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PHYSICS

9702/31

Paper 3 Advanced Practical Skills 1

October/November 2015

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.

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.

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

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This document consists of **14** printed pages and **2** blank pages.

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- 1** In this experiment, you will investigate the effect of air resistance on the motion of a circular card.
- (a)**
- (i)** Use the compasses to draw a circle of approximate diameter 20 cm on the card.
 - (ii)** Use the scissors to cut out the circle.
 - (iii)** Make a hole in the centre of the circle with the compasses. The hole should be big enough for the hook of the mass hanger to pass through.
 - (iv)** Measure and record the diameter d of the card as shown in Fig. 1.1.

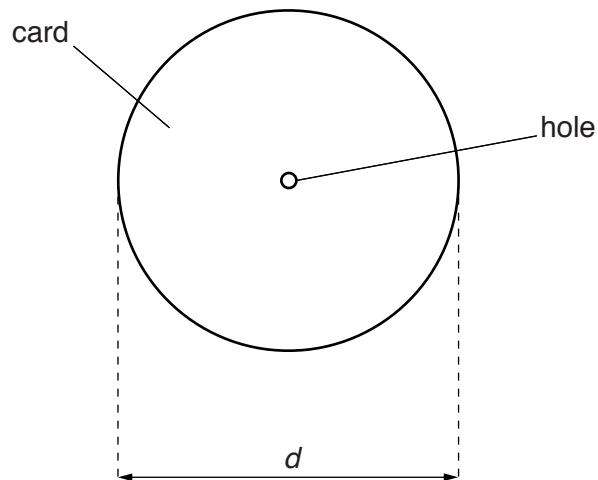


Fig. 1.1

$d =$ [1]



- (b) (i) Set up the apparatus as shown in Fig. 1.2.
The rule should have a 0 cm mark at the bottom and a 100 cm mark at the top.

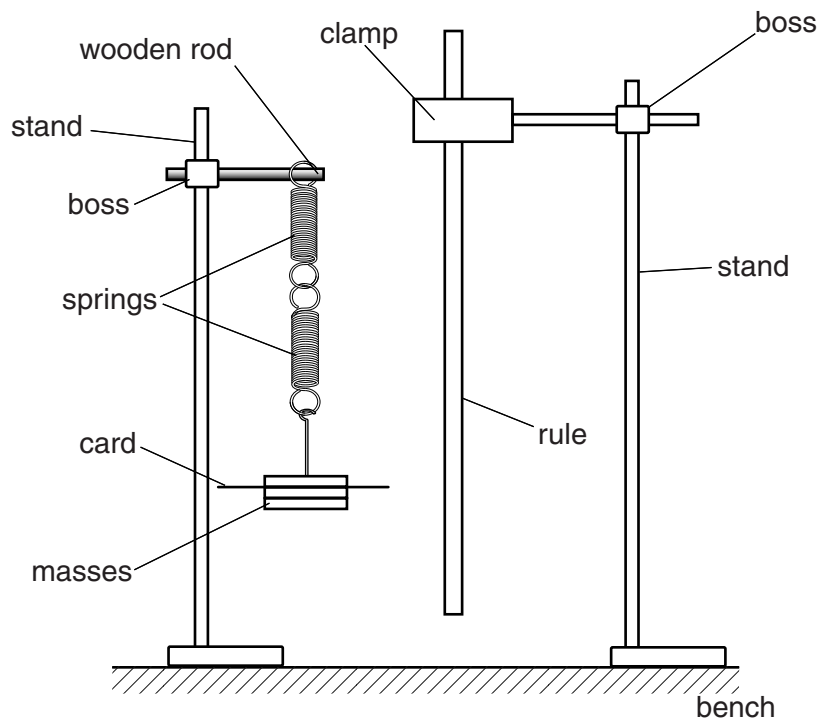


Fig. 1.2

- (ii) Adjust the rule until the 5.0 cm mark is level with the card as shown in Fig. 1.3.

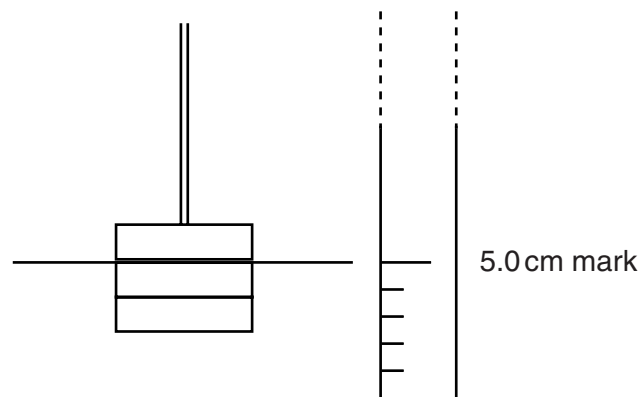


Fig. 1.3

- (c) (i) Pull the masses down so that the card is level with the 0 cm mark as shown in Fig. 1.4.

Release the masses and watch the movement of the masses and card. They will move up and down.

When the card returns to its lowest point for the first time, it has completed one cycle as shown in Fig. 1.4.

Gradually the card moves less and less and does not move down as far as the 0 cm mark.

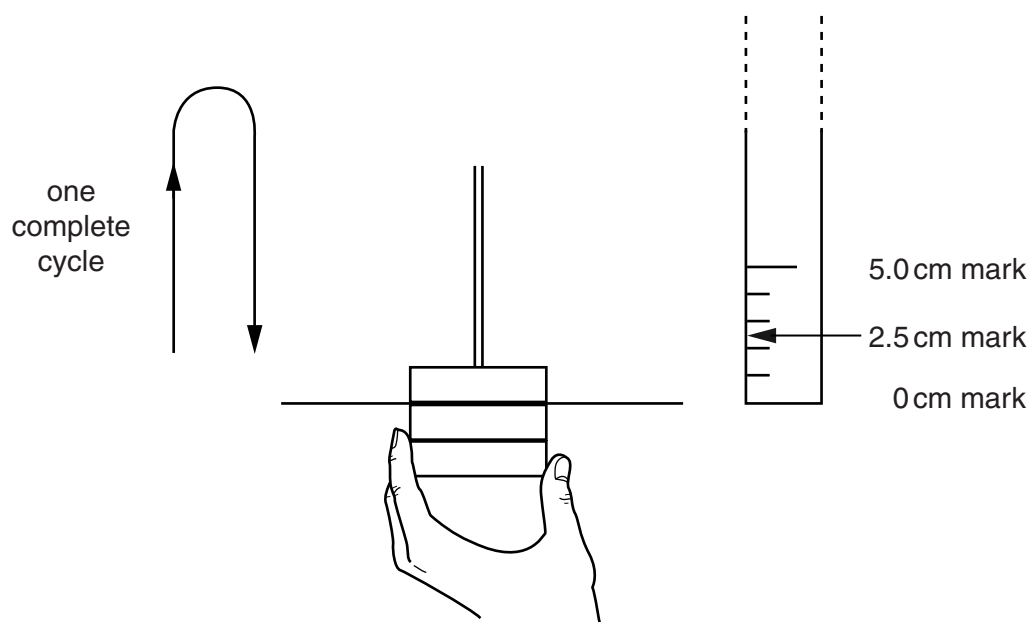


Fig. 1.4

- (ii) Pull the masses down so that the card is again level with the 0 cm mark. Release the masses and count the number N of cycles for the card to reach the 2.5 cm mark at its lowest point.

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



- (d) (i)** Remove the card from the mass hanger.

Use the compasses to draw a circle of approximate diameter 18 cm on the card.

Use the scissors to cut out the circle.

Measure and record the diameter d of the card.

$d =$

- (ii)** Repeat **(b)** and **(c)**.

$N =$

- (e) Cut smaller circles and repeat (b) and (c) until you have six sets of values of d and N . Include in your table the two sets of values already taken.

Also include values of $\frac{1}{d}$ and $\sqrt{N}$ in your table.

--

[10]

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

[3]

