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## 0625/53

October/November 2023

**1 hour 15 minutes**

You must answer on the question paper.

You will need: The materials and apparatus listed in the confidential 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.

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].

| For Examiner's Use |  |
|--------------------|--|
| 1                  |  |
| 2                  |  |
| 3                  |  |
| 4                  |  |
| Total              |  |

This document has **12** pages. Any blank pages are indicated.

- 1 In this experiment, you will determine the density of sand by two methods.

Carry out the following instructions, referring to Fig. 1.1 and Fig. 1.2.

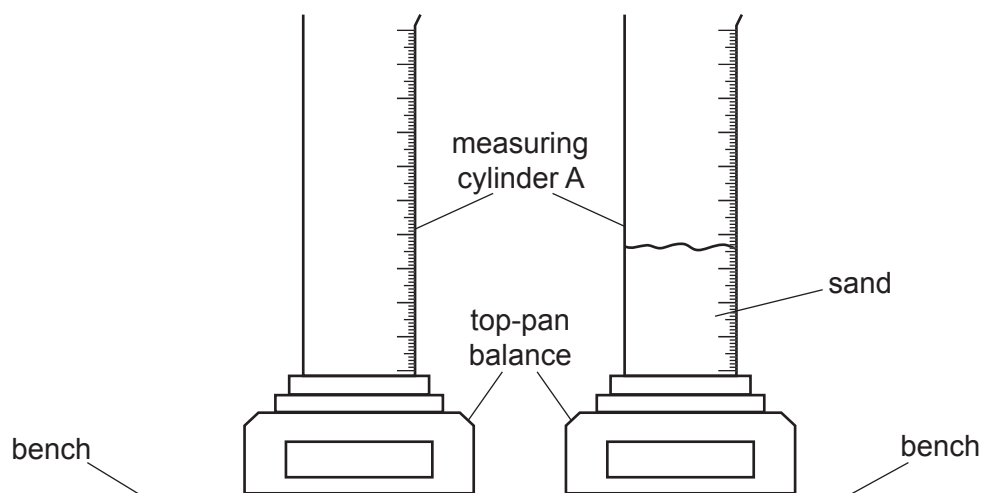


Fig. 1.1

Fig. 1.2

### Method 1

- (a) (i) Measure the mass  $m_1$  of measuring cylinder A using the top-pan balance, as shown in Fig. 1.1.

$$m_1 = \dots \text{ g}$$

Pour approximately  $100 \text{ cm}^3$  of sand into **measuring cylinder A**.

**The sand is to remain in the measuring cylinder for the rest of the experiment.**

Measure the volume  $V_1$  of sand in measuring cylinder A.

$$V_1 = \dots \text{ cm}^3$$

Measure the mass  $m_2$  of measuring cylinder A and the sand using the top-pan balance, as shown in Fig. 1.2.

$$m_2 = \dots \text{ g}$$

Use your values of  $m_1$  and  $m_2$  to calculate the mass  $m_3$  of the sand.

$$m_3 = \dots \text{ g} \quad [2]$$

- (ii) Calculate a value for the density  $\rho_1$  of the sand. Use your values from (a)(i) and the equation  $\rho_1 = \frac{m_3}{V_1}$ . Include a unit.

$$\rho_1 = \dots \quad [2]$$

- (iii) Describe **one** possible source of inaccuracy in the measurements taken in **method 1**. You may assume that all measurements are taken carefully and involve good experimental practice.

