

CANDIDATE
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PHYSICS

9702/31

Paper 3 Advanced Practical Skills 1

May/June 2018

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

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Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

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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.

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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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1 In this experiment, you will investigate the oscillations of a mass.

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

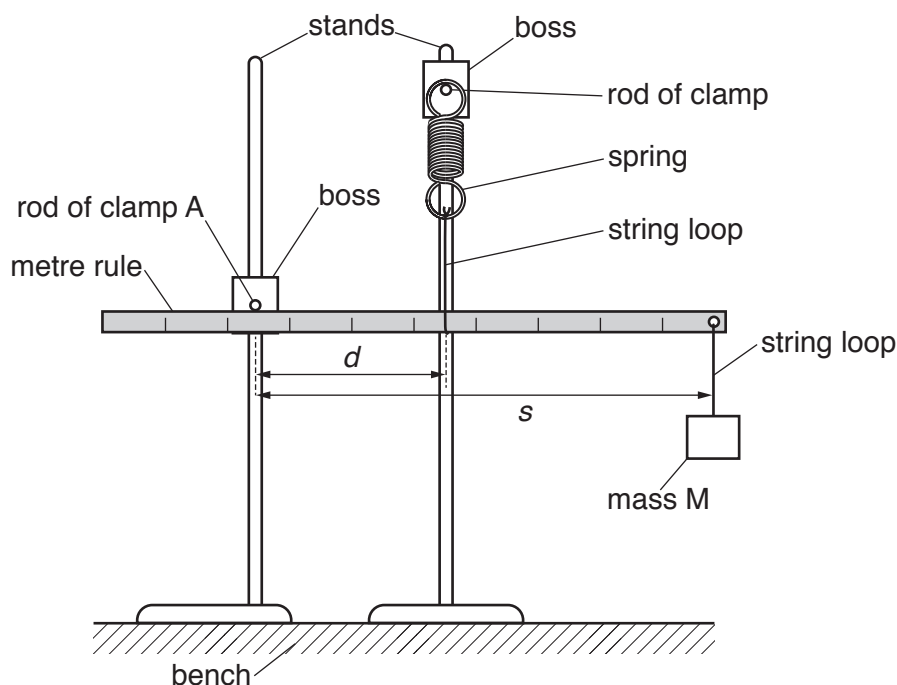


Fig. 1.1

- Hang mass M from the string loop near the end of the metre rule.
- Ensure that the metre rule is pushing up against the rod of clamp A at approximately the 24 cm mark.
- The distance between the rod of clamp A and the string attached to the spring is d . Adjust the position of the stand holding the spring so that d is approximately 30 cm.
- Adjust the height of the clamps until the rule is horizontal. Ensure that the spring is vertical.
- Measure and record d .

$d = \dots\dots\dots$

- The distance between the rod of clamp A and the string supporting M is s .

Measure and record s .

$s = \dots\dots\dots$

[1]

- (b) • Pull M down through a short distance.
- Release M so that it oscillates.
 - Determine the period T of these oscillations.

$T = \dots\dots\dots$ [1]

- (c) • **Without moving the stands**, slide the rule horizontally through the string loop so that d remains constant but s changes.
- Adjust the height of the clamps until the rule is horizontal. Ensure that the spring is vertical.
 - Measure and record s .

$s = \dots\dots\dots$

- Repeat (b).

$T = \dots\dots\dots$
[1]

- (d) Vary s and repeat (c) until you have five sets of values of s and T . You may include your previous sets of readings.

Record your results in a table. Include values of T^2 in your table.

[9]

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

[3]

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

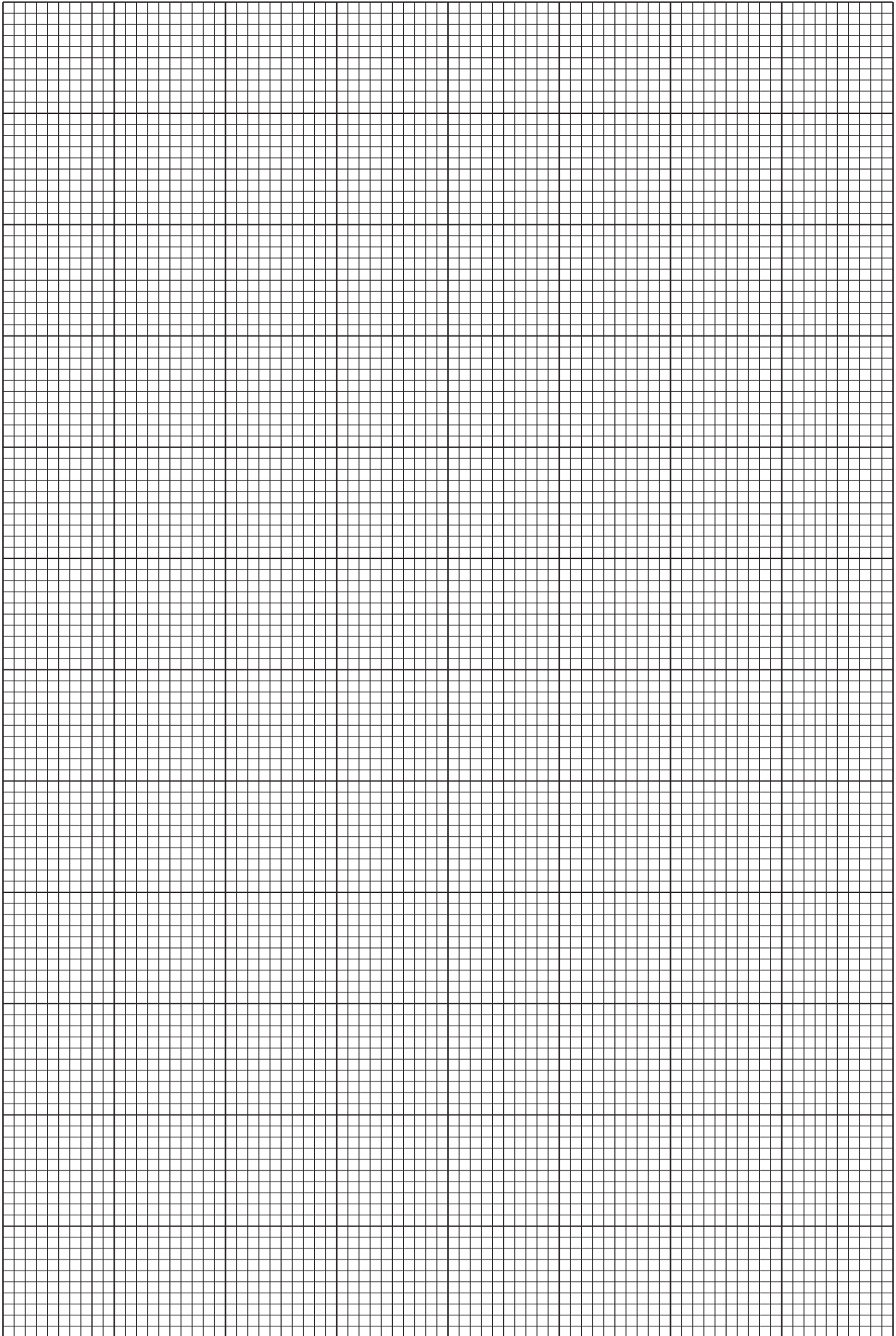
[1]

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

gradient = ...

y -intercept = ...

[2]



- (f) It is suggested that the quantities T and s are related by the equation

$$T^2 = Ps + Q$$

where P and Q are constants.

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

$P =$

$Q =$ [2]

[Total: 20]

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

2 In this experiment, you will investigate the oscillations of a magnet.

(a) You have been provided with a metal plate.

- Use tape to secure the plate at the edge of the bench as shown in Fig. 2.1.

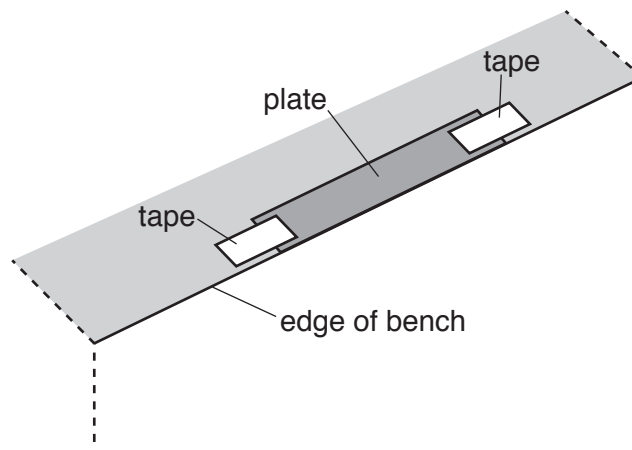


Fig. 2.1

- Use more tape to secure one of the paper strips to the bench so that it covers the plate, as shown in Fig. 2.2.

