

Cambridge International AS & A Level

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PHYSICS

9702/31

Paper 3 Advanced Practical Skills 1

May/June 2021

2 hours

You must answer on the question paper.

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

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
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- Do **not** write on any bar codes.
- You will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [].

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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) • Use the adhesive putty to attach the 100 g mass to the metre rule as close as possible to the 80 cm mark, as shown in Fig. 1.1.

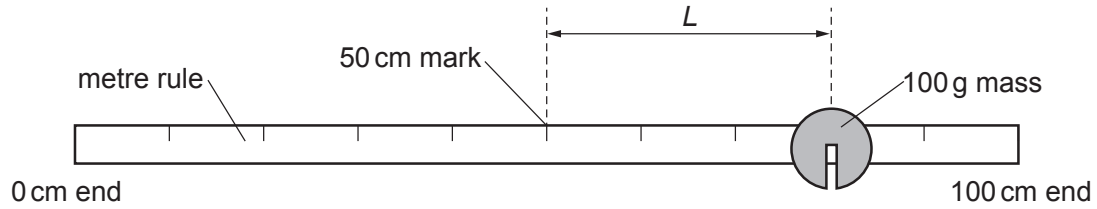


Fig. 1.1

- The distance between the 50 cm mark and the centre of the mass is L .

Measure and record L .

$L =$ [1]

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

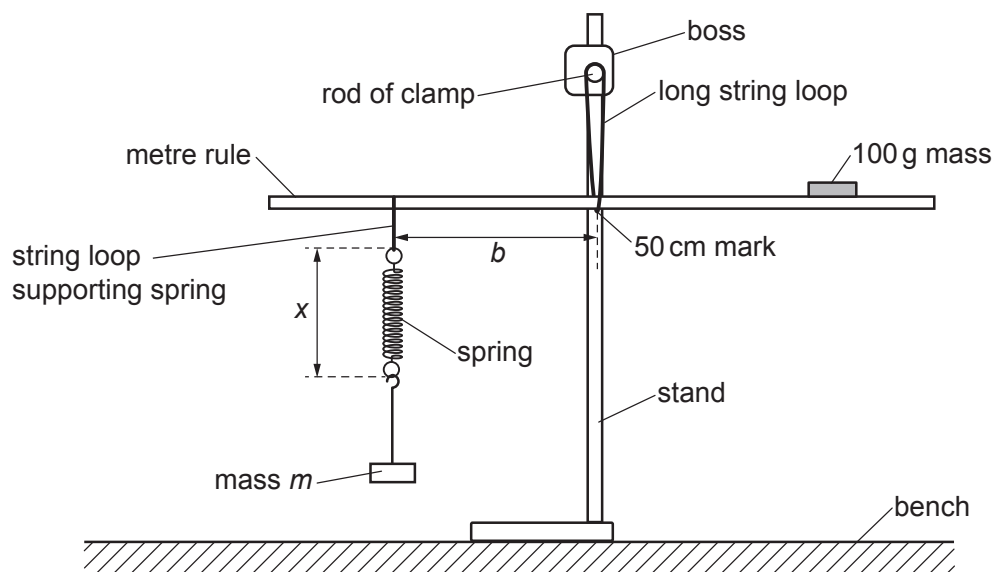


Fig. 1.2

- Suspend the rule from the long string loop at the 50 cm mark on the rule.
- Add the two 50 g masses to the mass hanger to make a total mass m of 110 g. Suspend mass m from the spring.
- Record m .

$m = \dots\dots\dots$ g

- The distance between the string loop supporting the spring and the 50 cm mark on the rule is b .

The distance between the top of the top loop of the spring and the bottom of the bottom loop of the spring is x , as shown in Fig. 1.2.

Adjust the position of the string loop supporting the spring until the rule is horizontal and in equilibrium.

- Measure and record x and b .

$x = \dots\dots\dots$

$b = \dots\dots\dots$

[1]

- (c) Repeat (b) with different values of m until you have six sets of readings. Record m , x and b . Include your values from (b).

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

[9]

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

[3]

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

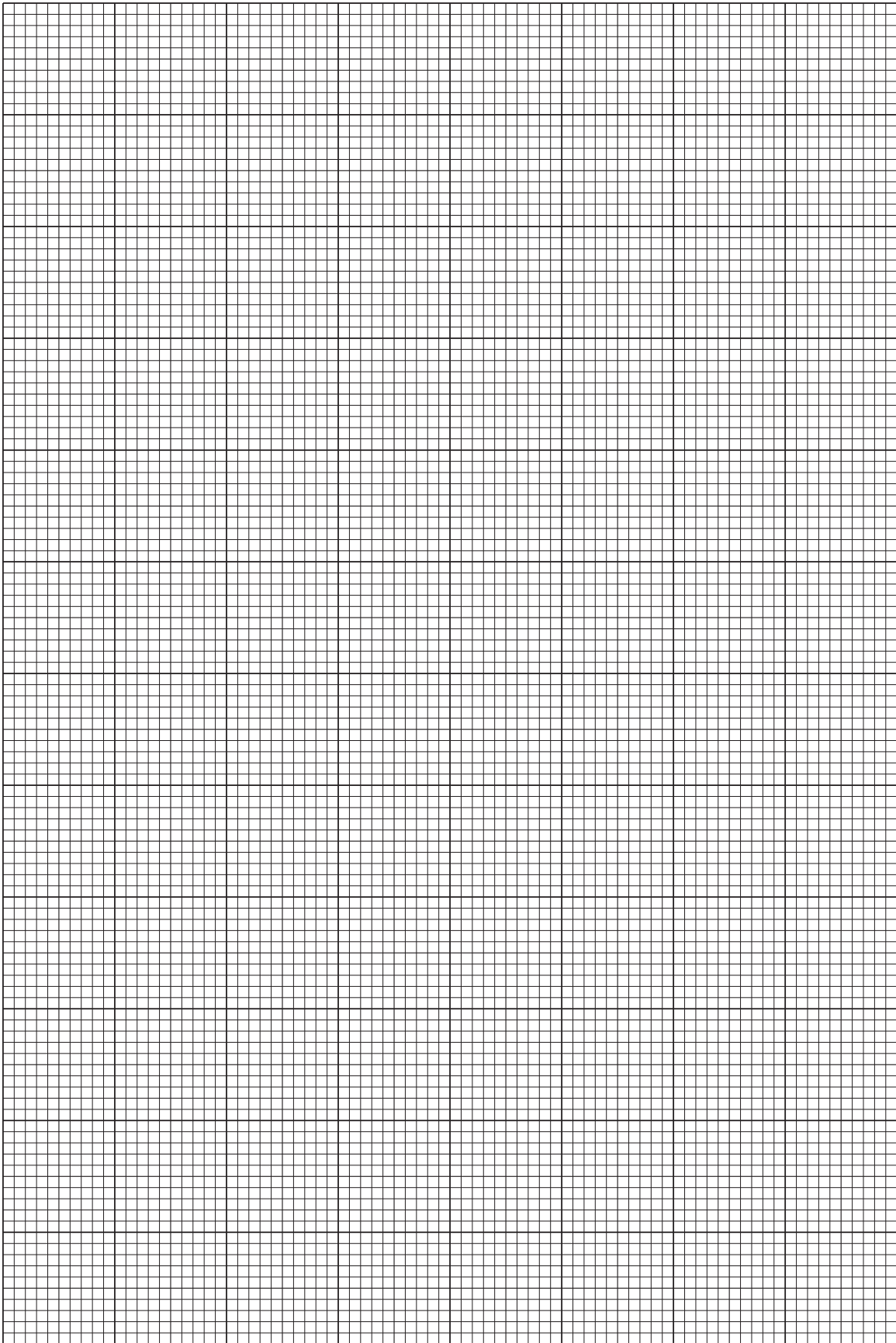
[1]

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

gradient = ...

y-intercept = ...

[2]



- (e) It is suggested that the quantities b and x are related by the equation

$$\frac{1}{b} = Px + Q$$

where P and Q are constants.

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

$P =$

$Q =$

[2]

- (f) A student repeats the experiment placing the 100g mass closer to the 50cm mark on the rule.

Theory suggests that P and Q are both inversely proportional to L .

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 how the rate of cooling of a hot liquid depends on its volume.

