* 0000800000001 *

Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

* 5 3 4 7 1 4 4 0 7 5 *

PHYSICS **5054/42**

Paper 4 Alternative to Practical **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 (DE/CGW) 337968/4

1 A student determines an approximate value for the density of the glass from which a test-tube is made.

The height h and the external diameter d of the test-tube are shown in a full-size diagram of the test-tube in Fig. 1.1.

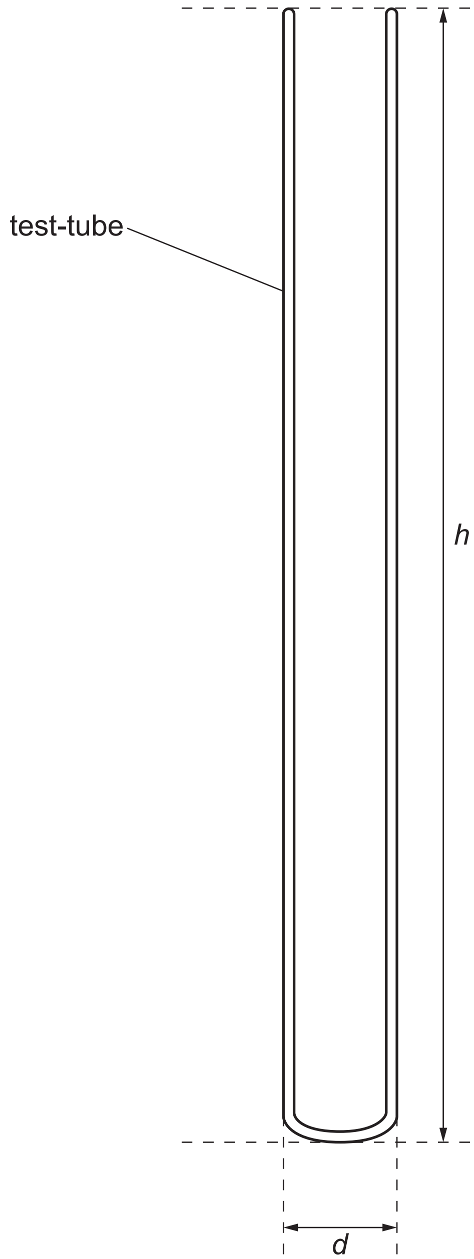

Fig. 1.1

(a) **(i)** Measure the height h of the test-tube in Fig. 1.1 to the nearest 0.1 cm.

h = ... cm [1]

(ii) Measure the external diameter d of the test-tube in Fig. 1.1.

d = ... cm [1]

(b) The student uses a ruler and two wooden blocks to help obtain an accurate answer for the height *h*.

Fig. 1.2 shows how the student uses the wooden blocks.

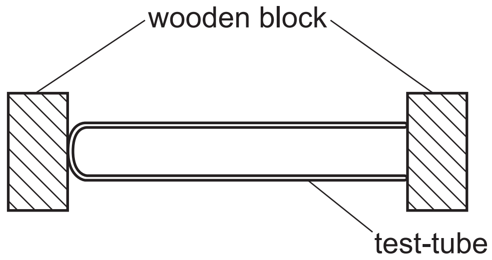

Fig. 1.2 (not to scale)

Explain why it is important for the student to ensure that the blocks are parallel to one another.

....

.... [1]

(c) The shape of the test-tube is approximately a cylinder.

Calculate the external volume V_E of the test-tube using the equation:

$$V_E = 0.79\,d^2\,h$$

V_E = ... cm^3 [1]

(d) The student:

- fills the test-tube to the top with water
- pours the water from the test-tube into a measuring cylinder.

Fig. 1.3 shows the measuring cylinder.