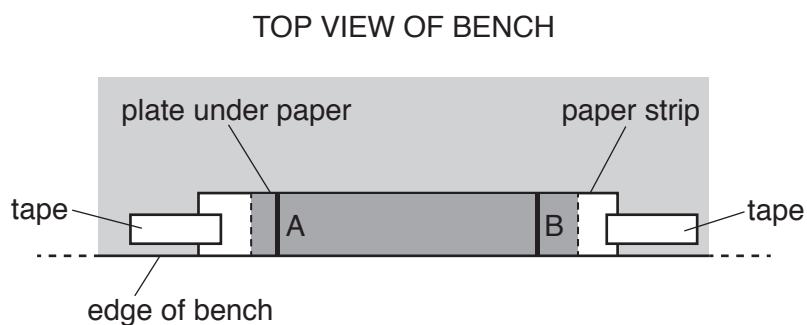


Fig. 2.2

You have been provided with a bar magnet attached to a string.

- Set up the apparatus as shown in Fig. 2.3.

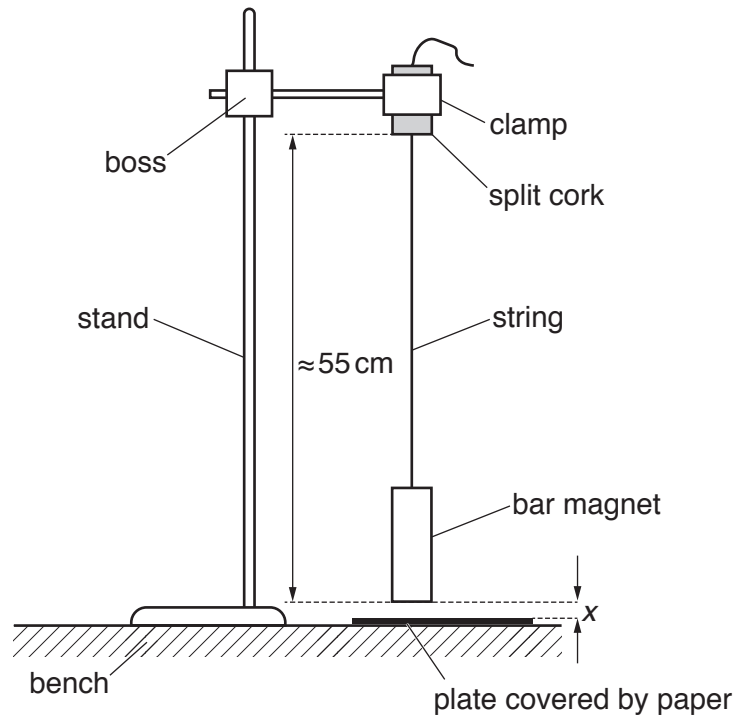


Fig. 2.3

- The distance between the bottom of the split cork and the bottom of the magnet should be approximately 55 cm.
- The distance between the bottom of the magnet and the paper strip is x . Adjust the height of the magnet so that x is approximately 3 mm.
- Measure and record x .

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

- (b) • Move the stand until the magnet hangs with one edge vertically above line A, as shown in Fig. 2.4.

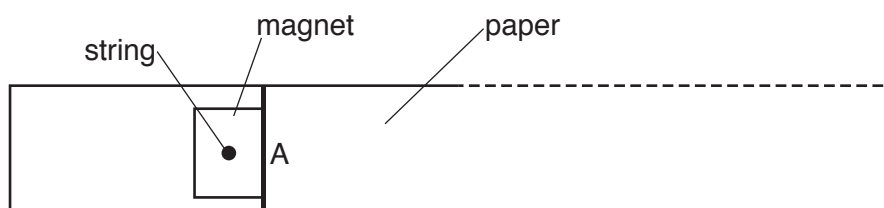


Fig. 2.4

- Pull the magnet to the right, keeping the string straight, until the same edge of the magnet is above line B, as shown in Fig. 2.5.



Fig. 2.5

- Release the magnet. The magnet will oscillate.
- Draw a line on the paper at the position of the edge of the magnet after 30 complete oscillations.
- Label this line C. The distance BC is y as shown in Fig. 2.6.

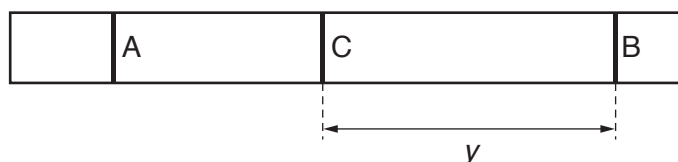


Fig. 2.6

- Measure and record y .

$y = \dots\dots\dots$ [2]

(c) Estimate the percentage uncertainty in your value of y .

percentage uncertainty = ... [1]

- (d) • Increase x to approximately 8 mm.
• Measure and record x .

$x =$

- Repeat (b).

$y =$ [3]

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

$$y = \frac{k}{\sqrt{x}}$$

where k is a constant.

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

first value of $k =$

second value of $k =$

[1]

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

.....

.....

.....

.....[1]

- (f) (i) • Remove the plate and paper strip from the bench. Do not adjust the height of the magnet above the bench.
- Using the second strip of paper, repeat **(b)** without the plate.

$y =$ [1]

- (ii) Using your second value of k , calculate x when y has the value given in **(f)(i)**.

$x =$ [1]

- (iii) Justify the number of significant figures that you have given for your value of x in **(f)(ii)**.

.....

.....

.....[1]

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

1.
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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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[Total: 20]

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May/June 2018

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1 In this experiment, you will investigate the motion of a rolling sphere.

(a) (i) • Assemble the apparatus as shown in Fig. 1.1.

The top end of the track is a distance d above the bench.

The initial value of d should be approximately 5 cm.

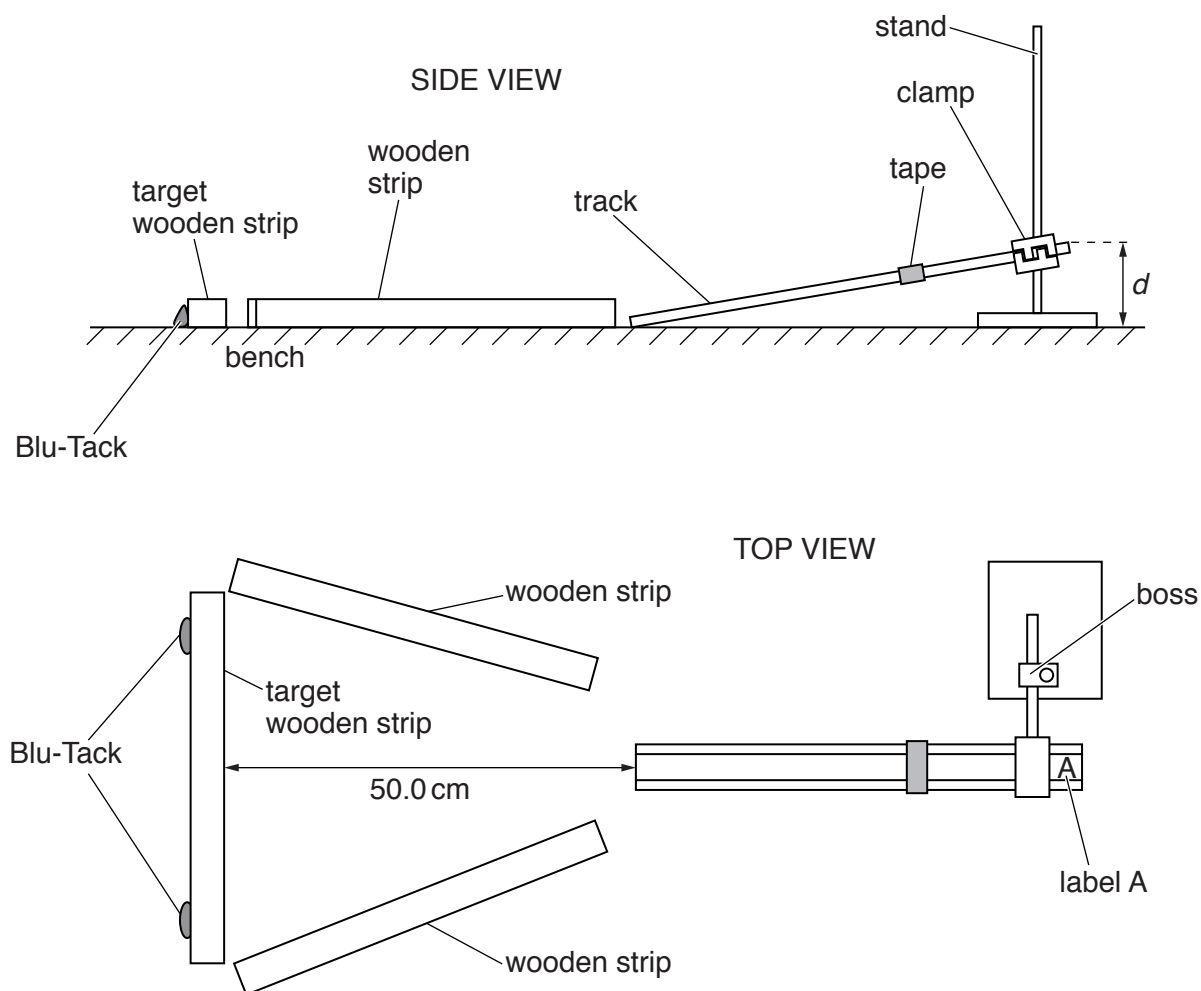


Fig. 1.1

- Ensure that the distance between the bottom of the track and the target wooden strip is 50.0 cm.

