# Cambridge O Level

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

**PHYSICS** **5054/31**

Paper 3 Practical Test October/November 2023

**1 hour 30 minutes**

You must answer on the question paper.

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

**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 [ ].

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

This document has **16** pages. Any blank pages are indicated.

**[Turn over**

**1** In this experiment you will determine the speed of a wave on the surface of water.

You are provided with:

- a plate filled with water
- a dropping pipette
- a stop-watch
- a 30 cm ruler
- a small beaker of water
- paper towels to mop up any spillages.

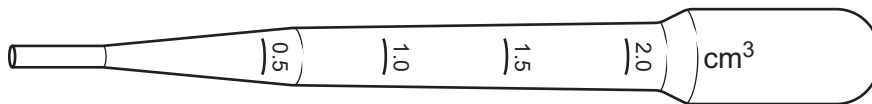**(a)** Fig. 1.1 shows a scale marked on the side of the dropping pipette.



**Fig. 1.1**

Describe the technique you use to put 1.0 cm$^3$ of water into the dropping pipette.

.......................................................................................................................................................

.......................................................................................................................................................

.......................................................................................................................................................

.................................................................................................................................................. [3]

**(b)** Fig. 1.2 shows a wavefront moving outwards from the centre of the plate. The wavefront is produced by **one drop** of water from the dropping pipette.
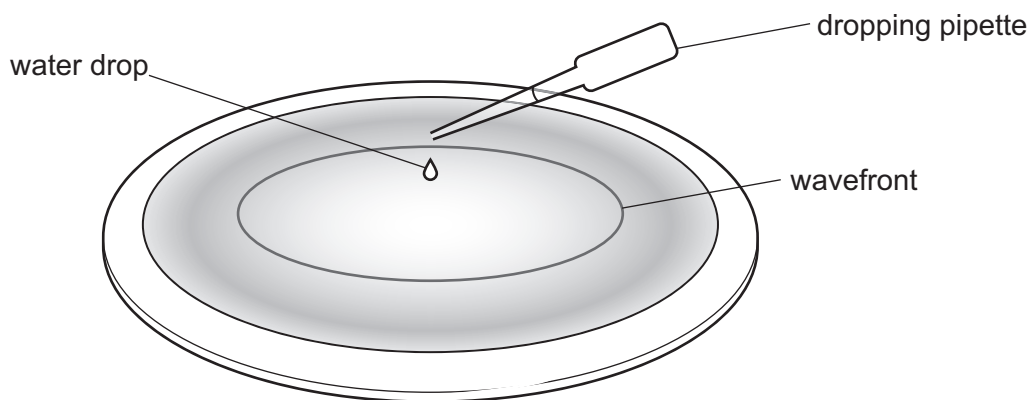


**Fig. 1.2**

Using the dropping pipette, let one drop of water fall into the centre of the plate.

Observe a wavefront travel to the edge of the plate, reflect back to the centre and then travel back out again. The wavefront will move in and out several times.

**(i)** Take measurements to determine an accurate time $t$ for the wavefront to travel **once** from the centre of the plate and back to the centre.

$t$ = ....................................................... s  [2]

**(ii)** Using your answer to **(b)(i)** calculate the speed of the wavefront.

You will need to make and record an additional measurement.

Use the equation:

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

speed = ............................................... cm/s  [2]

**(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]

**4**

**BLANK PAGE**

**2** In this experiment you will investigate the resistance of a resistance wire.

You are provided with:

- a power source
- a length of resistance wire attached to a metre rule
- a resistor of resistance $10\,\Omega$
- a voltmeter
- connecting leads
- a switch
- a flying lead with a crocodile clip at the free end.

