



--	--	--	--	--

--	--	--	--

0653/51

May/June 2019

1 hour 15 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Write your centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

Notes for Use in Qualitative Analysis for this paper are printed on page 12.

At the end of the examination, fasten all your work securely together.

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

For Examiner's Use	
1	
2	
3	
4	
Total	

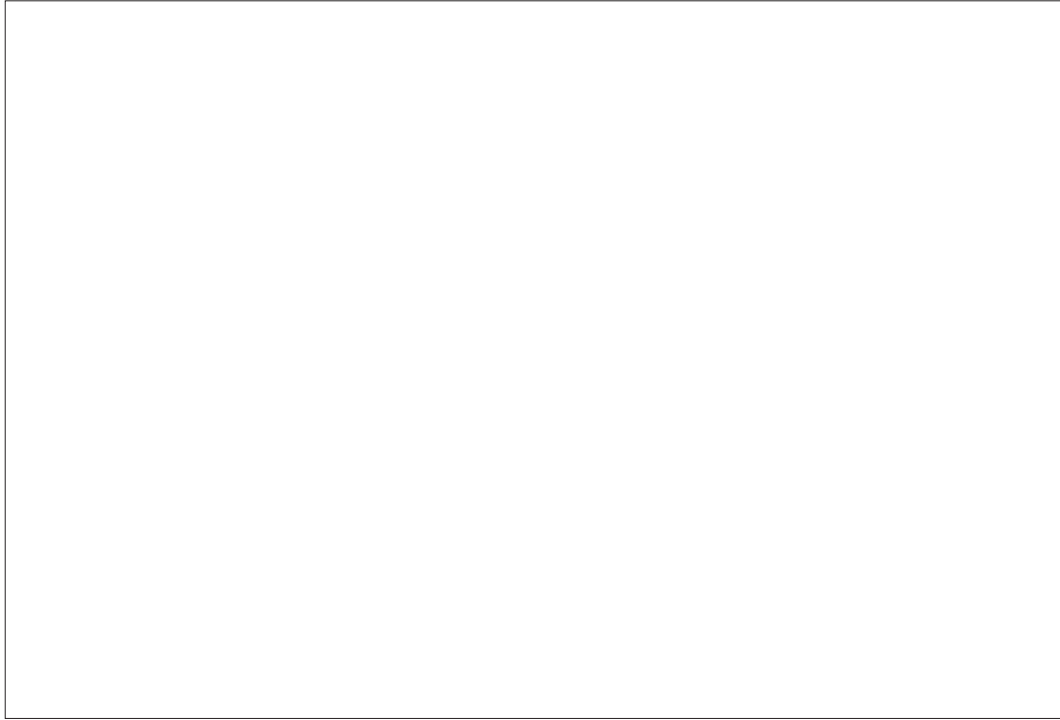
This document consists of **12** printed pages.

1 You are going to investigate the nutrient content of an apple.

(a) You are provided with half of an apple, **A**.

(i) Remove the plastic film from the apple.

In the box, make a large detailed drawing of the **cut surface** of the apple.



[2]

(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 half apple, **A**, and record this value.

width of apple **A** = ... mm
[1]

(iii) Calculate the magnification of your drawing.

Show your working.

magnification of drawing = ... [1]

- (b) • Place the half apple, **A**, on the white tile. Use the knife, with care, to cut two small cubes of apple. The cubes must be small enough to fit into the test-tubes provided.
- Place one cube into a test-tube and add two drops of iodine solution.
 - Place the second cube into another test-tube and add about 1 cm³ of Benedict's solution. Heat in a water bath for five minutes.

(i) Record your observations.

colour observed after adding iodine solution

colour observed after heating with Benedict's solution

[2]

(ii) State the conclusions about the nutrient content of an apple that can be made from your observations.

.....

..... [1]

[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.

