

CANDIDATE
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PHYSICS

9702/31

Paper 3 Advanced Practical Skills 1

October/November 2014

2 hours

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

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Write in dark blue or black pen.

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

- 1** In this experiment, you will investigate the motion of a system of masses.
- (a)** Set up the apparatus as shown in Fig. 1.1, with the shorter length of string above the central loop and the longer length of string below the central loop. Place four slotted masses in the bottom loop and four slotted masses in the central loop.

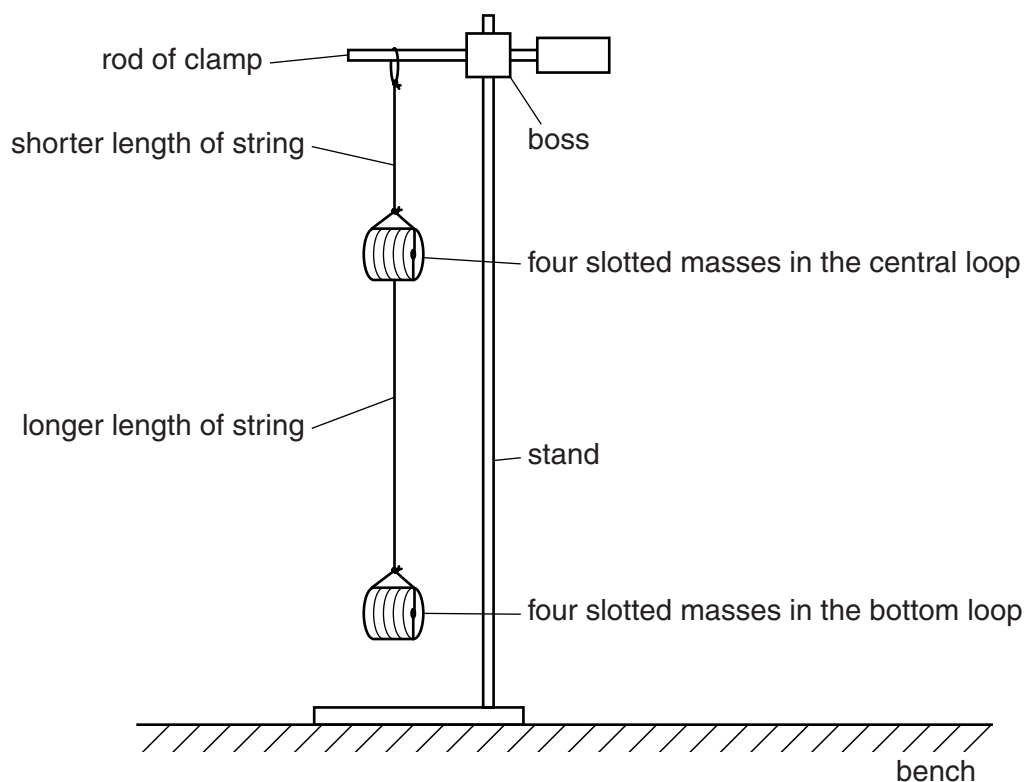


Fig. 1.1

(b) Move the slotted masses in the bottom loop to the left.

Release the slotted masses and watch the movement.

The slotted masses will move to the right and then to the left again, completing a swing as shown in Fig. 1.2.

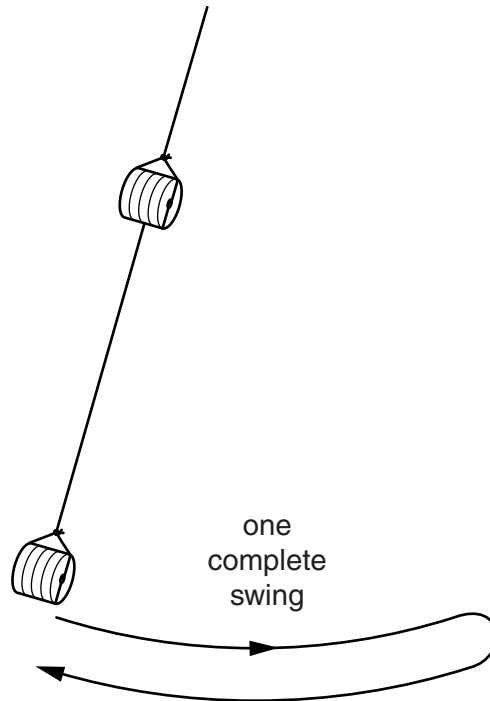


Fig. 1.2

Measure and record the time for at least 10 complete swings.

Record enough readings to determine an accurate value for the time T taken for one complete swing.

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

(c) Change the number of slotted masses in each loop. Use **all** the eight slotted masses.

(i) Count and record the number B of slotted masses in the bottom loop.

$B =$

(ii) Count and record the number C of slotted masses in the central loop.

$C =$

(iii) Repeat (b).

$T =$

- (d) Repeat (c) until you have six sets of values of B , C and T . Include your results from (b) and (c).

For each set of values, use all eight slotted masses.

Include values of $\frac{T^2}{B}$ and $\frac{C}{B}$ in your table.

--

[10]

- (e) (i) Plot a graph of $\frac{T^2}{B}$ on the y -axis against $\frac{C}{B}$ on the x -axis.

[3]

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

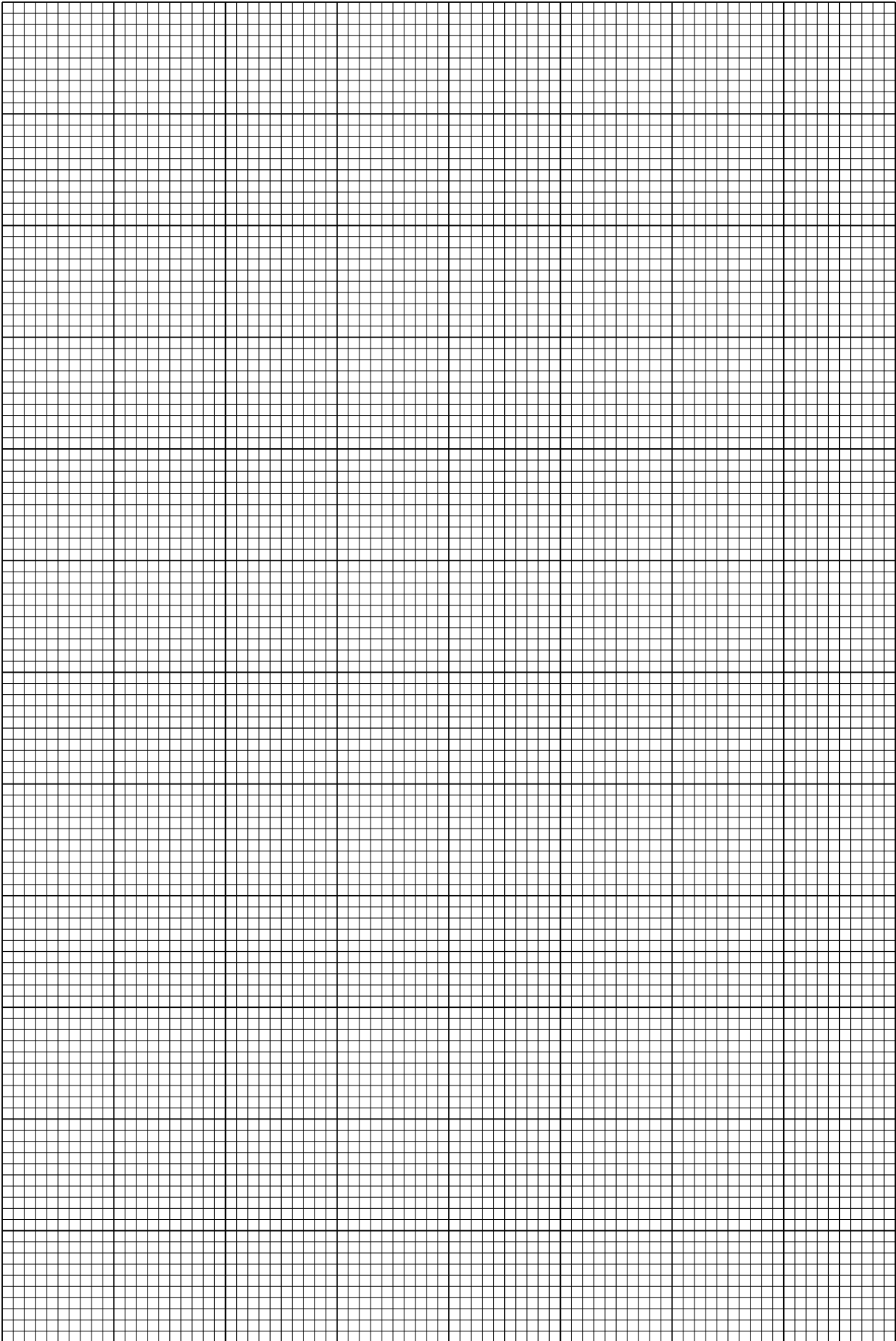
[1]

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

gradient = ...

y -intercept = ...

[2]



- (f) The quantities T , B and C are related by the equation

$$\frac{T^2}{B} = \frac{FC}{B} + G$$

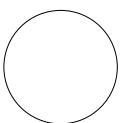
where F and G are constants.

