



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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5054/42

May/June 2023

1 hour

You must answer on the question paper.

No additional materials are needed.

- 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.

- 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 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.

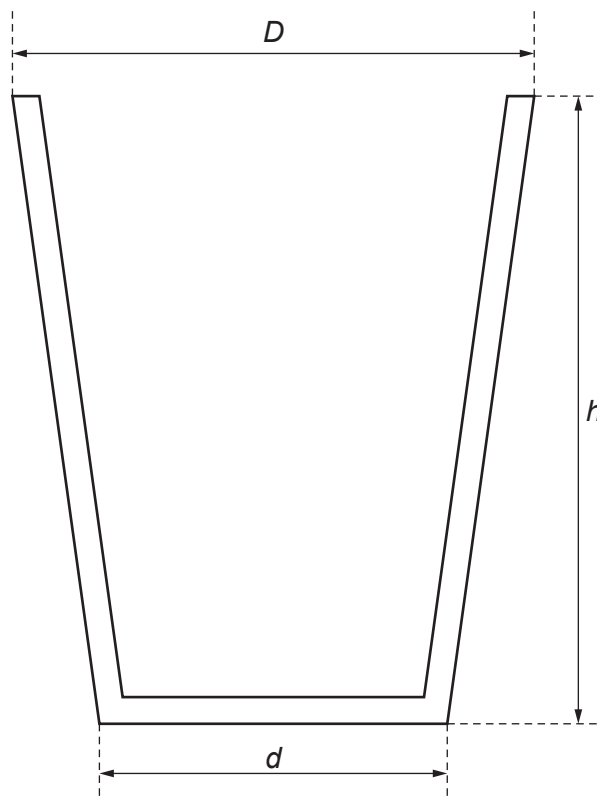


Fig. 1.1

- (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:

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

$$d_A = \dots\dots\dots \text{ cm [1]}$$

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

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

$$V_1 = \dots\dots\dots \text{ cm}^3 \text{ [1]}$$

(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.

$$C = \dots\dots\dots \text{ cm [1]}$$

- (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:

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

$$V_2 = \dots\dots\dots \text{ cm}^3 \text{ [1]}$$

(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 .

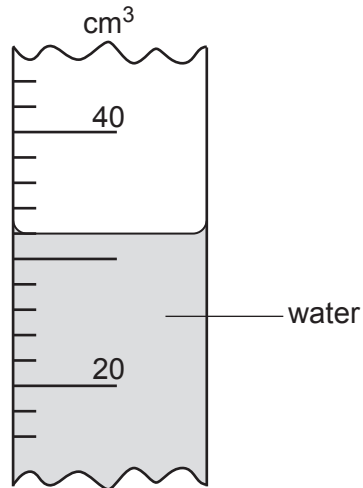


Fig. 1.2

- (i) Write down the new reading R .

$R = \dots\dots\dots \text{ cm}^3$ [1]

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

Show your working.

$V_3 = \dots\dots\dots \text{ cm}^3$ [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.

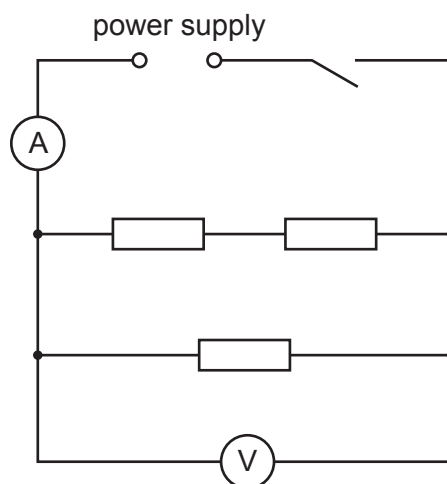


Fig. 2.1

(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.