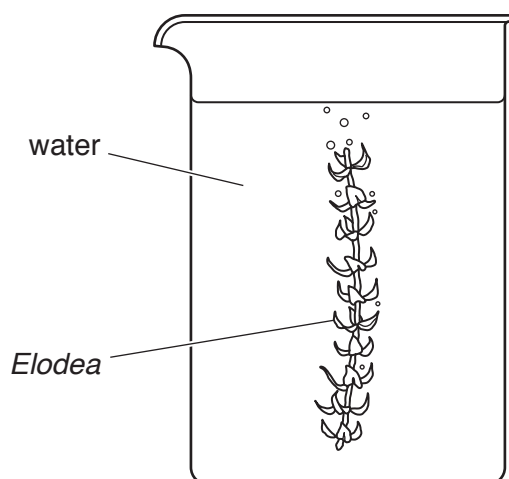


Fig. 2.1

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

You are not required to carry out this investigation.

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 You are going to investigate the temperature changes which occur when aqueous copper(II) sulfate reacts separately with excess magnesium and with excess zinc.

(a) Method

1. Use a measuring cylinder to place 25 cm^3 aqueous copper(II) sulfate into the small beaker.
2. Measure the temperature of the aqueous copper(II) sulfate. Record this temperature in Table 3.1 to the nearest 0.5°C for time = 0.
3. Start the stop-clock and immediately add 2g magnesium powder, an excess, to the beaker and stir.
4. Measure the temperature every 30 seconds for 5 minutes. Record these temperatures, to the nearest 0.5°C , in Table 3.1.
5. Pour the mixture into the waste container.
6. Rinse the small beaker with distilled water.

[2]

Table 3.1

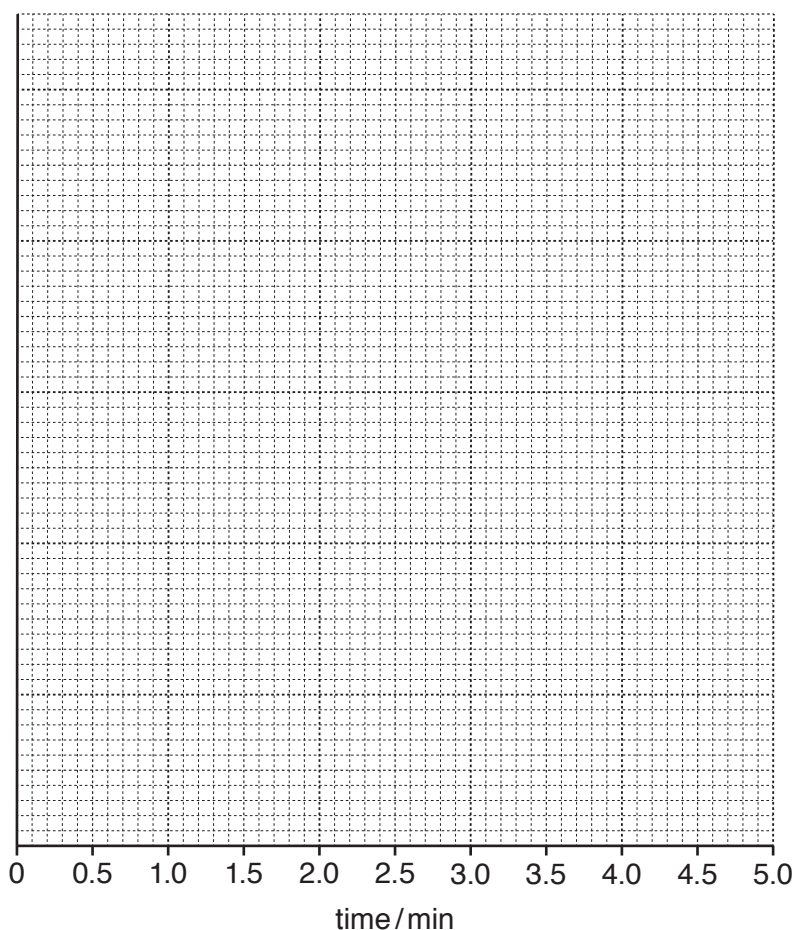
reaction with magnesium	
time / min	temperature / $^\circ\text{C}$
0	
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	

Table 3.2

reaction with zinc	
time / min	temperature / $^\circ\text{C}$
0	
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	

- (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 only. Extend the line further than the highest point. Label the line magnesium.

