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9702/31

May/June 2013

2 hours

Additional Materials: As listed in the Confidential Instructions.

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You may use a pencil for any diagrams, graphs or rough working.
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You are reminded of the need for good English and clear presentation in your answers.

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.

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For
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Use

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

(a) Measure and record the distance L between the two holes in the wooden strip as shown in Fig. 1.1.



Fig. 1.1

$L =$ m [1]

(b) Write down the mass M given on the card.

$M =$ kg



- (c) (i) Set up the apparatus as shown in Fig. 1.2, with mass $m = 0.040$ kg.

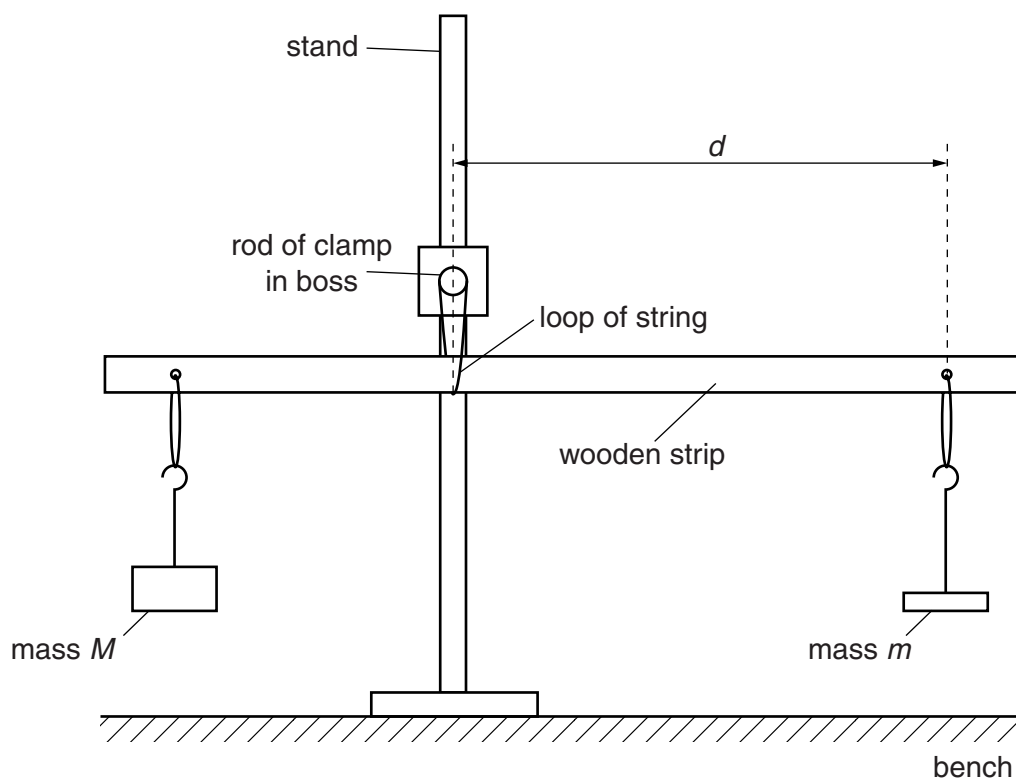


Fig. 1.2

- (ii) Adjust the position of the wooden strip until it balances.

Measure and record the distance d , as shown in Fig. 1.2.

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

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Use

(d) Vary m and repeat (c)(ii) until you have six sets of readings of m and d .

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

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[10]

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

[3]

(ii) Draw the straight line of best fit.

[1]

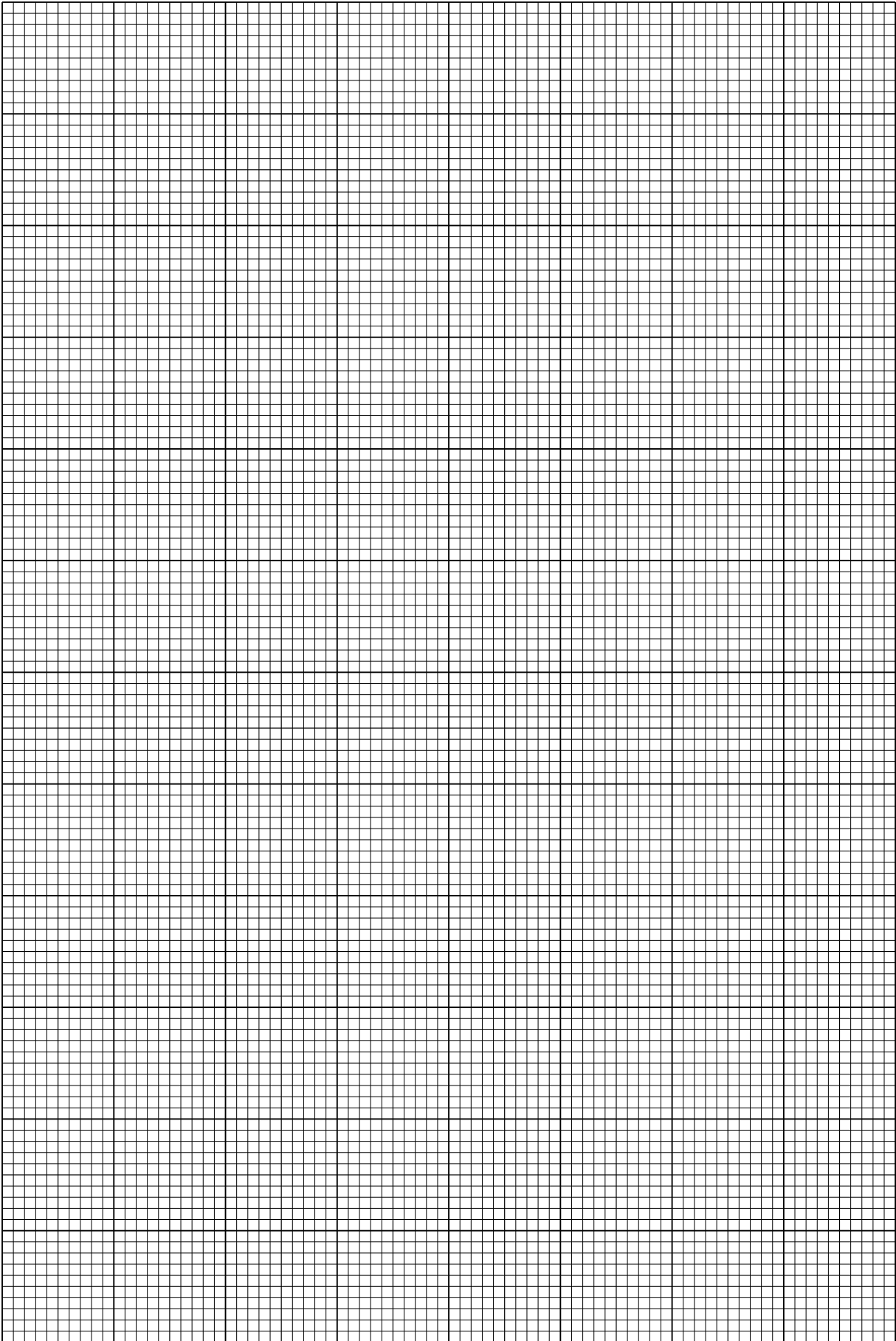
(iii) Determine the gradient and y -intercept of this line.

gradient = ...

y -intercept = ...

