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Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

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COMBINED SCIENCE **5129/32**

Paper 3 Experimental Skills and Investigations **October/November 2024**

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 or correction fluid.
- 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 [ ].

This document has **16** pages. Any blank pages are indicated.

DC (PQ/FC) 337973/3

1 A student investigates refraction.

procedure

The student:

- places a transparent block on a sheet of paper
- labels the corners of the block **A**, **B**, **C** and **D** as shown in Fig. 1.1
- places a pin at $\mathbf{P_1}$ and another pin at $\mathbf{P_2}$
- adjusts the position of his eye along face **DC** of the block so that the images of the pins at $\mathbf{P_1}$ and $\mathbf{P_2}$ are aligned
- places **two more** pins $\mathbf{P_3}$ and $\mathbf{P_4}$ so that all the pins appear to be one behind the other.

(a) On Fig. 1.1, draw a straight line from $\mathbf{P_1}$ through $\mathbf{P_2}$ to a point on the face **AB** of the block and label this point **E**.

Draw another straight line from $\mathbf{P_4}$ through $\mathbf{P_3}$ to a point on the face **DC** of the block and label this point **F**.

Draw a straight line from point **E** to point **F**.

At point **E**, draw a vertical line, of length 5 cm, at a right angle to **AB** and label this line **normal**. Label the end of the normal line lying outside the outline of the glass block with an **N**.

Extend the normal to face **DC** of the block and label the point where the normal meets DC with a **G**. [3]

(b) Measure:

the angle θ_i between the line **NE** and the line $\mathbf{P_1E}$

θ_i = ... °

the angle θ_r between the line **GE** and the line **EF**.

θ_r = ... °
[2]

(c) Measure:

the distance *a* between point **F** and point **G**

a = ... mm

the distance *b* between point **E** and **F**.

b = ... mm
[2]