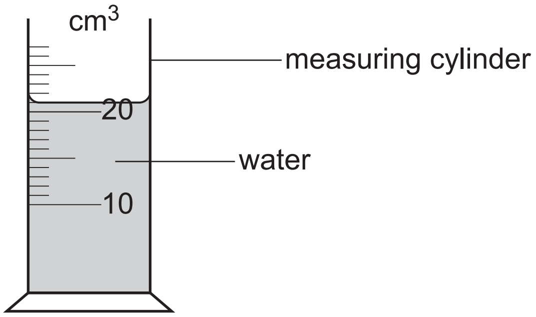

Fig. 1.3

Record the reading V_I on the measuring cylinder.

This is the internal volume of the test-tube.

V_I = ... cm^3 [1]

(e) Calculate the volume V_G of the glass in the test-tube using the equation:

$$V_G = V_E - V_I$$

V_G = ... cm^3 [1]

(f) Suggest **one** source of inaccuracy in measuring the internal volume of the test-tube V_I.

....

.... [1]

(g) **(i)** The student uses a balance to measure the mass *m* of the test-tube.

Fig. 1.4 shows the reading on the balance.

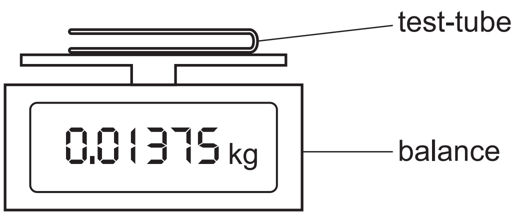

Fig. 1.4

Record *m* to the nearest **gram**.

m = ... g [1]

(ii) Use your results from **(g)(i)** and **(e)** to calculate the density ρ of the glass from which the test-tube is made using the equation:

$$\rho = \frac{m}{V_G}$$

Give the unit for your answer.

ρ = ... unit = ... [2]

[Total: 10]

2 A student investigates the resistance of a light-emitting diode (LED) when different currents flow through it.

The student sets up the circuit shown in Fig. 2.1.

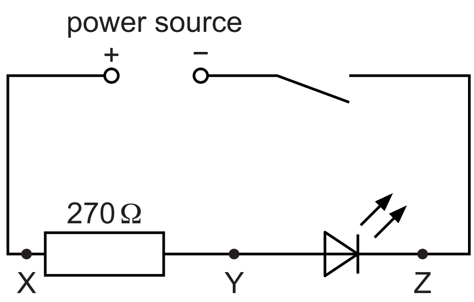

Fig. 2.1

(a) The student:

- connects a voltmeter across the 270 Ω resistor between points X and Y
- closes the switch
- records the voltmeter reading of the potential difference V_{XY} in the top row of Table 2.1
- opens the switch.

Table 2.1

resistance between X and Y / Ω	V_{XY} / V	V_{YZ} / V	$(V_{XY} + V_{YZ})$ / V	I / A	R_{LED} / Ω
270	....	2.1	....	....	....
470	2.6	2.0	4.6	0.0053	380
560	....	2.0	4.6	0.0046	430

(i) On Fig. 2.1, draw the symbol for a voltmeter connected to measure the potential difference V_{XY} across the 270 Ω resistor. [1]

(ii) Fig. 2.2 shows the voltmeter reading of the potential difference V_{XY} when the voltmeter is connected across the 270 Ω resistor.

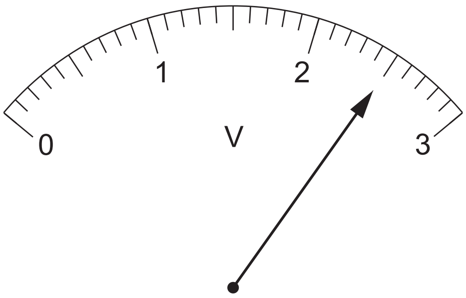

Fig. 2.2

Record V_{XY} in Table 2.1. [1]

(b) The student:

- disconnects the voltmeter from points X and Y
- reconnects the voltmeter across the LED between points Y and Z
- closes the switch
- records the voltmeter reading of the potential difference V_{YZ} in the correct row of Table 2.1
- opens the switch.

(i) Calculate the value of $(V_{XY} + V_{YZ})$ for the 270 Ω resistor. Record your answer in Table 2.1.