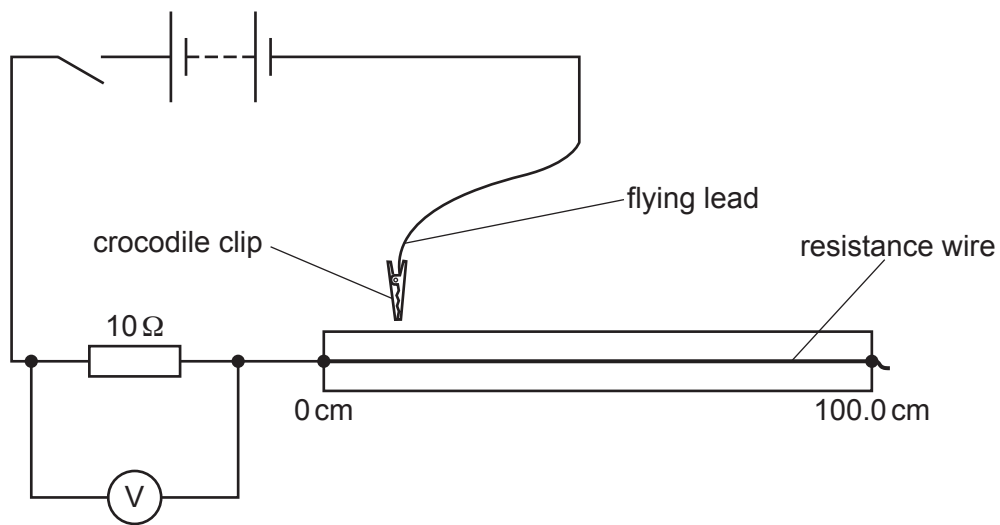The supervisor has assembled the apparatus as shown in Fig. 2.1.



**Fig. 2.1**

The crocodile clip at the end of the flying lead may be connected at different points along the length of the resistance wire.

**(a)** Close the switch.

- Connect the crocodile clip attached to the flying lead to the resistance wire at the 100.0 cm mark on the metre rule.
- Read the voltage $V$ shown on the voltmeter and then remove the crocodile clip from the wire.
- Record in Table 2.1 your reading of voltage $V$.
- Repeat and record $V$ for lengths $L$ = 80.0 cm, 60.0 cm, 40.0 cm and 20.0 cm of the resistance wire.

Remove the crocodile clip from the wire between each reading. Open the switch after you have recorded $V$ for all lengths $L$.

**Table 2.1**

| $L$ ........ | $V$ ........ | $I$ ........ | $\frac{1}{I}$ ........ |
|---|---|---|---|
| 100.0 | | | |
| 80.0 | | | |
| 60.0 | | | |
| 40.0 | | | |
| 20.0 | | | |

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. [4]

