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0653/61

May/June 2019

1 hour

No Additional Materials are required.

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The number of marks is given in brackets [] at the end of each question or part question.

This document consists of **13** printed pages and **3** blank pages.

1 A student investigates the nutrient content of an apple.

(a) Fig. 1.1 shows a photograph of the cut surface of an apple.



Fig. 1.1

(i) In the box, make an enlarged detailed drawing of the cut surface of the apple.

- (ii) Use a ruler to measure your drawing, in millimetres, at its widest point and record this value.

width of apple in drawing = ... mm

Measure the same distance on the photograph in Fig. 1.1 and record this value.

width of apple from photograph = ... mm
[1]

- (iii) Calculate the magnification of your drawing.

Show your working.

magnification of drawing = ... [1]

- (b) Describe how you would test this fruit to show the presence of reducing sugar. Include the observation that shows a positive result.

test

.....

.....

.....

.....

observation for a positive result

..... [3]

[Total: 7]

- 2 Fig. 2.1 shows a cut stem of the water plant *Elodea* placed in a beaker of water. When light shines on the *Elodea* it photosynthesises, and bubbles of gas are produced.

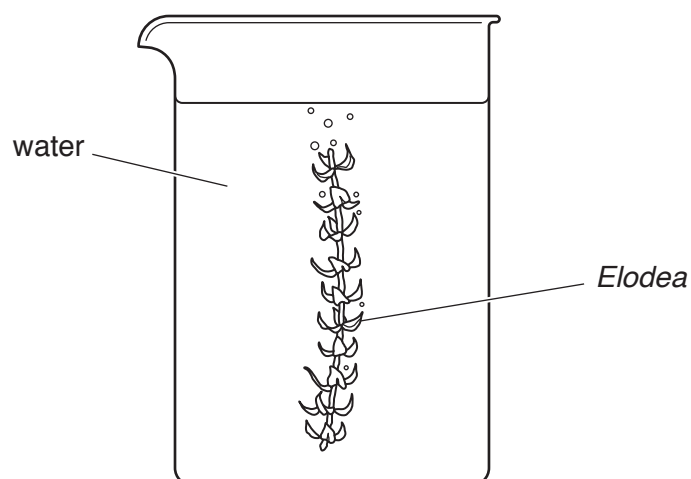


Fig. 2.1

Plan an investigation to find out how the rate of photosynthesis of *Elodea* is affected by the brightness of the light.

In your answer, include:

- the apparatus needed, including a labelled diagram if you wish
- a brief description of the method, including how you will treat variables and any safety precautions
- the measurements you will make
- how you will process your results
- how you will use your results to draw a conclusion.

- 3 A student investigates the temperature change which occurs when aqueous copper(II) sulfate reacts separately with excess magnesium and with excess zinc.

(a) Method

1. Using a measuring cylinder the student places 25 cm^3 aqueous copper(II) sulfate into a small glass beaker.
2. She measures the temperature of the aqueous copper(II) sulfate and records it in Table 3.1 to the nearest 0.5°C for time = 0.
3. She starts the stop-clock and immediately adds 2g magnesium powder, an excess, to the beaker and stirs.
4. She measures the temperature every 30 seconds for 4 minutes. She records the temperatures, to the nearest 0.5°C , in Table 3.1.

Table 3.1

reaction with magnesium	
time / min	temperature / $^\circ\text{C}$
0	20.0
0.5	
1.0	47.0
1.5	60.0
2.0	60.0
2.5	58.0
3.0	56.5
3.5	
4.0	53.0

Fig. 3.1 shows the thermometer scales for the temperatures at 0.5 and 3.5 minutes.

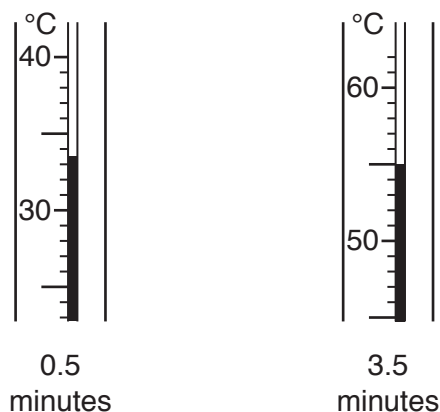
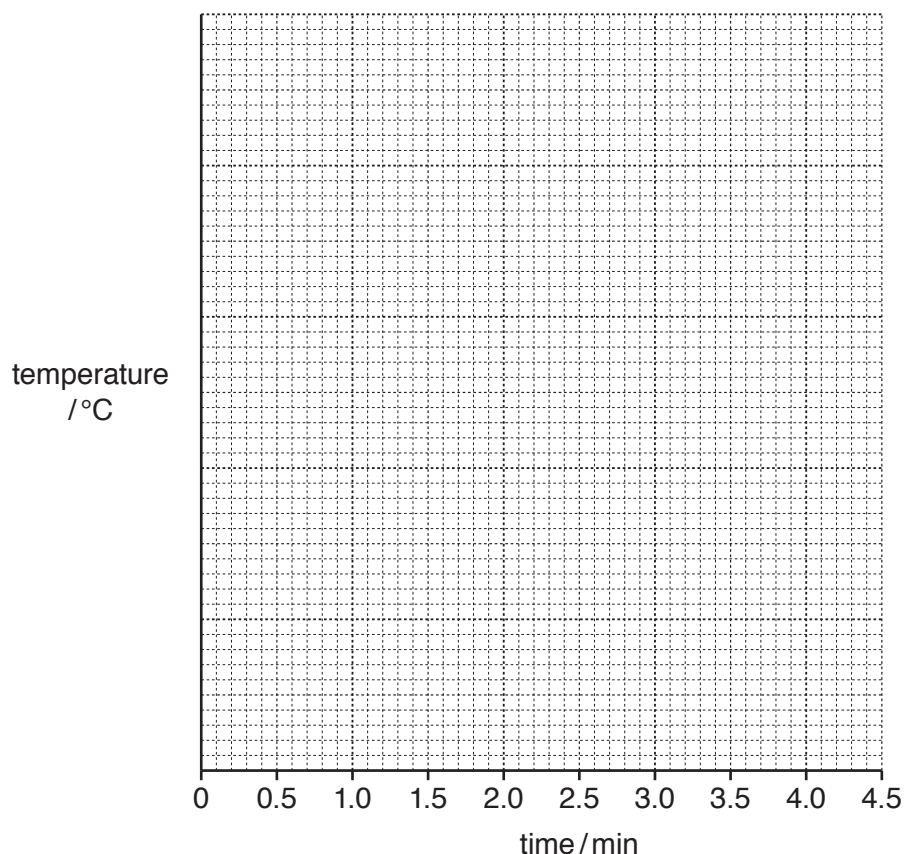