Draw a best-fit line through the **decreasing** temperatures only. 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) (i) Repeat steps 1 to 6 in (a) using 2 g zinc, an excess, instead of magnesium.

Record the temperatures in Table 3.2. [2]

- (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) Suggest and explain **one** improvement to the **apparatus** which would increase the accuracy of the maximum temperature.

improvement

explanation
..... [1]

[Total: 13]

- 4 You are going to calculate the density of a liquid using two different methods.

You are provided with a balance, a measuring cylinder, a beaker containing liquid **L** and a test-tube.

Method 1

- (a) (i) Measure and record the mass m_c of the measuring cylinder to the nearest 0.01 g.

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

- (ii) Add approximately 75 cm³ of liquid **L** to the measuring cylinder.

Record the exact volume V_L of liquid **L** to the nearest 0.5 cm³.

Keep the liquid in the measuring cylinder for (b).

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

- (iii) Measure and record the total mass of the measuring cylinder and liquid **L**.

$$\text{total mass} = \dots\dots\dots \text{ g [1]}$$

- (iv) Determine the mass m_L of liquid **L**. Use your answers to (a)(i) and (a)(iii) and the equation shown:

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

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

- (v) Calculate the density ρ_L of liquid **L**. Use your answers to (a)(ii) and (a)(iv) and the equation shown:

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

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

Method 2

- (b) (i) Measure and record the mass m_t of the test-tube to the nearest 0.01 g.

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

- (ii) Measure the length l_t of the test-tube and the internal diameter d_t of the test-tube each to the nearest 0.1 cm.

$$l_t = \dots\dots\dots \text{ cm}$$

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

- (iii) Calculate the approximate volume V_t of the test-tube. Use your answers to (b)(ii) and the equation shown:

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

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

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

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

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

- (v) Carefully lower the test-tube into the measuring cylinder of liquid **L** from (a) until the test-tube is floating as shown in Fig. 4.1.

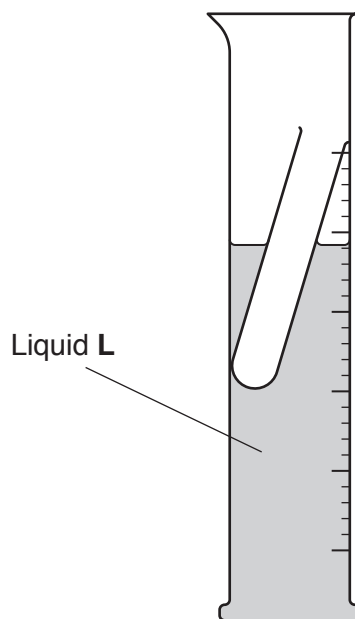


Fig. 4.1

Measure the length of the test-tube l_w that is below the surface of the liquid. You will need to support the test-tube very gently in an upright position to take this measurement.

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

- (vi) Calculate the density ρ_L of liquid **L**. Use your answers to (b)(ii), (b)(iv) and (b)(v) and the equation shown:

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

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

- (c) Compare your values of ρ_L in (a)(v) and (b)(vi).

Suggest whether your two values of ρ_L agree within the limits of experimental error. Explain your answer.

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

- (d) Suggest **one** practical difficulty in **method 2** that makes it difficult to get an accurate answer for the density of the liquid.

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

[Total: 13]

NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
ammonium (NH_4^+)	ammonia produced on warming	—
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
copper (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test results
ammonia (NH_3)	turns damp, red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

0653/52

May/June 2019

1 hour 15 minutes

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

Notes for Use in Qualitative Analysis for this paper are printed on page 12.