- Place the sphere on the track and hold it gently against the tape, as shown in Fig. 1.2.

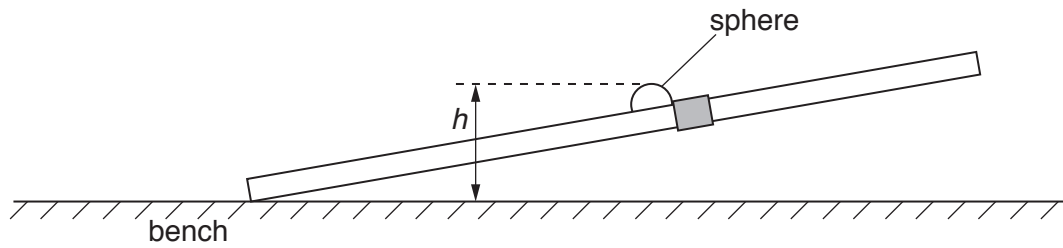


Fig. 1.2

- Measure and record the height h of the top of the sphere above the bench.

$h = \dots\dots\dots$ [1]

- (ii)
 - Release the sphere.

- Measure and record the time t from release for the sphere to reach the target.

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

- (b) Change d and repeat (a) until you have six sets of values of h and t . Do not use values of d greater than 10 cm.

Ensure that the distance from the bottom of the track to the target is **always 50.0 cm**.

Record your results in a table. Include values of $\frac{1}{t^2}$ in your table.

[9]

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

[3]

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

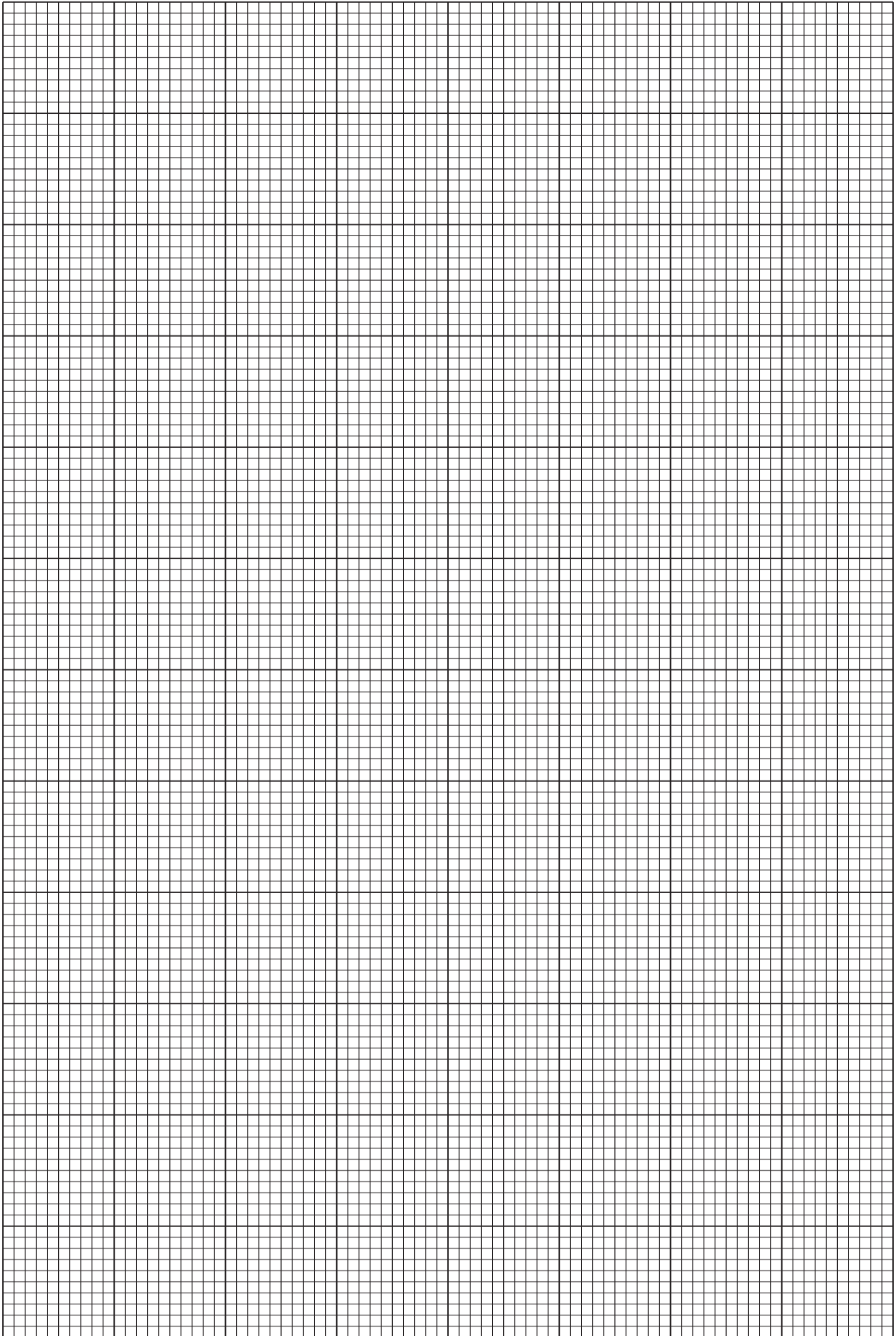
[1]

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

gradient = ...

y -intercept = ...

[2]



- (d) It is suggested that the quantities t and h are related by the equation

$$\frac{1}{t^2} = ah + b$$

where a and b are constants.

Use your answers in (c)(iii) to determine the values of a and b .

Give appropriate units.

$a =$

$b =$

[2]

[Total: 20]

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

2 In this experiment, you will investigate stationary wave patterns.

- (a)** You are provided with two pieces of string of different diameters. Each piece of string has a 10 g mass attached to one end. Using the **thinner** string, assemble the apparatus as shown in Fig. 2.1.

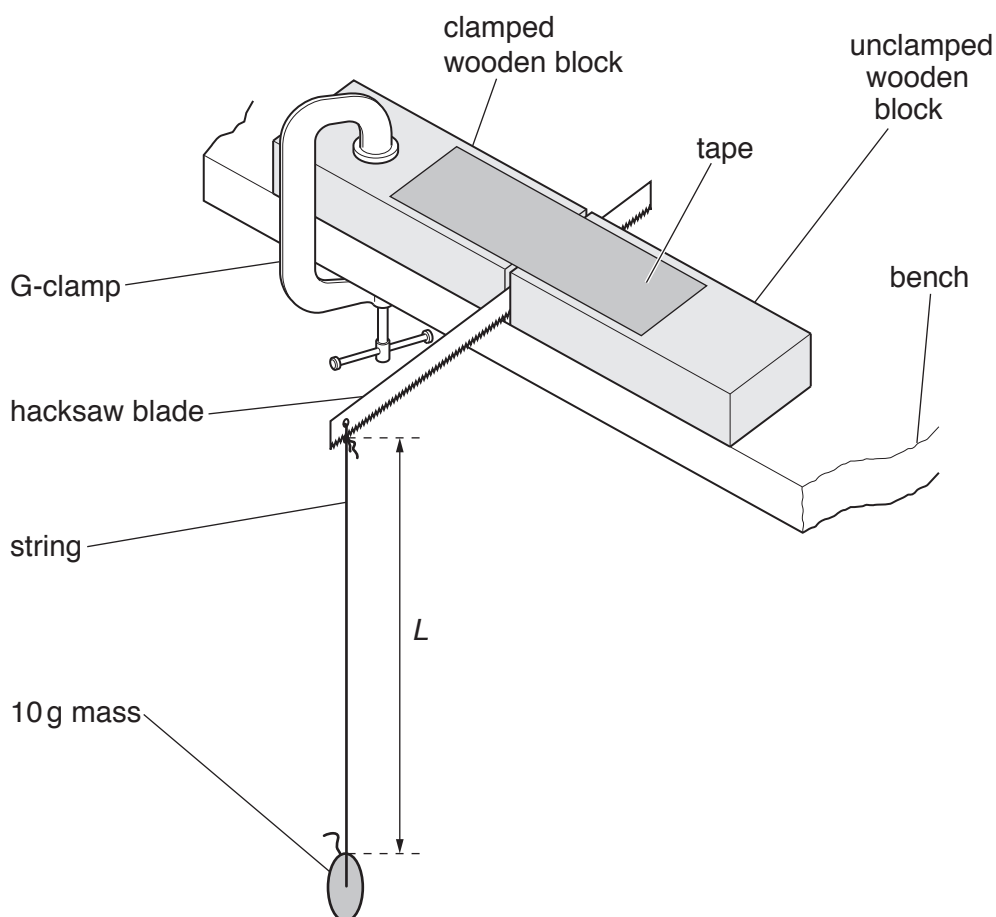


Fig. 2.1

The length of string between the hacksaw blade and the 10 g mass is L , as shown in Fig. 2.1.

