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9702/31

October/November 2013

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.
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1	
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For
Examiner's
Use

- 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.

$d = \dots\dots\dots$ [1]

- (ii)** Calculate the cross-sectional area A of the wire, in m^2 , using the formula

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

$A = \dots\dots\dots \text{m}^2$

- (b) (i)** Use the wire attached to the metre rule, one of the voltmeters and one of the resistors to set up the partial circuit shown in Fig. 1.1.

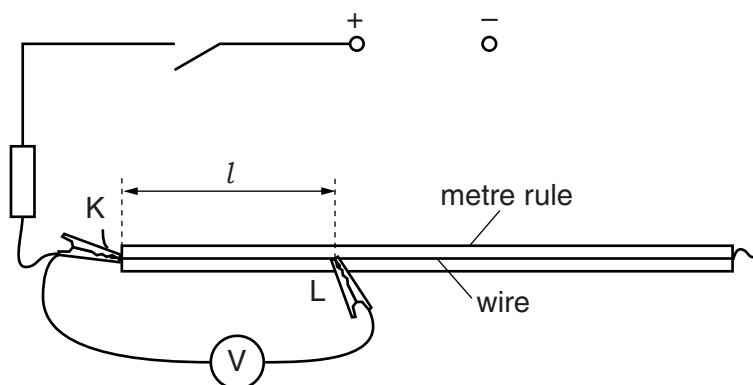


Fig. 1.1

There are two crocodile clips, one labelled K and the other labelled L. Place K and L so that the distance l between them is approximately 30 cm.

- (ii)** Measure and record the distance l between K and L.

$l = \dots\dots\dots \text{m}$

- (iii) Use the other resistor and the other voltmeter to complete the circuit shown in Fig. 1.2.

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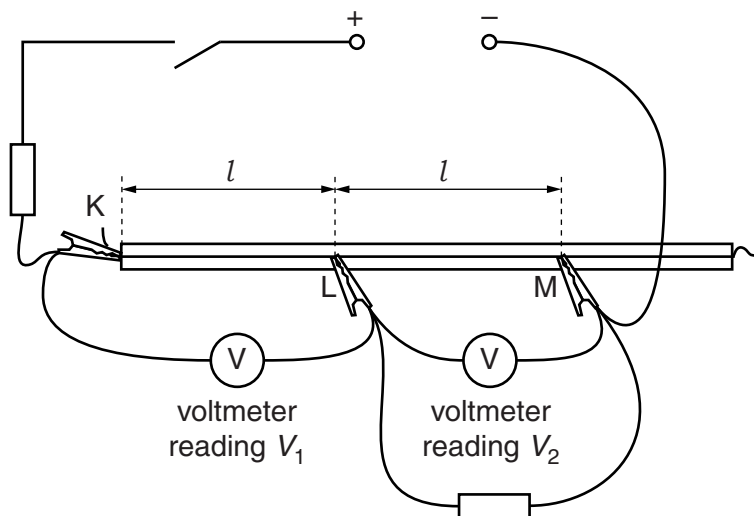


Fig. 1.2

- (iv) Place the crocodile clip M at a distance l from L. The value of l should be the same as in (b)(ii).
- (c) (i) Switch on the power supply.
- (ii) Record the voltmeter readings V_1 and V_2 as shown in Fig. 1.2.

$V_1 = \dots\dots\dots V$

$V_2 = \dots\dots\dots V$
[1]

- (iii) Switch off the power supply.

- (d) Change l and repeat (b)(ii), (b)(iv) and (c) until you have six sets of readings of l , V_1 and V_2 . For each set of readings, distances KL and LM should **both** be l .

Include values of $\frac{V_1}{V_2}$ in your table.

For
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Use

[10]

- (e) (i) Plot a graph of $\frac{V_1}{V_2}$ on the y-axis against l on the x-axis.

[3]

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

[1]

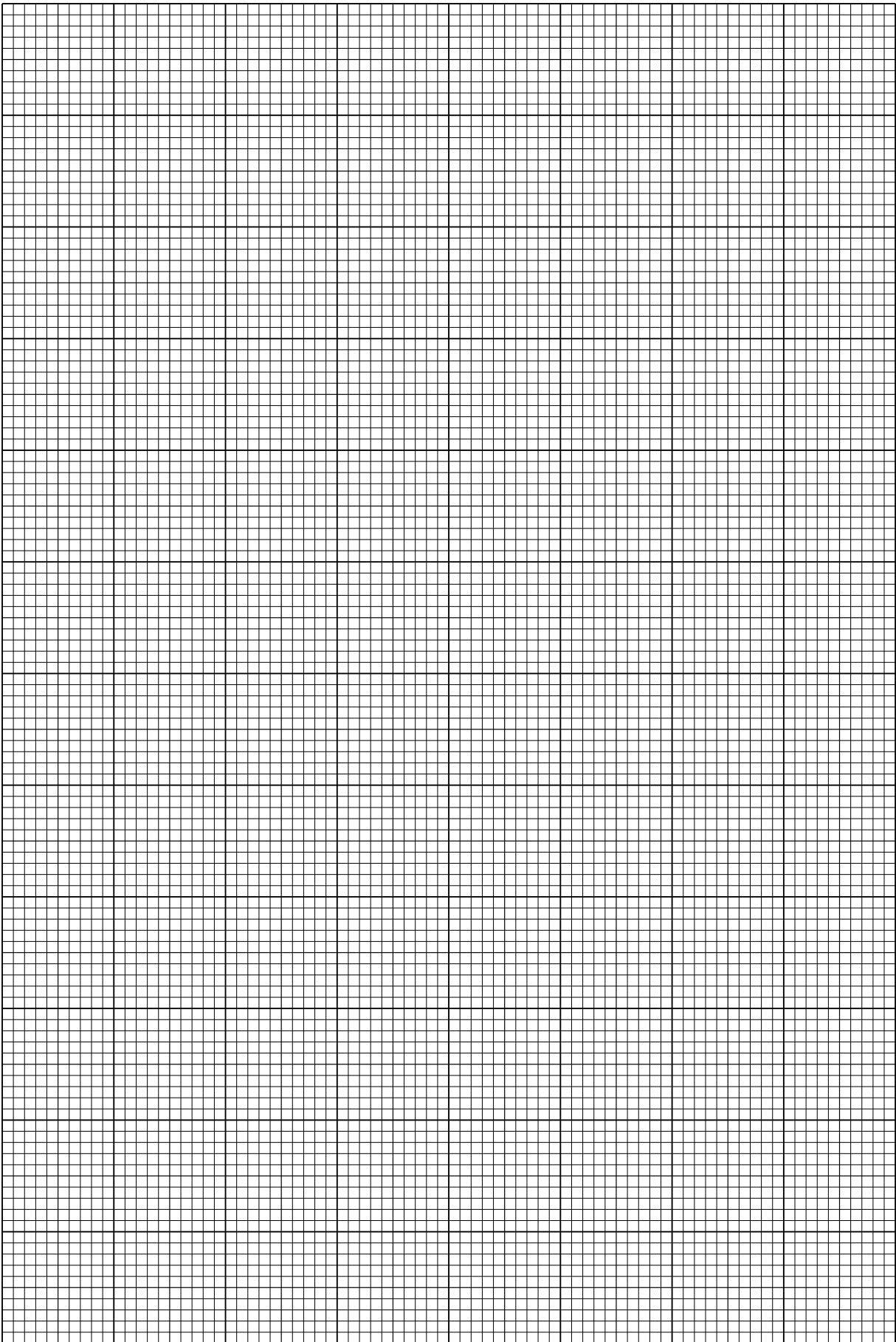
- (iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

[2]

For
Examiner's
Use



- (f) The quantities V_1 , V_2 and l are related by the equation

$$\frac{V_1}{V_2} = Pl + Q$$

where P and Q are constants.

- (i) Use your answers in (e)(iii) to determine values for P and Q .

$$P = \dots\dots\dots \text{m}^{-1}$$

$$Q = \dots\dots\dots [1]$$

For
Examiner's
Use

- (ii) The resistivity ρ of the material of the wire, in Ωm , can be found using the relationship

$$\rho = PAR$$

where $R = 10\Omega$.

Use your answers in (a)(ii) and (f)(i) to calculate a value for ρ .

$$\rho = \dots\dots\dots \Omega\text{m} [1]$$

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For
Examiner's
Use

- 2** In this experiment, you will investigate the change in shape of a rubber band when masses are hung from it.

