Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8262541891

PHYSICS **5054/42**

Paper 4 Alternative to Practical **May/June 2023**

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 (CJ/SG) 316511/3

1 A student measures the capacity of a drinks cup by three different methods.

The capacity of a cup is the maximum volume of liquid that it can hold.

(a) method 1

The student measures:
- the height *h* of the cup
- the diameter *D* of the top of the cup
- the diameter *d* of the bottom of the cup.

Fig. 1.1 shows a full-size diagram of the cup.

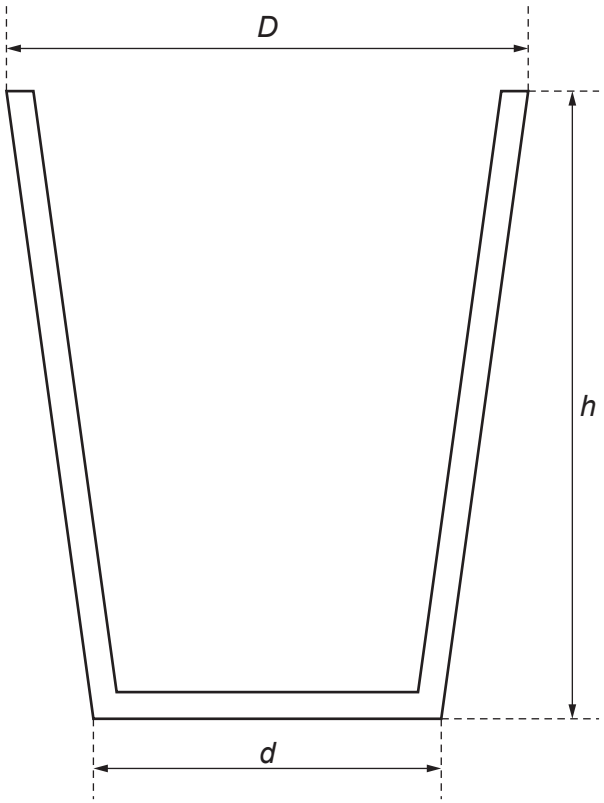


Fig. 1.1

(i) Measure the height *h*, the diameter *D* and the diameter *d* of the cup in the diagram.

h = ... cm

D = ... cm

d = ... cm
[2]

(ii) Calculate the average diameter d_A of the cup using your readings from **(a)(i)** and the equation:

$$d_A = \frac{(D + d)}{2}$$

d_A = ... cm [1]

(iii) Calculate a value for the capacity V_1 of the cup using the equation:

$$V_1 = \frac{\pi\, d_A^2 h}{4}$$

V_1 = ... cm^3 [1]

(b) method 2

The student uses a length of string and a metre rule to determine the average circumference C of the cup.

The student:
- wraps some of the string 5 times around the cup
- measures the length l of string used.

$$l = 87.9\,\text{cm}$$

(i) Calculate the average circumference C of the cup.

C = ... cm [1]

(ii) Use your values of h from **(a)(i)** and C from **(b)(i)** to calculate a value for the capacity V_2 of the cup using the equation:

$$V_2 = \frac{C^2 h}{4\pi}$$

V_2 = ... cm^3 [1]

(c) method 3

The student:
- fills a measuring cylinder with water, up to the 220 cm^3 mark
- pours water from the measuring cylinder into the cup until the cup is full
- records the new reading R on the measuring cylinder.

Fig. 1.2 shows the new reading R.

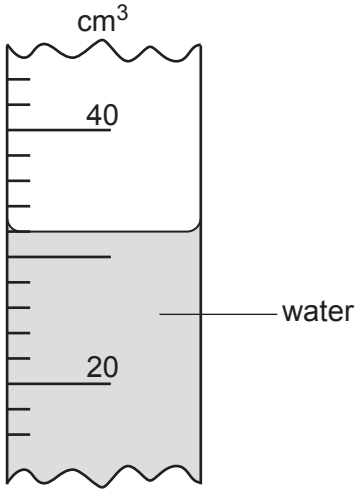


Fig. 1.2

(i) Write down the new reading R.

R = ... cm^3 [1]

(ii) Determine the volume of water V_3 in the cup.

Show your working.

V_3 = ... cm^3 [1]

(d) All three methods of determining the capacity of the drinks cup give values which are approximate.

State **one** reason why the volume calculated in **method 2** and **one** reason why the volume calculated in **method 3** are **not** accurate.

method 2 .....

.....

.....

method 3 .....

.....

.....

