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PHYSICS

Paper 3 Advanced Practical Skills 1

9702/31

May/June 2014

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

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Answer **both** questions.

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1 In this experiment, you will investigate a system in equilibrium due to several forces.

- (a) Measure and record the distance L_0 between the ends of the spring, as shown in Fig. 1.1.
Note that this distance includes the two loops at the ends.

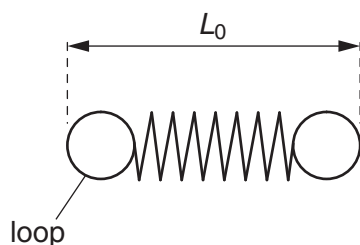


Fig. 1.1

$L_0 = \dots\dots\dots$ m [1]

- (b) (i) Set up the apparatus as shown in Fig. 1.2. Mass m should be 0.200 kg.
Do not change the height of the pulley or the clamp.

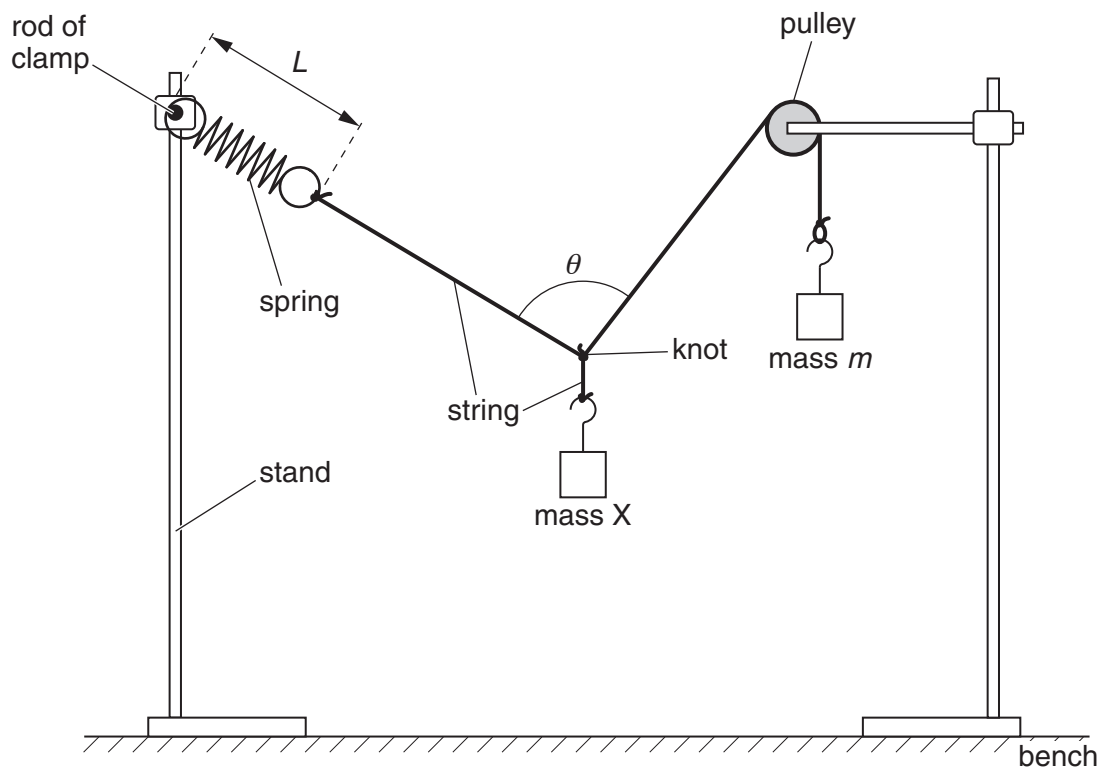


Fig. 1.2

- (ii) Adjust the apparatus until the angle θ is 90° .

You may move the stands **sideways** or slide the knot along the string.

- (iii) Measure and record the distance L between the ends of the spring loops.

$L = \dots\dots\dots\text{m}$ [1]

- (iv) Calculate the extension e of the spring using $e = L - L_0$.

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

- (c) Vary m and repeat (b)(ii), (b)(iii) and (b)(iv) until you have six sets of readings of m and L .

Include values of m^2 , e and e^2 in your table.

--

[10]

- (d) (i) Plot a graph of e^2 on the y -axis against m^2 on the x -axis.

[3]

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

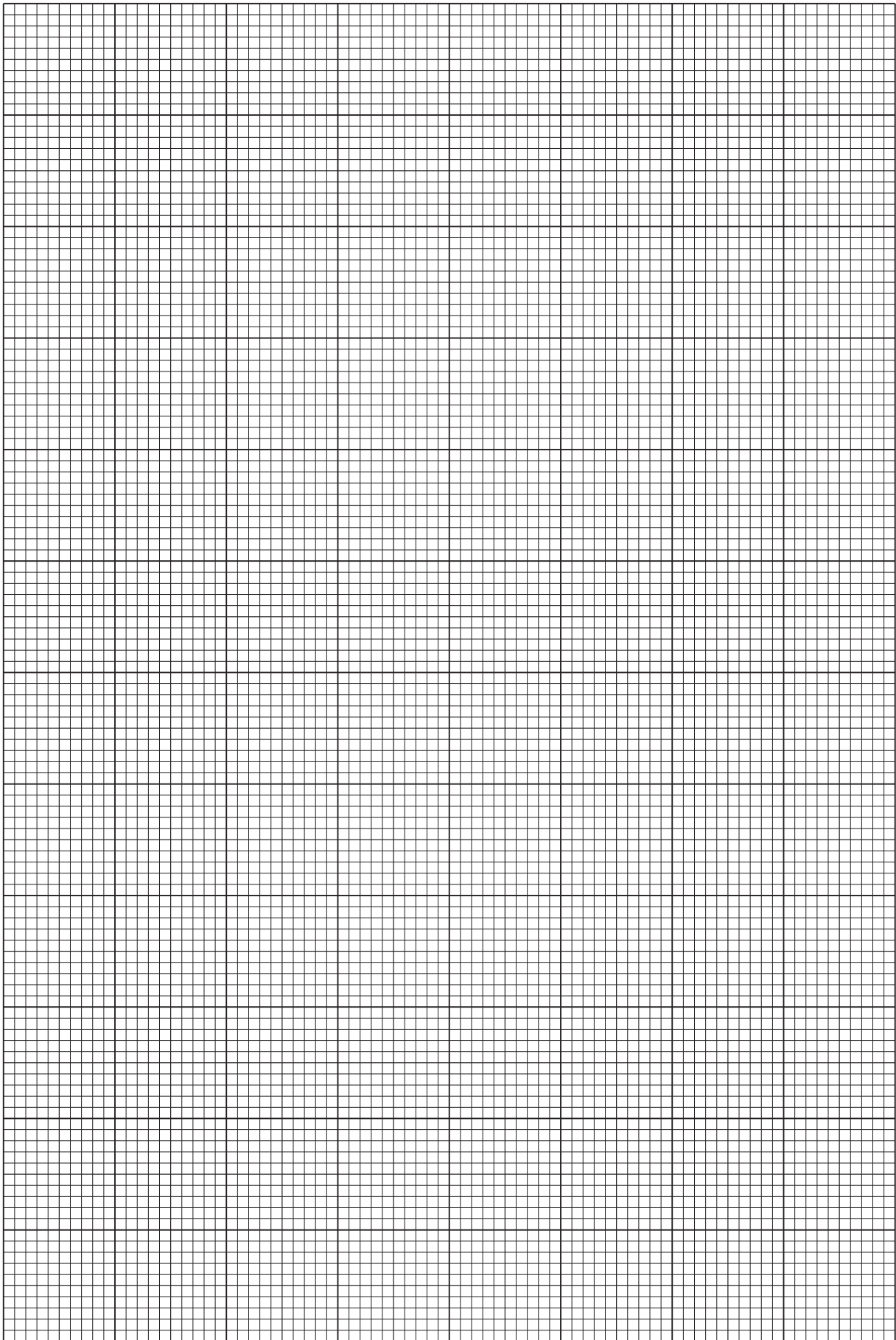
[1]

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

gradient = ...

y -intercept = ...

[2]



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

$$e^2 = -Pm^2 + Q$$

where P and Q are constants.

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

$P =$

$Q =$ [1]

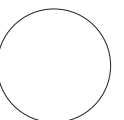
☐

- (f) The mass M of X is given by

$$M = \sqrt{\frac{Q}{P}}.$$

Use your answers in (e) to determine the value of M .
Include a unit for M .

$M =$ [1]

☐


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

- 2** In this experiment, you will investigate the motion of a hacksaw blade supported by a G-clamp.

- (a)** Using the Blu-Tack, attach the two slotted masses as close as possible to one end of the hacksaw blade, as shown in Fig. 2.1.



Fig. 2.1

- (b) (i)** Set up the apparatus as shown in Fig. 2.2.

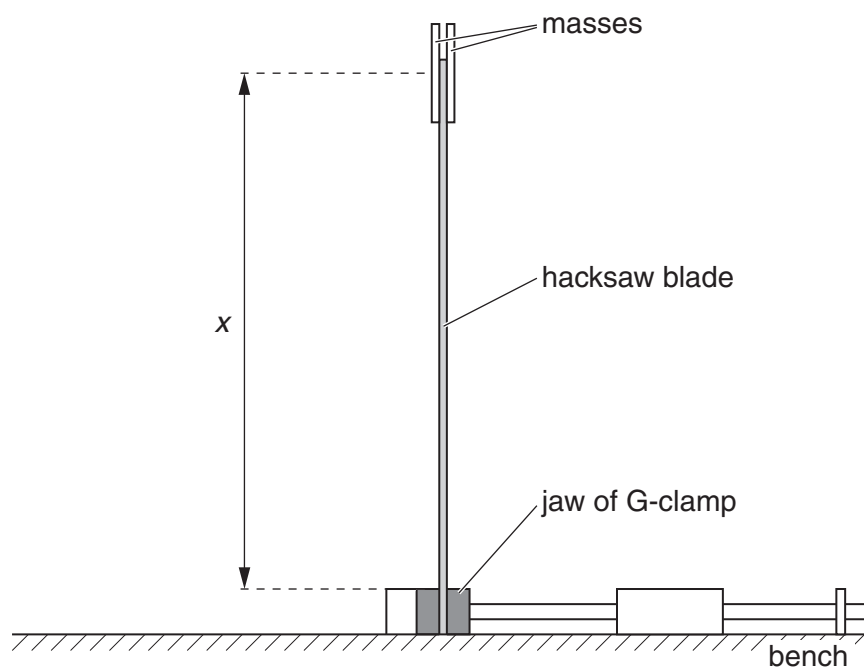


Fig. 2.2

- (ii)** Measure and record the distance x between the top of the jaw of the G-clamp and the centre of the masses, as shown in Fig. 2.2.