[2]

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

$$\frac{1}{d} = Pm + Q$$

where P and Q are constants.

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

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

$$Q = \dots\dots\dots$$

[1]

- (g) The constant P is related to L and M by

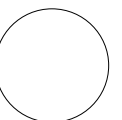
$$P = \frac{1}{kML}$$

where k is a constant.

Using your answers in (a), (b) and (f), calculate a value for k .
You need not include units for k .

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

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2 In this experiment, you will investigate the motion of a wooden rod supported by a string.

(a) (i) Set up the apparatus as shown in Fig. 2.1 with height h approximately 40 cm.

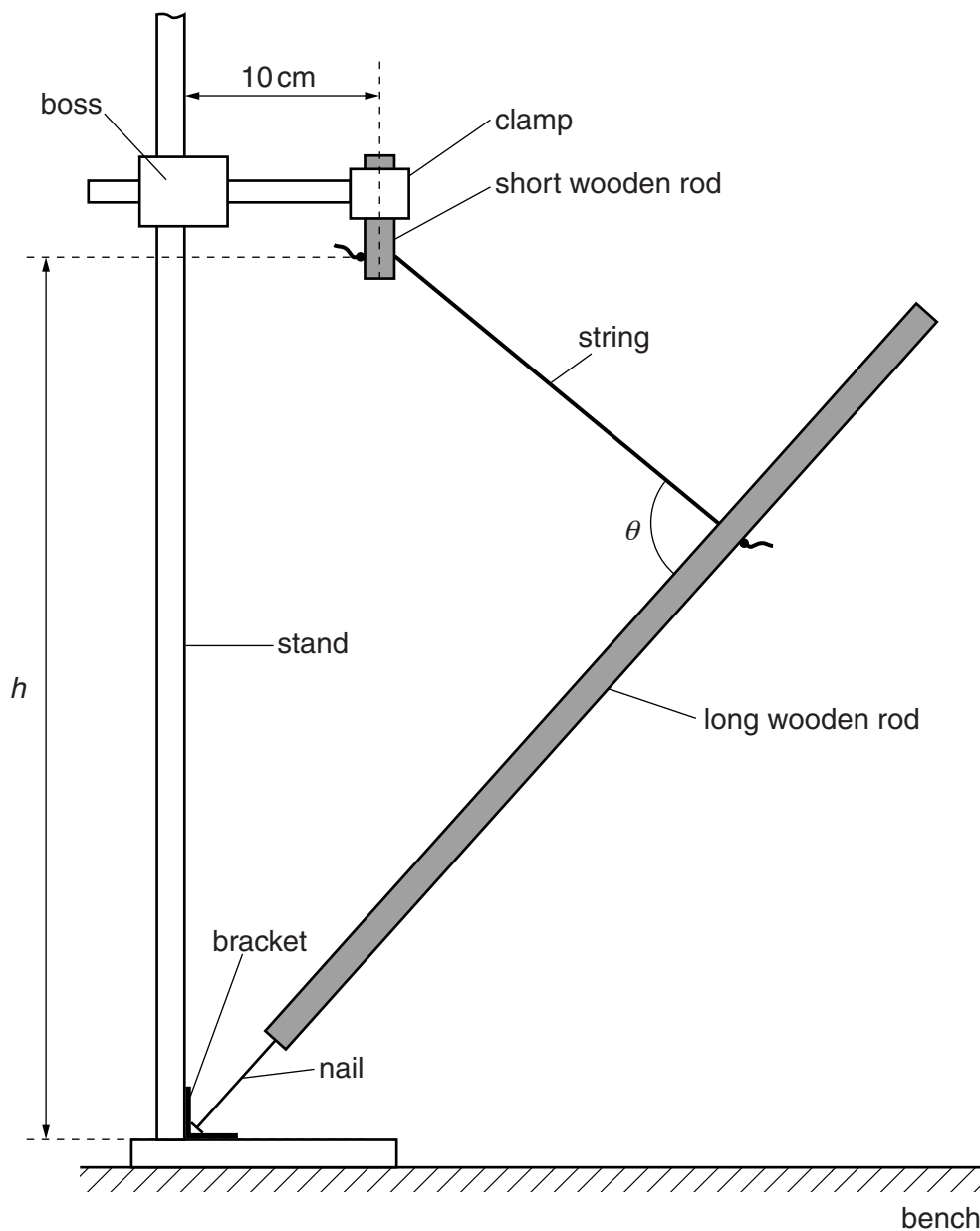


Fig. 2.1

The short wooden rod should be held firmly in the clamp.

Place the bracket on the base of the stand and rest the head of the nail in the centre of the bracket.

- (ii) Measure and record the angle θ between the string and the long wooden rod as shown in Fig. 2.1.

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Use

$\theta = \dots\dots\dots$ [2]

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

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

- (iv) Calculate $\sin \theta$.

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

- (b) Gently displace the end of the long wooden rod to the left as shown in Fig. 2.2 (top view).

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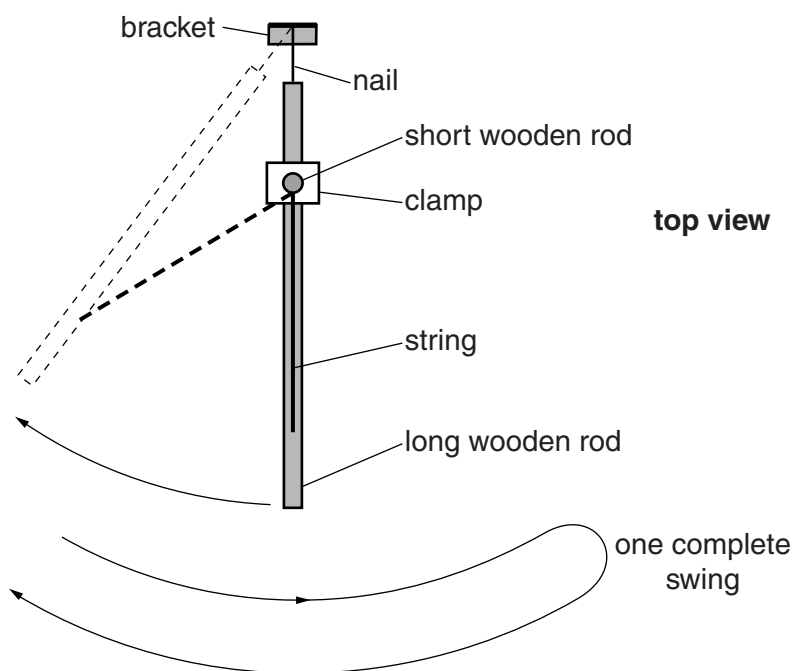


Fig. 2.2

Release the rod and watch the movement.
The rod will move to the right and back towards the left, completing a swing.
The time taken for one complete swing is T .
By timing several of these complete swings, determine an accurate value for T .

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

(c) (i) Reduce h to approximately 20 cm.

(ii) Repeat (a)(ii), (a)(iv) and (b).

For
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Use

$$\theta = \dots\dots\dots$$

$$\sin \theta = \dots\dots\dots$$

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

[3]

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

$$T^2 = k \sin \theta$$

where k is a constant.