[2]

[Total: 10]

2 A student investigates the effective resistance of different combinations of resistors and lamps in circuits.

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

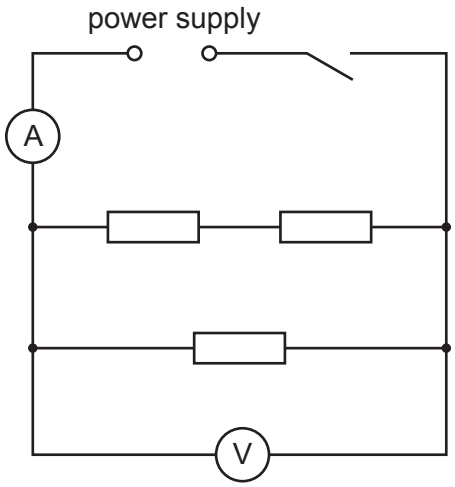


Fig. 2.1

(a) The student:
- closes the switch
- measures the potential difference V_1 across the resistors and the current I_1 in the circuit
- opens the switch.

The readings on the voltmeter and ammeter are shown in Fig. 2.2 and Fig. 2.3.

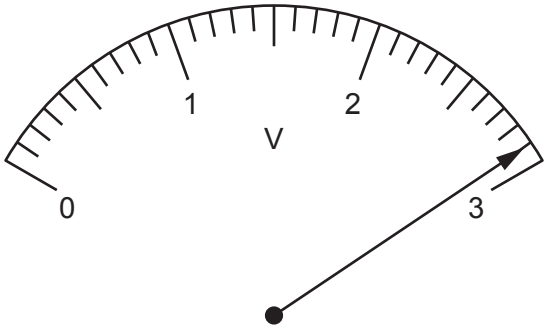


Fig. 2.2

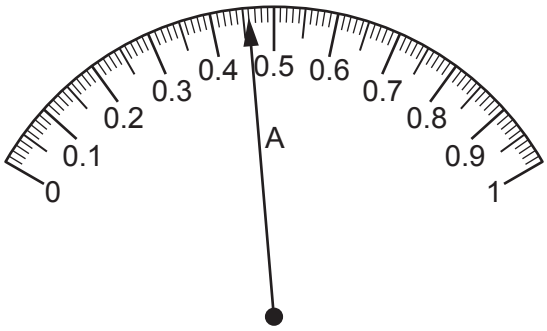


Fig. 2.3

(i) Record the potential difference V_1 and the current I_1 shown in Fig. 2.2 and Fig. 2.3.

V_1 = ... V

I_1 = ... A
[2]

(ii) Calculate the effective resistance R_1 of the combination of resistors using the equation:

$$R_1 = \frac{V_1}{I_1}$$

R_1 = ... Ω [1]

(iii) Suggest why the switch is opened after the readings of potential difference and current have been taken.

.....

..... [1]

(b) The student:

- rearranges the circuit so that the resistors are connected as shown in Fig. 2.4
- closes the switch
- measures the potential difference V_2 and the current I_2
- opens the switch.

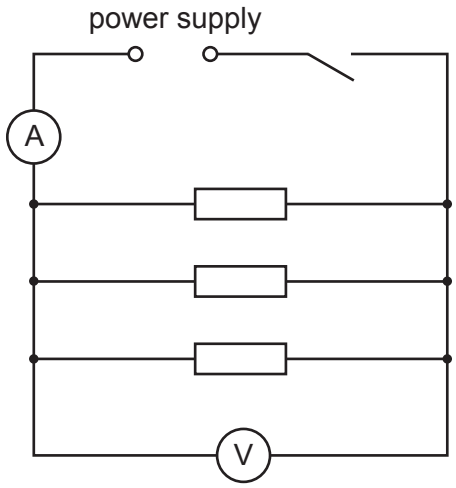


Fig. 2.4

The new readings are:

$$V_2 = 2.8\,\text{V}$$

$$I_2 = 0.88\,\text{A}$$

Calculate the effective resistance R_2 of the combination of resistors using the equation:

$$R_2 = \frac{V_2}{I_2}$$

Record your answer on the answer line.

Write down the value of $2R_2$

R_2 = ... Ω

$2R_2$ = ... Ω

[1]

(c) If the resistors are identical, theory suggests that $R_1 = 2R_2$.

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

State whether the results indicate that the resistors are identical. Support your statement with a calculation.

calculation

statement .....

..... [2]

(d) The student repeats the experiments in **(a)** and **(b)** but replaces the resistors with lamps. He obtains the following results:

The effective resistance R_3 of the combination of lamps connected as in Fig. 2.1 is 5.2 Ω.

The effective resistance R_4 of the combination of lamps connected as in Fig. 2.4 is 3.4 Ω.