$x =$ [2]

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

percentage uncertainty = ...[1]

- (c) (i) Gently displace the top end of the hacksaw blade to the left. Release the blade and watch the movement. The blade will move to the right and back towards the left, completing a swing as shown in Fig. 2.3.

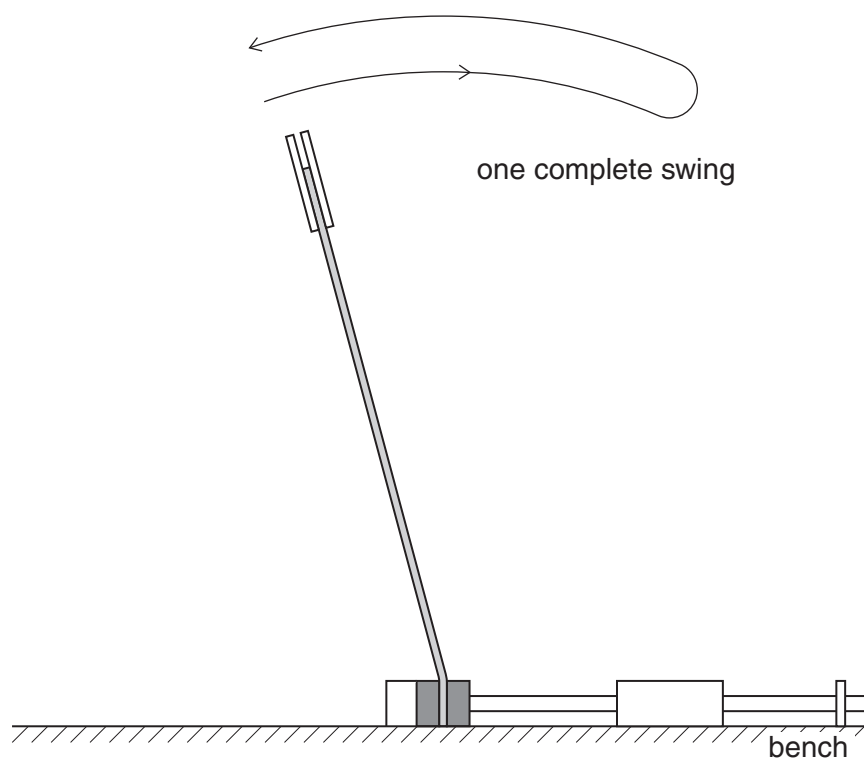


Fig. 2.3

- (ii) The time taken for one complete swing is T . By timing several of these complete swings, determine an accurate value for T .

$T = \dots\dots\dots$ [2]

- (iii) Calculate the frequency f of the swings where $f = \frac{1}{T}$.

$f = \dots\dots\dots$ Hz [1]

--

- (d) (i) Reduce x by attaching the masses to another position on the hacksaw blade.
- (ii) Repeat (b)(ii) and (c).

$x =$

--

$T =$

$f =$ Hz
[3]

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

$$f^2 = \frac{k}{x^3}$$

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.

.....

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.....

..... [1]

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

1.

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2.

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[4]



- (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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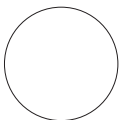
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1 In this experiment, you will investigate the equilibrium of a rod supported by a spring.

(a) The apparatus has been assembled for you as shown in Fig. 1.1.

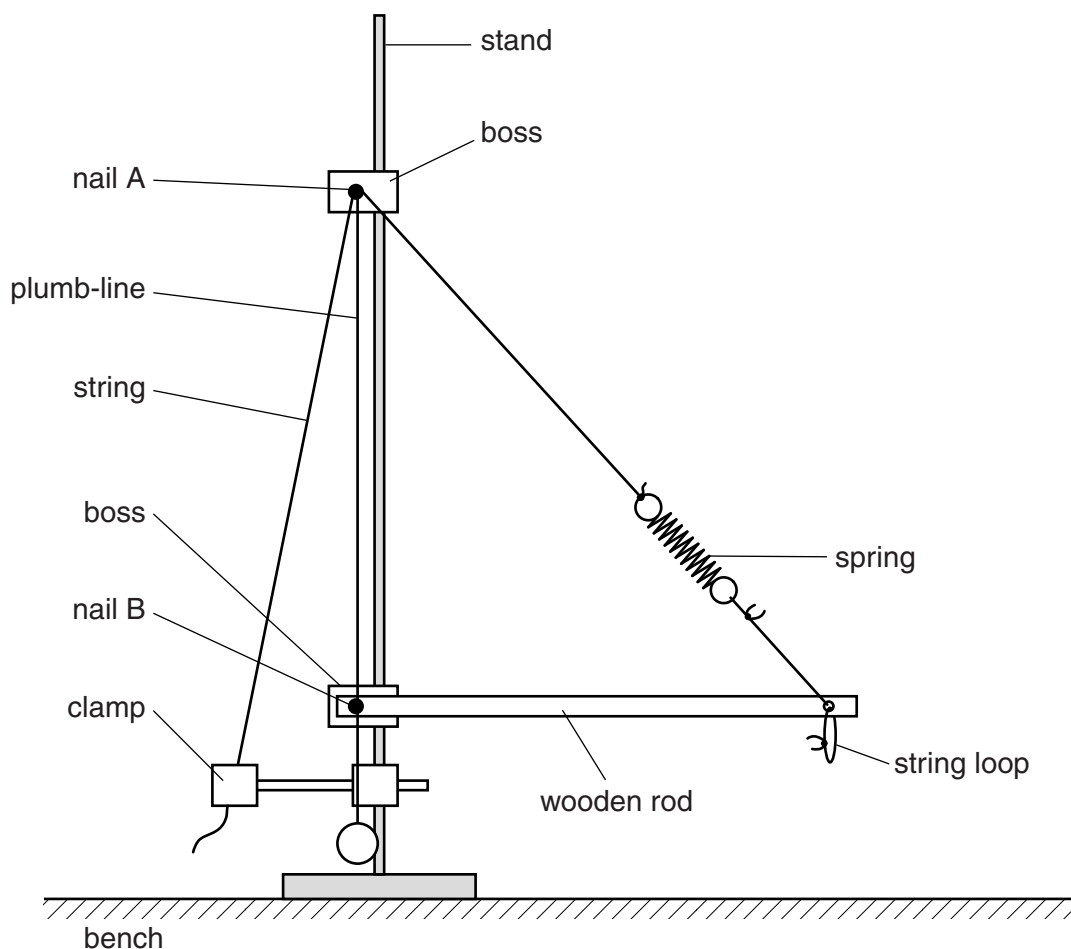


Fig. 1.1

(i) Lift the end of the rod attached to the spring so that there is no tension in the spring. Measure and record the unstretched length l_0 of the spring, as shown in Fig. 1.2.

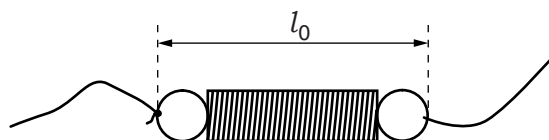


Fig. 1.2

$l_0 = \dots\dots\dots$ cm [1]

(ii) Release the end of the rod. Suspend the mass M from the string loop.

- (b) (i) Move the string in the clamp to make the rod horizontal.
- (ii) Use the plumb-line to ensure that nail B is vertically below nail A, as shown in Fig. 1.3.