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

first value of $k =$

second value of $k =$

[1]

- (ii) 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.

.....

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.....[1]

For
Examiner's
Use

- (e) (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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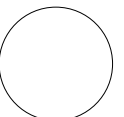
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PHYSICS

9702/32

Paper 3 Advanced Practical Skills 2

May/June 2013

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.

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You may use a pencil for any diagrams, graphs or rough working.

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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.

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 submitted only if it becomes necessary to do so.

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

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- 1** In this experiment, you will investigate the time for the voltage across a component to decrease after a switch is opened.

You have been provided with a circuit containing a power supply, switch and a component C, as shown in Fig. 1.1.

Throughout the experiment **do not disconnect this circuit**.

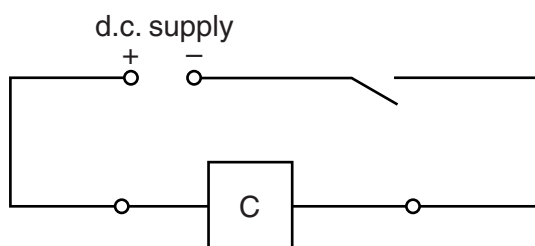


Fig. 1.1

- (a)** Assemble the circuit of Fig. 1.2 with the $10.0\text{ k}\Omega$ resistor clipped into the component holder as resistance S.

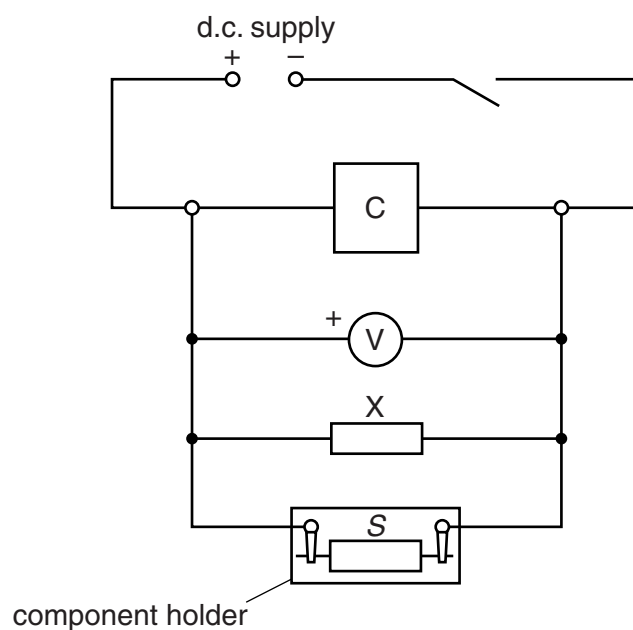


Fig. 1.2

- (b) (i) Close the switch and check that the voltmeter reading is between 4V and 8V.
- (ii) When the switch is opened the voltmeter reading will gradually decrease. Take measurements to find the time t for the voltmeter reading to decrease to 2.0V after the switch is opened. Record t .

For
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Use

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

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

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[10]

- (d) (i) Plot a graph of $\frac{1}{t}$ on the y -axis against $\frac{1}{S}$ 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]

☐
☐

For
Examiner's
Use

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

$$\frac{1}{t} = \frac{a}{S} + ab$$

where a and b are constants.

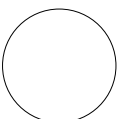
Using your answers from (d)(iii), determine the values of a and b .
Give appropriate units.

For
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$a =$

$b =$

[2]



Please turn over for Question 2.

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- 2** In this experiment, you will investigate the relationship between the volume of a bubble of air in water and the diameter of the tube that produces it.

(a) You are provided with a syringe connected to a length of plastic tube which has a smaller tube sealed into its end with Blu-Tack.

(i) Take measurements to determine the internal diameter d of the smaller tube.

$d = \dots\dots\dots$ [2]

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

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

(b) (i) Position the plunger at the 5 ml mark on the syringe. Check that there is no water in the syringe or tube.

(ii) Immerse the end of the tube approximately 2 cm below the surface of the water in the beaker, as shown in Fig. 2.1.

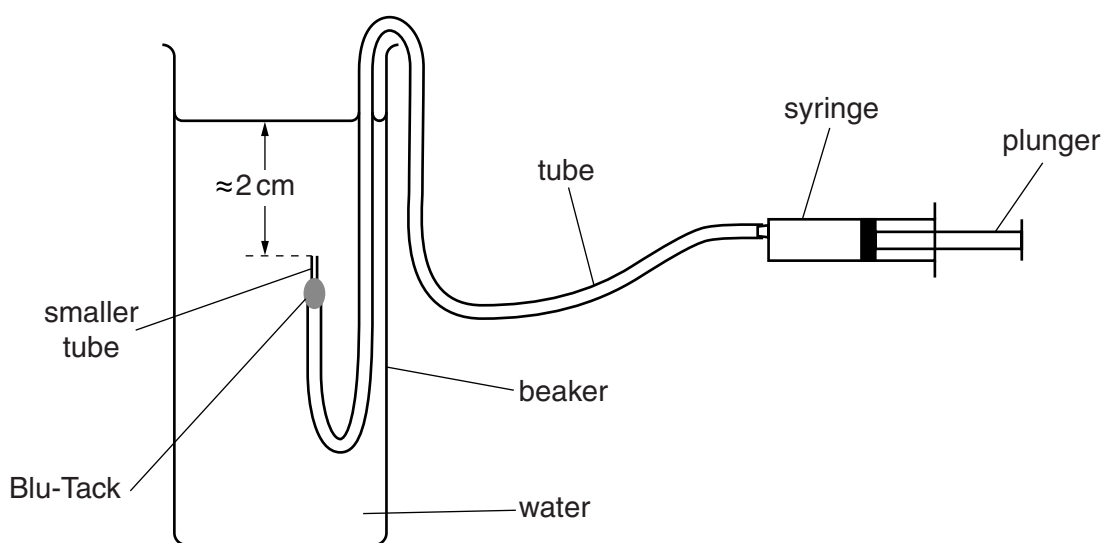


Fig. 2.1

- (c) (i) Slowly push in the syringe plunger until it is just past the 4 ml mark on the syringe barrel.
Record the reading r_1 from the syringe. (Note that 1 ml = 1 cm³.)

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$$r_1 = \dots\dots\dots \text{cm}^3 [1]$$

- (ii) Count the number n of bubbles that are produced as you slowly push in the plunger until it is just past the 2 ml mark. Record n and the new reading r_2 from the syringe.

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

$$r_2 = \dots\dots\dots \text{cm}^3$$

- (iii) Calculate the average volume V of air in a single bubble using the relationship

$$V = \frac{r_1 - r_2}{n}.$$

$$V = \dots\dots\dots \text{cm}^3 [1]$$

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

.....

 [1]

- (e) (i) Take the tube out of the beaker and remove the smaller tube and Blu-Tack from the end.
- (ii) Take measurements to determine the internal diameter d of the length of tube still attached to the syringe.

For
Examiner's
Use

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

- (iii) Repeat steps (b) and (c).

$r_1 = \dots\dots\dots \text{cm}^3$

$n = \dots\dots\dots$

$r_2 = \dots\dots\dots \text{cm}^3$

$V = \dots\dots\dots \text{cm}^3$
[2]

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

$$V^3 = kd^2$$

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.