.....  
 ..... [1]

## Method 2

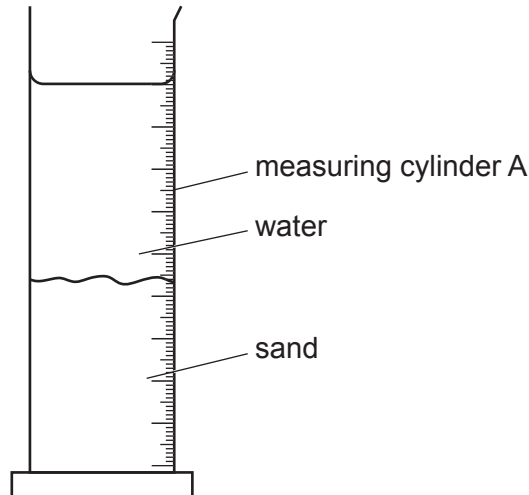


Fig. 1.3

- (b) (i) Pour exactly  $100\text{ cm}^3$  of water into **measuring cylinder B**.

Pour this water into measuring cylinder A, as shown in Fig. 1.3.

Wait until the water level is constant then record the reading  $V_2$  of the water level in measuring cylinder A.

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

- (ii) On Fig. 1.3, draw an arrow showing the correct line of sight for reading the water level in measuring cylinder A. [1]

- (iii) Calculate another value for the density  $\rho_2$  of the sand.

Use your values from (a)(i) and (b)(i) and the equation  $\rho_2 = \frac{m_3}{(V_2 - k)}$ , where  $k = 100\text{ cm}^3$ .

$$\rho_2 = \dots\dots\dots \quad [2]$$

- (c) Another student wants to determine the density of the particles in a sample of sand.

- (i) Explain why **method 1** would **not** be a suitable method for her to use.

.....  
 ..... [1]

- (ii) Explain why **method 2** would give a more accurate value for the density of the particles in the sample of sand.

.....  
 ..... [1]

[Total: 11]

- 2 In this experiment, you will investigate the cooling of hot water in surroundings with different temperatures.

Carry out the following instructions, referring to Fig. 2.1 and Fig. 2.2.

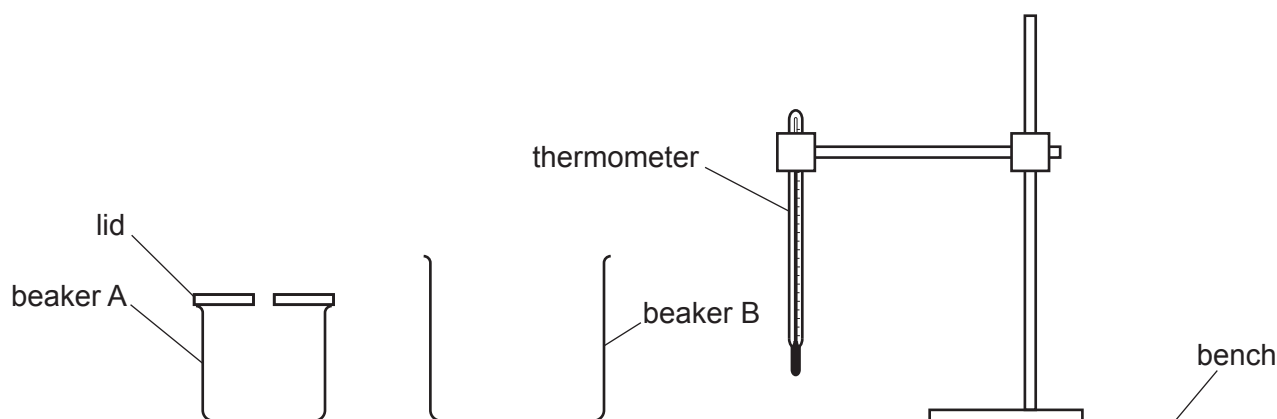


**Fig. 2.1**

- (a) (i) Pour  $100\text{ cm}^3$  of cold water into beaker B.  
Place the thermometer in the water.

Measure, and record in the appropriate column heading of Table 2.1, the temperature  $\theta_1$  of the water. [1]

- (ii) Remove the thermometer from the water in beaker B.  
Remove the lid from beaker A.  
Place beaker A inside beaker B, as shown in Fig. 2.2, so that the water in beaker B rises between the sides of the two beakers.