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

$F =$

$G =$

[2]



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

- 2** In this experiment, you will investigate how the number of turns of wire around a rod depends on the diameter of the wire.

(a) You have been provided with a wooden rod and two lengths of wire.

(i) Measure and record the diameter D of the rod as shown in Fig. 2.1.

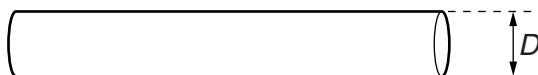


Fig. 2.1

$D =$ [1]

(ii) Measure and record the diameter d of the **thinner** wire.

$d =$ [1]

(iii) Calculate $\left(D + \frac{d}{2}\right)$.

$\left(D + \frac{d}{2}\right) =$ [1]

(b) (i) Cut the thinner wire so that its length is **exactly** 50.0 cm.

(ii) Wrap the thinner wire around the rod.

Count and record the number $(n + t)$ of turns of wire around the rod, where n is the number of complete turns and t is your estimate of the remaining part of a turn.

$(n + t) =$ [2]

(iii) Estimate the percentage uncertainty in your value of $(n + t)$.

percentage uncertainty = ...[1]

(c) Repeat (a)(ii), (a)(iii), (b)(i) and (b)(ii) for the **thicker** wire.

$d =$

$\left(D + \frac{d}{2}\right) =$

$(n + t) =$
[3]

- (d) It is suggested that the relationship between $(n + t)$, d and D is

$$(n + t) = \frac{k}{\left(D + \frac{d}{2}\right)}$$

where k is a constant.

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

first value of $k =$

second value of $k =$ [1]

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

.....

 [1]

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

.....

 [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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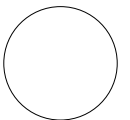
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1 In this experiment, you will investigate the motion of a ball and rod.

(a) Press the ball of modelling clay onto the end of the wooden rod, as shown in Fig. 1.1.

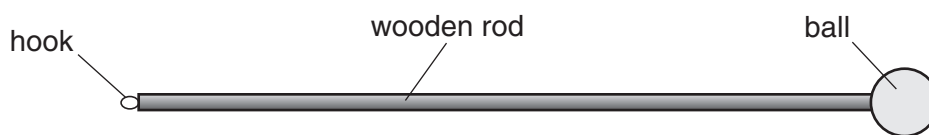


Fig. 1.1

(b) (i) Set up the apparatus as shown in Fig. 1.2 with the nail through the hook in the wooden rod.

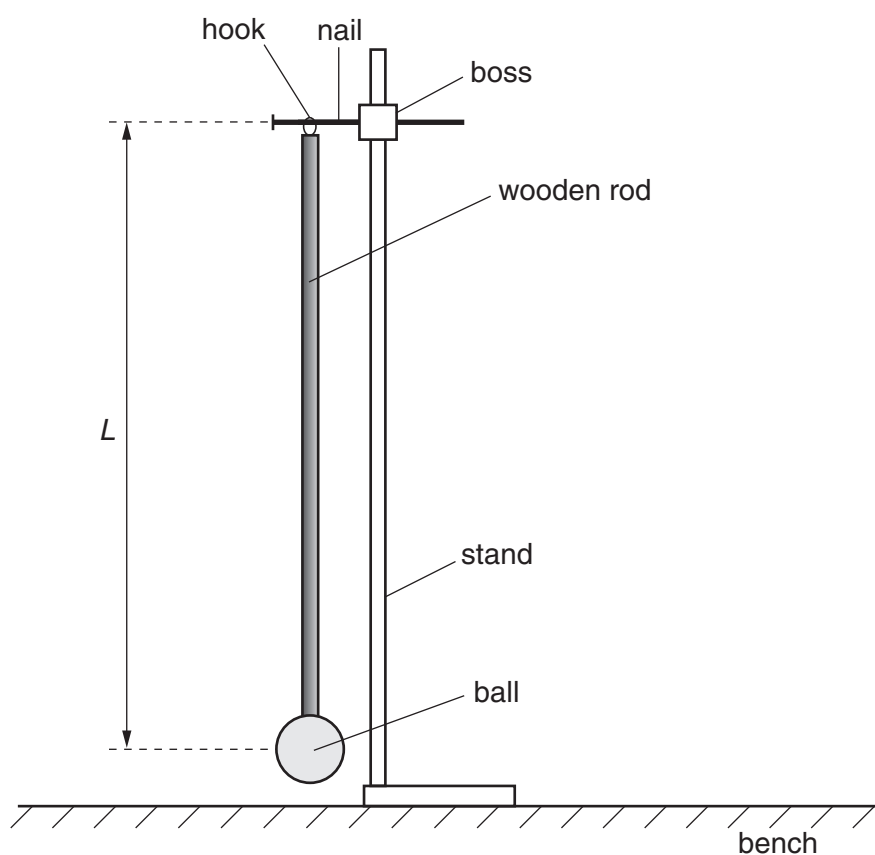


Fig. 1.2

(ii) Measure and record the distance L between the nail and the centre of the ball.

$L =$

(c) Move the bottom of the rod to the left.

Release the rod and watch the movement.

The rod will move to the right and then to the left again, completing a swing as shown in Fig. 1.3.

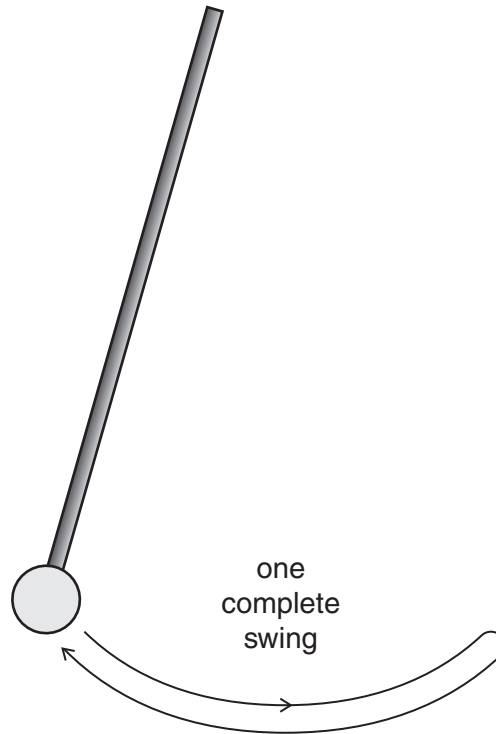


Fig. 1.3

Measure and record the time for at least 10 swings.

Record enough readings to determine an accurate value for the time T taken for one complete swing.

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

- (d) Decrease L by moving the ball along the rod, and repeat (b)(ii) and (c) until you have six sets of values of L and T .

Include values of T^2L and L^2 in your table.

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[10]

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

[3]

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

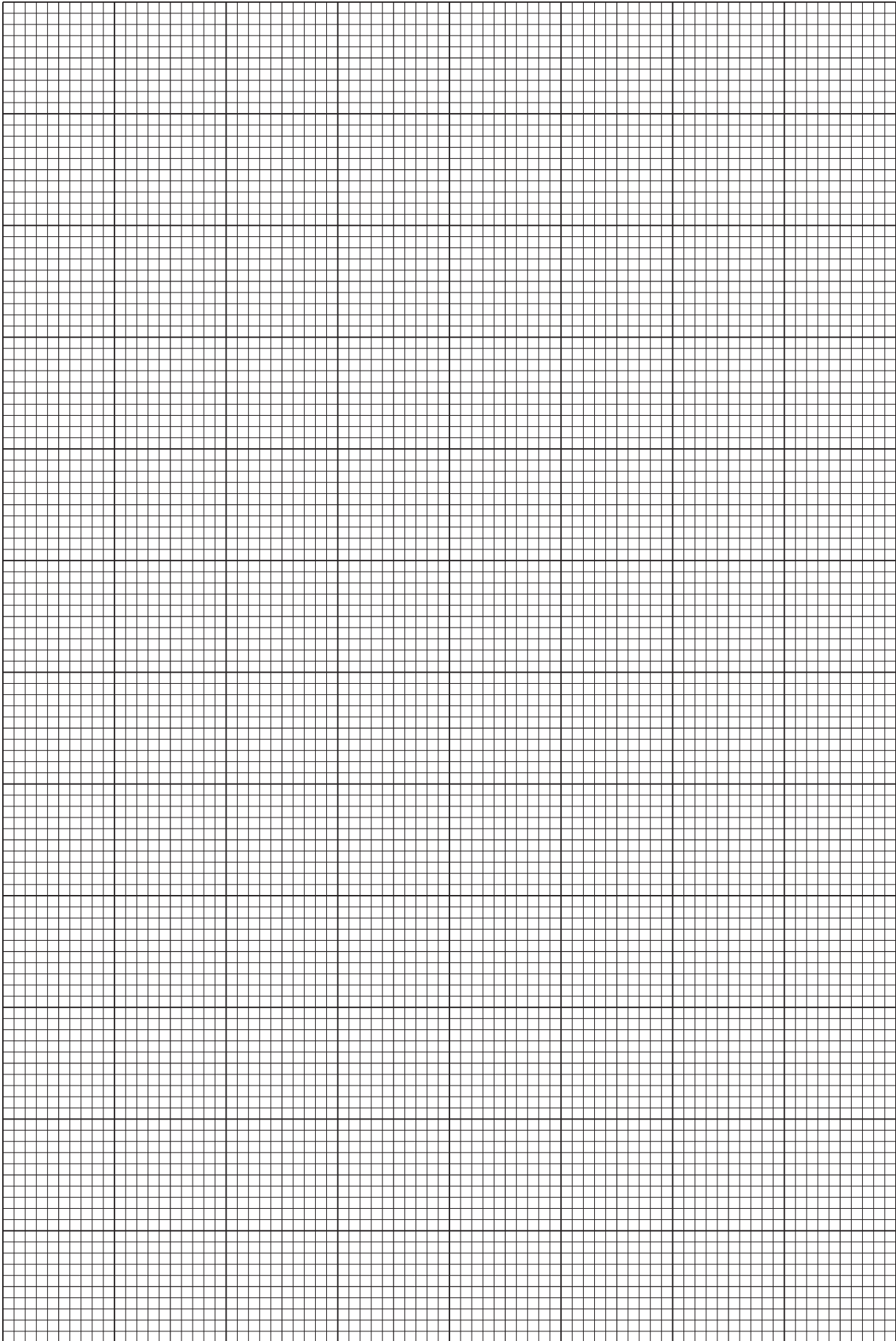
[1]

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

gradient = ...

y -intercept = ...

