Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

9973558067

PHYSICS **5054/41**

Paper 4 Alternative to Practical **October/November 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.

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1 A student determines the speed of a wavefront on the surface of water.

The student fills a plate with water and uses a dropping pipette to let one drop of water fall into the centre of the plate as shown in Fig. 1.1.

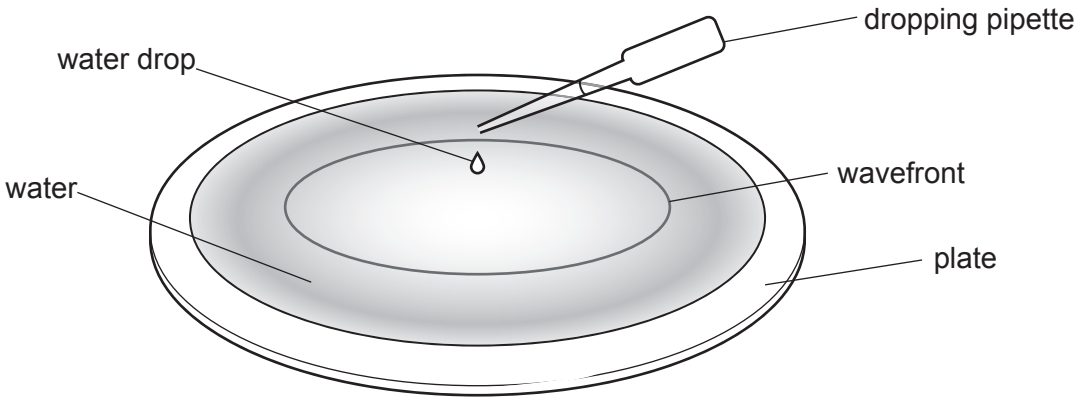


Fig. 1.1

The wavefront that is produced travels outwards to the rim of the plate and then reflects back to the centre.

(a) Fig. 1.2 shows a scale marked on the side of the dropping pipette.

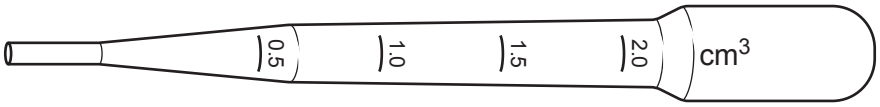


Fig. 1.2

Describe the technique the student uses to put 1.0 cm^3 of water into the dropping pipette.

.....

.....

.....

..... [3]

(b) The student observes the wavefront travel outwards from the centre of the plate and then reflect from the rim back to the centre.

Fig. 1.3 is a side view of the wavefront as it spreads out across the diameter *D* of the plate.

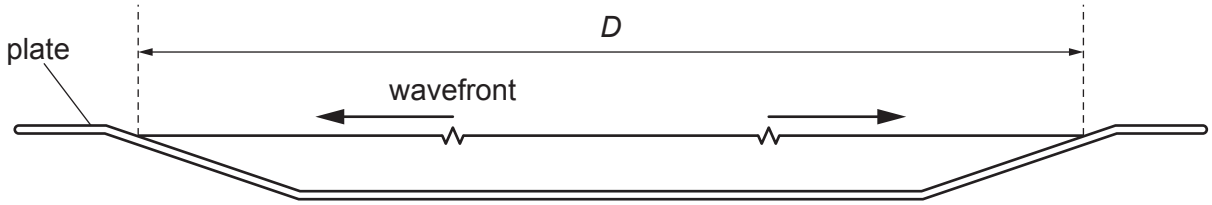


Fig. 1.3 (drawn to a scale of 1:2)

(i) The student uses a stop-watch to measure the time *t* taken for the wavefront to travel outwards from the centre of the plate and then back to the centre.

Fig. 1.4 shows three readings for time *t*.



Fig. 1.4

Use the stop-watch readings in Fig. 1.4 to determine an accurate value for *t*.

Show your working and give your answer to a suitable number of significant figures.

t = ... s [2]

(ii) The speed of the wavefront can be calculated using the equation:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

Fig. 1.3 is drawn to a scale of 1:2. It is half the size of the plate used in the experiment.

Calculate the speed of the wavefront using your answer from **(b)(i)** and a measurement taken from Fig. 1.3.

speed = ... cm / s [2]

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(c) (i) Identify **two** causes of uncertainty in this experiment.

1 .....

.....

.....

2 .....

.....

.....

[2]

(ii) Suggest **one** improvement that could be made to this experiment.

.....

.....

