



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

CANDIDATE
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PHYSICS

9702/31

Advanced Practical Skills 1

October/November 2011

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 work you hand in.

Write in dark blue or black pen.

You may use a soft 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.

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 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.

You are reminded of the need for good English and clear presentation in your answers.

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

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For
Examiner's
Use

- 1** In this experiment you will investigate the equilibrium position of a metre rule with a mass attached to one end.

(a) (i) Use a loop of string to balance the metre rule as shown in Fig. 1.1.

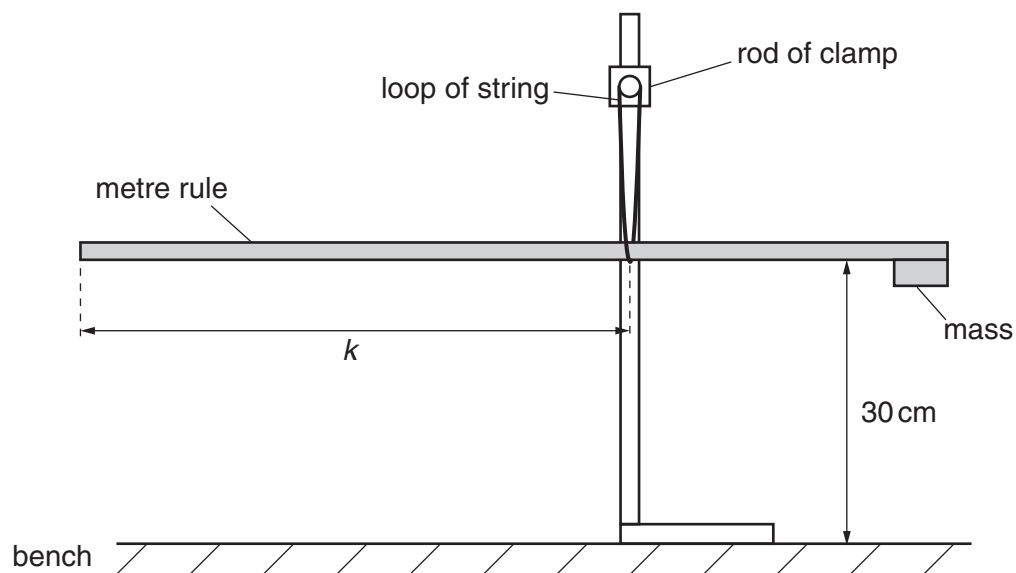


Fig. 1.1

- (ii)** Measure and record distance k between the loop and the end of the rule as shown in Fig. 1.1.

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

- (b) (i) Use the other loop of string to attach the mass hanger at a distance d from the end of the rule as shown in Fig. 1.2. The value of d should be approximately 5 cm.
- (ii) For this value of d , adjust the position of the rule so that it balances. The new distance between the first loop and the end of the rule is D , as shown in Fig. 1.2.

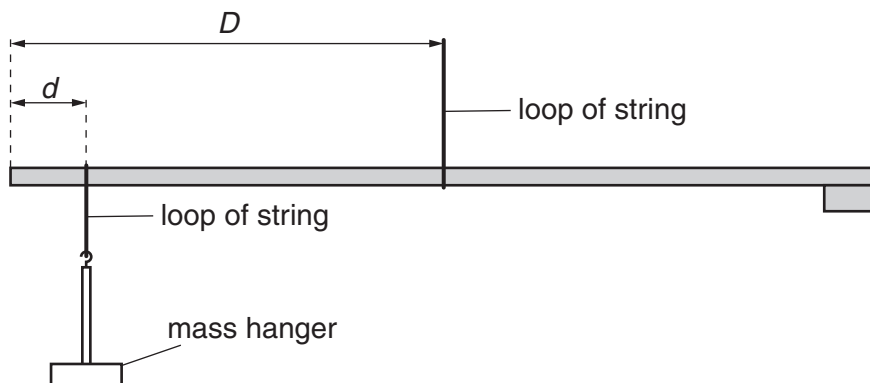


Fig. 1.2

- (iii) Measure and record lengths d and D .

$d =$

$D =$

[1]

- (iv) Calculate the value of $\frac{(D-d)}{D}$.

$\frac{(D-d)}{D} =$

- (c) By moving the mass hanger along the metre rule, repeat (b)(ii), (b)(iii) and (b)(iv) until you have six sets of values of d and D .

Include values of $\frac{1}{D}$ and $\frac{(D-d)}{D}$ in your table.

For
Examiner's
Use

[10]

- (d) (i) Plot a graph of $\frac{(D-d)}{D}$ 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
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- (e) The quantities d and D are related by the equation

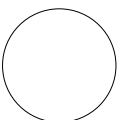
$$\frac{(D - d)}{D} = \frac{A}{D} - B$$

where A and B are constants.

Use your answers in (d)(iii) to determine the value of $\frac{A}{B}$.
Give appropriate units.

For
Examiner's
Use

$$\frac{A}{B} = \dots\dots\dots [2]$$



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 motion of a thin card shape depends on its size.

You have been provided with two identical strips of card. Spare strips are available if necessary.

- (a)** Measure and record the thickness t of one of the strips of card.

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

- (b) (i)** Measure and record the length L of the same strip of card as shown in Fig. 2.1.

