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CAMBRIDGE International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

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* 6 0 4 0 7 2 5 1 5 8 *

COMBINED SCIENCE **0653/62**

Paper 6 Alternative to Practical **February/March 2026**

1 hour

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS
- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen. Do **not** use correction fluid or tape.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].
- Notes for use in qualitative analysis are provided in the question paper.

This document has **20** pages. Any blank pages are indicated.

1 (a) A student investigates diffusion in beetroot.

Beetroot cells contain a red colour that diffuses out of the cells when placed in water. The more diffusion, the darker the solution surrounding the beetroot.

The student wants to find out if the surface area of the beetroot affects the rate of diffusion.

Figure 1.1 shows one of the cylinders of beetroot the student uses in the investigation.

Figure 1.1

(i) Figure 1.2 shows a cross-section of the cylinder of beetroot drawn to scale.

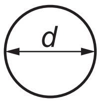

Figure 1.2

Measure the diameter *d* of the cylinder of beetroot.

d = ... mm [1]

(ii) Calculate the surface area of the cylinder of beetroot.

Use the equation shown.

$$\text{surface area} = 157d + 1.57d^2$$

Give your answer to **two** significant figures.

surface area = ... mm^2 [2]

(b) **Procedure**

The student:

step 1 cuts four identical cylinders of beetroot into pieces as shown in Figure 1.3

cylinder of beetroot	**A**	**B**	**C**	**D**
how to cut				
number of pieces	1	2	4	8

Figure 1.3

step 2 puts the pieces of beetroot into boiling tubes labelled **A**, **B**, **C** and **D**

step 3 adds 10 cm^3 of distilled water to each boiling tube

step 4 shakes each boiling tube and leaves them for 10 minutes

step 5 labels four test-tubes **A**, **B**, **C** and **D**

step 6 pours off the solution surrounding the beetroot piece in boiling tube **A** into test-tube **A**

step 7 repeats **step 6** with the other boiling tubes and test-tubes

step 8 compares the intensity of the colour of the solution in each test-tube with the colour chart in Figure 1.5

step 9 determines an intensity score for each solution, **A**, **B**, **C** and **D**.

Figure 1.4 shows the four boiling tubes after 10 minutes and the solutions after they are poured into the four test-tubes.