..... [1]

[Total: 10]

2 A student investigates the resistance of a resistance wire.

The circuit used is shown in Fig. 2.1.

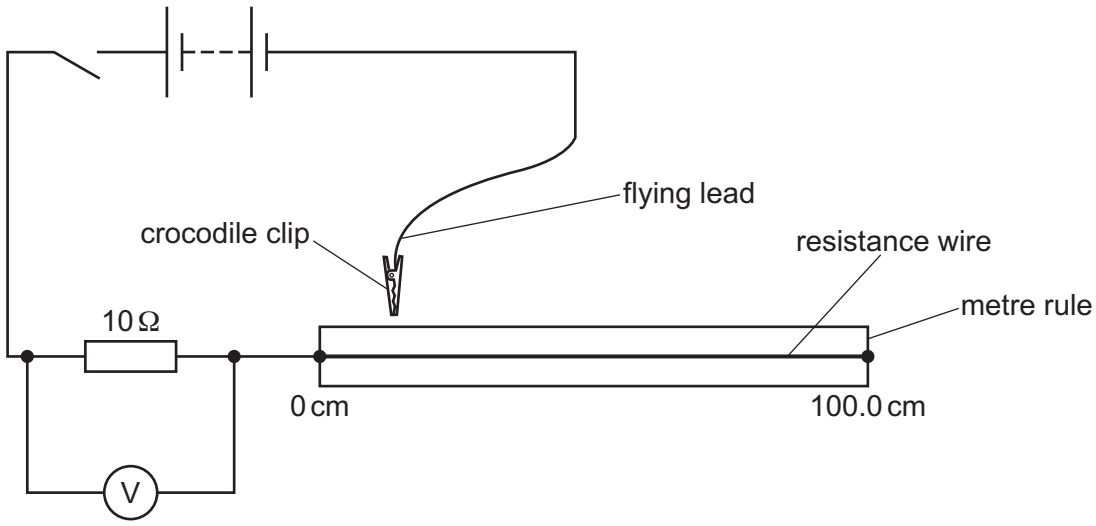


Fig. 2.1

The crocodile clip attached to the flying lead is connected to different points along the length of the resistance wire.

(a) Fig. 2.2 shows the voltmeter when the flying lead is connected to the resistance wire at the 100.0 cm mark on the rule and the switch closed.

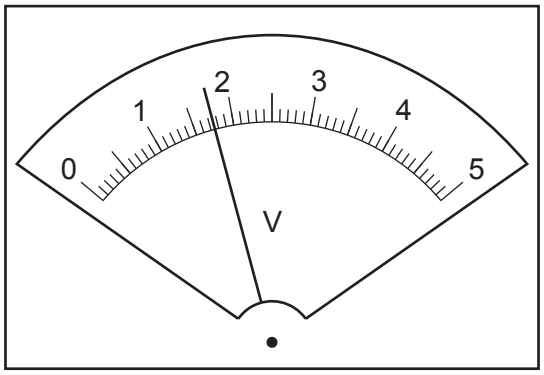


Fig. 2.2

(i) Read the voltage shown in Fig. 2.2 and record the reading in Table 2.1 on page 6. [1]

Table 2.1

L	V	I	$\frac{1}{I}$ .....
100.0			
80.0	2.00		
60.0	2.30		
40.0	2.70		
20.0	3.20		

(ii) Calculate the current I for each length L shown in Table 2.1 using the equation $I = \frac{V}{10}$.

Record your answers in Table 2.1.

Calculate values of $\frac{1}{I}$ for each length L shown in Table 2.1 and record your answers in Table 2.1.

Write the units in the top row of the table. [3]

(b) (i) On the grid on page 7, plot a graph of $\frac{1}{I}$ on the y-axis against L on the x-axis.

Start both axes at the origin (0,0). [2]

(ii) Draw the straight line of best fit. Extend this line to intercept the y-axis. [1]

(iii) Determine the gradient G and y-intercept c of this line.

Show clearly on the graph the values you choose and show your working.

gradient G = ...

y-intercept c = ...
[2]

(c) Theory suggests that:

$$R_w = \frac{1000\,G}{c}$$

where R_w is the resistance of the wire.