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

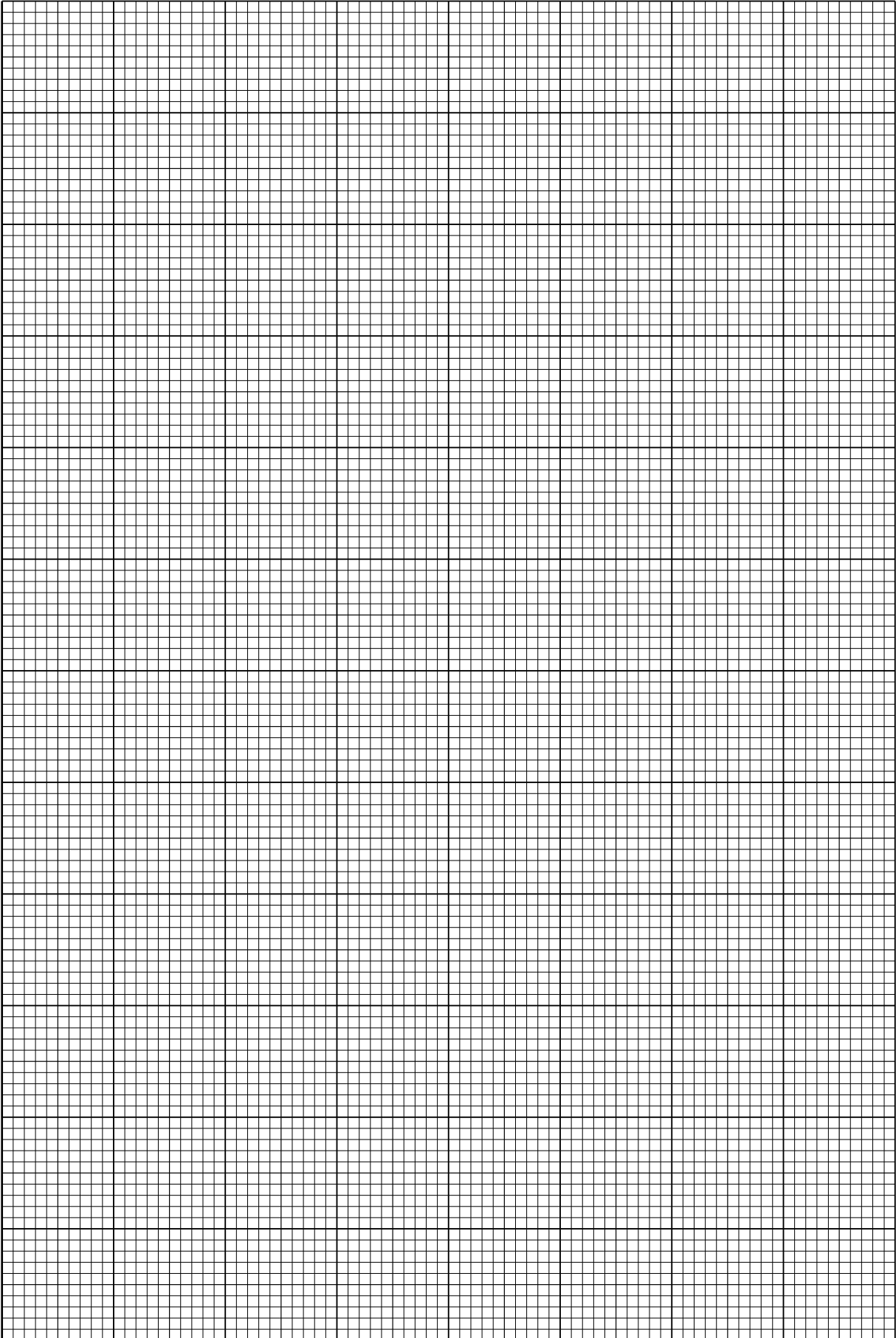
[1]

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

gradient = ...

y -intercept = ...

[2]



- (g) It is suggested that the quantities N and d are related by the equation

$$\sqrt{N} = \frac{A}{d} + B$$

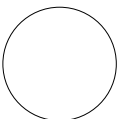
where A and B are constants.

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

$A =$

$B =$

[2]



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

2 In this experiment, you will investigate the motion of a marble.

(a) (i) Balance the wooden rod on the pivot as shown in Fig. 2.1.

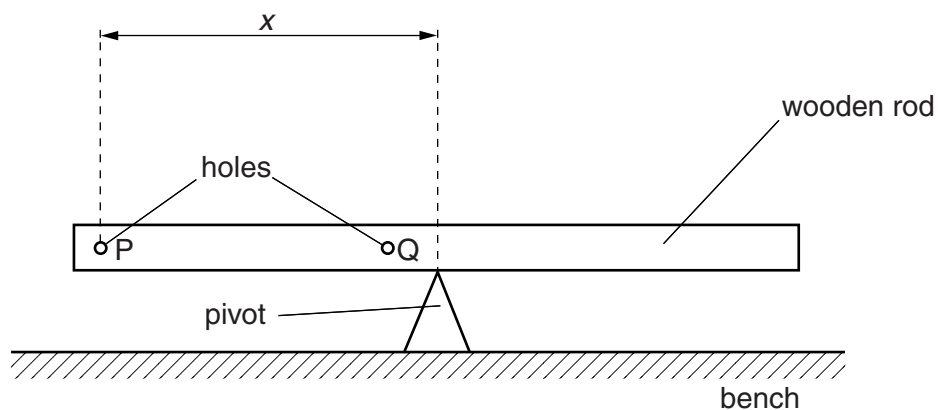


Fig. 2.1

(ii) Measure and record the distance x from the hole P to the pivot as shown in Fig. 2.1.
Do not mark the wooden rod.

$x =$ m [2]

(b) (i) Calculate C using

$$C = \frac{x^2 + h^2}{x}$$

where $h = 0.100$ m.

$C =$ m [1]

--

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

.....

 [1]

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- (c) (i) Set up the apparatus with the nail through hole P, as shown in Fig. 2.2.

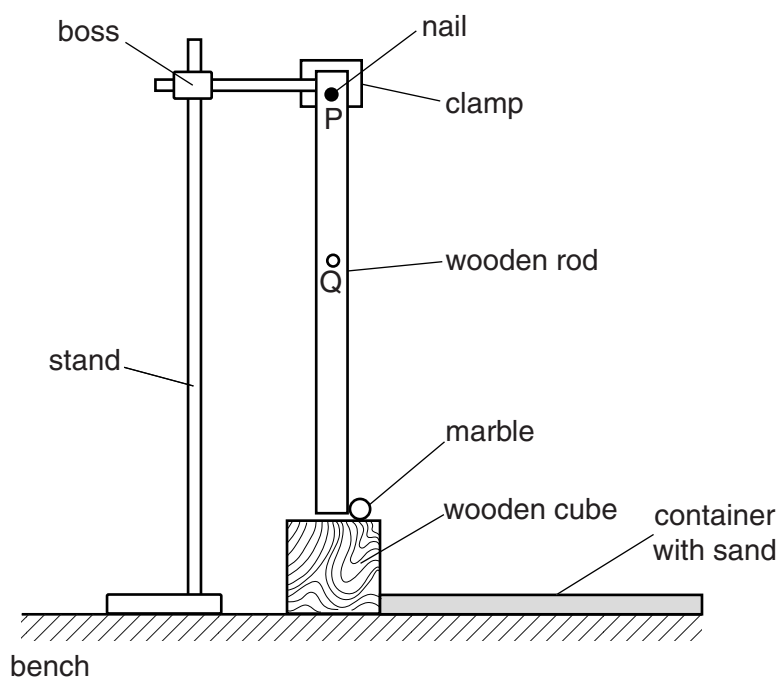


Fig. 2.2

The nail should be held in the clamp. The bottom of the wooden rod should be just above the top of the wooden cube. The marble should be in contact with the wooden rod.

- (ii) Move the wooden rod to the left through a distance of 20 cm as shown in Fig. 2.3. Release the wooden rod. The wooden rod will move to the right and strike the marble.

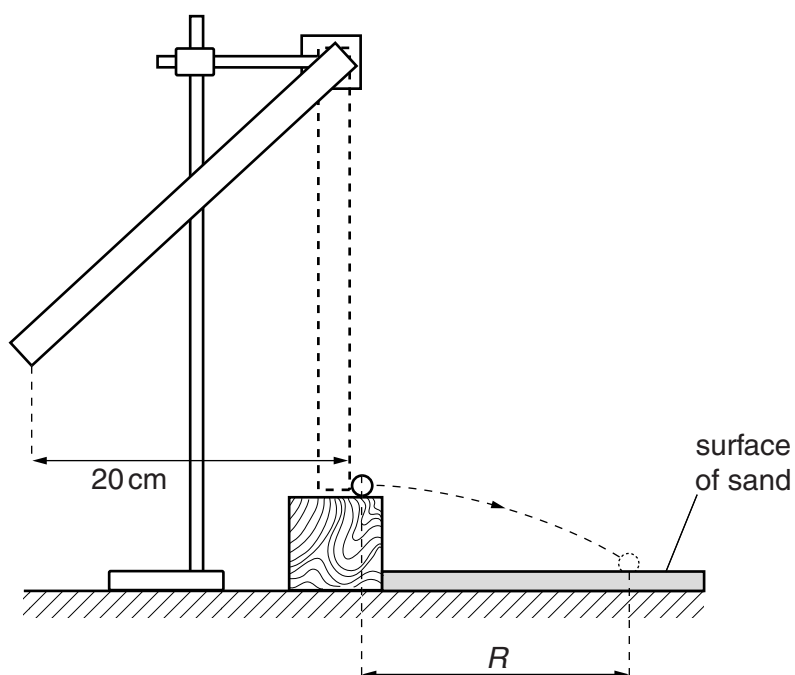


Fig. 2.3

Measure and record the horizontal distance R moved by the marble through the air.

$R = \dots\dots\dots$ [2]

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

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

--

(d) Using hole Q, repeat (a), (b)(i), (c)(i) and (c)(ii).

$x = \dots\dots\dots$ m

$C = \dots\dots\dots$ m

$R = \dots\dots\dots$

[3]

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

$$C = \frac{k}{R^2}$$

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 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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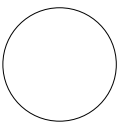
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1 In this experiment, you will investigate the equilibrium of a wooden rod.