**(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 from the origin (0,0). [2]

**(ii)** Draw the straight line of best fit. Extend this line to intercept the $y$-axis. [1]
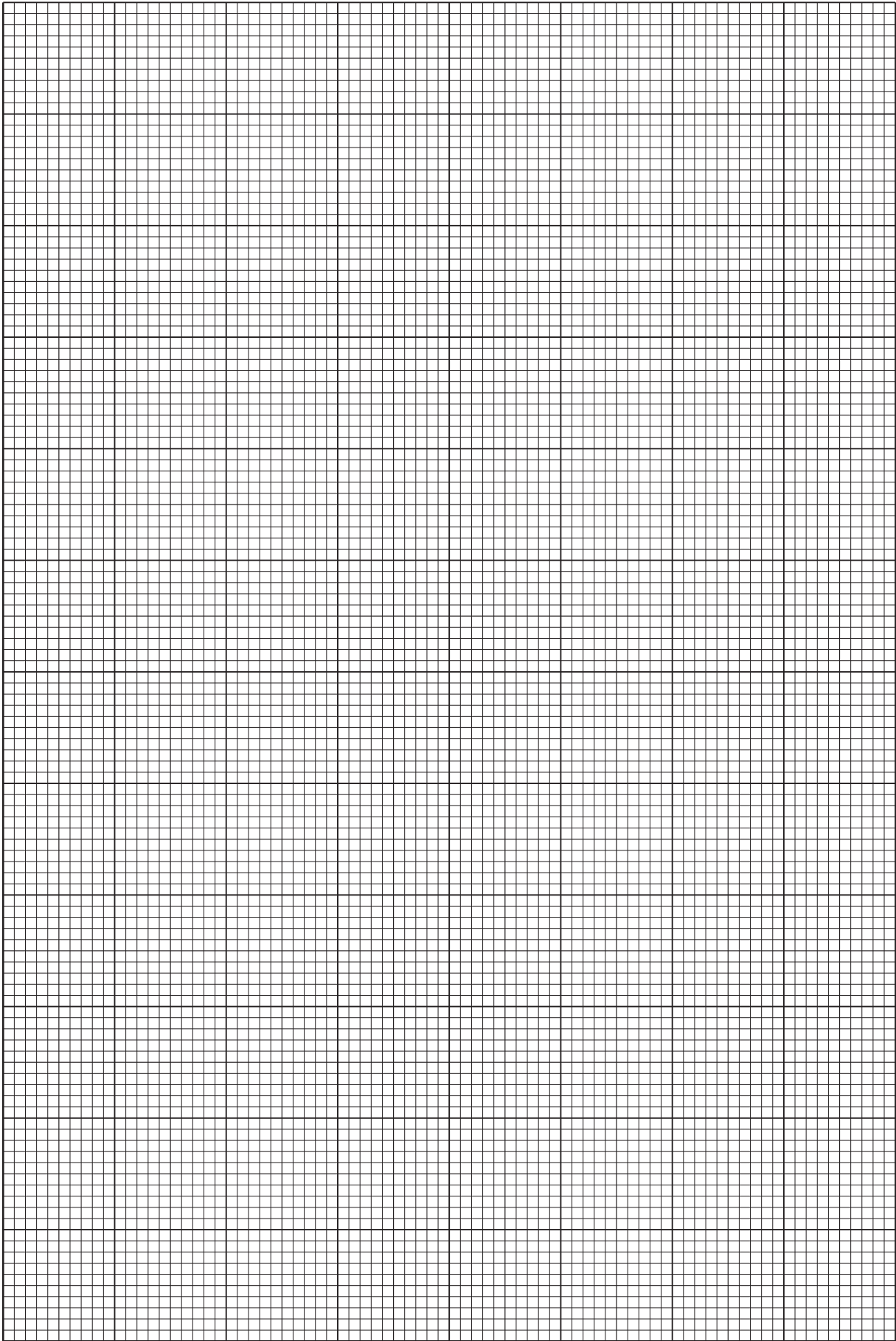
**(iii)** Determine the gradient $G$ and $y$-intercept $c$ of this line.

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 resistance wire.

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

Show your working.

$R_w$ = ........................................................ Ω  [1]

[Total: 10]

**Question 3 starts over the page.**

 **[Turn over**

**3** In this experiment you will investigate the indentation made by a glass ball in the surface of some modelling clay.

You have been provided with:

- a glass ball
- two 100 g masses
- a small lump of adhesive putty
- a metre rule
- a set square.

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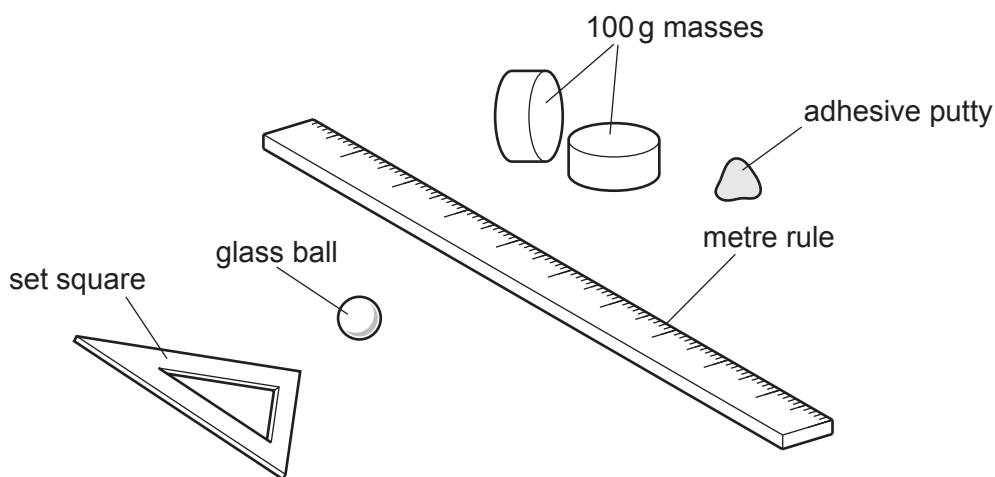