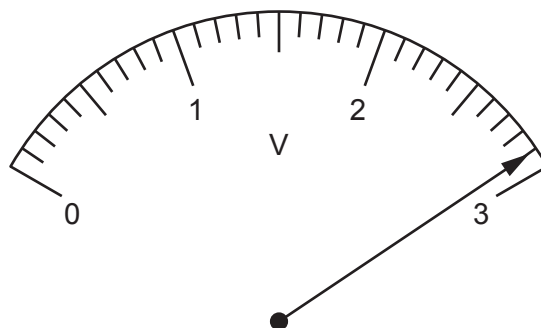


Fig. 2.2

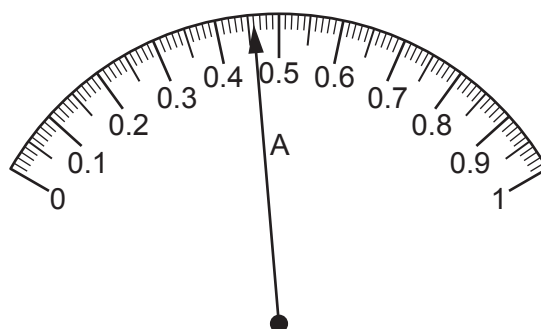


Fig. 2.3

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

$V_1 = \dots\dots\dots$ V

$I_1 = \dots\dots\dots$ A
[2]

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

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

$R_1 = \dots\dots\dots$ 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.

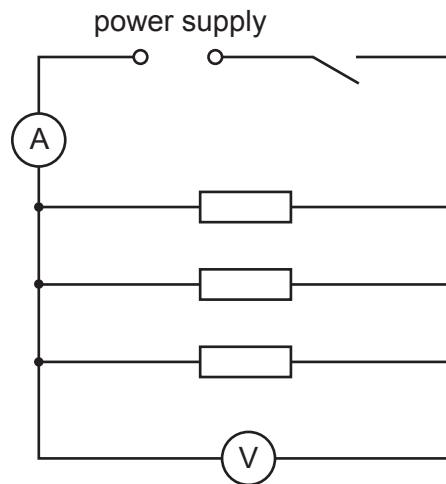


Fig. 2.4

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 $2R_2$

$$R_2 = \dots\dots\dots \Omega$$

$$2R_2 = \dots\dots\dots \Omega$$

[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 5.2Ω .

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

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.

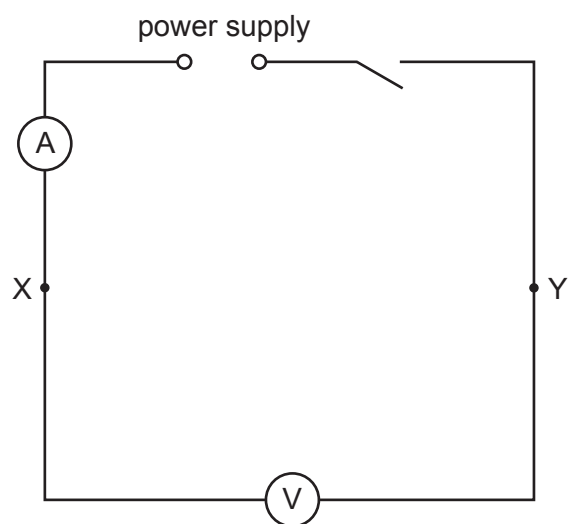


Fig. 2.5

[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.

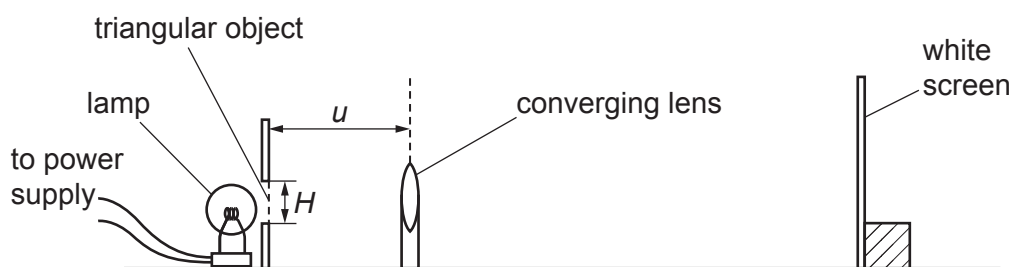


Fig. 3.1 (not to scale)

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

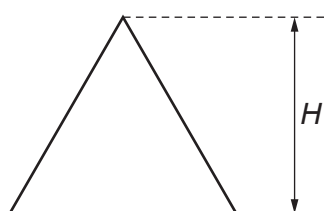


Fig. 3.2

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

$H = \dots\dots\dots$ 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.