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

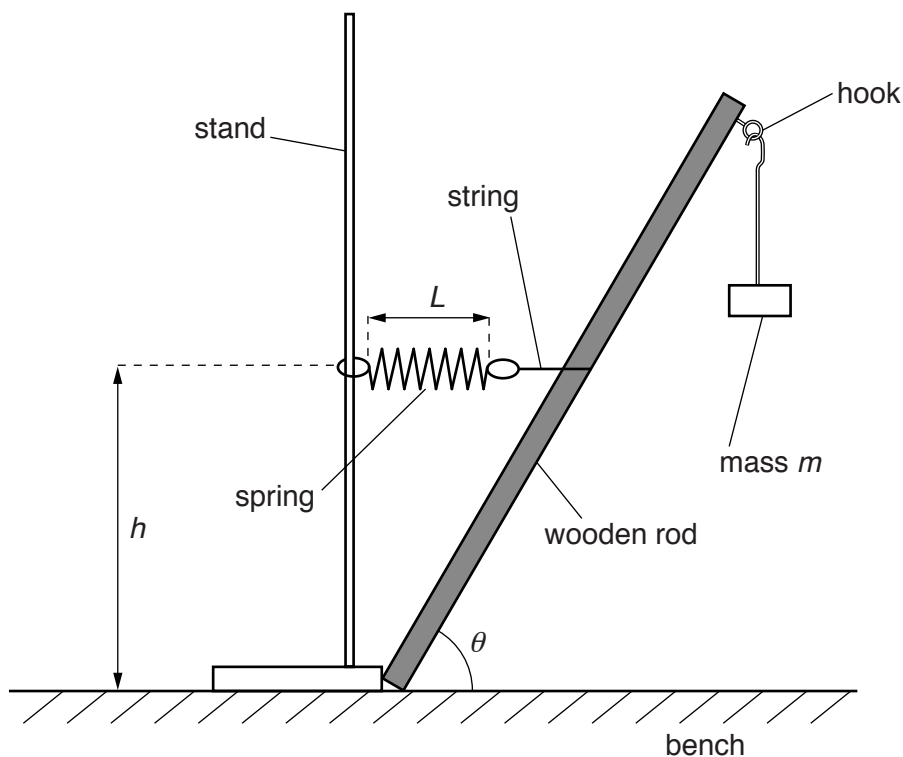


Fig. 1.1

The mass m should be 60g. The string should be approximately half-way along the wooden rod. The spring should be horizontal.

(b) (i) Measure and record the length L of the coiled part of the spring.

$L =$ [1]

(ii) Measure and record the height h of the loop of the spring above the bench.

$h =$

(iii) Measure and record the angle θ between the wooden rod and the bench.

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

(c) Change mass m to 80 g.

Adjust the position of the spring and string so that the length L is the same as in (b)(i) and the string is horizontal.

Repeat (b)(ii) and (b)(iii).

$h =$

$\theta =$ [°]

[1]

- (d) (i) Copy your value of L from (b)(i).

$L =$

- (ii) Change m and repeat (b)(ii) and (b)(iii) until you have six sets of values of m , h and θ .

For each value of m , adjust the position of the spring and string so that L is the same as in (d)(i) and the spring is horizontal.

Include your values from (b) and (c).

Also include values of $\frac{h}{\cos \theta}$ in your table.

--

[10]

- (e) (i) Plot a graph of $\frac{h}{\cos \theta}$ on the y-axis against m on the x-axis.

[3]

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

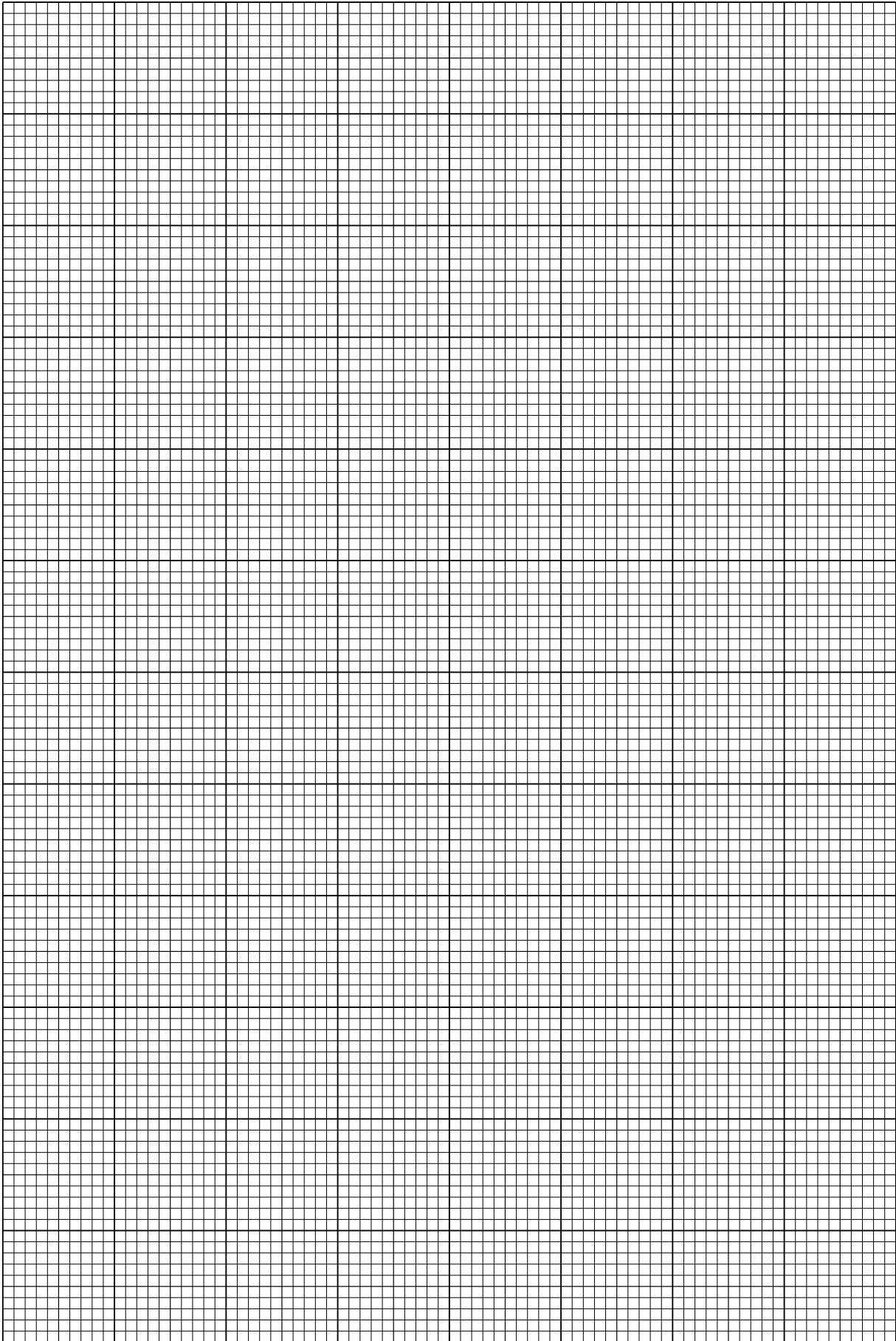
[1]

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

gradient = ...

y-intercept = ...

[2]



- (f) The quantities h , θ and m are related by the equation

$$\frac{h}{\cos \theta} = Am + B$$

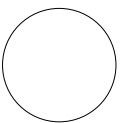
where A and B are constants.

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

$A =$

$B =$

[2]



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

2 In this experiment, you will investigate the motion of a loaded wooden rod.

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

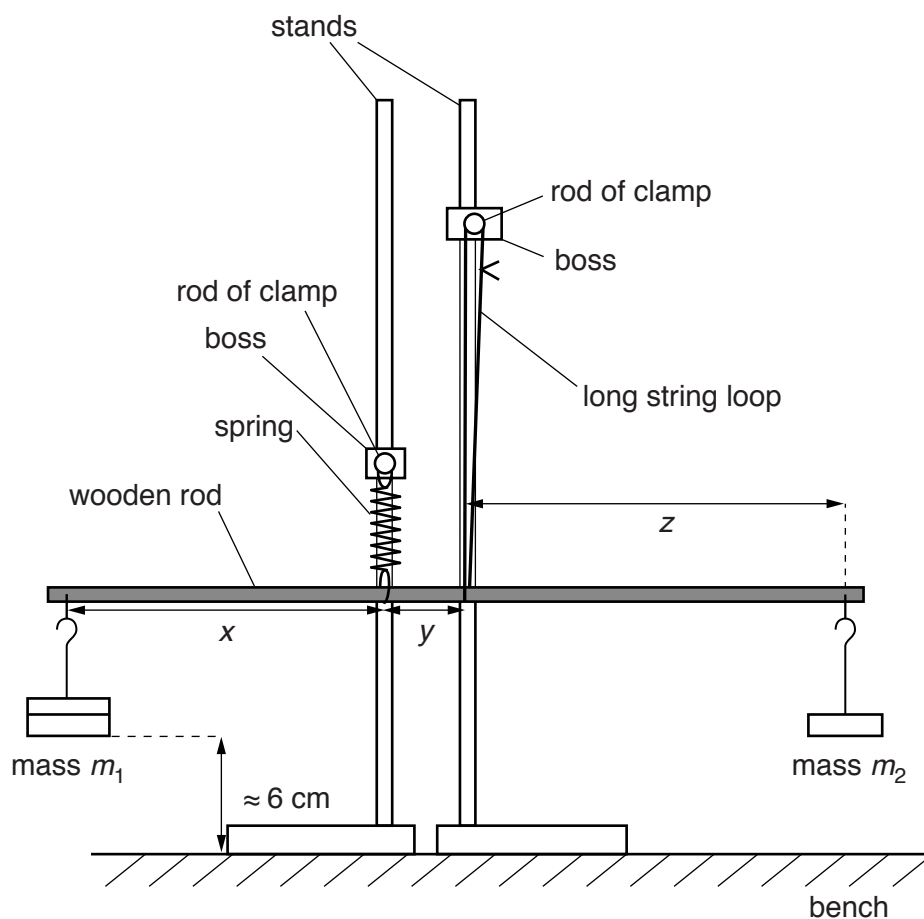


Fig. 2.1

Support the wooden rod by passing it through the loop of the spring and the long string loop.