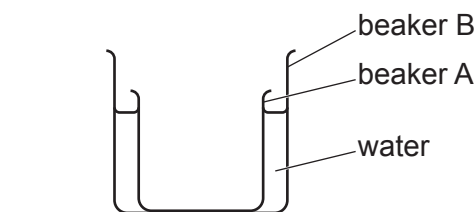


**Fig. 2.2**

Pour  $150\text{ cm}^3$  of hot water into beaker A and replace the lid.  
Place the thermometer in the water in beaker A.

In Table 2.1, record the temperature  $\theta_A$  of the water at time  $t = 0$  and immediately start the stop-watch.

Record the temperature  $\theta_A$  of the water at  $t = 30\text{ s}$ ,  $60\text{ s}$ ,  $90\text{ s}$ ,  $120\text{ s}$ ,  $150\text{ s}$  and  $180\text{ s}$ .

[1]

- (b) (i) Remove the thermometer and lid from beaker A.  
Remove beaker A from beaker B and empty both beakers.

Pour 50 cm<sup>3</sup> of cold water and 50 cm<sup>3</sup> of hot water into beaker B.  
Place the thermometer in the water.

Measure, and record in the appropriate column heading of Table 2.1, the temperature  $\theta_2$  of the water.

[1]

- (ii) Repeat (a)(ii) for this arrangement.

[2]

**Table 2.1**

|              | beaker A<br>in <b>cold</b> water<br>$\theta_1 = \dots\dots\dots^\circ\text{C}$ | beaker A<br>in <b>warm</b> water<br>$\theta_2 = \dots\dots\dots^\circ\text{C}$ |
|--------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| $t/\text{s}$ | $\theta_A/^\circ\text{C}$                                                      | $\theta_A/^\circ\text{C}$                                                      |
| 0            |                                                                                |                                                                                |
| 30           |                                                                                |                                                                                |
| 60           |                                                                                |                                                                                |
| 90           |                                                                                |                                                                                |
| 120          |                                                                                |                                                                                |
| 150          |                                                                                |                                                                                |
| 180          |                                                                                |                                                                                |

- (c) Write a conclusion stating in what way the temperature of the water surrounding beaker A affects the rate of cooling of the hot water in beaker A.  
Justify your answer by reference to values from your readings.

.....  
 .....  
 .....  
 ..... [2]

- (d) Calculate the average cooling rate  $R$  for beaker A cooling in **cold** water. Use your readings for beaker A from Table 2.1 and the equation

$$R = \frac{\theta_{A0} - \theta_{A180}}{T}$$

where  $T = 180\text{ s}$  and  $\theta_{A0}$  and  $\theta_{A180}$  are the temperatures of the water in beaker A at  $t = 0$  and  $t = 180\text{ s}$ . Include the unit for the cooling rate.

$R =$  ..... [2]

- (e) Another student repeats this experiment at the same room temperature.

State **one** other variable that she controls in order to obtain readings as close as possible to your readings.

.....  
 ..... [1]

- (f) During the experiment, the increase in temperature of the water surrounding beaker A affects the results of the investigation.

Suggest **one** change to the experiment to reduce this effect.

.....  
 .....  
 ..... [1]

[Total: 11]

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3 In this experiment, you will determine the focal length of a converging lens.

Carry out the following instructions, referring to Fig. 3.1.