- (a) You have been provided with a cup. The diameter of the base of the cup is d , as shown in Fig. 2.1.

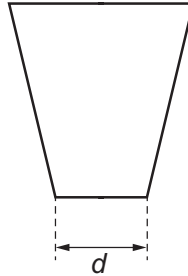


Fig. 2.1

Measure and record d .

$d =$ [1]

- (b)
- Pour boiling water into the cup until it is approximately one-third full.
 - When the temperature of the water is 75°C , start the stop-watch.

Record this starting temperature θ_0 .

$\theta_0 =$ $^{\circ}\text{C}$

- After two minutes, measure and record the temperature θ .

$\theta =$ $^{\circ}\text{C}$

- Calculate $\Delta\theta$ using

$$\Delta\theta = (\theta_0 - \theta).$$

$\Delta\theta =$ $^{\circ}\text{C}$
[1]

- (c) (i) The height of the water in the cup is h and the diameter of the surface of the water is D , as shown in Fig. 2.2.

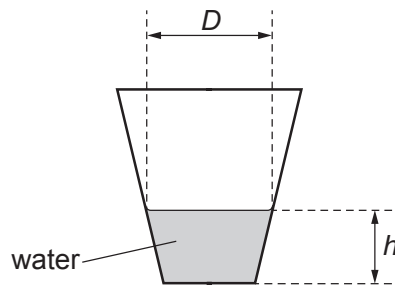


Fig. 2.2

Measure and record h and D .

$h =$

$D =$ [2]

- (ii) Estimate the percentage uncertainty in your value of h . Show your working.

percentage uncertainty = ... [1]

- (iii) Calculate C where

$$C = \frac{D^3 - d^3}{D - d}.$$

$C =$ [1]

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

.....

 [1]

- (d) • Empty the cup.
- Repeat **(b)**, **(c)(i)** and **(c)(iii)** with the cup approximately two-thirds full.

$$\theta_0 = \dots\dots\dots\text{ }^{\circ}\text{C}$$

$$\theta = \dots\dots\dots\text{ }^{\circ}\text{C}$$

$$\Delta\theta = \dots\dots\dots\text{ }^{\circ}\text{C}$$

$$h = \dots\dots\dots$$

$$D = \dots\dots\dots$$

$$C = \dots\dots\dots$$

[3]

- (e) It is suggested that the relationship between $\Delta\theta$, h and C is

$$\Delta\theta = \frac{k}{\sqrt{hC}}$$

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.

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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[Total: 20]

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PHYSICS

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Paper 3 Advanced Practical Skills 2

May/June 2021

2 hours

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- 1** In this experiment, you will investigate the patterns produced by overlaid grids.
- (a)** Grid A is the grid of parallel, equally spaced lines shown in Fig. 1.1.

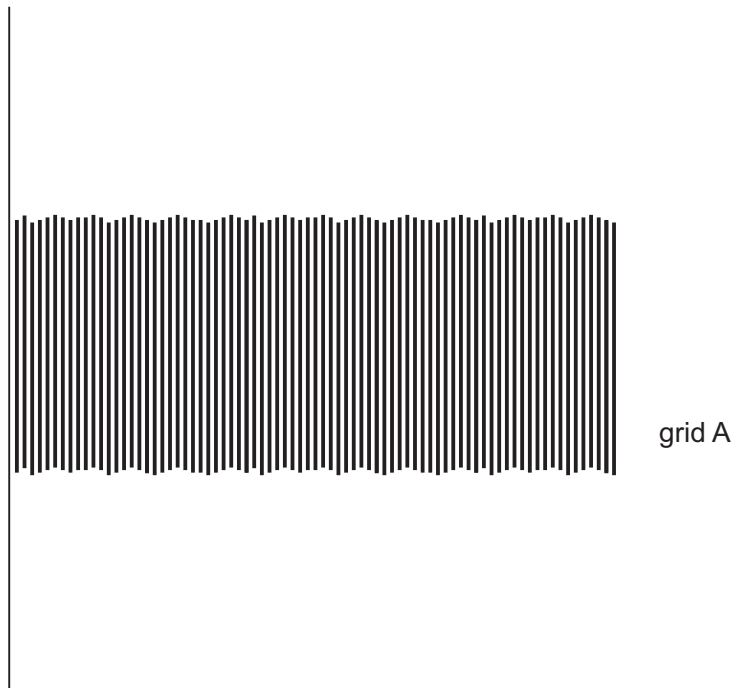


Fig. 1.1

Take measurements to determine the average spacing s_A between the centres of the lines on grid A.

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

(b) You have been provided with a second grid (labelled grid B) printed on a transparent sheet.

- Place grid B on top of grid A in **Fig. 1.1**.
- Turn grid B so that there is a small angle G between the grids. A pattern of fringes will be produced, as shown in the example in **Fig. 1.2**.

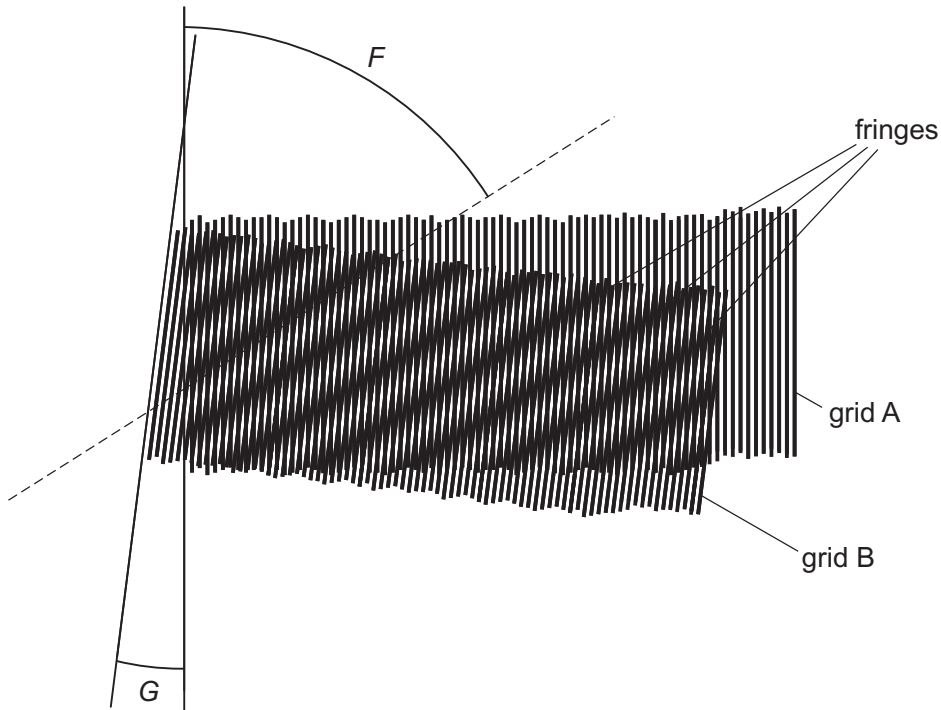


Fig. 1.2

- **Do not take measurements from Fig. 1.2.**

Measure and record your value of G from **Fig. 1.1**.

$G = \dots\dots\dots^\circ$

- The fringes make an angle F with grid A, as shown in **Fig. 1.2**.

Measure and record your value of F from **Fig. 1.1**.

$F = \dots\dots\dots^\circ$
[1]

- (c) Rotate grid B and repeat (b) until you have six sets of values of G and F .

Use values of G in the range 0° to 20° .

Record your results in a table. Include values of $\sin F$ and $\sin(F - G)$ in your table.

[8]

- (d) (i) Plot a graph of $\sin(F - G)$ on the y -axis against $\sin F$ on the x -axis.

