Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME	

CENTRE NUMBER		CANDIDATE NUMBER	

* 2 7 3 0 7 9 9 4 9 0 *

PHYSICS **5054/41**

Paper 4 Alternative to Practical **May/June 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.

1 A student finds the volume of a small glass ball (marble) by two different methods.

(a) method 1

The student:

- places six small glass balls by the side of a metre rule as shown in Fig. 1.1
- makes sure that there are no gaps between the balls.

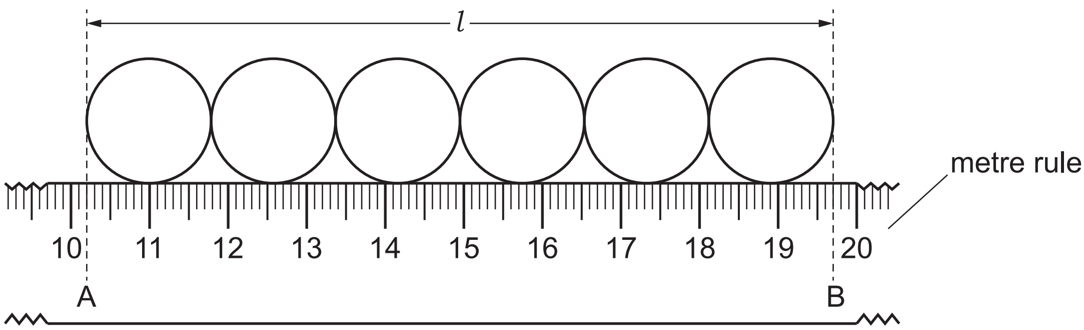

Fig. 1.1

(i) Take readings on the metre rule of the positions of points A and B shown in Fig. 1.1.

Give your readings to the nearest 0.1 cm.

position of point A = ... cm

position of point B = ... cm
[1]

(ii) The length l on Fig. 1.1 is the distance between points A and B.
The average diameter d of one ball can be found using the equation:

$$l = 6d$$

Use your answers to **(a)(i)** to calculate the length l and diameter d. Give your answers to the nearest 0.1 cm.

l = ... cm

d = ... cm
[2]

(iii) The average volume V of **one** glass ball using this method, is given by the equation:

$$V = \frac{3.14d^3}{6}$$

Calculate V.

V = ... cm^3 [1]

(b) method 2

- The student pours water into a measuring cylinder.

(i) The volume of water in the measuring cylinder V_1 is shown in Fig. 1.2.

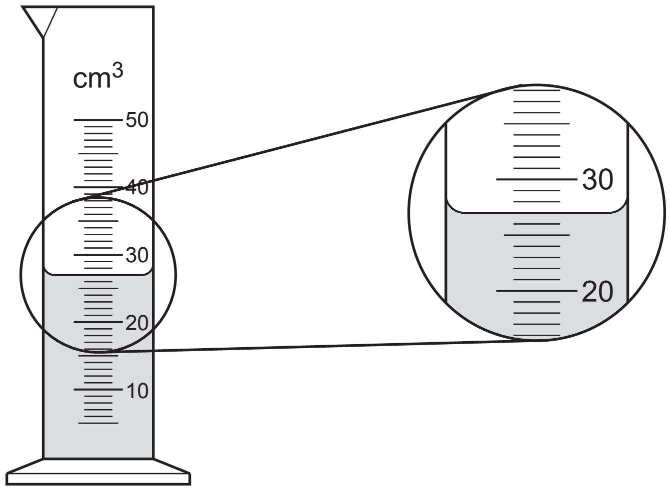

Fig. 1.2

Write down the reading V_1.

V_1 = ... cm^3 [1]

(ii) • The six glass balls are carefully added to the water in the measuring cylinder.

The new reading on the measuring cylinder V_2 is shown in Fig. 1.3.

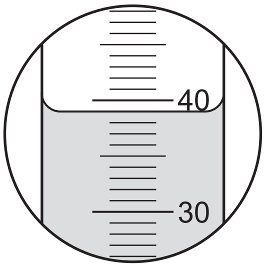

Fig. 1.3

The volume V_T of the six balls is given by

$$V_T = V_2 - V_1.$$

Calculate V_T. Show your working.

V_T = ... cm^3 [1]

(iii) Calculate the average volume V of **one** ball using this method. Give your answer to the nearest $0.1\,cm^3$.

