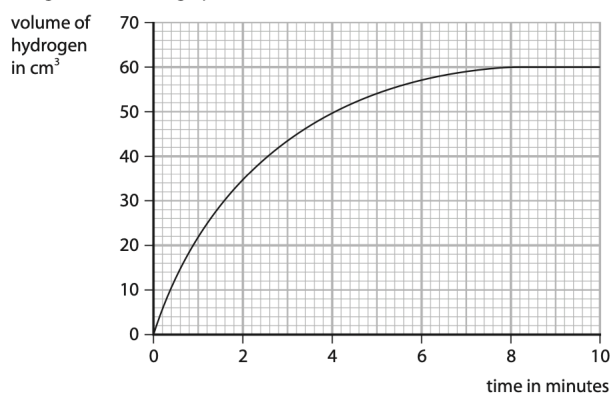


Figure 14

A)

- (i) Name a piece of apparatus that would be better to measure the volume of gas produced, instead of the 250 cm³ measuring cylinder.

Give a reason for your answer.

(2)

name of apparatus

reason

B)

- (ii) Calculate the mean rate of production of hydrogen over the first 90 seconds, in cm³ per second.

(3)

rate = ... cm³ per second

C)

- (iii) The student measured the volume of gas for 10 minutes.

State why the measurements could have been stopped at 9 minutes.

(1)

Q12. (2023) – 2c

- 2 A student investigated the temperature change that took place when different salts were dissolved in water.

The student used the following method.

step 1 pour 50 cm³ of water into a polystyrene cup and record the temperature of the water

step 2 find the mass of an empty boiling tube

step 3 add 2 spatula measures of a salt to the boiling tube and find its new mass

step 4 add the salt to the water

step 5 stir the mixture and record the temperature after 2 minutes.

Figure 3 shows the apparatus used.

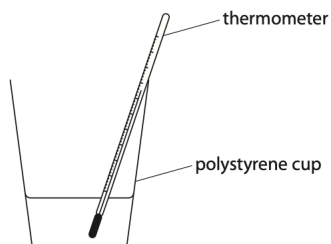


Figure 3

- (c) Explain why a polystyrene cup is a better container to use for this investigation than a glass beaker.

(2)

Q13. (2023) – 7b (iii)

- 7 In the complete combustion of alkanes, the alkane reacts with oxygen to produce carbon dioxide and water only.

(b) Figure 13 shows some information about four alkanes.

alkane	formula	structure of one molecule
propane	C ₃ H ₈	
butane		<pre> H H H H H — C — C — C — C — H H H H H </pre>
pentane	C ₅ H ₁₂	<pre> H H H H H H — C — C — C — C — C — H H H H H H </pre>
hexane	C ₆ H ₁₄	<pre> H H H H H H H — C — C — C — C — C — C — H H H H H H H </pre>

Figure 13

*(iii) A student is asked to compare the amount of energy released during the combustion of two alkanes, hexane and octane.

The student is given the apparatus shown in Figure 14.

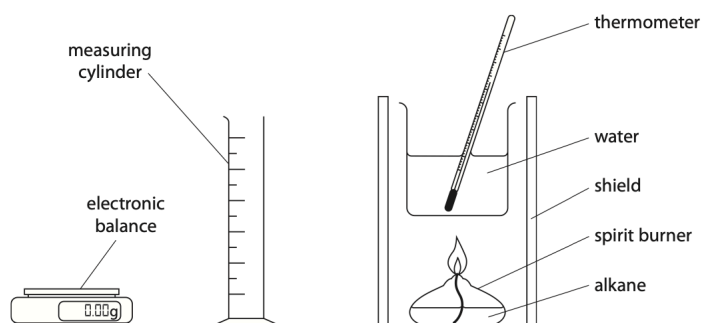


Figure 14

Using the apparatus shown, devise a plan for the student to compare the masses of hexane and octane required to raise the temperature of water by 30°C, describing how any variables in the experiment can be controlled to make a fair comparison.

(6)

Q14. (2023) – 8a, 8b (i), 8e

- 8 A student used the apparatus shown in Figure 15 to investigate the reaction between marble chips and dilute hydrochloric acid.

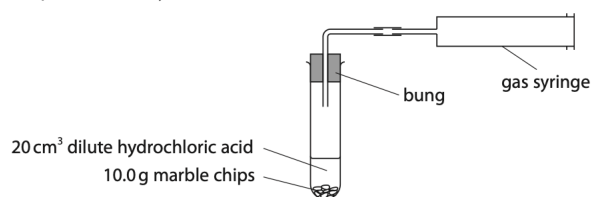


Figure 15

The student recorded the volume of gas every minute as shown in Figure 16.