[1]

(ii) The current I in the circuit can be calculated using the equation:

$$I = \frac{V_{XY}}{R}$$

where R = 270 Ω.

Calculate I. Record your answer in Table 2.1.

[1]

(iii) The resistance R_{LED} of the LED can be calculated using the equation:

$$R_{LED} = \frac{V_{YZ}}{I}$$

Calculate R_{LED}. Record your answer in Table 2.1.

[1]

(c) The student repeats the procedure in **(a)** and **(b)**, replacing the 270 Ω resistor, first with a 470 Ω resistor and then with a 560 Ω resistor.

The student's results are shown in Table 2.1, but the value of V_{XY} for the 560 Ω resistor is missing.

Calculate V_{XY} and record your answer in Table 2.1 on page 6.

[1]

(d) As the resistance between terminals X and Y changes, the current in the circuit changes.

Examine the results in Table 2.1.

Describe how the change in current affects:

(i) $(V_{XY} + V_{YZ})$

....

.... [1]

(ii) R_{LED}.

....

.... [1]

(e) Another student assembles a circuit using the circuit diagram shown in Fig. 2.1. This student finds that, when the switch is closed, the LED does not light up.

The student tests the components and finds that the power source is producing an e.m.f., and that none of the other components are broken.

Suggest the error this student has made while assembling the circuit.

....

.... [1]

(f) Name and draw the symbol of a single device that can be used to change the current in the circuit without the need to connect different resistors across the terminals X and Y in the circuit in Fig. 2.1.

name of device ....

symbol for device

[1]

[Total: 10]

3 A student investigates the image formed by a converging lens.

(a) The student:

- arranges the apparatus as shown in Fig. 3.1

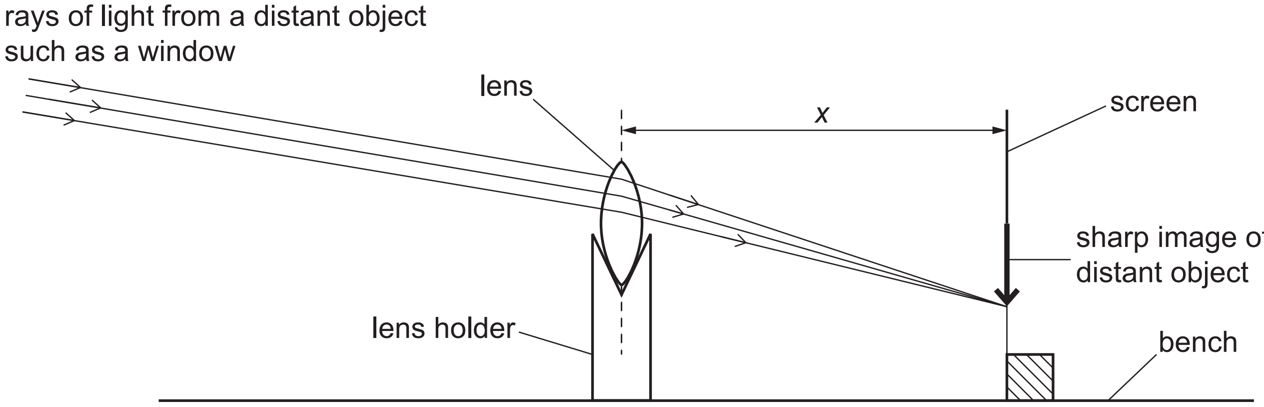

Fig. 3.1

- places a white screen approximately 30 cm from the lens
- adjusts the position of the screen until a sharp image of a window in the laboratory, a few metres distant from the lens, is formed on the screen.

(i) Measure and record, in centimetres to the nearest 0.1 cm, the distance *x* on Fig. 3.1 from the lens to the screen.

x = ... cm [1]

(ii) The distance *x* shown on Fig. 3.1 is drawn to a scale of one-third full size.

Use your answer from **(a)(i)** to calculate the actual distance from the lens to the screen.