V = ... cm^3 [1]

(c) Suggest whether **method 1** or **method 2** gives the more accurate value for the volume of the ball.

Explain your answer.

method giving more accurate value ....

explanation ....

....

....
[1]

(d) The student now uses the six glass balls to find the average mass of one glass ball using a small beaker and a top pan (electronic) balance.

Describe the method the student uses.

....

....

....

....

....

.... [2]

[Total: 10]

2 A student investigates how the temperature of the surroundings affects the rate of cooling of water.

(a) (i) The student:

- pours 100 cm^3 of hot water into a 250 cm^3 beaker
- uses a thermometer to take the temperature of the water at time t = 0 s.

The thermometer reading at time t = 0 s is shown in Fig. 2.1.

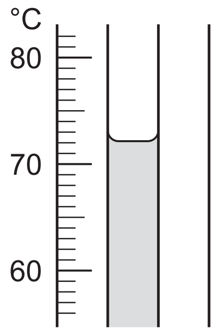

Fig. 2.1

Record the temperature of the water at time t = 0 s in Table 2.1.

Table 2.1

t / s	θ / °C
0	....
30	69
60	67
90	66
120	65
150	64
180	63
210	62
240	61

[1]

(ii) The student then records the temperature θ of the water every 30 s for 240 s. The results are recorded in Table 2.1.

Before taking each temperature reading, the student carefully stirs the water in the beaker. Explain why.

....

....

.... [1]

(iii) Calculate the average cooling rate C_1 of the water for the first 90 s of the experiment. Use the readings in Table 2.1 and the equation:

$$C_1 = \frac{\theta_0 - \theta_{90}}{t}$$

where θ_0 is the temperature of the water at 0 s, θ_{90} is the temperature at 90 s and t is the time of 90 s.

Give the unit for C_1.

C_1 = ... unit .... [2]

(iv) Calculate the average cooling rate C_2 of the water for the final 90 s of the experiment. Use the equation:

$$C_2 = \frac{\theta_{150} - \theta_{240}}{t}$$

where θ_{150} is the temperature of the water at 150 s, θ_{240} is the temperature of the water at 240 s and t is the time of 90 s.

C_2 = ... unit .... [1]

(v) Compare your values of C_1 and C_2. Explain any difference in these values.

....

....

.... [1]

(b) The student repeats the procedure described in **(a)(i)** but this time he places the 250 cm^3 beaker inside a larger beaker containing iced water. The arrangement is shown in Fig. 2.2.

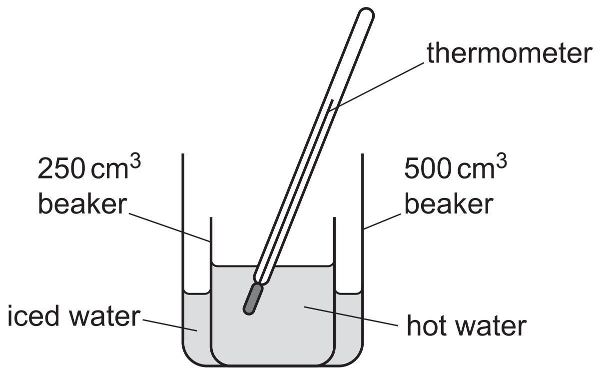

Fig. 2.2

The student reads the temperature θ of the hot water, records the reading and immediately starts the stop-watch.

Table 2.2. shows the temperature θ at times t = 0 s, 30 s, 60 s, and 90 s.

Table 2.2

t / s	θ / °C
0	75
30	68
60	62
90	57

(i) Calculate the average cooling rate of the hot water for the 90 s. Use the readings in Table 2.2 and the equation:

$$C_3 = \frac{\theta_0 - \theta_{90}}{t}$$

C_3 = ... unit .... [1]

(ii) Describe how C_3 differs from C_1. Explain your answer.

....

....

.... [1]

(iii) The recorded readings show that this experiment is **not** a valid comparison of C_1 and C_3.

By referring to the results recorded in Table 2.1 and Table 2.2, explain why this is not a valid comparison.

....

.... [1]

(iv) State **one** other variable that should be kept constant to make a valid comparison.

....

....

.... [1]

[Total: 10]

3 A student measures the focal length of a lens.

Fig. 3.1 shows the apparatus she uses and the position of the lens when a clearly focused image is formed on the screen.

