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9702/31

October/November 2010

2 hours

Additional Materials: As listed in the Confidential Instructions.

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
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Answer **both** questions.

You will be allowed to work with the apparatus for a maximum of one hour for each question.

You are expected to record all your observations as soon as these observations are made, and to plan the presentation of the records so that it is not necessary to make a fair copy of them.

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Additional answer paper and graph paper should be used only if it becomes necessary to do so.

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All questions in this paper carry equal marks.

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- 1 In this experiment, you will determine the resistance of an unknown resistor.

You have been supplied with a chain of eight resistors, as shown in Fig. 1.1.

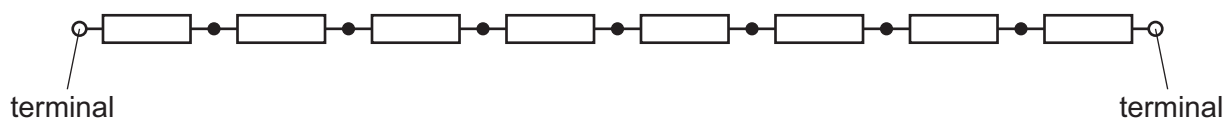


Fig. 1.1

Connection to one or more of the resistors can be made by attaching a crocodile clip between individual resistors.

The resistance of each individual resistor is $1000\ \Omega$.

The formula for the total resistance R of resistors in series is

$$R = R_1 + R_2 + R_3 + \dots$$

- (a) (i) Set up the circuit in Fig. 1.2, with resistor X in the position shown.

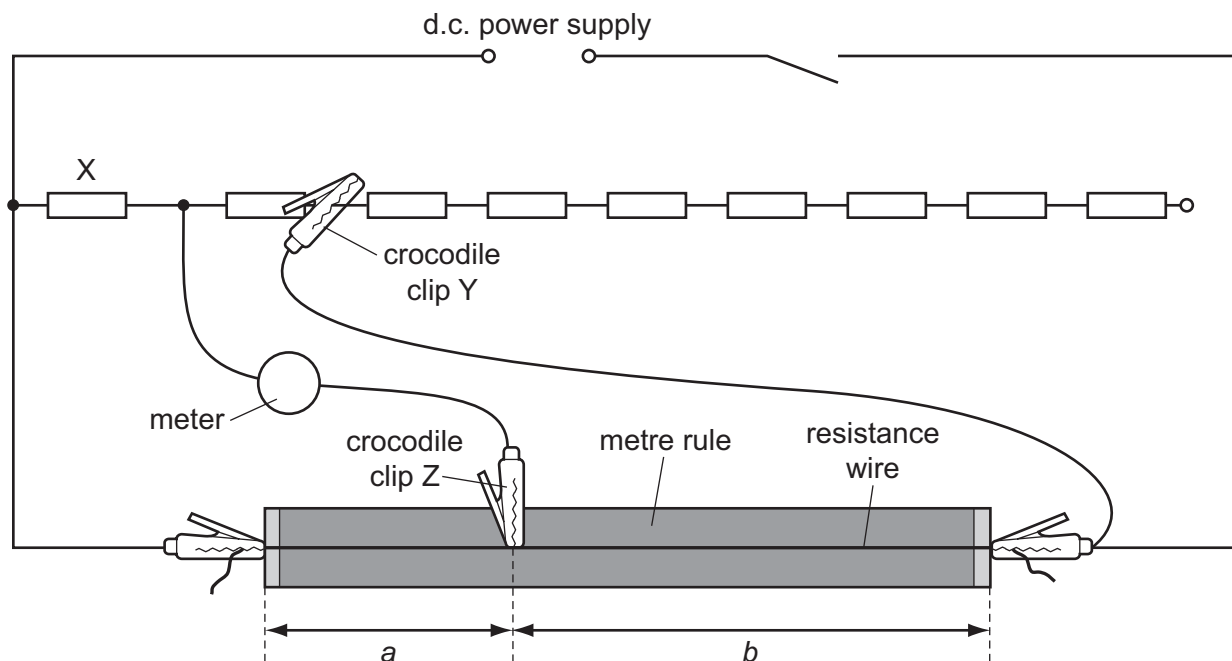


Fig. 1.2

Only the first resistor in the chain is included in the circuit. This has resistance R of $1000\ \Omega$.

- (ii) Place Z on the resistance wire and move Z until the meter reading is zero.

Measure and record lengths a and b .

$a =$

$b =$

- (b)** Vary R by adjusting the position of Y on the chain of resistors.

Repeat **(a)(ii)** until you have six sets of readings of R , a and b .

Include values of $\frac{b}{a}$ in your table of results.

☐

- (c) (i)** Plot a graph of $\frac{b}{a}$ on the y -axis against R on the x -axis.

(ii) Draw the straight line of best fit.

(iii) Determine the gradient of this line.

gradient = ...

☐

- (d) The quantities a , b and R are related by the equation

$$\frac{a}{b} = \frac{X}{R}$$

where X is the resistance of resistor X .

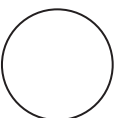
Use your answer in (c)(iii) to determine the value of X .
Give an appropriate unit.

$X =$

☐

- (e) Using your graph, determine the value of R that would be needed for the lengths a and b to be equal to each other.

$R =$

☐
☐


You may not need to use all of the materials provided.

- 2 In this experiment, you will investigate how the motion of two masses connected by a string passing over a pulley depends on the difference between the two masses.

(a) Set up the apparatus with the pulley supported by the clamp. One possible way of doing this is shown in Fig. 2.1.