(a) Set up the apparatus as shown in Fig. 2.1.

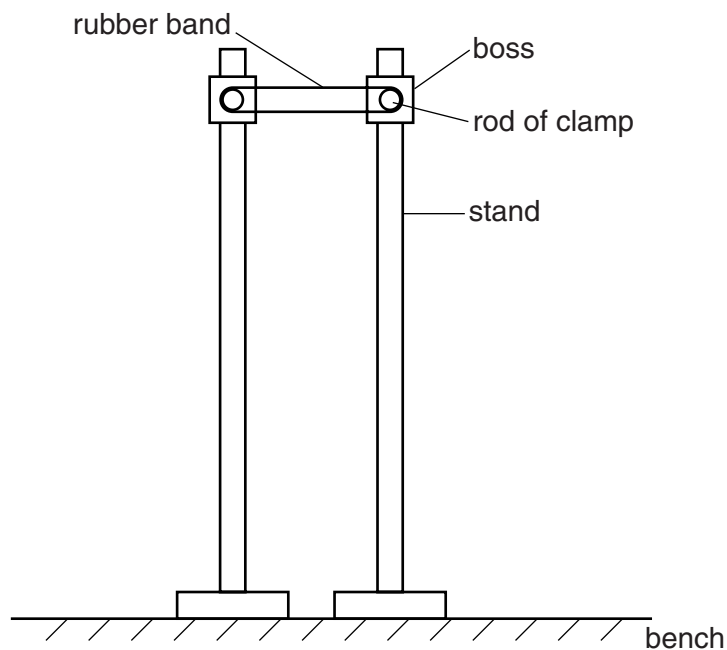


Fig. 2.1

The rods of the two clamps must be at the same height above the bench.

Position the stands so that the rubber band has no slack.

(b) Measure and record the mass m of the mass hanger.

$m = \dots\dots\dots$ [1]

- (c) (i) Suspend the mass hanger from the centre of the lower part of the rubber band as shown in Fig. 2.2.

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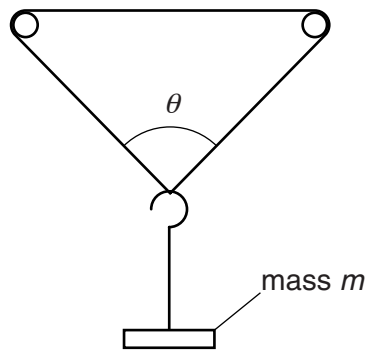


Fig. 2.2

- (ii) Measure and record the angle θ as shown in Fig. 2.2.

$\theta = \dots\dots\dots$ [2]

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

percentage uncertainty = $\dots\dots\dots$ [1]

- (iv) Calculate $\tan \frac{\theta}{2}$.

$\tan \frac{\theta}{2} = \dots\dots\dots$ [1]

- (v) Calculate $\tan^2 \frac{\theta}{2}$.

$\tan^2 \frac{\theta}{2} = \dots\dots\dots$

- (d) (i) Add the slotted mass to the mass hanger.
Measure and record the total mass m of the mass hanger and slotted mass.

For
Examiner's
Use

$$m = \dots\dots\dots[1]$$

- (ii) For this total mass, repeat (c)(i), (c)(ii), (c)(iv) and (c)(v).

$$\theta = \dots\dots\dots$$

$$\tan \frac{\theta}{2} = \dots\dots\dots$$

$$\tan^2 \frac{\theta}{2} = \dots\dots\dots[2]$$

- (e) Remove the slotted mass from the mass hanger.
Measure and record the angle θ .

$$\theta = \dots\dots\dots[1]$$

- (f) It is suggested that the relationship between m and θ is

$$m = \frac{k}{\tan^2 \frac{\theta}{2}}$$

where k is a constant.

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

first value of k = ...

second value of k = ... [1]

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

.....

 [1]

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

.....

 [1]

For
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- (g) (i) Describe four sources of uncertainty or limitations of the procedure for 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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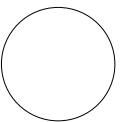
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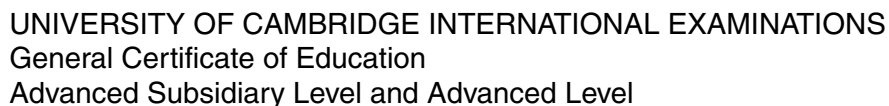
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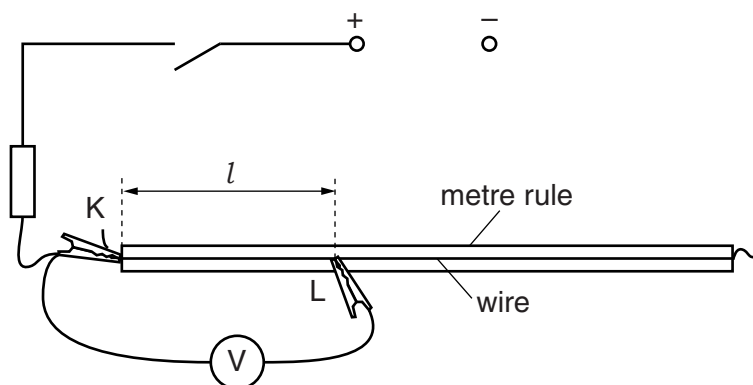


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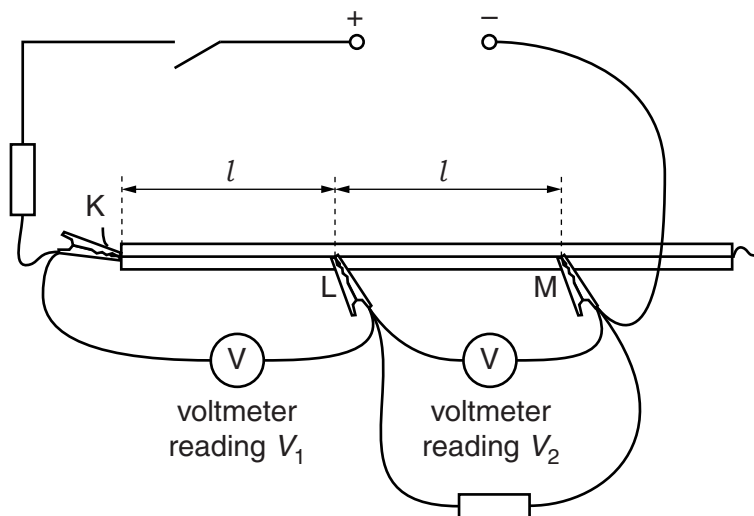