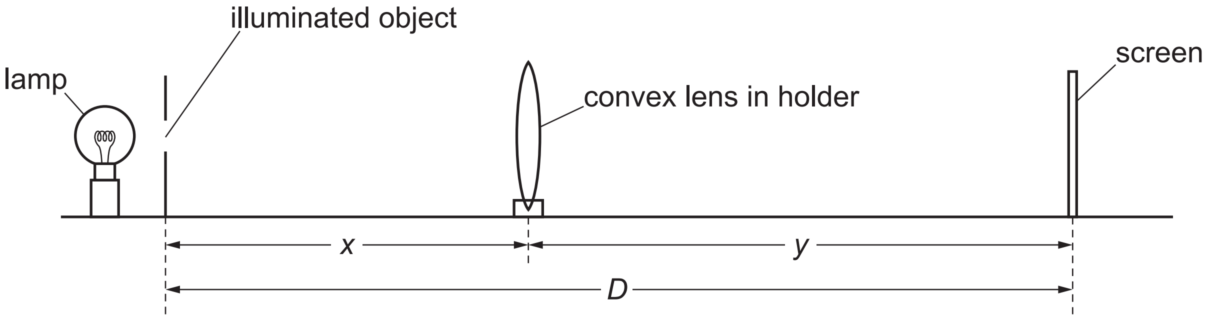

Fig. 3.1 (one fifth full size)

The student:

- places the screen a distance D = 60.0 cm from the illuminated object
- places the lens between the object and the screen so that the lens is very close to the illuminated object
- moves the lens slowly away from the illuminated object until a clearly focused image is formed on the screen.

(a) **(i)** Measure and record distance x on Fig. 3.1.

x = ... cm [1]

(ii) Fig. 3.1 is drawn to a scale of one fifth full size.

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

u = ... cm [1]

(iii) Deduce the image distance v, the distance from the lens to the screen when a clear image is seen.

v = ... cm [1]

(b) Fig. 3.2 shows the shape of the illuminated object and Fig. 3.3 shows the image seen on the screen.

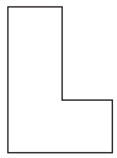

Fig. 3.2

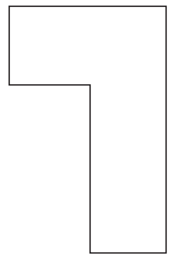

Fig. 3.3

Describe **two** differences between the illuminated object and its image on the screen.

1 ....

....

2 ....

....
[2]

(c) **(i)** The student moves the screen away from the illuminated object and repeats the procedure for values of D = 70.0 cm, 80.0 cm, 90.0 cm and 100.0 cm.

Table 3.1 shows the values recorded.

Add your values for u and v from **(a)(ii)** and **(a)(iii)** to Table 3.1 on page 12.

Complete Table 3.1 by calculating the value of ($u \times v$) for each value of D.
Give your answers to 3 significant figures.

[Turn over

Table 3.1

D / cm	u / cm	v / cm	$(u \times v)$ / cm^2
60.0			
70.0	21.0	49.0	
80.0	19.5	60.5	
90.0	18.6	71.4	
100.0	17.8	82.2	

[2]

(ii) Use the grid provided in Fig. 3.4 on page 13 to plot a graph of $(u \times v)$ / cm^2 on the y-axis against D / cm on the x-axis.

You do not need to start your axes at the origin (0,0).

Draw the straight line of best fit. [4]

(iii) The focal length f of the lens is numerically equal to the gradient of the line.

Calculate the gradient of the line. Show all working and indicate on your graph in Fig. 3.4 the values you use.

f = ... cm [2]

(d) The lens manufacturer states that the focal length of the lens is 15.0 cm ± 10%.

Decide, with a calculation, whether your value of f agrees with this statement and tick the box that shows your answer.

calculation:

☐ My value for f **agrees** with the manufacturer's statement.

☐ My value for f **does not agree** with the manufacturer's statement.