[3]

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

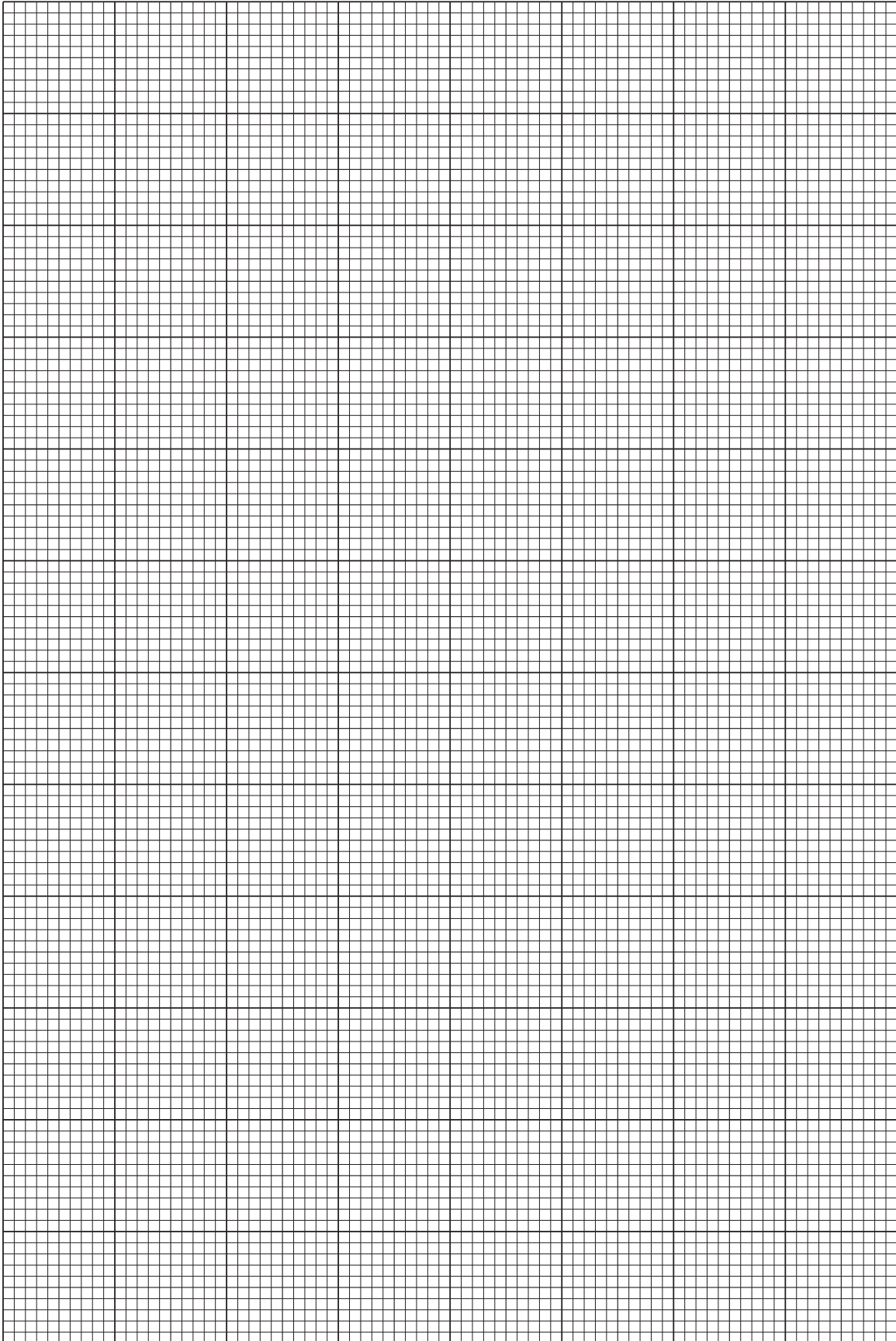
[1]

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

gradient = ...

y -intercept = ...

[2]



- (e) It is suggested that the quantities F and G are related by the equation

$$\sin(F - G) = p \sin F + q$$

where p and q are constants.

Use your answers in (d)(iii) to determine the values of p and q .

$$p = \dots\dots\dots$$

$$q = \dots\dots\dots$$

[2]

- (f) The constant p is related to the spacing of the lines of grids A and B by

$$p = \frac{s_B}{s_A}$$

where s_B is the line spacing of grid B.

Use your values of p and s_A to calculate s_B .

$$s_B = \dots\dots\dots \text{mm} \quad [1]$$

[Total: 20]

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

2 In this experiment, you will investigate the oscillations of a mass on a spring.

- (a) (i)** • Set up the apparatus as shown in Fig. 2.1 using the 50 g mass hanger.

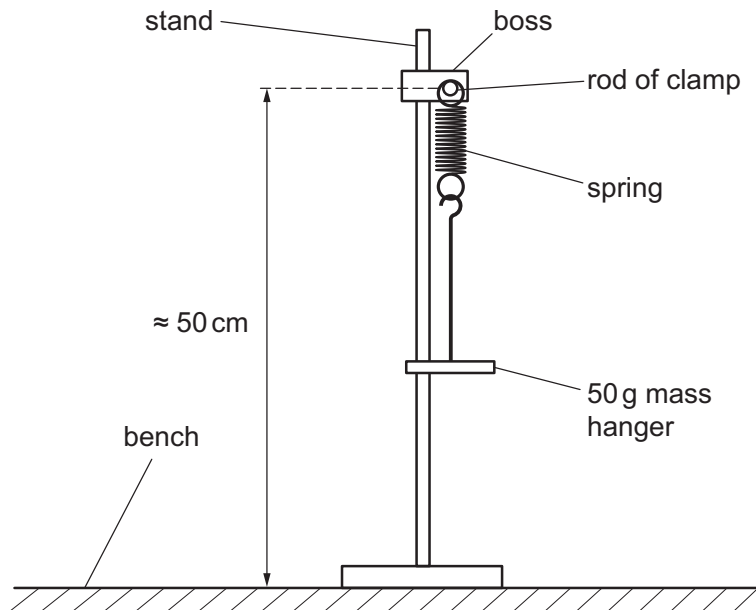


Fig. 2.1

- Pull the mass hanger down by approximately 1 cm. Release it so that it oscillates vertically, with no swinging motion.
- Take measurements to find the period T_V of these oscillations.

$T_V = \dots\dots\dots$ [2]

- (ii)** • Ensure that the mass hanger has stopped moving.
- Push the mass hanger approximately 1 cm away from you. Release it so that it swings towards and away from you, with as little vertical oscillation as possible.
 - Take measurements to find the period T_S of these oscillations.

$T_S = \dots\dots\dots$ [1]

- (b) Repeat (a) with a total mass of 150 g suspended from the spring.

$$T_V = \dots\dots\dots$$

$$T_S = \dots\dots\dots [2]$$

- (c) It is suggested that the quantity $T_S^2 - T_V^2$ is independent of the mass suspended from the spring.

- (i) Using your data, calculate two values of $T_S^2 - T_V^2$.

$$\text{first value of } T_S^2 - T_V^2 = \dots\dots\dots$$

$$\text{second value of } T_S^2 - T_V^2 = \dots\dots\dots [1]$$

- (ii) Justify the number of significant figures you have given for your values of $T_S^2 - T_V^2$.

.....

 [1]

(iii) Explain whether your results in (c)(i) support the suggestion.

.....

.....

.....

..... [1]

- (d) (i) • Remove the masses from the spring and the spring from the rod.
- Measure and record the length x_1 of the spring, as shown in Fig. 2.2.

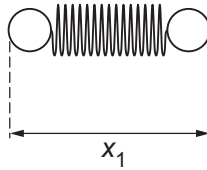


Fig. 2.2

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

- (ii) Estimate the percentage uncertainty in your value of x_1 . Show your working.

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

- (iii) Measure and record the length x_2 of the mass hanger, as shown in Fig. 2.3.

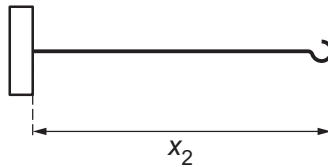


Fig. 2.3

$x_2 = \dots\dots\dots$ cm [1]

- (iv) Using your first value of $T_S^2 - T_V^2$, calculate g using

$$g = \frac{4\pi^2(x_1 + x_2)}{T_S^2 - T_V^2}.$$

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

(e) (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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PHYSICS

9702/33

Paper 3 Advanced Practical Skills 1

May/June 2021

2 hours

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

(a) You have been provided with two identical wooden strips labelled A and B.

Measure and record the length L of the wire between the nails on strip A, as shown in Fig. 1.1.