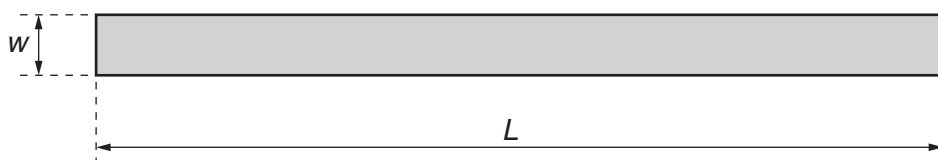


Fig. 2.1

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

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

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

- (c) (i)** Measure and record the width w of the same strip as shown in Fig. 2.1.

$w = \dots\dots\dots$

- (ii) Determine the volume V of the strip, using the equation

$$V = t L w$$

For
Examiner's
Use

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

- (d) (i) Use tape to stick the two strips together, so that they do not overlap, to make the shape shown in Fig. 2.2.

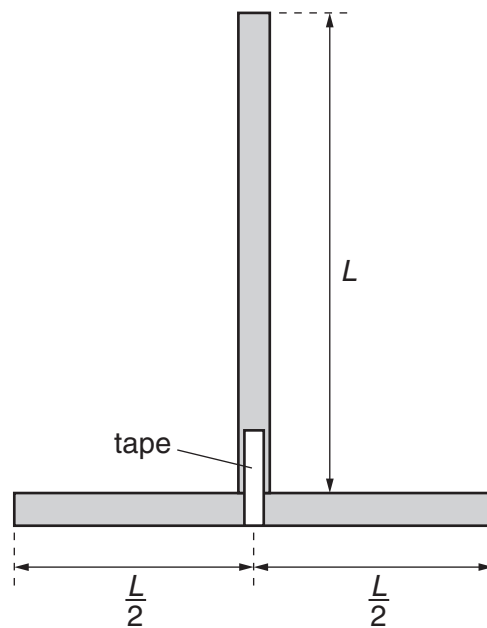


Fig. 2.2

- (ii) Use the pin to make a hole at the top of the vertical strip as shown in Fig. 2.3.

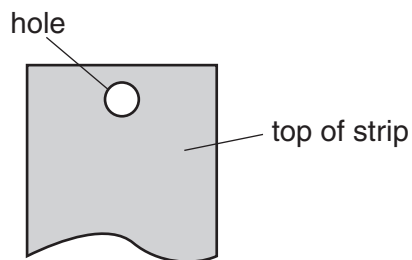


Fig. 2.3

The hole should be central and as near to the top as possible and be large enough for the card to swing freely on the pin.

- (iii) Using the cork and pin, suspend the card shape as shown in Fig. 2.4.

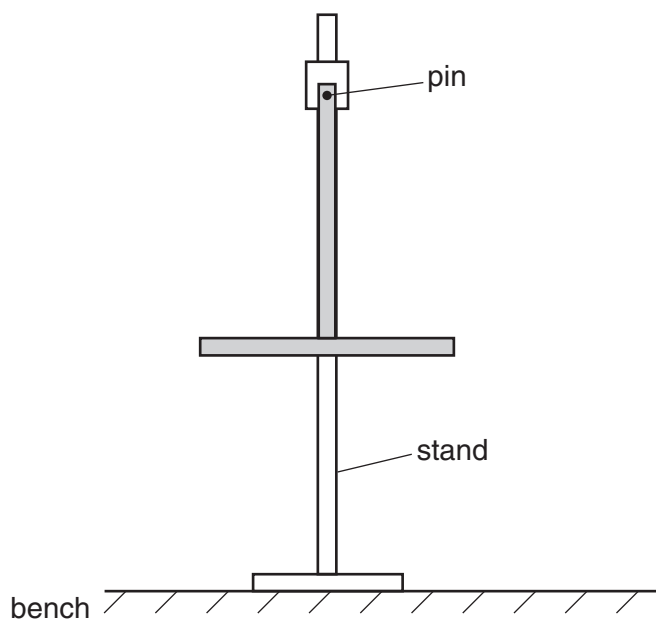


Fig. 2.4

- (e) Move the card shape to the left. Release the shape and watch its movement. The shape will move to the right and then to the left again, completing a swing as shown in Fig. 2.5.

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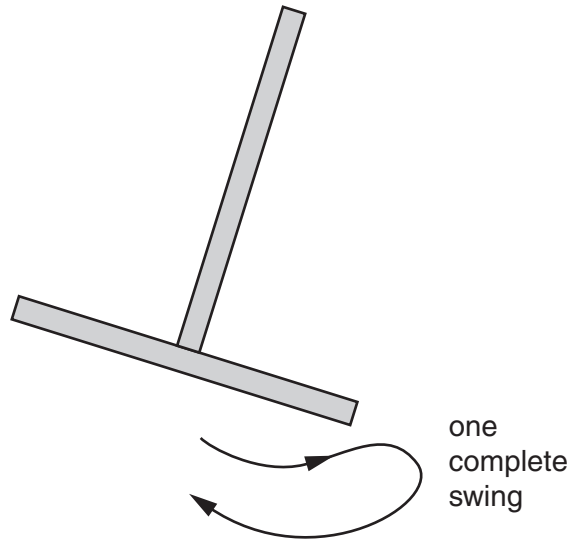


Fig. 2.5

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]

- (f) Cut both strips so that L is approximately 10 cm, as shown in Fig. 2.6.

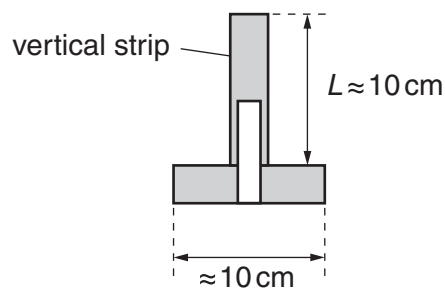


Fig. 2.6

Measure and record the length L of the vertical strip.