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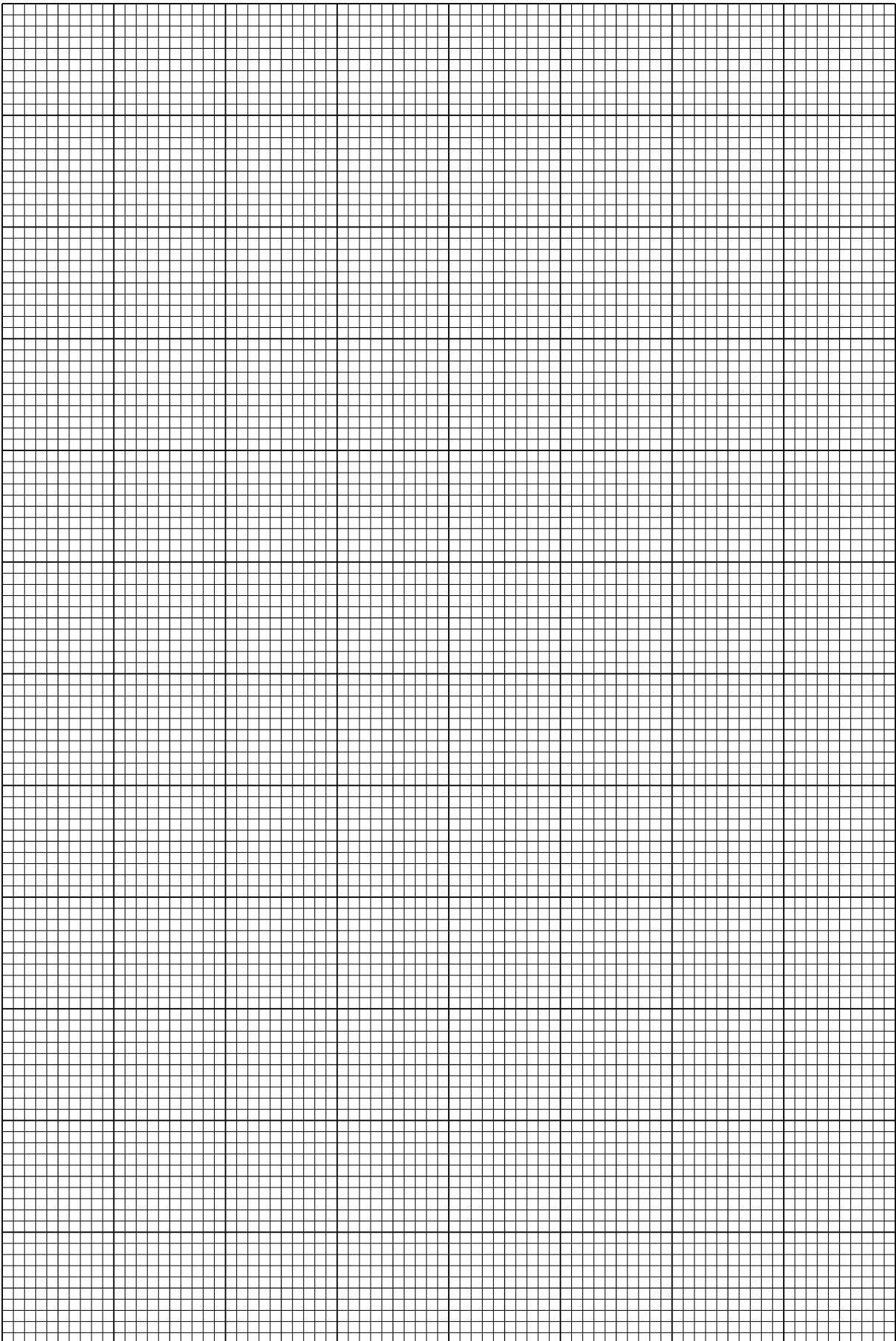
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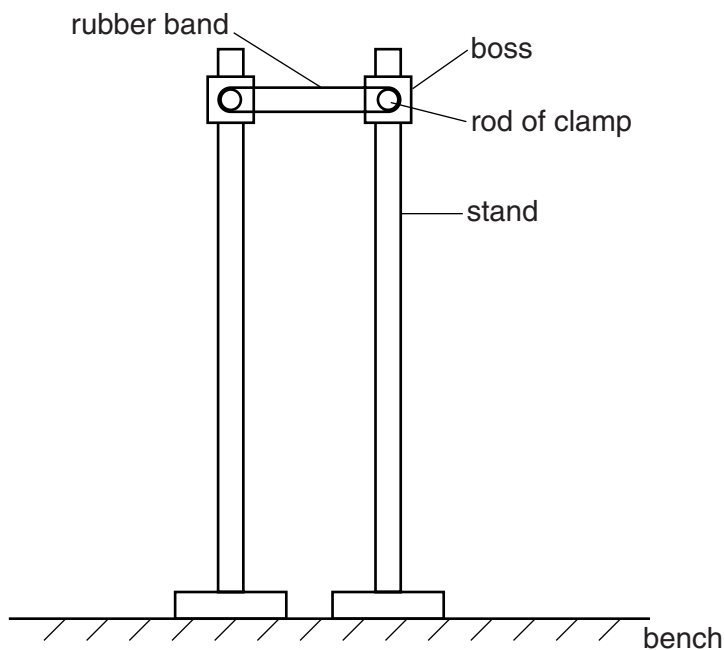


Fig. 2.1

The rods of the two clamps must be at the same height above the bench.

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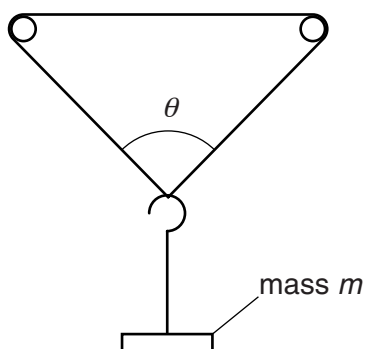


Fig. 2.2

- (ii) Measure and record the angle θ as shown in Fig. 2.2.

$\theta = \dots\dots\dots$ [2]

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

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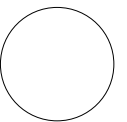
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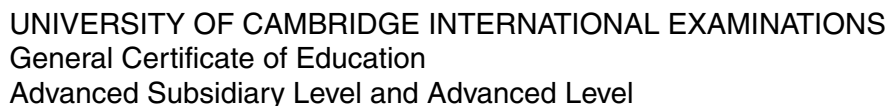
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Use

- 1** In this experiment, you will investigate how the forces supporting a wooden strip change as the position of a suspended mass is moved.

- (a) (i)** Suspend the single spring and the mass hanger from the rod of one of the clamps. Measure and record the height h_1 of the mass hanger above the bench, as shown in Fig. 1.1.

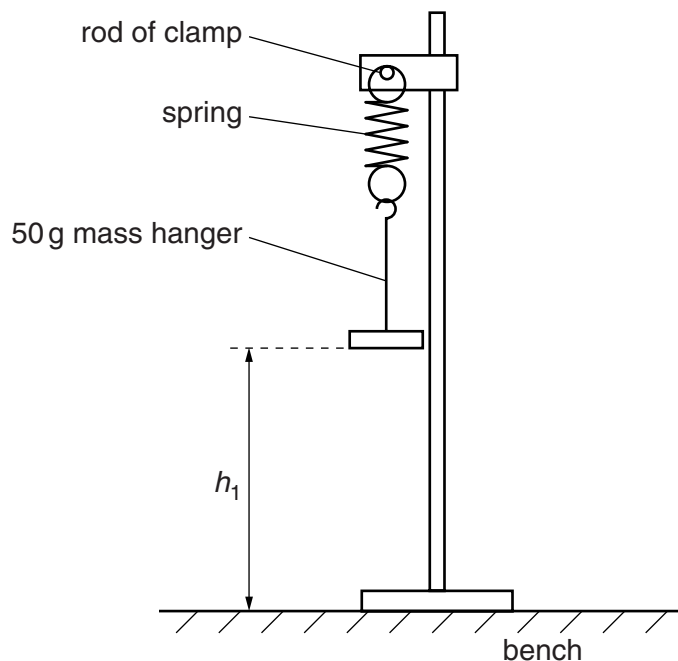


Fig. 1.1

$h_1 =$

- (ii)** Add the 50 g slotted mass to the hanger. Measure and record the new height h_2 of the mass hanger above the bench.

$h_2 =$ [1]

- (iii)** Calculate the change in height C , where $C = h_1 - h_2$.

$C =$

- (b) (i) Assemble the apparatus as shown in Fig. 1.2, with the mass M near to the middle of the wooden strip.

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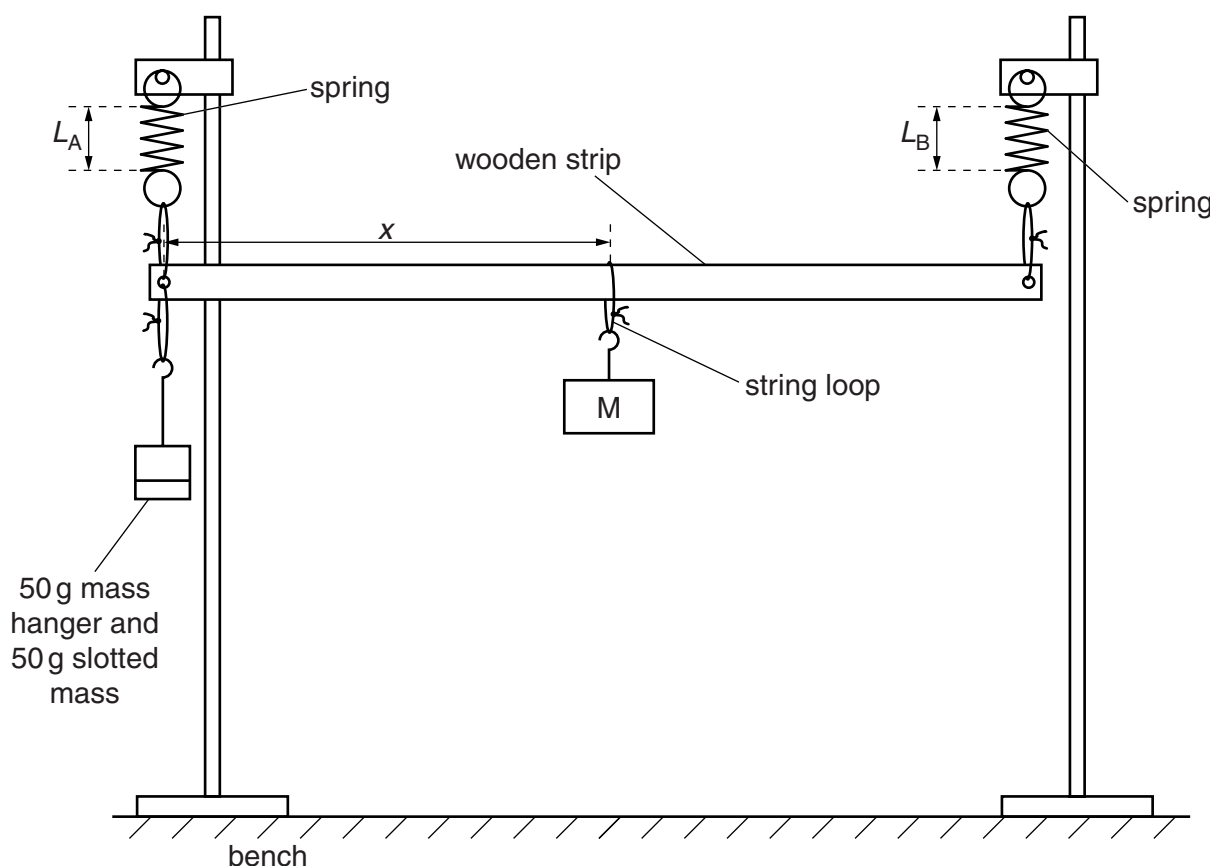