Fig. 3.1

Read the temperatures to the nearest 0.5°C and record them in Table 3.1.

[2]

- (b) (i) On the grid provided plot a graph of temperature (vertical axis) against time.



[2]

- (ii) Draw a best-fit straight line for the **increasing** temperatures. Extend the line further than the highest point. Label the line magnesium.

Draw a best-fit line through the **decreasing** temperatures. Extend the line back past the highest point.

[1]

- (iii) The maximum temperature reached by the reaction is where the two lines cross.

State the maximum temperature reached by the reaction.

maximum temperature = ... °C [1]

- (c) Suggest a value for the maximum temperature reached if 5 g magnesium powder is reacted with 25 cm³ of the same copper(II) sulfate solution.

maximum temperature = ... °C [1]

- (d) She then repeats the experiment using 2g zinc powder, an excess, instead of magnesium powder.

She records the temperatures in Table 3.2.

Table 3.2

reaction with zinc	
time / mins	temperature / °C
0	20.0
0.5	29.5
1.0	38.0
1.5	45.0
2.0	45.0
2.5	
3.0	41.5
3.5	40.0
4.0	38.0

- (i) Fig. 3.2 shows the thermometer scale for the temperature at 2.5 minutes.

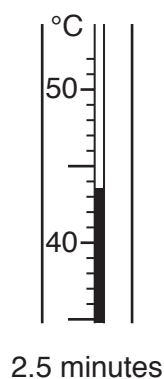


Fig. 3.2

Read the temperature to the nearest 0.5 °C and record it in Table 3.2. [1]

- (ii) Repeat (b) for the results for zinc. Draw the graph on the same grid as that used for magnesium.
Label this graph zinc.

State the maximum temperature reached by this reaction.

maximum temperature = ... °C [2]

- (e) Suggest why the maximum temperature for magnesium is different from the maximum temperature for zinc.

.....
..... [1]

- (f) (i) State the name of a piece of apparatus which could be used to measure the volume of copper(II) sulfate more accurately.

..... [1]

- (ii) Suggest **and** explain **one** other improvement to the **apparatus** that would increase the accuracy of the maximum temperature for the reactions.

improvement

explanation

..... [1]

[Total: 13]

- 4 A student calculates the density of a liquid using two different methods.

Method 1

- (a) He measures the mass m_c of an empty measuring cylinder.

$$m_c = 102.31 \text{ g}$$

He adds approximately 75 cm^3 of the liquid to the measuring cylinder.

- (i) Fig. 4.1 shows part of the measuring cylinder scale.

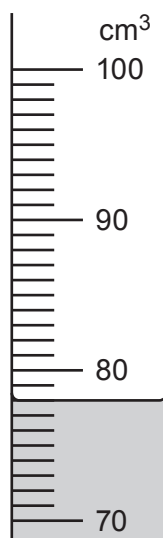


Fig. 4.1

Read and record the volume V_L of the liquid to the nearest 0.5 cm^3 .

$$V_L = \dots\dots\dots \text{ cm}^3 \quad [1]$$

- (ii) State how parallax (line of sight) errors are avoided when using a measuring cylinder.

.....
 [1]

- (iii) He measures and records the total mass of the measuring cylinder and liquid.

$$\text{total mass} = 189.00 \text{ g}$$

Determine the mass m_L of the liquid. Use the equation shown.

$$m_L = \text{total mass} - m_c$$

$$m_L = \dots\dots\dots \text{ g} \quad [1]$$

- (iv) Calculate the density ρ_L of the liquid. Use your answers in (a)(i) and (a)(iii) and the equation shown.