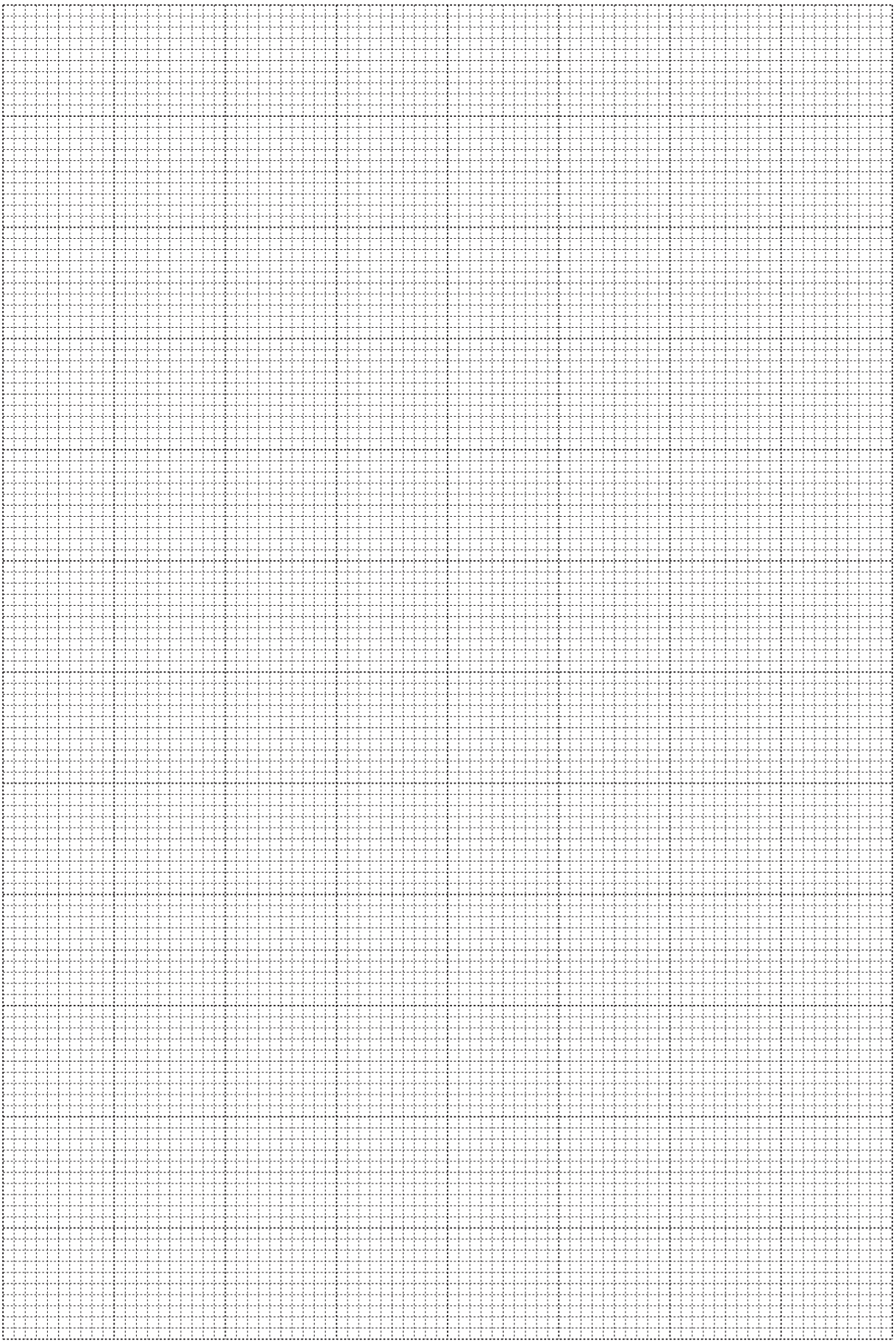
Use your answers in **(b)(iii)** to determine R_w.

Show your working.

R_w = ... Ω [1]

[Total: 10]

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3 A student investigates the indentation made by a glass ball in the surface of modelling clay.

(a) Describe briefly how to use the apparatus in Fig. 3.1 to determine the diameter of the glass ball.

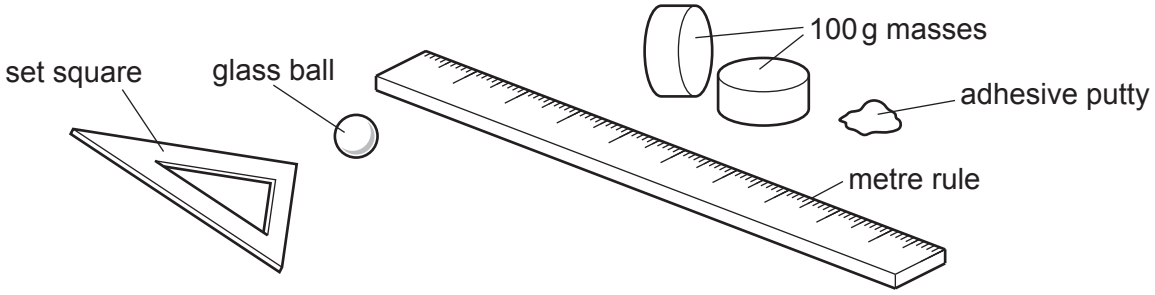


Fig. 3.1

Draw a labelled diagram of the arranged apparatus to help your explanation.