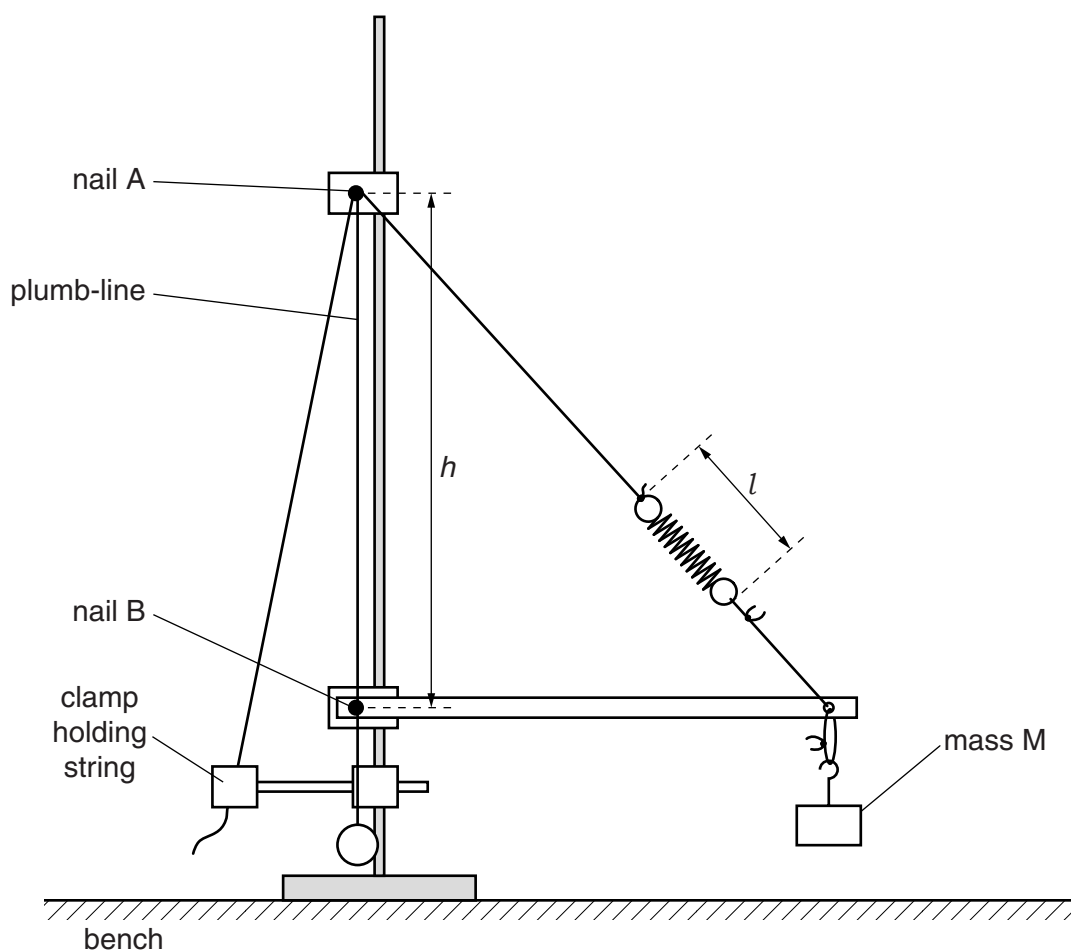


Fig. 1.3

- (iii) Measure and record the distance h between the two nails, and the length l of the spring, as shown in Fig. 1.3.

$h = \dots\dots\dots$ cm

$l = \dots\dots\dots$ cm
[1]



- (c) Raise nail B and repeat (b) until you have six sets of values of h and l .

Include values for $\frac{1}{h^2}$ and $(l - l_0)^2$ in your table.

--

[10]

- (d) (i) Plot a graph of $(l - l_0)^2$ on the y -axis against $\frac{1}{h^2}$ on the x -axis.

[3]

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

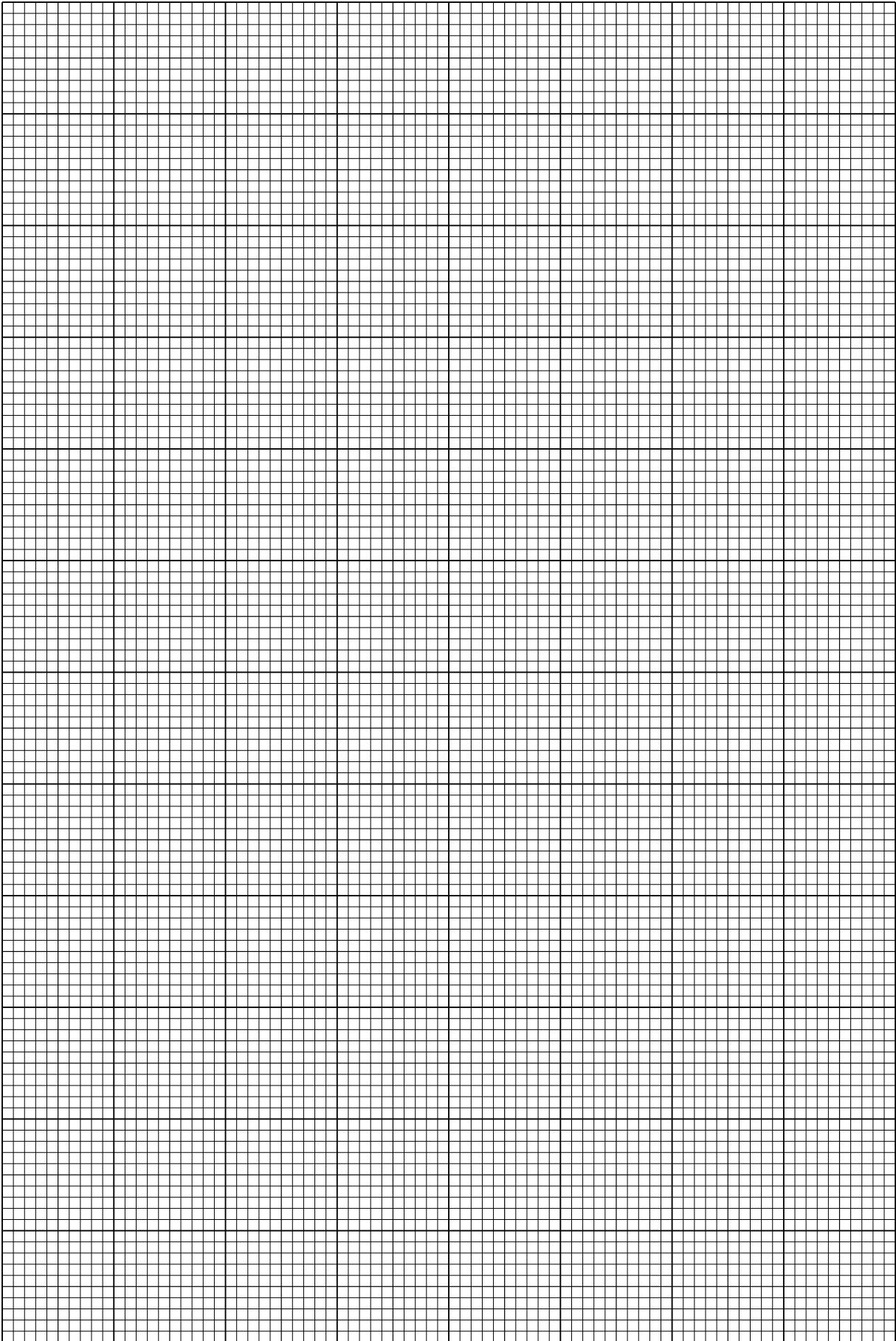
[1]

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

gradient = ...

y -intercept = ...

[2]



- (e) The quantities l and h are related by the equation

$$(l - l_0)^2 = \frac{p}{h^2} + q$$

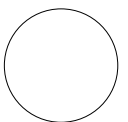
where p and q are constants.

Using your answers from (d)(iii), determine the values of p and q .
Give appropriate units.

$p =$

$q =$

[2]



Please turn over for Question 2.

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

2 In this experiment, you will investigate the motion of a mass and a spring.

(a) You are provided with a spring.

- (i)** Measure and record the diameter d of the coiled section of the spring as shown in Fig. 2.1. Record the number n of turns in the coiled section.

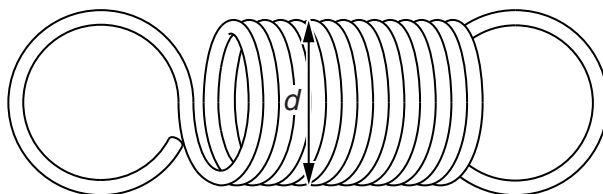


Fig. 2.1

$d =$ cm

$n =$ [1]

- (ii)** Calculate the length l of wire used to make the coiled section of the spring using the relationship $l = \pi nd$.

$l =$ cm [1]

- (b) (i)** Set up the apparatus as shown in Fig. 2.2 with mass 1 suspended from the spring and secured with Blu-Tack.

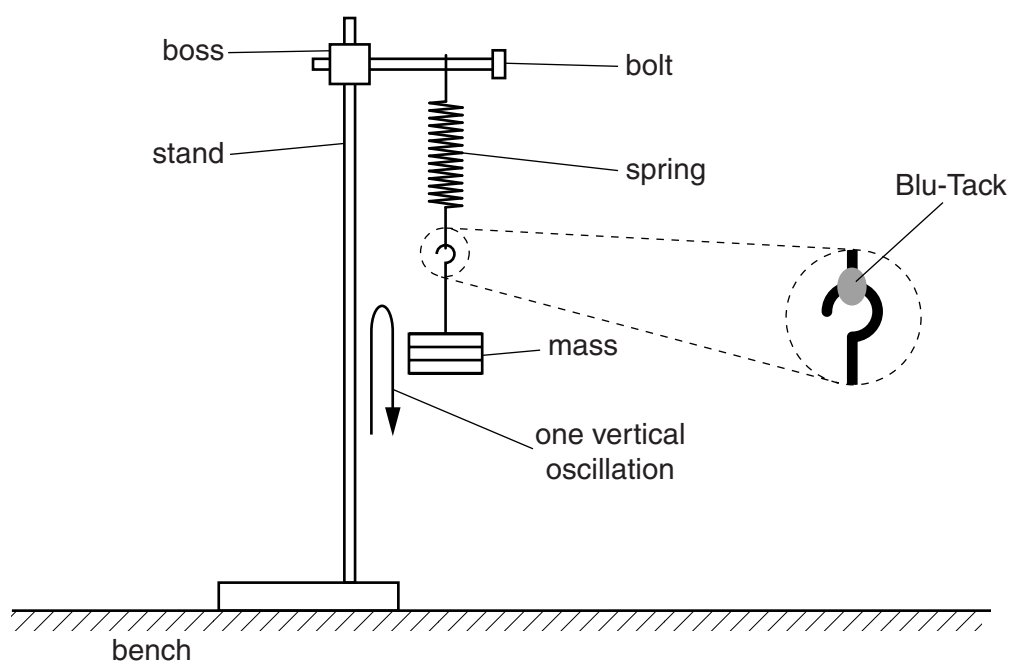


Fig. 2.2

- (ii) Pull the mass down approximately 2 cm and release it. One vertical oscillation is shown in Fig. 2.2. Measure and record the time t for the mass to make 10 vertical oscillations.

$t = \dots\dots\dots$ [2]

- (c) (i) Lower the bolt until the bottom of the stationary mass is approximately 6 cm above the bench, as shown in Fig. 2.3.