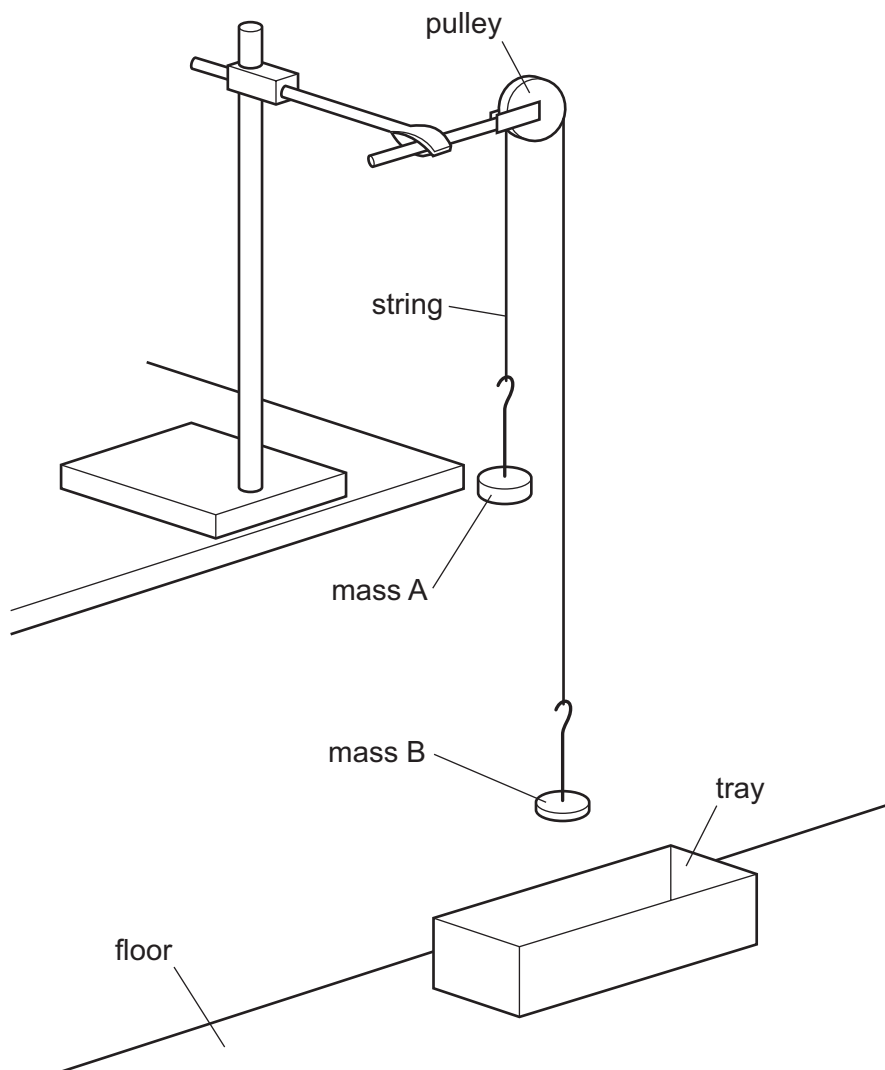


Fig. 2.1

Using the masses and hangers provided, make both the mass m_A of A and the mass m_B of B equal to 100 g. It must be possible to transfer masses **from B to A**.

(b) Adjust the position of the apparatus so that the masses and pulley overhang the bench.

- (c) (i) Adjust the height of the apparatus so that the distance h between the bottom of mass A and the floor is approximately 1 metre, as shown in Fig. 2.2.

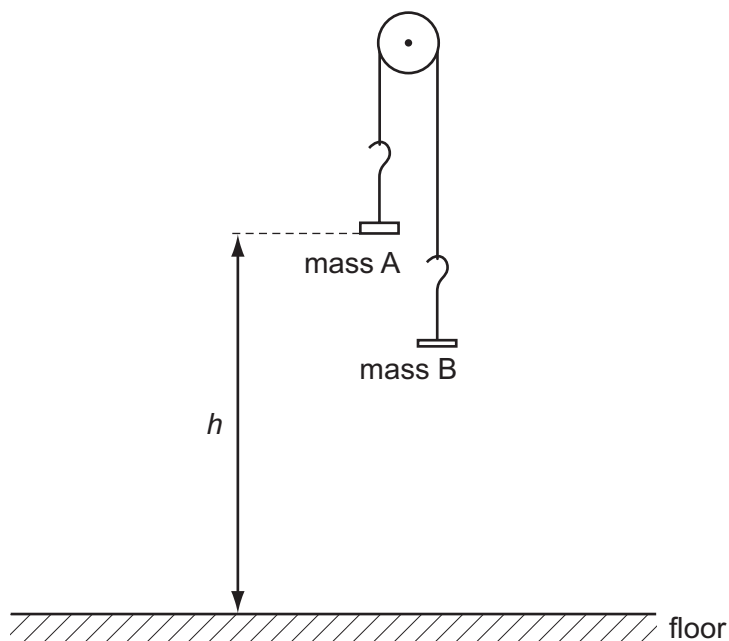


Fig. 2.2

- (ii) Measure and record h .

$h =$

- (d) (i) Transfer 10 g from mass B to mass A.

- (ii) Record the mass m_A of mass A and the mass m_B of mass B.
Calculate the difference in mass ($m_A - m_B$).

$m_A =$

$m_B =$

$(m_A - m_B) =$

- (iii) Release mass A from height h as recorded in (c)(ii) and determine the time t it takes to reach the floor.

$t =$

- (e) Estimate the percentage uncertainty in your value of t .

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percentage uncertainty = ...

- (f) Transfer another 10 g from mass B to mass A and repeat (d)(ii) and (d)(iii).

$m_A =$

$m_B =$

$(m_A - m_B) =$

$t =$

- (g) It is suggested that the relationship between $(m_A - m_B)$ and t is

$$(m_A - m_B) = \frac{k}{t^2}$$

where k is a constant.

- (i) Using your data, calculate two values of k .

first value of $k =$

second value of $k =$

- (ii) Justify the number of significant figures that you have given for your values of k .

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- (iii) Explain whether your results support the suggested relationship.

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(h) (i) Describe four sources of uncertainty or limitations of the procedure in this experiment.

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(ii) Describe four improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

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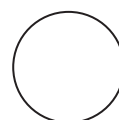
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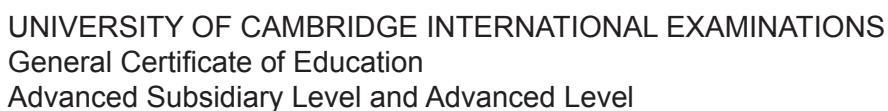
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- 1** In this experiment, you will investigate how the motion of a pendulum bob is affected by the height of the bob above the bench.