This distance is the focal length *f* of the lens.

f = ... cm [1]

(b) The student:

- rearranges the apparatus as shown in Fig. 3.2

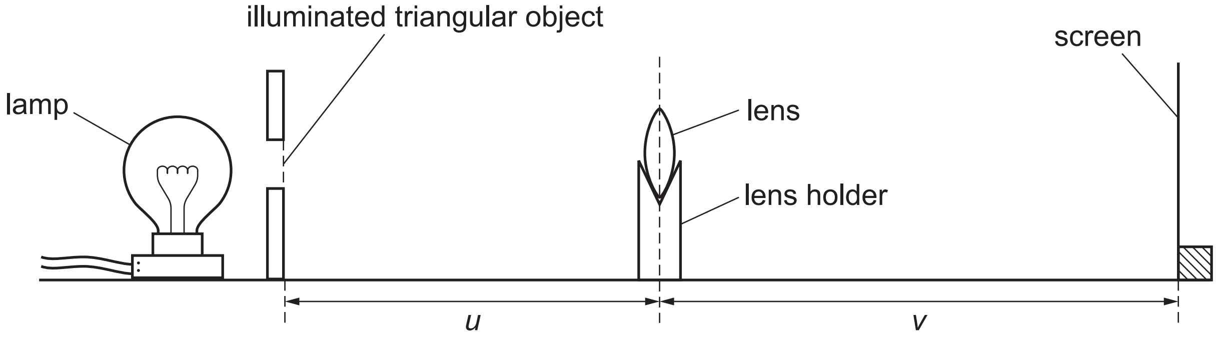

Fig. 3.2 (not to scale)

- switches on the lamp
- places the lens a distance u = 20.0 cm from an illuminated triangular object
- adjusts the position of the screen until a sharp image of the triangular object is formed on the screen
- measures the image distance v from the lens to the screen.

v = 60.5 cm

Calculate the values of (u + v) and uv.

Record your values of (u + v) and uv to an appropriate number of significant figures on the answer lines and in the first row of Table 3.1.

(u + v) = ...

uv = ...

[1]

(c) The student repeats **(b)** for values of u between u = 25.0 cm and u = 55.0 cm.

The student's results are shown in Table 3.1.

Add appropriate units to the headers of the last two columns. [1]

Table 3.1

u / cm	v / cm	(u + v) /	uv / ....
20.0	60.5	…………..	…………..
25.0	37.3	62	933
40.0	24.7	65	988
50.0	21.7	72	1090
55.0	20.7	76	1140

(d) On the grid provided in Fig. 3.3, plot a graph of uv on the y-axis against $(u + v)$ on the x-axis.

You do **not** need to start either axis from the origin (0, 0). Draw the straight line of best fit.