[2]



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

$$T^2L = AL^2 + B$$

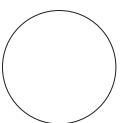
where A and B are constants.

Use your answers in (e)(iii) to 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 how the rebound height of a ball from an inclined board depends on the angle of the board.

- (a) (i)** You have been provided with a ball and a board.
Place the board on the bench.
Hold the ball above the board as shown in Fig. 2.1.
Move the ball until the height h_1 of the bottom of the ball above the board is 40 cm.

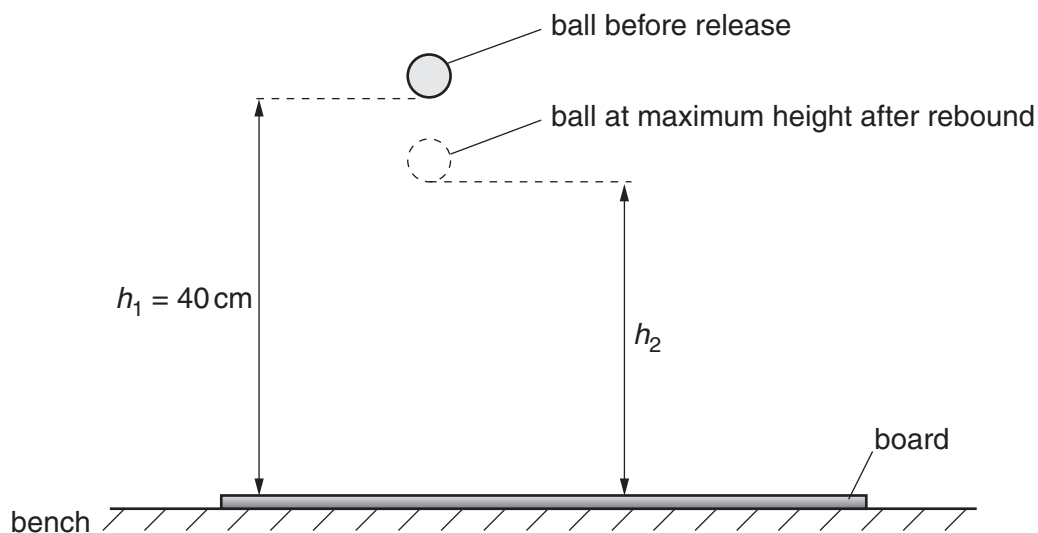


Fig. 2.1

- (ii)** Release the ball.
Measure and record the maximum height h_2 of the ball after rebound.

$h_2 = \dots\dots\dots$ [2]

- (iii)** Calculate q , where

$$q = \frac{h_2}{h_1}.$$

$q = \dots\dots\dots$

- (b) (i) Raise the board so that it makes an angle θ with the bench as shown in Fig. 2.2.

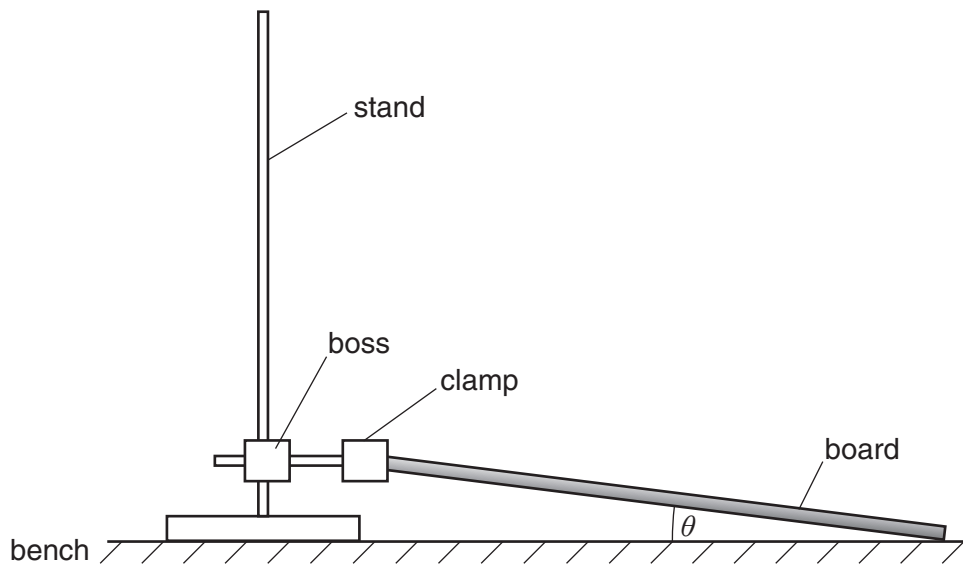


Fig. 2.2

- (ii) Adjust the board until θ is in the range 10° to 12° . Measure and record θ .

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

- (iii) Calculate $\cos^2(2\theta)$.

$$[\cos^2(2\theta) = \cos(2\theta) \times \cos(2\theta)]$$

$\cos^2(2\theta) = \dots\dots\dots$ [1]

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

.....

.....

..... [1]

- (c) (i) Place the large container on its side with its open face towards the board as shown in Fig. 2.3.

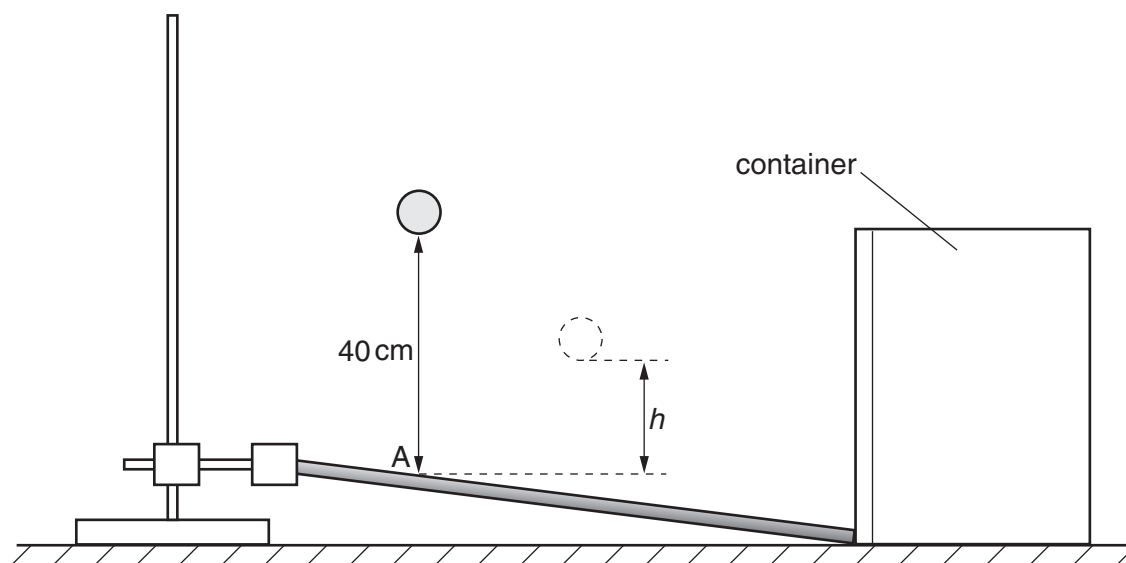


Fig. 2.3

- (ii) Hold the ball 40 cm above the board.
- (iii) Release the ball. Watch it bounce at A and follow a curved path before bouncing into the container. Measure and record the maximum height h of the ball after rebound, as shown in Fig. 2.3.

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

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

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

- (d) (i) Adjust the board until θ is in the range 20° to 22° .
Measure and record θ .

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

- (ii) Repeat (b)(iii), (c)(ii) and (c)(iii).

$\cos^2(2\theta) = \dots\dots\dots$

$h = \dots\dots\dots$ [2]

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

$$h = kq \cos^2(2\theta)$$

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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- (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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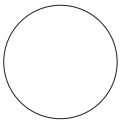
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PHYSICS

9702/34

Paper 3 Advanced Practical Skills 2

October/November 2014

2 hours

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1 In this experiment, you will investigate the refraction of light by a transparent block.