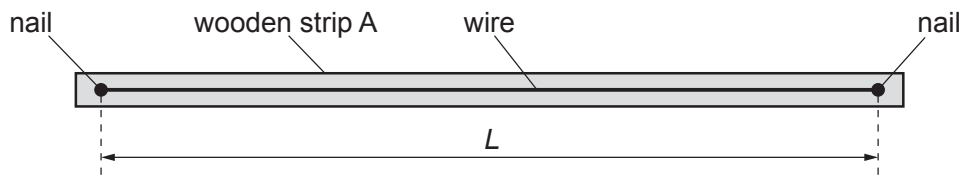


Fig. 1.1

$L =$ [1]

- (b) • Set up the circuit shown in Fig. 1.2.

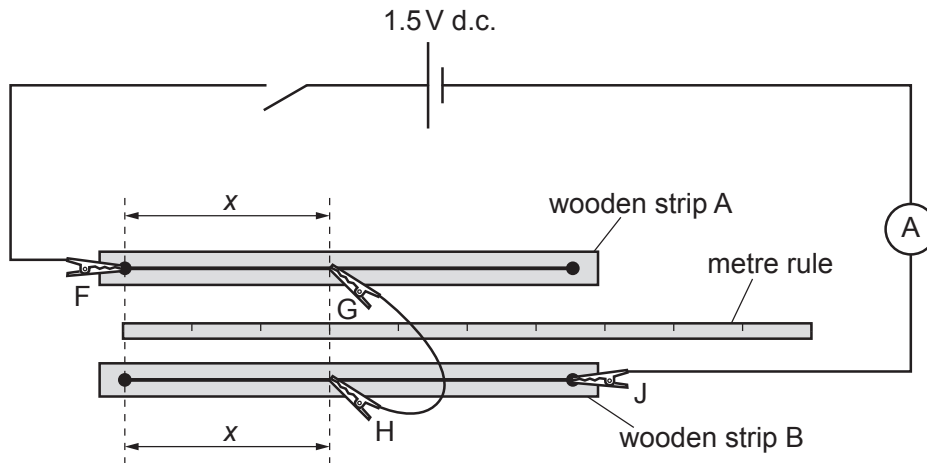


Fig. 1.2

- F, G, H and J are crocodile clips.

Attach G to the wire on wooden strip A so that the distance x between the nail on strip A and G is approximately 30 cm, as shown in Fig. 1.2.

- Attach H to the wire on wooden strip B so that it is the same distance x from the nail on strip B.
- Close the switch.
- Record x and the ammeter reading I .

$x =$

$I =$

- Open the switch.

[1]

- (c) Vary x and repeat (b) until you have six sets of readings of x and I . Include your values from (b).

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

[9]

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

[3]

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

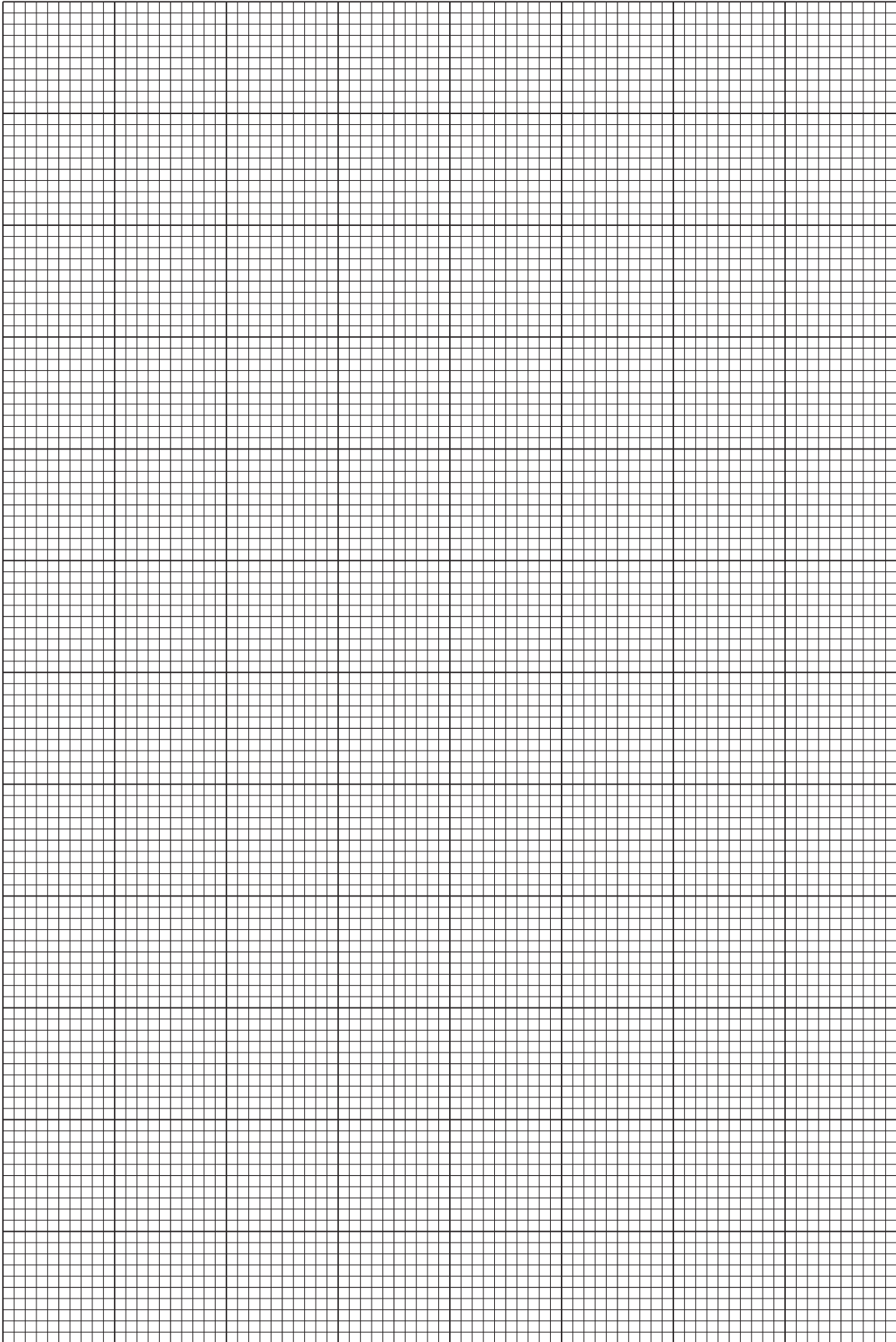
[1]

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

gradient = ...

y -intercept = ...

[2]



- (e) It is suggested that the quantities I and x are related by the equation

$$\frac{1}{I} = Px + Q$$

where P and Q are constants.

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

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

$$Q = \dots\dots\dots [2]$$

- (f) Theory suggests that

$$\frac{P}{Q} = \frac{\left(\frac{\rho_A}{\rho_B} - 1\right)}{L}$$

where ρ_A is the resistivity of the wire on strip A and ρ_B is the resistivity of the wire on strip B.

Calculate $\frac{\rho_A}{\rho_B}$.

$$\frac{\rho_A}{\rho_B} = \dots\dots\dots [1]$$

[Total: 20]

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

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

(a) You have been provided with a rectangular wooden strip with a hole in its centre.

- Use some of the adhesive putty to attach the two 100 g masses as near as possible to one end of the strip, as shown in Fig. 2.1 and Fig. 2.2.

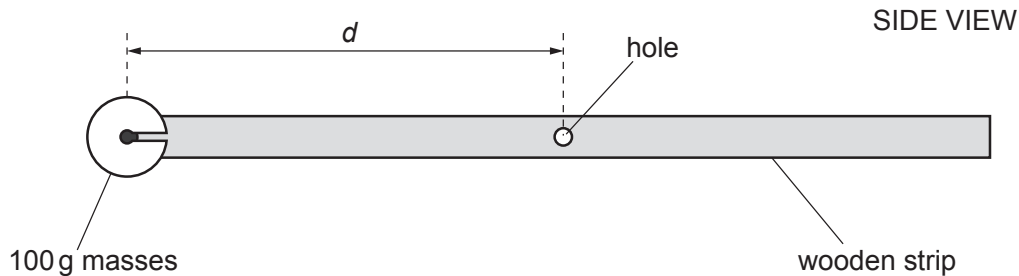


Fig. 2.1

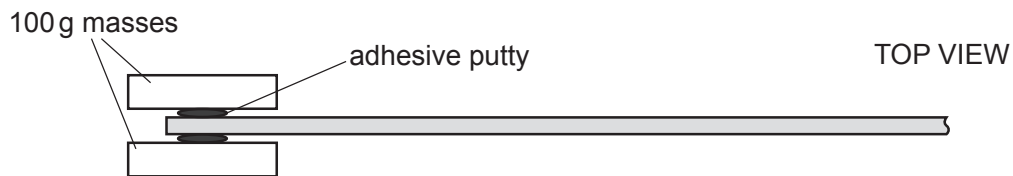


Fig. 2.2

- The distance between the centre of the masses and the hole is d , as shown in Fig. 2.1.