Measure and record L .

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

(b) The length of hacksaw blade outside the blocks is x , as shown in Fig. 2.2.

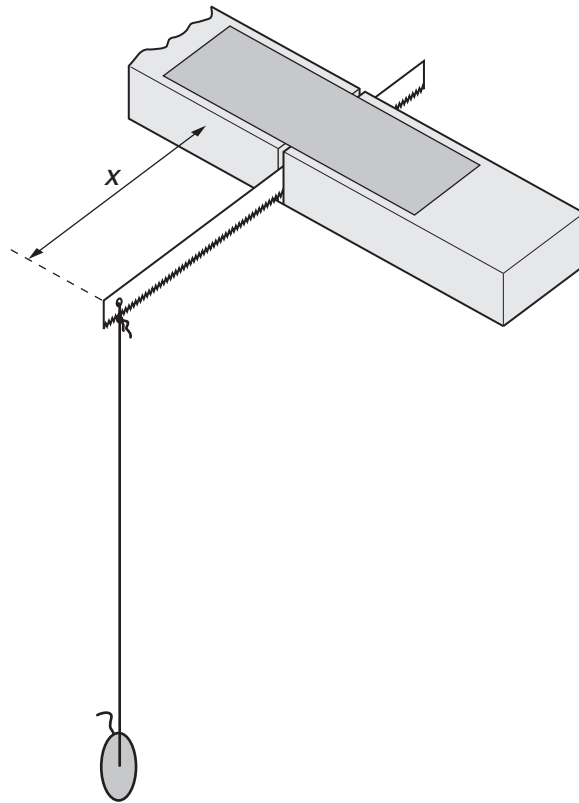


Fig. 2.2

When the end of the hacksaw blade is moved a small distance to one side and released, the string vibrates.

For certain values of x , the string vibrates in stationary wave patterns. Examples of these patterns are shown in Fig. 2.3.

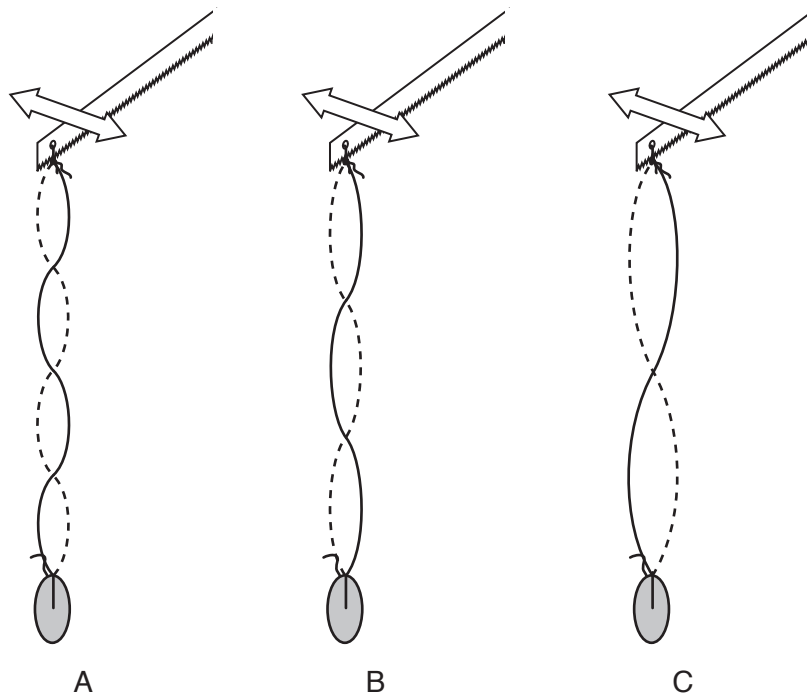


Fig. 2.3

- Press down on the unclamped wooden block.
- Move the end of the hacksaw blade a small distance to one side and release it.
- Change x in small steps. Keep changing x , testing for a pattern at each step, **until the pattern B with three loops is clearly produced.**
- Measure and record x .

$x =$ [2]

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

percentage uncertainty = ... [1]

(d) Calculate the value of λ in metres, using $\lambda = \frac{2L}{3}$.

$\lambda =$ m [1]

(e) Justify the number of significant figures you have given for your value of λ .

.....

 [1]

(f) You are provided with a card stating the mass per unit length μ of the string.

- Record the value of μ from the card.

$$\mu = \dots\dots\dots \text{ kg m}^{-1}$$

- Calculate the frequency f of the vibrations, using

$$f = \frac{1}{\lambda} \sqrt{\left(\frac{mg}{\mu}\right)}$$

where $m = 0.010 \text{ kg}$ and $g = 9.81 \text{ m s}^{-2}$.

$$f = \dots\dots\dots \text{ Hz [1]}$$

(g) Repeat (a), (b), (d) and (f) using the **thicker** string.

$$L = \dots\dots\dots$$

$$x = \dots\dots\dots$$

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

$$\mu = \dots\dots\dots \text{ kg m}^{-1}$$

$$f = \dots\dots\dots \text{ Hz [3]}$$

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

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

where k is a constant.

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

first value of k = ...

second value of k = ... [1]

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

.....

 [1]

- (i) (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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1 In this experiment, you will investigate an electrical circuit.

- (a)** • Set up the circuit shown in Fig. 1.1.

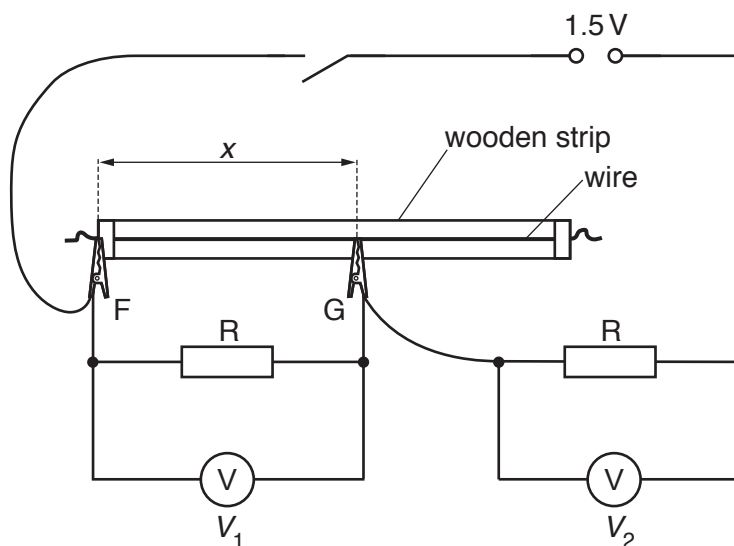


Fig. 1.1

F and G are crocodile clips.

- Place G on the wire so that the distance x between the ends of F and G is approximately 40 cm.
- Measure and record x .

$x = \dots\dots\dots$

- Close the switch.
- Record the voltages V_1 and V_2 .

$V_1 = \dots\dots\dots$

$V_2 = \dots\dots\dots$

- Open the switch.

[2]

- (b) Vary x until you have six sets of readings of x , V_1 and V_2 .

Record your results in a table. Include values of $(V_2 - V_1)$ and $\frac{V_1}{x}$ in your table.