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

(g) Repeat (d)(ii), (d)(iii) and (e) for this new shape.

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Examiner's
Use

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

(h) It is suggested that the relationship between T and L for this shape is

$$T^2 = k L$$

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 support the suggested relationship.

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

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

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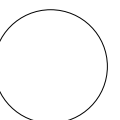
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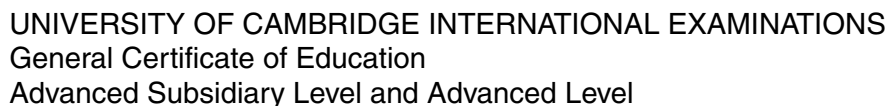
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9702/33

October/November 2011

2 hours

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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 that is taped to the metre rule, set up the circuit shown in Fig. 1.1. Close the switch.

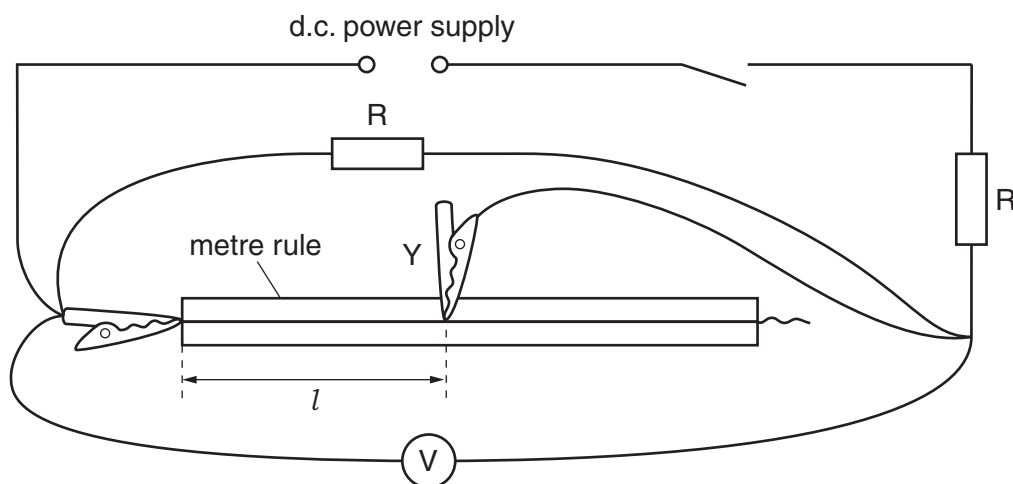


Fig. 1.1

- (ii)** Position the crocodile clip Y approximately half-way along the wire.
- (iii)** Measure and record the length l of wire between the two crocodile clips and the voltmeter reading V .

$l = \dots\dots\dots$

$V = \dots\dots\dots$

[1]

- (c) By moving crocodile clip Y, change l and repeat (b)(iii) until you have six sets of readings of l and V for $l \geq 20$ cm. Include values of $\frac{1}{l}$ and $\frac{1}{V}$ in your table.

For
Examiner's
Use

[10]

- (d) (i) Plot a graph of $\frac{1}{V}$ 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 = ...

y-intercept = ...

[2]

For
Examiner's
Use

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

$$\frac{1}{V} = \frac{M}{l} + N$$

where M and N are constants.

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

$$M = \dots\dots\dots \text{mV}^{-1}$$

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

[1]

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

$$\rho = \frac{5AN}{M}.$$

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

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

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Use

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Please turn over for Question 2.

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For
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Use

- 2** In this experiment you will investigate how the motion of a metre rule depends on the length of the string loops used to suspend it.

(a) Measure and record the width w of one of the metre rules, as shown in Fig. 2.1.

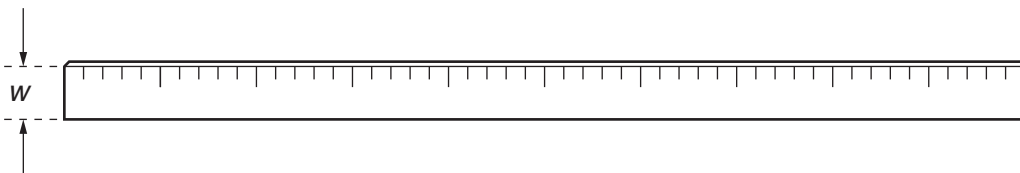


Fig. 2.1

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

- (b)** **(i)** Select the two longer pieces of string.
(ii) Tie the ends of one piece of string to make a loop.
(iii) Measure and record the length l of this loop, as shown in Fig. 2.2.

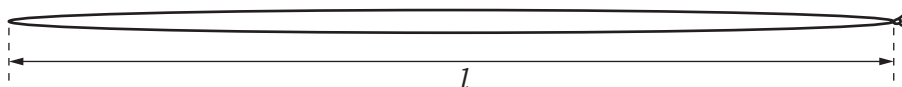


Fig. 2.2

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

- (iv)** Repeat **(ii)** with the other long piece of string. The length of this loop should be the same as that in **(iii)**.

- (c) (i) Use the stands to set up the two metre rules and the two loops of string as shown in Fig. 2.3.