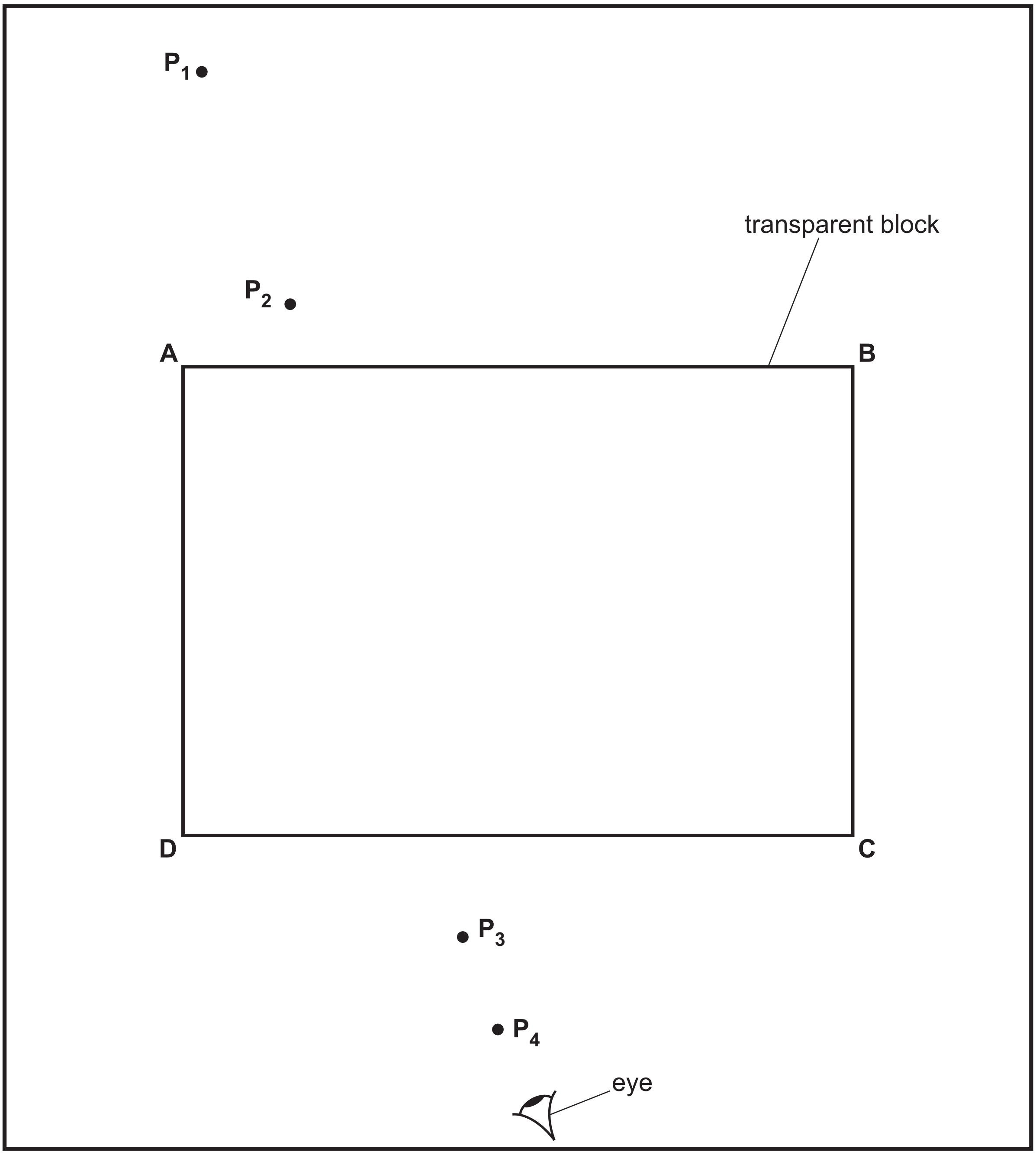

Fig. 1.1

(d) A teacher says that for any pair of values θ_i and θ_r, the ratio $\dfrac{\sin\theta_i}{\sin\theta_r}$ is equal to a constant k.

For this transparent block $k = 1.54$.

The constant k may also be calculated using the equation: $k = \dfrac{0.34\,b}{a}$

Use your values of a and b in part **(c)** in this equation to calculate another value of k.

Record your answer to 3 significant figures.

k = ... [2]

(e) The two values of k can be considered to be equal within the limits of experimental accuracy if they are within 10% of each other.

State whether your results show that the two values obtained for k are equal.

Tick (✓) **one** box.

Yes, my k values are within 10% of each other, so they are equal. ☐

No, my k values are **not** within 10% of each other, so they are **not** equal. ☐

Show a calculation to support your statement.

[1]

(f) A student suggests changes to the procedure on page 2 to determine a more accurate value of k.

Which suggested change will **not** result in a more accurate value of k?

Tick (✓) **one** box.

do the experiment in a darkened room ☐

use blocks of different sizes ☐

vary the pin positions to produce different values of θ_i ☐

use more pins ☐

[1]

[Total: 11]

2 A student investigates the temperature changes that occur when ammonium chloride is dissolved in water.

procedure

The student:

- measures 25.0 cm^3 of water into a beaker
- measures the temperature of the water in the beaker
- measures 2 g of ammonium chloride and adds it to the beaker
- continually stirs the mixture
- measures the temperature regularly
- records the time and the temperature in Table 2.1.

(a) **(i)** Name the apparatus used to measure 25.0 cm^3 of water and the apparatus used to measure the temperature.

apparatus used to measure 25.0 cm^3 of water ....

apparatus used to measure the temperature ....
[2]

(ii) Fig. 2.1 shows parts of the apparatus used to measure the temperatures at 30 s and 150 s.

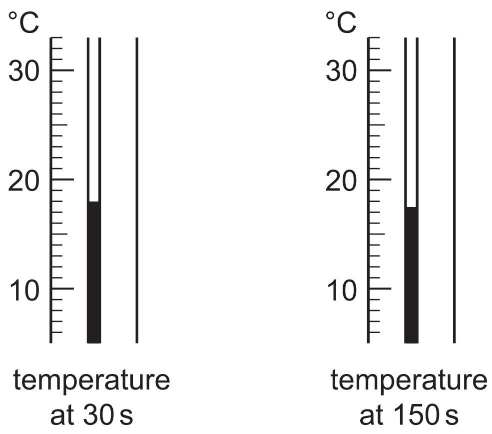

Fig. 2.1

Use the information in Fig. 2.1 to complete Table 2.1 on page 6. [1]

Table 2.1

time / s	temperature / °C
0	21.5
30	....
60	15.0
90	15.0
120	16.0
150	....
180	18.5
240	21.0

(iii) Plot your temperature readings from **(a)(ii)** on the grid in Fig. 2.2.