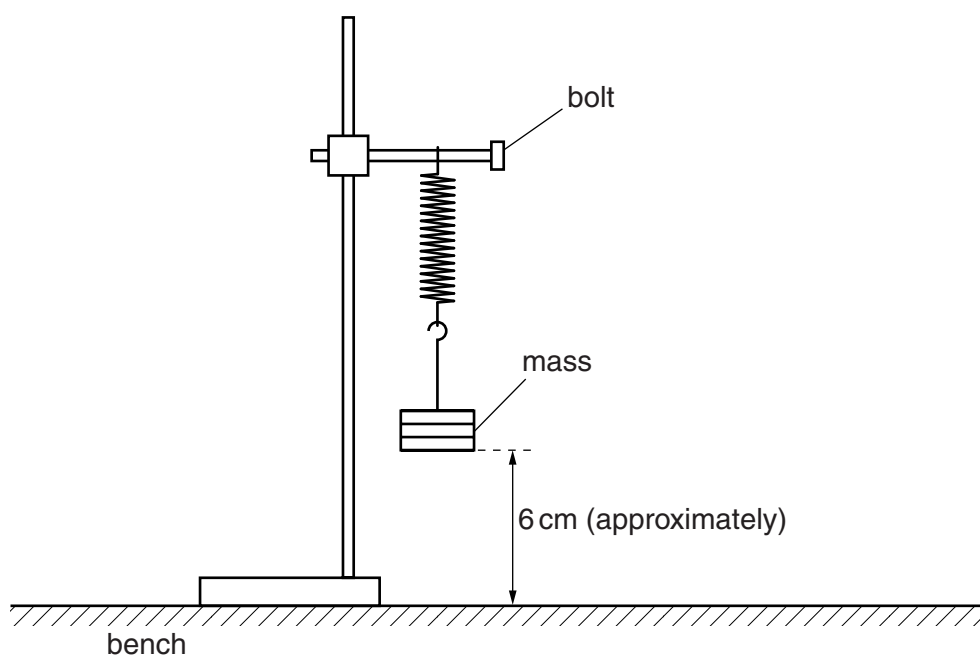


Fig. 2.3

- (ii) Pull the mass down until it touches the bench. Release the mass and watch the loop on the bolt, looking to see if the loop rises above the bolt producing a gap as shown in Fig. 2.4.

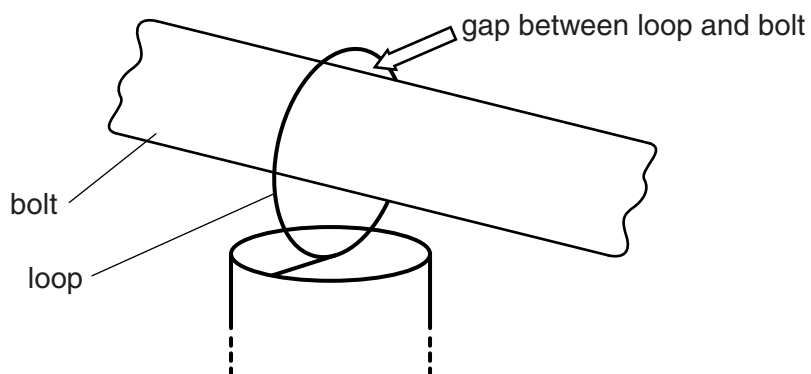


Fig. 2.4

- (iii) Keep raising the bolt and repeating (ii) until the loop just rises above the bolt at the top of the first oscillation.
With the mass stationary, measure and record the distance A from the bottom of the mass to the bench.

$A = \dots\dots\dots$ [1]

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

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

- (e) Detach the mass from the spring. Repeat (b) and (c) using mass 2.

$t = \dots\dots\dots$

$A = \dots\dots\dots$
[2]

- (f) It is suggested that the relationship between A , t and l is

$$A = kt^2l$$

where k is a constant.

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

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

second value of $k = \dots\dots\dots$
[2]

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

.....

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.....[1]

☐

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

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.....[1]

☐

- (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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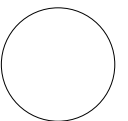
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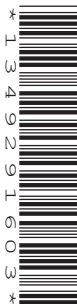
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- 1** In this experiment, you will investigate how the current in a circuit varies as the resistance of the circuit is changed.

- (a)** Measure and record the length L of wire between the crocodile clips on the wire labelled F.

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



- (b)** Set up the circuit as shown in Fig. 1.1.

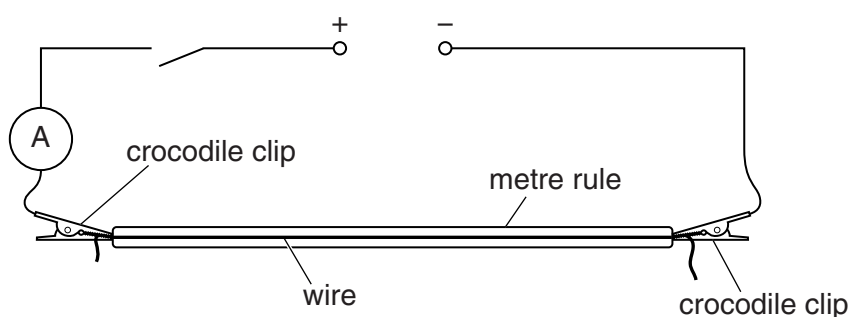


Fig. 1.1

- (c) (i)** Attach wire F to the wire on the metre rule as shown in Fig. 1.2.

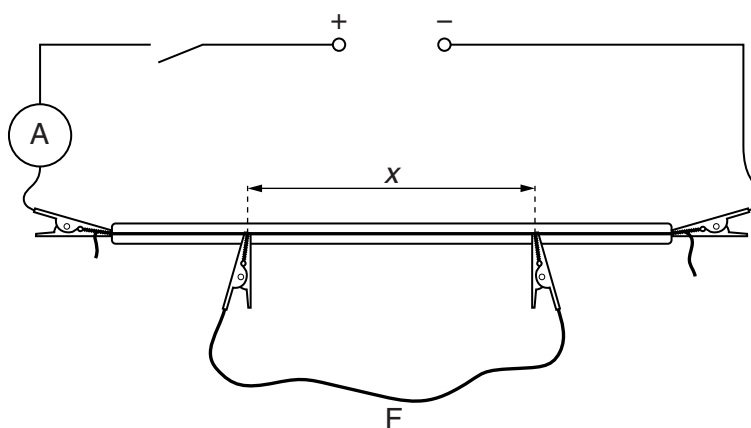


Fig. 1.2

The distance x between the crocodile clips should be approximately 50 cm.

- (ii)** Measure and record x .

$x = \dots\dots\dots$

(d) (i) Close the switch.

(ii) Record the ammeter reading I .

$I = \dots\dots\dots$ [1]

(iii) Open the switch.

(e) Change x and repeat (c)(ii) and (d) until you have six sets of readings of x and I .

Include values of $\frac{x^2}{(x+L)}$ and $\frac{1}{I}$ in your table.

[10]

(f) (i) Plot a graph of $\frac{1}{I}$ on the y -axis against $\frac{x^2}{(x+L)}$ on the x -axis.

[3]

(ii) Draw the straight line of best fit.

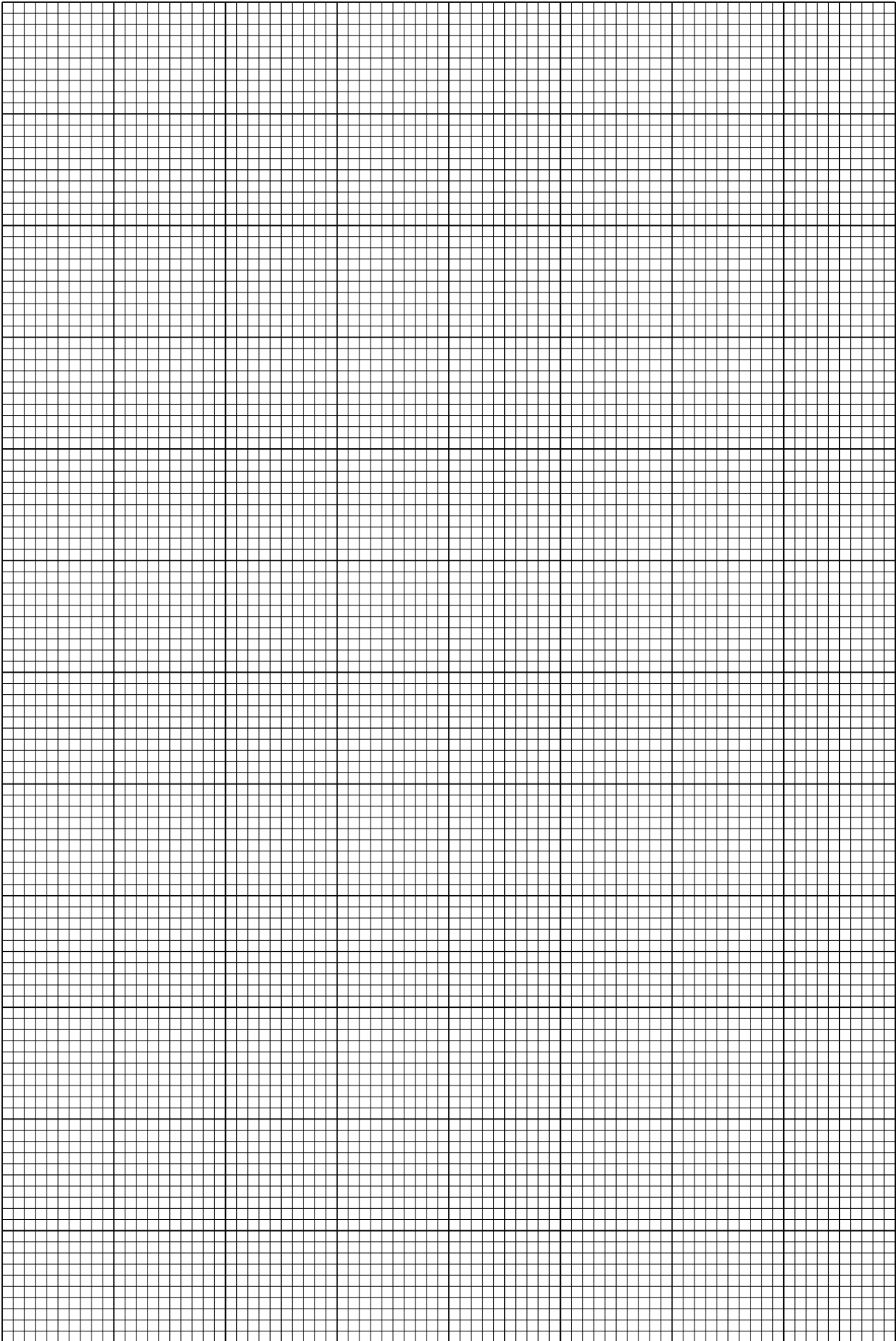
[1]

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

gradient = $\dots\dots\dots$

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

[2]



- (g) The quantities I , x and L are related by the equation

$$\frac{1}{I} = -\frac{Px^2}{(x+L)} + Q$$

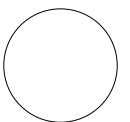
where P and Q are constants.