[10]

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

[3]

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

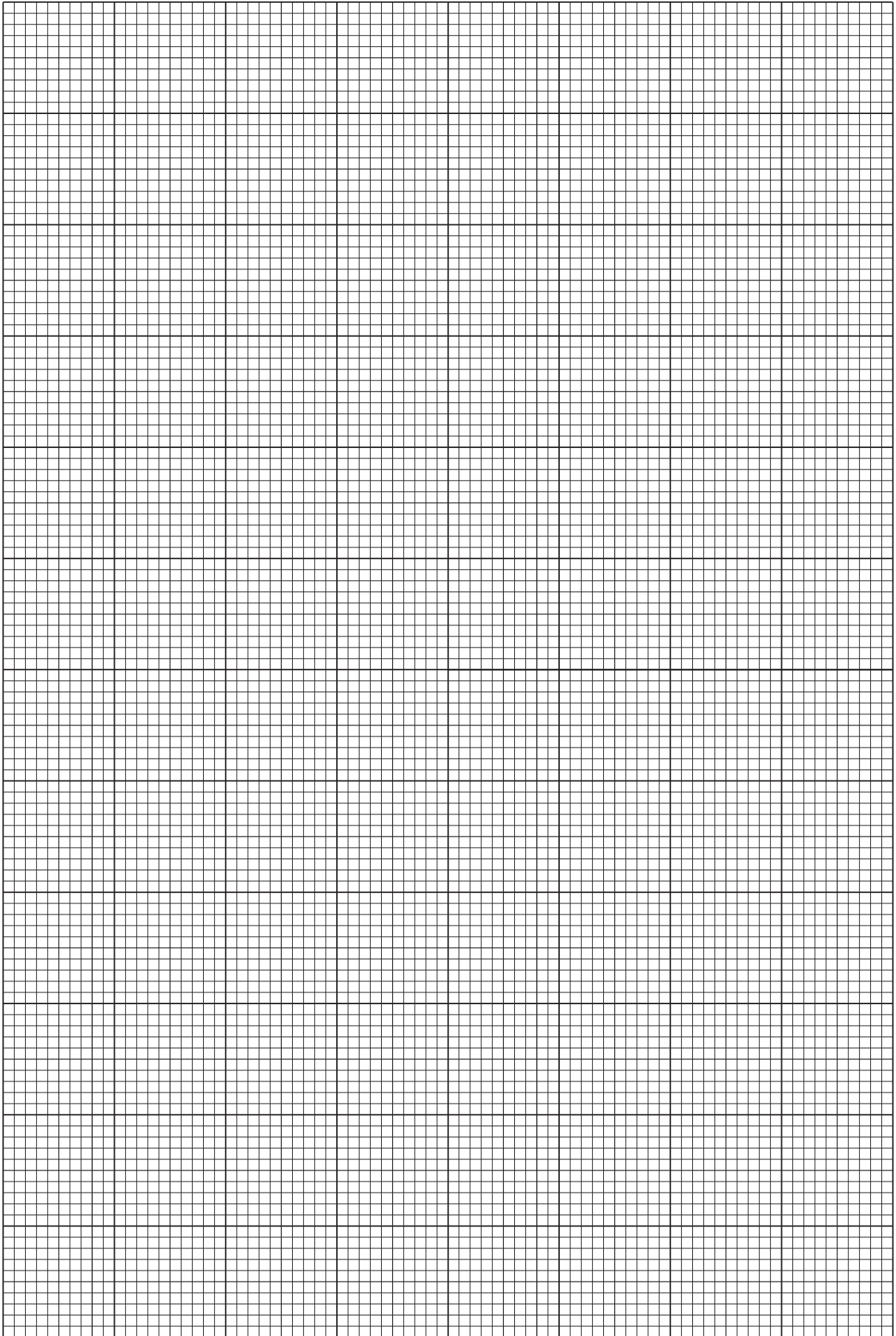
[1]

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

gradient = ...

y -intercept = ...

[2]



- (d) It is suggested that the quantities V_2 , V_1 and x are related by the equation

$$(V_2 - V_1) = \frac{PV_1}{x} + Q$$

where P and Q are constants.

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

$P =$

$Q =$

[2]

[Total: 20]

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

2 In this experiment, you will investigate the motion of an interrupted pendulum.

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

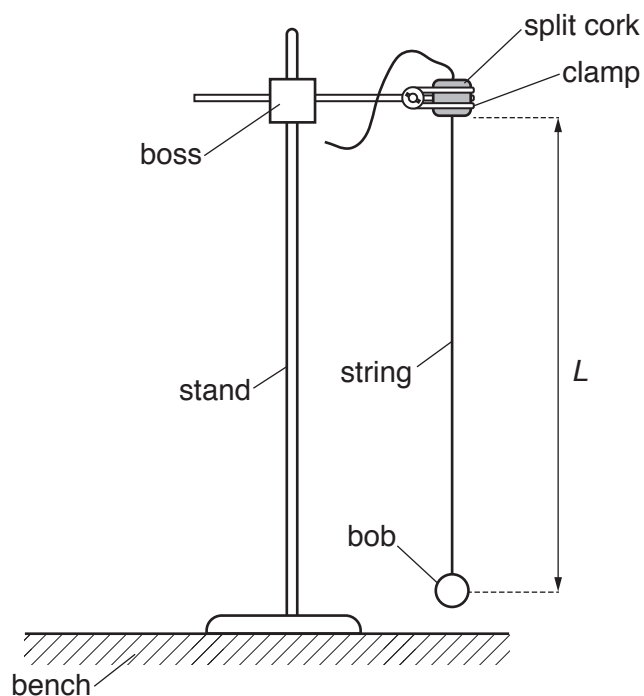


Fig. 2.1

- Adjust the string in the split cork so that the distance L between the bottom of the split cork and the centre of the bob is approximately 55 cm.
- Measure and record L .

$L =$

- Calculate $\frac{L}{2}$.

$\frac{L}{2} =$

[1]

- (b) (i)
- Attach the other boss and clamp and the wooden rod to the stand as shown in Fig. 2.2.
 - Adjust the position of the wooden rod so that, when the string is touching the rod, the angle A between the vertical and the string is approximately 14° , as shown in Fig. 2.2.
 - Without changing the length of the pendulum, ensure the distance between the wooden rod and the centre of the bob is $\frac{L}{2}$.

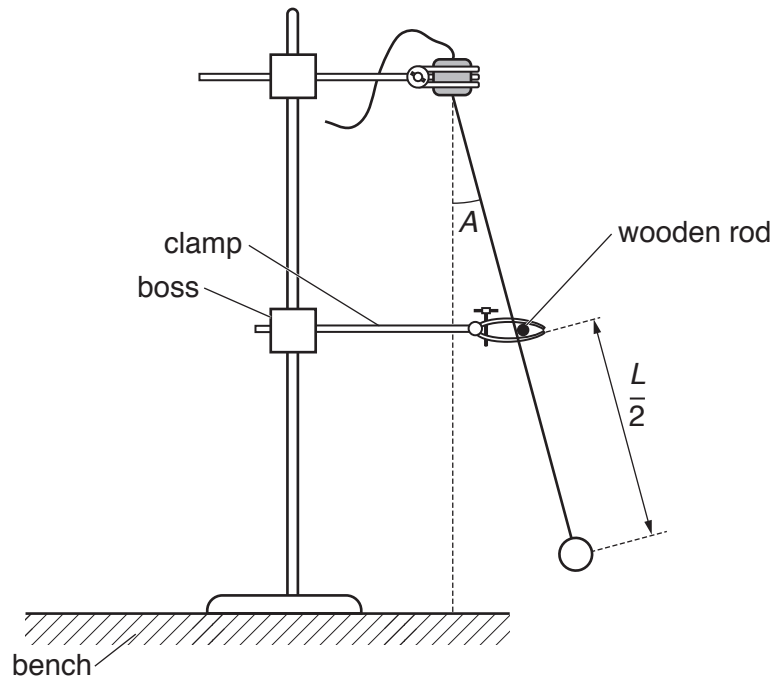


Fig. 2.2

- Measure and record angle A .

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

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

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

- (c) (i) • Pull the bob away from the wooden rod so that the angle between the string and the vertical is 45° , as shown in Fig. 2.3.

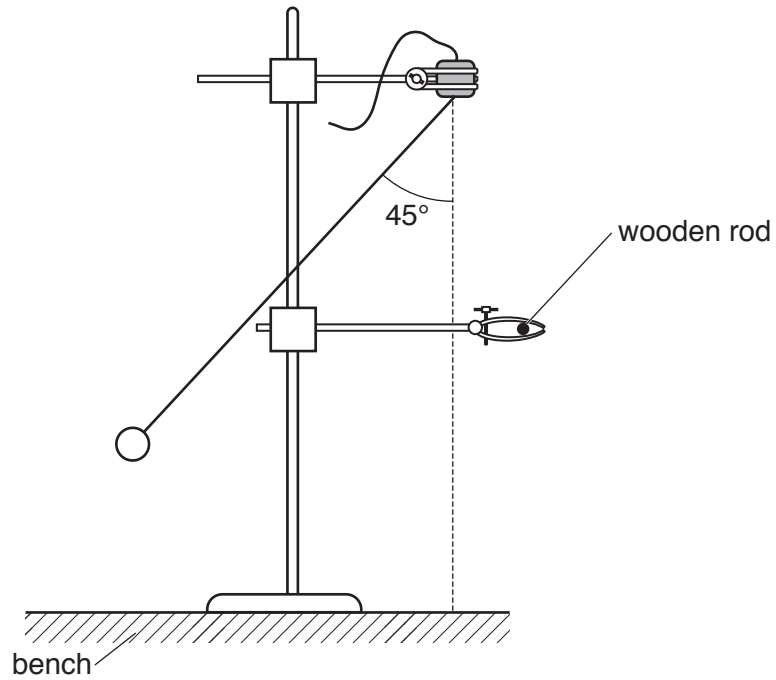


Fig. 2.3

- Release the bob. The bob will oscillate and hit the wooden rod.
- Determine the period T of these oscillations.