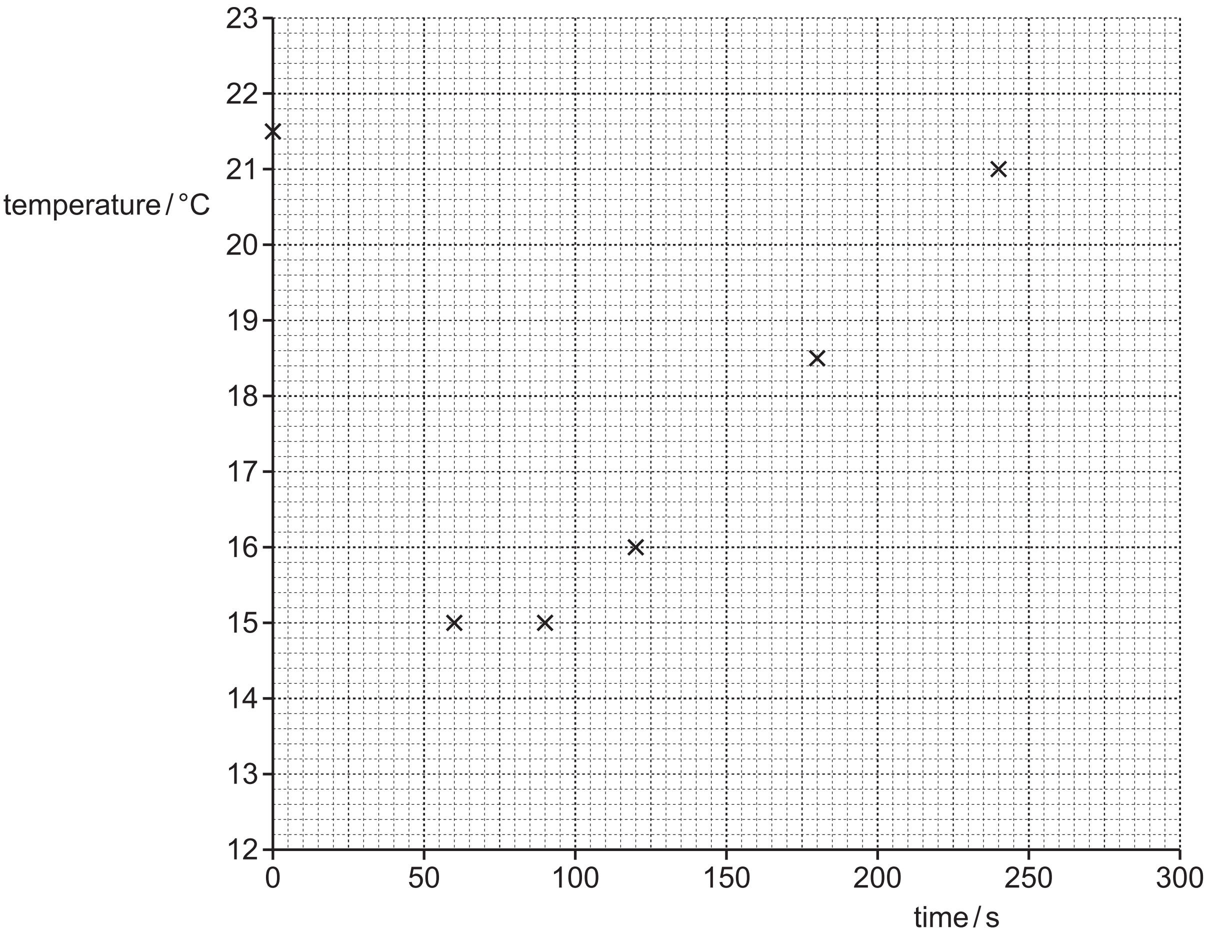

Fig. 2.2

[1]

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(iv) On the grid in Fig. 2.2, draw **one** straight line of best fit using the first **three** points only.

Draw **another** straight line of best fit using the last **five** points only.

Extend **both** lines of best fit so that they meet. [2]

(v) The point where both best-fit lines meet is the lowest temperature that the mixture reaches.

State the lowest temperature that the mixture reaches.

lowest temperature = ... °C [1]

(vi) Use your answer to **(a)(v)** to determine the maximum decrease in the temperature of the mixture.

maximum decrease in temperature = ... °C [1]

(b) **(i)** Use the data to explain why the student concludes that dissolving ammonium chloride is endothermic.

....

....

.... [1]

(ii) The true values of the first three temperatures are lower than the measured values.

Give a reason for the true values being lower than the measured values, and suggest an improvement to the procedure to reduce the error.

reason ....

....

improvement ....

....
[2]

[Total: 11]

3 A student investigates how quickly acid of different concentrations diffuses through agar jelly.

An indicator is added to agar jelly containing an alkali. This turns the agar jelly pink.