Using your answers in (f)(iii), determine values for P and Q .
Give appropriate units.

$P =$

$Q =$

[2]



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

- 2** In this experiment, you will investigate how the motion of a sphere on a track depends on the radius of the track.

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

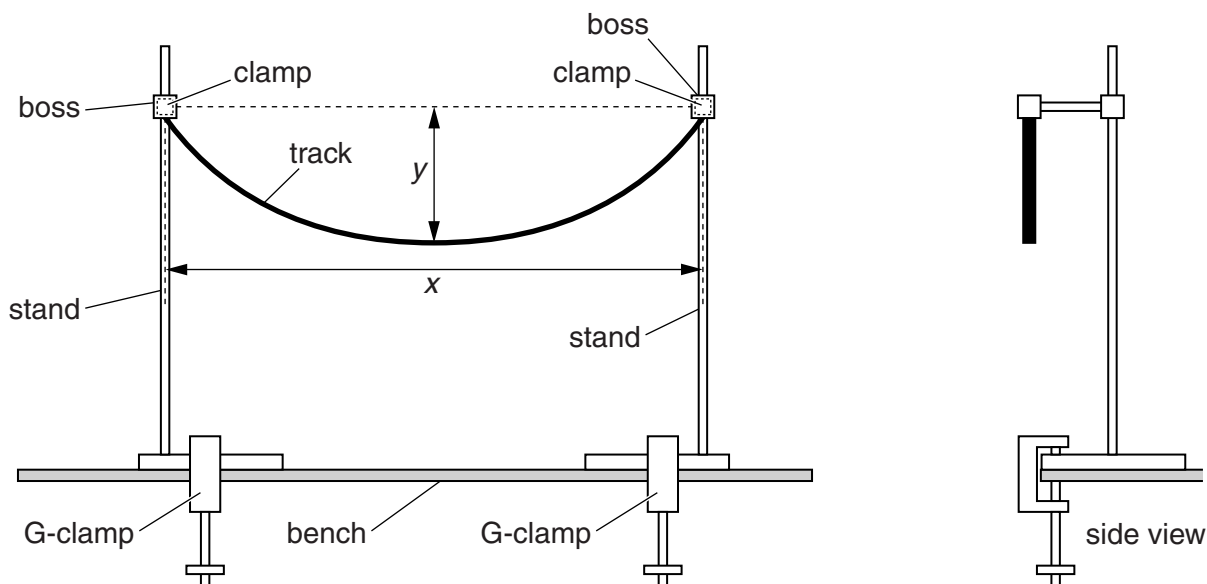


Fig. 2.1

The distance x is the horizontal distance between the ends of the track.

The distance y is the vertical distance between the top and bottom of the track.

The distance y should be approximately 10 cm.

- (b) (i)** Measure and record the distance y as shown in Fig. 2.1.

$y = \dots\dots\dots$ [1]

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

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

- (iii) Measure and record the distance x as shown in Fig. 2.1.

$x = \dots\dots\dots$ [1]

- (iv) Calculate the radius R of the track where R is given by

$$R = \frac{x^2}{8y} + \frac{y}{2}.$$

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

- (c) (i) Place a sphere on the track as shown in Fig. 2.2.

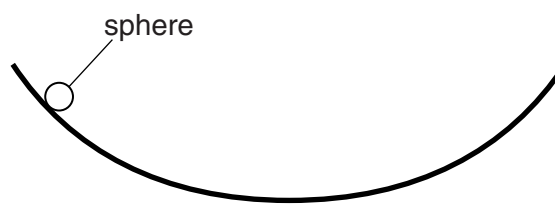


Fig. 2.2

- (ii) Release the sphere and watch the movement.
The sphere will move down one side of the track and up the other side before returning, completing a cycle as shown in Fig. 2.3.

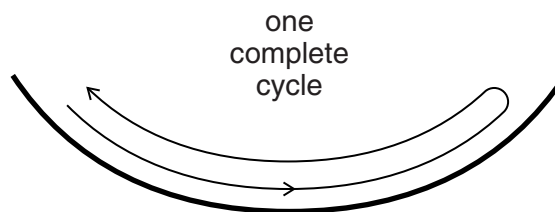


Fig. 2.3

- (iii) The time taken for one complete cycle is T .
By timing several of these complete cycles, determine an accurate value for T .

$T = \dots\dots\dots$ [2]

- (d) Reduce x by approximately 5 cm and repeat (b)(i), (b)(iii), (b)(iv) and (c).

$y = \dots\dots\dots$

$x = \dots\dots\dots$

$R = \dots\dots\dots$

--

$T = \dots\dots\dots$

[3]

- (e) It is suggested that the relationship between T and R is

$$T^2 = kR$$

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.

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..... [1]

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

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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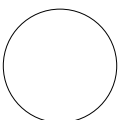
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- 1** In this experiment, you will investigate the motion of a system of masses as its shape is changed.

- (a)** You are provided with a length of wire, bent into two arms, with a mass attached at the end of each arm as shown in Fig. 1.1.

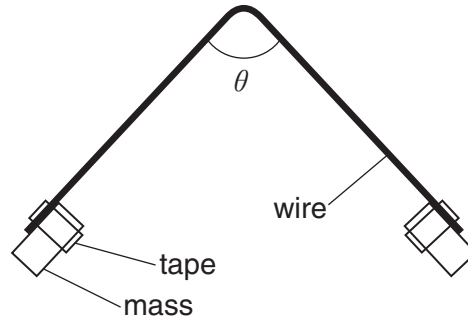


Fig. 1.1

- (i)** Measure and record the angle θ between the two arms.

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

- (ii)** Calculate $\sin^2\left(\frac{\theta}{2}\right)$, where

$$\sin^2\left(\frac{\theta}{2}\right) = \sin\left(\frac{\theta}{2}\right) \times \sin\left(\frac{\theta}{2}\right).$$

$$\sin^2\left(\frac{\theta}{2}\right) = \dots\dots\dots$$

- (b) You are provided with a spring suspended from a stand. A hook is suspended from the bottom of the spring. Hang the wire from the upper part of the hook and hang the mass hanger from the lower part of the hook as shown in Fig. 1.2.

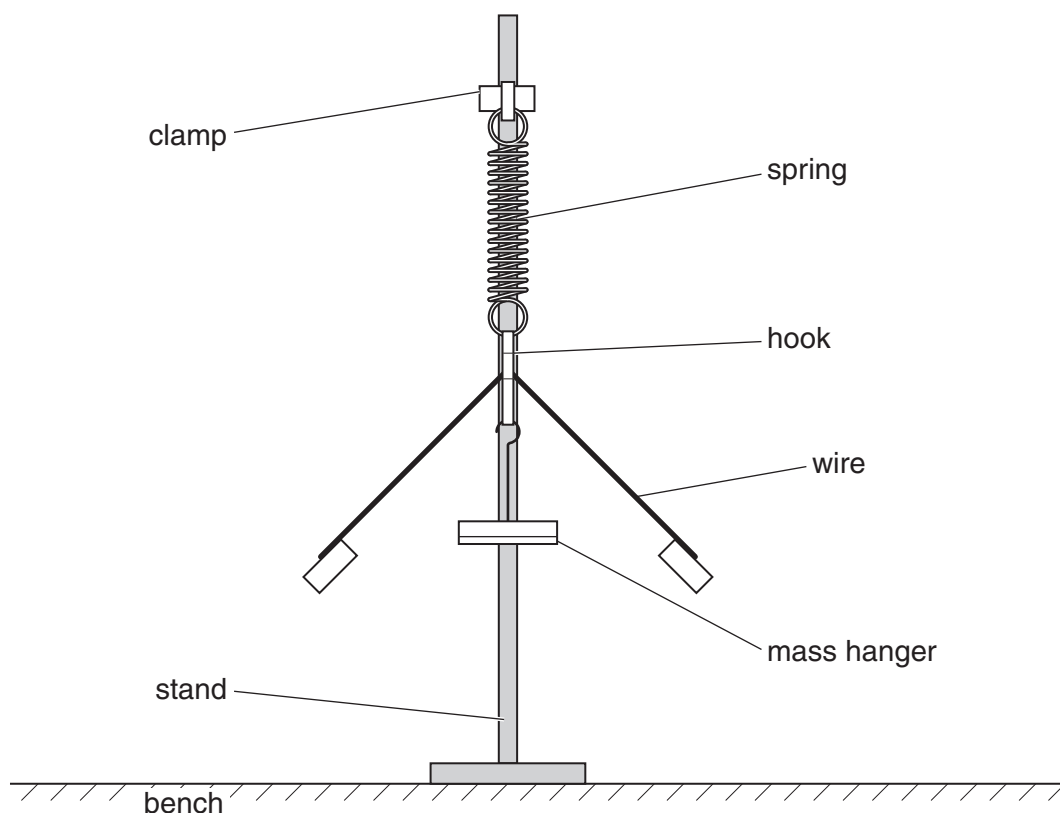


Fig. 1.2

- (i) Twist the mass hanger through about 45° and release it so that the mass hanger and wire rotate back and forth as shown in Fig. 1.3.