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

(ii) Calculate d where

$$d = \frac{\sin A}{\sin 45^\circ}.$$

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

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

.....

[1]

- (d) • Move the position of the wooden rod so that angle A is approximately 28° .
- Without changing the length of the pendulum, ensure the distance between the wooden rod and the centre of the bob is $\frac{L}{2}$.
- Measure and record angle A and repeat **(c)(i)** and **(c)(ii)**.

$$A = \dots\dots\dots$$

$$T = \dots\dots\dots$$

$$d = \dots\dots\dots[3]$$

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

$$T = k(d + 1.707)$$

where k is a constant.

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

first value of k = ...

second value of k = ... [1]

- (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.

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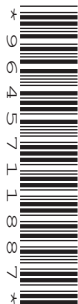
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- 1** In this experiment, you will investigate an electrical circuit.

You are provided with groups of components connected in parallel. The circuit symbol for each of these components is shown in Fig. 1.1.



Fig. 1.1

- (a)** • Assemble the circuit shown in Fig. 1.2.

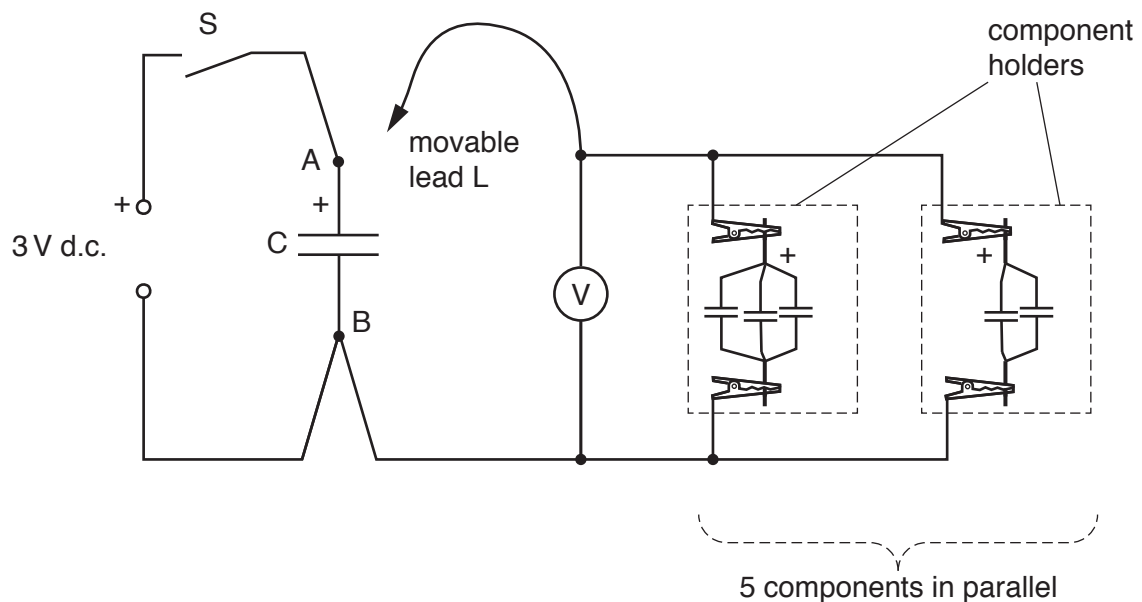


Fig. 1.2

- Check that the positive terminals of the power supply, component C and the groups of components are connected as shown in Fig. 1.2.
- Connect the movable lead L to terminal A.
- Close the switch S.
- Record the voltage V_S shown on the voltmeter.

$V_S = \dots\dots\dots$

- Open switch S.

[1]

- (b) • Record the total number n of components in parallel in the component holders.

$n =$

- Move the movable lead L and connect it to terminal B.
- Close switch S.
- Open switch S after approximately 5 s.
- Move the movable lead L and connect it to terminal A. **Immediately** record the voltage V shown on the voltmeter.

$V =$ [2]

- (c) Change n and repeat (b) until you have six sets of values of n and V . One of the component holders may be left empty if required.

Record your results in a table. Include your values from (b). Also include values of $\frac{1}{V}$ in your table.

[9]

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

[3]

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

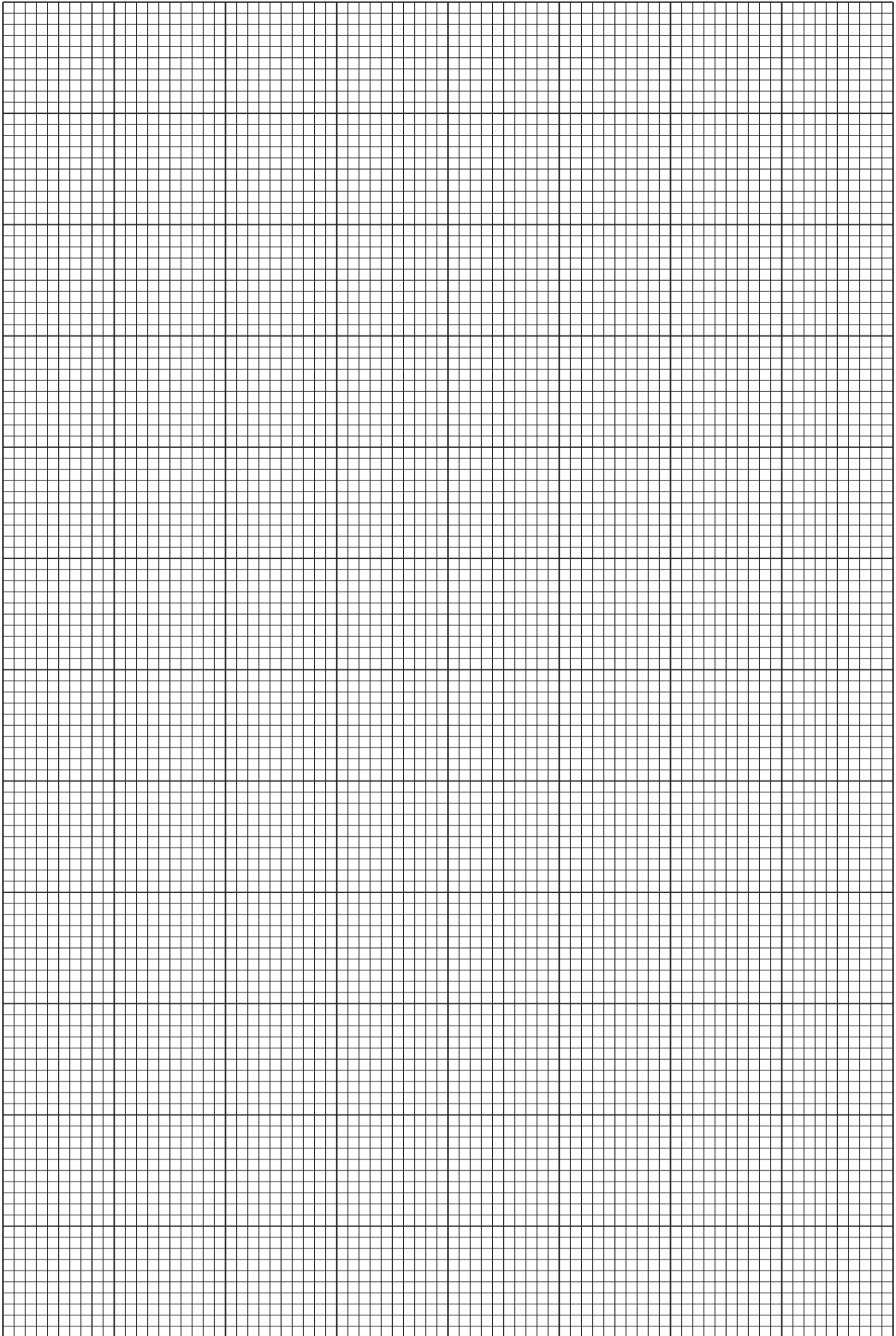
[1]

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

gradient = ...

y -intercept = ...

[2]



- (e) It is suggested that the quantities V and n are related by the equation

$$\frac{1}{V} = an + b$$

where a and b are constants.