(a) (i) Set up the apparatus as shown in Fig. 1.1.

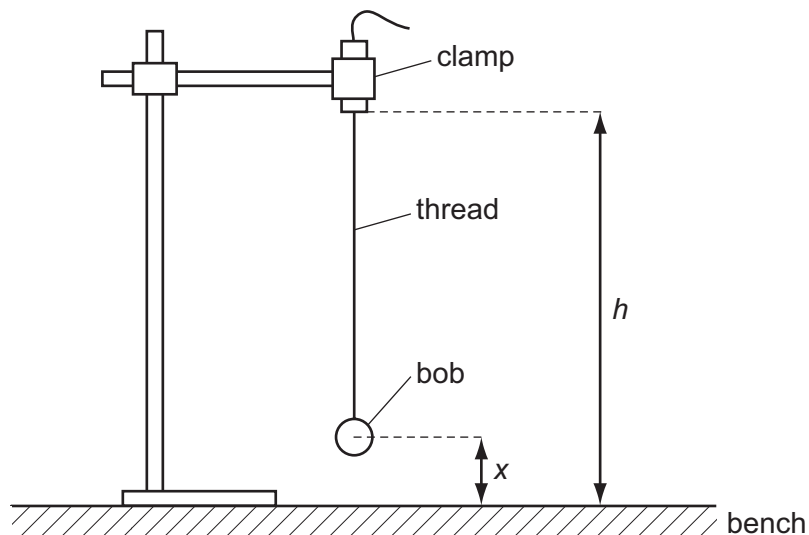


Fig. 1.1

The distance h from the point of suspension to the bench should be as large as possible.

The distance x between the centre of the bob and the bench should be approximately 5 cm.

(ii) Measure and record distance h .

Throughout this experiment, do not change the distance h .

$h =$

(iii) Measure and record distance x .

$x =$



- (b) Displace the bob a small distance to the left. Release the bob and watch the movement.

The time the bob takes for each complete swing, first to the right and then back to the left, as shown in Fig. 1.2, is T .

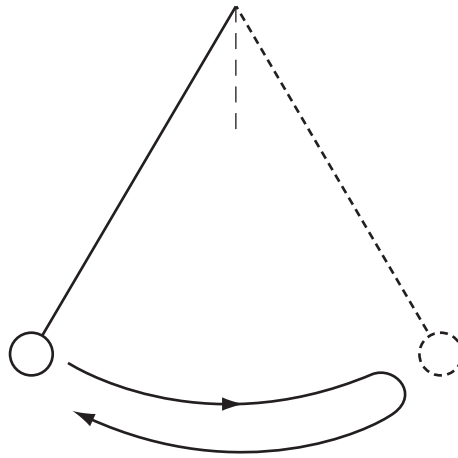


Fig. 1.2

By timing several of these complete swings, determine an accurate value of T .

$T =$



- (c) Keeping h constant, change x and repeat (a)(iii) and (b) until you have six sets of values for x and T . Include values for T^2 in your table of results.

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- (d) (i) Plot a graph of T^2 on the y -axis against x on the x -axis.
- (ii) Draw the straight line of best fit.
- (iii) Determine the gradient and y -intercept of this line of best fit.

gradient = ...

y -intercept = ...

- (e) The quantities T and x are related by the equation

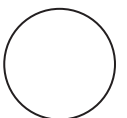
$$T^2 = A - Bx$$

where A and B are constants.

Use your answers to (d)(iii) to determine the value of $\frac{A}{B}$.

Give an appropriate unit.

$$\frac{A}{B} = \dots\dots\dots$$



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- 2 In this experiment, you will investigate how the potential difference across a current-carrying wire depends on its diameter.

(a) Measure and record the diameter d of wire A.

$d =$

- (b) Connect the circuit shown in Fig. 2.1. The wire A should be connected into the circuit using crocodile clips placed close to the ends of the wire.

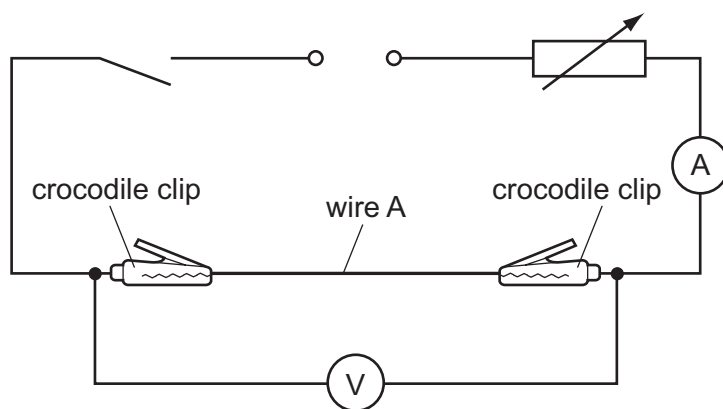


Fig. 2.1

- (c) (i) Measure and record the length L of wire between the crocodile clips.

$L =$

- (ii) Estimate the percentage uncertainty in your value of L .

percentage uncertainty = ...

- (d) (i) Close the switch. Adjust the variable resistor until the current is close to 90 mA. Record this current I .

$I =$

- (ii) Record the voltmeter reading V and then open the switch.

$V =$

☐

- (e) Measure and record the diameter d of wire B.

$d =$

☐

- (f) (i) In the circuit, replace wire A with wire B, maintaining the same length L of wire between the crocodile clips as in (c)(i).

- (ii) Close the switch. Adjust I to the same value as in (d)(i). Record V and then open the switch.

$V =$

☐
☐

- (g) It is suggested that the relationship between V , L and d is

$$V = \frac{kL}{d^2}$$

where k is a constant.

- (i) Using your data, calculate two values of k .

value of k for wire A = ...

value of k for wire B = ...

☐

- (ii) Justify the number of significant figures that you have given for your values of k .

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- (iii) Explain whether your results support the suggested relationship.

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Question 2 continues on the next page.

(h) (i) Describe four sources of uncertainty or limitations of the procedure in this experiment.