- (a)** You are provided with a sheet of paper with lines marked as shown in Fig. 1.1. The sheet is attached to a board.

Stick a pin vertically into the board on the line AB approximately 3 cm to the right of A. Stick another pin vertically into the board at C.

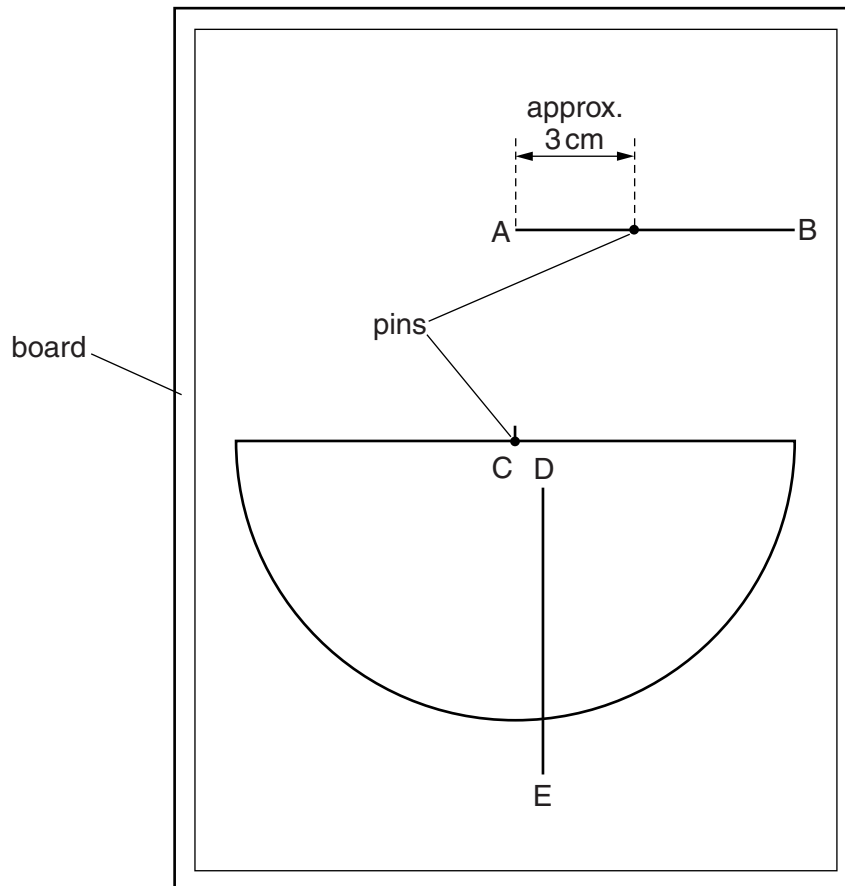


Fig. 1.1 (not to scale)

- (b) (i) View the two pins horizontally from the direction shown in Fig. 1.2. Stick the third pin into the board on the curved line so that it is in line with the first two pins.

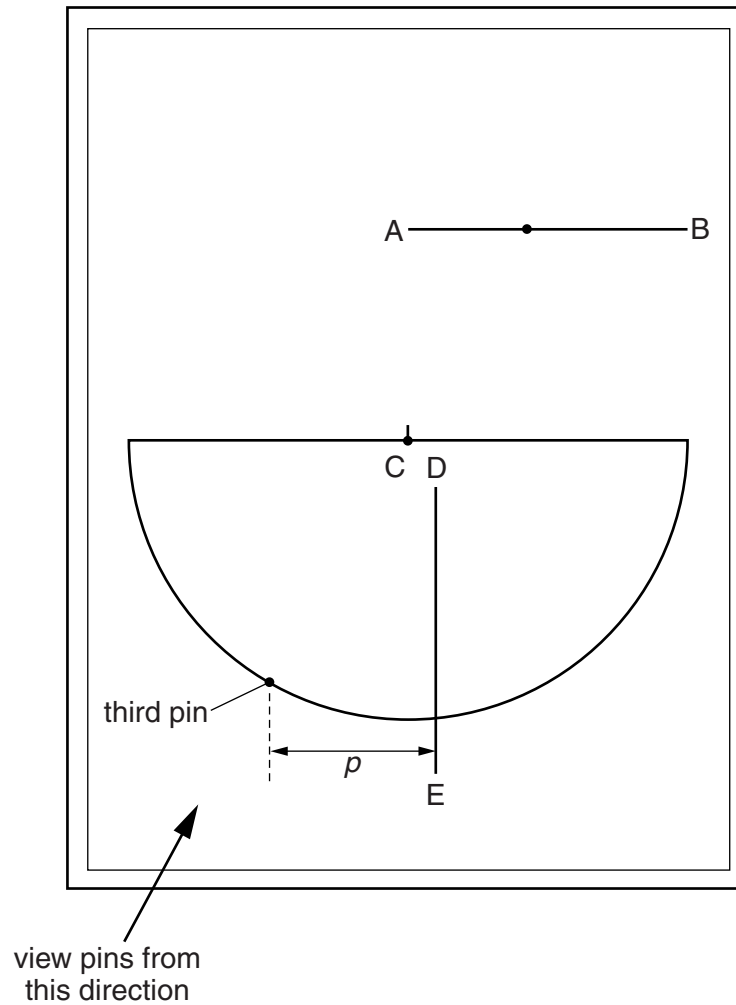


Fig. 1.2 (not to scale)

- (ii) Measure and record the perpendicular distance p from the third pin to the line DE, as shown in Fig. 1.2.

$p =$ cm [1]

- (iii) Remove the third pin from the board.

- (c) (i) Place the semicircular block on the board with its centre mark next to the pin at C, as shown in Fig. 1.3.
- (ii) View the first two pins horizontally from the direction shown in Fig. 1.3. Look at the bottom of the first pin **through** the block. Stick the third pin in the board on the curved line so that it appears to be in line with the first two pins.

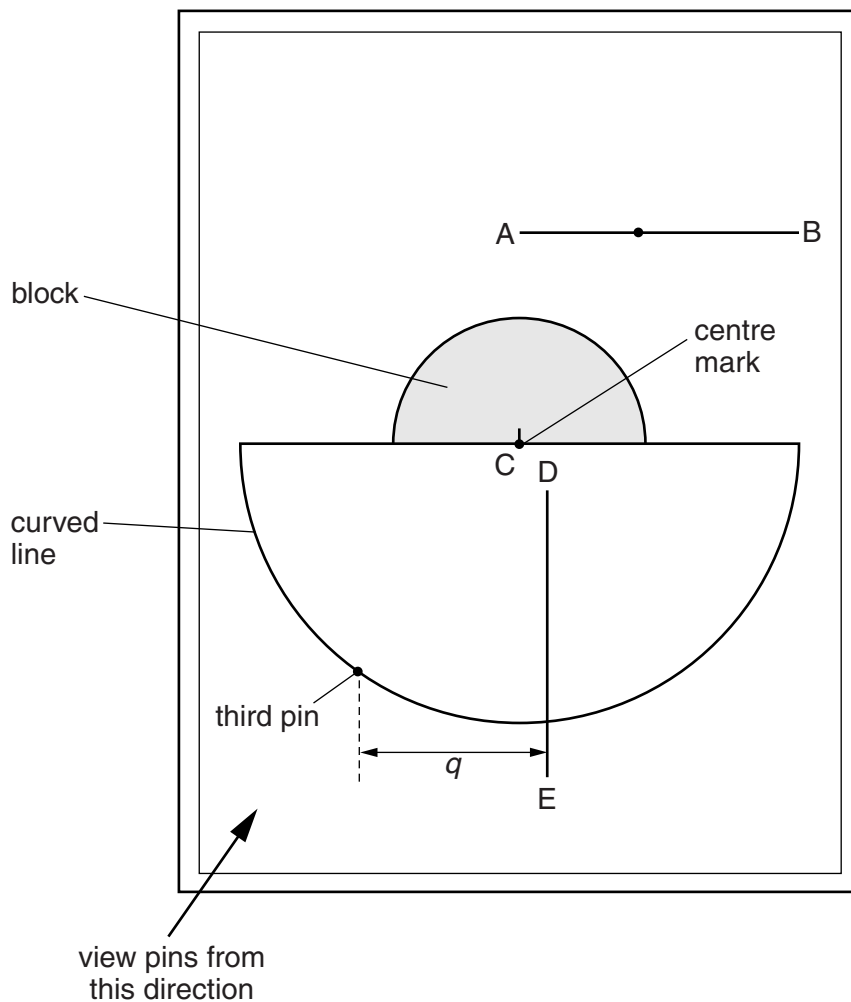


Fig. 1.3 (not to scale)

- (iii) Measure and record the perpendicular distance q from the third pin to the line DE, as shown in Fig. 1.3.

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

- (iv) Remove the third pin and the block from the board.

- (d)** Move the first pin to a different position on the line AB. Repeat **(b)** and **(c)** until you have six sets of values of p and q .

Include values for $\frac{q}{p}$ and $\frac{1}{p}$ in your table.