Mass m_1 should be 200 g and mass m_2 should be 100 g.

The bottom of mass m_1 should be approximately 6 cm above the bench.

(ii) Adjust the apparatus until the wooden rod is balanced and horizontal. The spring and long string loop should be vertical.

- (iii) Measure and record the distances x , y and z as shown in Fig. 2.1, where

x is the distance between the loop above m_1 and the spring loop,
 y is the distance between the spring loop and the long string loop,
 z is the distance between the long string loop and the loop above m_2 .

$x =$

$y =$

$z =$

[2]

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

percentage uncertainty = ... [1]

--

- (b) Calculate C where

$$C = m_1(x + y)^2 + m_2z^2.$$

$C =$ [1]

--

- (c) (i) Pull the left side of the wooden rod down by 5 cm.

Release the wooden rod and watch the movement.

The wooden rod will move up and down again, completing a cycle as shown in Fig. 2.2.

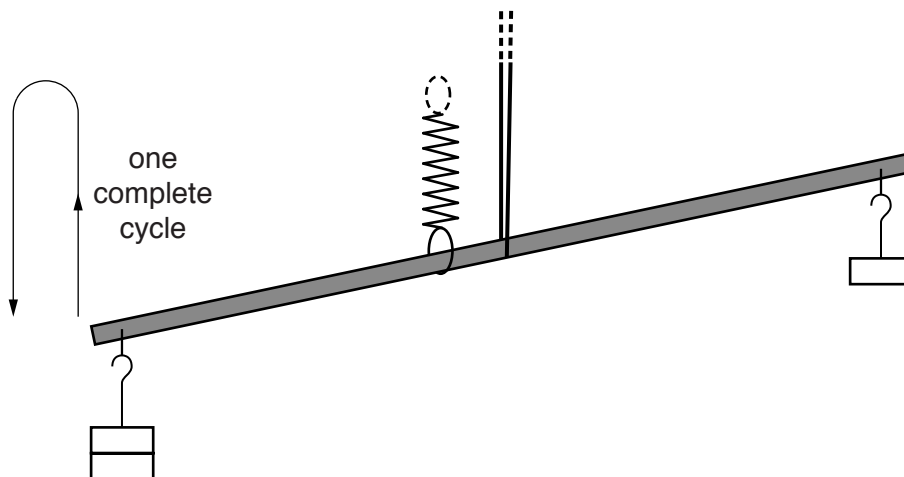


Fig. 2.2

- (ii) The time taken for one complete cycle is T .

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

$T =$ [2]

- (iii) Calculate T^2 .

$T^2 =$

- (iv) Justify the number of significant figures that you have given for your value of T^2 .

.....

 [1]

--

- (d) **Keeping distance y constant**, change m_2 to 50 g and repeat (a)(ii), (a)(iii), (b), (c)(i), (c)(ii) and (c)(iii).

$x =$

$y =$

$z =$

$C =$

$T =$

$T^2 =$

[3]

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

$$T^2 = kC$$

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 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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- (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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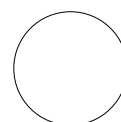
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PHYSICS

9702/34

Paper 3 Advanced Practical Skills 2

October/November 2015

2 hours

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1 In this experiment, you will investigate forces in equilibrium.

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

The angle θ should be approximately 150° . String AB should be parallel to the bench, and the bottom of mass M should be approximately 10 cm above the bench.

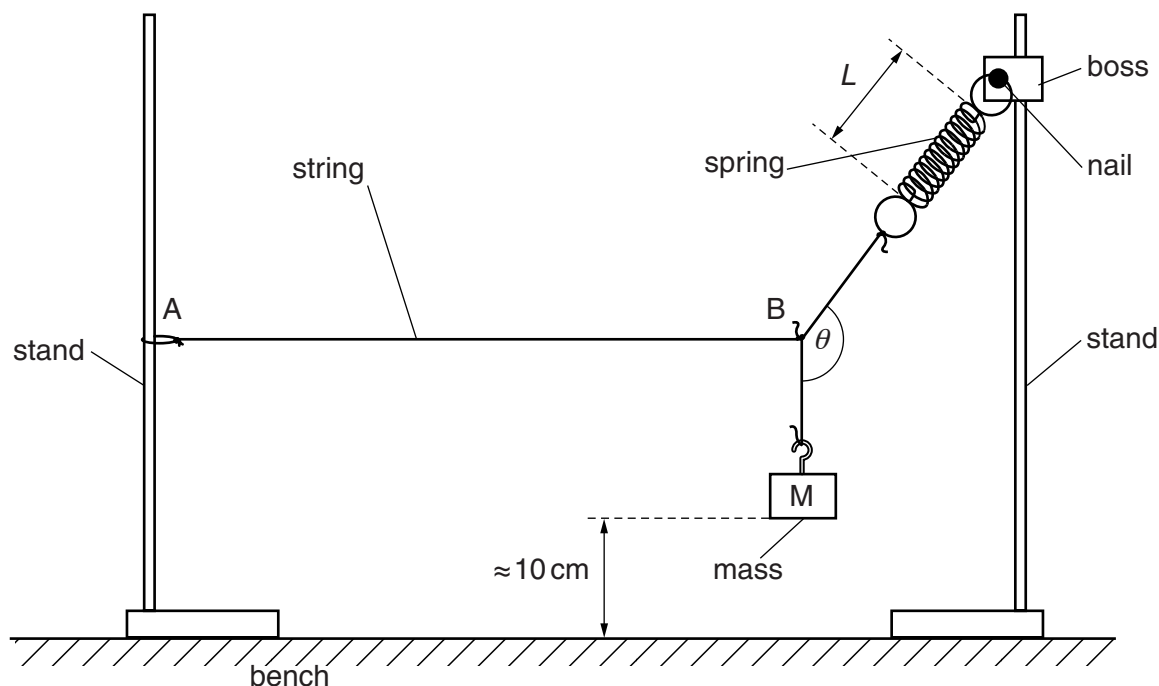


Fig. 1.1

(b) (i) Measure and record the angle θ between the string attached to mass M and the string attached to the spring, as shown in Fig. 1.1.

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

(ii) Measure and record the length L of the coiled part of the spring, as shown in Fig. 1.1.

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

(c) (i) Change the distance between the stands.

Adjust the height of A until string AB is parallel to the bench. If the apparatus is unstable, you may need to use the G-clamp to secure one of the stands to the bench.

(ii) Measure and record θ and L .

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

$L = \dots\dots\dots$

- (d) Repeat (c) until you have six sets of values of θ and L . Include your values from (b) and (c).

Also include values of $\frac{1}{\sin(\theta - 90^\circ)}$ in your table.

[10]

- (e) (i) Plot a graph of $\frac{1}{\sin(\theta - 90^\circ)}$ on the y-axis against L on the x-axis.

[3]