Record your answer to a suitable number of significant figures.

$$\rho_L = \frac{m_L}{V_L}$$

$$\rho_L = \dots\dots\dots \text{ g/cm}^3 \text{ [2]}$$

Method 2

- (b) (i) The student measures the mass m_t of a test-tube. Fig. 4.2 shows the balance reading.

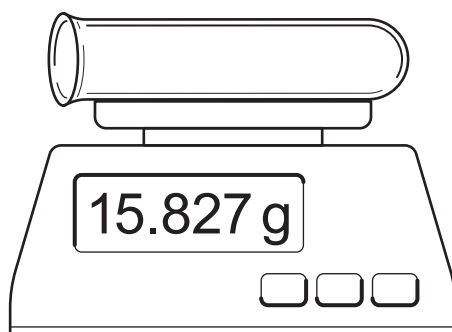


Fig. 4.2

Read and record the mass of the test-tube to the nearest 0.01 g.

$$m_t = \dots\dots\dots \text{ g [1]}$$

- (ii) He also measures the length l_t and the diameter d_t of the test-tube. His results are shown in Fig. 4.3.

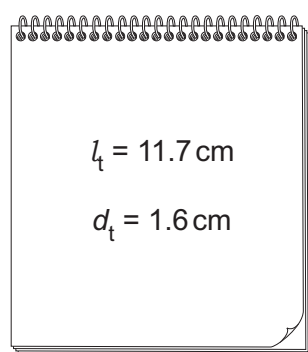


Fig. 4.3

Use the student's values of l_t and d_t to calculate the volume V_t of the test-tube. Use the equation shown:

$$V_t = 0.79 \times d_t^2 \times l_t$$

$$V_t = \dots\dots\dots \text{ cm}^3 \text{ [1]}$$

- (iii) Calculate the density ρ_t of the test-tube. Use your answers to (b)(i) and (b)(ii) and the equation shown:

$$\rho_t = \frac{m_t}{V_t}$$

$$\rho_t = \dots\dots\dots \text{ g/cm}^3 \text{ [1]}$$

- (iv) The student lowers the test-tube into a measuring cylinder containing the liquid until it floats, as shown in Fig. 4.4.

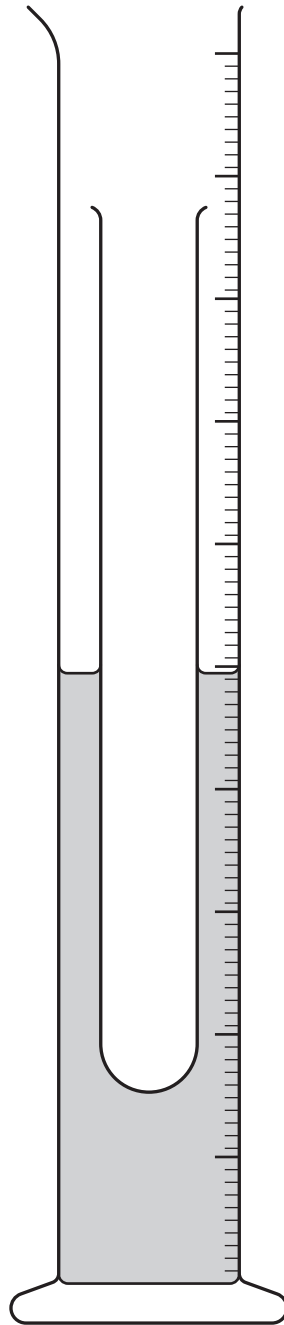


Fig. 4.4

Use a ruler to measure the length l_b of the test-tube, to the nearest 0.1 cm, that is below the surface of the liquid.

$$l_b = \dots\dots\dots \text{ cm [1]}$$

- (v) Calculate the density ρ_L of the liquid. Use the data in (b)(ii) and your answers to (b)(iii) and (b)(iv) and the equation shown:

$$\rho_L = \frac{\rho_t \times l_t}{l_b}$$

$$\rho_L = \dots\dots\dots \text{g/cm}^3 \quad [1]$$

- (c) Compare the values of ρ_L that you calculated in (a)(iv) and (b)(v).

State whether your two values of ρ_L agree, within the limits of experimental error. Explain your answer with reference to the data.

.....
 [1]

- (d) **Method 2** assumes that the test-tube is a perfect cylinder.

- (i) Use Fig. 4.4 to explain why this assumption is incorrect.

.....
 [1]

- (ii) State what effect this assumption will have on:

1. the calculated volume V_t of the test-tube

.....

2. the calculated value of the density ρ_L of the liquid.

.....
 [1]

[Total: 13]

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This document consists of **11** printed pages and **1** blank page.

1 A student investigates the effects of the enzyme pectinase on fruit.

(a) Pectinase is an enzyme that breaks down plant cell walls, and juice is released.

An apple is finely chopped and divided between two beakers, labelled **A** and **B**:

- 5% pectinase solution is added to the chopped apple in beaker **A**
- water is added to the chopped apple in beaker **B**
- both beakers are left overnight.

Fig. 1.1 shows the two beakers.