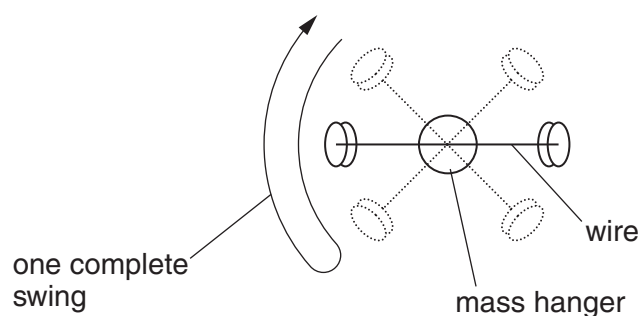


Fig. 1.3 (top view)

- (ii) Measure and record the time t for the mass hanger and wire to make 5 complete swings.

$t = \dots\dots\dots$ [2]

- (c) Remove the wire from its hook. Bend the wire to change the angle θ . The arms of the wire must remain straight.

Repeat **(a)** and **(b)** until you have five sets of readings for θ and t .

Include values for t^2 and $\sin^2\left(\frac{\theta}{2}\right)$ in your table.

--

[9]

- (d) (i) Plot a graph of t^2 on the y -axis against $\sin^2\left(\frac{\theta}{2}\right)$ on the x -axis.

[3]

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

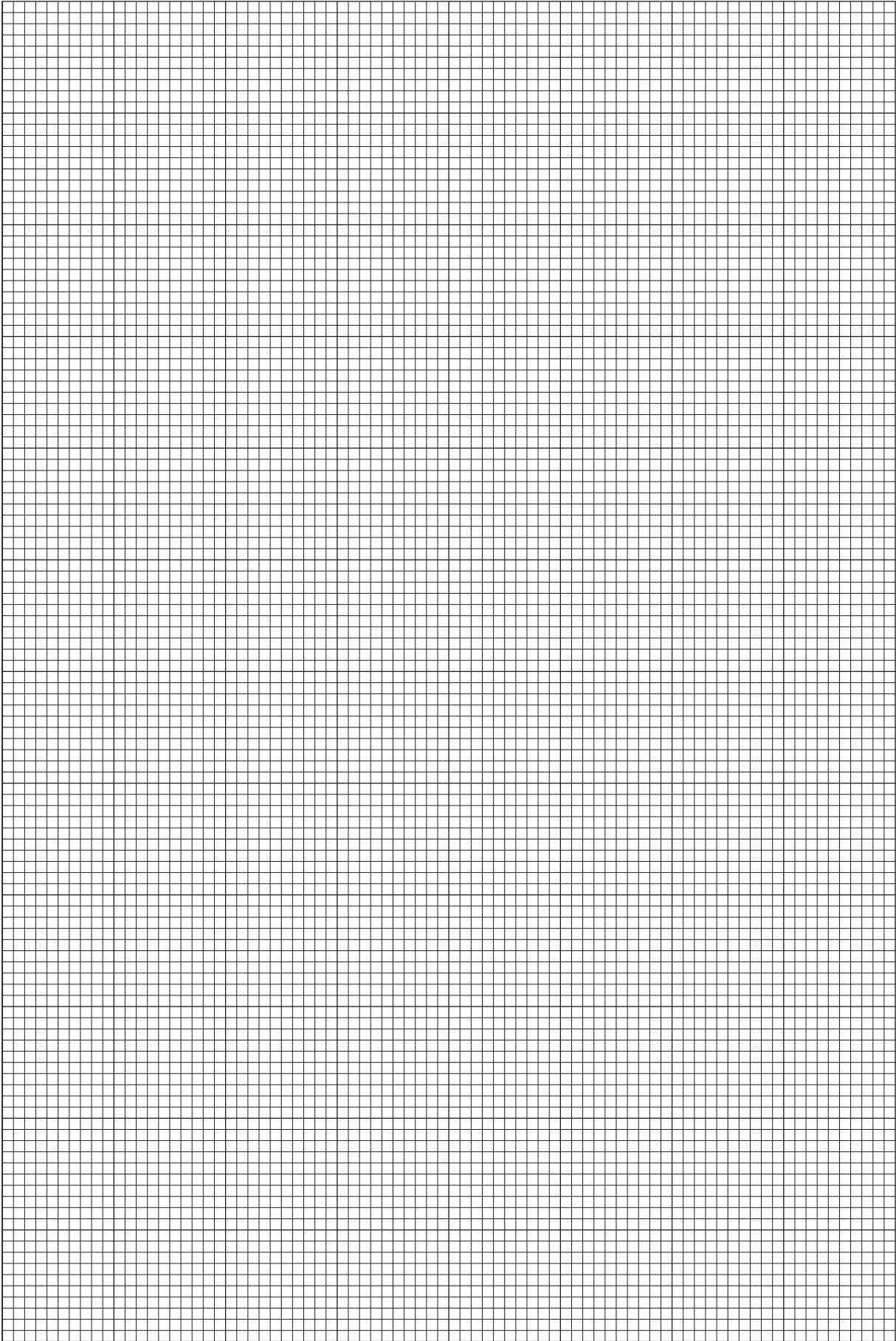
[1]

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

gradient = ...

y -intercept = ...

[2]



- (e) The quantities t and θ are related by the equation

$$t^2 = p + q \sin^2\left(\frac{\theta}{2}\right)$$

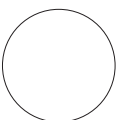
where p and q are constants.

Using your answers from (d)(iii), determine the values of p and q .
Give appropriate units.

$p =$

$q =$

[2]



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

2 In this experiment, you will investigate the collision between two spheres.

- (a) You are provided with two spheres. Take measurements to find the average **radius** r of the spheres.

$r = \dots\dots\dots$ mm [1]

- (b) You are provided with a flat board, as shown in Fig. 2.1.

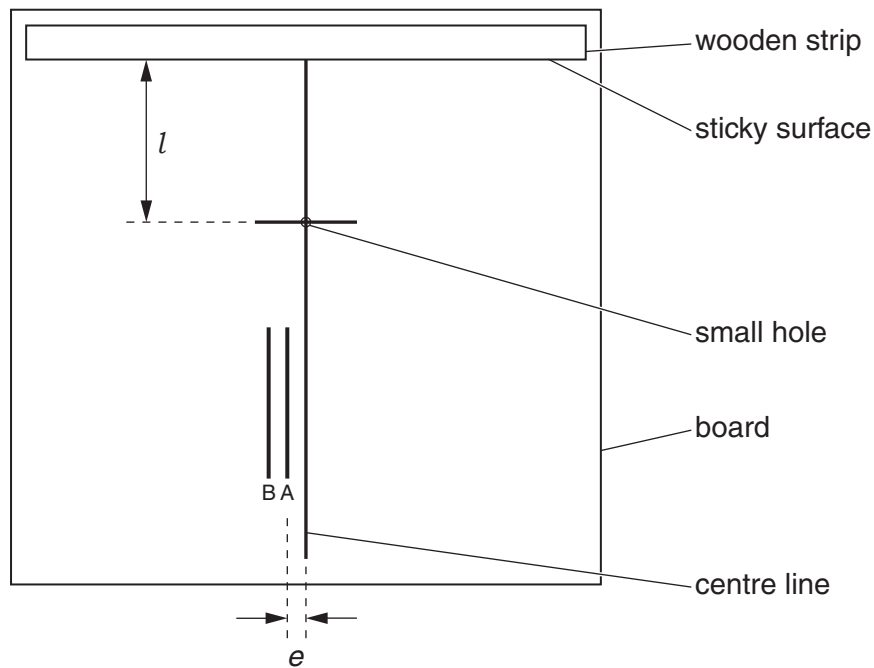


Fig. 2.1

A wooden strip with a sticky surface is attached to the board, and there is a small hole in the board.

- (i) Measure and record the distance l between the small hole and the sticky surface.

$l = \dots\dots\dots$ mm [1]

- (ii) Measure and record the perpendicular distance e between the centre line and the line labelled A.

$e = \dots\dots\dots$ mm [1]

- (c) (i) You are provided with a ramp with a groove in it. Position the ramp on the board with the centre of the groove along line A, and position one of the spheres in the hole, as shown in Fig. 2.2.

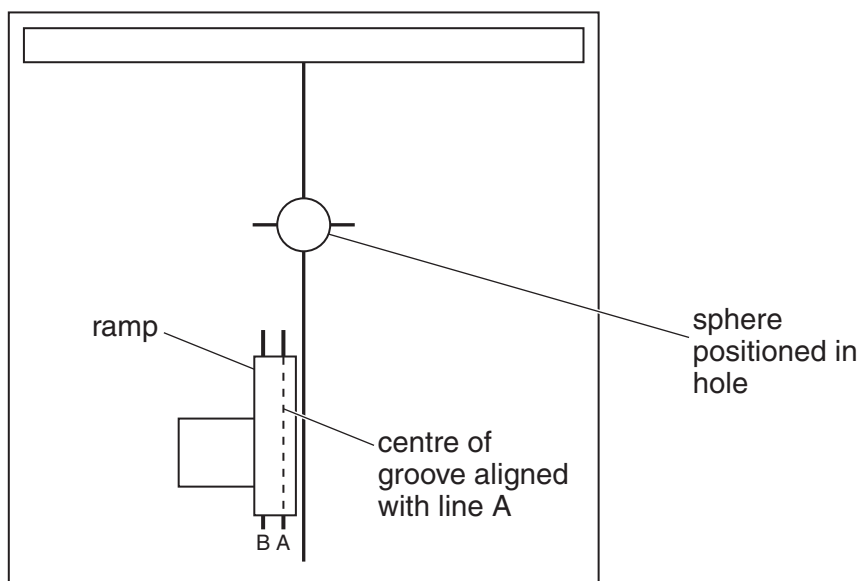


Fig. 2.2

- (ii) Place the second sphere on the groove and release it so that it rolls down and hits the sphere in the hole. Both spheres will roll forward and hit the wooden strip. Measure and record the distance x between the centre of the right-hand sphere and the centre line, as shown in Fig. 2.3.