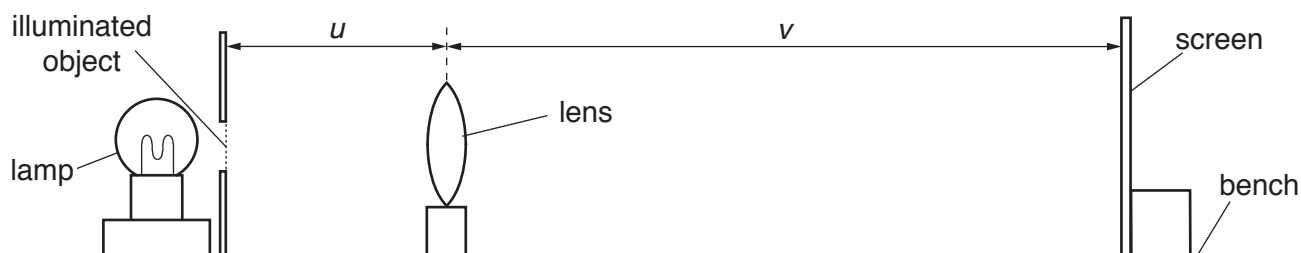


**Fig. 3.1**

- (a) (i) Place the lens a distance  $u = 20.0\text{ cm}$  from the triangular illuminated object.  
Place the screen near the lens.  
Switch on the lamp.  
Move the screen until a clear focused image of the triangular illuminated object is seen on the screen.

Measure, and record in Table 3.1, the distance  $v$  between the lens and the screen.

Repeat the procedure for  $u = 30.0\text{ cm}$ ,  $40.0\text{ cm}$ ,  $50.0\text{ cm}$  and  $60.0\text{ cm}$ .

Switch off the lamp.

**Table 3.1**

| $u/\text{cm}$ | $v/\text{cm}$ | $\frac{u}{v}$ |
|---------------|---------------|---------------|
| 20.0          |               |               |
| 30.0          |               |               |
| 40.0          |               |               |
| 50.0          |               |               |
| 60.0          |               |               |

[2]

- (ii) Describe a technique to obtain an image on the screen that is as sharp as possible in this experiment.

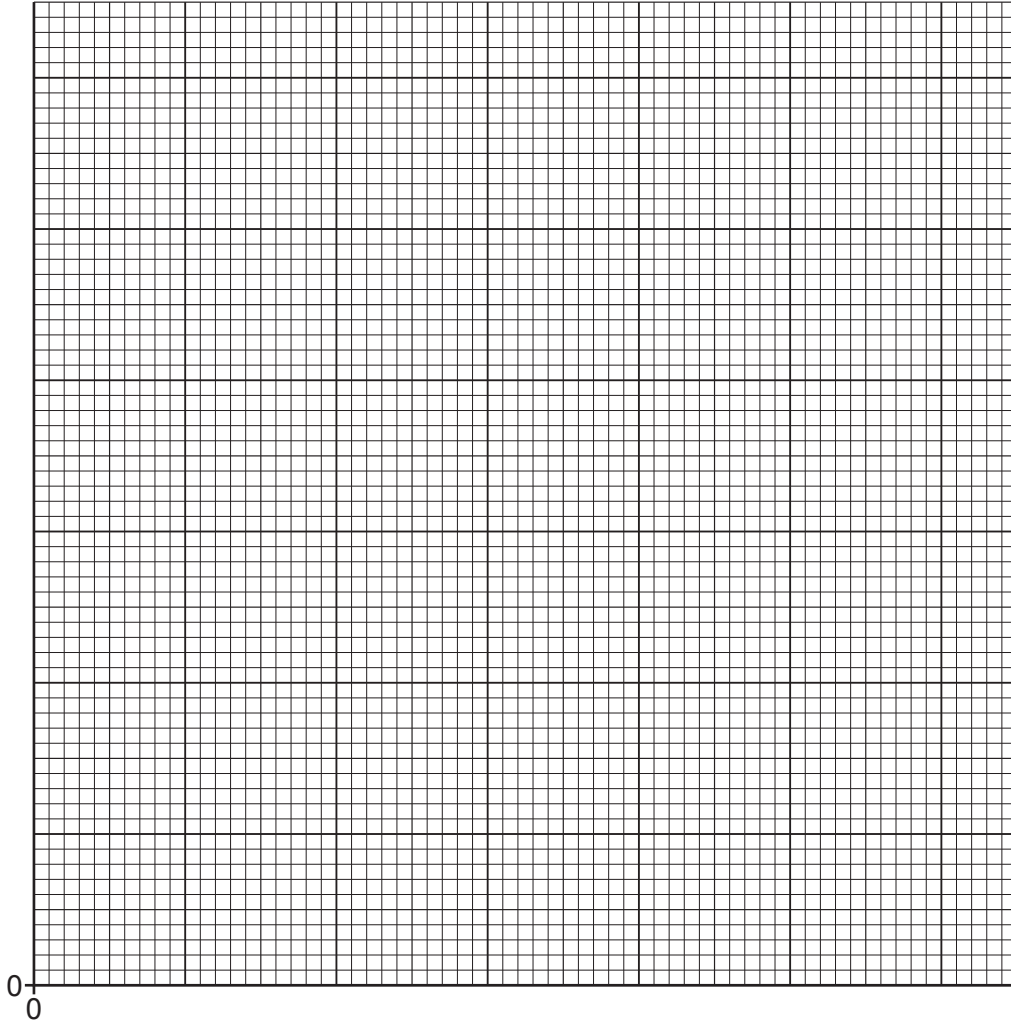
.....