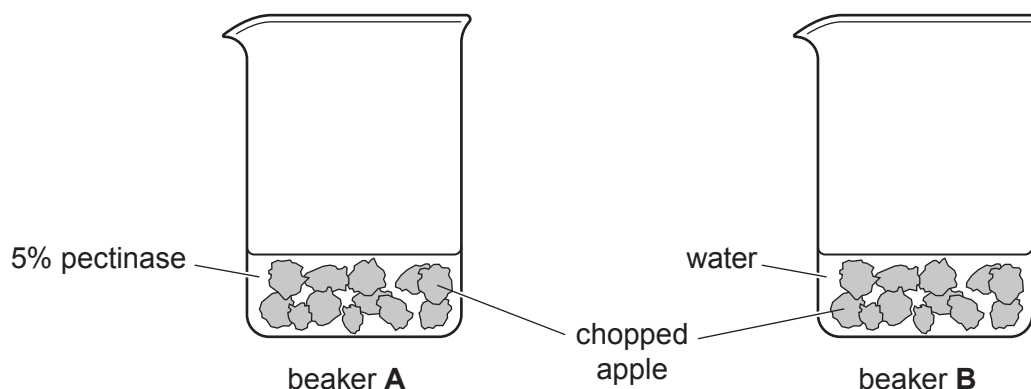


Fig. 1.1

(i) Explain the purpose of using water instead of pectinase in beaker **B**.

.....
 [1]

(ii) State **two** variables that should have been controlled when beaker **A** and beaker **B** were left overnight.

variable 1

variable 2

[2]

- (b) After leaving overnight, the juice is separated from the apple in each beaker and the volume of juice is measured.
- (i) Draw and label the apparatus you could use to separate the chopped apple from the juice in beaker **A**.

[3]

- (ii) The volume of apple juice collected from beaker **A** and from beaker **B** is shown in Fig. 1.2.

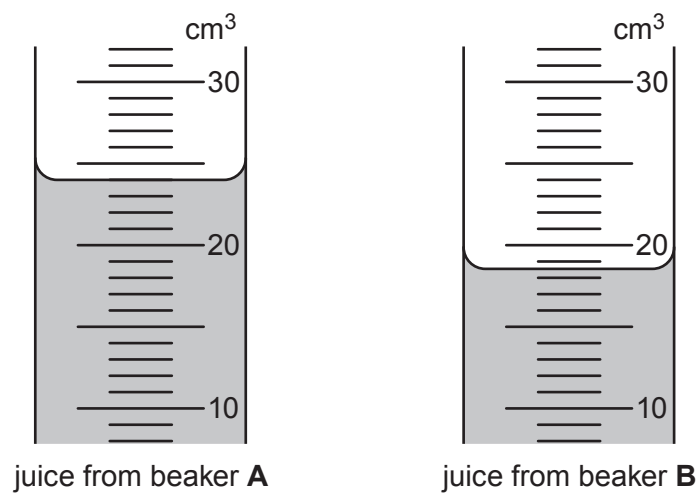


Fig. 1.2

Read and record the volume of juice from each beaker to the nearest 0.5 cm³.

volume of juice from beaker **A** = ... cm³

volume of juice from beaker **B** = ... cm³
[1]

[Total: 7]

- 2 A plant loses water from its leaves through transpiration.

A student states:

A plant in humid air will lose less water than a plant in dry air.

Plan an investigation to test whether this statement is correct.

In your answer, include:

- the apparatus needed, including a labelled diagram if you wish
- a brief description of the method, including how you will treat variables and any safety precautions
- the measurements you will make
- how you will process your results
- how you will use your results to draw a conclusion.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [7]

- 3 A student investigates the amount of precipitate formed when barium nitrate solution and sodium sulfate solution react together.

Barium nitrate solution and sodium sulfate solution are both colourless. They react together to form a white precipitate.

Method

- She labels seven test-tubes **1, 2, 3, 4, 5, 6** and **7**.
- Using a measuring cylinder she adds 3 cm^3 barium nitrate solution into each test-tube.
- Using a measuring cylinder she adds 1 cm^3 sodium sulfate solution into test-tube **1** and stirs with a glass rod.
- She adds 2 cm^3 sodium sulfate solution into test-tube **2** and stirs with a glass rod.
- She adds 3 cm^3 , 4 cm^3 , 5 cm^3 , 6 cm^3 and 7 cm^3 sodium sulfate solution into test-tubes **3, 4, 5, 6** and **7**, as shown in Table 3.1. She stirs each test-tube with a glass rod.
- After 5 minutes, she uses a ruler to measure the height in mm of the solid precipitate in each test-tube. She records these heights in Table 3.1.

Table 3.1

test-tube number	volume of sodium sulfate solution added/ cm^3	height of precipitate/mm
1	1	7
2	2	14
3	3	
4	4	28
5	5	
6	6	36
7	7	36

- (a) Fig. 3.1 shows the heights of precipitate for test-tubes **3** and **5**.