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

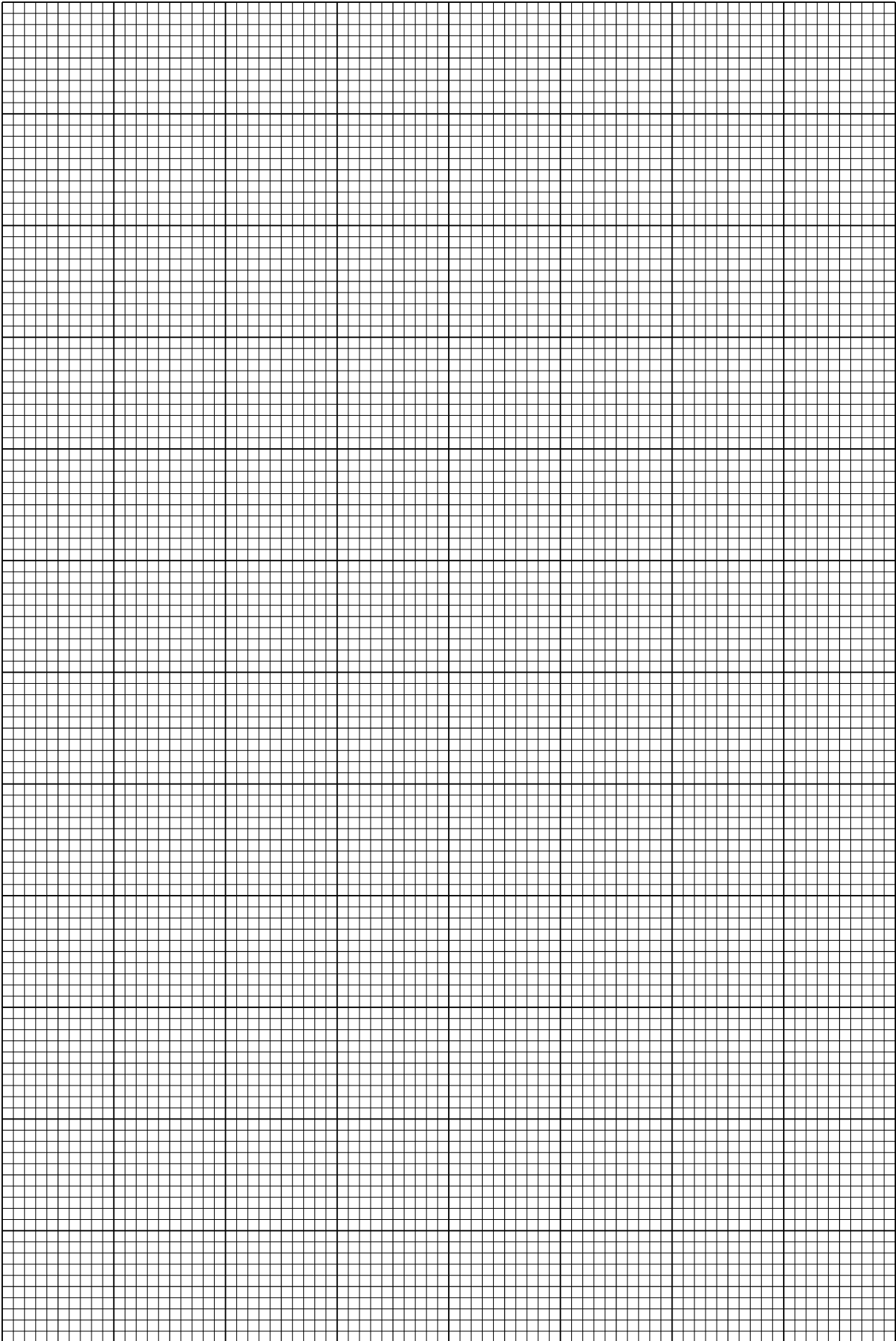
[1]

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

gradient = ...

y-intercept = ...

[2]



- (f) The quantities θ and L are related by the equation

$$\frac{1}{\sin(\theta - 90^\circ)} = aL + b$$

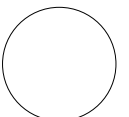
where a and b are constants.

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

$a =$

$b =$

[2]



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

- 2** In this experiment, you will investigate the relationship between the performance of an electrical component and its volume.

(a) You are provided with two cylindrical components.

- (i)** Measure and record the diameter d and the length l of the larger cylindrical component, as shown in Fig. 2.1.

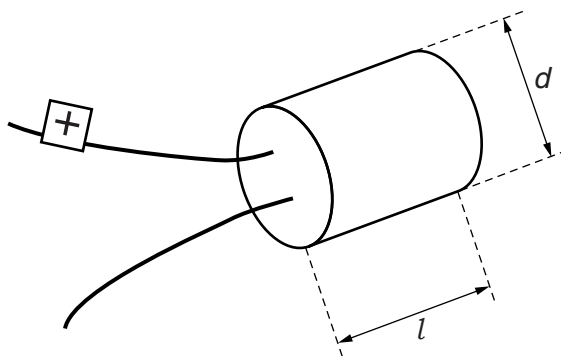


Fig. 2.1

$d =$

$l =$

[2]

- (ii)** Calculate the volume V of the component using $V = \frac{\pi d^2 l}{4}$.

$V =$ [1]

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

.....

 [1]

- (c) (i) Assemble the circuit shown in Fig. 2.2, using the larger cylindrical component. Ensure that the positive terminals are all connected as shown.

Switch on the power supply.

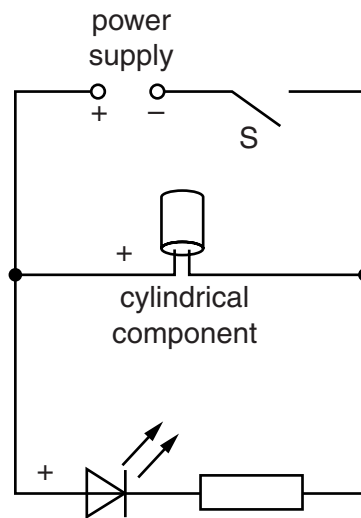


Fig. 2.2

- (ii) Close switch S and watch the LED light up. Open switch S and watch the LED **gradually** go out.
- (iii) Take measurements to find the time t between opening the switch S and the LED going out.

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

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

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

--

(e) Using the smaller cylindrical component, repeat (a) and (c).

$d =$

$l =$

$V =$

$t =$

[3]

(f) It is suggested that the relationship between t and V is

$$t = kV$$

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 in (f)(i) support the suggested relationship.

.....

.....

.....

.....[1]

☐

- (g) (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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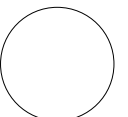
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PHYSICS

9702/35

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- 1** In this experiment, you will investigate how the potential difference across a resistor changes as the resistance of the circuit is changed.

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

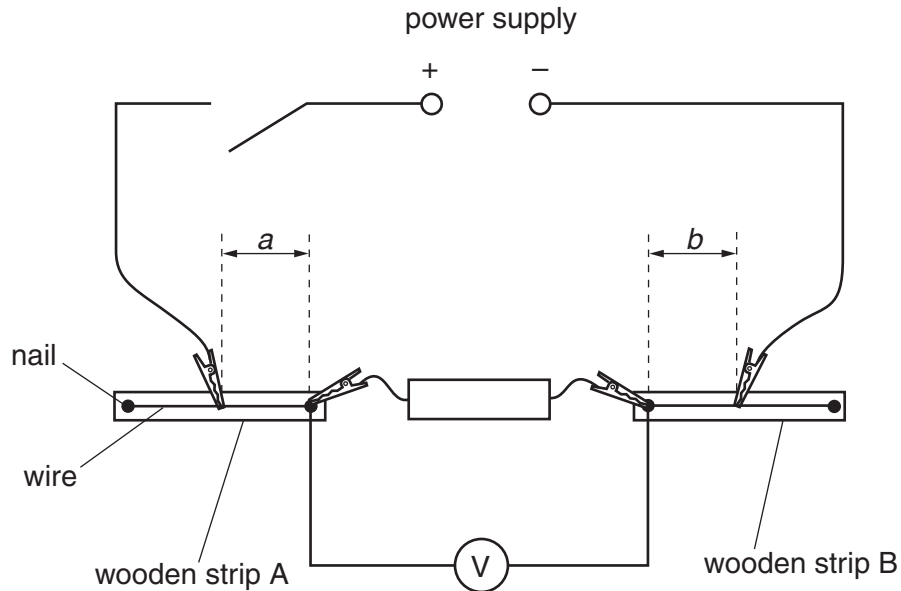


Fig. 1.1

The two crocodile clips attached to the wires on the wooden strips should be approximately half-way along each of the wires.

(ii) Measure and record the lengths a and b .

$a =$

$b =$

(iii) Calculate the value of C where $C = a + b$.

$C =$

(iv) Close the switch.

(v) Record the voltmeter reading V .

$V =$

(vi) Open the switch.

- (b) (i)** Change the value of a . Measure and record this value of a .

$a =$ [1]

- (ii)** Calculate the new value of b using $b = C - a$.

$b =$

- (iii)** Change b to the value shown in **(b)(ii)**.

- (iv)** Close the switch.

- (v)** Record the voltmeter reading V .

$V =$ [1]

- (vi)** Open the switch.

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

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

[10]

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

[3]

(ii) Draw the straight line of best fit.