Measure and record d .

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

(b) Estimate the percentage uncertainty in your value of d . Show your working.

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

- (c) (i) • Attach the two 50 g masses to the other end of the strip so that the distance between the centres of these masses and the hole is also equal to d .
- Set up the apparatus as shown in Fig. 2.3.

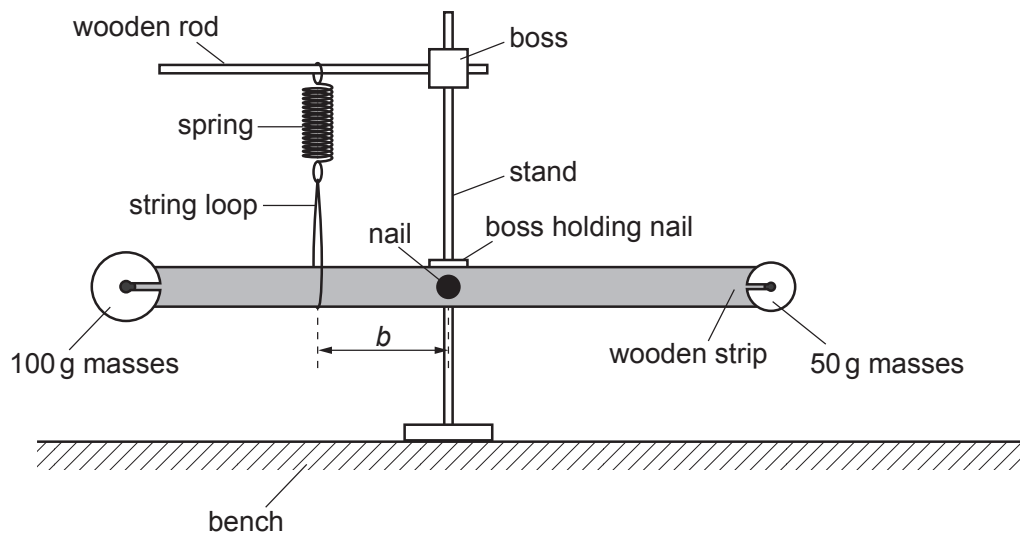


Fig. 2.3 (not to scale)

- The distance between the string loop and the nail in the centre of the strip is b . Adjust the position of the string loop and spring until b is approximately 10 cm.
- Adjust the heights of the bosses until the strip is horizontal and the spring and string loop are vertical.
- Measure and record b .

$b =$ [1]

- (ii) Calculate α where

$$\alpha = \frac{b}{d}.$$

$\alpha =$ [1]

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

.....

.....

..... [1]

- (d) • Move the end of the strip with the 100 g masses down through a short distance.
- Release the end of the strip. The strip will oscillate up and down.
 - Take measurements to determine the period T of these oscillations.

$T =$ [2]

- (e) • Change the value of b to approximately 20 cm.
- Adjust the heights of the bosses until the strip is horizontal and the spring and string loop are vertical.
 - Measure and record b .

$b =$

- Repeat (c)(ii) and (d).

$\alpha =$

$T =$ [2]

- (f) It is suggested that the relationship between T and α is

$$T = \frac{C}{\alpha}$$

where C is a constant.

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

first value of $C = \dots\dots\dots$

second value of $C = \dots\dots\dots$

[1]

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

.....

 [1]

- (g) Theory suggests that

$$C = 2\pi\sqrt{\frac{3m}{k}}$$

where m is 0.100 kg and k is the spring constant of the spring.

Use your second value of C to determine a value for k . Give an appropriate unit.

$k = \dots\dots\dots$ [1]

(h) (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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1 In this experiment, you will investigate the oscillations of a chain.

- (a) (i) • Assemble the apparatus as shown in Fig. 1.1 with each nail held securely in a boss and at the same height above the bench. Position the stands so that the distance between the nails is approximately 60 cm.

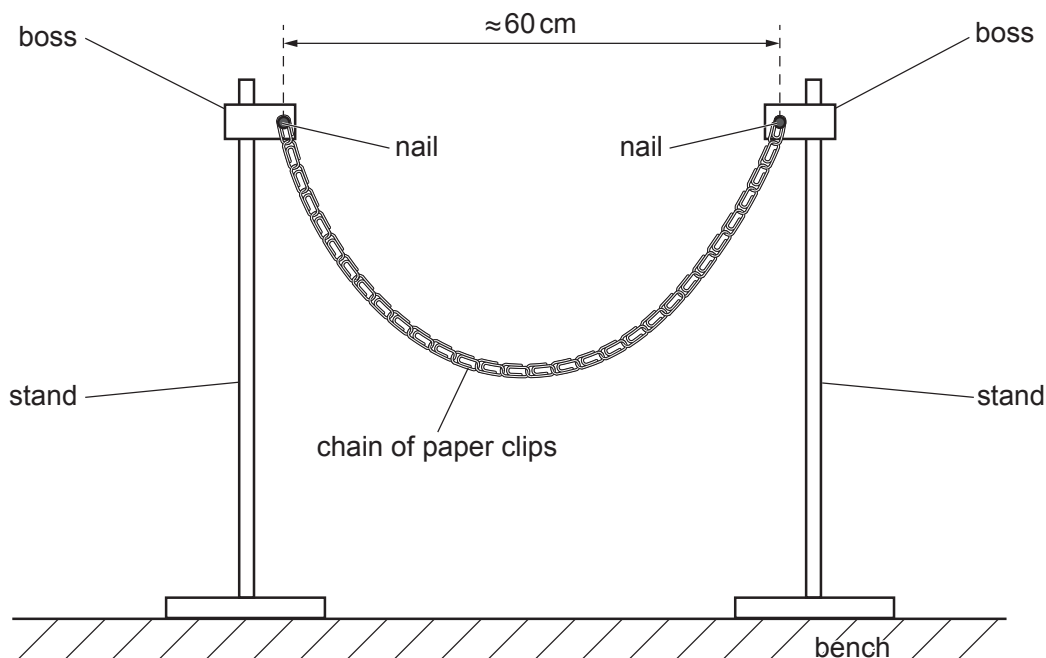


Fig. 1.1

- Rest one of the metre rules on the nails, as shown in Fig. 1.2.

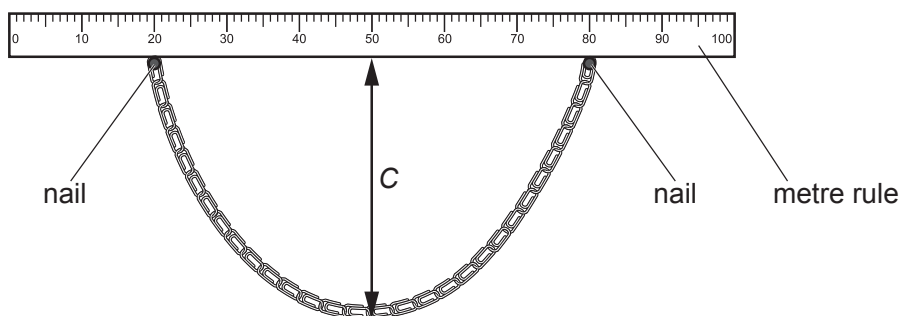


Fig. 1.2

- The vertical distance between the horizontal metre rule and the lowest part of the chain is C .

Using the other metre rule, measure and record C .

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

- (ii) • Push the bottom of the chain a short distance away from you. Release it so that it swings towards and away from you.
- Take measurements to determine the period T of these oscillations.