For
Examiner's
Use

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

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

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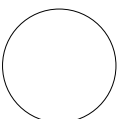
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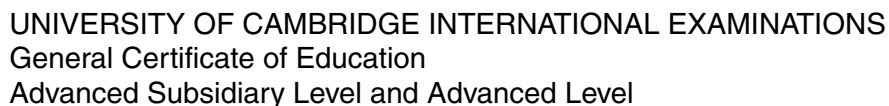
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- 1** In this experiment, you will determine the resistivity of a metal in the form of a wire.

- (a) (i)** Measure and record the diameter d of the short sample of wire that is attached to the card. You may remove the wire from the card.

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

- (ii)** Calculate the cross-sectional area A of the wire, in m^2 , using the formula

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

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

- (b) (i)** Using the wire attached to the metre rule, set up the circuit shown in Fig. 1.1.

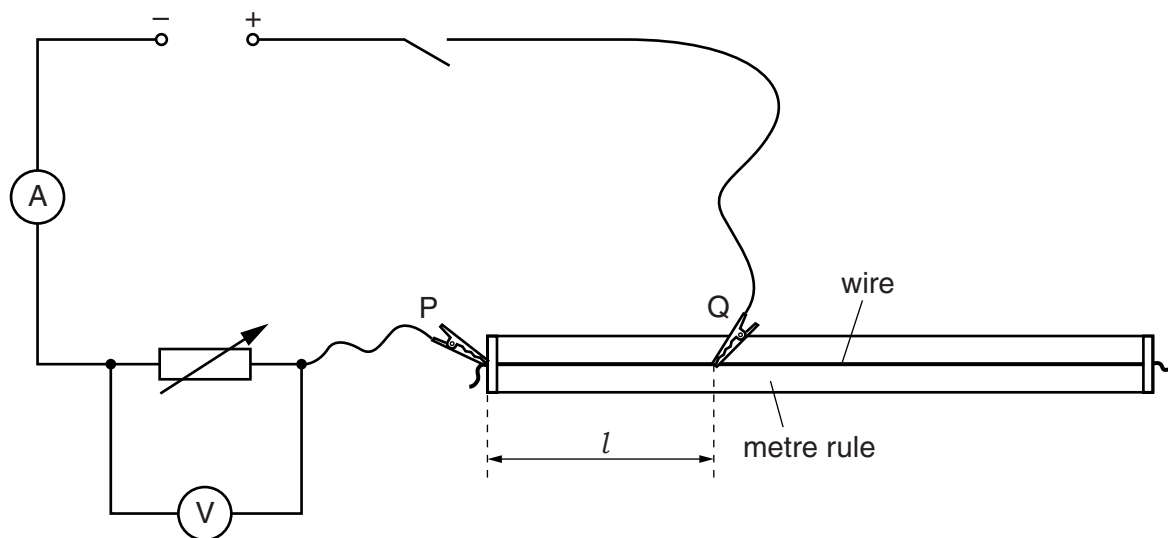


Fig. 1.1

There are two crocodile clips labelled P and Q.
P will remain in the same position throughout the experiment.
Q can be moved to different positions along the wire.

- (ii) Position the slider approximately half-way along the rheostat (variable resistor).
- (iii) Attach Q approximately half-way along the wire.
- (iv) Switch on the power supply.
- (v) Measure and record the length l of wire between P and Q.
Record the voltmeter reading V .

$l = \dots\dots\dots$ m

$V = \dots\dots\dots$ V
[1]

- (vi) Record the ammeter reading I .
(1 mA = 0.001 A)

$I = \dots\dots\dots$ A

- (vii) Switch off the power supply.

- (c) (i) Reposition Q at a new distance l from P.

- (ii) Switch on the power supply.
- (iii) Adjust the slider on the rheostat until the ammeter reading is the same value as in (b)(vi).
- (iv) Measure and record the length l of wire between P and Q.
Record the voltmeter reading V .

$l = \dots\dots\dots$ m

$V = \dots\dots\dots$ V

- (v) Switch off the power supply.

- (d) Repeat (c) until you have six sets of readings of l and V .

For each value of l , adjust the slider on the rheostat so that the ammeter reading I remains constant at the value in (b)(vi).

You may find it helpful to copy your value from (b)(vi) here.

$I = \dots\dots\dots$ A

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

For
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Use

[10]

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

[3]

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

[1]

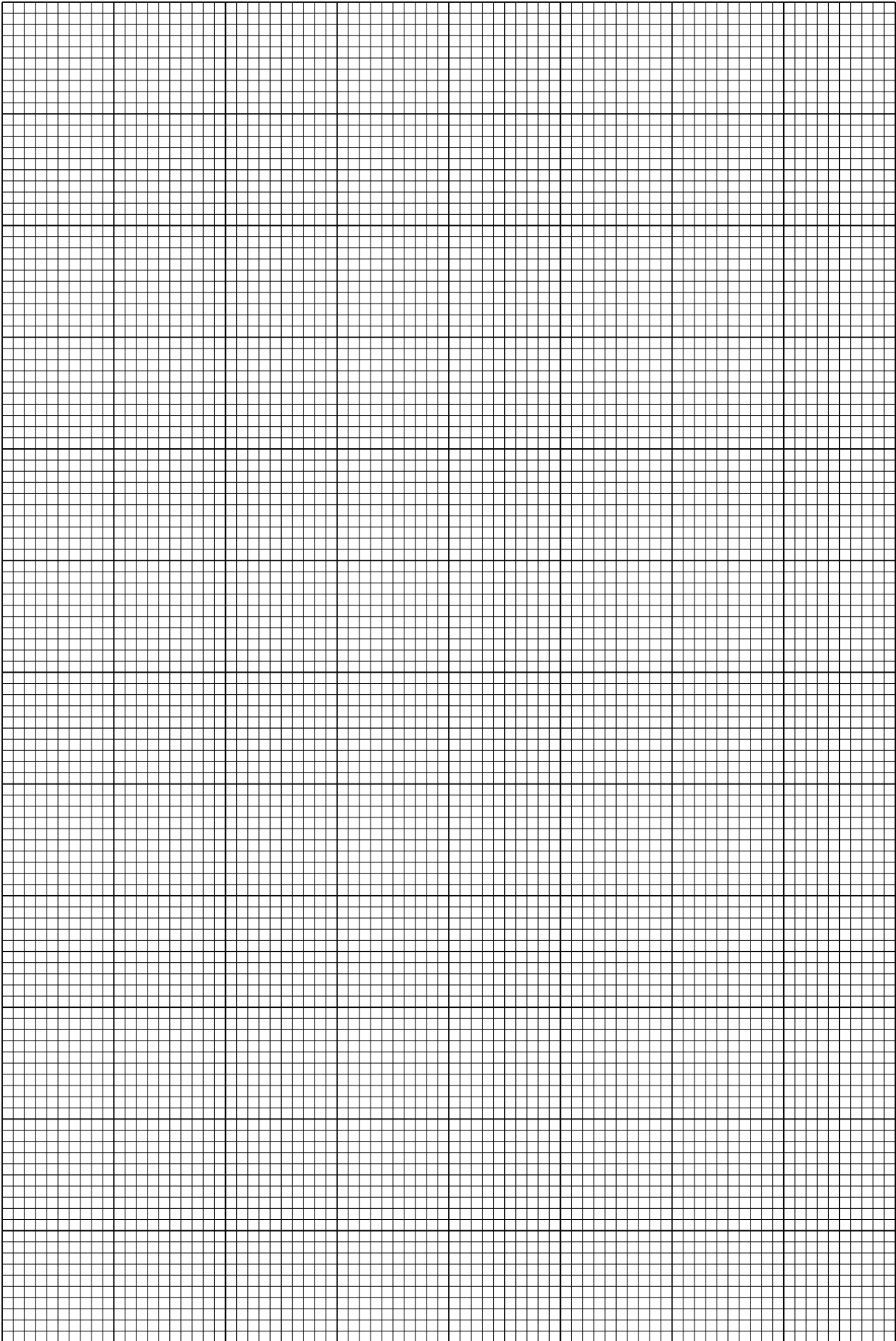
- (iii) Determine the gradient and y -intercept of this line.