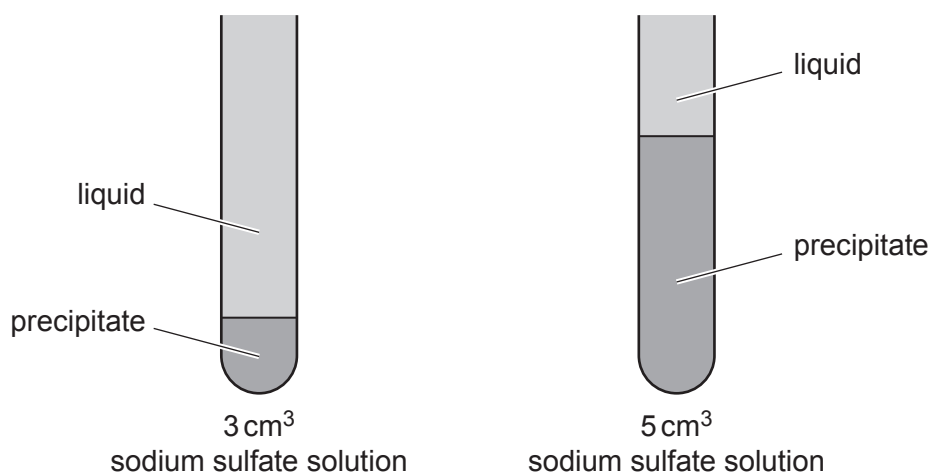
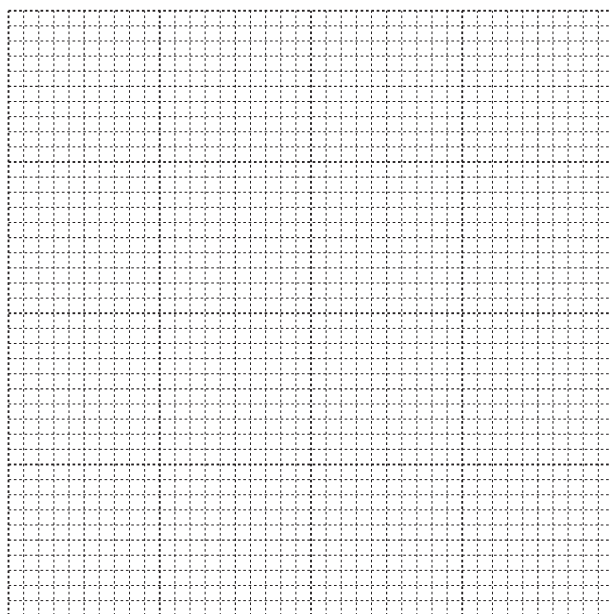


Fig. 3.1

Measure the heights to the nearest mm and record them in Table 3.1.

- (b) (i) On the grid provided plot the graph of height of precipitate (vertical axis) against volume of sodium sulfate solution added. [3]



- (ii) Circle the anomalous point on the graph.

Suggest what might have happened to cause this anomaly.

.....
 [1]

- (iii) Draw the best-fit line. [1]

- (iv) Describe the relationship between height of precipitate and volume of sodium sulfate solution.

..... [1]

- (v) Use your graph to determine the height of precipitate formed when 1.5 cm^3 sodium sulfate solution is added to 3 cm^3 barium nitrate solution.

Show clearly on your graph how you arrived at your answer.

height = ... mm [1]

- (vi) The volume of sodium sulfate solution added to the barium nitrate solution continues to be increased. Predict what happens to the height of the precipitate formed. Explain your answer.

prediction

.....

explanation

..... [2]

- (c) State and explain **two** improvements that could be made to the experiment to make the results more accurate.

1. improvement

explanation

.....

2. improvement

explanation

.....

[2]

[Total: 13]

4 A student investigates ice melting in a beaker of water.

(a) He uses a measuring cylinder and a balance to determine the mass m_w of 100 cm^3 of water.

$$m_w = 100.05\text{ g}$$

(i) Describe how he uses this apparatus to find the mass m_w of the water.

.....

.....

..... [2]

(ii) The student pours 100 cm^3 water into a beaker and measures the temperature of the water. Fig. 4.1 shows the thermometer reading.

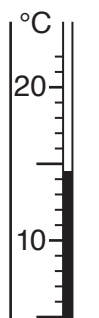


Fig. 4.1

Read and record the temperature T_i of the water to the nearest 0.5°C .

$$T_i = \dots\dots\dots^\circ\text{C} \quad [2]$$

(iii) He takes an ice cube and measures its mass. Fig. 4.2 shows the reading on the balance.

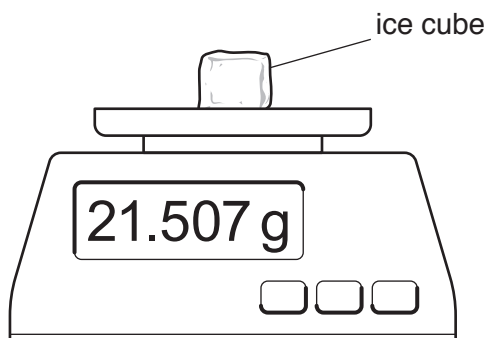


Fig. 4.2

Read and record the mass m_i of the ice cube to the nearest 0.01 g .

$$m_i = \dots\dots\dots\text{g} \quad [1]$$

(b) The student then carries out the following procedure:

- He adds the ice cube to the beaker of water and immediately starts the stop-clock.
- After 3 minutes he stirs the water.
- He measures and records the temperature T_f of the water.

$$T_f = 7.0^\circ\text{C}$$

- He removes the ice cube immediately, dries it and measures its final mass m_f .

$$m_f = 9.95\text{ g}$$

- (i) Explain how stirring the water improves the accuracy of the temperature measurement.