$T =$ [2]

- (b) Repeat (a) with different distances between the stands until you have six sets of values of C and T .

All values of C must be greater than 15 cm.

Record your results in a table. Include values of $\frac{1}{T}$ and $\frac{1}{\sqrt{C}}$ in your table.

[9]

- (c) (i) Plot a graph of $\frac{1}{T}$ on the y -axis against $\frac{1}{\sqrt{C}}$ on the x -axis.

[3]

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

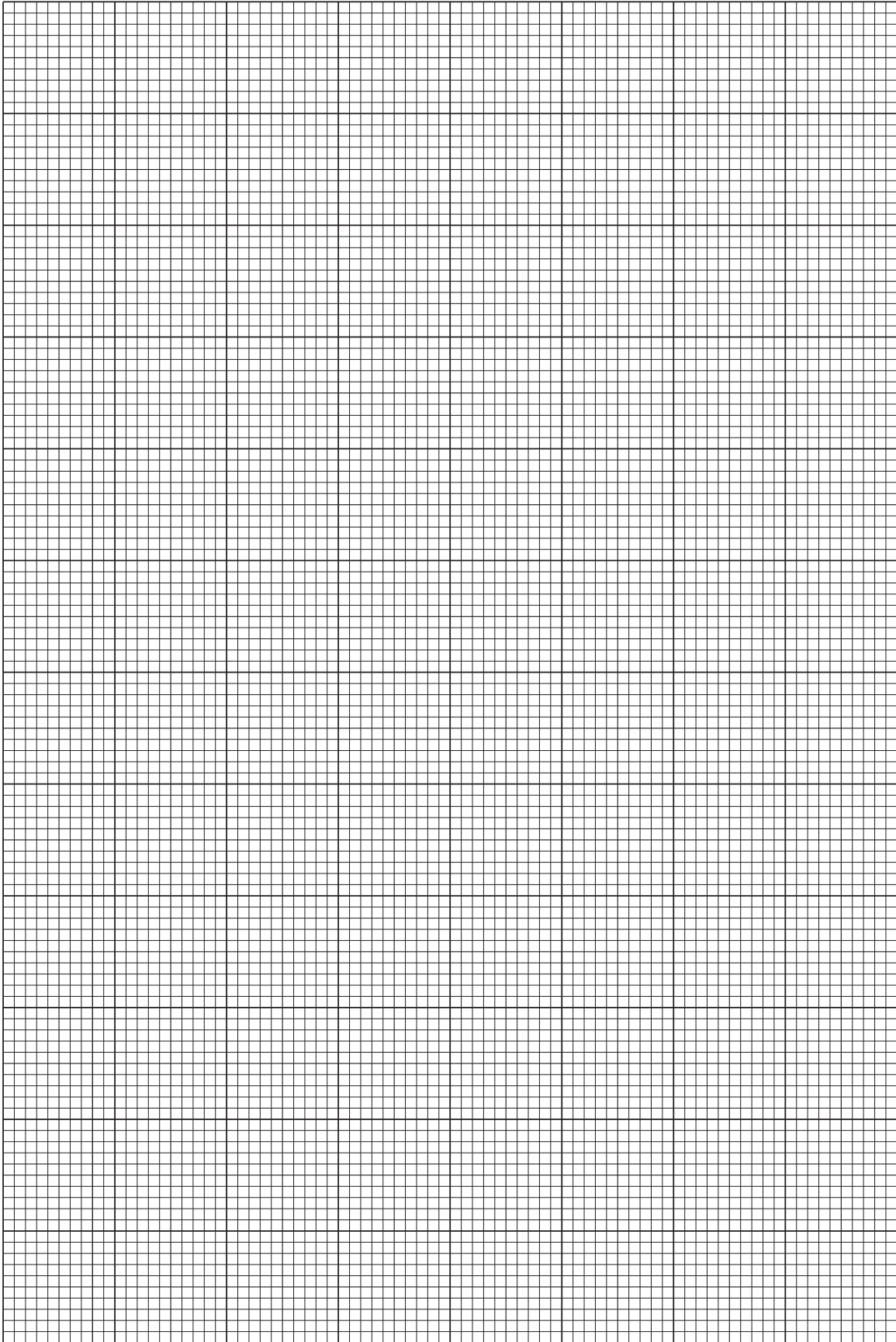
[1]

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

gradient = ...

y -intercept = ...

[2]



(d) It is suggested that the quantities T and C are related by the equation

$$\frac{1}{T} = \frac{a}{\sqrt{C}} + b$$

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 the deformation of a foam ring.

- (a) (i) • Assemble the apparatus as shown in Fig. 2.1.
The wooden rod should pivot freely on the nail.

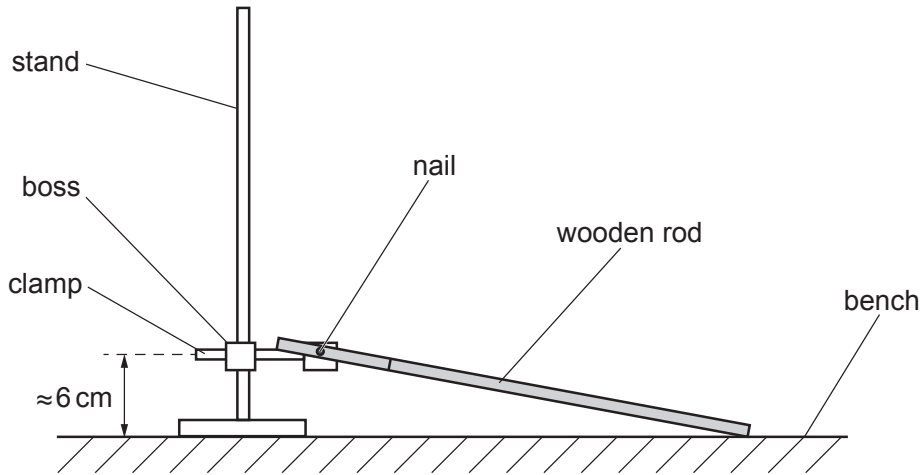


Fig. 2.1

- Take the **larger** of the two foam rings.
- Using the metre rule, measure and record the inner diameter D_1 and the outer diameter D_2 , as shown in Fig. 2.2.

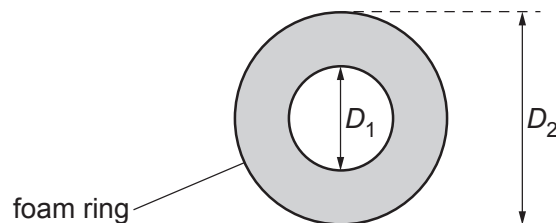


Fig. 2.2

$D_1 =$ mm

$D_2 =$ mm
[2]

- (ii) Estimate the percentage uncertainty in your value of D_2 . Show your working.

percentage uncertainty = ... [1]

- (b) • Position the ring under the line on the rod and centrally on the wooden block, as shown in Fig. 2.3.

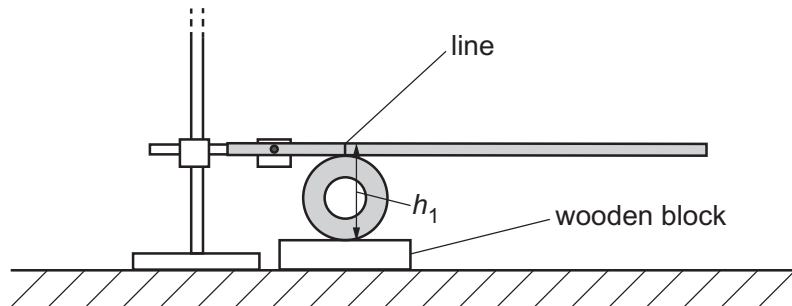


Fig. 2.3

- Adjust the height of the boss so that the rod is horizontal.
- The vertical distance, next to the ring, of the top of the rod above the block is h_1 , as shown in Fig. 2.3.

Using the calipers, measure and record h_1 .

$h_1 =$ mm

- Place the slotted mass at the end of the rod, as shown in Fig. 2.4.