gradient = $\dots\dots\dots$

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

[2]

For
Examiner's
Use



- (f) The quantities V and l are related by the equation

$$\frac{V}{l} = \frac{M}{l} - N$$

where M and N are constants.

- (i) Use your answers in (e)(iii) to determine values for M and N .

$$M = \dots\dots\dots \text{V}$$

$$N = \dots\dots\dots \text{V m}^{-1}$$

[1]

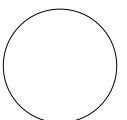
- (ii) The resistivity ρ of the material of the wire, in Ωm , can be found using the relationship

$$\rho = \frac{NA}{I}.$$

Using your answers in (a)(ii), (b)(vi) and (f)(i), calculate a value for ρ .

$$\rho = \dots\dots\dots \Omega \text{ m} [1]$$

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For
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- 2** In this experiment, you will investigate how the loss of gravitational potential energy of a rolling ball depends on its initial height.

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

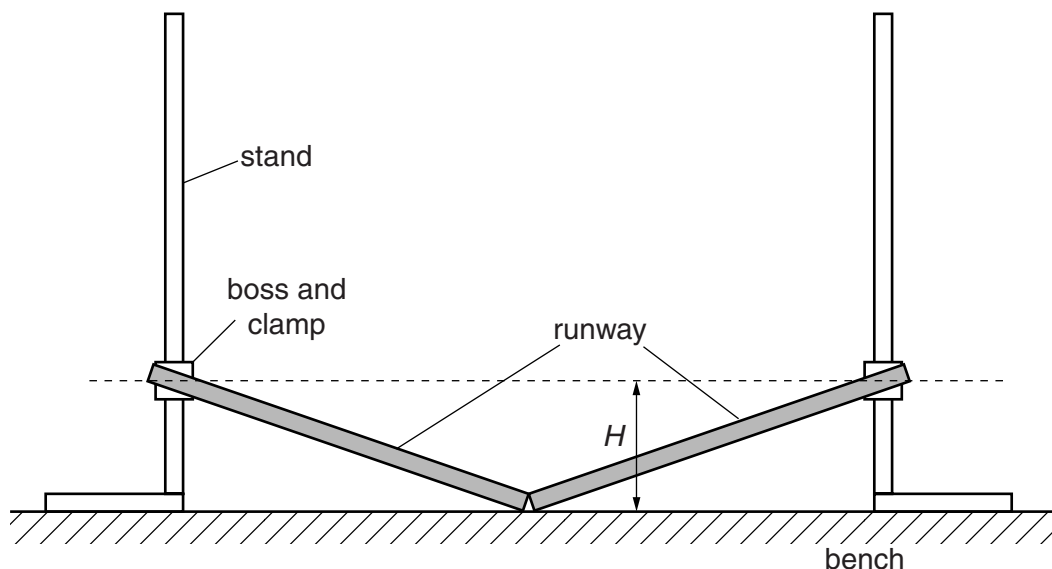


Fig. 2.1

One end of each runway should be resting on the bench. The other end should be clamped firmly at a height H approximately 15 cm above the bench.

The runways should be lined up so that a ball rolling down one would roll up the other.

(ii) Measure and record H .

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



- (b) (i) Place the ball close to the top of one of the runways as shown in Fig. 2.2.

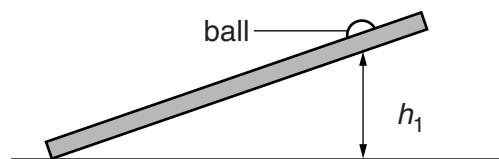


Fig. 2.2

- (ii) Measure and record the height h_1 of the bottom of the ball above the bench.

$h_1 = \dots\dots\dots$ [1]

- (iii) Estimate the percentage uncertainty in your value of h_1 .

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

- (c) (i) Place the ball on the runway at the height given in (b)(ii).

- (ii) Release the ball.

- (iii) The ball should roll down one runway and up the other one, as shown in Fig. 2.3.

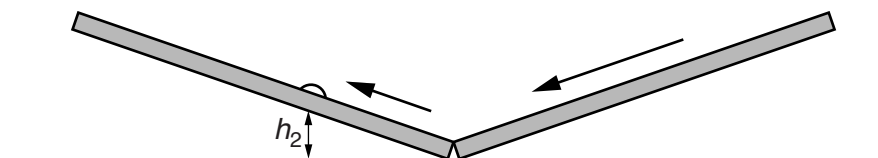


Fig. 2.3

Measure and record the maximum height h_2 of the bottom of the ball above the bench.

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

For
Examiner's
Use

- (d) Calculate the fractional loss of energy F , where

$$F = \frac{(h_1 - h_2)}{h_1}.$$

For
Examiner's
Use

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

- (e) Place the ball at a lower starting position so that the height h_1 is approximately half the value in (b)(ii).
Repeat (b)(ii), (c)(ii), (c)(iii) and (d).

$$h_1 = \dots\dots\dots$$

$$h_2 = \dots\dots\dots$$

$$F = \dots\dots\dots[3]$$

- (f) It is suggested that the relationship between F and h_1 is

$$F^3 = \frac{k}{h_1}$$

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 (f)(i) support the suggested relationship.

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 [1]

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

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

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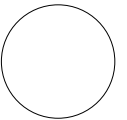
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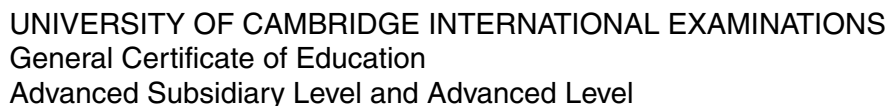
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9702/34

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- 1 In this experiment, you will investigate how a force acting on a pivoted wooden strip changes as the pivot position is moved.
- (a) (i) Assemble the apparatus as shown in Fig. 1.1 with the nail through the **central** hole in the wooden strip.