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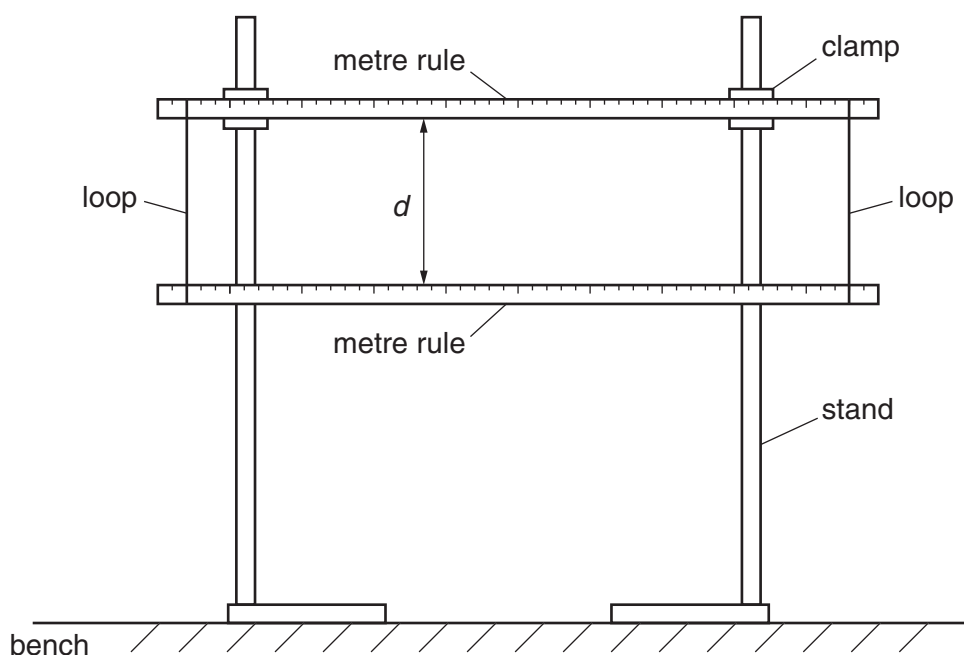


Fig. 2.3

The rules should be horizontal with the scale markings facing you.
The loops should be vertical, parallel to each other and placed at the 5 cm and 95 cm marks on both rules.

- (ii) Using your values in (a) and (b)(iii), determine the distance d using the relationship

$$d = l - 2w.$$

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

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

$$\text{percentage uncertainty} = \dots\dots\dots [1]$$

- (d) Move the left end of the bottom rule towards you and the right end away from you. Release the rule and watch the movement. The left end of the rule 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 .

For
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Use

$$T = \dots\dots\dots \text{ s [2]}$$

- (e) Repeat (b), (c)(i), (c)(ii) and (d) for the shorter lengths of string.

$$l = \dots\dots\dots \text{ [1]}$$

$$d = \dots\dots\dots$$

$$T = \dots\dots\dots \text{ s [2]}$$

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

$$T^2 = kd$$

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 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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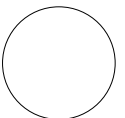
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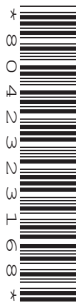
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PHYSICS

9702/34

Advanced Practical Skills 2

October/November 2011

2 hours

Candidates answer on the Question Paper.

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Additional answer paper and graph paper should be submitted only if it becomes necessary to do so.

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For Examiner's Use

1

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Total

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For
Examiner's
Use

- 1** In this experiment, you will investigate the variation of a potential difference in a resistor network.

(a) Set up the circuit of Fig. 1.1. The resistor R should have a resistance R where $R = 2.2\text{ k}\Omega$.

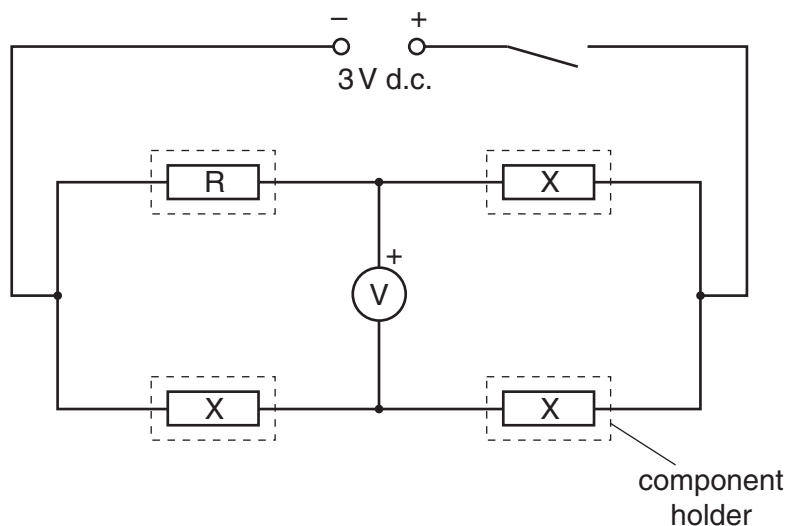


Fig. 1.1

- (b)** Close the switch and record the voltmeter reading V , which should be in the range $+0.10\text{ V}$ to $+0.90\text{ V}$.
Open the switch.

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

- (c) (i)** Change resistor R for one of another value. Close the switch and record the new resistance R and the voltmeter reading V .
Open the switch.

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

$V = \dots\dots\dots$

- (ii) Repeat (c)(i) until you have six sets of readings for R (in $\text{k}\Omega$) and V . Include in your table of results values for $\left(\frac{R}{R+1}\right)$, where R is in $\text{k}\Omega$.

Some resistors may give negative values for V .

For
Examiner's
Use

☐

[11]

- (d) (i) Plot a graph of V on the y -axis against $\left(\frac{R}{R+1}\right)$ 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 relationship between V and R is

$$V = a \left(\frac{R}{R+1} \right) - b$$

where a and b are constants, and R is in $\text{k}\Omega$.