[10]

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

[2]

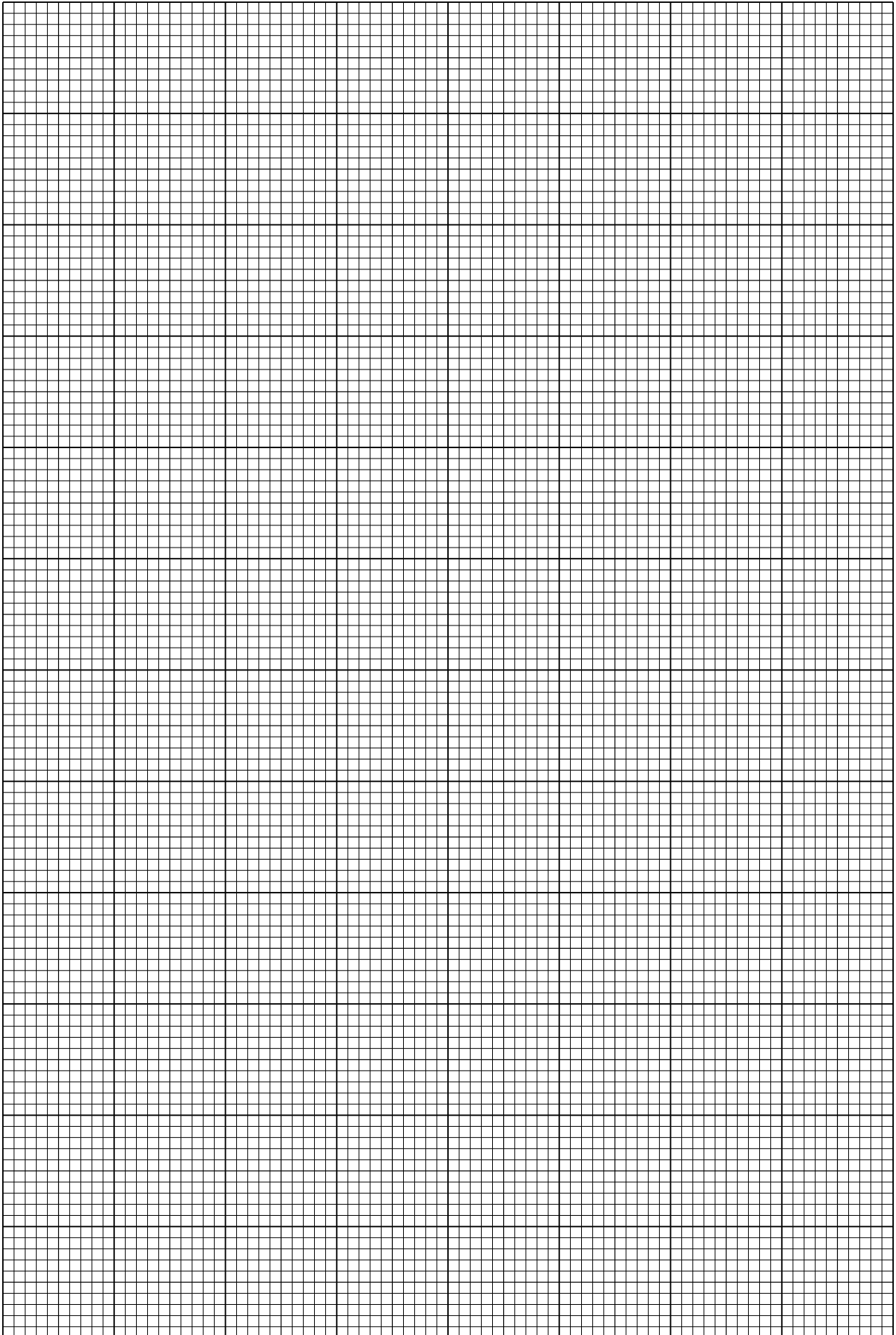
- (ii)** Draw the straight line of best fit.

[1]

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

gradient = ...
 y -intercept = ...

[2]



- (f) The quantities q and p are related by the equation

$$\frac{q}{p} = \frac{a(1-b)}{p} + b$$

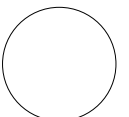
where a and b are constants.

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

$a =$

$b =$

[3]



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

- 2** In this experiment, you will investigate the relationship between surface area and friction as a rod is hammered into a container of rice.

(a) You are provided with two pencils labelled P and Q.

- (i)** Measure and record the distance d between the opposite flat faces of pencil P, as shown in Fig. 2.1.

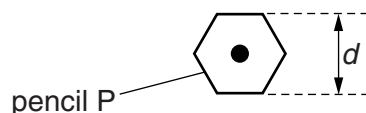


Fig. 2.1

$d =$ cm [1]

- (ii)** Measure and record the length x between the two marks on pencil P, as shown in Fig. 2.2.

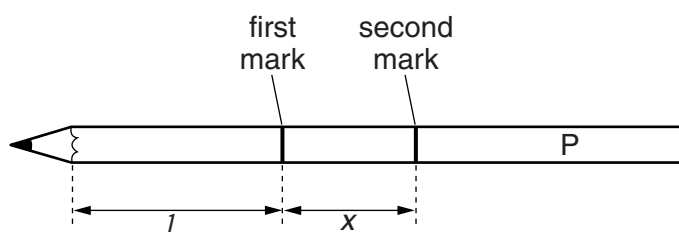


Fig. 2.2

$x =$ cm [1]

- (iii)** Measure and record the length l along the flat section of the pencil to the first mark, as shown in Fig. 2.2.

$l =$ cm [1]

(b) Estimate the percentage uncertainty in your value of l .

percentage uncertainty = ... [1]

- (c) Calculate the surface area A of the pencil up to the first mark, using the relationship

$$A = 2\sqrt{3}dl.$$

$A =$ [1]

- (d) (i) Push the sharp end of the pencil vertically into the centre of the container of rice until the first mark is about 1 cm above the surface of the rice, as shown in Fig. 2.3.

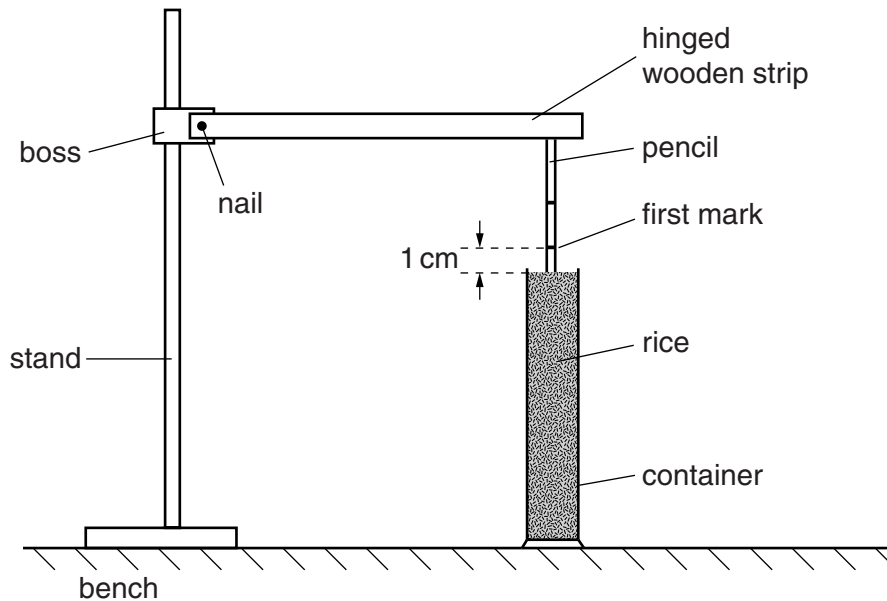


Fig. 2.3

- (ii) Position the stand and wooden strip so that the free end of the wooden strip rests on top of the pencil. Adjust the height of the nail so that the wooden strip is horizontal, as shown in Fig. 2.3.
- (iii) Raise the free end of the wooden strip by 3 cm and drop it onto the pencil. Repeat until the first mark on the pencil is level with the surface of the rice.
- (iv) Adjust the height of the nail so that the wooden strip is horizontal again.
- (v) Raise the free end of the wooden strip by 3 cm and drop it onto the pencil. Repeat until the second mark on the pencil is level with the surface of the rice, counting the number n of times the wooden strip is dropped.

$n =$ [2]

(e) Repeat (a), (c) and (d) using pencil Q.

$d =$

$x =$

$l =$

☐

$A =$

$n =$

[2]

☐

(f) It is suggested that the relationship between n and A is

$$n = kAx$$

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]

☐

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(iii) 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.