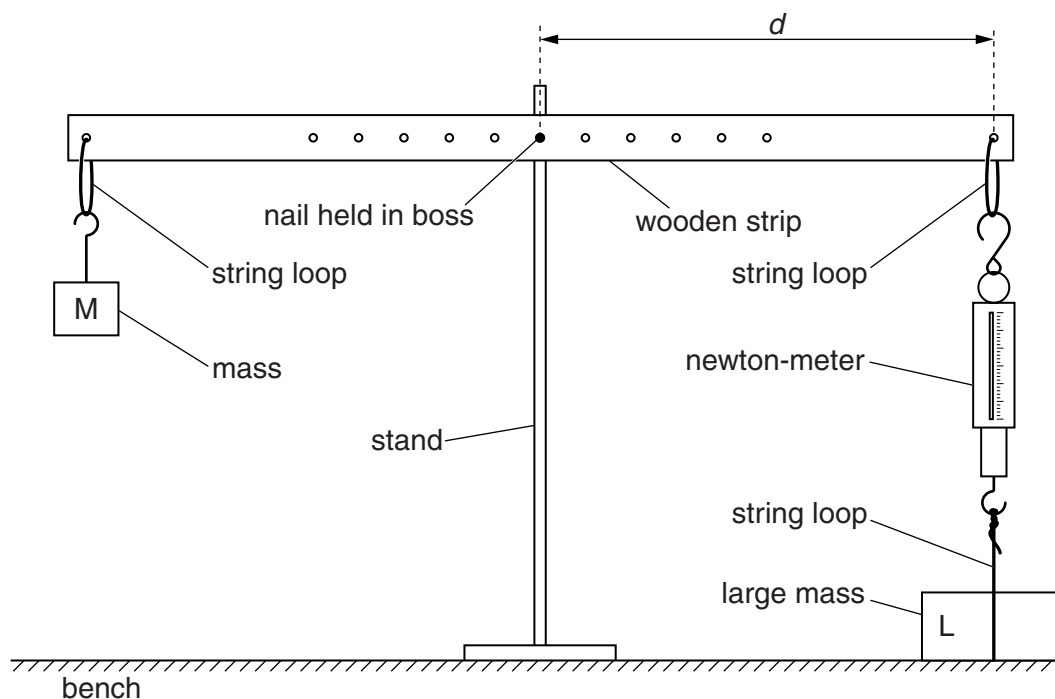


Fig. 1.1

- (ii) Adjust the nail height so that the wooden strip is parallel to the bench. Adjust the position of the stand or the large mass so that the newton-meter is vertical.
- (b) (i) Measure and record the distance d from the nail to the string loop attached to the newton-meter, as shown in Fig. 1.1.

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

- (ii) Record the force F indicated by the newton-meter.

$F = \dots\dots\dots$ N

- (c) Reposition the strip with the nail through different holes and repeat (a)(ii) and (b) until you have six sets of values of d and F .
Include values of $\frac{1}{d}$ in your table.

For
Examiner's
Use

Do not use holes that result in a force outside the range of the newton-meter.

☐

[11]

- (d) (i) Plot a graph of F 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]

For
Examiner's
Use

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

$$F = \frac{a}{d} + b$$

where a and b are constants.

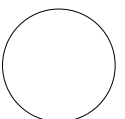
Using your answers from (d)(iii), determine the values of a and b .
Give appropriate units.

$a =$

$b =$

[2]

For
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Use



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Examiner's
Use

- 2 In this experiment, you will investigate how the speed of water flowing through a tube depends on the tube length.

- (a) (i) Take measurements to determine the internal diameter D of the flexible tube, as shown in Fig. 2.1.



Fig. 2.1

$D = \dots\dots\dots$ cm [2]

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

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

- (b) Remove the plunger from the syringe body.

- (c) (i) Measure the length l of the flexible tube.

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

- (ii) Push the nozzle of the syringe body securely into one end of the flexible tube and then assemble the apparatus as shown in Fig. 2.2. Attach enough modelling clay near the bottom of the tube to make it hang vertically.

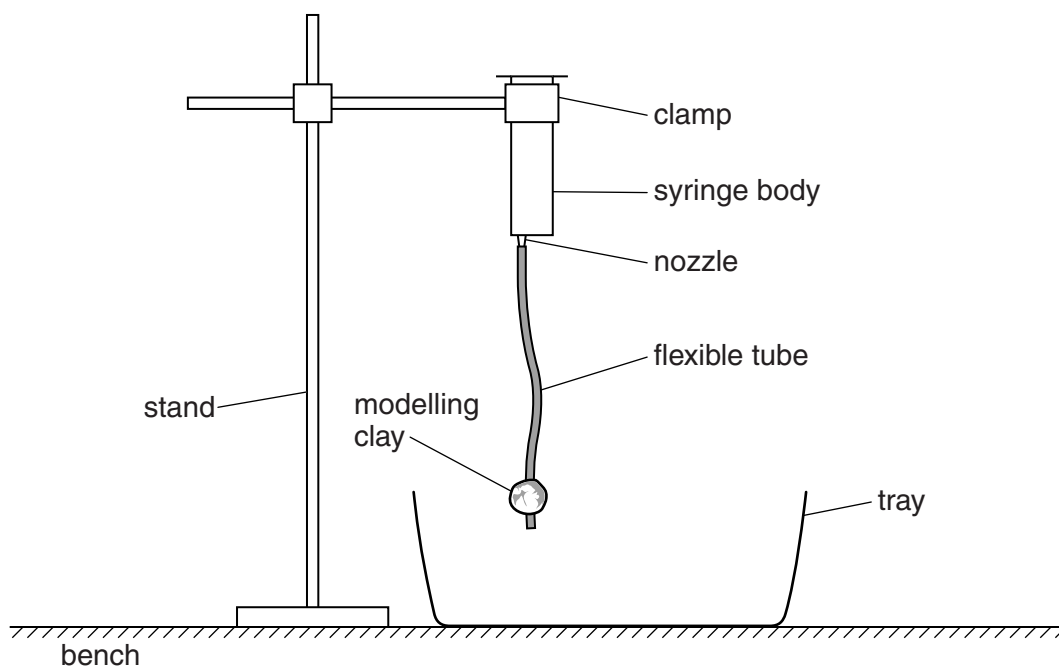


Fig. 2.2

- (iii) Fill the syringe body to the top with water.

As the water level falls in the syringe body, take measurements to find the time t for the level to fall from the 40 cm^3 graduation to the 10 cm^3 graduation. (Note that $1\text{ ml} = 1\text{ cm}^3$.)

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Use

$t = \dots\dots\dots \text{ s} \quad [1]$

- (iv) Calculate the average speed v of the water in the tube using the relationship

$$v = \frac{120}{\pi D^2 t}.$$

$v = \dots\dots\dots \text{ cm s}^{-1} \quad [1]$

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

.....

 [1]

- (e) (i) Detach the tube from the syringe body and reduce its length by cutting it in half.

- (ii) Repeat (c) with one of the shorter tubes.

$l = \dots\dots\dots$

$t = \dots\dots\dots \text{ s}$

$v = \dots\dots\dots \text{ cm s}^{-1}$
 [3]

- (f) It is suggested that the relationship between v and l is

$$v^2 = kl$$

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]

For
Examiner's
Use

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

For
Examiner's
Use

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.

.....

2.

.....