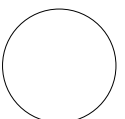
Using your answers from (d)(iii), determine the values of a and b .
Give an appropriate unit for b .

For
Examiner's
Use

$a =$

$b =$

[2]



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

For
Examiner's
Use

- 2** In this experiment you will investigate the effect of cross-sectional area on the breaking force of polythene.

- (a)** You are provided with eight strips of polythene, each with a hole at one end. Four of the strips are marked P and four are marked Q.
For one of the strips, measure and record the thickness t of the polythene (measure near the end without the hole).

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

- (b)** Each strip has two cuts in it, as shown in Fig. 2.1.

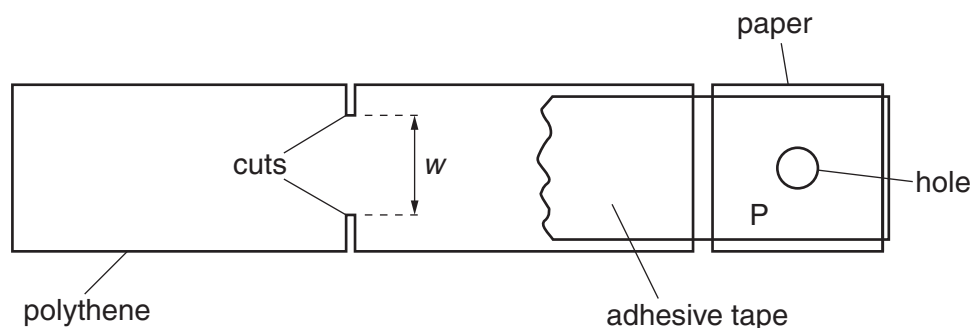


Fig. 2.1

For the strips marked P,

- (i)** measure the distance w between the cuts,

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

- (ii)** estimate the percentage uncertainty in w .

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

- (c) The cross-sectional area A of the strip between the cuts is shown in Fig. 2.2.

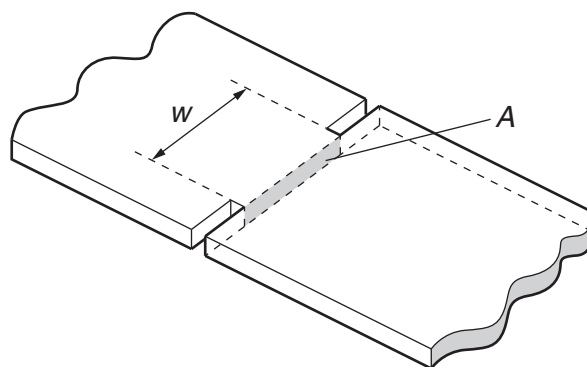


Fig. 2.2

Calculate A using the relationship $A = wt$.

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

- (d) (i) Lay a strip marked P on the bench and hook the newton-meter through the hole. Use a piece of adhesive tape to fix the other end of the strip to the bench, as shown in Fig. 2.3.

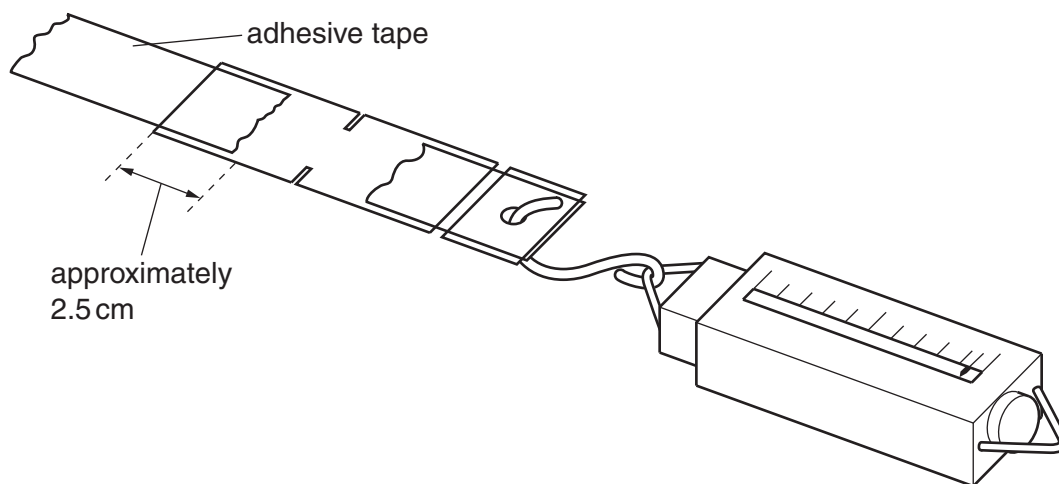


Fig. 2.3

- (ii) Slowly pull the newton-meter until the strip breaks.
- (iii) Repeat (d)(i) and (d)(ii) for the other strips marked P. Record the average breaking force F .

$F = \dots\dots\dots$ [2]

(e) Repeat (b)(i), (c) and (d), but this time using the strips marked Q.

For
Examiner's
Use

$w =$ mm

$A =$ mm²

$F =$
[3]

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

$$F = kA$$

where k is a constant.

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]

- (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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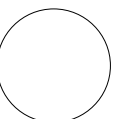
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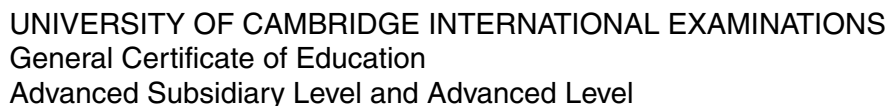
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9702/35

October/November 2011

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- 1** In this experiment you will investigate how the depth to which a beaker is submerged in water depends on the mass added to the beaker.