The agar jelly turns colourless when the alkali in the agar jelly is neutralised by acid.

procedure

The student:

- cuts a circular hole in the centre of the pink agar jelly in three petri dishes as shown in Fig. 3.1

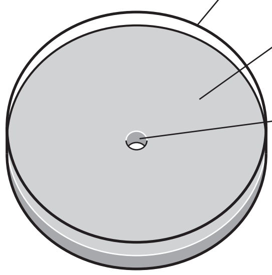


Fig. 3.1

- places 1 cm^3 of an acid solution with a concentration of 20 g/dm^3 into the hole in one petri dish
- repeats the process in the other two petri dishes, using acid solutions with acid of concentration 40 g/dm^3 and acid of concentration 80 g/dm^3
- waits 30 minutes and then measures and records the diameter of the agar jelly that has turned colourless in each petri dish.

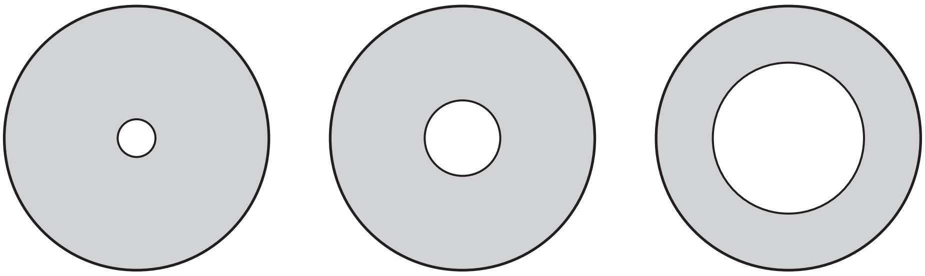
(a) The student uses the same volume of acid and the same period of time for all three dishes.

State **two** other variables that the student keeps constant to make sure that this is a fair test.

variable 1 ....

variable 2 ....
[2]

(b) The student's results are shown in Fig. 3.2.



acid of concentration 20 g / dm^3 | acid of concentration 40 g / dm^3 | acid of concentration 80 g / dm^3

Fig. 3.2

(i) Measure the diameter of the colourless circle in the agar jelly in Fig. 3.2 for acid of concentration 20 g / dm^3 and for acid of concentration 40 g / dm^3.

Record your measurements in Table 3.1.

Table 3.1

acid of concentration g / dm^3	diameter of colourless circle / mm
20	....
40	....
80	20

[2]

(ii) Calculate the total area of the colourless circle for the petri dish where acid of concentration 80 g / dm^3 is used.

Use the formula:

$$\text{area of circle} = 3.14\,r^2$$

where r is the **radius** of the colourless circle.

area = ... mm^2 [2]

(iii) Suggest **one** improvement to the procedure on page 8 to give more accurate values for the diameters of the colourless circles.

....

....

[1]

(c) Fig. 3.3 shows a photograph of a thumb.

Make a **large** drawing of the thumb in the box.

Fig. 3.3

[4]

[Total: 11]

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4 A student places a block of mass M on a ramp inclined at an angle θ as shown in Fig. 4.1.

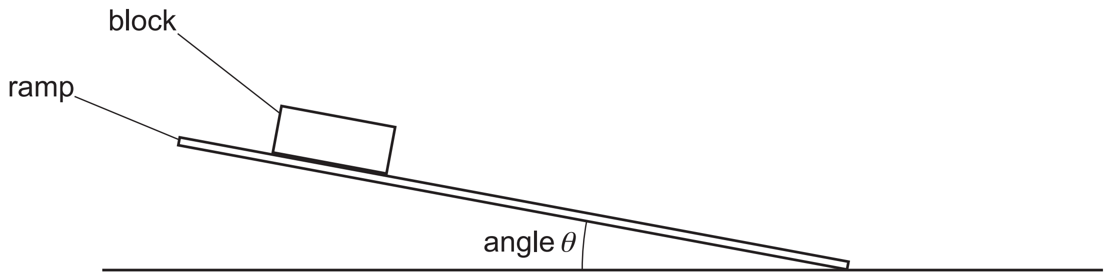

Fig. 4.1

When angle θ is large enough, the block will start to slide down the ramp. The value of θ when the block **starts** to slide is θ_{SLIDE}.

The student suggests that θ_{SLIDE} is directly proportional to the mass M of the block placed on the ramp.

Plan an investigation to find out if this suggested relationship is correct.

The arrangement of some of the apparatus you will use is shown in Fig. 4.1. Additionally, you may use any other apparatus commonly found in a school laboratory for your plan.

Include in your answer:

- the additional apparatus you will use
- a brief description of the method, including an appropriate number and range of observations
- what you will keep constant
- a sketch of the graph you would obtain if the suggested relationship is correct.

A diagram of the apparatus and a results table are **not** required but you may include them if it helps to explain your plan.

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[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
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
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

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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