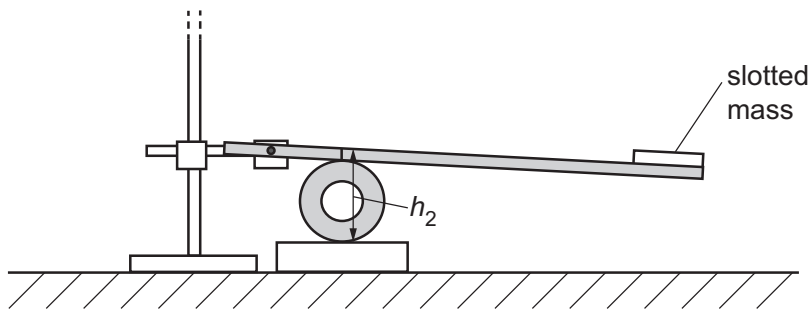


Fig. 2.4

- The vertical distance, next to the ring, of the top of the rod above the block is now h_2 , as shown in Fig. 2.4.

Measure and record h_2 .

$h_2 = \dots\dots\dots$ mm

- Calculate y where $y = h_1 - h_2$.

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

- (c) (i) The distance between the nail and the line is A and the distance between the nail and the centre of the slotted mass is B , as shown in Fig. 2.5.

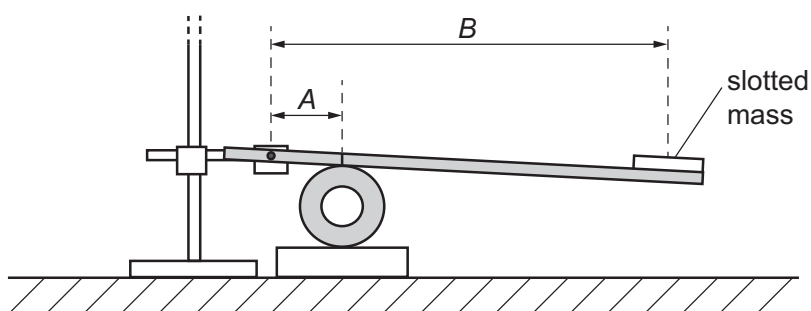


Fig. 2.5

Measure and record A and B .

$A = \dots\dots\dots$ cm

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

- (ii) Calculate the additional force F on the ring using

$$F = \frac{mgB}{A}$$

where $g = 9.81 \text{ N kg}^{-1}$ and $m = 0.100 \text{ kg}$.

$F = \dots\dots\dots$ N [1]

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

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

- (d) • Take the **smaller** of the two foam rings.
- Using the metre rule, measure and record the inner diameter D_1 and the outer diameter D_2 .

$D_1 =$ mm

$D_2 =$ mm

- Repeat (b) using the smaller ring.

$h_1 =$ mm

$h_2 =$ mm

$y =$ mm
[2]

- (e) It is suggested that the relationship between D_1 , D_2 , F and y is

$$\frac{(D_2^2 - D_1^2)}{D_2^3} = \frac{kF}{y}$$

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.

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 2021

2 hours

You must answer on the question paper.

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

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You will be allowed to work with the apparatus for a maximum of 1 hour for each question.
- You should record all your observations in the spaces provided in the question paper as soon as these observations are made.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [].

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1	
2	
Total	

This document has **12** pages.

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

1 In this experiment, you will investigate the motion of a pendulum bob.

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

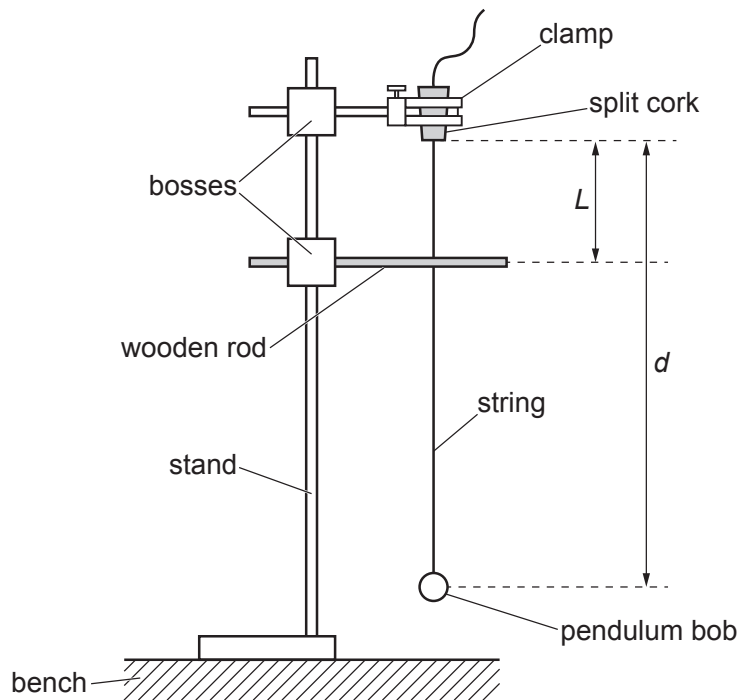


Fig. 1.1

- The distance between the bottom of the cork and the centre of the bob is d .

The distance between the bottom of the cork and the centre of the wooden rod is L .

Adjust the height of the rod until the value of L is approximately 10 cm. Ensure the rod is horizontal and the string is just touching the rod.

- Measure and record L .

$L =$ [1]

- (b)
- Adjust the string in the cork until the value of d is approximately 30 cm.
 - Measure and record d .

$d =$

- Pull the bob towards you through a short distance at right angles to the rod.
- Release the bob. The bob will oscillate.
- Determine the period T of these oscillations.

$T =$ s
[1]

- (c) • Write down your value of L from (a).

$L =$

- Keeping L **constant**, repeat (b) with different values of d until you have five sets of values of d and T .

Record your results in a table. Include values of $\frac{T}{\sqrt{d}}$ and $\sqrt{\frac{(d-L)}{d}}$ in your table.

[10]

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

[3]

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

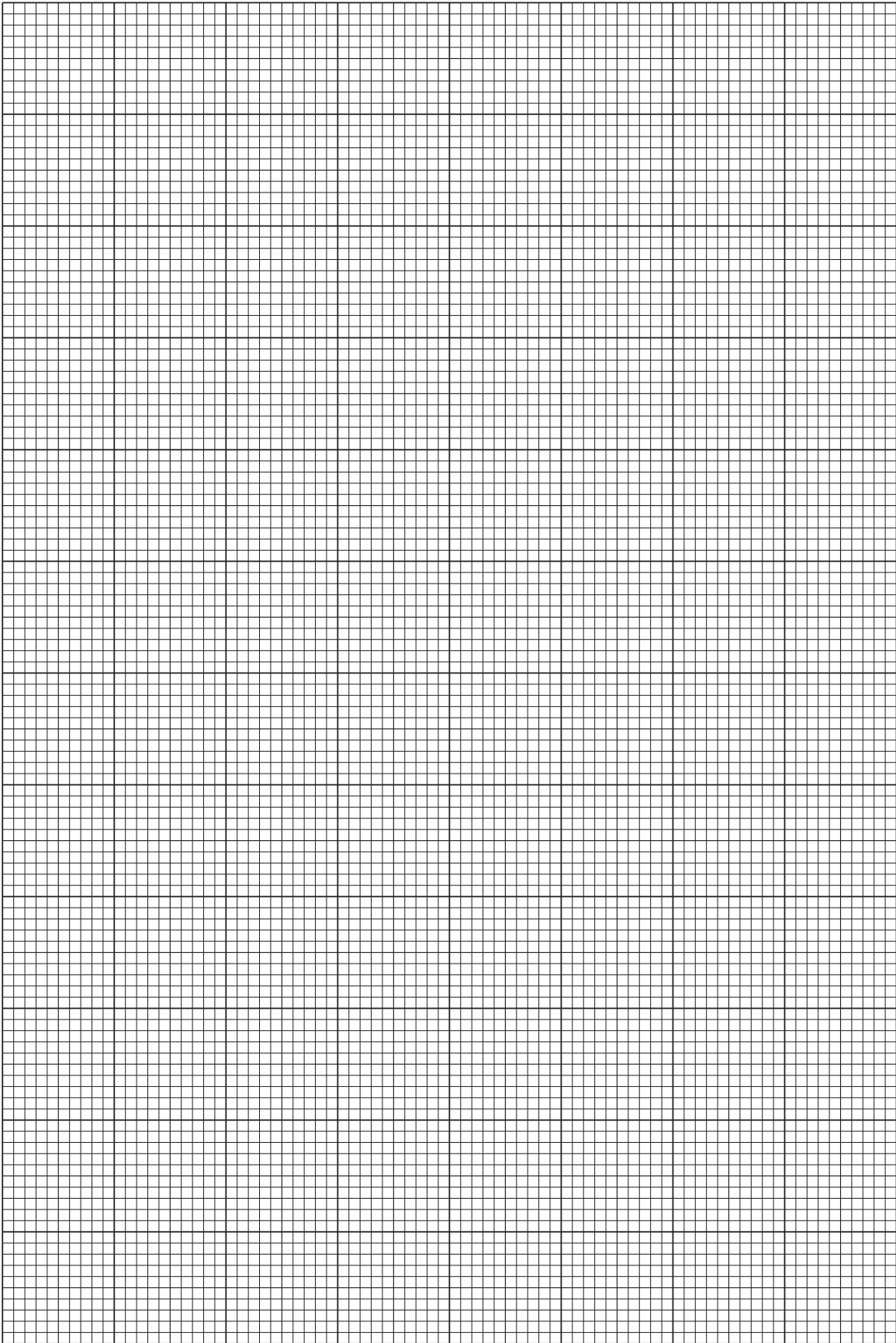
[1]