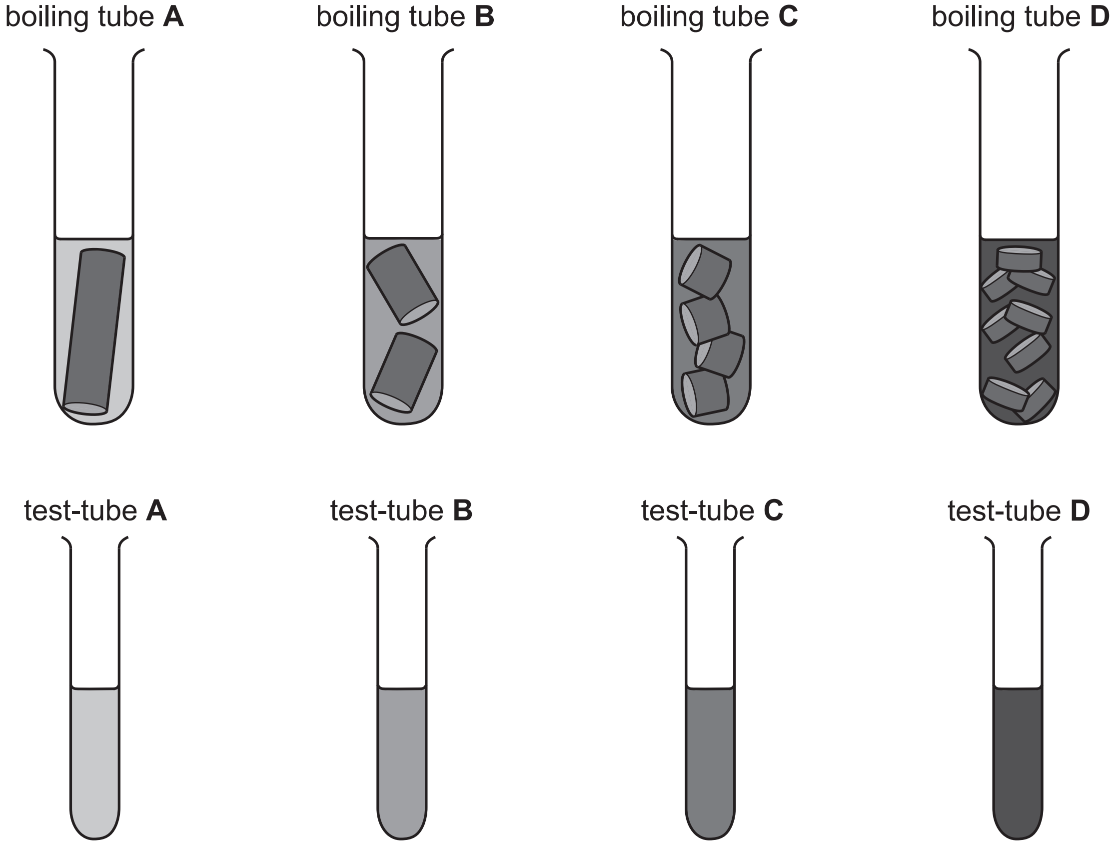

Figure 1.4

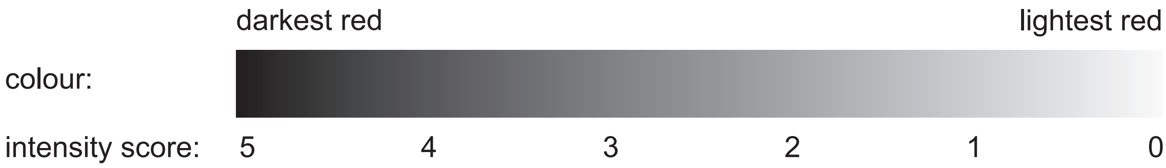

Figure 1.5

(i) Using Figure 1.5, record in Table 1.1 an intensity score for each solution shown in Figure 1.4.

Table 1.1

solution	number of pieces of beetroot	intensity score
A	1	
B	2	
C	4	
D	8	

[2]

(ii) State the relationship between the number of pieces of beetroot and the intensity score.

....

.... [1]

(iii) Cutting the beetroot cylinders into pieces increases the surface area.

State how the surface area affects the rate of diffusion from beetroot cells.

....

.... [1]

(c) (i) Identify **one** hazard and state a suitable safety precaution the student takes when doing this investigation.

hazard ....

precaution ....
[2]

(ii) Suggest why the solutions are poured from the boiling tubes into test-tubes in **step 6** and **step 7**.

....

.... [1]

(iii) Identify a possible source of error in **step 9**.

....

.... [1]

(d) The student investigates the effect of surface area on the change in mass of beetroot.

The student:

- cuts cylinders of beetroot with different surface areas
- measures the mass of the cylinders
- places them in distilled water for 10 minutes
- determines the change in mass
- repeats the investigation two more times.

The results are shown in Table 1.2.

Table 1.2

surface area / mm^2	**change in mass / g**			
	trial 1	**trial 2**	**trial 3**	**average**
500	1.1	1.3	1.2	1.2
1000	1.6	1.5	1.5	
2000	1.9	1.7	1.8	1.8

(i) Calculate the average change in mass for the cylinder with a surface area of 1000 mm^2.

average change in mass = ... g [1]

(ii) The student concludes that as the surface area increases, the change in mass increases.

Describe how the procedure is modified to increase confidence in this conclusion.

....

