

**Cambridge Assessment**  
**International Examinations**



# **PHYSICS**

**ATP (2017)**  
**SOLVED**

Mega Lecture

By  
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**Cambridge International Examinations**  
Cambridge Ordinary Level

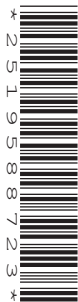
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**PHYSICS**

**5054/41**

Paper 4 Alternative to Practical

**May/June 2017**

**1 hour**

Candidates answer on the Question Paper.

No Additional Materials are required.

**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 **all** questions.

Electronic calculators may be used.

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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.

This document consists of **8** printed pages.

- 1 A strip of paper is attached to a small toy car. As the toy car moves, it pulls the strip of paper through a timer. The timer marks a dot on the paper every 0.020 s.

Fig. 1.1 shows a section of the paper strip with the first four dots marked. The first of these dots to be marked on the paper is labelled A.



Fig. 1.1 (full scale)

- (a) (i) Tick the box that describes the motion of the car.

<input type="checkbox"/>	acceleration
<input type="checkbox"/>	constant speed
<input checked="" type="checkbox"/>	deceleration

- (ii) Explain your answer.

*The distance between the dots is decreasing in equal intervals of time showing that the speed of car is decreasing.*

[2]

- (b) The distance of each dot from A is  $d$ . Dot A was marked on the strip at time  $t = 1.000$  s.

Take measurements from Fig. 1.1 and, in the space below, draw a table of results for  $d$  against  $t$ .

$time/s$	$distance/m$
1.000	0.0
1.020	6.0
1.040	10.0
1.060	12.0

[4]

- (c) Use your data to calculate the average speed of the car between  $t = 1.000$  s and  $t = 1.060$  s.

Use the equation

$$\begin{aligned} \text{average speed} &= \frac{\text{distance travelled}}{\text{time taken}} \\ &= \frac{12.0 - 0.0}{1.060 - 1.000} \\ &= \frac{12}{0.060} = 200 \end{aligned}$$

average speed = 200 cm / s [1]

- 2 A student investigates the flow of water through a hole in the bottom of a straight-sided plastic bottle. A small circular hole is drilled in the bottom of the bottle. A scale is drawn on the side of the bottle, as shown in Fig. 2.1. The bottle is held in a clamp and placed above a sink.

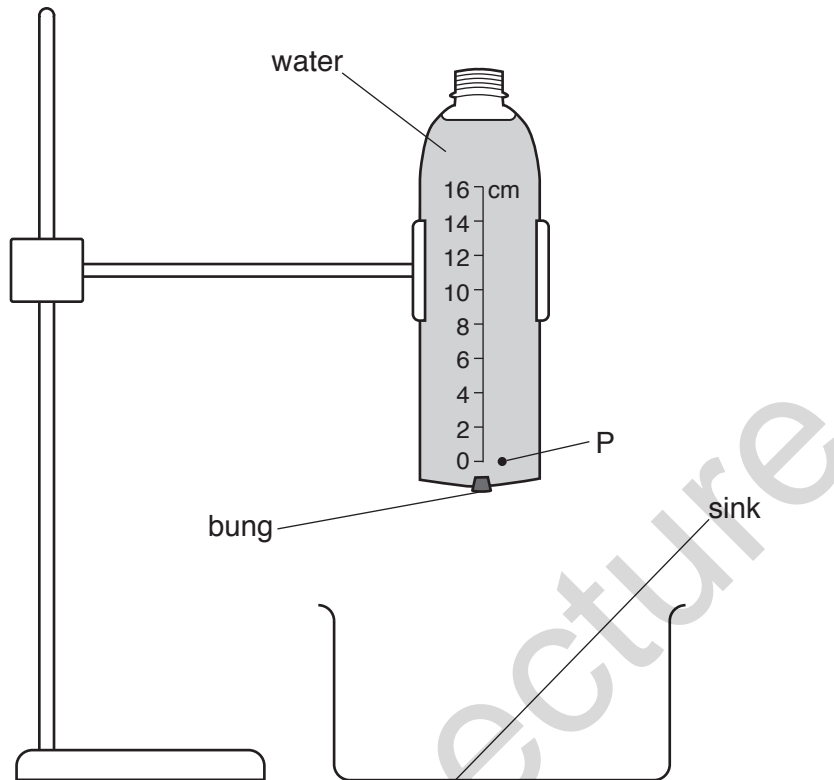


Fig. 2.1 (not to scale)

The student fills the bottle with water and removes the bung at the bottom. He starts his stopwatch when the water level passes one of the marks on the scale and stops it when the water level reaches P, a point which is a few centimetres above the base of the bottle. The water level falls a distance  $h$ .

- (a) The time  $t$  for the water level to fall a distance  $h$  is measured three times.

When  $h = 14.0\text{ cm}$ , the times measured in seconds are:

35.4      35.6      35.3

Calculate the average time  $t_{\text{av}}$ .

$$t_{\text{av}} = \frac{35.4 + 35.6 + 35.3}{3}$$
$$= \frac{106.3}{3} = 35.4$$

$t_{\text{av}} = \dots 35.4 \text{ s} \dots [1]$

(b) The experiment is repeated for a range of values of  $h$ . The results are shown in Fig. 2.2.