[1]

[Total: 14]

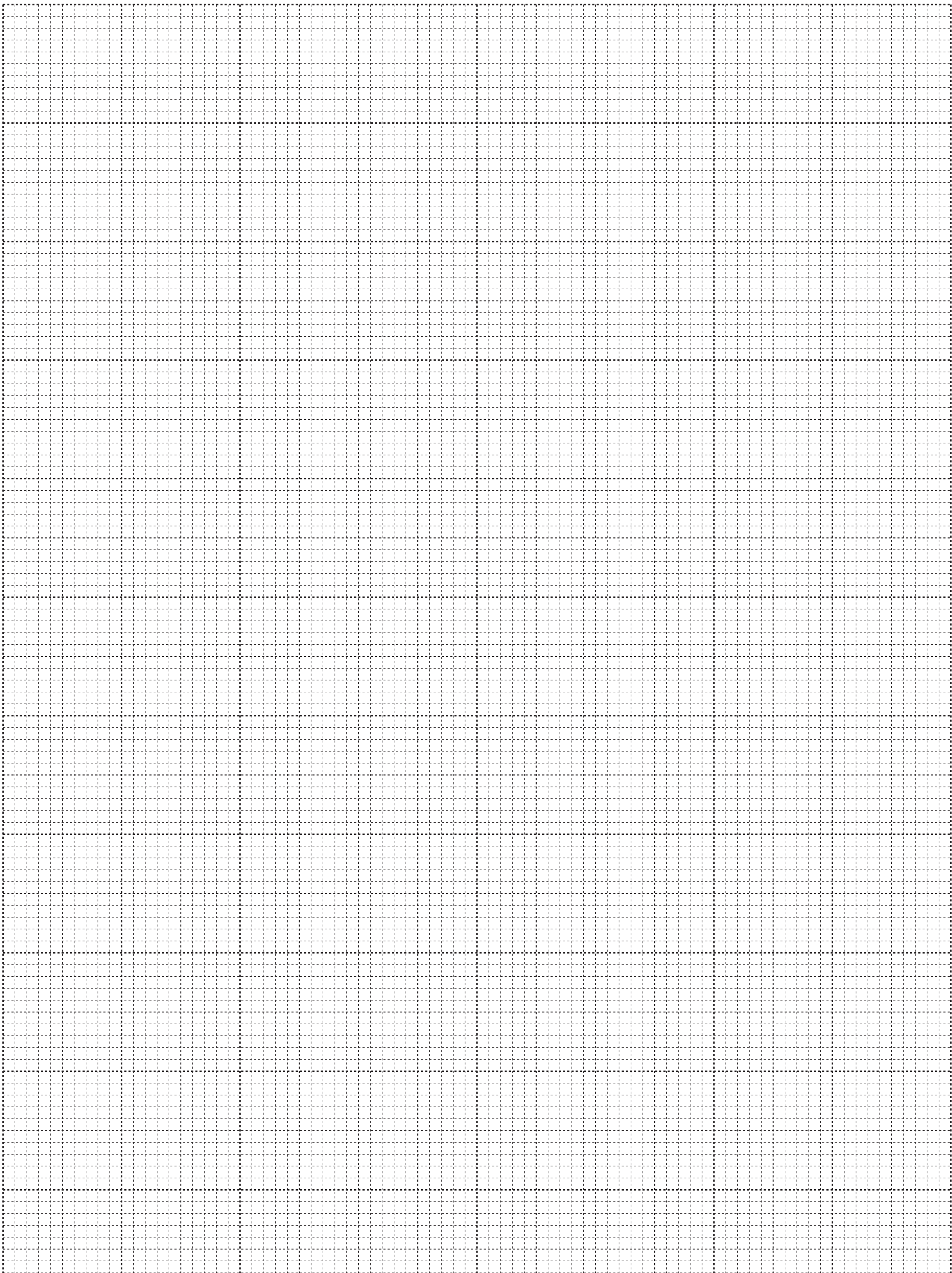

Fig. 3.4

4 Plan an experiment to investigate how the thickness of a metal wire affects its resistance.

The resistance of a wire can be found using the equation:

$$\text{resistance of wire} = \frac{\text{potential difference (p.d.) across wire}}{\text{current in the wire}}$$

The following apparatus is available:

- six lengths of metal wire, each of different thickness
- an ammeter
- a voltmeter
- a power supply
- several connecting leads
- a micrometer.

Other apparatus normally available in a school laboratory can also be used.

In your plan, you should:

- draw a circuit diagram to show how you will use the apparatus
- explain briefly how to carry out the investigation
- state the key variables to keep constant
- draw a table, with column headings, to show how to display readings (you are not required to enter any readings in the table)
- explain how to use these readings to reach a conclusion.

....

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....

....

[6]

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