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(ii) Describe four improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

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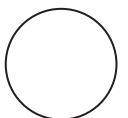
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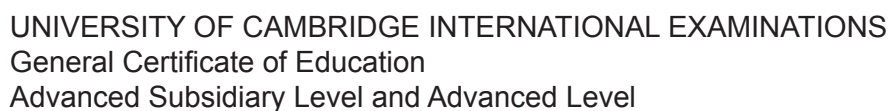
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9702/34

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- 1** In this experiment, you will investigate the equilibrium position of a metre rule that is balanced on a curved surface.

- (a)** Mount the cylinder provided on its side on the board, wedging it with modelling clay, as shown in Fig. 1.1. If the cylinder has a lip, this should hang over the edge of the board, as shown.

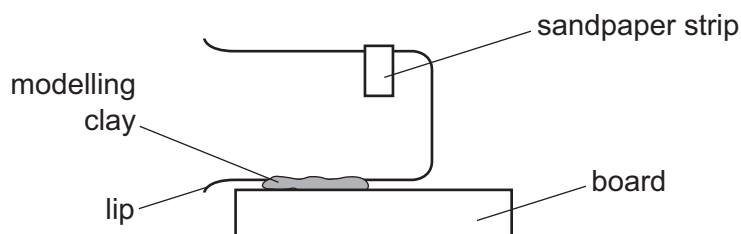


Fig. 1.1 (side view)

Note that the sandpaper strip is on the top of the cylinder.

- (b)** One of the metre rules has a cotton loop, fixed at the 65 cm mark. Balance this metre rule on the sandpaper strip so that it is parallel to the bench, as shown in Fig. 1.2.

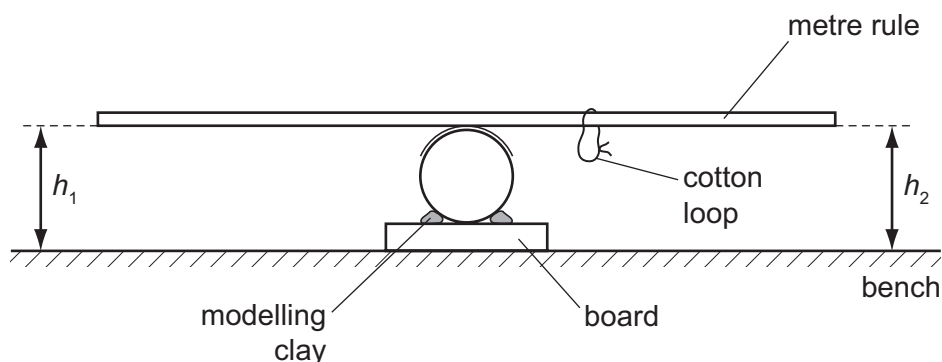


Fig. 1.2 (end view)

- (c)** Measure and record the heights h_1 and h_2 from the bench to the bottom of each end of the metre rule (see Fig. 1.2).

$h_1 = \dots\dots\dots$ cm

$h_2 = \dots\dots\dots$ cm

- (d) (i) Open out three paperclips as shown in Fig. 1.3.

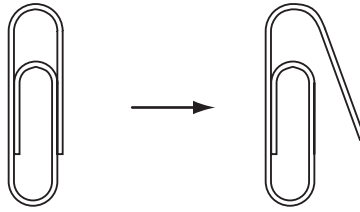


Fig. 1.3

- (ii) Hang the three paperclips from the cotton loop and measure and record h_1 and h_2 .

$h_1 = \dots\dots\dots$ cm

$h_2 = \dots\dots\dots$ cm

- (iii) In (ii), the number n of paperclips was 3.
Now increase n and measure h_1 and h_2 again until you have six sets of values for n , h_1 and h_2 .
Include in your table of results values for $\frac{1}{(h_1 - h_2)}$ and $\frac{1}{n}$.

- (e) (i) Plot a graph of $\frac{1}{(h_1 - h_2)}$ on the y-axis against $\frac{1}{n}$ on the x-axis.

- (ii) Draw the straight line of best fit.

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

gradient = $\dots\dots\dots$

y-intercept = $\dots\dots\dots$

- (f) It is suggested that the relationship between h_1 , h_2 and n is

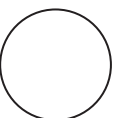
$$\frac{1}{(h_1 - h_2)} = \frac{a}{n} + b$$

where a and b are constants.

Using your answers from (e)(iii), determine the values of a and b . Give appropriate units.

$a =$

$b =$



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Please turn over for Question 2.

You may not need to use all of the materials provided.

- 2** In this experiment, you will investigate water flow through a hole in a container.

You are provided with a transparent plastic bottle with a small hole drilled in its base and with labels marking two positions P and Q.

The apparatus has been set up for you as shown in Fig. 2.1.

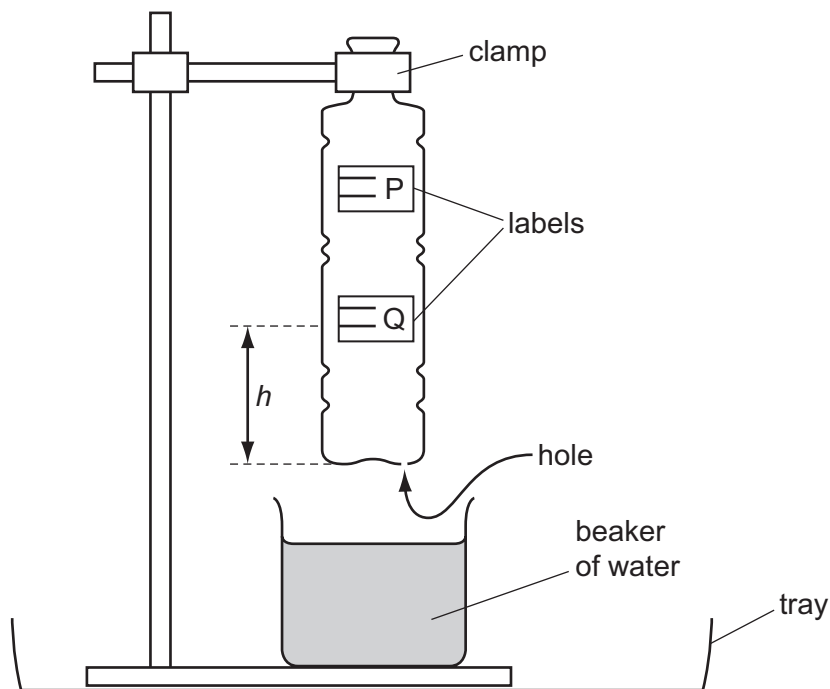


Fig. 2.1

- (a) (i)** Remove the bottle from the clamp and measure the diameter d of the bottle at position Q.