time in minutes	0	1	2	3	4	5	6
volume of gas in cm ³	0	52	78	91	97	100	100

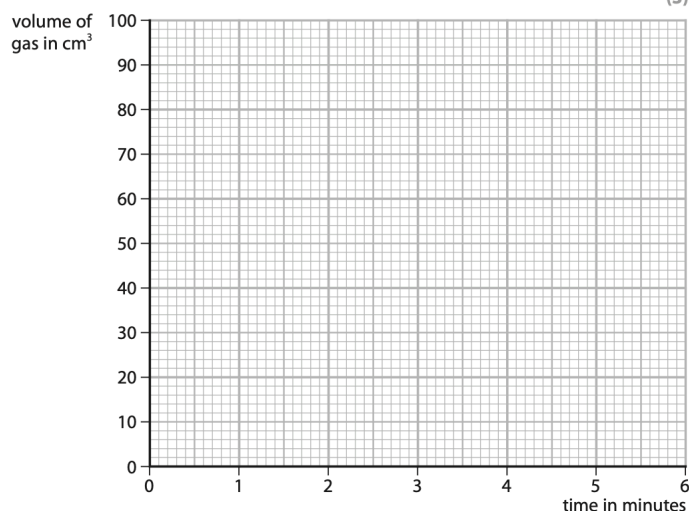
Figure 16

A)

- (a) On the grid, plot the results shown in Figure 16.

Draw a curve of best fit.

(3)



B)

- (b) Rate of reaction can be calculated using

$$\text{rate of reaction} = \frac{\text{volume of gas produced in 1 minute}}{1 \text{ minute}}$$

Figure 17 shows the rates of reaction calculated from the results of this experiment.

The rate of reaction for the time interval 2 to 3 minutes is missing.

time interval	0 to 1 minute	1 to 2 minutes	2 to 3 minutes	3 to 4 minutes	4 to 5 minutes
rate of reaction in $\text{cm}^3 \text{min}^{-1}$	52	26		6	3

Figure 17

- (i) Calculate the rate of reaction for the time interval 2 to 3 minutes.

(1)

rate of reaction = ... $\text{cm}^3 \text{min}^{-1}$

C)

- (e) State what could be used to measure time in the investigation.

(1)

Q15. (2024) – 4b

- (b) In an experiment, a salt is dissolved in water.

The temperature change is measured.

Figure 7 shows the apparatus that is used.

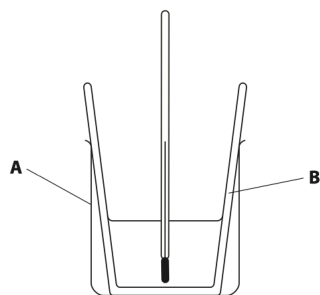


Figure 7

A)

- (i) State what is used to measure the temperature change in Figure 7.

(1)

B)

- (ii) State
- one**
- reason for using the piece of equipment
- A**
- in Figure 7.

(1)

C)

- (iii) A student suggests putting a lid on piece of equipment
- B**
- .

State why this would help to give a more accurate value for the temperature change.

(1)

Q16. (2024) – 8a, 8b (i, ii), 8e, 8f

- 8 A student investigates the reaction between marble chips and dilute hydrochloric acid.

The student measures the total volume of carbon dioxide gas produced each minute, for 10 minutes.

A)

- (a) Figure 14 shows part of the apparatus used in the experiment.

Complete Figure 14 by drawing and labelling apparatus that could be used to collect and measure the volume of the carbon dioxide gas.

(2)

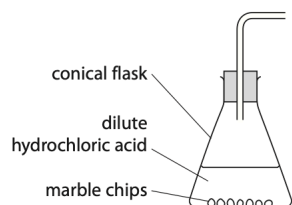


Figure 14

B)

- (b) Figure 15 shows a graph of the results of the experiment.

A tangent has been drawn on the curve at a time of 3.5 minutes.

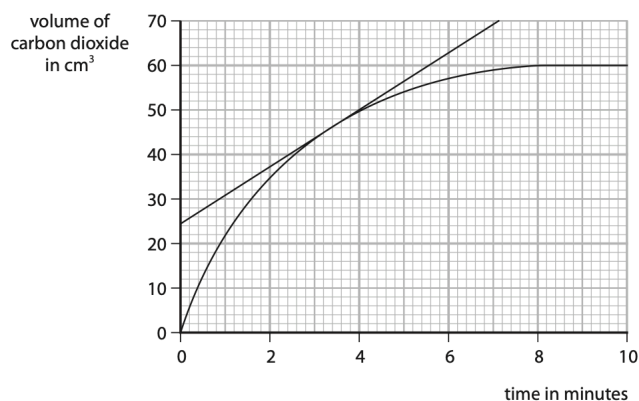


Figure 15

- (i) State the total volume of carbon dioxide produced in the first 3.5 minutes.

(1)

volume = ... cm³

C)

- (ii) Using the tangent, calculate the rate of reaction at 3.5 minutes in cm³ per minute.

$$\text{rate of reaction} = \frac{\text{change in gas volume}}{\text{change in time}}$$

(3)

.....

.....

.....

.....

rate = ... cm³ per minute

D)

(e) In this experiment the volume of carbon dioxide gas produced is measured.

Give a different way that the amount of carbon dioxide produced can be measured.

(1)

E)

(f) In this experiment there is an excess of dilute hydrochloric acid.

State what you would see in the conical flask at the end of the experiment.

(1)