Fig. 1.2

- (ii) Adjust the apparatus so that the wooden strip is horizontal and the springs are vertical.
- (iii) Measure and record the distance x from the left-hand hole in the wooden strip to the string loop supporting M , as shown in Fig. 1.2.
- $x =$
- (iv) Measure and record the length L_A of the coiled section of the left-hand spring, and the length L_B of the coiled section of the right-hand spring.

$L_A =$

$L_B =$

[1]

- (c) Reposition the string loop supporting M.
Repeat **(b)(ii)**, **(b)(iii)** and **(b)(iv)** until you have six sets of values of x , L_A and L_B .
Include values for $(L_A - L_B)$ and for $\frac{(L_A - L_B)}{C}$ in your table.

For
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Use

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[10]

- (d) (i) Plot a graph of $\frac{(L_A - L_B)}{C}$ 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.

[3]

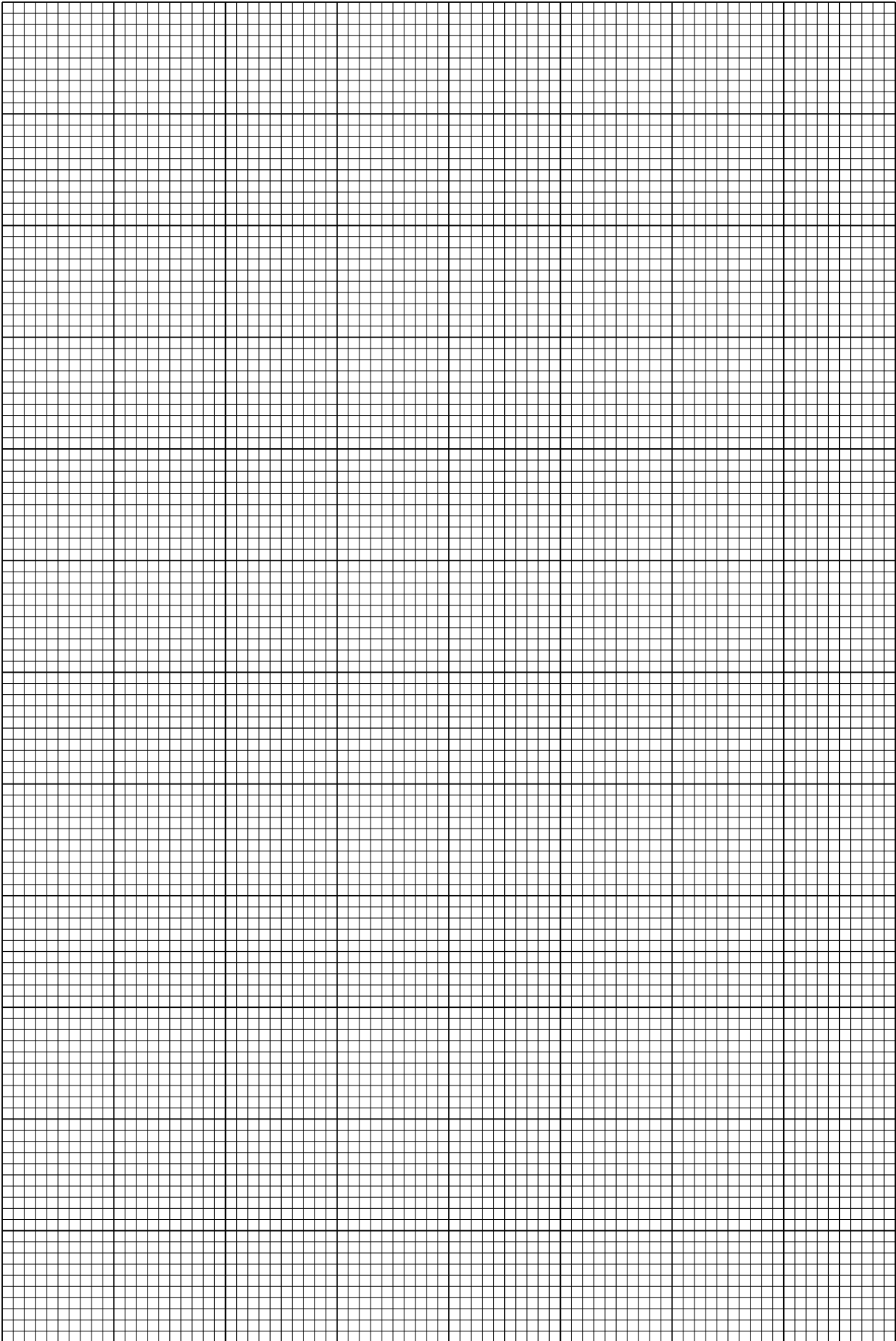
[1]

gradient = ...

y -intercept = ...

[2]

For
Examiner's
Use



- (e) The quantities L_A , L_B , C and x are related by the equation

$$\frac{(L_A - L_B)}{C} = ax + b$$

where a and b are constants.

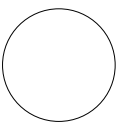
Use your answers from (d)(iii) to determine the values of a and b .
Give appropriate units.

$a = \dots\dots\dots$

$b = \dots\dots\dots$

[2]

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Examiner's
Use



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

For
Examiner's
Use

2 In this experiment, you will investigate the equilibrium of a spool of thread.

- (a) (i) Using the smaller of the two spools provided, take measurements to determine the outside diameter D and the inner diameter d , as shown in Fig. 2.1.

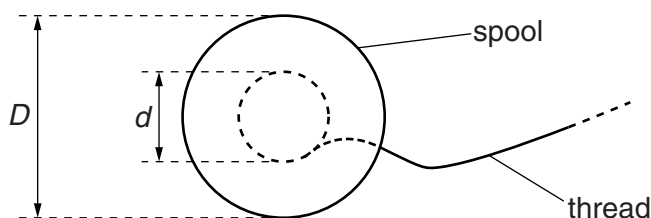


Fig. 2.1

$D =$ mm

$d =$ mm
[2]

- (ii) Calculate the ratio R , where $R = \frac{d}{D}$.

$R =$ [1]

- (b) Justify the number of significant figures that you have given for your value of R .

.....

 [1]

- (c) Use the stand, boss and clamp to support the protractor as shown in Fig. 2.2.