**Fig. 3.1**

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

...........................................................................................................................................

...........................................................................................................................................

...........................................................................................................................................

................................................................................................................................ [3]

**(ii)** Measure and record the diameter $D$ of the glass ball.

$D$ = .................................................. mm [1]

**(b)** You are also provided with:

- a stand, boss, clamp and G-clamp
- a wooden strip
- a piece of modelling clay
- a loop of string
- a 30 cm ruler
- a mass hanger.

The supervisor has clamped the wooden strip. Ensure that the clamp is able to rotate freely in the boss.

- Place the glass ball and the modelling clay between the centre of the wooden strip and the bench as shown in Fig. 3.2.
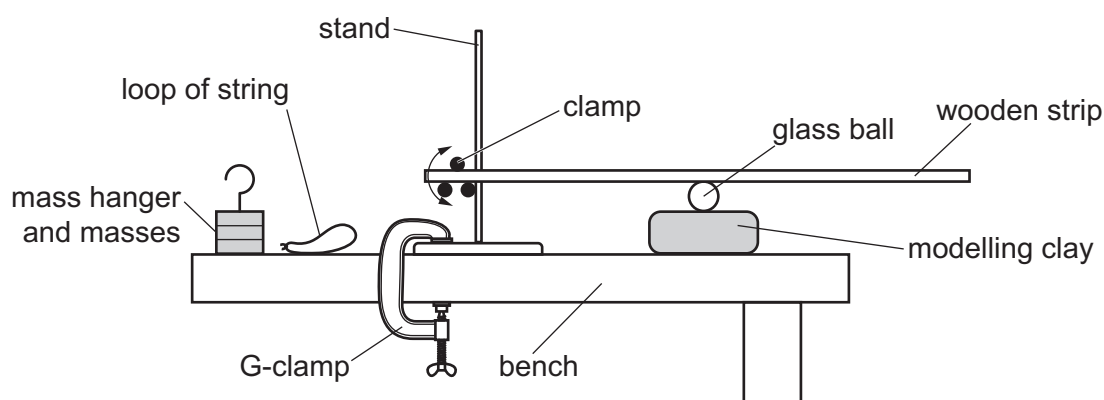


**Fig. 3.2**

- Put the two 100 g masses onto the mass hanger.

The combined weight $F_1$ of the mass hanger and both 100 g masses is 3.0 N.

- Place the mass hanger and masses directly above the glass ball for about one minute.
- Remove the mass hanger and masses.
- Raise the wooden strip and remove the ball from the modelling clay.

Observe a small circle where the ball has been pressed into the surface of the clay. This is an indentation.

**(i)** Measure and record the diameter $d_1$ of the indentation.

$d_1 =$ ................................................... mm [1]

**(ii)** The area of a circle can be calculated using the equation:

$$A = \frac{\pi d^2}{4}$$

where $A$ is the area and $d$ is the diameter of the circle.

Calculate the area $A_1$ of the indentation with diameter $d_1$.

$A_1 =$ ................................................ mm² [1]

**(c) (i)** • Replace the ball on a different part of the modelling clay under the wooden strip.
 • Lower the strip so that it rests on top of the wooden ball.
 • Using the loop of string attach the mass hanger and masses near the end of the wooden strip as shown in Fig. 3.3.