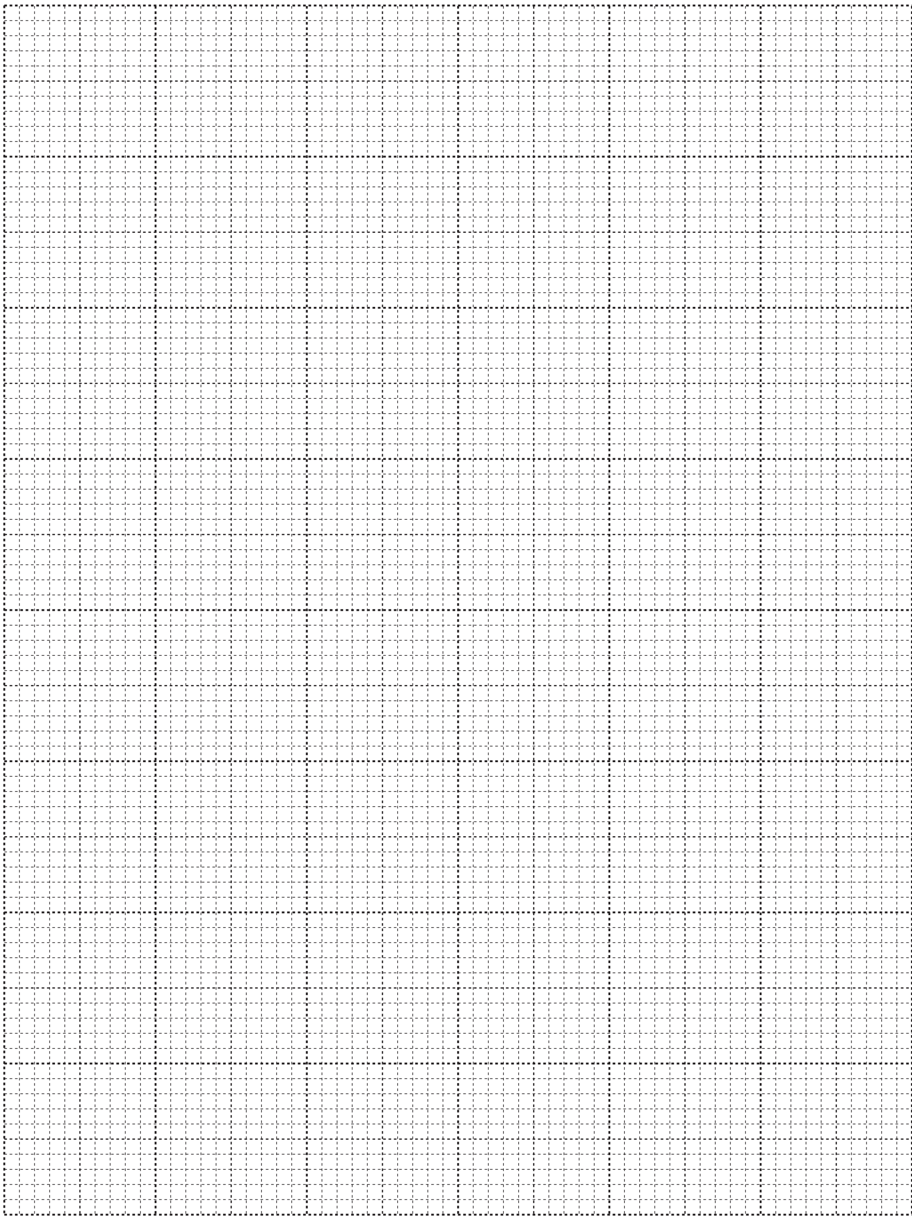

Fig. 3.3

[4]

(e) Calculate the gradient of the line.

Indicate on the graph the points you use.

Show all your working.

gradient = ... [2]

(f) Two quantities can be considered to be the same within the limits of experimental accuracy if their values are within 10% of each other.

The gradient of your line calculated in **(e)** is numerically equal to the focal length *f* of the lens in cm.

Compare your value of *f* obtained in **(a)(ii)** with the value of the gradient obtained in **(e)**.

State if your two values can be considered to be the same.

Support your statement with a calculation.

calculation

statement ....

.... [2]

(g) **(i)** When measuring the object and image distances with a metre rule, it is important to avoid line-of-sight (parallax) errors.

State how the student avoids parallax errors when doing the experiment.

....

.... [1]

(ii) Describe a technique that the student uses to make sure that the image on the screen is as sharply focused as possible.

....

....

.... [1]

[Total: 14]

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4 Water is heated from room temperature to its boiling temperature in a glass beaker.

Plan an experiment to investigate if the time taken for the water to reach its boiling temperature depends on the diameter of the water surface exposed to the air.

You are provided with:

- a supply of cold water
- a set of glass beakers of different sizes
- a Bunsen burner, tripod and gauze
- a measuring cylinder.

You may use any other common laboratory apparatus.

In your plan include:

- any other apparatus needed
- a brief description of the method, including what you will measure and how you will make sure your measurements are accurate
- the variables you will control
- a results table to record your measurements (you are not required to enter any readings in the table)
- how you will process your results to draw a conclusion.

You may include a labelled diagram if you wish.

....

....

....

....

....

[6]

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