.....
 [1]

- (ii) Explain why it is important to dry the ice cube to get an accurate measure of its final mass.

.....
 [1]

- (c) (i) Calculate the drop in temperature T_d of the water during the experiment. Use your answer to (a)(ii), the data in (b) and the equation shown:

$$T_d = T_i - T_f$$

$$T_d = \dots\dots\dots^\circ\text{C} \quad [1]$$

- (ii) Calculate the thermal energy E_l lost by the water. Use the data in (a), your answer to (c)(i) and the equation shown.
 Give your answer to a suitable number of significant figures.

$$E_l = m_w \times 4.2 \times T_d$$

$$E_l = \dots\dots\dots\text{ J} \quad [2]$$

- (d) (i) Calculate the mass m_m of ice that melted in the experiment. Use your answer to (a)(iii), the data in (b) and the equation shown:

$$m_m = m_i - m_f$$

$$m_m = \dots\dots\dots\text{ g} \quad [1]$$

- (ii) 334 J of thermal energy is needed to melt 1 g of ice and change it into water.

Calculate the energy E_m used to melt the ice in this experiment. Use your answer to (d)(i) and the equation shown:

$$E_m = m_m \times 334$$

$$E_m = \dots\dots\dots \text{J} \quad [1]$$

- (e) In this experiment the amount of thermal energy needed to melt the ice cube is greater than the thermal energy lost by the water.

Suggest where the extra energy used to melt the ice comes from.

.....

..... [1]

[Total: 13]

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- 1 (a) A student uses the apparatus shown in Fig. 1.1 to investigate the composition of inspired air and expired air.

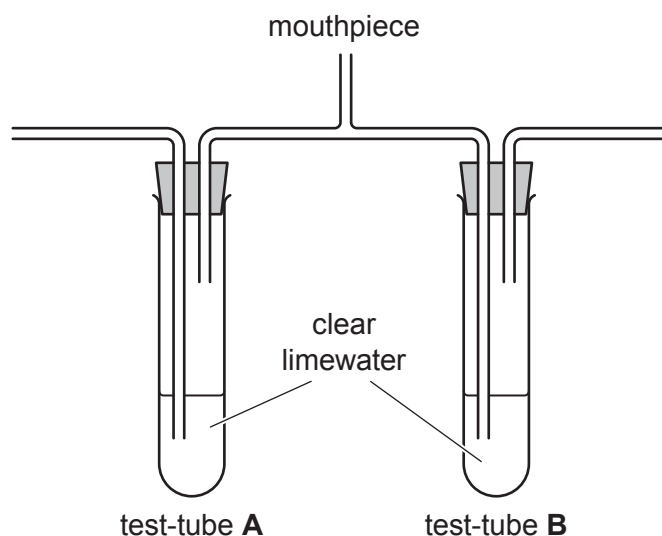


Fig. 1.1

Limewater is used to test for carbon dioxide.

- (i) Add arrows to Fig. 1.1 to show the movement of air through the limewater when a person breathes out (expires) through the mouthpiece. [1]

- (ii) Describe the appearance of limewater when air with a high percentage of carbon dioxide is passed through it.

..... [1]

- (iii) State the name of an indicator that could be used to detect the presence of carbon dioxide.

..... [1]

- (iv) Describe one safety precaution that the student should take when using the apparatus shown in Fig. 1.1.

.....

..... [1]

- (b) The student wants to test the expired air for the presence of oxygen.

- (i) Describe a test for oxygen. Include the observation for a positive result.

.....

..... [1]

- (ii) Table 1.1 shows the relative amount of oxygen in inspired air and expired air.

Table 1.1

air	relative amount of oxygen /arbitrary units
inspired	20
expired	15

Calculate the percentage reduction in the amount of oxygen in inspired and expired air.

Show your working.

percentage reduction = ... % [2]

[Total: 7]

- 2** A person's heart rate increases as they do more exercise. After the person stops exercising, the heart rate will return to normal.

(a) Describe one technique for measuring a person's heart rate.

.....
..... [1]

(b) Plan an investigation, using the technique you have described in **(a)**, to find out the average time it takes for the heart rate to return to normal after exercise.

In your answer, include:

- the apparatus needed, including a labelled diagram if you wish
- a brief description of the method
- how you will treat variables and any safety precautions
- the measurements you will make
- how you will use your results to draw a conclusion.

.....

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.....

.....

..... [6]

[Total: 7]

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- 3 A student investigates the volume of carbon dioxide given off when calcium carbonate (marble chips) reacts with hydrochloric acid.

(a) Method

- She places marble chips in a conical flask.
- She adds 25 cm³ hydrochloric acid and quickly connects the delivery tube to the conical flask.
- She starts the stopclock and measures the volume of carbon dioxide gas collected in a measuring cylinder every minute for 7 minutes.
- She records the volumes, to the nearest 0.5 cm³ in Table 3.1.

- (i) Fig. 3.1 shows the conical flask, its contents and the delivery tube.