.... [1]

[Total: 13]

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Turn over

2 A student investigates the effect of water on a white solid **G**.

(a) (i) **Procedure**

The student:

step 1 assembles the apparatus shown in Figure 2.1

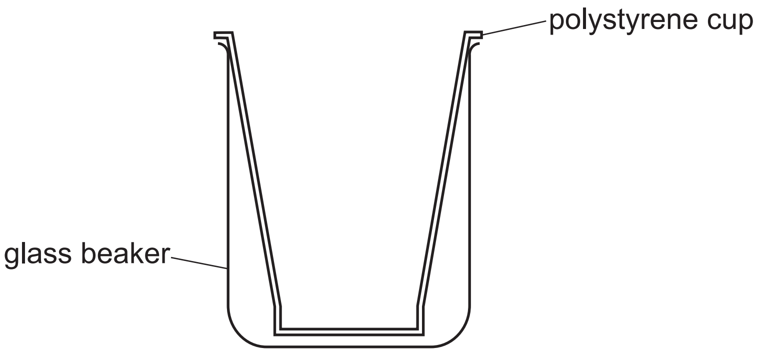


Figure 2.1

step 2 pours 25 cm^3 of cold water into the polystyrene cup

step 3 records the temperature of this cold water

step 4 adds some solid **G** into the water

step 5 stirs the mixture of **G** and water

step 6 records the maximum temperature of this mixture.

Figure 2.2 shows the readings on the thermometer in **step 3** and **step 6**.

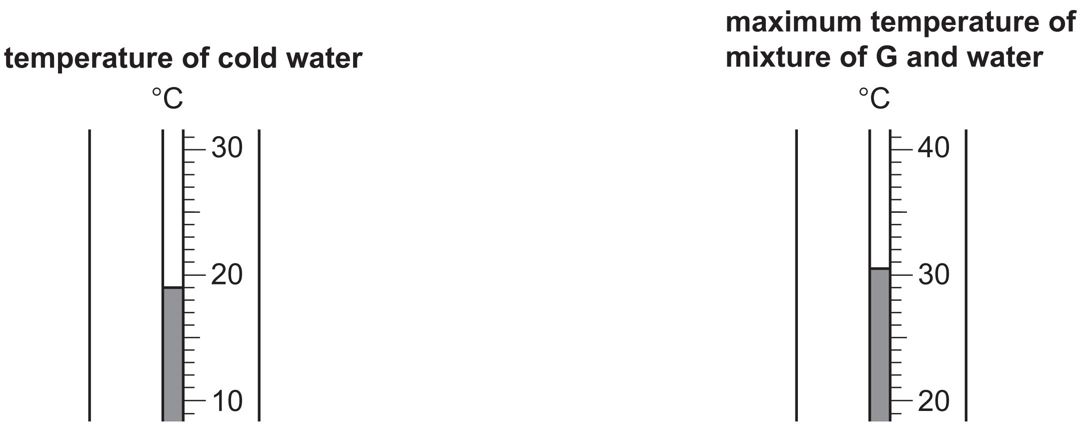


Figure 2.2

Record in Table 2.1, these temperatures to the nearest 0.5 °C.

Table 2.1

	/ °C
temperature of cold water	
maximum temperature of mixture of **G** and water	
temperature increase	

[2]

(ii) Calculate the temperature increase.

Record this value in Table 2.1. [1]

(iii) The experiment is done using a polystyrene cup inside a glass beaker instead of just in a glass beaker.

Suggest why.

....

.... [1]

(b) A student follows the procedure in **2(a)** seven times.