$d = \dots\dots\dots$ cm

- (ii)** Calculate the cross-sectional area A of the bottle at position Q, using the relationship

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

$A = \dots\dots\dots$ cm²

- (b) On the label at position Q, there are two horizontal lines, as shown in Fig. 2.2.

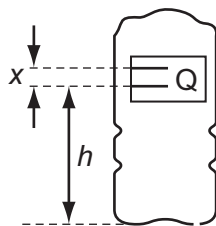


Fig. 2.2

- (i) Measure and record the distance x between the lines at position Q.

$x = \dots\dots\dots$ cm

- (ii) Estimate the percentage uncertainty in x .

percentage uncertainty = $\dots\dots\dots$

- (c) (i) Calculate the volume V of the bottle between the lines at position Q using the relationship $V = Ax$.

$V = \dots\dots\dots$ cm³

- (ii) Measure and record the distance h between the base of the bottle and the lower line at position Q.

$h = \dots\dots\dots$ cm

- (d) (i) Locate the small hole in the base of the bottle.

- (ii) Replace the bottle in the clamp as in Fig. 2.1.

Cover the hole in the base of the bottle with your finger and then add water to the bottle so that the water level is just above the lines at position Q.
Replace the beaker under the bottle.

- (iii) Remove your finger so that water flows into the beaker and measure the time it takes for the water level to drop between the two lines at position Q.
Record this time t .

$t = \dots\dots\dots$ s

- (iv) Calculate the flow rate R , using the relationship $R = \frac{V}{t}$. Give an appropriate unit.

$R = \dots\dots\dots$

- (e) (i) Remove the bottle from the clamp and repeat (b)(i) and (c) for the lines at position P, using your value of cross-sectional area from (a)(ii).

$x = \dots\dots\dots$ cm

$V = \dots\dots\dots$ cm³

$h = \dots\dots\dots$ cm

☐

- (ii) Repeat (d) for the lines at position P.

$t = \dots\dots\dots$ s

$R = \dots\dots\dots$

☐

- (f) (i) It is suggested that the relationship between R and h is

$$R = kh$$

where k is a constant.

Using your data, calculate two values of k .

k for position Q = $\dots\dots\dots$

k for position P = $\dots\dots\dots$

☐

- (ii) Explain whether your results support the suggested relationship.

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(g) (i) Describe four sources of uncertainty or limitations of the procedure in this experiment.

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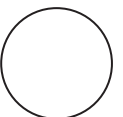
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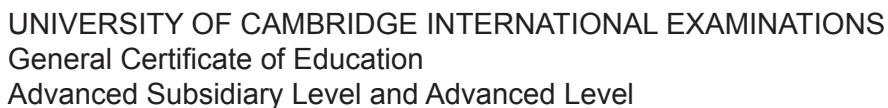
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- 1** In this experiment, you will determine the resistivity of a metal in the form of a wire.

- (a) (i)** Measure and record the diameter d of the short sample of wire that is attached to the card. You may remove the wire from the card.

$d = \dots\dots\dots$

- (ii)** Calculate the cross-sectional area A of the wire using the formula

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

$A = \dots\dots\dots$

- (b) (i)** Set up the circuit shown in Fig. 1.1 and close the switch.

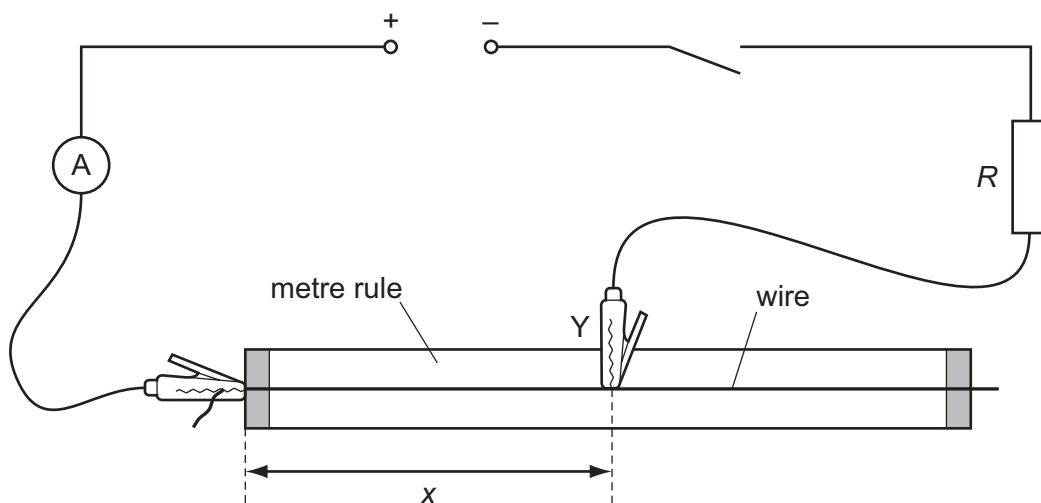


Fig. 1.1

- (ii)** Position the crocodile clip labelled 'Y' half-way along the wire.
- (iii)** Measure and record the distance x of wire between the two crocodile clips, and the ammeter reading I .

$x = \dots\dots\dots$

$I = \dots\dots\dots$

(c) Change x and repeat (b)(iii) until you have six sets of readings of x and I .

Include values of $\frac{1}{I}$ in your table.

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(d) (i) Plot a graph of $\frac{1}{I}$ on the y -axis against x on the x -axis.

(ii) Draw the straight line of best fit.

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

gradient = ...

y -intercept = ...