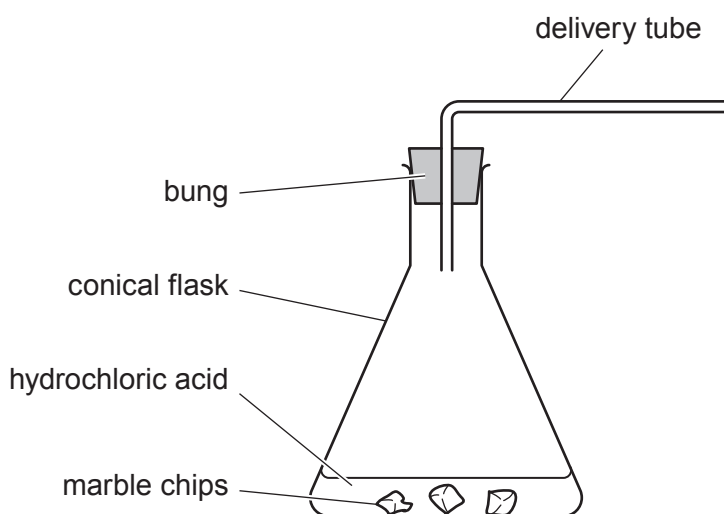


Fig. 3.1

Complete the diagram in Fig. 3.1 to show the gas being collected in the measuring cylinder. Include labels in your diagram. [2]

- (ii) Carbon dioxide gas is slightly soluble in water.

Describe a method of collecting the gas which would give more accurate values for the amount of carbon dioxide given off in the reaction.

.....
 [1]

(iii) Fig. 3.2 shows the reading on the measuring cylinder at 3 minutes and 4 minutes.

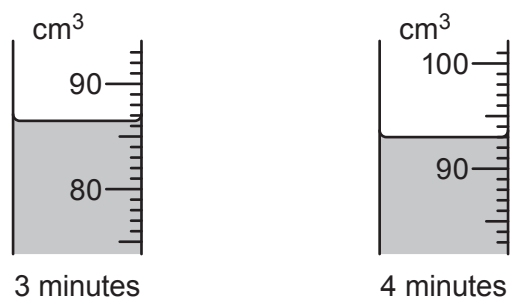


Fig. 3.2

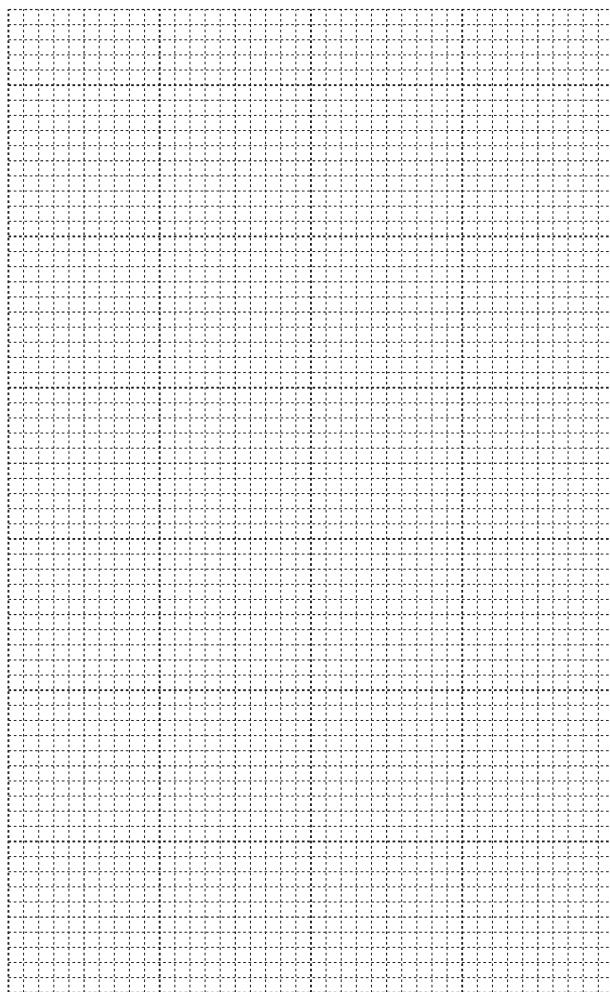
Read the measuring cylinders and record in Table 3.1 the values to the nearest 0.5 cm^3 .

Table 3.1

time / min	total volume carbon dioxide / cm^3
0	0
1	47.0
2	74.5
3	
4	
5	94.5
6	96.0
7	96.0

[2]

- (b) (i) On the grid provided plot a graph of volume of carbon dioxide (on the vertical axis) against time. [3]



- (ii) Draw the best-fit curve. [1]

- (c) Describe and explain what is happening in the reaction in the conical flask at 7 minutes.

description

explanation

[1]

- (d) The student repeats the experiment in (a) using more concentrated hydrochloric acid but keeping everything else the same.

She notices that the reaction is faster and produces more carbon dioxide gas.

Draw a line on the graph to show the results of this second experiment.

Label your line **D**.

[2]

- (e) The student repeats the experiment in (a) using sulfuric acid. The marble chips do not produce very much gas and stop bubbling after only 2 minutes.

The word equation for this reaction is shown.

calcium carbonate + sulfuric acid $\rightarrow$ calcium sulfate + carbon dioxide + water

The teacher says this is because the calcium sulfate that is made is insoluble.

Suggest how this calcium sulfate stops the reaction.

.....

..... [1]

[Total: 13]

- 4 A student investigates the relationship between the speed of sound in different materials and the density of the materials.