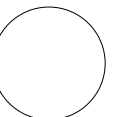
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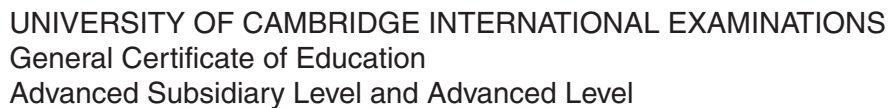
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9702/35

May/June 2013

2 hours

Additional Materials: As listed in the Confidential Instructions.

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 a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

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.

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.

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*For
Examiner's
Use*

- 1** In this experiment, you will investigate how the motion of an oscillating system depends on the mass attached to the system.

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

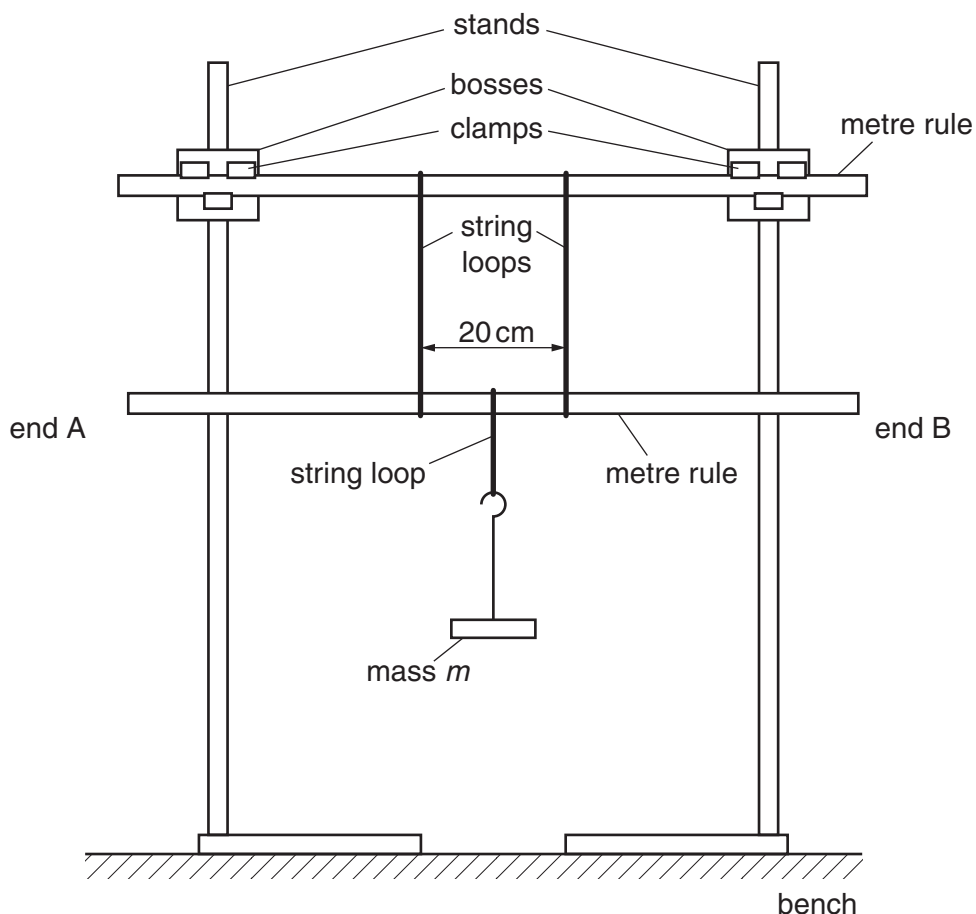


Fig. 1.1

Slide the two longer loops of string onto a rule and fix this rule in the clamps.

Adjust the clamps until the rule is parallel to the bench.

Slide the shorter loop onto the second rule and use the longer loops to support this second rule.

Both rules should have their markings facing you. The strings should be vertical, 20 cm apart and equal distances from the centre of the second rule.

Use the shorter loop of string to suspend a mass m at the 50 cm mark on the second rule, where $m = 0.500$ kg.

- (ii) Move the end A of the lower rule towards you and the end B away from you. Release the rule and watch the movement. End A will move away from you and back towards you, completing a swing. The time taken for one complete swing is T . By timing several of these complete swings, determine an accurate value for T .

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

- (b)** Change m and repeat **(a)(ii)** until you have six sets of values of m and T .

Include values of $\frac{1}{T^2}$ in your table.

For
Examiner's
Use

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[10]

- (c) (i)** Plot a graph of $\frac{1}{T^2}$ 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.

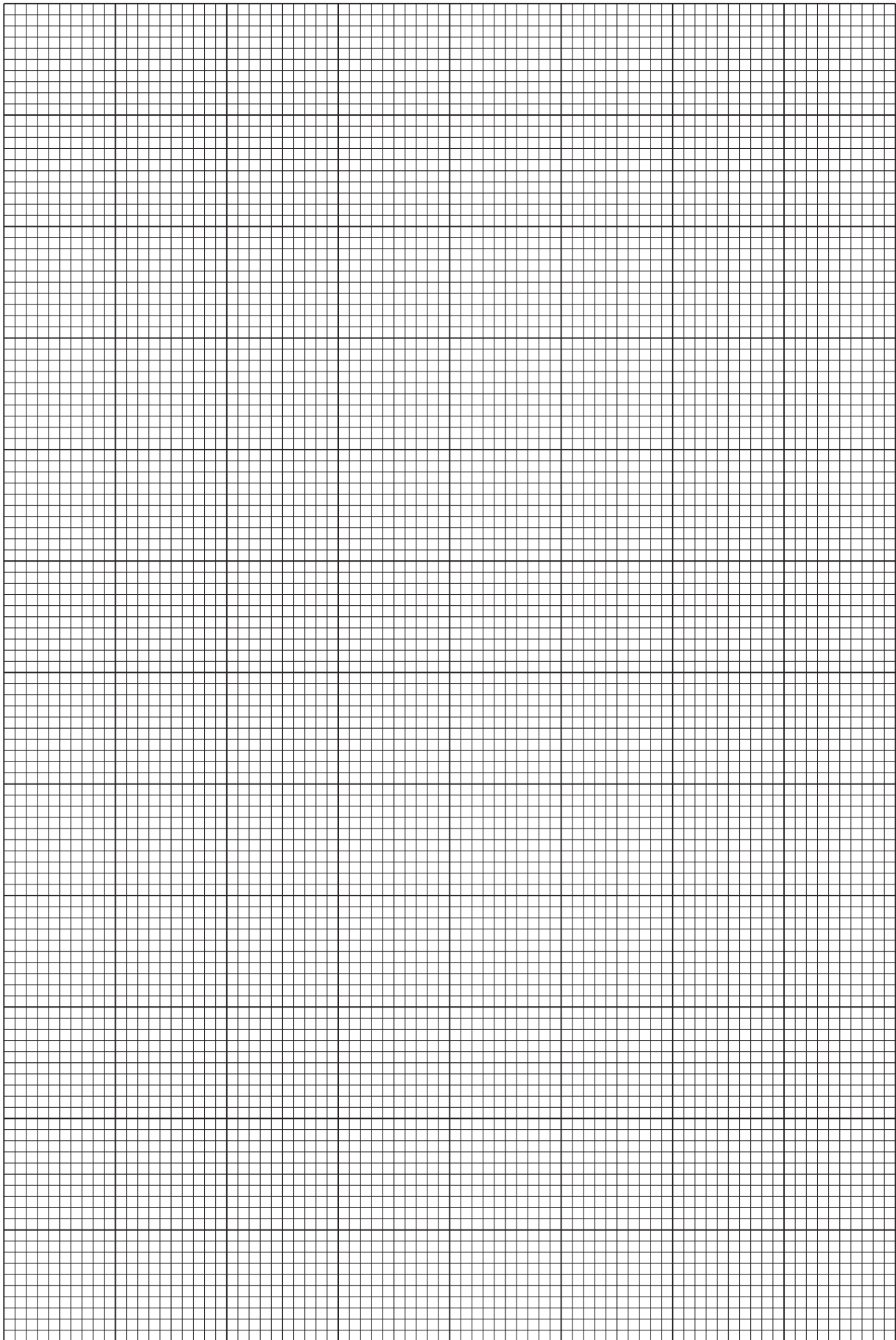
gradient = ...

y -intercept = ...