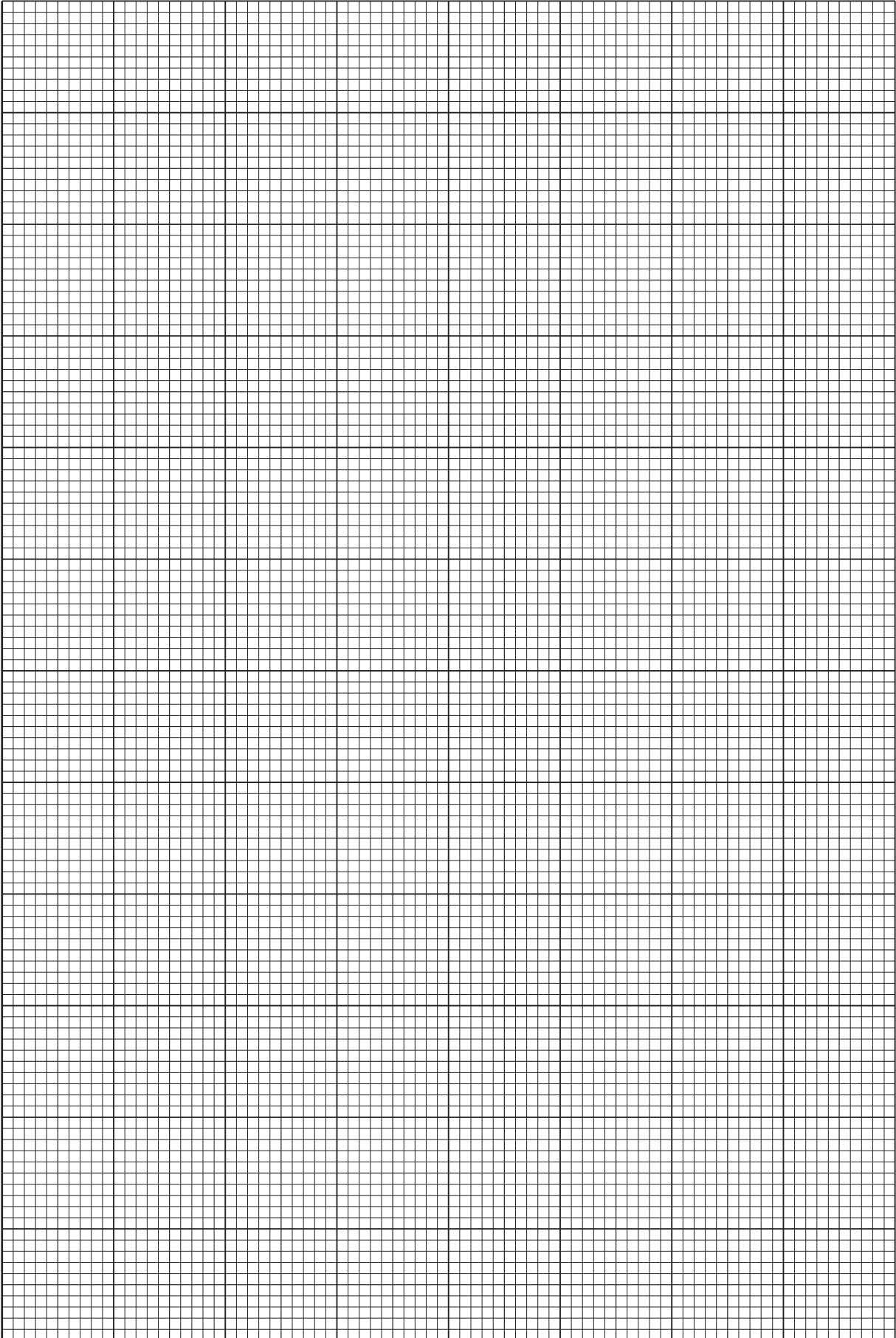
[1]

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

gradient = ...

y -intercept = ...

[2]



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

$$\frac{1}{V} = Pb + Q$$

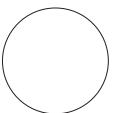
where P and Q are constants.

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

$P =$

$Q =$

[2]



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

2 In this experiment, you will investigate the motion of a magnetised object in a magnetic field.

(a) You have been provided with a nail and two magnets.

Hold the head of the nail.

Move one of the magnets as shown by the dotted path in Fig. 2.1.

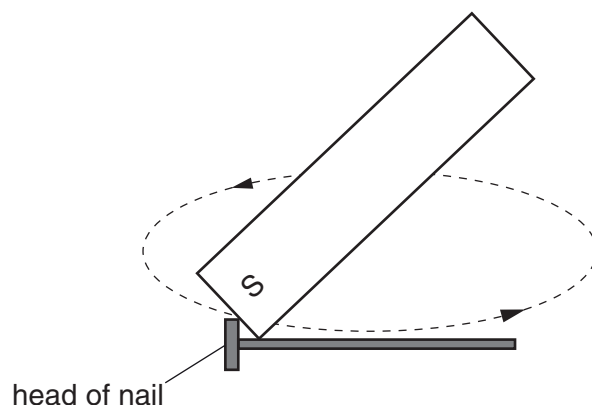


Fig. 2.1

The S pole of the magnet should remain in contact with the nail until it reaches the end of the nail. At the end of the nail, lift the magnet above the nail and back to the head. Repeat 10 times.

The nail should not touch a magnet during the remainder of the experiment. If it does, you should re-magnetise the nail by repeating (a).

(b) (i) Place the sheet of paper flat on the bench as shown in Fig. 2.2.

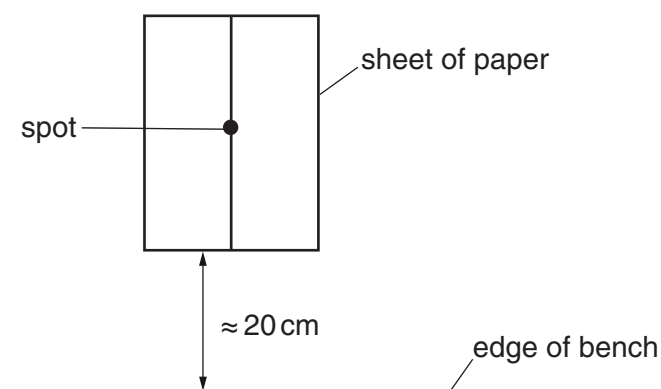


Fig. 2.2

- (ii) Set up the apparatus as shown in Fig. 2.3.

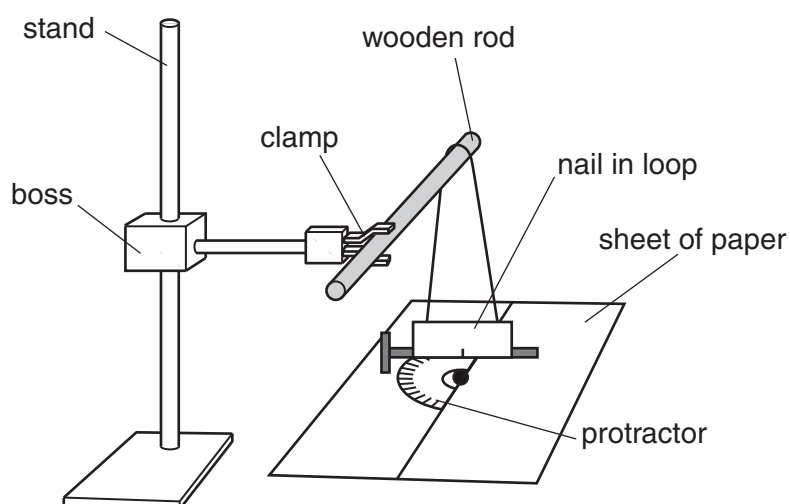


Fig. 2.3

Place the protractor on the line with its centre over the spot.

Align the rod so that the rod is directly above and parallel to the line on the sheet of paper.

Place the nail in the paper loop.

Suspend the loop from the rod. The nail will be perpendicular to the line on the sheet of paper.

The nail should be just above the protractor with the mark on the loop above the spot on the line. The loop should be free to rotate.

- (iii) With the apparatus set up as shown in Fig. 2.3, position the magnets on the sheet of paper as shown in Fig. 2.4.

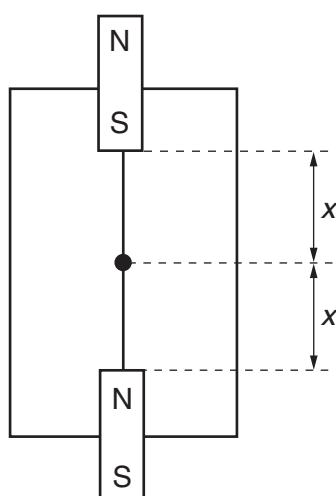


Fig. 2.4

Move the magnets along the line until the nail rotates through approximately 45° . The magnets should each be the same distance x from the spot and **should remain in these positions throughout the experiment.**

- (iv) Measure and record x .

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

- (c) (i) Without removing the loop and nail, move the wooden rod so that the rod makes an angle θ of approximately 30° to the line on the sheet of paper as shown in Fig. 2.5.

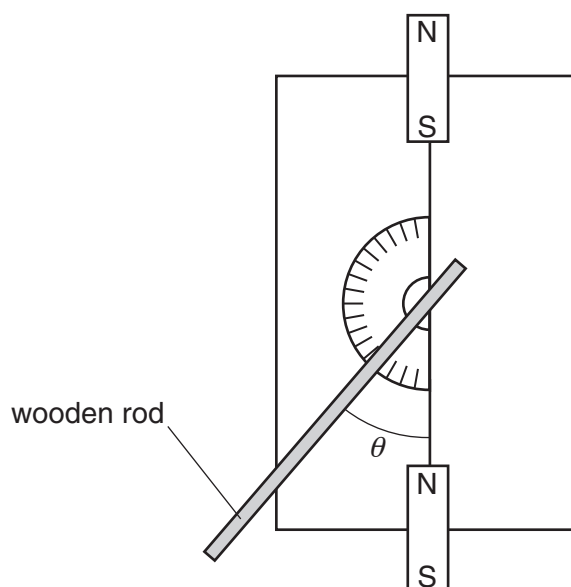


Fig. 2.5

The mark on the loop should be above the spot.

Measure and record θ .

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

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

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

- (iii) Calculate $\cos^2\left(\frac{\theta}{2}\right)$.

$$\cos^2\left(\frac{\theta}{2}\right) = \dots\dots\dots [1]$$

- (iv) Justify the number of significant figures that you have given for your value of $\cos^2\left(\frac{\theta}{2}\right)$.

.....

.....

..... [1]

- (d) (i) Rotate the nail and loop through approximately 45° . Release the nail. It should complete a cycle as shown in Fig. 2.6.