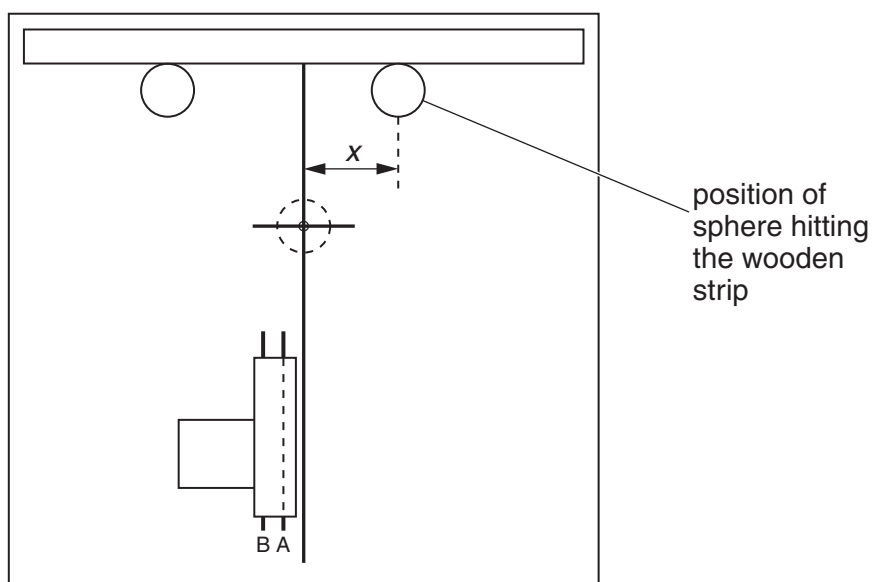


Fig. 2.3

$x = \dots\dots\dots$ mm [2]



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

percentage uncertainty = ... [1]

- (iv) Before the sphere hits the wooden strip, its path makes an angle θ with the centre line. Calculate θ using the relationship

$$\tan \theta = \left(\frac{x}{l-r} \right).$$

$\theta =$ [2]

- (d) Repeat (b)(ii), (c)(i), (c)(ii) and (c)(iv) with the distance e measured to line B and the centre of the groove along line B.

$e =$ mm

$x =$ mm

$\theta =$ [1]

- (e) It is suggested that the relationship between θ , e and r is

$$\sin \theta = \frac{ke}{2r}$$

where k is a constant.

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

first value of k = ...

second value of k = ...

[2]

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

.....

 [1]

--

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

1.

.....

2.

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3.

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4.

.....

[4]



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

1.

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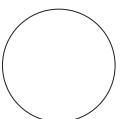
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PHYSICS

Paper 3 Advanced Practical Skills 1

9702/35

May/June 2014

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

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 an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

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.

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

Electronic calculators may be used.

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.

At the end of the examination, fasten all your work securely together.

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

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

- 1** In this experiment, you will investigate a system in equilibrium due to several forces.

- (a)** You have been provided with a wooden beam with 11 holes.

Measure and record the distance k along the wooden beam between the centres of hole 1 and hole 5 as shown in Fig. 1.1.

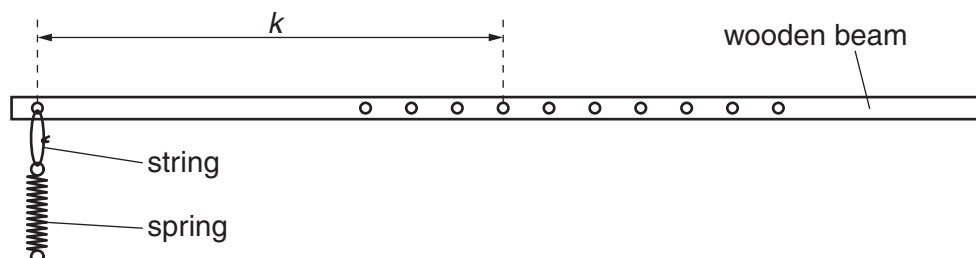


Fig. 1.1

$k = \dots\dots\dots$

- (b) (i)** Set up the apparatus as shown in Fig. 1.2 with the nail through hole 6 of the wooden beam.

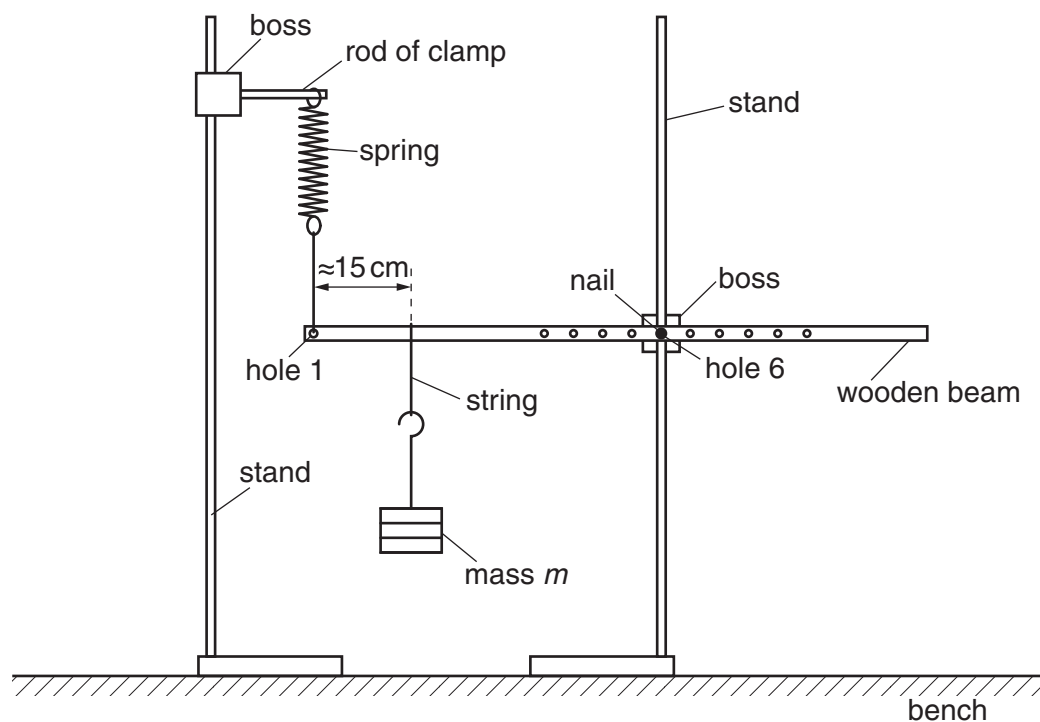


Fig. 1.2

The mass m is 300 g. Position the mass m approximately 15 cm from hole 1.

- (ii) Adjust the apparatus so that the spring is vertical and the wooden beam is horizontal.

The distance a is the distance between the nail and the string attached to the spring.

The distance b is the distance between the nail and the string attached to the mass as shown in Fig. 1.3.

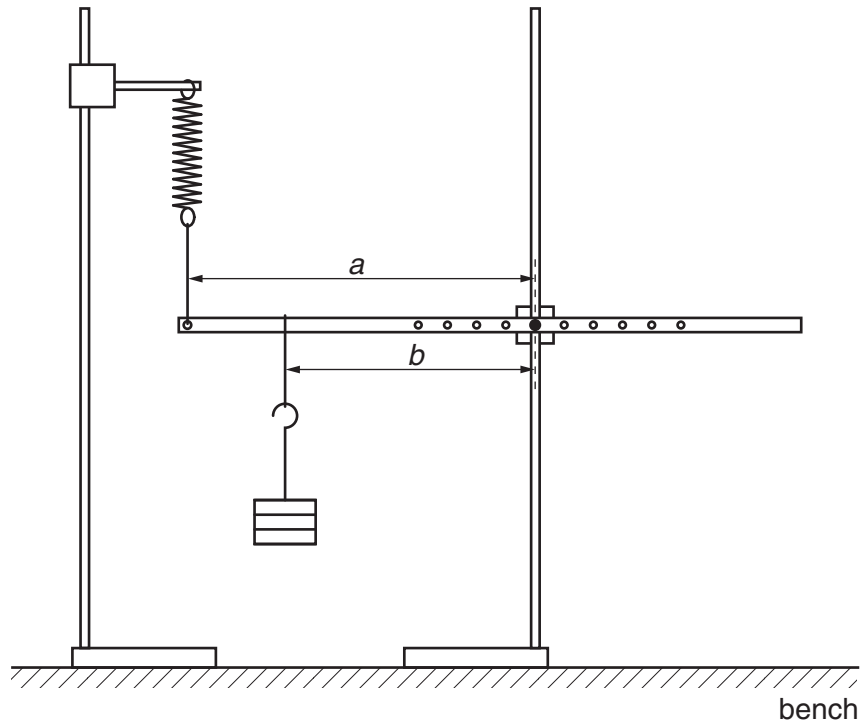


Fig. 1.3

- (iii) Measure and record a and b .

$a =$

$b =$

[1]



- (iv) Measure and record the length L of the stretched spring as shown in Fig. 1.4.