(a) Measure and record the height h of the beaker as shown in Fig. 1.1.

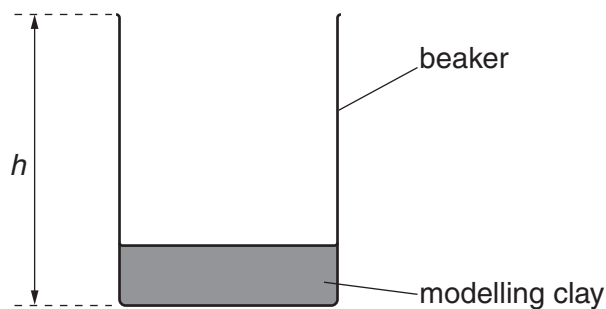


Fig. 1.1

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

- (b)** (i) Place the beaker from **(a)** inside the larger container, which contains water. The beaker will float in the water and may tilt to one side.
- (ii) Measure and record the distance d between the **lowest** point of the bottom of the beaker and the water surface as shown in Fig. 1.2.

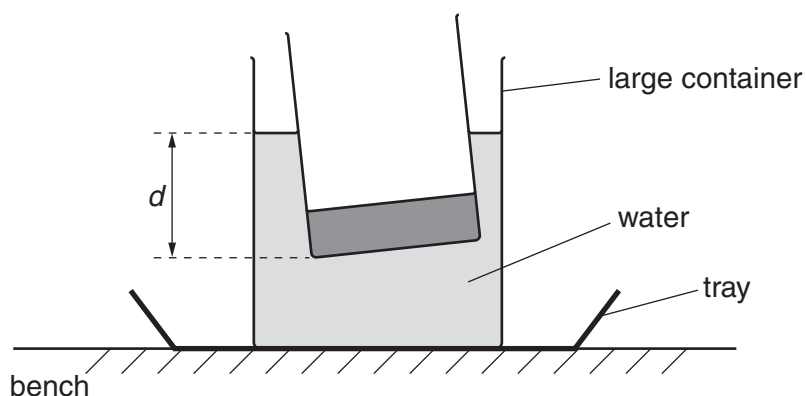


Fig. 1.2

This measurement should be taken from outside the large container.

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

- (c) Carefully place the 50 g mass on top of the modelling clay in the beaker.
For this added mass m of 50 g, measure and record the new distance d .

$d =$

- (d) Change the added mass in the small beaker and measure d .
Repeat this until you have six sets of readings of m and d .

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

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[10]

- (e) (i) Plot a graph of $\frac{m}{d}$ on the y -axis against $\frac{1}{d}$ on the x -axis.
(ii) Draw the straight line of best fit.
(iii) Determine the gradient and y -intercept of this line.

[3]

[1]

gradient = ...

y -intercept = ...

[2]

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- (f) It is suggested that the quantities m and d are related by the equation

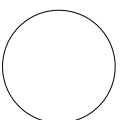
$$\frac{m}{d} = -\frac{A}{d} + B$$

where A and B are constants.

Use your answers in (a) and (e)(iii) to determine the least value of m that would be needed to completely submerge the beaker.
Give an appropriate unit.

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$m = \dots\dots\dots$ [2]



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Please turn over for Question 2.

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- 2** In this experiment you will investigate how the rate of heat energy transferred from a resistor depends on the voltage across it.

- (a)** **(i)** Pour water into the measuring cylinder to the 50 ml mark.
- (ii)** Pour the water from the measuring cylinder into the empty beaker. Determine and record the mass m of water in the beaker. (1 ml of water has a mass of 1 g.)

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

- (iii)** Estimate the percentage uncertainty in m .

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

- (b)** **(i)** Set up the circuit shown in Fig. 2.1.

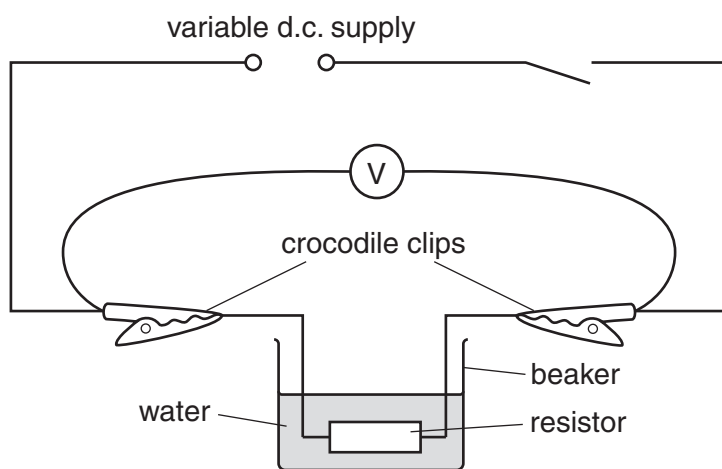


Fig. 2.1

- (ii)** Adjust the output of the power supply to approximately 4 V.
- (iii)** Close the switch. Measure and record the voltmeter reading V . Open the switch.

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

- (c) Measure and record the temperature θ_1 of the water in the beaker.

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$$\theta_1 = \dots\dots\dots [1]$$

- (d) (i) Close the switch and start the stopwatch.

- (ii) After four minutes, measure and record the temperature θ_2 of the water.

$$\theta_2 = \dots\dots\dots [1]$$

- (iii) Calculate and record the temperature rise ($\theta_2 - \theta_1$).

$$(\theta_2 - \theta_1) = \dots\dots\dots [1]$$

- (e) Repeat (b)(iii) for an output voltage in the range 7V–9V.