- (e) The quantities I and x are related by the equation

$$\frac{1}{I} = Mx + N$$

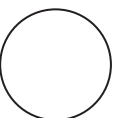
where M and N are constants and

$$\frac{M}{N} = \frac{\rho}{AR}$$

where ρ is the resistivity of the material of the wire and the resistance R of the fixed resistor is given on a card.

Use your answers in (a)(ii) and (d)(iii) to determine a value for ρ .

$\rho = \dots\dots\dots$



You may not need to use all of the materials provided.

2 In this experiment, you will investigate the equilibrium of a wooden strip.

(a) (i) Attach masses to the apparatus as shown in Fig. 2.1.

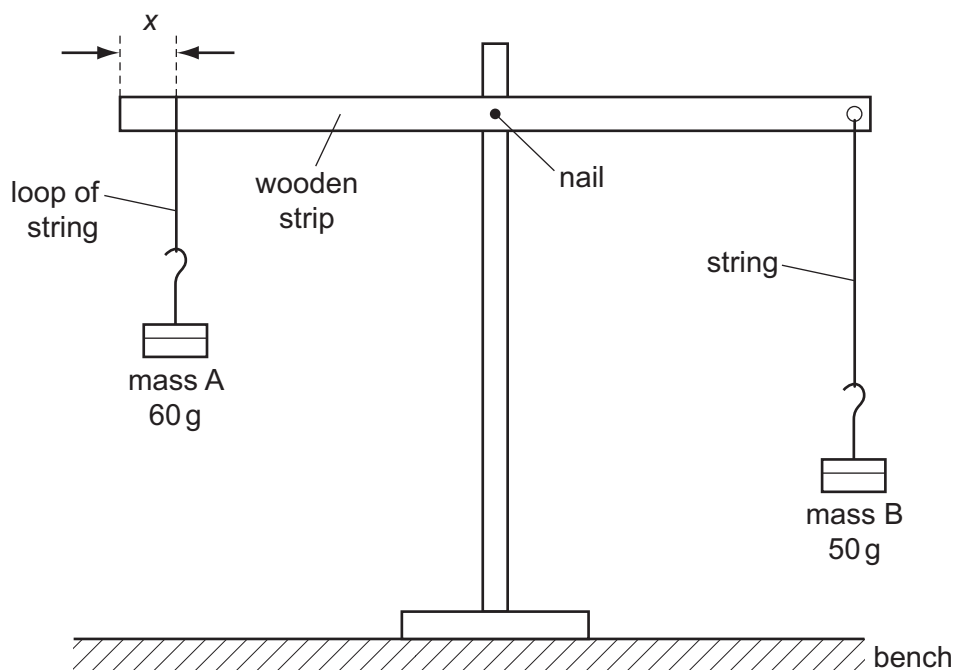


Fig. 2.1

Mass A is suspended from the wooden strip using the loop of string. The distance between this loop and the nearest end of the wooden strip is x .

(ii) Change x until the wooden strip is balanced and approximately parallel to the bench. Measure and record x .

$x =$



- (b) (i) Remove both masses. Thread the string for mass B over the pulley, and then attach the masses again, as shown in Fig. 2.2.

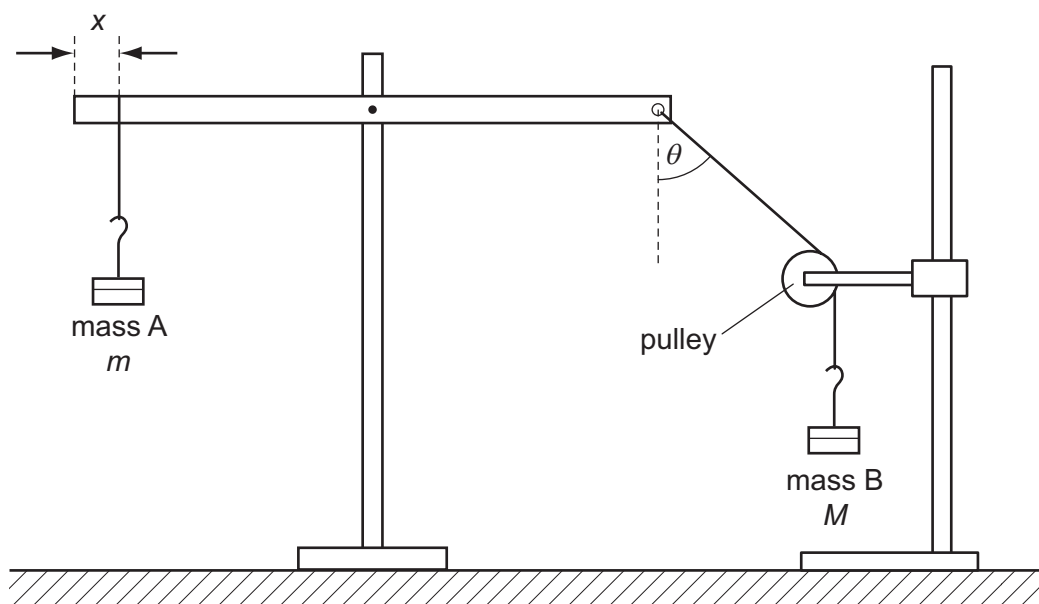


Fig. 2.2

- (ii) Transfer 10 g from mass A to mass B.
- (iii) With x at the same value as in (a)(ii), adjust the position of the pulley until the wooden strip is parallel to the bench. Measure and record the angle θ that the string for mass B makes with the vertical, as shown in Fig. 2.2.

$\theta =$

- (iv) Estimate the percentage uncertainty in your value of θ .

percentage uncertainty = ...

- (v) Record the mass m of mass A and the mass M of mass B.

$m =$

$M =$

- (vi) Calculate $\frac{m}{M}$.

$\frac{m}{M} =$

- (c) Transfer another 10 g from mass A to mass B. Repeat (b)(iii), (b)(v) and (b)(vi).

$\theta =$

$m =$

$M =$

$\frac{m}{M} =$

- (d) It is suggested that the relationship between m , M and θ is

$$\cos \theta = k \frac{m}{M}$$

where k is a constant.

- (i) Using your data, calculate two values of k .

first value of $k =$

second value of $k =$

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- (ii) Justify the number of significant figures that you have given for your values of k .

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- (iii) Explain whether your results support the suggested relationship.