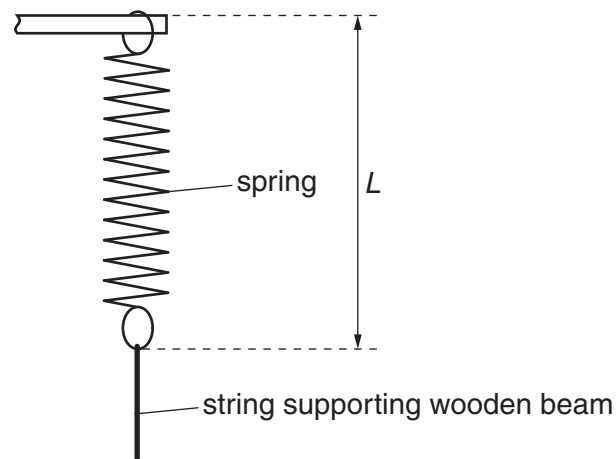


Fig. 1.4

$L =$ [1]

- (c) Vary a by moving the nail to a different hole.

Adjust b until the value of L is the same as in (b)(iv).

Ensure that the spring is vertical and the beam is horizontal.

Measure and record a and b .

$a =$

$b =$

(d) Repeat (c) until you have six sets of readings of a and b .

Include values of $\frac{1}{b}$ and $\frac{a}{b}$ in your table.

[10]

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

[3]

(ii) Draw the straight line of best fit.

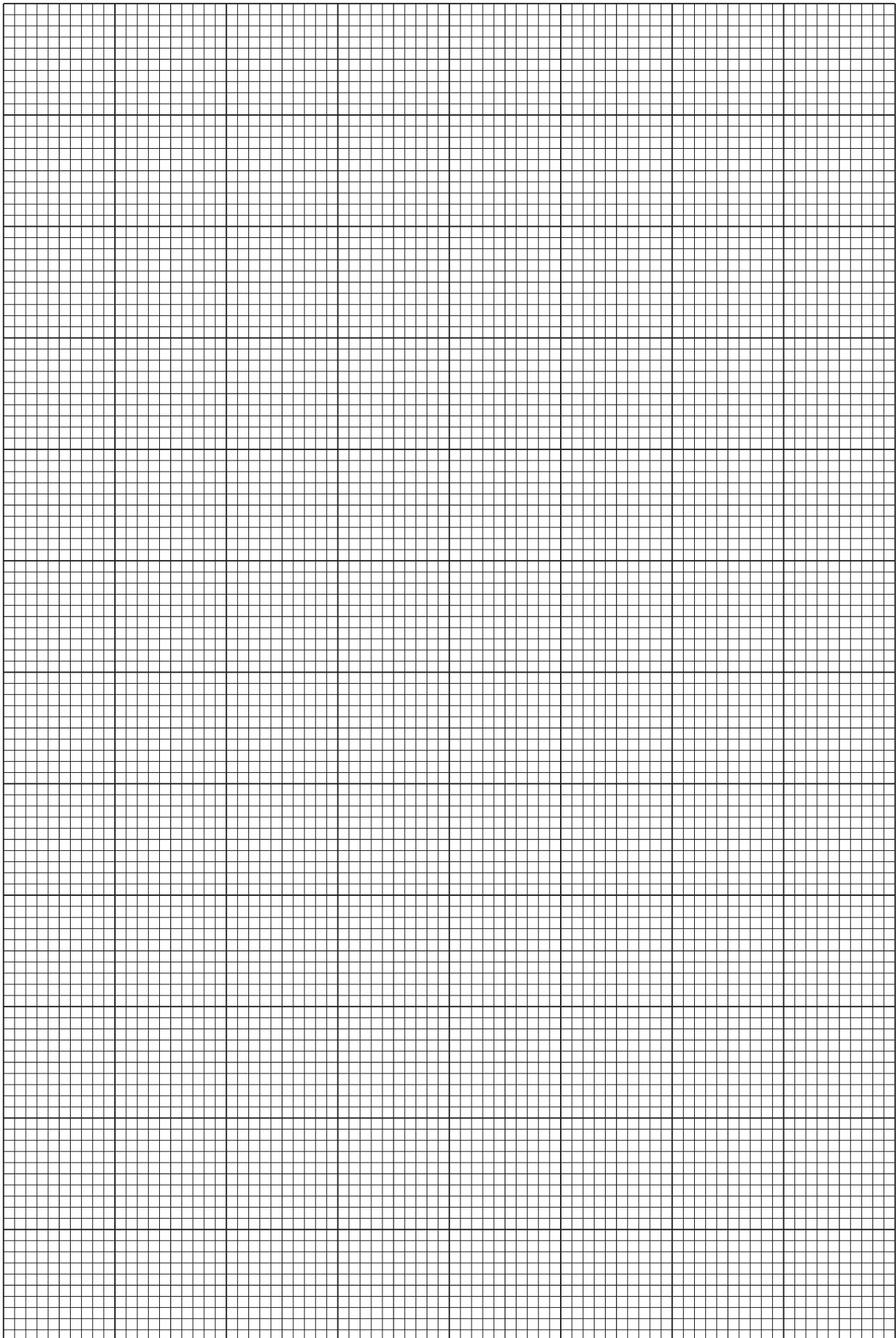
[1]

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

gradient = ...

y -intercept = ...

[2]



- (f) The quantities a and b are related by the equation

$$\frac{1}{b} = -\frac{Pa}{b} + Q$$

where P and Q are constants.

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

Give appropriate units.

$$P = \dots\dots\dots$$

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

☐

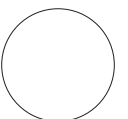
- (g) The mass M of the wooden beam is given by

$$M = \frac{m}{kQ}.$$

Use values in (a), (b)(i) and (f) to determine the value of M .

Include a unit for M .

$$M = \dots\dots\dots [1]$$

☐


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

- 2** In this experiment, you will investigate how the extension of a Plasticine cylinder under an applied load depends on the diameter of the cylinder.

- (a) (i)** Use the boards to roll the Plasticine into a cylinder of uniform diameter and approximate length 20 cm as shown in Fig. 2.1.

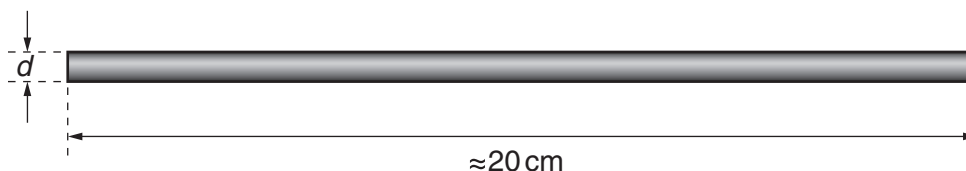


Fig. 2.1

- (ii)** Use the micrometer to measure the diameter d of the cylinder as shown in Fig. 2.1. Record d .

$d =$ [3]

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

percentage uncertainty = ... [1]

--

- (b) (i) Make two **shallow** marks on the Plasticine cylinder as shown in Fig. 2.2. The distance x between the marks should be approximately 10 cm.

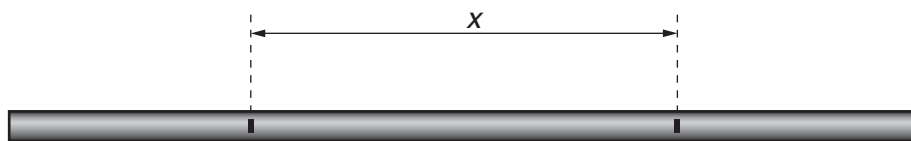


Fig. 2.2

The marks should not be deep enough to affect the strength of the cylinder.

- (ii) Measure and record x .

$x =$

- (c) (i) Attach the clip to one end of the cylinder. Hold the other end of the cylinder so that it hangs vertically as shown in Fig. 2.3.

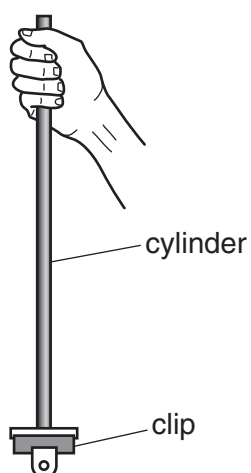


Fig. 2.3

- (ii) Suspend a mass of 400 g from the clip as shown in Fig. 2.4 for a time of 60 s.

If the cylinder breaks within this time, repeat **(a)**, **(b)** and **(c)(i)** and suspend a mass of 300 g for 60 s. If necessary, cross out your answers and write in your new answers. You will not be penalised for this.

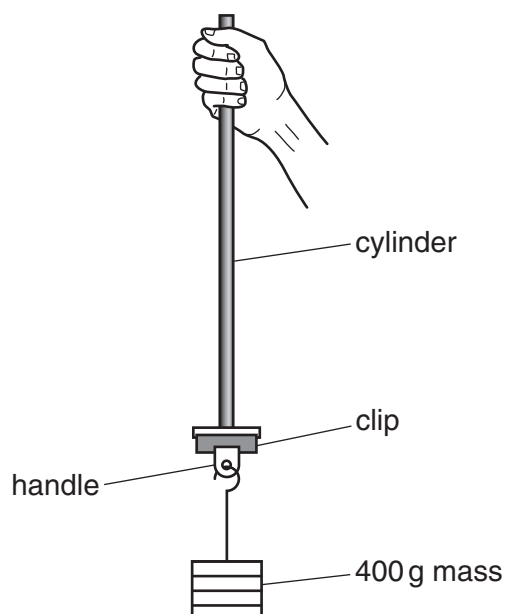


Fig. 2.4

- (iii) Carefully remove the mass and clip from the cylinder.
- (iv) Measure and record the distance x_1 between the two marks on the cylinder.

$x_1 = \dots\dots\dots$ [1]

- (v) Calculate the extension e of the cylinder between the marks using

$$e = x_1 - x.$$

$e = \dots\dots\dots$ [1]

- (d) (i) Use the boards to roll all the Plasticine into a cylinder of uniform diameter and approximate length 15 cm.
- (ii) Using the same mass, repeat (a)(ii), (b) and (c).

$d =$

$x =$

$x_1 =$

$e =$

[3]

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

$$e = \frac{k}{d^4}$$

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]

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

1.

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2.

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[4]



- (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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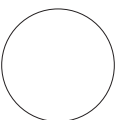
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