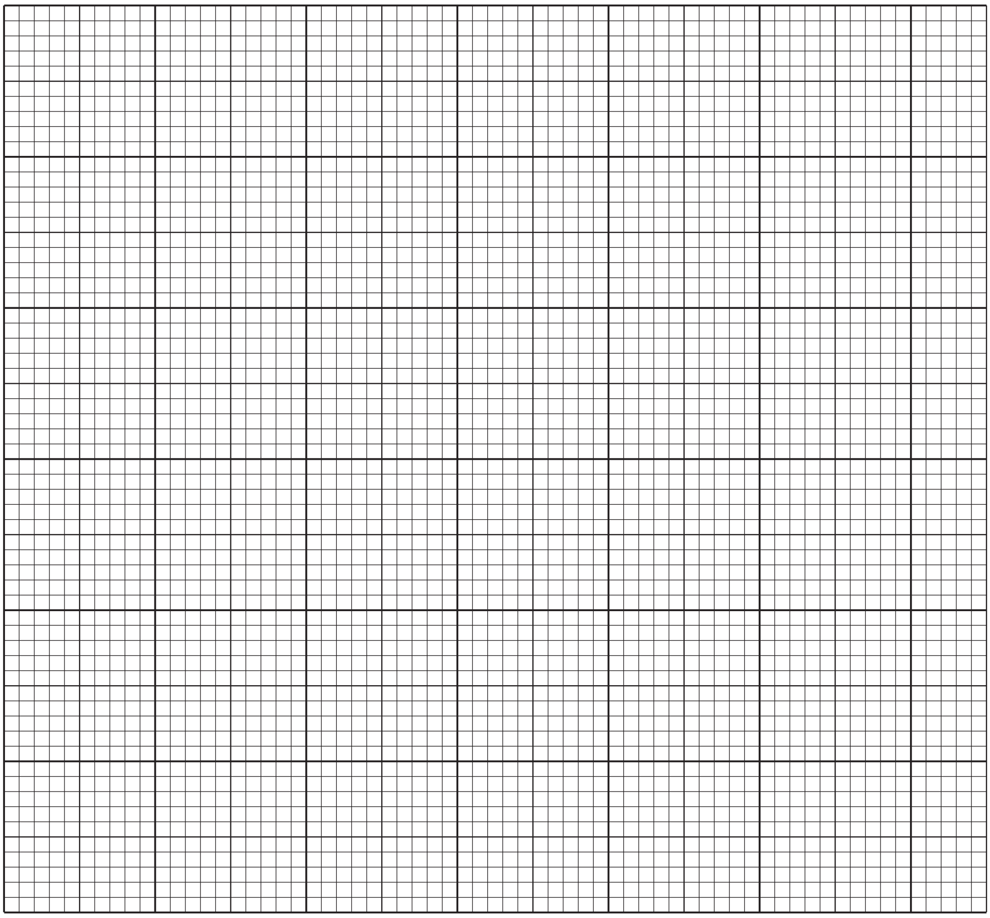
Each time the student adds a different mass of **G** to water.

Table 2.2 shows the results the student obtains.

Table 2.2

mass of G added to water /g	temperature increase /°C
0.0	0.0
0.5	4.5
1.0	9.0
1.5	13.5
2.0	14.0
2.5	22.5
3.0	27.0

(i) On the grid, plot temperature increase (vertical axis) against the mass of **G** added to water.



[3]

(ii) One of the results is anomalous.

Circle this anomalous result on the grid. [1]

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

(iv) Explain how the graph shows that the temperature increase is proportional to the mass of **G** added to water.

....

....

.... [1]

(v) Estimate the mass of **G** the student adds to the water in **2(a)(i)**.

Use the temperature increase from Table 2.1 and your graph.

mass of **G** = ... g [1]

(c) The student tests the solution from **step 6** of the procedure in **2(a)(i)**.

This solution is aqueous copper sulfate, which is blue in colour.

Procedure

The student:

- pours 1 cm depth of the solution from **step 6** into a test-tube
- adds 1 cm depth of dilute nitric acid and 1 cm depth of aqueous barium nitrate to the test-tube
- immediately observes a precipitate.

(i) Explain why it is difficult to determine the actual colour of the precipitate.

....

.... [1]

(ii) Suggest how the procedure is changed to confirm the actual colour of the precipitate.

....

.... [1]

[Total: 13]

3 A student investigates the density of a metal object.

(a) The student places the metal object on a balance.

Figure 3.1 shows the reading on the balance.

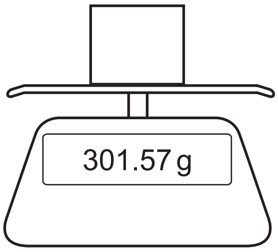


Figure 3.1

Record the mass *m* to the nearest 0.1 g.

m = ... g [1]

(b) Procedure

The student:

- places a small plastic pot in a tray, as shown in Figure 3.2

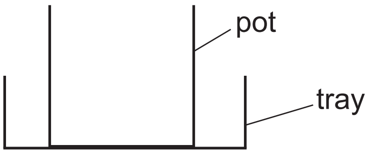


Figure 3.2

- pours water into the pot until it is completely full
- places the metal object into the water.