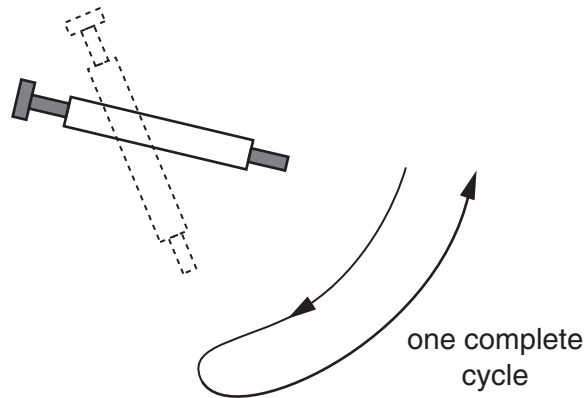


Fig. 2.6

- (ii) The time taken for one complete cycle is T .

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

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

- (e) (i) Remove the nail from the loop and replace it in the loop **the other way round**.
 (ii) Repeat (d) to obtain the time T taken for one complete cycle.

$T =$

- (iii) You have two values of T from (d)(ii) and (e)(ii).

One of your values of T will be shorter than the other. This is T_1 . The other value is T_2 . Record your values of T_1 and T_2 below.

shorter time $T_1 =$

longer time $T_2 =$

- (iv) Calculate $\frac{T_1}{T_2}$.

$\frac{T_1}{T_2} =$

- (f) Repeat (c)(i), (c)(iii), (d) and (e) with the wooden rod at an angle θ of approximately 60° .

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

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

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

with nail other way round, $T = \dots\dots\dots$

shorter time $T_1 = \dots\dots\dots$

longer time $T_2 = \dots\dots\dots$

$$\frac{T_1}{T_2} = \dots\dots\dots$$

[3]

- (g) It is suggested that the relationship between T_1 , T_2 and θ is

$$\frac{T_1}{T_2} = k \cos^2 \left(\frac{\theta}{2} \right)$$

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]

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

1.

.....

2.

.....

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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2.

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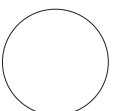
3.

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[4]



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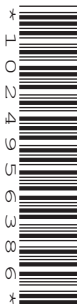
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PHYSICS

9702/36

Paper 3 Advanced Practical Skills 2

October/November 2015

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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1	
2	
Total	

This document consists of **12** printed pages.

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

1 In this experiment, you will investigate the upthrust on an object partly immersed in water.

(a) Measure and record the height H of the flask, as shown in Fig. 1.1.

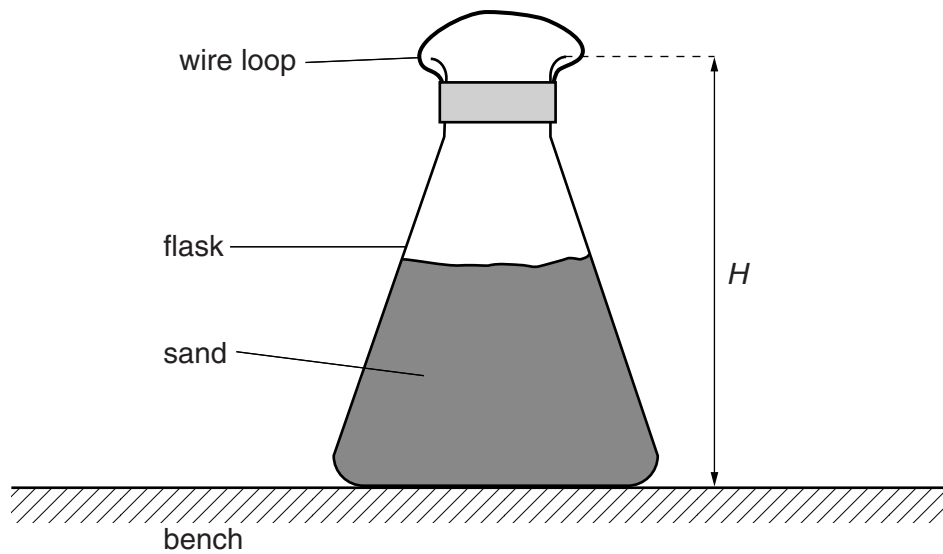


Fig. 1.1

$H =$ cm [1]

- (b) Assemble the apparatus as shown in Fig. 1.2, with the bottom of the flask approximately 4 cm below the water surface.

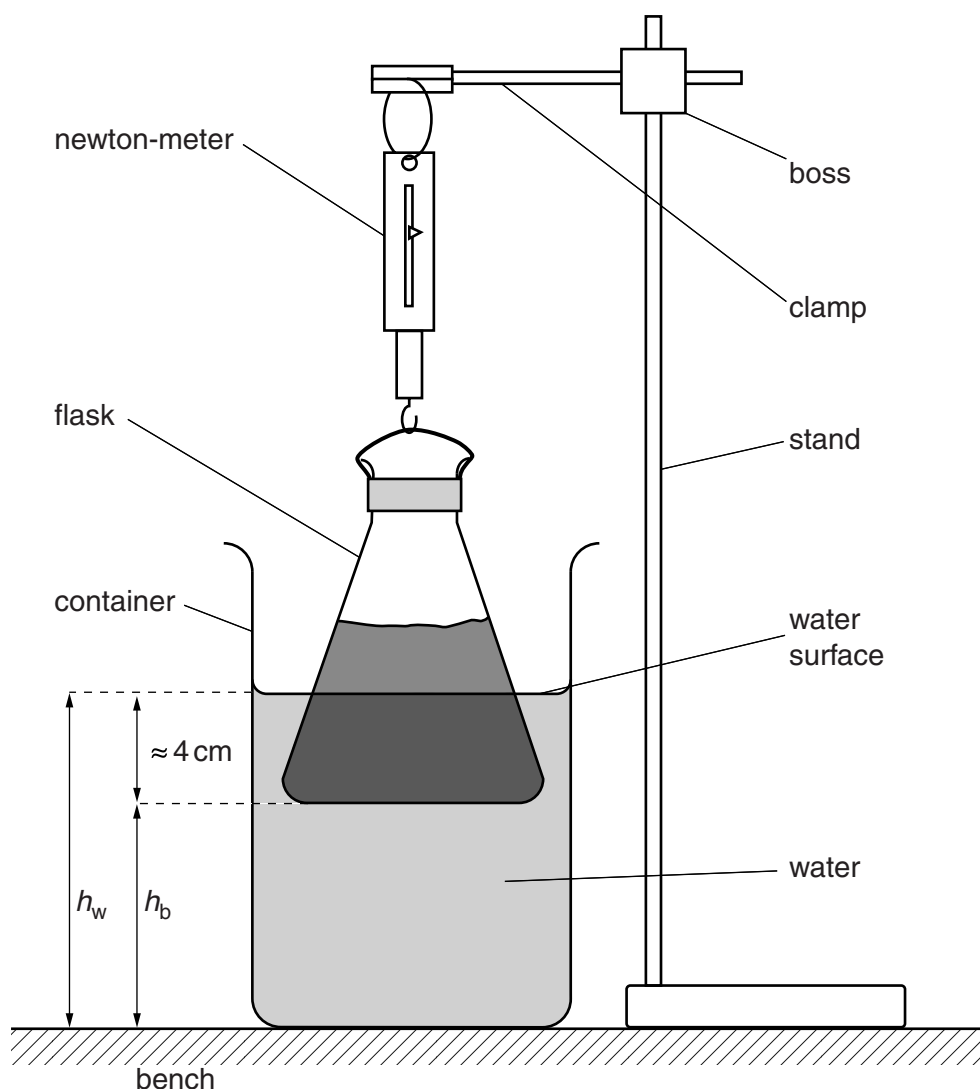


Fig. 1.2

- (c) (i) Measure and record the height h_w of the water surface above the bench, as shown in Fig. 1.2.

$h_w = \dots\dots\dots$ cm

- (ii) Measure and record the height h_b of the bottom of the flask above the bench, as shown in Fig. 1.2.

$h_b = \dots\dots\dots$ cm

- (iii) Record the newton-meter reading F .

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

- (iv) Calculate x , using $x = h_w - h_b$.

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

- (d) Adjust the height of the boss and repeat (c) until you have six sets of values of h_w , h_b and F .

For all values of h_b , the water surface should be in contact with the **sloping** sides of the flask.

Include values of x and $(H - x)^3$ in your table.

--

[9]

- (e) (i) Plot a graph of F on the y -axis against $(H - x)^3$ on the x -axis.