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

- (f) Repeat (c) and (d) for this new output voltage.

$$\theta_1 = \dots\dots\dots$$

$$\theta_2 = \dots\dots\dots$$

$$(\theta_2 - \theta_1) = \dots\dots\dots$$

[2]

- (g) It is suggested that the relationship between V , θ_1 and θ_2 is

$$V^2 = k(\theta_2 - \theta_1)$$

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 support the suggested relationship.

.....

 [1]

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

For
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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.

1.

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PHYSICS

9702/36

Advanced Practical Skills 2

October/November 2011

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 a soft 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.

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 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.

You are reminded of the need for good English and clear presentation in your answers.

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

The number of marks is given in brackets [] after each question or part question.

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1

2

Total

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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 mass and pulley system.

(a) The apparatus has been set up in an arrangement similar to that shown in Fig. 1.1.

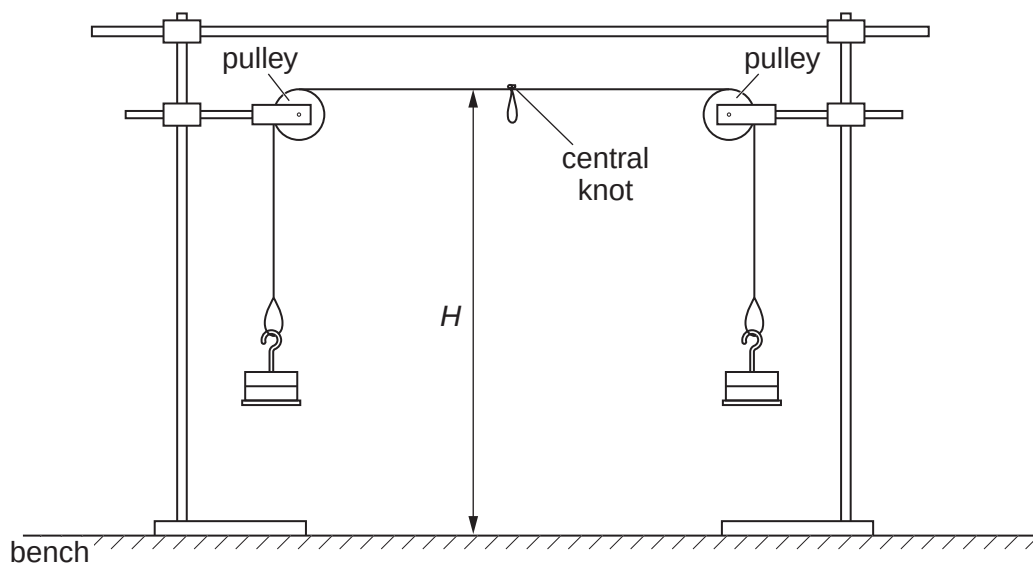


Fig. 1.1

(b) Measure and record the height H of the central knot above the bench.

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

(c) (i) Suspend the mass hanger from the central loop as shown in Fig. 1.2.

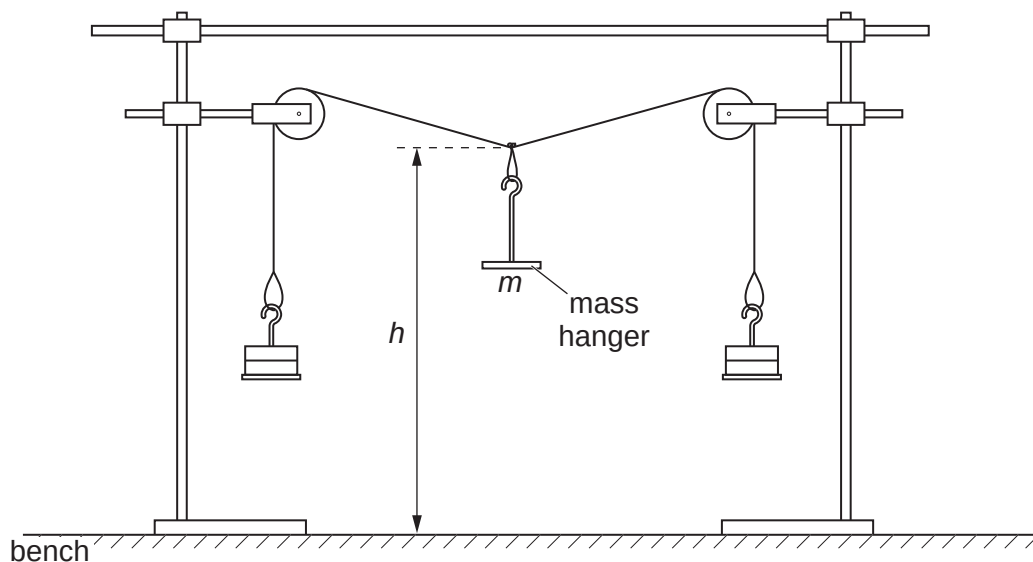


Fig. 1.2

(ii) Record the central suspended mass m .

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

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- (iii) Measure and record the height h of the central knot above the bench, as shown in Fig. 1.2.

$h = \dots\dots\dots$ m

- (iv) Calculate the deflection y , where $y = (H - h)$.

$y = \dots\dots\dots$ m

- (d) Change m by adding masses to the hanger suspended from the central loop and repeat (c)(ii), (c)(iii) and (c)(iv) until you have six sets of values for m , h and y .

Include in your table of results values for $\frac{1}{y^2}$ and $\frac{1}{m^2}$.