.....

.....

..... [2]

(b) The student uses the glass ball to make an indentation in a piece of modelling clay.

Fig. 3.2 shows the apparatus used.

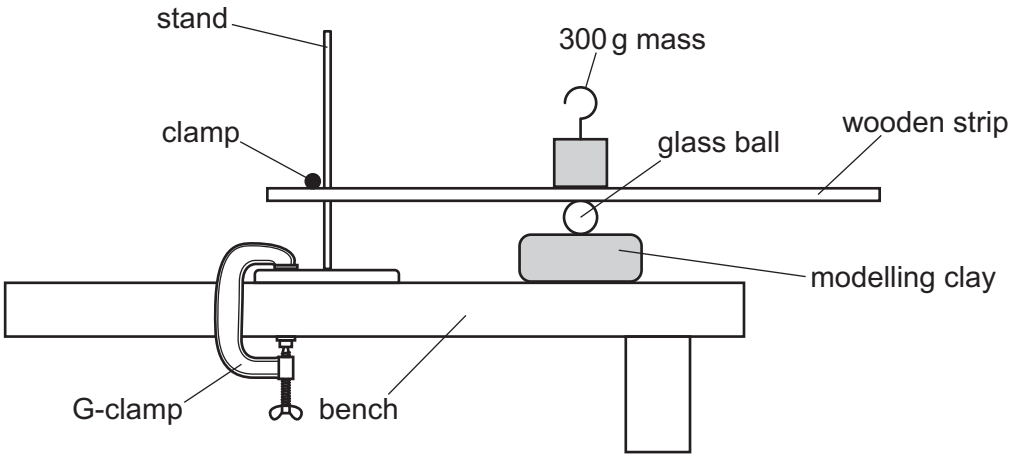


Fig. 3.2

A 300 g mass with weight F_1 = 3.0 N is placed on a wooden strip directly above the glass ball. The mass is left in place for one minute and then removed.

(i) The student repeats the experiment with the ball on a different part of the clay and the 300 g mass hanging at the end of the wooden strip as shown in Fig. 3.3.

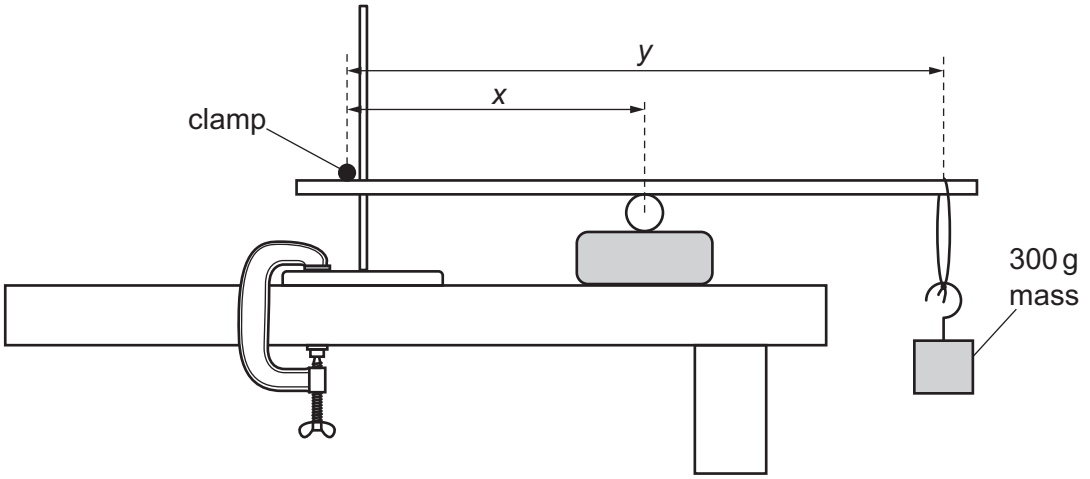


Fig. 3.3 (drawn to a scale of 1:5)

The lengths *x* and *y* in Fig. 3.3 are shown to a scale of 1:5. The actual lengths *X* and *Y* are five times larger.