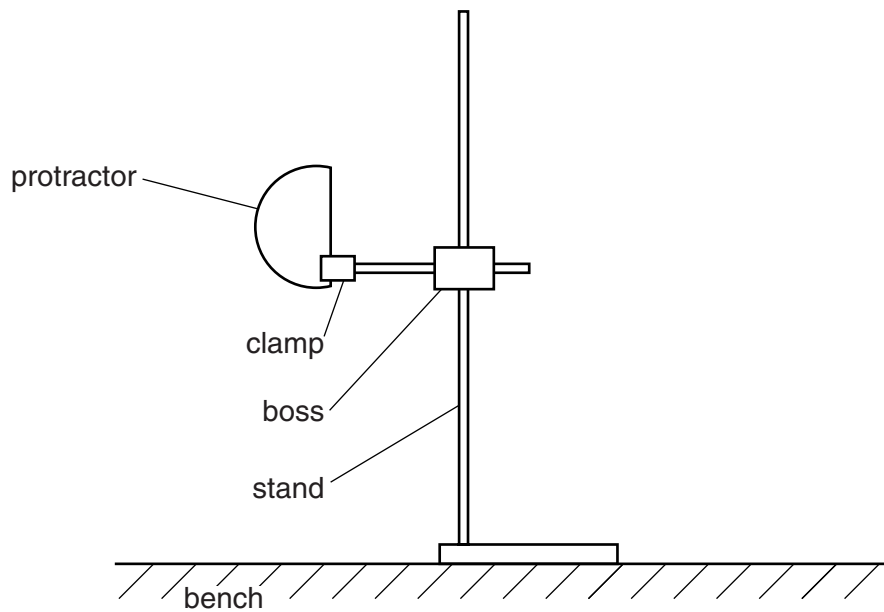


Fig. 2.2

- (d) (i) Using the smaller of the two spools, wrap the thread around its inner diameter until there is about 30cm of thread left unwound.
- (ii) With the spool on the bench, gently pull the thread vertically as shown in Fig. 2.3.

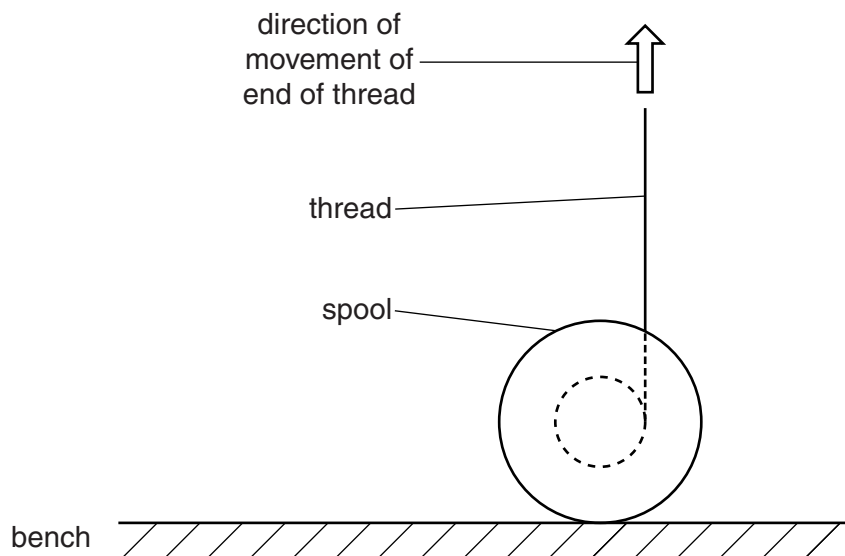


Fig. 2.3

- (iii) The spool will move to the left until the thread reaches a constant angle θ to the vertical with the spool rotating but not moving along the bench, as shown in Fig. 2.4.

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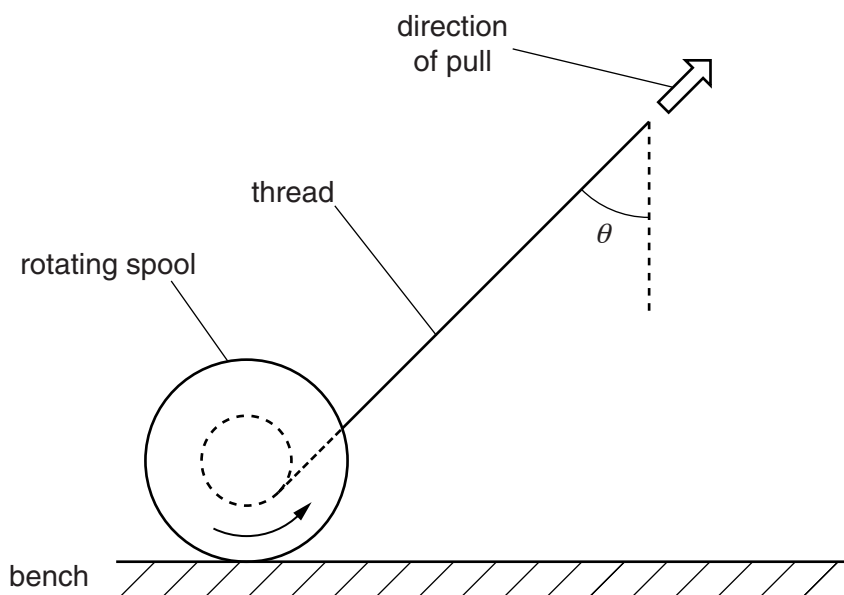


Fig. 2.4

- (iv) Measure and record the angle θ .

$\theta = \dots\dots\dots$ [2]

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

percentage uncertainty = $\dots\dots\dots$ [1]

(f) Repeat (a) and (d) but using the larger of the two spools.

For
Examiner's
Use

$D =$

$d =$

$R =$

$\theta =$

[3]

☐

- (g) It is suggested that the relationship between θ and R is

$$\sin \theta = kR$$

where k is a constant.

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

first value of $k = \dots\dots\dots$

second value of $k = \dots\dots\dots$

[1]

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

.....

 [1]

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

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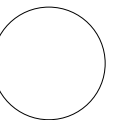
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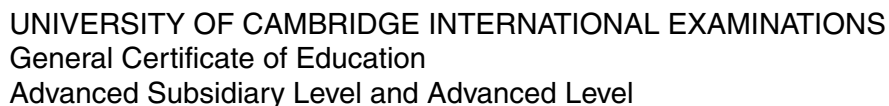
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1 In this experiment, you will investigate the motion of a swinging bob and a wooden rod.

(a) Measure and record the distance L between the end of the rod and the end of the hook as shown in Fig. 1.1.



Fig. 1.1

$L = \dots\dots\dots$ m [1]

(b) (i) Set up the apparatus as shown in Fig. 1.2.

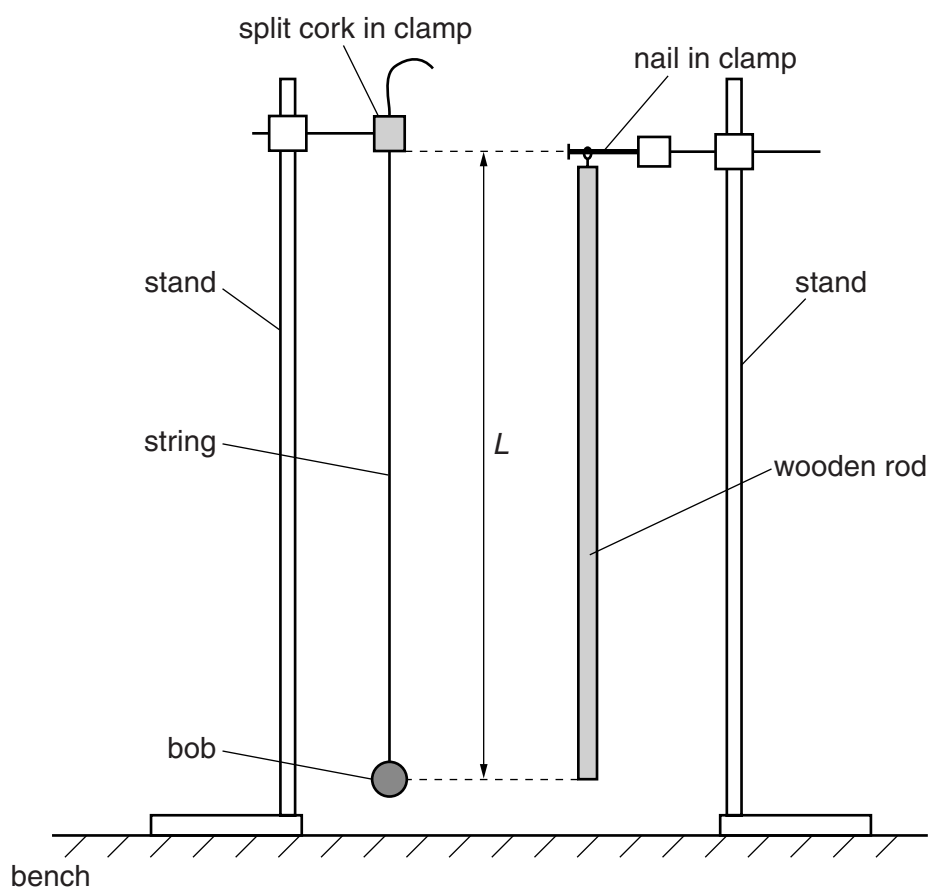


Fig. 1.2

The distance between the bottom of the split cork and the centre of the bob should be equal to the value of L in **(a)**.