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

For Examiner's Use	
1	
2	
3	
4	
Total	

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

1 You are going to investigate the amount of precipitate formed in two different reactions.

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

Method

- A. Label six test-tubes **3, 4, 5, 6, 7** and **8**. Numbers 1 and 2 have been omitted deliberately.
- B. Using a measuring cylinder pour 3 cm^3 barium nitrate solution into each test-tube.
- C. Using a clean measuring cylinder add 3 cm^3 sodium sulfate solution into test-tube **3**. Stir the solution with the glass rod. Rinse the glass rod with distilled water.
- D. Add 4 cm^3 sodium sulfate solution into test-tube **4**. Stir the solution with the glass rod. Rinse the glass rod with distilled water.
- E. Add 5 cm^3 , 6 cm^3 , 7 cm^3 and 8 cm^3 sodium sulfate solution into test-tubes **5, 6, 7** and **8** as shown in Table 1.1. Use the glass rod to stir each solution and rinse the glass rod each time with distilled water.
- F. Leave the test-tubes to stand for at least six minutes to allow the precipitates to settle.

While you are waiting for the precipitates to settle you should start (c).

- G. After six minutes, use a ruler to measure the height in mm of the solid precipitate in each test-tube. Start at test-tube **8**.

Record these heights to the nearest millimetre in Table 1.1.

Table 1.1

test-tube number	volume of sodium sulfate solution added / cm^3	height of precipitate / mm
3	3	
4	4	
5	5	
6	6	
7	7	
8	8	

[2]

(b) Look at the results in **your** experiment in **Table 1.1**.

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

..... [1]

- (ii) 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]

- (iii) State **two** improvements that could be made to **your** experiment to make the results more accurate. For each improvement explain how it increases the accuracy.

1. improvement

explanation

.....

2. improvement

explanation

.....

[2]

- (c) A student performs a similar experiment to that in (a) using a fixed volume of copper sulfate solution in the test-tube and adds ammonia solution. A blue precipitate is formed.

Her results are shown in Table 1.2.

Table 1.2

test-tube number	volume of ammonia solution added/cm ³	height of precipitate /mm
1	1	1.1
2	2	2.6
3	3	3.5
4	4	4.6
5	5	3.7
6	6	1.9
7	7	0.1
8	8	0.0

- (i) On the grid of Fig. 1.1, plot a graph of the **student's** results in Table 1.2.

Plot the height of precipitate (vertical axis) against volume of ammonia solution added.
[3]

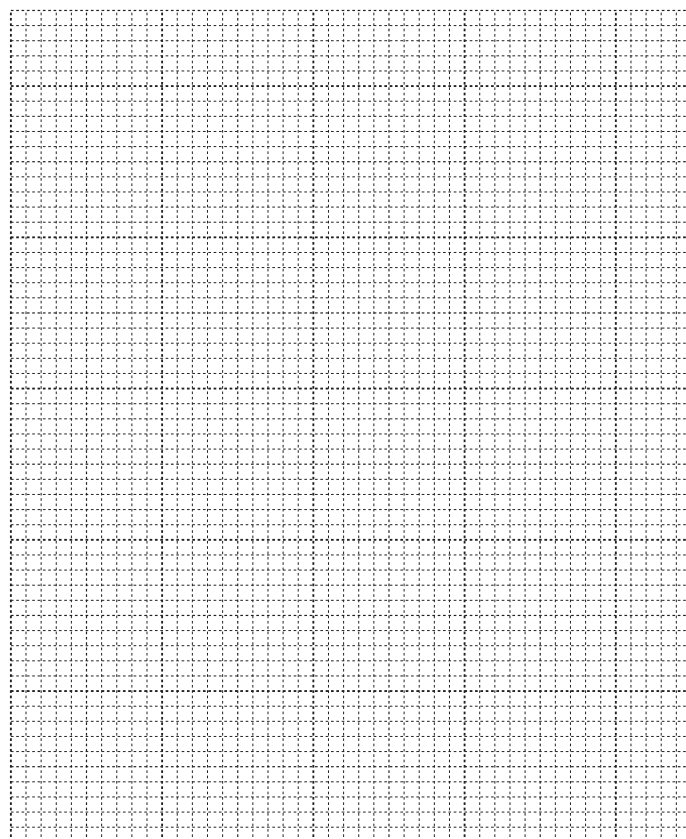


Fig. 1.1

- (ii) On Fig. 1.1, draw the best-fit straight line for test-tubes **1, 2, 3** and **4**.