The teacher explains that the resistance of the lamp filaments changes due to a heating effect and therefore R_3 is not equal to $2R_4$.

Suggest **one** observation that the student makes while doing the experiment that supports the teacher's explanation.

.....

..... [1]

(e) The student extends the investigation using a different combination of the three lamps to the two combinations already used in **(a)** and **(b)**.

Complete the circuit diagram in Fig. 2.5 to show a third way of connecting three lamps between X and Y.

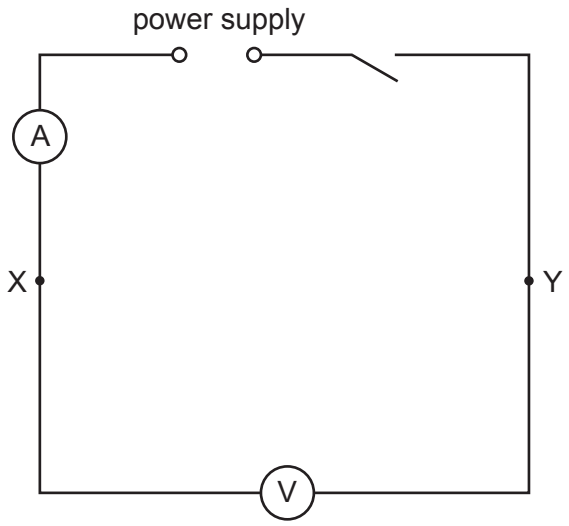


Fig. 2.5

[2]

[Total: 10]

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

The student arranges the apparatus as shown in Fig. 3.1.

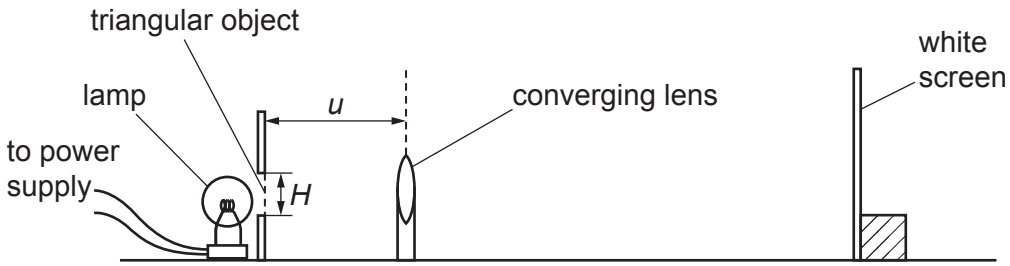


Fig. 3.1 (not to scale)

The illuminated triangular object is shown full size in Fig. 3.2.

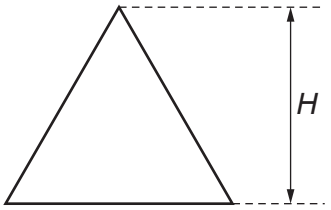


Fig. 3.2

(a) Measure and record the height *H* of the triangular object.

H = ... cm [1]

(b) The student:

- switches on the lamp and places the lens a distance *u* = 20.0 cm from the triangular object
- adjusts the position of the screen until a sharp, focussed image of the triangular object is formed on the screen.

The image is shown full-size in Fig. 3.3.

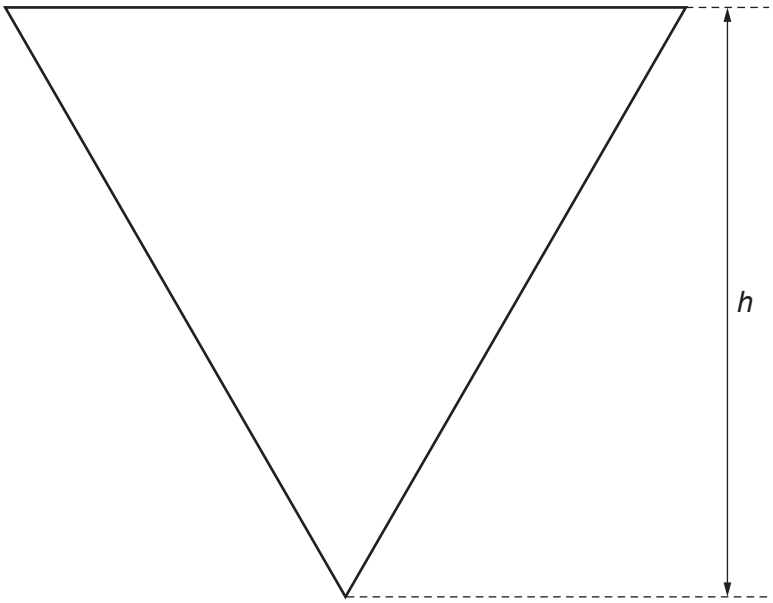


Fig. 3.3

(i) Measure the height h of the image on the screen shown in Fig. 3.3 on page 11.

h = ... [1]

(ii) Calculate the value of $\frac{1}{h}$.