Measure *x* and *y* on Fig. 3.3.

x on Fig. 3.3 = ... mm

y on Fig. 3.3 = ... mm
[1]

(ii) Calculate the actual lengths *X* and *Y* in metres to the nearest mm.

actual length *X* = ... m

actual length *Y* = ... m
[1]

(iii) Calculate the force F_2, exerted on the clay by the ball, using the equation:

$$F_2 = \frac{3Y}{X}$$

Show your working.

F_2 = ... N [1]

(c) When the ball presses into the surface of the clay, it makes a small circular mark. This mark is called an indentation.

Fig. 3.4 shows the indentations made by the glass ball in the surface of the clay. The indentations are drawn full size.

The smaller indentation is made by the mass positioned as shown in Fig. 3.2. The larger indentation is made by the mass positioned as shown in Fig. 3.3.

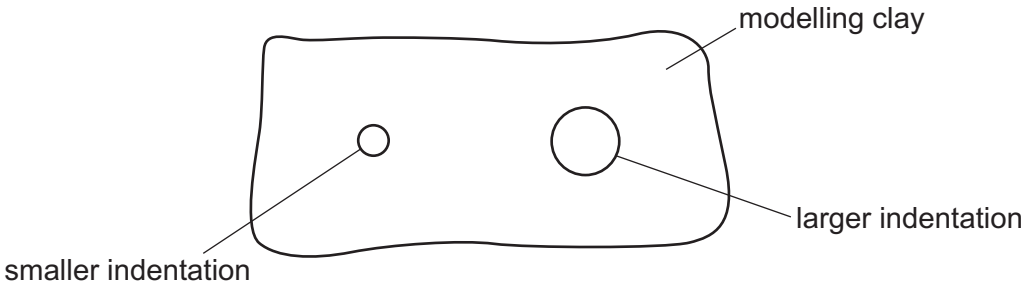


Fig. 3.4 (drawn full size)

Measure and record the diameter of the smaller indentation d_1 and the diameter of the larger indentation d_2.

d_1 = ... mm

d_2 = ... mm
[1]

(d) The graph in Fig. 3.5 shows the relationship between the diameter of the indentation and the surface area of the modelling clay inside the indentation for this glass ball.