..... [1]

(b) For each distance  $u$ , calculate, and record in Table 3.1, a value for  $\frac{u}{v}$ . [1]

(c) Plot a graph of  $u/\text{cm}$  ( $y$ -axis) against  $\frac{u}{v}$  ( $x$ -axis). Start your graph at the origin (0,0).

Draw the best-fit line.



[4]

(d) (i) Determine the value  $u_0$  of  $u$  when  $\frac{u}{v} = 0$ .

$u_0 = \dots\dots\dots$  [1]

(ii) The gradient of the graph is numerically equal to the focal length  $f$  of the lens.

Determine the value of  $f$  for this experiment.

Show clearly on the graph how you obtained the necessary information to determine the gradient.

$f = \dots\dots\dots$  [2]

[Total: 11]

**[Turn over]**

4 A student investigates the brightness of a lamp.

Plan an experiment to investigate how the intensity (brightness) of the light produced by the lamp is affected by the current in the lamp.

The apparatus available includes:

- a lamp and power supply
- a light meter which measures the intensity of light arriving at it
- an ammeter
- a variable resistor.

You are **not** required to do this experiment.

In your plan, you should:

- complete the circuit diagram in Fig. 4.1 to show the variable resistor connected to control the current in the lamp
- state the key variables to be kept constant
- explain briefly how to do the experiment
- draw a table with column headings, to show how to display the readings (you are **not** required to enter any readings in the table)
- explain how to use the readings to reach a conclusion.

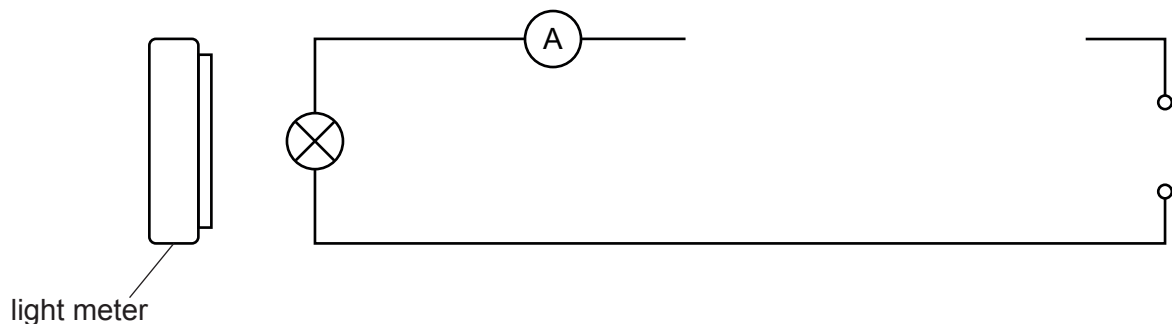


Fig. 4.1



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