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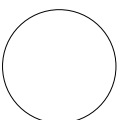
(ii) Describe four improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

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

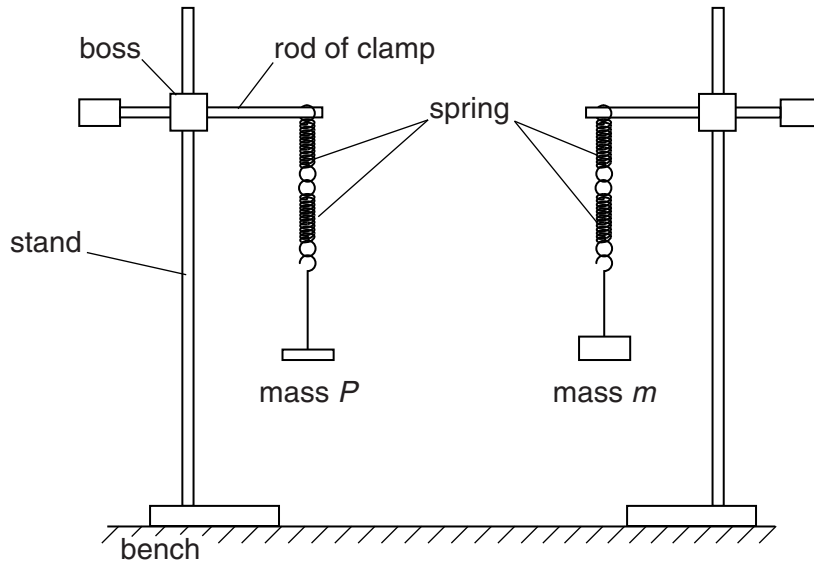


Fig. 1.1

The mass P must be 200 g and **must remain constant throughout the experiment.**

The mass m should be 250 g.

(ii) Calculate and record $(m - P)$.

$(m - P) = \dots\dots\dots[1]$

- (b) (i) Pull both masses down through a short distance.
Release both masses at the same time and watch the movement.
The two masses will move up and down becoming out of step.
After a time the masses will be back in step so that they reach the lowest point together.
- (ii) Pull both masses down through a short distance. Release both masses at the same time.
Start the stopwatch when the masses are back in step and reach the lowest point together for the **first** time.
- Measure and record the time t taken for the masses to reach their lowest point together for the **sixth** time.

$t = \dots\dots\dots$ [1]

(c) Increase m and repeat (a)(ii) and (b)(ii) until you have six sets of readings of m and t .

Include values of $\frac{1}{t^2}$ and $(m - P)$ in your table.

[10]

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

[3]

(ii) Draw the straight line of best fit.

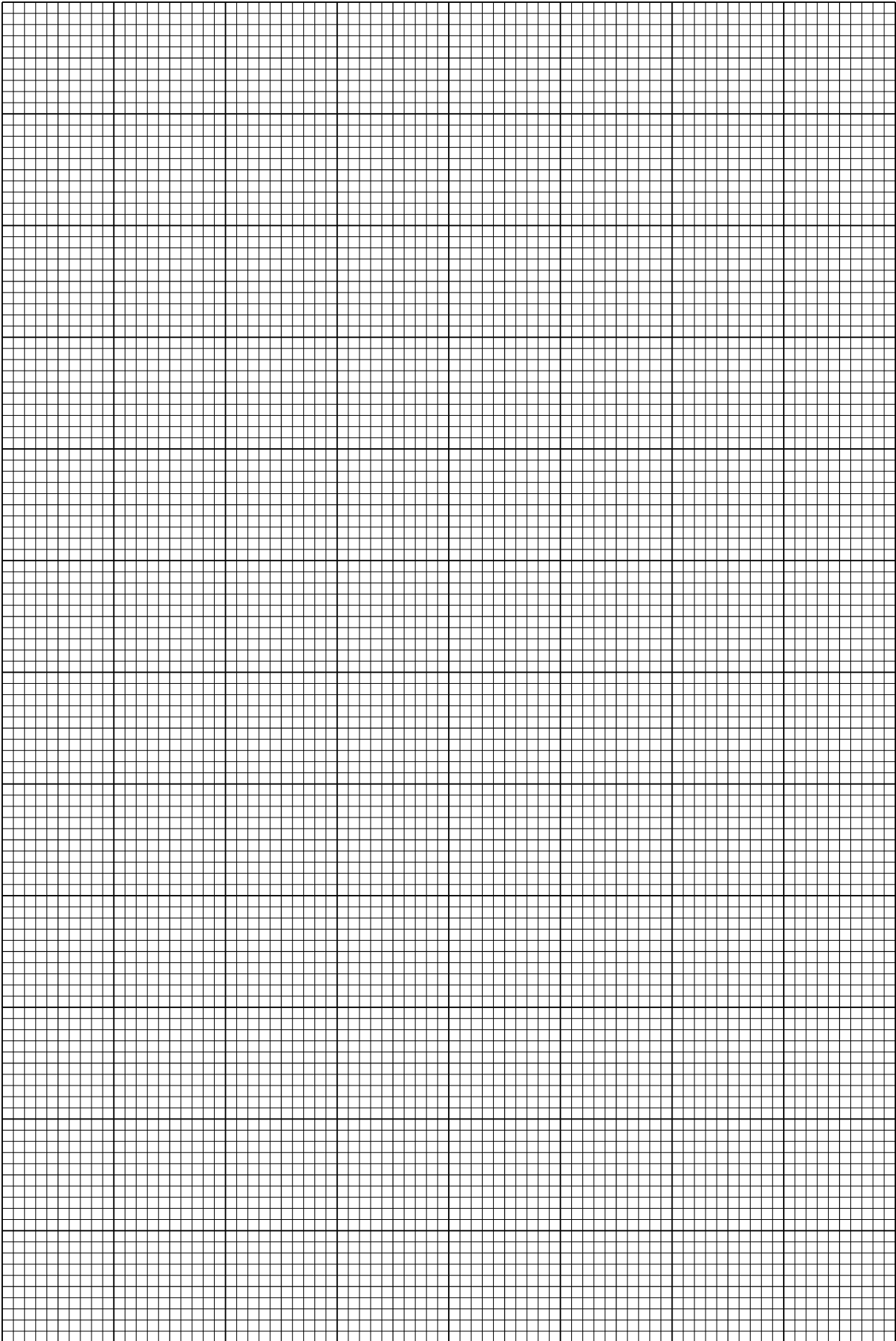
[1]

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

gradient = ...

y -intercept = ...

[2]



- (e) It is suggested that the quantities t , m and P are related by the equation

$$\frac{1}{t^2} = U(m - P) + V$$

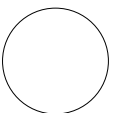
where U and V are constants.

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

$U =$

$V =$

[2]



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

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

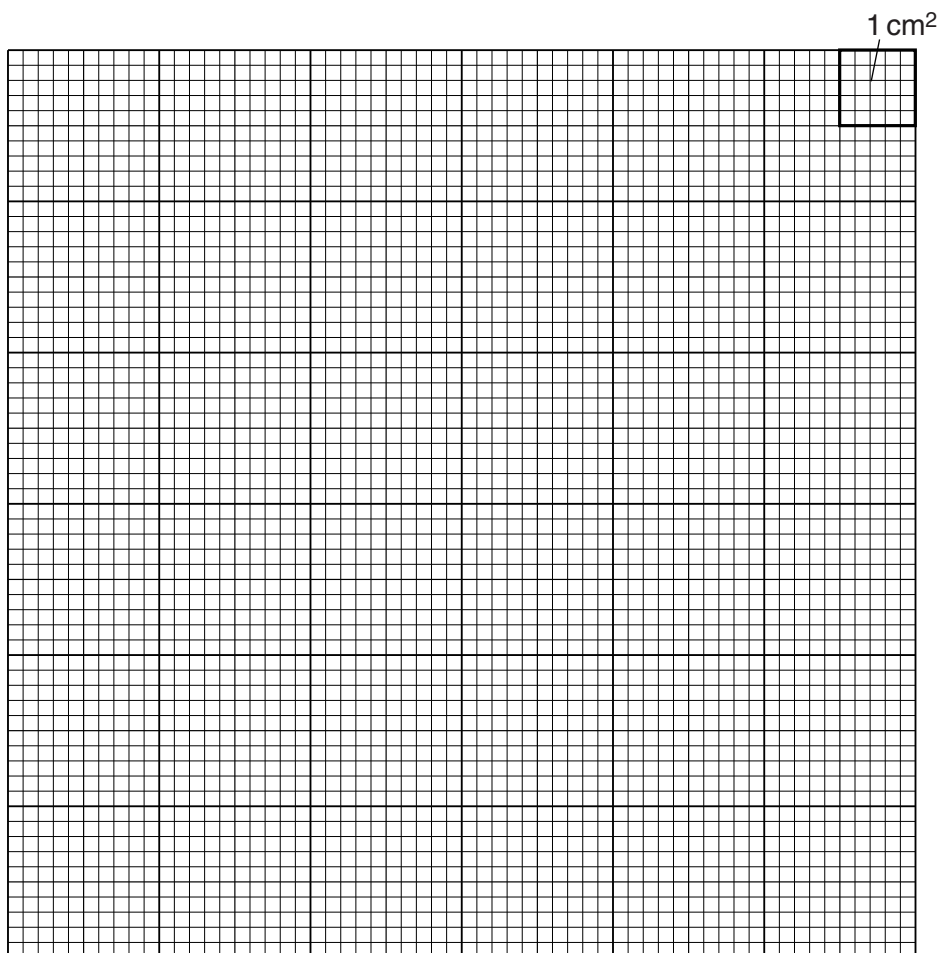
- (a)** You have been provided with two plastic cups labelled C and D.
Cup C has had part of the base removed. Cup D has had all of the base removed.

Measure and record the thickness x of the plastic of the two cups.

$x =$ [1]

- (b) (i)** Place cup C on the grid below and draw around the hole with the pencil.

Use the grid to determine the area A of the hole in cup C.



$A =$ cm² [1]

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

percentage uncertainty = ...[1]

- (iii) Calculate the volume V of the plastic removed to make the hole, where

$$V = Ax.$$

$V =$ [2]

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

.....