On Fig. 1.1, draw a second line of best fit for test-tubes **5, 6, 7**, and **8**. [1]

- (iii) State the volume of ammonia which needs to be added to form the maximum height of precipitate. This is the point where the two lines of best fit intersect.

volume = ... cm³ [1]

- (iv) Describe and explain what is happening in the test-tubes numbered **5, 6, 7** and **8** in the student's experiment.

.....

..... [1]

[Total: 13]

2 You are going to investigate the effects of the enzyme pectinase on fruit.

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

You are provided with two beakers that have been left overnight.

- Beaker **A** contains chopped apple with 5% pectinase solution.
- Beaker **B** contains chopped apple with water.

(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) You are going to separate the juice from the chopped apple in beaker **A** and measure the volume of the juice collected after 5 minutes.

- Separate the chopped apple from the juice in beaker **A**.
- At the same time repeat for beaker **B**, using separate apparatus.
- Leave for 5 minutes.

(i) Draw and label the assembled apparatus you used to separate the chopped apple from the juice.

[3]

(ii) After 5 minutes record the volume of apple juice you have collected from beaker **A** and beaker **B**.

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

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

[1]

[Total: 7]

BLANK PAGE

- 3 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.

You are not required to carry out this investigation.

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]

4 You are going to investigate ice melting in a beaker of water.

(a) (i) Measure and record the mass m_a of the empty measuring cylinder to the nearest 0.01 g.

$m_a = \dots\dots\dots$ g

- Add 100 cm³ of water to the measuring cylinder.
- Measure and record the mass m_b of the measuring cylinder and water to the nearest 0.01 g.

$m_b = \dots\dots\dots$ g
[1]

(ii) Calculate the mass m_w of the 100 cm³ of water. Use your answers to (a)(i) and the equation shown:

$$m_w = m_b - m_a$$

$m_w = \dots\dots\dots$ g [1]

(iii) Measure and record the temperature T_i of the water to the nearest 0.5 °C.

$T_i = \dots\dots\dots$ °C [1]

(b) (i) Take one ice cube and measure and record its mass m_i to the nearest 0.01 g.

$m_i = \dots\dots\dots$ g [1]

- (ii)
- Pour the water from the measuring cylinder into a beaker.
 - Add the ice cube to the beaker of water.
 - Immediately start the stop-clock.
 - After 3 minutes, stir the water with the glass rod.
 - Measure and record the temperature T_f of the water.

$T_f = \dots\dots\dots$ °C [1]

- (iii)
- Immediately remove the ice cube from the beaker.
 - Dry the ice cube with the paper towel provided.
 - Measure and record the mass m_f of the ice cube.

$m_f = \dots\dots\dots$ g [1]

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

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

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

$$T_d = T_i - T_f$$

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

- (ii) Calculate the thermal energy E_l lost by the water. Use your answers to (a)(ii) and (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 answers to (b)(i) and (b)(iii) 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]

NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
ammonium (NH_4^+)	ammonia produced on warming	—
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
copper (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia (NH_3)	turns damp, red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.



--

--	--	--	--	--

--	--	--	--

0653/53

May/June 2019

1 hour 15 minutes

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

Notes for Use in Qualitative Analysis for this paper are printed on page 12.