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(e) (i) Describe four sources of uncertainty or limitations of the procedure in this experiment.

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(ii) Describe four improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

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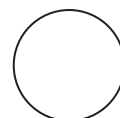
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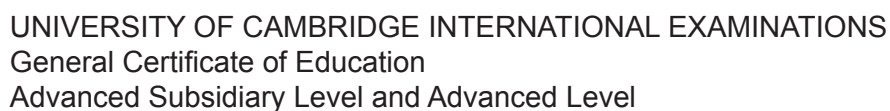
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9702/36

October/November 2010

2 hours

Additional Materials: As listed in the Confidential Instructions.

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

You may lose marks if you do not show your working or if you do not use appropriate units.

You are reminded of the need for good English and clear presentation in your answers.

All questions in this paper carry equal marks.

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1	
2	
Total	

This document consists of **10** printed pages and **2** blank pages.

You may not need to use all of the materials provided.

1 In this experiment, you will investigate the equilibrium position of a flat board.

(a) The board is suspended from a nail as in Fig. 1.1. Check that the board can swing freely.

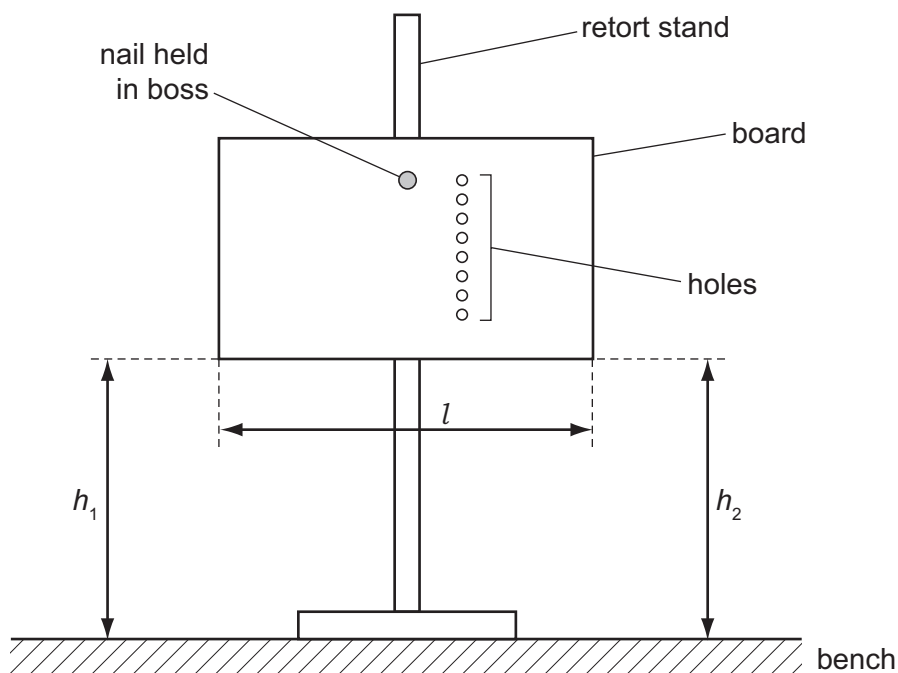


Fig. 1.1

(b) Measure the heights h_1 and h_2 of the two lower corners of the board above the bench.

If necessary, add a small amount of Blu-Tack to the top edge of the board so that the two heights are the same (i.e. so that the lower edge of the board is parallel to the bench).

(c) Measure and record the length l of the lower edge of the board.

$l =$ cm



- (d) Using the wire hook, attach the 150 g mass to the top hole in the board, as shown in Fig. 1.2.

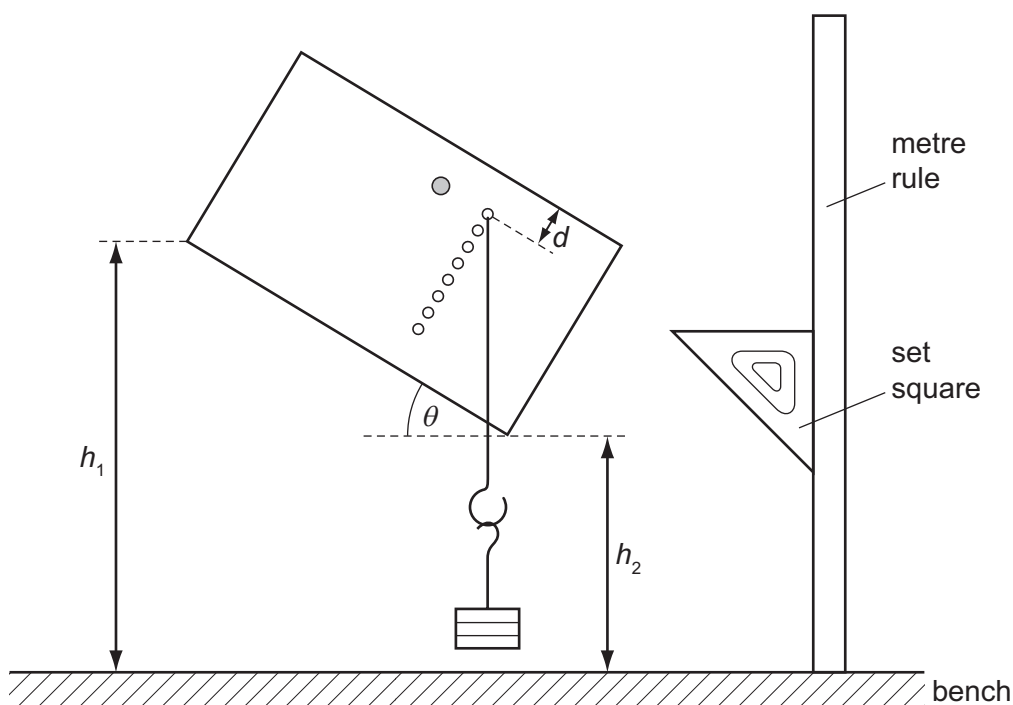


Fig. 1.2

The distance d is measured from the top edge of the board to the hole with the hook in it. The angle θ is the angle between the lower edge of the board and the horizontal.