Use your answers in (d)(iii) to determine the values of a and b .

Give appropriate units.

$a =$

$b =$

[2]

[Total: 20]

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

2 In this experiment, you will investigate the motion of a plastic bottle floating in water.

- (a)**
- Pour 500 cm^3 of water from the jug into the beaker ($1\text{ ml} = 1\text{ cm}^3$).
 - Pour this water into the bottle.
 - Place the 100g mass hanger with two 100g slotted masses in the bottle, as shown in Fig. 2.1.

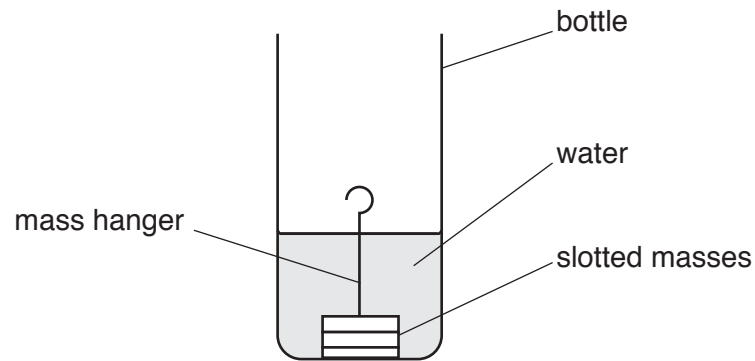


Fig. 2.1

- Assume that the density of the added water is 1.0 g cm^{-3} (1.0 cm^3 of water has a mass of 1.0g).

Calculate the total mass M of the mass hanger, slotted masses and water in the bottle.

$M = \dots\dots\dots\text{ kg [1]}$

- (b) (i)
- Carefully place the bottle in the bucket of water so that the bottle floats vertically in the water.
 - Carefully push the bottle down, ensuring that its top remains above the level of the water in the bucket.
 - Release the bottle so that it oscillates **vertically**, as indicated in Fig. 2.2.

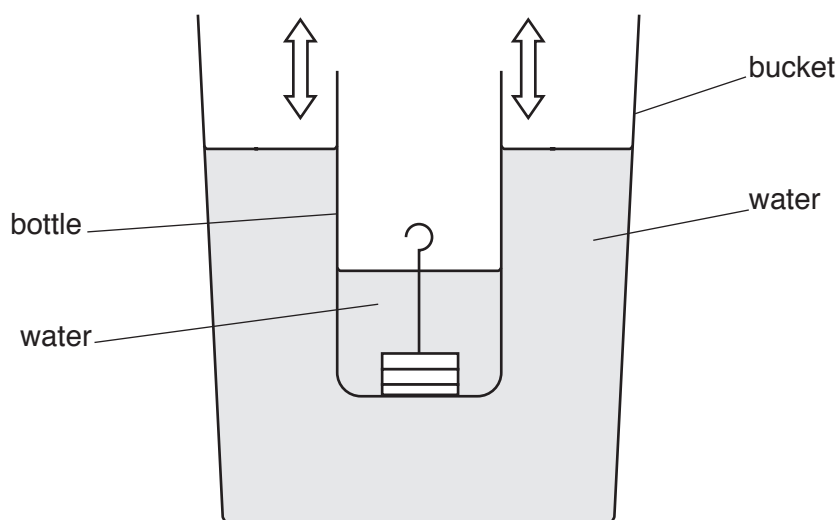


Fig. 2.2

- Take measurements to find the period T of the oscillations.

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

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

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

- (c) (i) • Remove the bottle from the bucket and place it in the tray.
- Add three more 100g slotted masses to the mass hanger in the bottle.
- Calculate the new total mass M .

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

- (ii) Repeat (b)(i).

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

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

$$M = kT^2$$

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]

- (e) (i) Measure and record the diameter D of the bottle.

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

- (ii) Calculate the cross-sectional area A of the bottle using

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

$$A = \dots\dots\dots \text{m}^2 [1]$$

- (iii) The density ρ of the water in the bucket is given by

$$\rho = \frac{4\pi^2 k}{Ag}$$

where $g = 9.81 \text{ ms}^{-2}$.

Using your second value of k , calculate ρ .

$$\rho = \dots\dots\dots \text{kg m}^{-3} [1]$$

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

1.
.....
2.
.....
3.
.....
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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[4]

[Total: 20]

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PHYSICS

9702/35

Paper 3 Advanced Practical Skills 1

May/June 2018

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.

For Examiner's Use	
1	
2	
Total	

This document consists of **11** printed pages and **1** blank page.

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

1 In this experiment, you will investigate the equilibrium of a metre rule.

(a) (i) You have been provided with some masses.

Set up the apparatus as shown in Fig. 1.1.

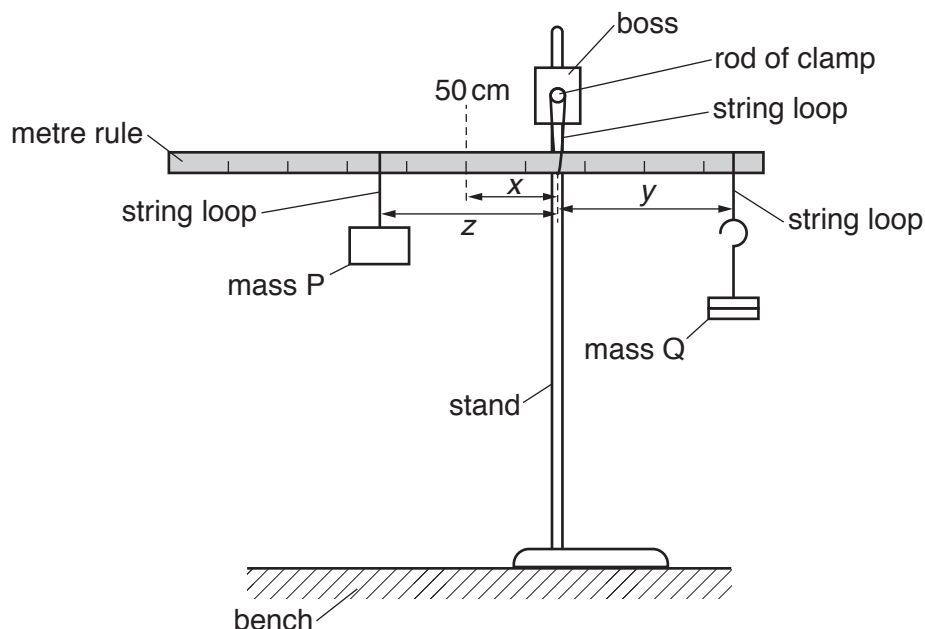


Fig. 1.1

- Mass Q should be 200 g.
- The distance between the 50 cm mark on the rule and the string loop supporting the rule is x . Adjust the position of the metre rule so that x is approximately 15 cm.
- The distance between the string loop supporting mass P and the string loop supporting the rule is z . Adjust the position of mass P so that z is approximately 30 cm.
- The distance between the string loop supporting the rule and the string loop supporting mass Q is y . Adjust the position of mass Q until the rule is balanced.
- Measure and record z .

$z = \dots\dots\dots$ [1]

(ii) • Measure and record x .

$x = \dots\dots\dots$

- Measure and record y .

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

- (b) • Write down your value of z from (a)(i).

$z = \dots\dots\dots$

- **Keeping z constant**, change x and adjust y until the rule is balanced. Repeat until you have six sets of values of x and y . Record your results in a table.

You may include readings where x is measured to the left of the 50 cm mark.
In such cases x has a negative value.

[8]

- (c) (i) Plot a graph of y on the y -axis against x on the x -axis.