Give your answer to 2 significant figures.

$\frac{1}{h}$ = ... [1]

Add your values for h and $\frac{1}{h}$ to Table 3.1.

(c) The student repeats **(b)** for different values of u.

He records all his readings in Table 3.1.

Table 3.1

u/cm	h	$\frac{1}{h}$ .....
20.0		
25.0	3.9	
30.0	2.6	
40.0	1.6	
50.0	1.1	

(i) Complete the headers by adding appropriate units. [1]

(ii) Calculate the remaining values of $\frac{1}{h}$ and add them to Table 3.1. [1]

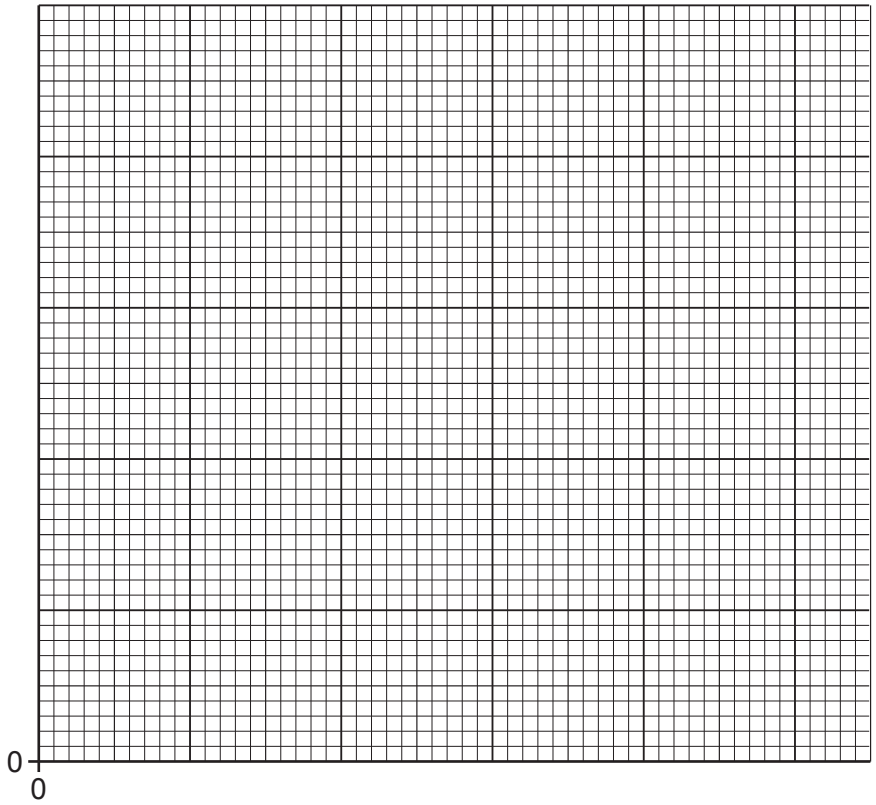
(d) The screen is a square sheet of white card of side 10 cm. Look at the data in Table 3.1 and suggest why the student does not use values of u which are less than 20.0 cm.

.....

..... [1]

(e) On the grid provided, plot a graph of $\frac{1}{h}$ on the y-axis against u on the x-axis.

Start both axes from the origin (0, 0). Draw the straight line of best fit.



[4]

(f) **(i)** Calculate the gradient m of your line. Show all working and indicate on the graph the values you use.

m = ... [2]

(ii) Calculate the focal length f of the lens. Use your value of H from **(a)** and the equation:

$$f = \frac{1}{mH}$$

f = ... cm [1]

(g) When measuring the height of the image on the screen, the student's hand and the ruler obstruct the light from the object and prevent it from reaching the screen.

Suggest **one** improvement to the apparatus used by the student to overcome this problem.

.....

..... [1]

[Total: 14]

4 A student investigates the time taken for ice cubes to melt when they are placed in a beaker of hot water.

Plan an experiment to investigate how the thickness of the cardboard insulation around a beaker affects the time taken for the ice cubes in the beaker to melt.

The following apparatus is available:

250 cm^3 beaker
supply of hot water
supply of ice cubes
thermometer
stopwatch
supply of 2 mm thick cardboard sheets.

In your plan you should:

- 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 the readings
- explain how to use your readings to reach a conclusion.

.....

.....

.....

.....

[6]

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