(a) Table 4.1 shows information about the properties of different materials.

Table 4.1

material	$\frac{\text{density}}{\text{kg/m}^3}$	$\frac{\text{speed of sound in material}}{\text{m/s}}$	solid, liquid or gas?	Is this material metallic?
air	1.204	343	gas	no
aluminium	2691	6320	solid	yes
copper	8960	4600	solid	yes
lead	11 340	1210	solid	yes
rubber	1100	60	solid	no
water		1484	liquid	no

- (i) Name the material in which sound travels the slowest.

..... [1]

- (ii) Name the **solid** material with the lowest density.

..... [1]

- (iii) Use the information in Table 4.1 to place the metallic materials in order from lowest speed of sound to highest speed of sound.

..... metal in which speed of sound is lowest

.....

..... metal in which speed of sound is highest

[1]

- (iv) Use information in Table 4.1 to describe the relationship between the speed of sound in metallic materials and the density of the metal.

.....

..... [1]

- (b) (i) The student does an experiment to find the density of pure water.
- He pours some water into a measuring cylinder.
 - He measures the mass of the cylinder and water on a balance.
 - He empties out the water.
 - Then he measures the mass of the measuring cylinder on its own.

Fig. 4.1 shows his readings on the balance.

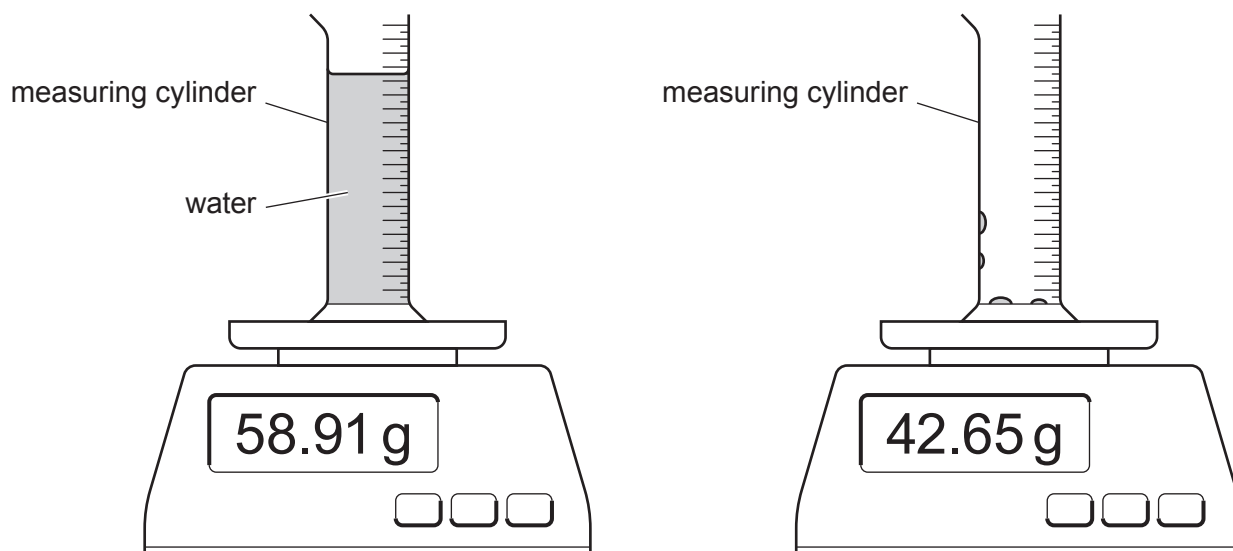


Fig. 4.1

Use the readings to calculate the mass of water. Show your working.

mass of water = ...g [2]

- (ii) Suggest a change to the experimental procedure carried out in (b)(i) that will improve the accuracy of the value of the mass of the measuring cylinder obtained by the student.

.....

..... [1]

- (iii) Fig. 4.2 shows part of the measuring cylinder containing the water.

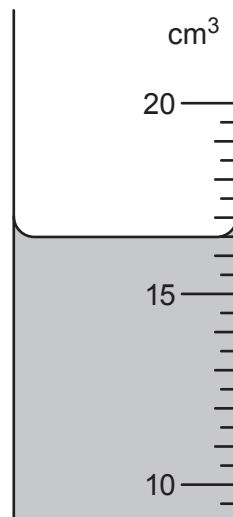


Fig. 4.2

Read and record the volume of water in the measuring cylinder to the nearest 0.5 cm^3 .

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

- (iv) Calculate the density of water. Use your answers to (b)(i) and (b)(iii) and the equation shown. Record your answer to an appropriate number of significant figures.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

density of water = ... g/cm^3 [2]

- (v) Determine the density of water in kg/cm^3 .

$$1 \text{ kg} = 1000 \text{ g}$$

density of water = ... kg/cm^3 [1]

- (vi) Determine the density of water in kg/m^3 .

$$1 \text{ m}^3 = 1\,000\,000 \text{ cm}^3$$

density of water = ... kg/m^3 [1]

- (c) Another student looks up the value for the density of pure water and it is given as 1000 kg/m^3 .

State whether your value of the density of water calculated in part (b)(vi) agrees with this value within the limits of experimental error. Justify your answer with reference to the two values.

statement

justification

..... [1]

[Total: 13]

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