[2]

☐
☐

For
Examiner's
Use



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

$$\frac{1}{T^2} = Pm + Q$$

where P and Q are constants.

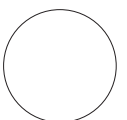
Using your answers in (c)(iii), determine the values of P and Q .
Give appropriate units.

For
Examiner's
Use

$P =$

$Q =$

[2]



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

For
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Use

- 2 In this experiment, you will investigate how the force acting on a straight wire in water depends on its length.

- (a) (i) Measure the length L of the shorter wire as shown in Fig. 2.1.

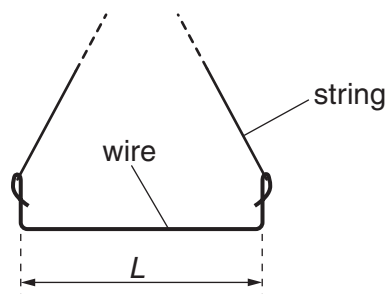


Fig. 2.1

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

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

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

- (b) (i) Set up the apparatus using the shorter wire as shown in Fig. 2.2.

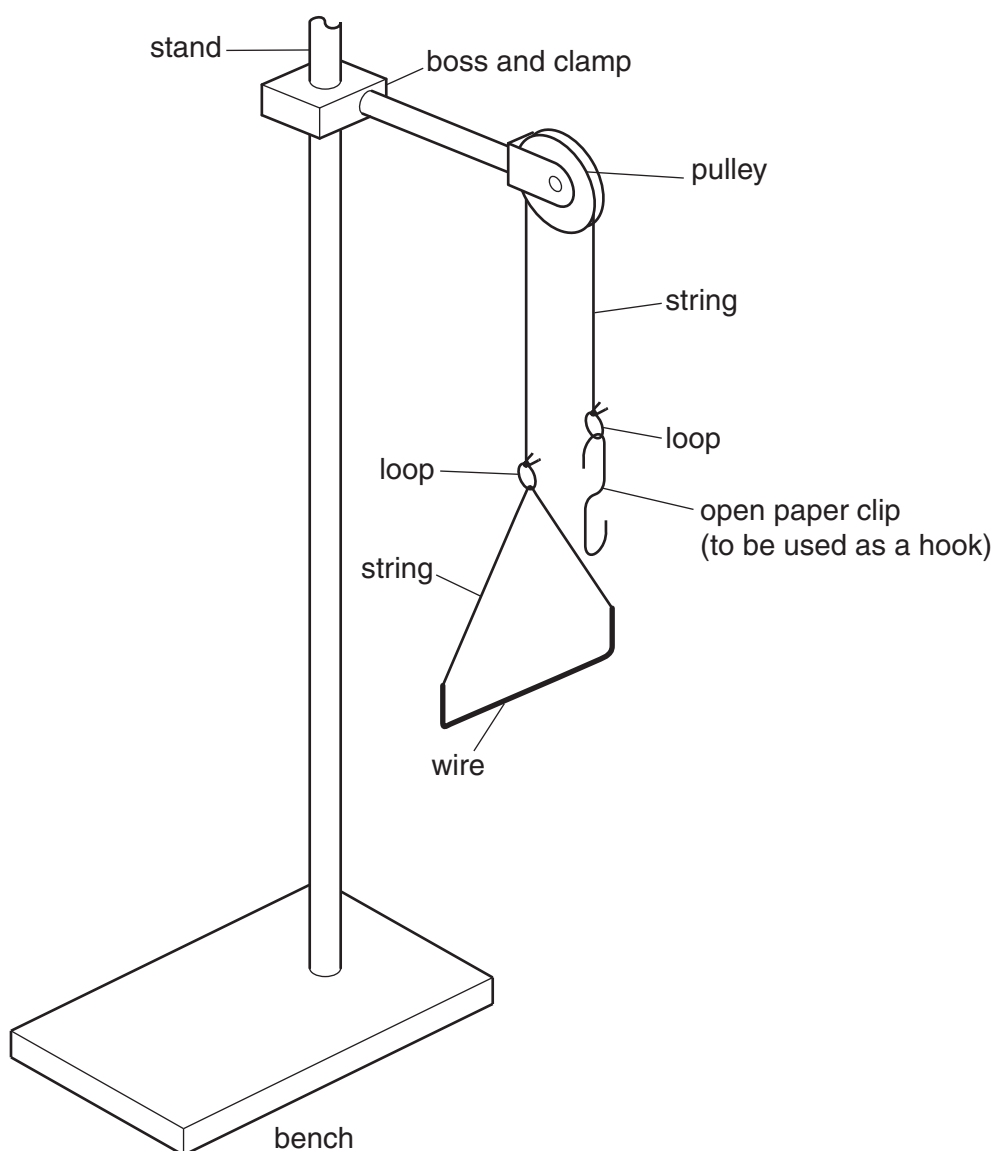


Fig. 2.2

- (ii) Gently add paper clips to the hook until the wire moves upwards.
- (iii) Count and record the number N_1 of paper clips you have added in (ii). Do not include the open paper clip which is used as a hook.

$N_1 = \dots\dots\dots$ [1]

- (c) (i) You have been provided with a tray containing water.
Set up the apparatus so that it is the same as in Fig. 2.2 but with the wire in the water. It may be necessary to adjust the position of the pulley.
- (ii) Gently add paper clips to the hook until the wire rises out of the water.
- (iii) Count and record the number N_2 of paper clips you have added in (ii).

For
Examiner's
Use

$$N_2 = \dots\dots\dots [2]$$

- (d) Calculate the force F needed to remove the wire from the water using

$$F = (N_2 - N_1) mg$$

where the mass m of one paper clip is $4.0 \times 10^{-4} \text{ kg}$, and $g = 9.8 \text{ N kg}^{-1}$.

$$F = \dots\dots\dots \text{ N } [1]$$

(e) Repeat (a)(i), (b), (c) and (d) for the longer wire.

For
Examiner's
Use

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

$$N_1 = \dots\dots\dots$$

$$N_2 = \dots\dots\dots$$

$$F = \dots\dots\dots \text{ N}$$

[3]

- (f) It is suggested that the relationship between F and L is

$$F = kL$$

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

.....

 [1]

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

.....

 [1]

For
Examiner's
Use

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

For
Examiner's
Use

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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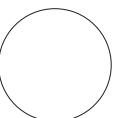
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