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[10]

- (e) (i) Plot a graph of $\frac{1}{y^2}$ on the y-axis against $\frac{1}{m^2}$ 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 = $\dots\dots\dots$

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

[2]

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(f) The relationship between y and m is

$$\frac{1}{y^2} = \frac{p}{m^2} - q$$

where p and q are constants.

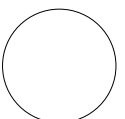
Using your answers from (e)(iii), determine the values of p and q .
Give appropriate units.

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$p =$

$q =$

[2]



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

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2 In this experiment you will investigate the range of a steel ball projectile.

- (a)** You are provided with a length of tube with a wooden block at each end. Mount the tube in clamps, with the tray of sand positioned below its lower end, as shown in Fig. 2.1.

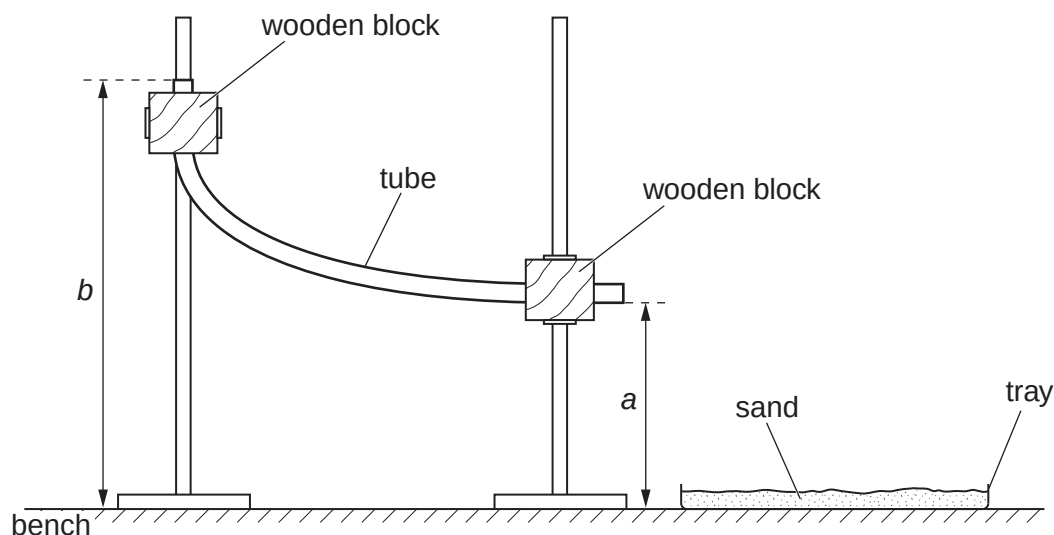


Fig. 2.1

- (b)** (i) Ensure that the lower end of the tube is horizontal and approximately 30 cm above the bench, and that the upper end of the tube is vertical and about 50 cm above the bench.
- (ii) Measure and record the height a above the bench of the lower end of the tube, as shown in Fig. 2.1.

$a =$

- (iii) Measure and record the height b above the bench of the higher end of the tube.

$b =$

[2]

- (c) (i) Drop the steel ball into the top of the tube and note its landing position in the tray of sand. The range R is the horizontal distance of the landing position from the end of the tube, as shown in Fig. 2.2.

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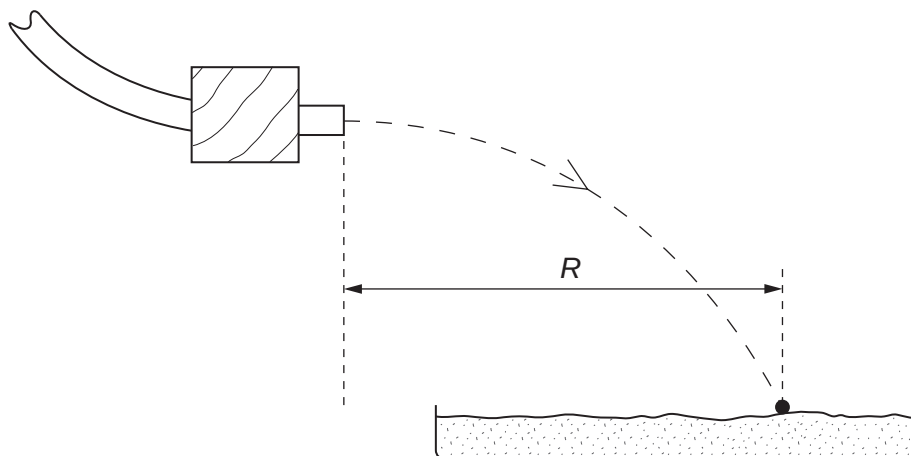


Fig. 2.2

- (ii) Measure and record R .

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

- (d) Estimate the percentage uncertainty in R .

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

- (e) Calculate the horizontal velocity v of the steel ball using the relationship $v = R \sqrt{\frac{g}{2a}}$, where $g = 9.81 \text{ ms}^{-2}$.

$v = \dots\dots\dots$ [1]

- (f) (i) Adjust the height of the upper end of the tube to about 30 cm above the bench, and adjust the height of the lower end to about 20 cm above the bench. Ensure that the lower end of the tube is horizontal.

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

$a =$

$b =$

[1]

$R =$ m [2]

$v =$ [1]

- (g) (i) It is suggested that the relationship between v , b and a is

$$v^2 = k(b - a)$$

where k is a constant.

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.

For
Examiner's
Use

1.

.....

2.

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3.

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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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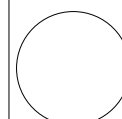
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