[3]

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

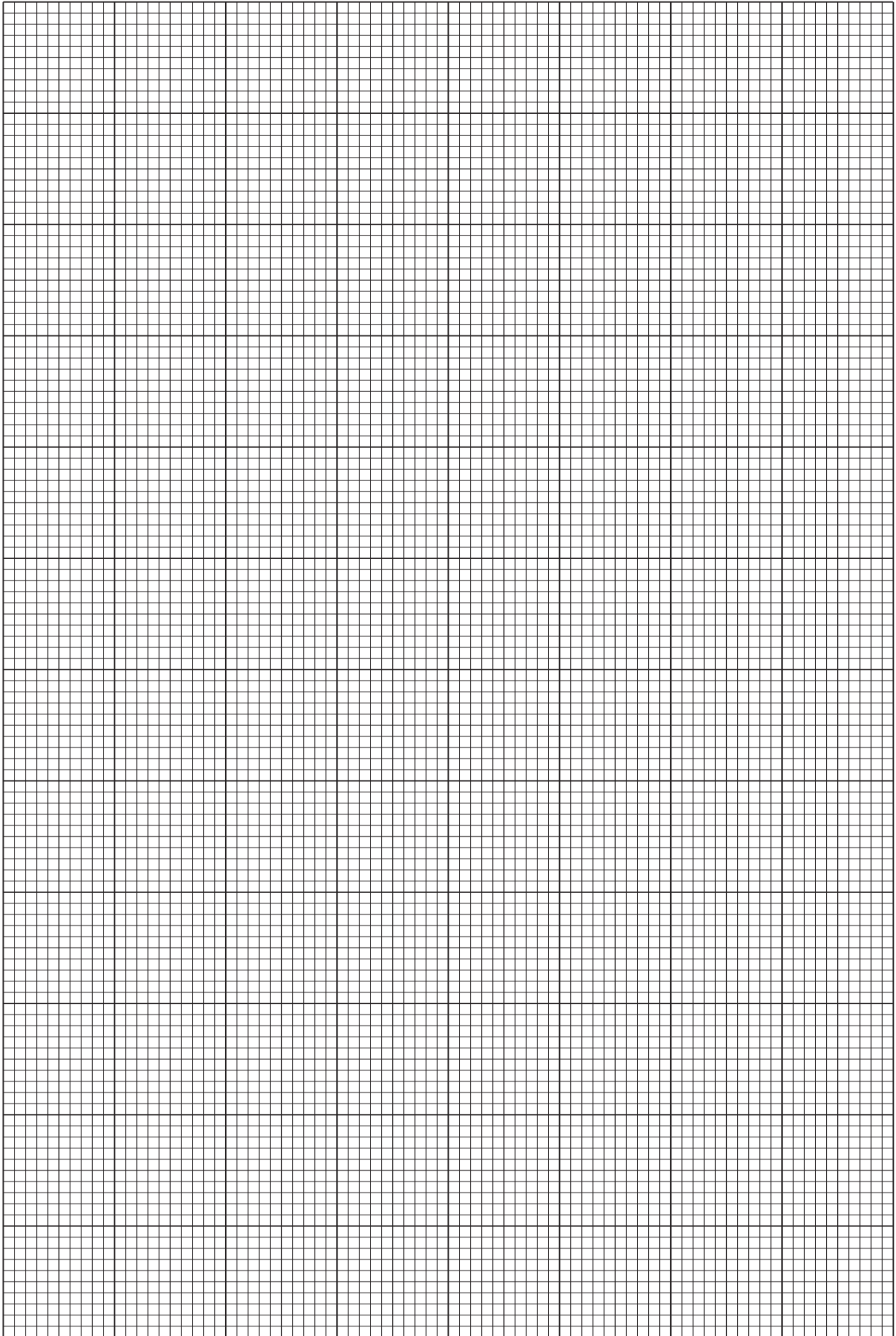
[1]

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

gradient = $\dots\dots\dots$

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

[2]



- (d) It is suggested that the quantities y and x are related by the equation

$$y = Ax + B$$

where A and B are constants.

Using your answers in (c)(iii), determine the values of A and B .
Give appropriate units.

$$A = \dots\dots\dots$$

$$B = \dots\dots\dots$$

[2]

- (e) The mass of P is p . The mass of Q is q , where $q = 0.200$ kg.

The constants A and B are related to p , q and z by

$$A = \frac{p}{q} \quad \text{and} \quad B = \frac{pz}{q}.$$

Calculate p .

$$p = \dots\dots\dots \text{ kg [1]}$$

- (f) The experiment is repeated using the same equipment but a smaller value of z .
For this experiment, draw a second line on the graph to show the expected results.
Label this line W.

[1]

[Total: 20]

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

2 In this experiment, you will investigate the current in a coil.

(a) (i) You have been provided with a bar magnet, masses and Blu-Tack.

- The total mass of the mass hanger and mass should be 200 g. Use the Blu-Tack to fix the bar magnet to the mass hanger, as shown in Fig. 2.1.

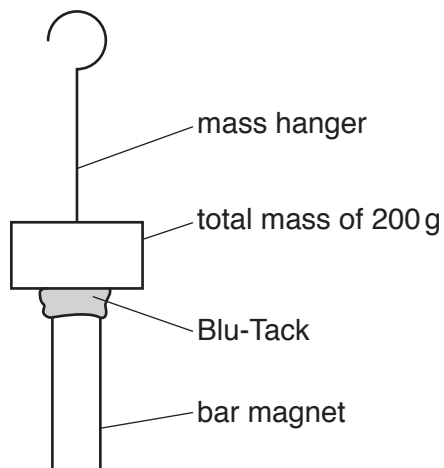


Fig. 2.1

- Set up the apparatus as shown in Fig. 2.2.

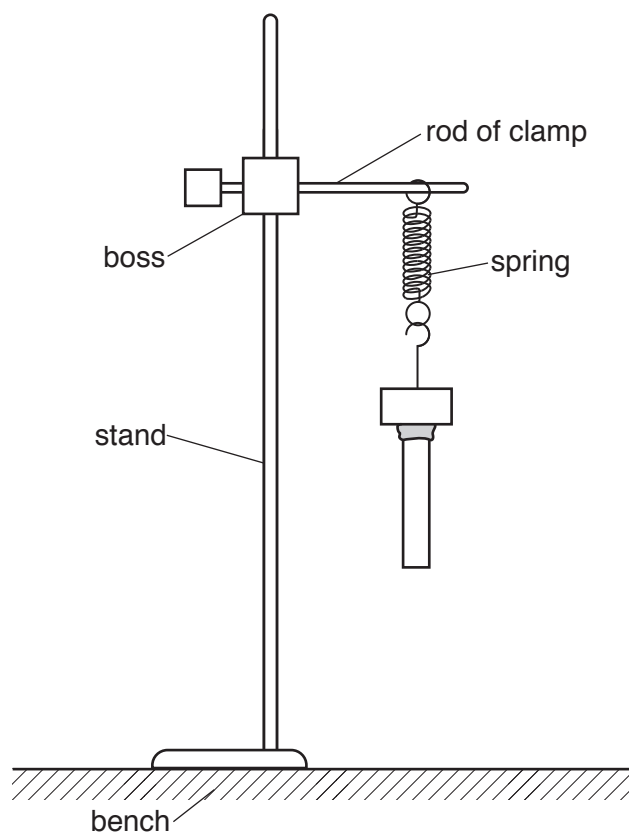


Fig. 2.2

- Pull the mass down through a short distance. Release the mass. The mass and magnet will oscillate.
- Determine the period T of these oscillations.

$T = \dots\dots\dots$ [1]

- (ii) Calculate the frequency f of the oscillations where

$$f = \frac{1}{T}.$$

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

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

.....

[1]

- (b) (i) • Take the cardboard tube with **more** turns of wire.
- Count and record the number n of turns of wire around the tube.

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

- (ii) • Connect the ammeter to the ends of the wire around the tube and place the tube below the magnet.
- Adjust the height of the bottom of the magnet so that it is level with the top of the tube as shown in Fig. 2.3.

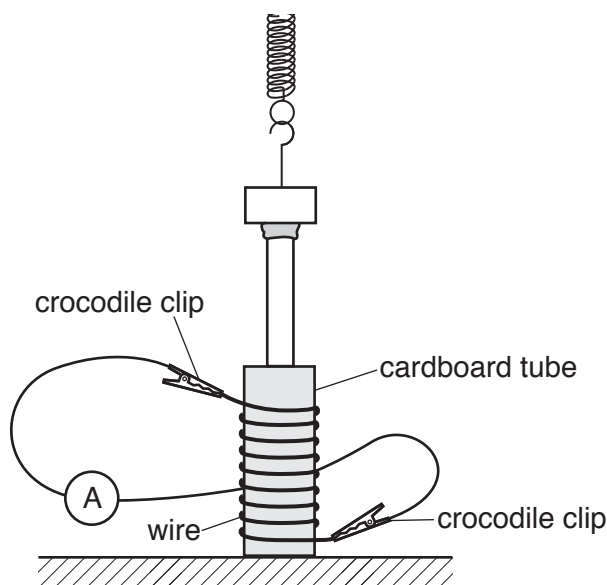


Fig. 2.3

- Pull the mass down so that it rests on the top of the tube with the magnet passing centrally through the tube. Release the mass. The mass will oscillate.
- Measure and record the maximum current I shown by the ammeter.

$I = \dots\dots\dots \mu\text{A}$ [1]

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

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

- (c) (i)
- Remove the tube.
 - Increase the total mass to 500 g.
 - Take measurements to determine the period T and frequency f of the oscillations of the mass and the magnet.

$T =$

$f =$ Hz
[2]

- (ii) Keep the mass as 500 g and use the tube with **fewer** turns of wire to repeat **(b)(i)** and **(b)(ii)**.

$n =$

$I =$ μA
[2]

- (d) It is suggested that the relationship between I , n and f is

$$I = knf$$

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]

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

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