- (e) (i) Measure and record h_1 and h_2 . You may find it useful to use a set square as shown in Fig. 1.2.

$h_1 = \dots\dots\dots$ cm

$h_2 = \dots\dots\dots$ cm

- (ii) Using your answer from (c), calculate θ (in degrees) using the relationship

$$\sin \theta = \frac{h_1 - h_2}{l}.$$

$\theta = \dots\dots\dots^\circ$

- (iii) Measure and record d .

$d = \dots\dots\dots$

- (f) Increase d by moving the hook and 150 g mass to a lower hole in the board, and repeat (e) until you have five sets of readings of h_1 , h_2 and d .

Include in your table values for θ and $\frac{1}{\tan \theta}$.

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- (g) (i) Plot a graph of $\frac{1}{\tan \theta}$ on the y-axis against d on the x-axis.
- (ii) Draw the straight line of best fit.
- (iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

(h) The quantities θ and d are related by the equation

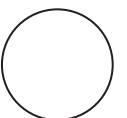
$$\frac{1}{\tan \theta} = ad + b$$

where a and b are constants.

Using your answers from (g)(iii), determine the values of a and b . Give units where appropriate.

$a =$

$b =$



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Please turn over for Question 2.

You may not need to use all of the materials provided.

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2 In this experiment, you will investigate the frictional force between strips of paper.

(a) You have been provided with three strips of paper, one of which is shaped, and a wire hook.

Attach the wire hook to the end of the shaped strip by folding and glueing, as shown in Fig. 2.1.

Glue together the other two strips over a 4 cm length at one end and clamp this glued end to the bench.

Position the strips as shown in Fig. 2.1.

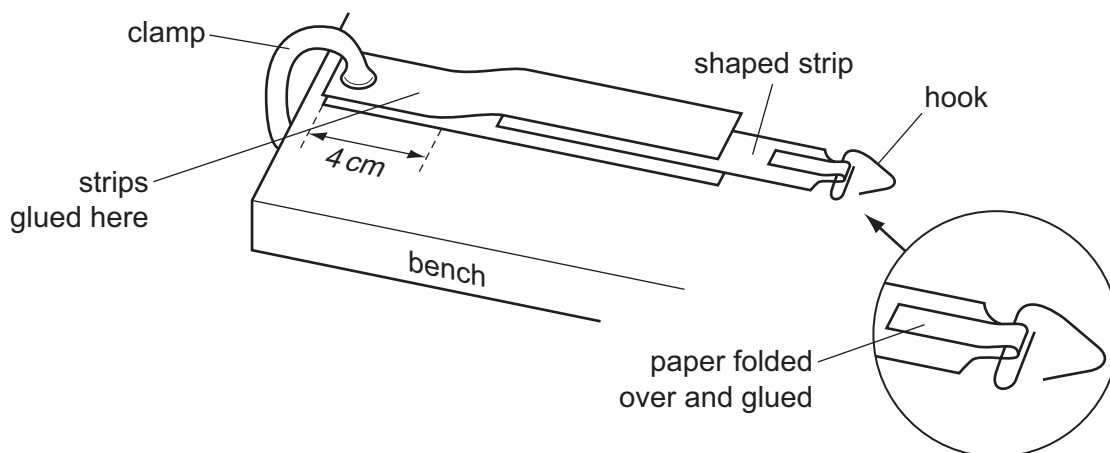


Fig. 2.1

(b) (i) You have also been provided with two rubber pencil erasers. Measure the length and width of the larger eraser and use these to calculate the area A of the largest face as shown in Fig. 2.2.

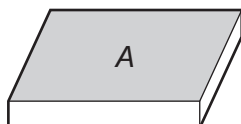


Fig. 2.2

length = ...

width = ...

$A =$

(ii) Justify the number of significant figures that you have given for your value of A .

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- (c) (i) Place the larger rubber pencil eraser on top of the paper strips and balance the 500 g mass on top of the eraser, as shown in Fig. 2.3.
- (ii) Attach the newton-meter to the hook and lay it horizontally on the bench as shown in Fig. 2.3. Check that it reads zero (adjust the zero if necessary).

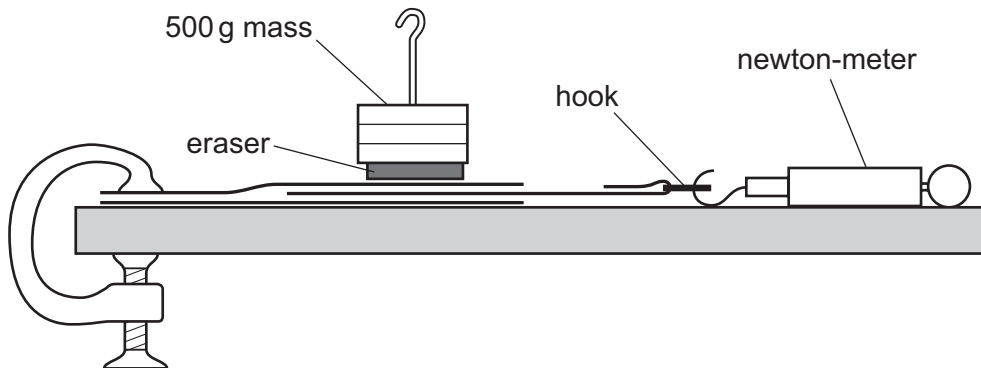


Fig. 2.3

- (d) (i) Pull the newton-meter until the middle paper strip starts to slide. Take measurements to determine the average force F that just makes the strip slide. Show your working.

$F = \dots\dots\dots$

- (ii) By considering the measurements that you took in (i), estimate the uncertainty in your value of F .

uncertainty = $\dots\dots\dots$ N

(e) Repeat (b)(i), (c) and (d)(i) but using the smaller piece of rubber eraser.

length = ...

width = ...

A = ...

F = ...

(f) It is suggested that F remains constant when A is changed.
Using your answer in (d)(ii), explain whether your results support the suggested relationship.

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(g) (i) Describe four sources of uncertainty or limitations of the procedure in this experiment.

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(ii) Describe four improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

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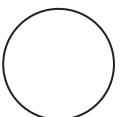
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