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

gradient = ...

y -intercept = ...

[2]



- (e) It is suggested that the quantities T and d are related by the equation

$$\frac{T}{\sqrt{d}} = P\sqrt{\frac{(d-L)}{d}} + Q$$

where P and Q are constants.

Using your answers in (d)(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 equilibrium of a wooden strip.

(a) You have been provided with a wooden strip. There are three holes in the strip and string is attached to two of the holes.

- Press the modelling clay onto the end of the strip as shown in Fig. 2.1.

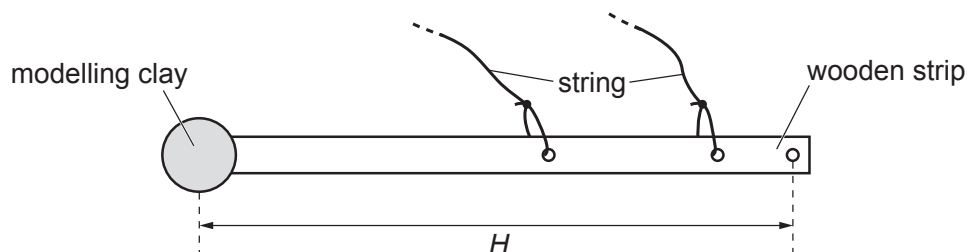


Fig. 2.1

- The distance between the centre of the modelling clay and the centre of the hole at the other end of the strip is H .

Using the ruler, take measurements to determine H .

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

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

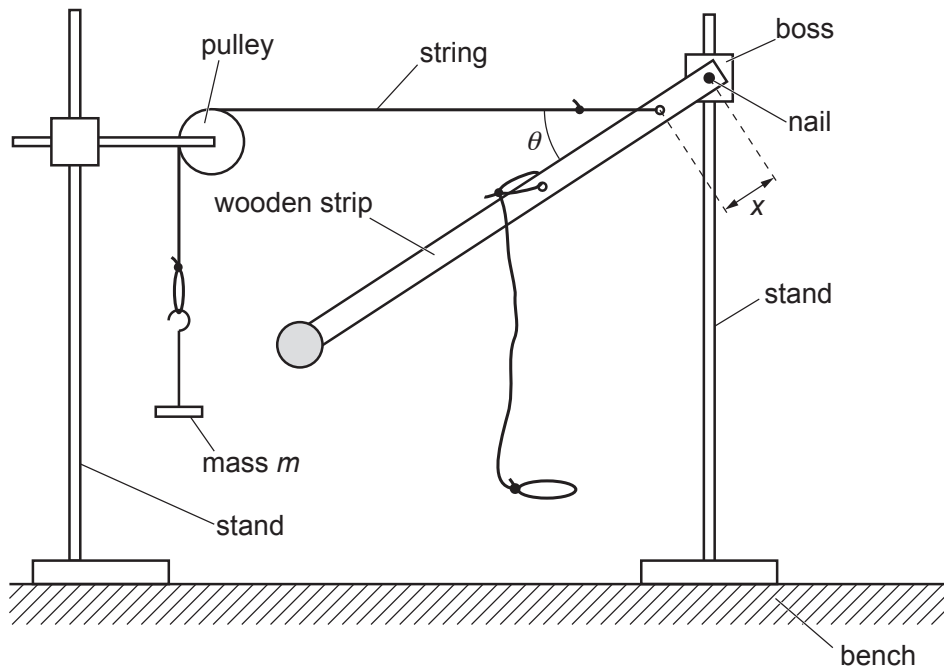


Fig. 2.2 (not to scale)

- Hang a mass m of 100 g from the string.
- Adjust the heights of the boss and pulley until the string between the strip and the pulley is horizontal.
- The distance between the nail and the hole through which the string is attached is x .

The angle between the strip and the horizontal string is θ .

Measure and record x and θ .

$x = \dots\dots\dots$ cm

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

[2]

- (ii) Estimate the percentage uncertainty in your value of θ . Show your working.

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

(iii) Calculate $x \tan \theta$.

$$x \tan \theta = \dots\dots\dots \text{ cm [1]}$$

(iv) Justify the number of significant figures that you have given for your value of $x \tan \theta$.

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

- (c)
- Remove the mass and the string from the pulley.
 - Set up the apparatus as shown in Fig. 2.3 using the other string.

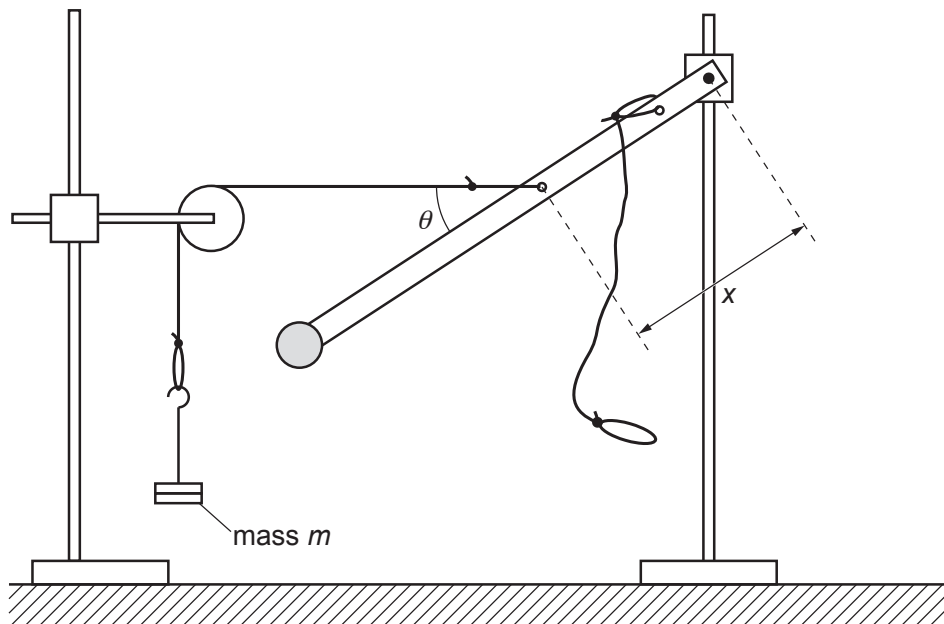


Fig. 2.3 (not to scale)

- Hang a mass m of 200 g from the string.
- Adjust the heights of the boss and pulley until the string between the strip and the pulley is horizontal.
- The distance between the nail and the hole through which the string is attached is x .

The angle between the strip and the horizontal string is θ .

Measure and record x and θ .

$x = \dots\dots\dots$ cm

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

- Calculate $x \tan \theta$.

$x \tan \theta = \dots\dots\dots$ cm
[3]

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

$$x \tan \theta = \frac{k}{m}$$

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]

- (e) Theory suggests that

$$k = \frac{5HM}{6}$$

where M is the mass of the wooden strip.

Use your second value of k to calculate a value for M .
 Give an appropriate unit.

M = ... [1]
[Turn over]

(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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