- (ii) Reduce the distance between the bottom of the split cork and the centre of the bob by approximately 3 cm.
- (iii) Measure and record the distance D between the bottom of the split cork and the centre of the bob, as shown in Fig. 1.3.

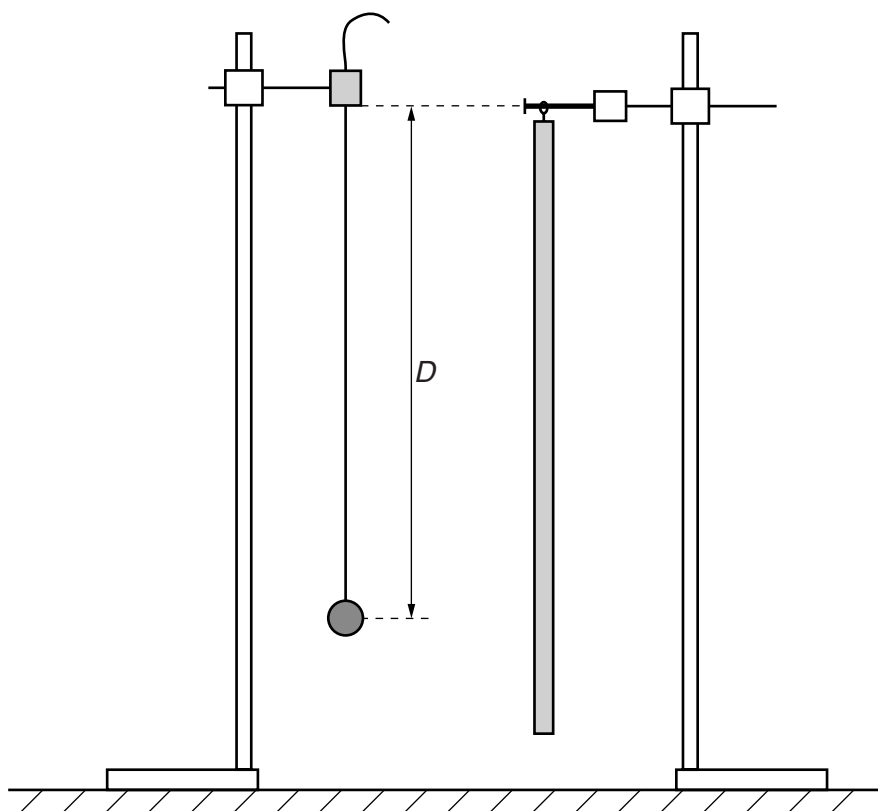


Fig. 1.3

$D = \dots\dots\dots$ m

- (iv) Calculate x where $x = L - D$.

$x = \dots\dots\dots$ m

- (c) (i) Move the bob towards you.
Release the bob and watch the movement.
The bob will move away from you and back towards you, completing a swing.
- (ii) Move the bottom of the wooden rod towards you.
Release the rod and watch the movement.
The rod will move away from you and back towards you, completing a swing.
- (iii) Move the bob **and** the bottom of the rod towards you.
Release the bob **and** the rod **at the same instant** and watch the movement.
The bob and the rod will swing backwards and forwards becoming out of step.
Eventually they will, for a short time, move together in step.
- (iv) Repeat (iii) and count the number n of swings **of the bob** between releasing the bob and rod and when they are back in step. Record n .

$n = \dots\dots\dots$ [1]

- (d) Decrease D and repeat (b)(iii), (b)(iv) and (c)(iv) until you have six sets of values of D , x and n .

Your values of D should be in the range $D \geq 40\text{ cm}$.

Include values of $\left(\frac{n+1}{n}\right)^2$ in your table.

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[10]

- (e) (i) Plot a graph of $\left(\frac{n+1}{n}\right)^2$ on the y -axis against x on the x -axis.

[3]

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

[1]

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

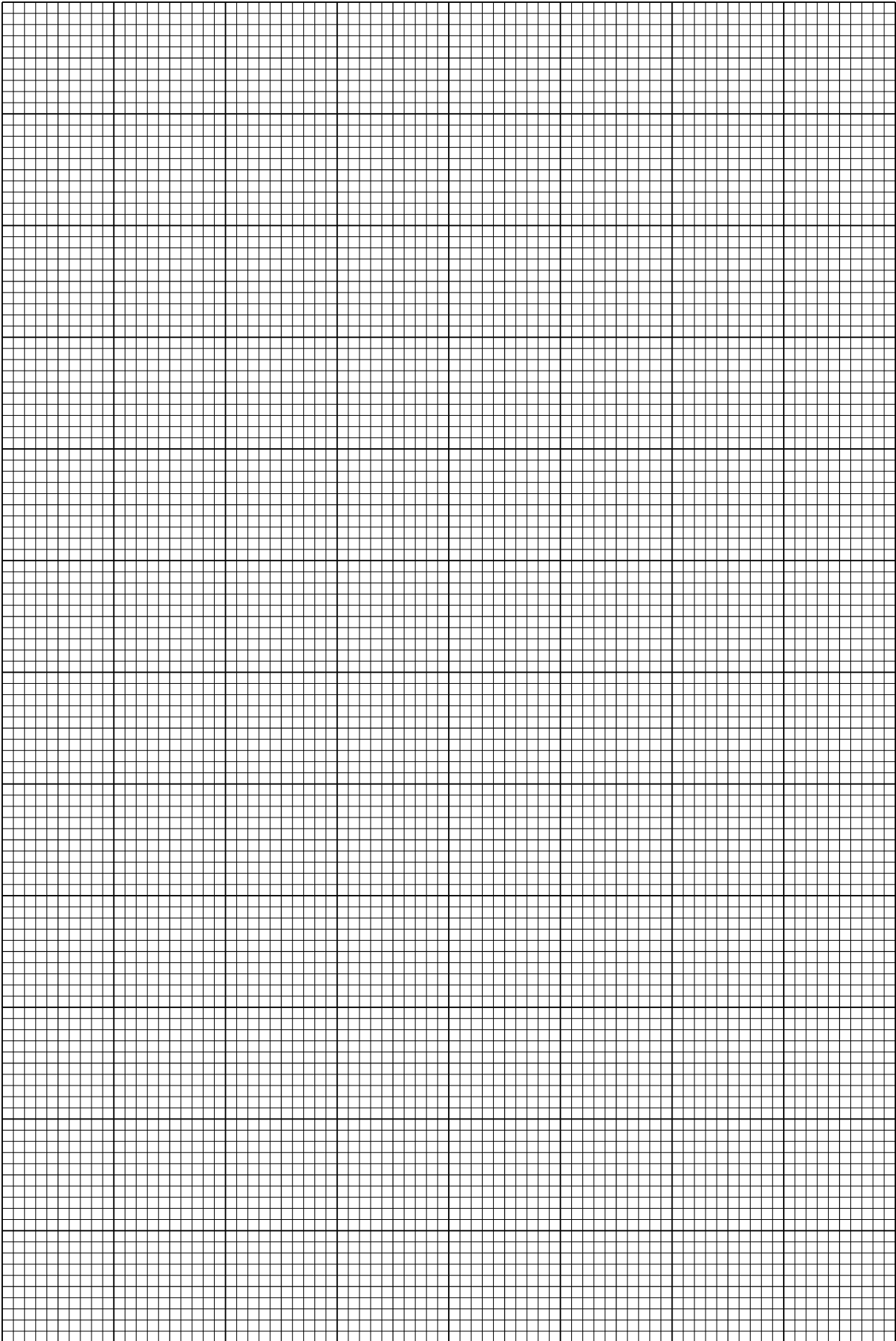
gradient = ...

y -intercept = ...

[2]

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- (f) The quantities n and x are related by the equation

$$\left(\frac{n+1}{n}\right)^2 = -Px + Q$$

where P and Q are constants.

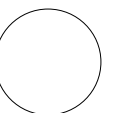
Use your answers in (e)(iii) to determine the values of P and Q .
Give appropriate units.