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

For Examiner's Use	
1	
2	
3	
4	
Total	

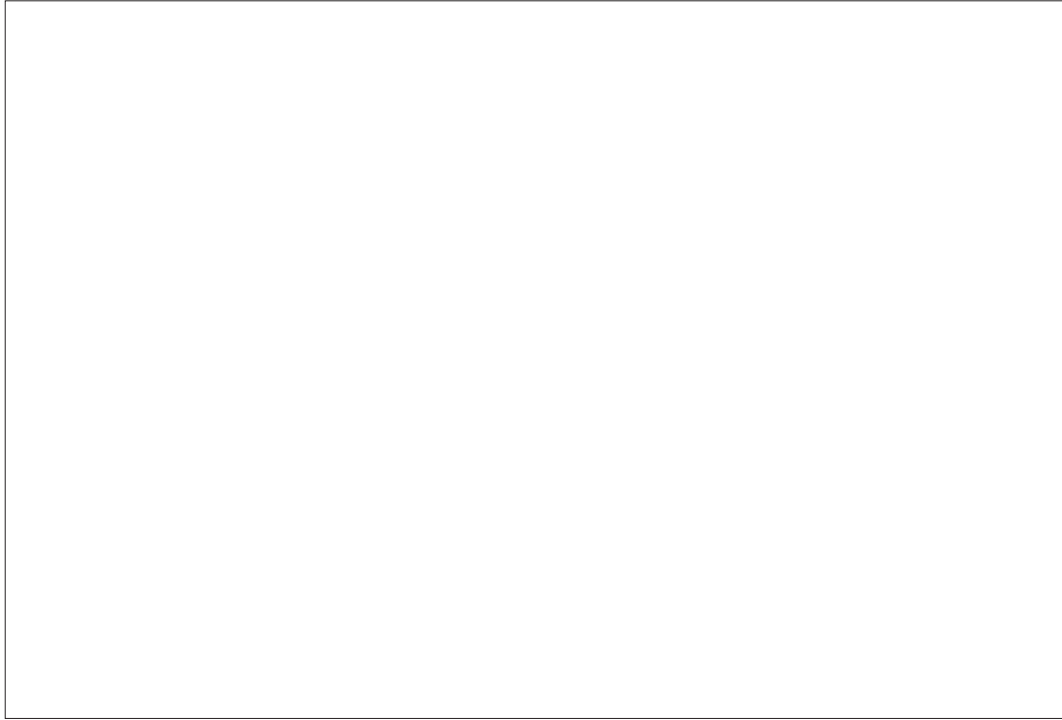
This document consists of **12** printed pages.

1 You are going to investigate the nutrient content of an apple.

(a) You are provided with half of an apple, **A**.

(i) Remove the plastic film from the apple.

In the box, make a large detailed drawing of the **cut surface** of the apple.



[2]

(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 half apple, **A**, and record this value.

width of apple **A** = ... mm
[1]

(iii) Calculate the magnification of your drawing.

Show your working.

magnification of drawing = ... [1]

- (b) • Place the half apple, **A**, on the white tile. Use the knife, with care, to cut two small cubes of apple. The cubes must be small enough to fit into the test-tubes provided.
- Place one cube into a test-tube and add two drops of iodine solution.
 - Place the second cube into another test-tube and add about 1 cm³ of Benedict's solution. Heat in a water bath for five minutes.

(i) Record your observations.

colour observed after adding iodine solution

colour observed after heating with Benedict's solution

[2]

(ii) State the conclusions about the nutrient content of an apple that can be made from your observations.

.....

..... [1]

[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.

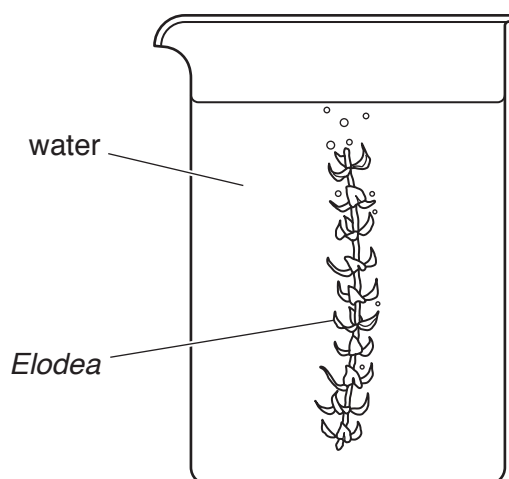


Fig. 2.1

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

You are not required to carry out this investigation.