[1]

- (c) (i) Using tape, attach the mass to cup C, as shown in Fig. 2.1.

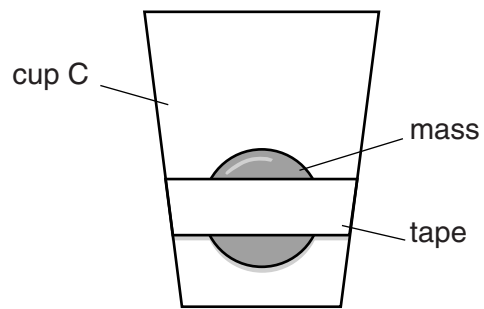


Fig. 2.1

- (ii) Hold the cup so that it rests on the surface of the water in the bucket as shown in Fig. 2.2.

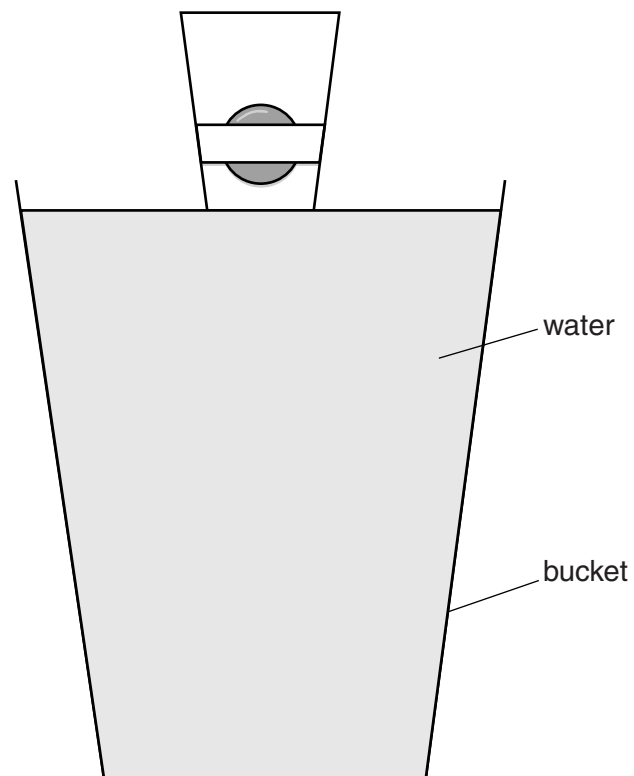


Fig. 2.2

- (iii) Release the cup and measure the time T for the cup to reach the bottom of the bucket.

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

- (d) Repeat (b)(i), (b)(iii) and (c) for cup D.

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

$V = \dots\dots\dots$

$T = \dots\dots\dots$ [3]

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

$$T^2 = \frac{k}{V}$$

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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2.

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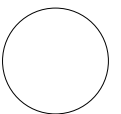
3.

.....

4.

.....

[4]



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PHYSICS

9702/36

Paper 3 Advanced Practical Skills 2

October/November 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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1	
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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 a network of resistors.

(a) (i) Assemble the circuit of Fig. 1.1.

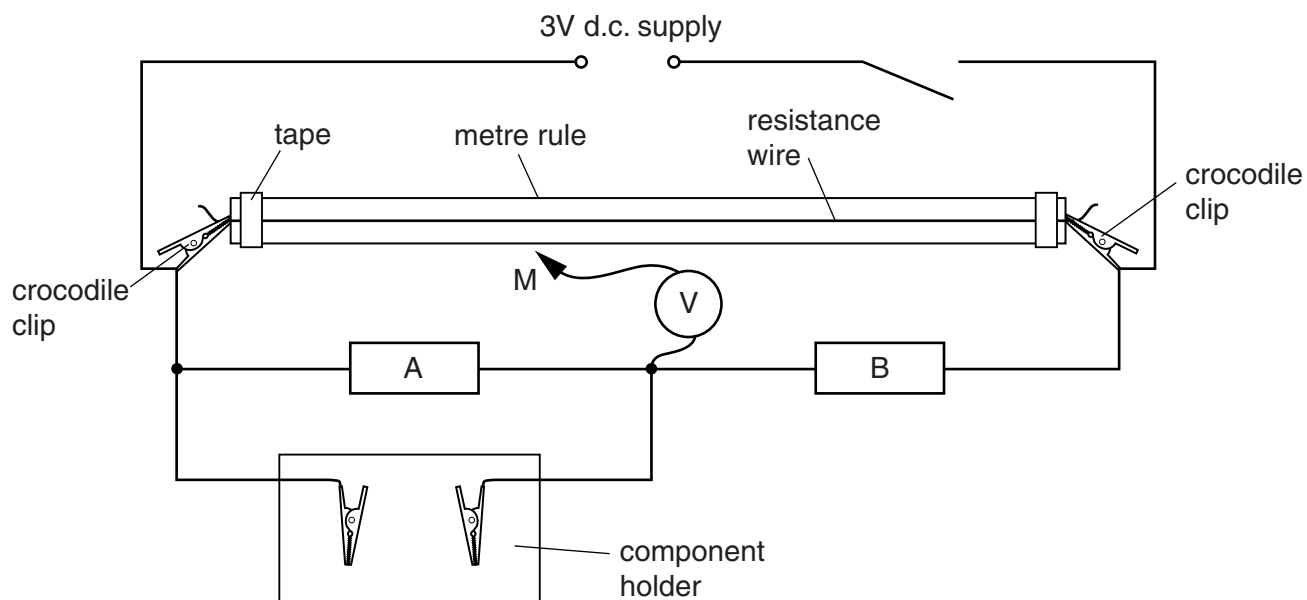


Fig. 1.1

(ii) To check that your circuit is correct, close the switch and place the movable contact M on the resistance wire at the 50cm mark.
Record the voltmeter reading, which should be between 0.3V and 0.7V.

voltmeter reading = ... [1]

(iii) Open the switch.

- (b) (i) Select one of the resistors labelled with a numerical value and connect it between the crocodile clips of the component holder. Record the resistance R of your selected resistor.

$R = \dots\dots\dots \text{ k}\Omega$

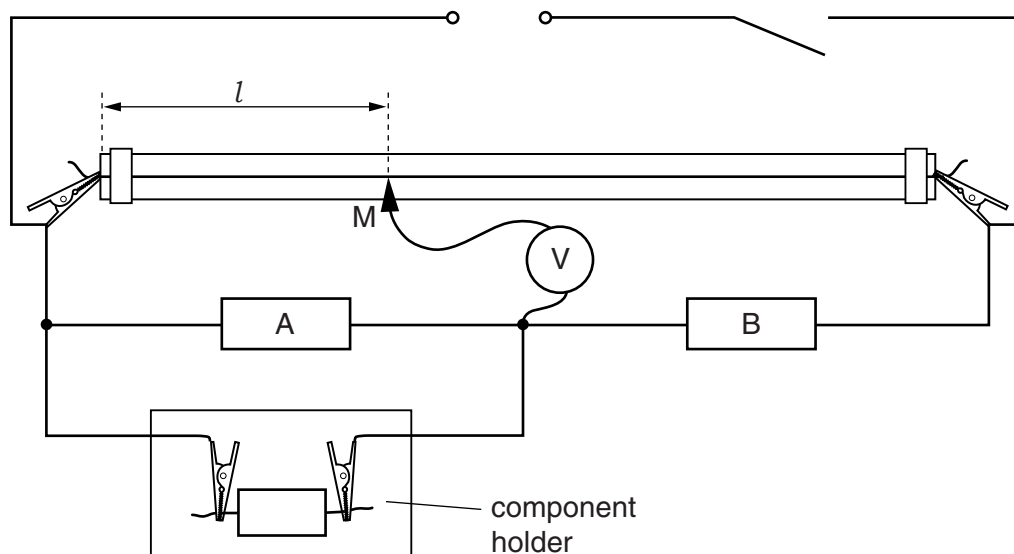


Fig. 1.2

- (ii) Close the switch. Adjust the position of M on the resistance wire until the voltmeter reads zero. Measure and record the length l as shown in Fig. 1.2.

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

- (iii) Open the switch.

- (c) Repeat (b) using different labelled resistors in the component holder until you have six sets of values of R and l . Include values of $\frac{1}{R}$ and $\frac{1}{l}$ in your table.