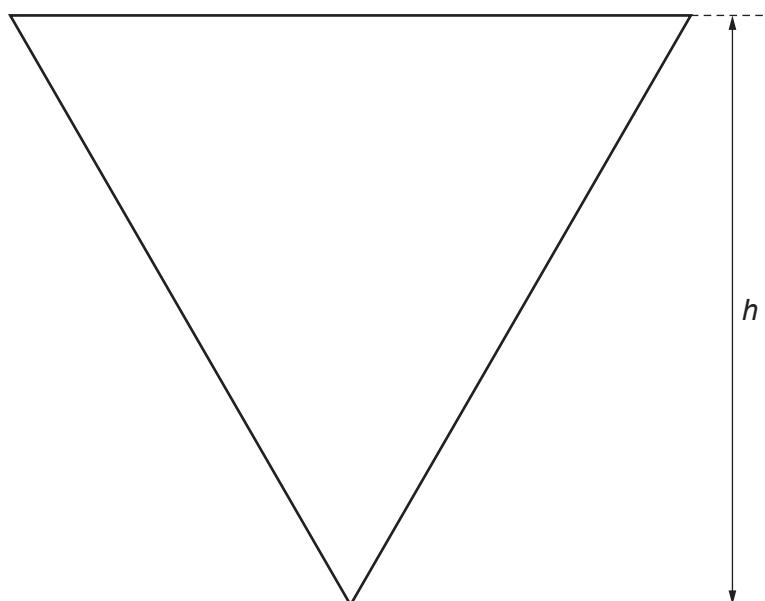


Fig. 3.3

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

$h = \dots\dots\dots$ [1]

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

Give your answer to 2 significant figures.

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

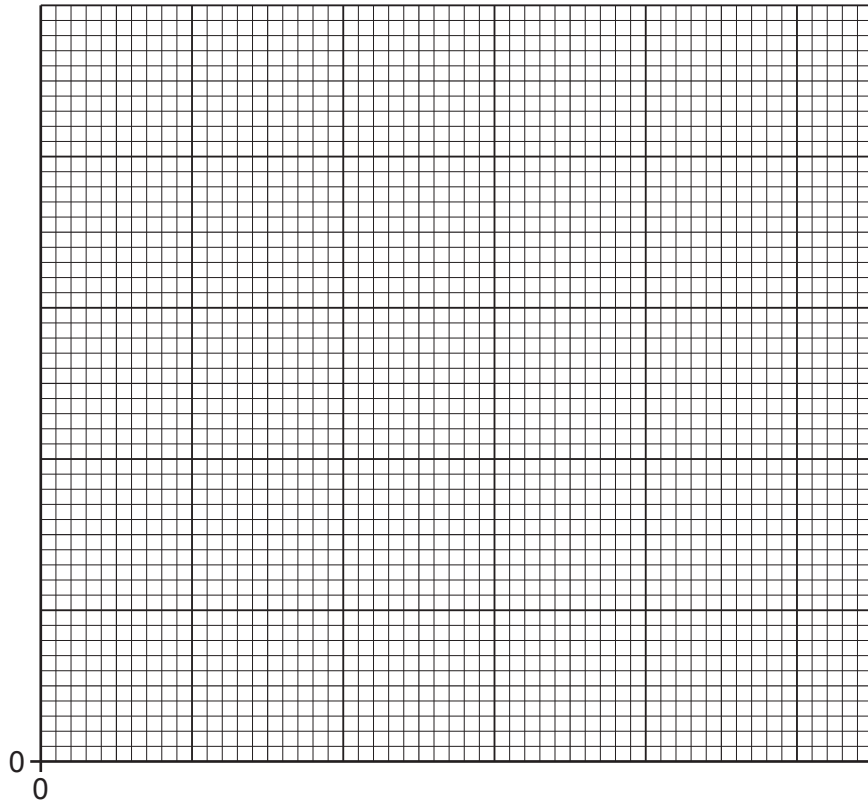
- (ii) Calculate the remaining values of $\frac{1}{h}$ and add them to Table 3.1. [1]

- (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 cm³ 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.

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