Water spills over the edge of the pot and into the tray, as shown in Figure 3.3.

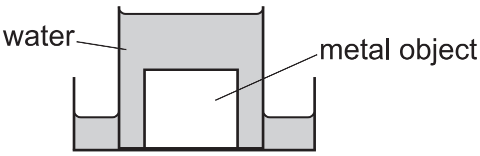


Figure 3.3

The student:

- removes the pot and its contents from the tray
- pours the water from the tray into a measuring cylinder.

Figure 3.4 shows the reading on the measuring cylinder.

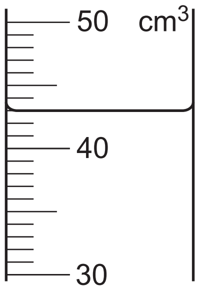


Figure 3.4

Record the volume of water V to the nearest cm^3.

V = ... cm^3 [1]

(c) Calculate the density of the metal object.

Use your answers in **3(a)** and **3(b)** and the equation shown.

$$\text{density} = \frac{m}{V}$$

density = ... g/cm^3 [1]

(d) Suggest **one** source of error in the student's results.

....

.... [1]

(e) Another student calculates the density of the metal object as 8.0 g/cm^3.

Two values are considered equal, within the limits of experimental error, if they are within 10% of each other.

Explain if the student's value of density is equal to the value in **3(c)** within the limits of experimental error.

Justify your answer with a calculation.

....

.... [2]

(f) Another student cools the metal object in a freezer. The object contracts due to the lower temperature.

The student repeats the procedure in **3(a)** and **3(b)** with the colder metal object.

State the effect cooling has on the calculated density of the metal object.

Explain your answer.

effect ....

explanation ....

....
[1]

[Total: 7]

Turn over

4 A ray of light enters a triangular glass prism with an angle of incidence i.

The ray of light is refracted as shown in Figure 4.1.

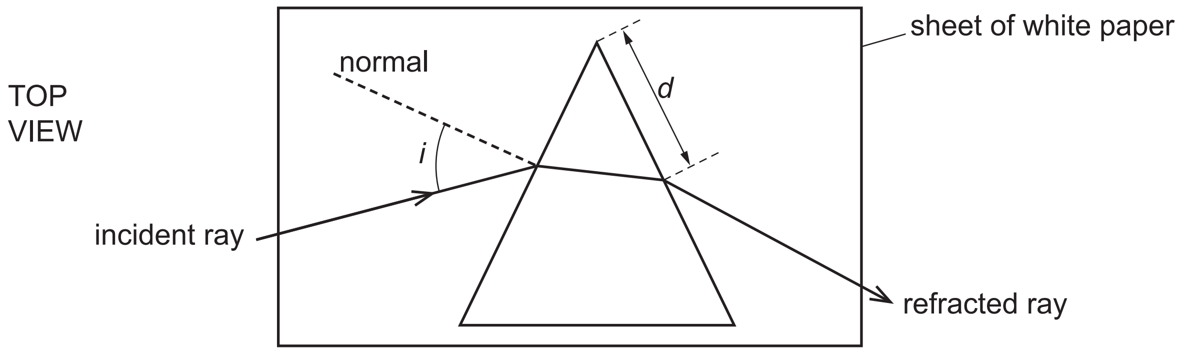


Figure 4.1

The distance d is the distance between the top of the prism and the point at which the refracted ray leaves the prism.

A student states that the distance d depends on angle i.

Plan an investigation to determine the relationship between d and i.

You are provided with:

- a triangular glass prism
- a sheet of paper.

You may use any common laboratory apparatus in your plan.

In your plan, include:

- any additional apparatus you will use
- a brief description of the method
- what you will measure
- a table to record your results (you do **not** need to enter any readings in the table)
- how you will process your results to reach a conclusion.

[7]

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NOTES FOR USE IN QUALITATIVE ANALYSIS

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, 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(II), 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, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
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