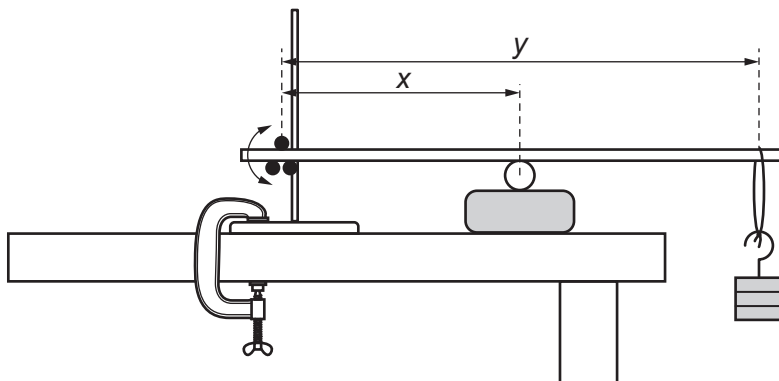Measure and record $x$ and $y$ in metres to the nearest mm.



**Fig. 3.3**

$x$ = .......................................................... m

$y$ = .......................................................... m
[1]

**(ii)** Calculate the force $F_2$ exerted on the modelling clay using the equation:

$$F_2 = \frac{3y}{x}$$

Show your working.

$F_2$ = ...................................................... N  [1]

**(iii)** Measure and record the diameter $d_2$ of the indentation produced by the ball in the clay.

Using the equation in **(b)(ii)**, calculate the area $A_2$ of the circle with diameter $d_2$.

$d_2$ = ...................................................... mm

$A_2$ = ...................................................... mm$^2$
[1]

**(d)** A student claims that:

$A_2 = kA_1$  and  $F_2 = kF_1$

where $k$ is a constant and $F_1 = 3.0\,\text{N}$.

**(i)** Using your values of $F_2$, $A_1$ and $A_2$ from **(c)(ii)**, **(b)(ii)** and **(c)(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]

**(e)** 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]

**4** A student investigates the factors affecting the bend angle $\theta$ 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.
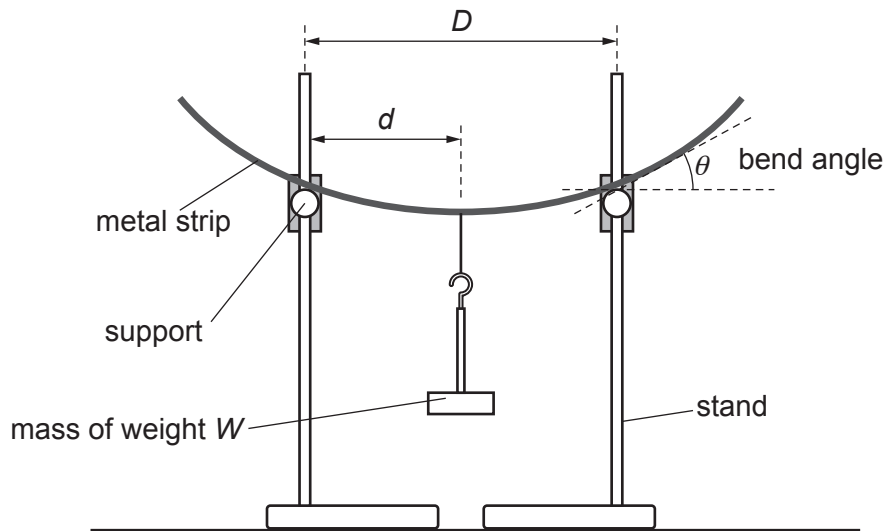


**Fig. 4.1**

Plan an experiment to investigate **one** variable affecting the bend angle $\theta$ shown on Fig. 4.1.

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

In your plan, you should:

- explain briefly how to carry out the investigation, including how you will measure $\theta$
- 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.

..................................................................................................................................................

..................................................................................................................................................

..................................................................................................................................................

[6]

**16**

**BLANK PAGE**