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$P =$

$Q =$

[2]



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

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2 In this experiment, you will investigate the motion of a water-filled ball in a container of water.

- (a)** Place the rubber bands on the cylindrical container approximately 10 cm apart, as shown in Fig. 2.1. The top rubber band should be level with the surface of the water.

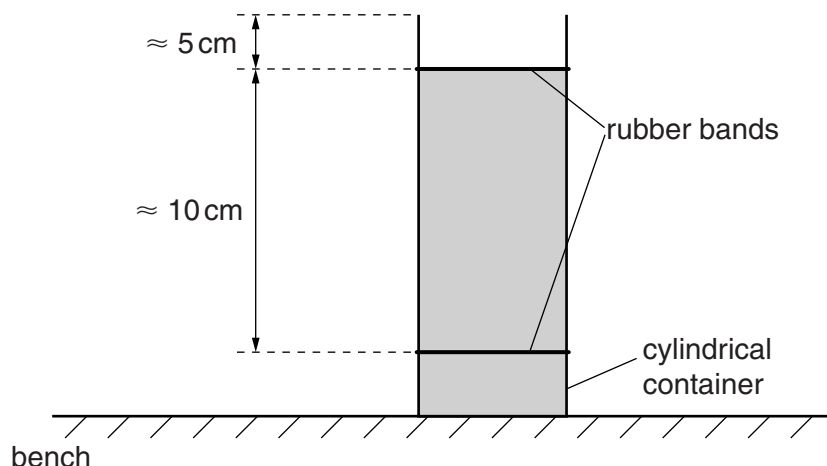


Fig. 2.1

- (b) (i)** You have been provided with a ball, a syringe and a beaker of water. Draw water from the beaker into the syringe and empty the contents into the hole in the ball. Determine the volume V_0 of water that is required to **fill** the ball. (1 ml = 1 cm³)

You may have to fill the syringe more than once.

$V_0 = \dots\dots\dots \text{cm}^3$ [1]

- (ii)** Describe how you determined the value of V_0 .

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

- (iii)** Hold the ball so that no water leaks out and use the syringe to remove 5 cm³ (5 ml) of water from the ball.

- (iv)** Use the Blu-Tack to seal the hole in the ball to prevent the water escaping.

- (v) Calculate the volume V of water remaining in the ball.

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

- (vi) Estimate the percentage uncertainty in your value of V .

percentage uncertainty = $\dots\dots\dots$ [1]

- (c) (i) Hold the ball so that its bottom is on the surface of the water, as shown in Fig. 2.2.

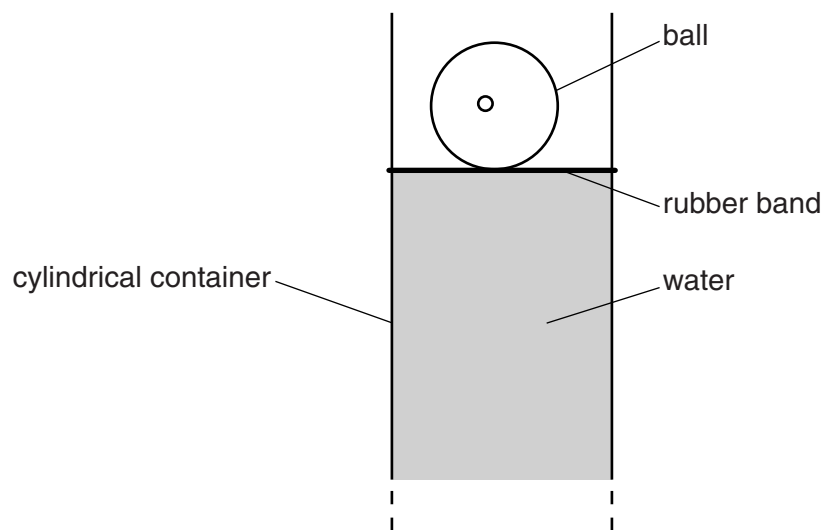


Fig. 2.2

- (ii) Release the ball. It will fall and then return to the surface.
Move the lower rubber band to the lowest position reached by the bottom of the ball as shown in Fig. 2.3.

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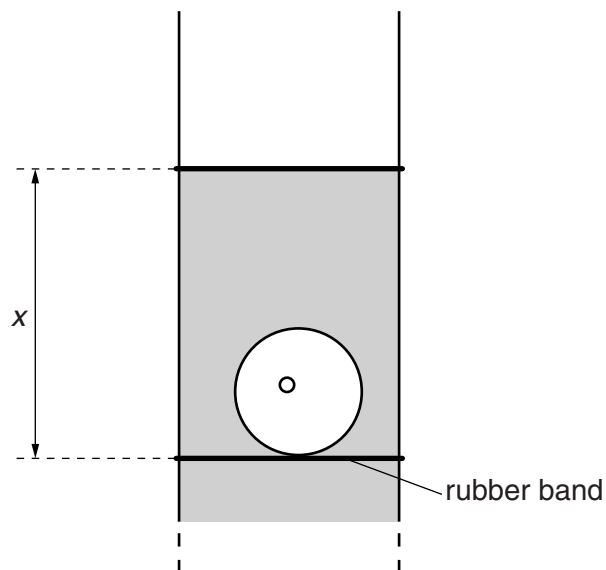


Fig. 2.3

- (iii) Measure and record the distance x between the rubber bands.

$x =$ cm [2]

- (d) (i) Remove another 5 cm³ (5 ml) of water from the ball.

- (ii) Repeat (b)(iv), (b)(v), and (c).

$V =$ cm³

$x =$ cm
[3]

- (e) It is suggested that the relationship between x and V is

$$x = kV^3$$

where k is a constant.

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

first value of $k =$

second value of $k =$ [1]

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

.....

 [1]

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

.....

 [1]

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- (f) (i) Describe four sources of uncertainty or limitations of the procedure for 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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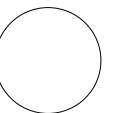
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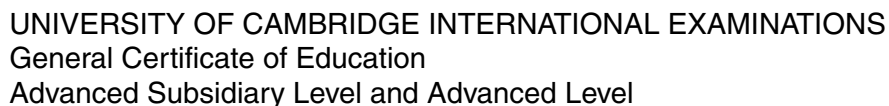
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9702/36

October/November 2013

2 hours

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

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

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

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

The number of marks is given in brackets [] at the end of each question or part question.

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1	
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Total	

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

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- 1** In this experiment, you will investigate the potential difference between two points in a circuit.

(a) Assemble the circuit of Fig. 1.1.

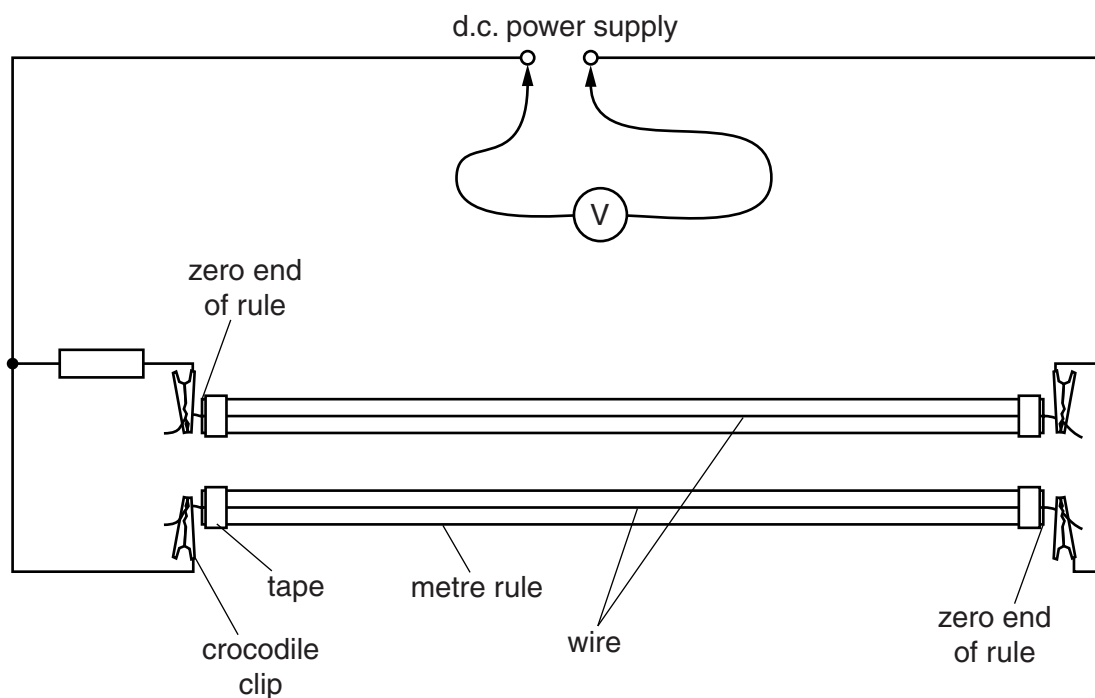


Fig. 1.1

- (b) (i)** Connect the voltmeter across the power supply.
Record the voltmeter reading E .