[3]

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

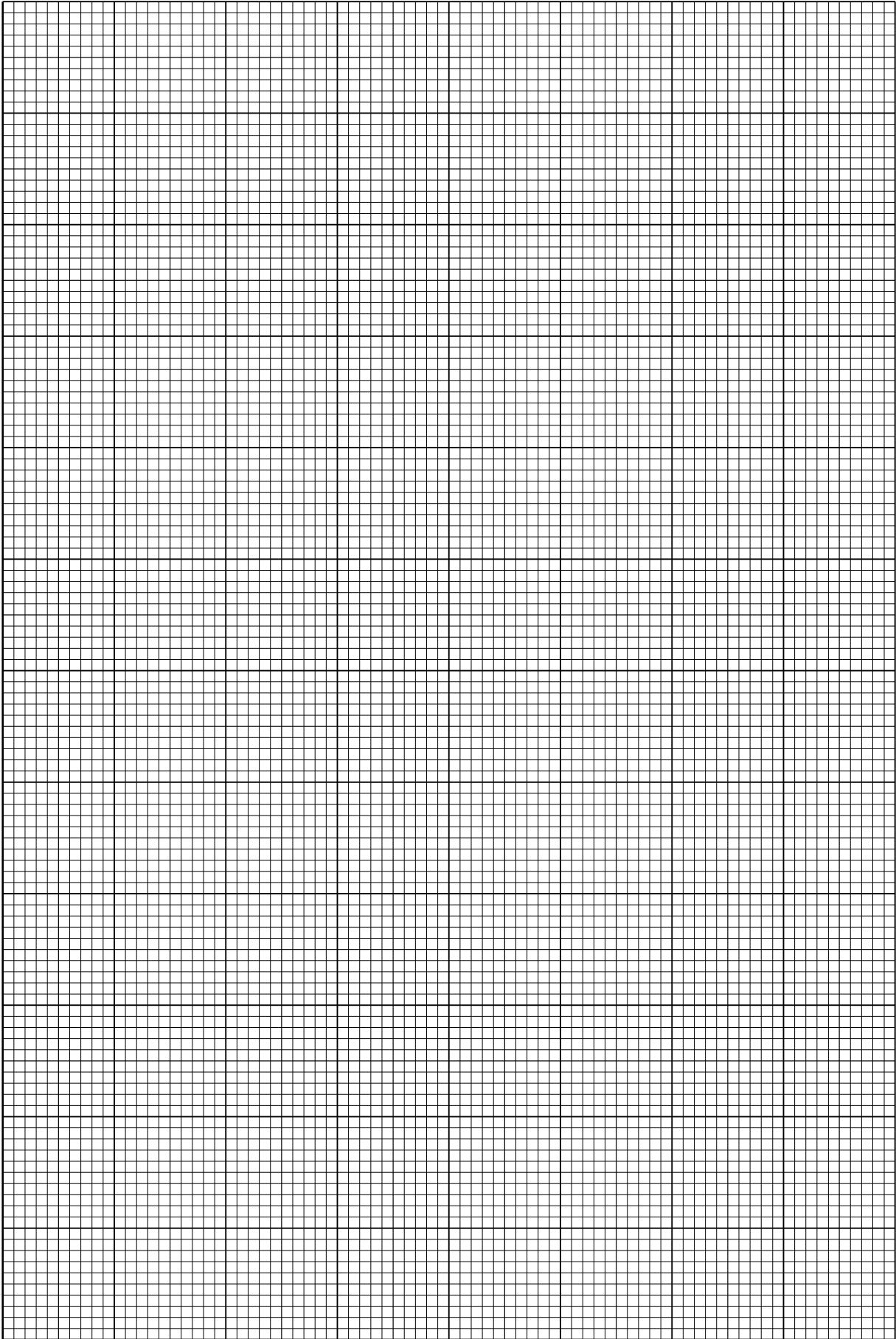
[1]

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

gradient = ...

y -intercept = ...

[2]



- (f) The quantities F , H and x are related by the equation

$$F = a(H - x)^3 + b$$

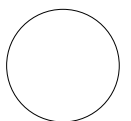
where a and b are constants.

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

$a =$

$b =$

[2]



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

2 In this experiment, you will investigate the motion of a flywheel rolling down a ramp.

(a) You are provided with a small flywheel, as shown in Fig. 2.1.

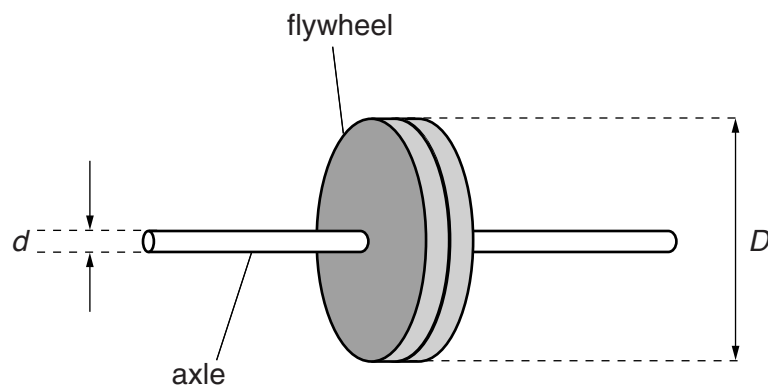


Fig. 2.1

(i) Measure and record the diameter d of the axle.

$d =$ cm [1]

(ii) Measure and record the diameter D of the flywheel.

$D =$ cm [1]

- (b) You have also been provided with a track. Set up the track with one end raised above the bench, as shown in Fig. 2.2.

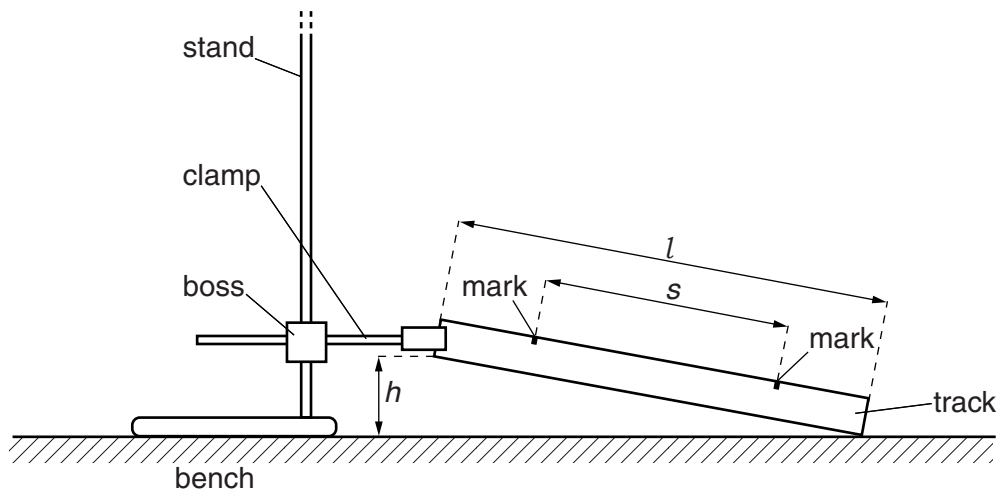


Fig. 2.2

The height h should be approximately 8 cm.

- (i) Measure and record the length l of the track.

$l =$

- (ii) Measure and record the height h above the bench of the raised end of the track.

$h =$

- (iii) Measure and record the distance s between the two marks on the track.

$s =$

[1]



- (c) (i) Place the axle of the flywheel on the track at the upper mark as shown in Fig. 2.3. Release the flywheel and watch it roll down to the lower mark (the top of the flywheel may need a gentle push to start it rolling).

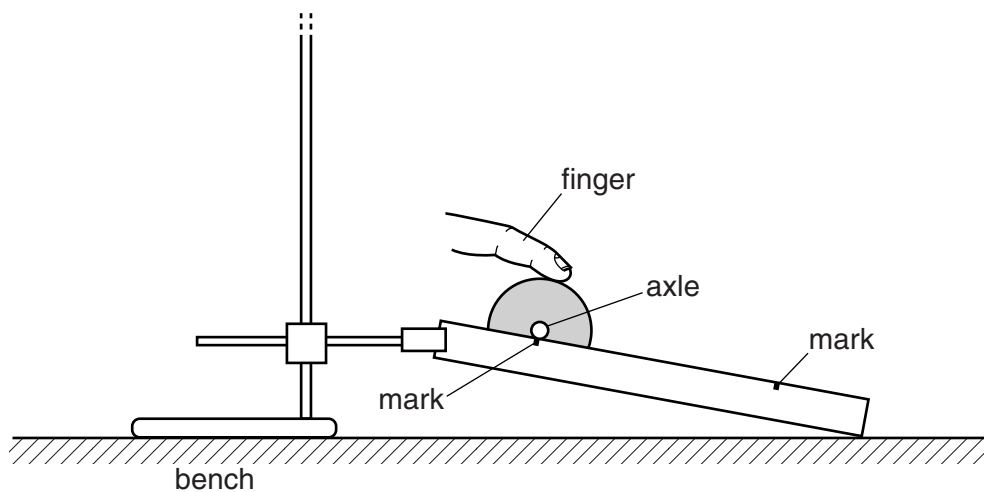


Fig. 2.3

- (ii) Replace the axle of the flywheel on the track at the upper mark. Take measurements to find the time t taken for the flywheel to roll from the upper mark to the lower mark.

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

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

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

--

- (iv) Theory suggests that an approximate value for the acceleration of free fall g is given by

$$g = \frac{slD^2}{hd^2t^2}.$$

Calculate a value for g . Give an appropriate unit.

$g =$ [1]

- (d) (i) Push the two plastic tubes onto the axle to increase the diameter of the axle, as shown in Fig. 2.4.

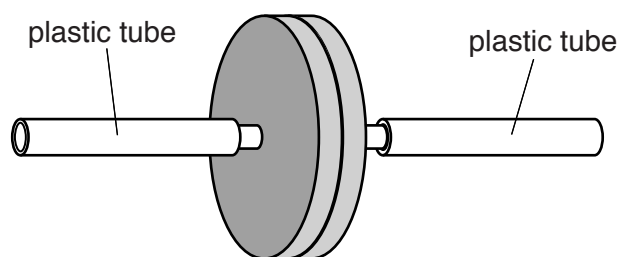


Fig. 2.4

- (ii) Repeat (a)(i) and (c)(ii).

$d =$ cm

$t =$ [2]

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

$$t = \frac{k}{d}$$

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 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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- (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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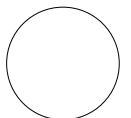
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