--

[10]

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

[3]

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

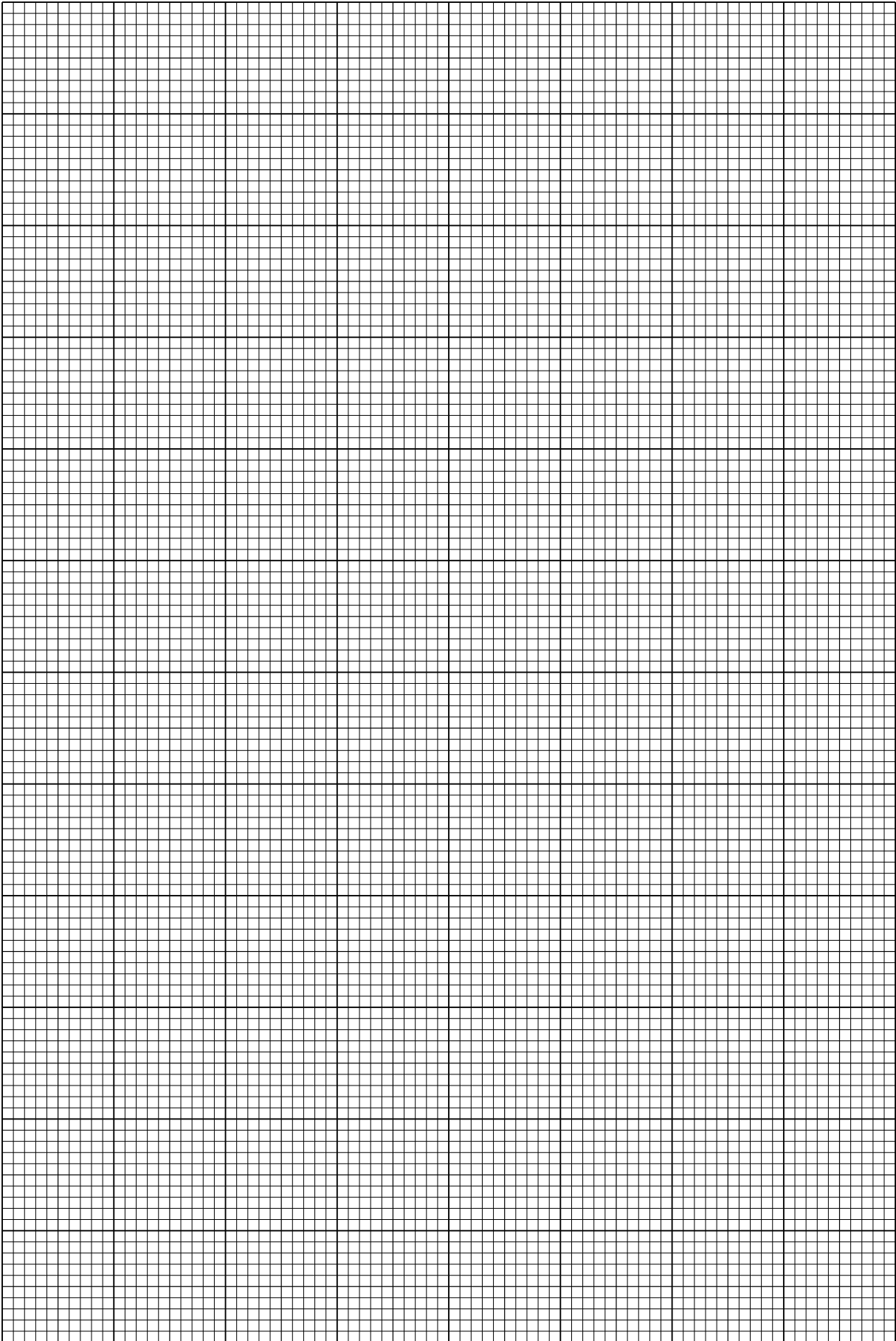
[1]

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

gradient = ...

y -intercept = ...

[2]



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

$$\frac{1}{l} = \frac{a}{R} + b$$

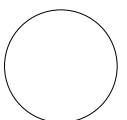
where a and b are constants.

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

$a =$

$b =$

[2]



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

2 In this experiment, you will investigate the motion of a partially-filled bottle.

- (a) (i)** Place the stand in the tray and suspend the empty bottle from the nail, as shown in Fig. 2.1.
Check that the bottle swings freely.

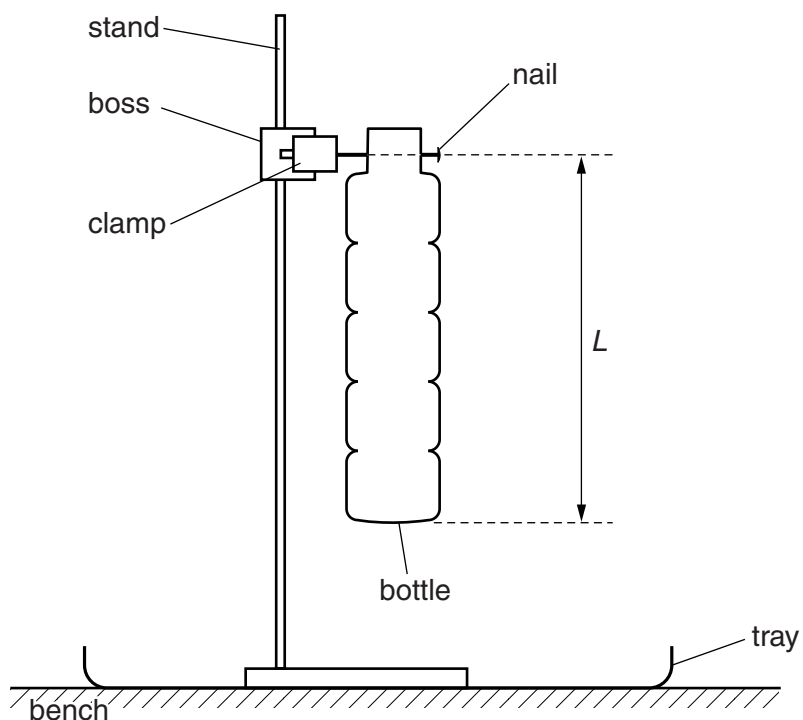


Fig. 2.1

- (ii)** Measure and record the distance L from the base of the bottle to the nail, as shown in Fig. 2.1.

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

- (b) (i) Pour water into the bottle until it is approximately half full, as shown in Fig. 2.2.

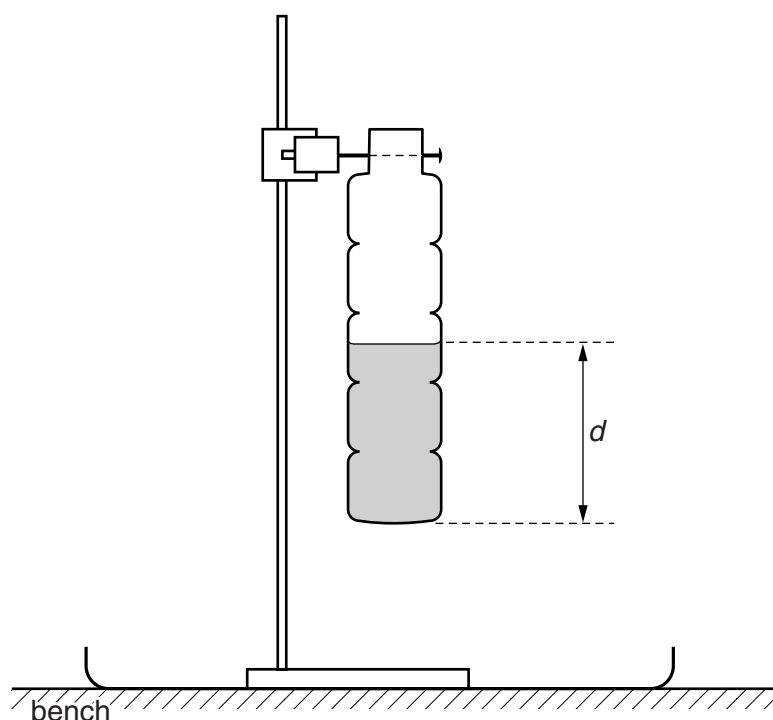


Fig. 2.2

- (ii) With the bottle hanging vertically, measure and record the distance d from the base of the bottle to the water surface, as shown in Fig. 2.2.

$d =$ mm [1]

- (iii) Calculate the ratio c using the relationship $c = \frac{d}{L}$.

$c =$

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

.....

 [1]

- (c) Calculate the value of q using the relationship

$$q = \frac{\frac{c^2}{3} - c + 1}{1 - \frac{c}{2}}.$$

$q = \dots\dots\dots$ [1]

- (d) (i) Push the base of the bottle approximately 4 cm to one side and then release it so that it swings, as shown in Fig. 2.3.

Ensure that the stand does not fall over when the bottle is swinging.

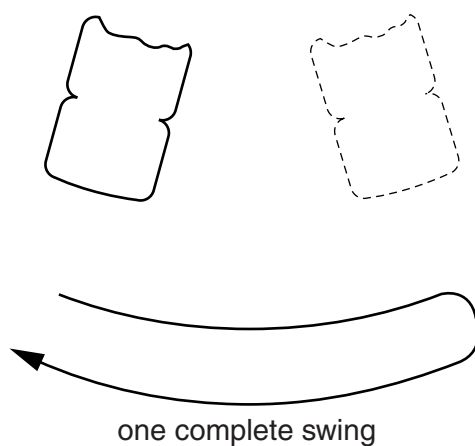


Fig. 2.3

- (ii) Measure and record the total time t for 10 complete swings.

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

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

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

- (e) (i) Pour more water into the bottle until it is approximately $\frac{3}{4}$ full.
 (ii) Repeat (b)(ii), (b)(iii), (c), (d)(i) and (d)(ii).

$d = \dots\dots\dots$ mm

$c = \dots\dots\dots$

$q = \dots\dots\dots$

$t = \dots\dots\dots$

[3]

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

$$t^2 = kq$$

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]

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

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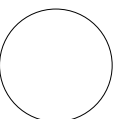
[4]



- (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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