$E = \dots\dots\dots$ [1]

- (ii)** Disconnect the voltmeter from the power supply.

- (c) (i) Position the voltmeter leads on the wires at distance x from the zero ends of both rules as shown in Fig. 1.2, where x is approximately 20 cm.

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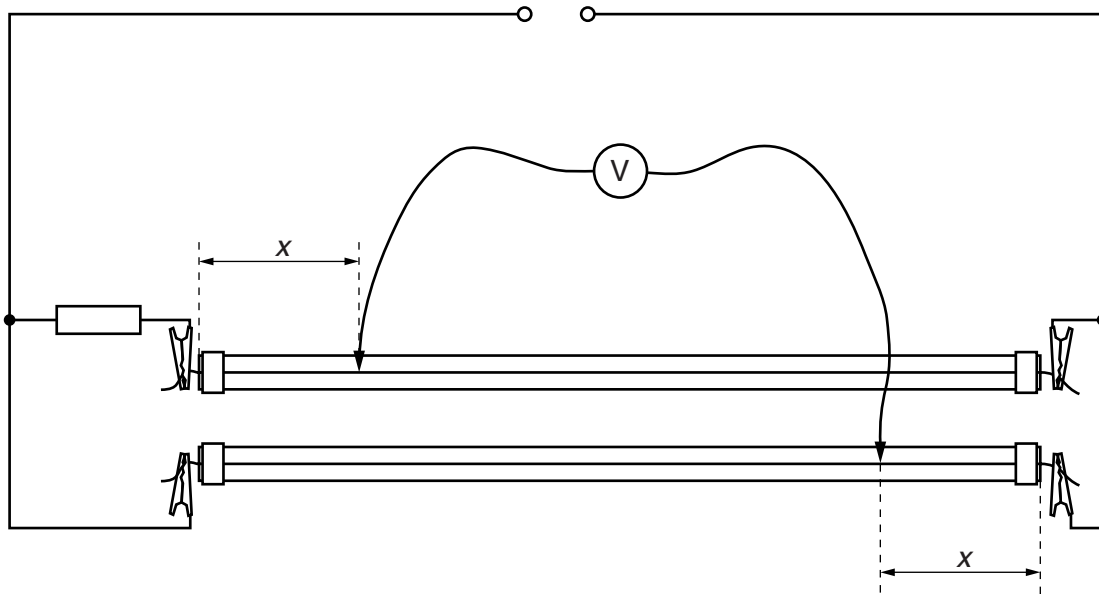


Fig. 1.2

- (ii) Record x and record the voltmeter reading V .
Include the sign (+ or –) of V .

$x =$

$V =$

- (iii) By moving both contacts, change x until the voltmeter reads zero.
Record x .

$x =$ [1]



- (d) Repeat (c)(i) and (c)(ii) with different values of x until you have six sets of values of x and V .
Include values of $\frac{V}{E}$ in your table.

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[10]

- (e) (i) Plot a graph of $\frac{V}{E}$ 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.

[3]

[1]

gradient = ...

y -intercept = ...

[2]

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- (f) The quantities V , E and x are related by the equation

$$\frac{V}{E} = ax + b$$

where a and b are constants.

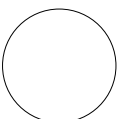
Use your answers from (e)(iii) to determine the values of a and b .
Give appropriate units.

$a =$

$b =$

[2]

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- 2 In this experiment, you will investigate the transfer of energy in a collision between rolling spheres.

- (a) You are provided with three spheres as shown in Fig. 2.1.

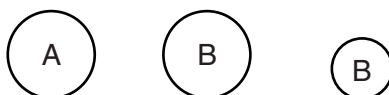


Fig. 2.1

- (i) Measure and record the mass m_A of the sphere labelled A.

$m_A = \dots\dots\dots$ g [1]

- (ii) Measure and record the mass m_B of the **smaller** of the two spheres labelled B.

$m_B = \dots\dots\dots$ g

- (iii) Calculate the value of R , where

$$R = \left(\frac{2m_A}{m_A + m_B} \right)^2.$$

$R = \dots\dots\dots$ [1]

- (iv) Justify the number of significant figures you have given for your value of R .

.....

 [1]

- (b) You are provided with a track mounted on a board.

Place the **smaller** sphere B on the track at the lowest point.

Measure and record the height h_0 of the bottom of the sphere above the bench, as shown in Fig. 2.2.

$h_0 = \dots\dots\dots$ [1]

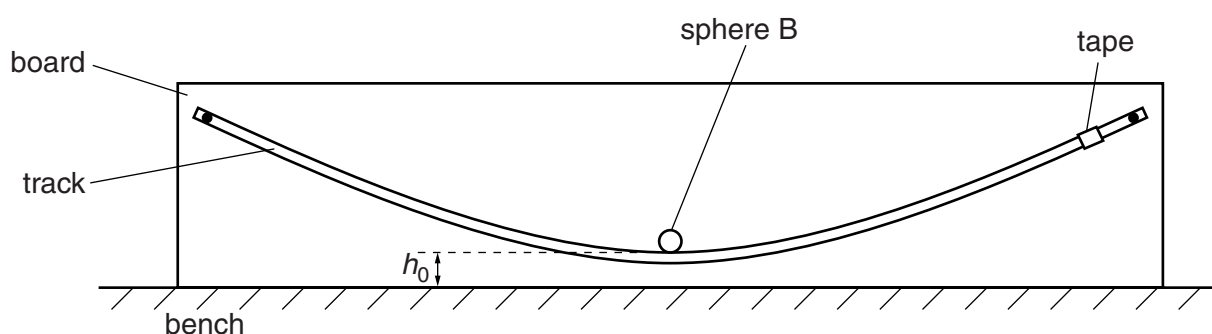


Fig. 2.2

- (c) Place sphere A on the track and resting against the tape, then release it so that it collides with sphere B.
Take measurements to find the maximum height h_B reached by sphere B after the collision, as shown in Fig. 2.3.

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$h_B = \dots\dots\dots$ [2]

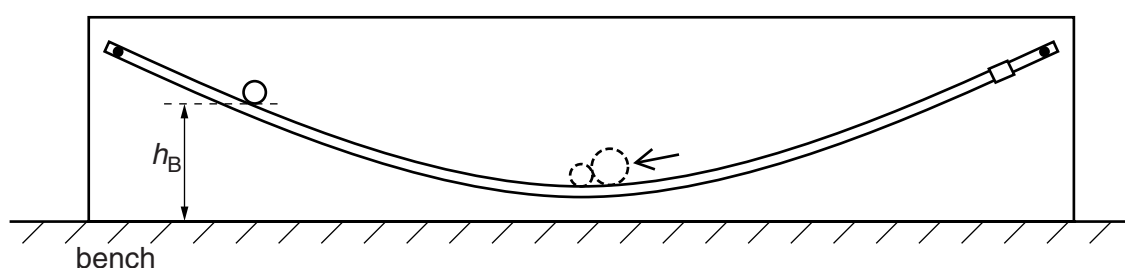


Fig. 2.3

- (d) Estimate the percentage uncertainty in your value of h_B .

percentage uncertainty = $\dots\dots\dots$ [1]

- (e) Copy the value of m_A from (a)(i).
Repeat steps (a)(ii), (a)(iii) and (c) using sphere A and the **larger** of the two spheres labelled B.

$m_A = \dots\dots\dots$ g

$m_B = \dots\dots\dots$ g

$R = \dots\dots\dots$

$h_B = \dots\dots\dots$ [3]

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

$$h_B - h_0 = kR$$

where k is a constant.

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

first value of $k = \dots\dots\dots$

second value of $k = \dots\dots\dots$

[1]

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

.....

 [1]

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

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1.

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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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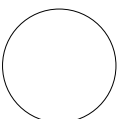
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