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 You are going to investigate the temperature changes which occur when aqueous copper(II) sulfate reacts separately with excess magnesium and with excess zinc.

(a) Method

1. Use a measuring cylinder to place 25 cm^3 aqueous copper(II) sulfate into the small beaker.
2. Measure the temperature of the aqueous copper(II) sulfate. Record this temperature in Table 3.1 to the nearest 0.5°C for time = 0.
3. Start the stop-clock and immediately add 2g magnesium powder, an excess, to the beaker and stir.
4. Measure the temperature every 30 seconds for 5 minutes. Record these temperatures, to the nearest 0.5°C , in Table 3.1.
5. Pour the mixture into the waste container.
6. Rinse the small beaker with distilled water.

[2]

Table 3.1

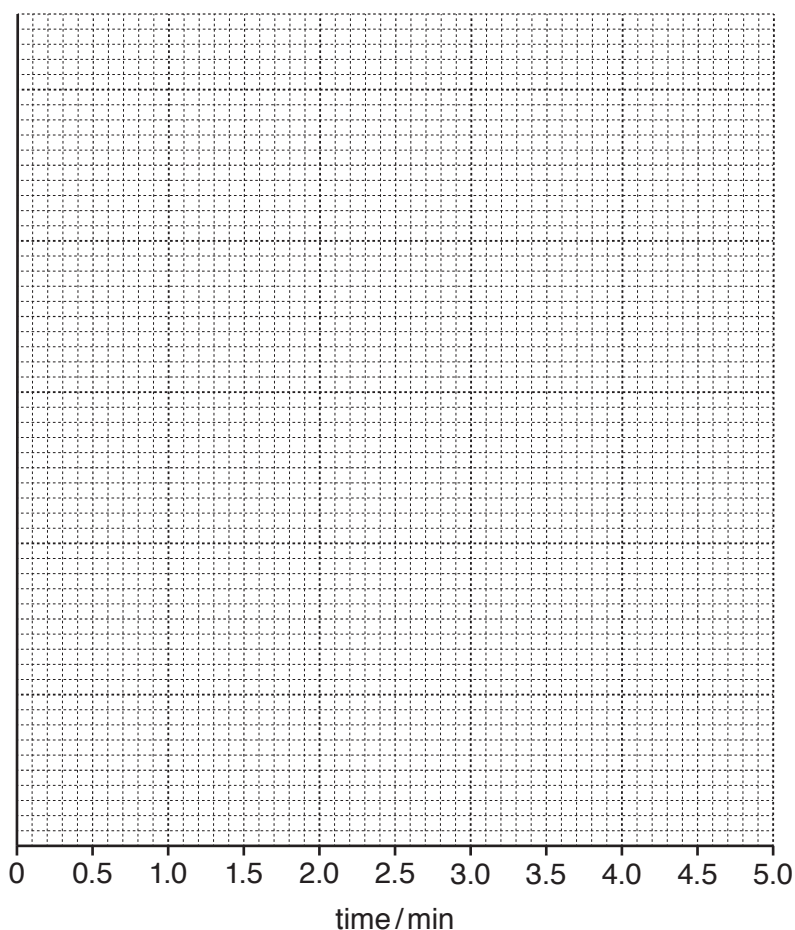
reaction with magnesium	
time / min	temperature / $^\circ\text{C}$
0	
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	

Table 3.2

reaction with zinc	
time / min	temperature / $^\circ\text{C}$
0	
0.5	
1.0	
1.5	
2.0	
2.5	
3.0	
3.5	
4.0	
4.5	
5.0	

- (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 only. Extend the line further than the highest point. Label the line magnesium.