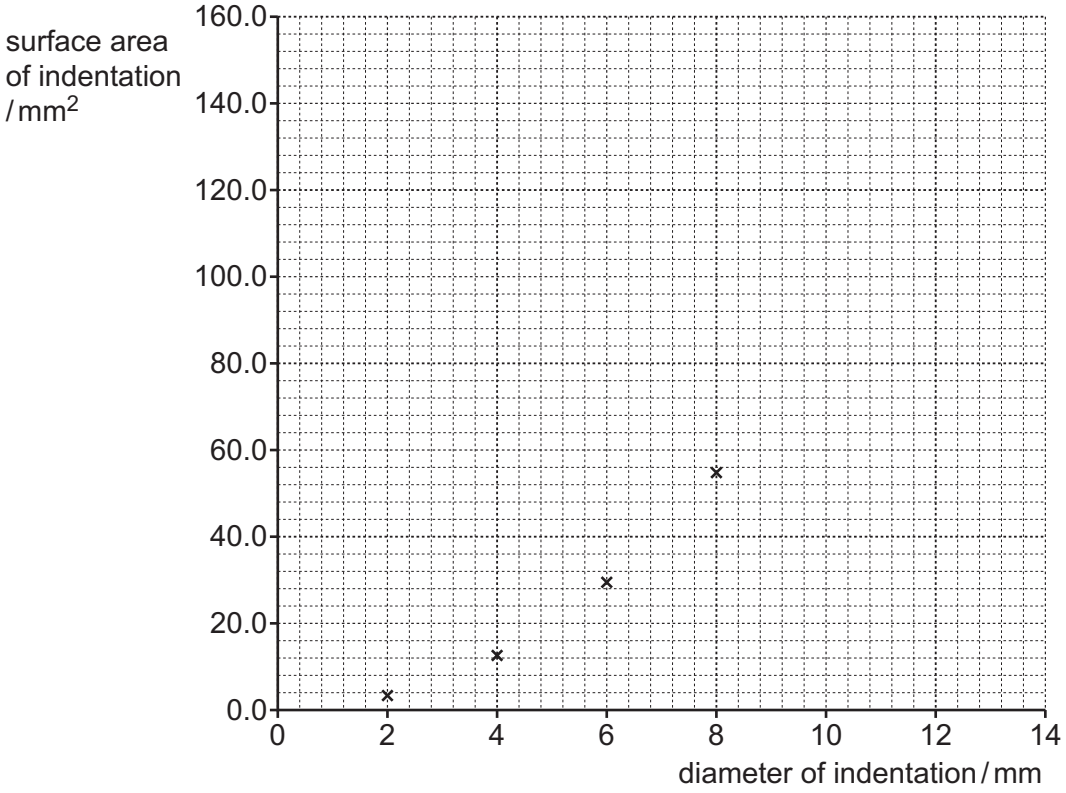


Fig. 3.5

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(i) On Fig. 3.5, plot the data shown in Table 3.1.

Table 3.1

diameter of indentation / mm	surface area of indentation / mm^2
10	90.0
12	141.3

[1]

(ii) On Fig. 3.5, draw the best-fit curve. [1]

(iii) Use Fig. 3.5 to determine the surface areas A_1 and A_2 of the modelling clay inside the indentations with diameters d_1 and d_2 recorded in **(c)**.

Show on your graph how you arrive at your answers.

Area A_1 of the indentation with the diameter d_1 = ... mm^2

Area A_2 of the indentation with the diameter d_2 = ... mm^2

[1]

(e) Another student claims that:

$A_2 = kA_1$ and $F_2 = kF_1$

where k is a constant, $F_1 = 3.0\,\text{N}$ and F_2 is your answer to **(b)(iii)**.

(i) Using your values of F_2, A_1 and A_2 from **(b)(iii)**, and **(d)(iii)**, calculate **two** values of k.

Record your answers to a suitable number of significant figures.

first value of k = ...

second value of k = ...
[2]

(ii) Values of k are assumed to be the same within the limits of experimental accuracy if they are within 10% of each other.

Explain whether these results show that the student's claim is correct.

.....

.....

..... [1]

(f) Students in another laboratory obtain different values of A_1 and A_2 using the same arrangement of the apparatus.

Identify **two** variables that should be controlled to ensure similar values of A_1 and A_2 when using modelling clay.

1 .....

2 .....
[2]

[Total: 14]

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Question 4 starts over the page.

4 A student investigates the factors affecting the bend angle θ of a metal strip.

The student places a thin, straight metal strip on two supports and attaches a mass of weight W to the middle of the strip. The metal strip bends as shown in Fig. 4.1.

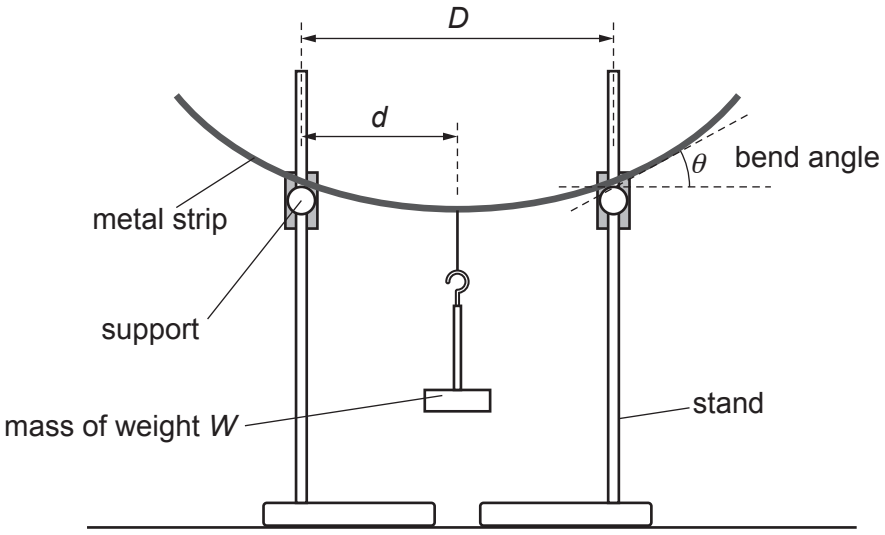


Fig. 4.1

Plan an experiment to investigate **one** variable affecting θ.

In your plan, you should:

- explain briefly how to carry out the investigation, including how you will measure θ
- state the variables to control
- draw a table, or tables, with column headings, to show how to display your readings (you are **not** required to enter any readings in the table)
- explain how to use your readings to reach a conclusion.

You may draw a diagram if you think this will help your plan.

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