Draw a best-fit line through the **decreasing** temperatures only. 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) (i) Repeat steps 1 to 6 in (a) using 2 g zinc, an excess, instead of magnesium.

Record the temperatures in Table 3.2. [2]

- (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) Suggest and explain **one** improvement to the **apparatus** which would increase the accuracy of the maximum temperature.

improvement

.....

explanation

..... [1]

[Total: 13]

- 4 You are going to calculate the density of a liquid using two different methods.

You are provided with a balance, a measuring cylinder, a beaker containing liquid **L** and a test-tube.

Method 1

- (a) (i) Measure and record the mass m_c of the measuring cylinder to the nearest 0.01 g.

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

- (ii) Add approximately 75 cm³ of liquid **L** to the measuring cylinder.

Record the exact volume V_L of liquid **L** to the nearest 0.5 cm³.

Keep the liquid in the measuring cylinder for (b).

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

- (iii) Measure and record the total mass of the measuring cylinder and liquid **L**.

$$\text{total mass} = \dots\dots\dots \text{ g [1]}$$

- (iv) Determine the mass m_L of liquid **L**. Use your answers to (a)(i) and (a)(iii) and the equation shown:

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

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

- (v) Calculate the density ρ_L of liquid **L**. Use your answers to (a)(ii) and (a)(iv) and the equation shown:

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

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

Method 2

- (b) (i) Measure and record the mass m_t of the test-tube to the nearest 0.01 g.

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

- (ii) Measure the length l_t of the test-tube and the internal diameter d_t of the test-tube each to the nearest 0.1 cm.

$$l_t = \dots\dots\dots \text{ cm}$$

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

- (iii) Calculate the approximate volume V_t of the test-tube. Use your answers to (b)(ii) and the equation shown:

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

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

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

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

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

- (v) Carefully lower the test-tube into the measuring cylinder of liquid **L** from (a) until the test-tube is floating as shown in Fig. 4.1.

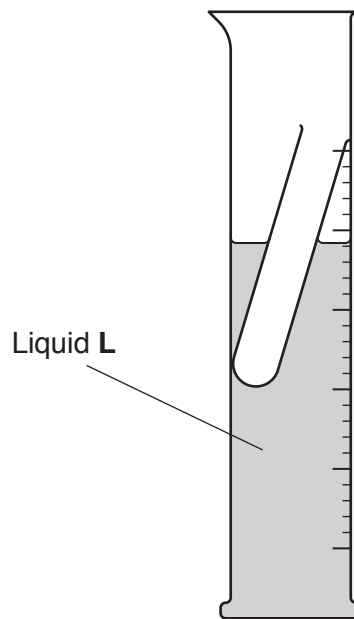


Fig. 4.1

Measure the length of the test-tube l_w that is below the surface of the liquid. You will need to support the test-tube very gently in an upright position to take this measurement.

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

- (vi) Calculate the density ρ_L of liquid **L**. Use your answers to (b)(ii), (b)(iv) and (b)(v) and the equation shown:

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

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

- (c) Compare your values of ρ_L in (a)(v) and (b)(vi).

Suggest whether your two values of ρ_L agree within the limits of experimental error. Explain your answer.

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

- (d) Suggest **one** practical difficulty in **method 2** that makes it difficult to get an accurate answer for the density of the liquid.

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

[Total: 13]

NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify, then add aqueous barium nitrate	white ppt.

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
ammonium (NH_4^+)	ammonia produced on warming	—
calcium (Ca^{2+})	white ppt., insoluble in excess	no ppt., or very slight white ppt.
copper (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test results
ammonia (NH_3)	turns damp, red litmus paper blue
carbon dioxide (CO_2)	turns limewater milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint

Flame tests for metal ions

metal ion	flame colour
lithium (Li^+)	red
sodium (Na^+)	yellow
potassium (K^+)	lilac
copper(II) (Cu^{2+})	blue-green

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at www.cambridgeinternational.org after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.