$h/\text{cm}$	$t_{\text{av}}/\text{s}$
2.0	6.5
4.0	12.5
6.0	18.4
8.0	23.1
10.0	27.1
12.0	32.1
14.0	35.4

Fig. 2.2

On Fig. 2.2, add your value for  $t_{\text{av}}$  from (a).

On Fig. 2.3, plot a graph of  $t_{\text{av}}/\text{s}$  on the  $y$ -axis against  $h/\text{cm}$  on the  $x$ -axis. Start both axes from the origin. Draw the smooth curve of best fit.

(c) The diameter  $d$  of the bottle is 10.0 cm. The average flow rate  $R$  of water is given by the equation

$$R = \frac{\pi d^2 h}{4 t_{\text{av}}}$$

Use your answer to (a) to find the average flow rate for  $h = 14.0$  cm. Give your answer to two significant figures.

$$R = \frac{\pi (10)^2 (14)}{4 (35.4)}$$

$$= 31.06$$

$$R = \dots 31 \dots \text{cm}^3/\text{s} \quad [2]$$

(d) The student increases the diameter of the hole in the bottle and repeats the experiment.

On Fig. 2.3, draw a possible second curve to represent the results you expect from this larger hole. Label this line S. [1]

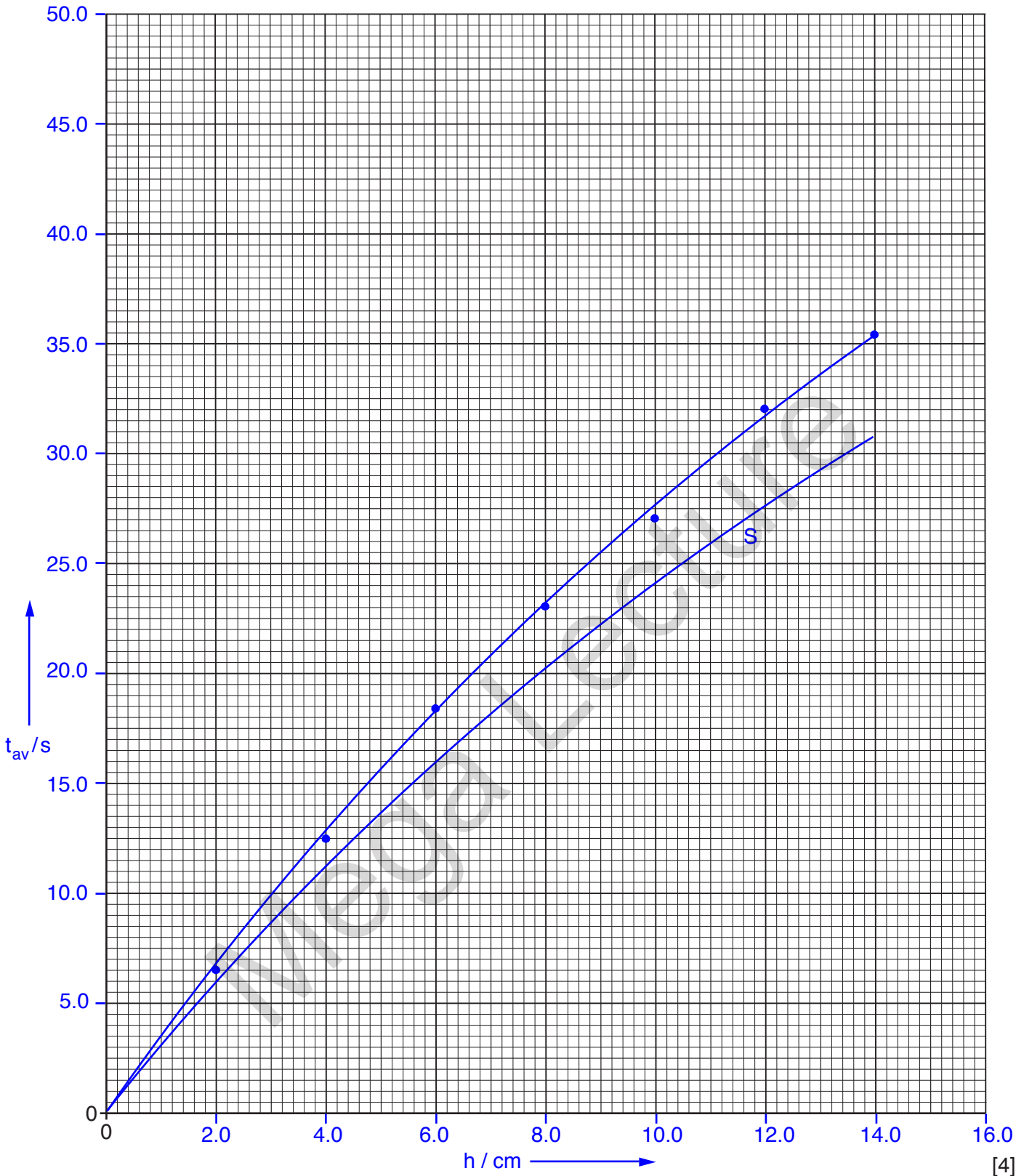


Fig. 2.3

(e) Suggest why the student did not measure the time taken for the bottle to empty completely.

*For the last few centimeters, the water starts dripping off instead of flowing smoothly so it was difficult for him to record the exact time when the bottle emptied completely.*

[1]

- 3 The lines AB and CD, as shown in Fig. 3.1, represent mirrors. A student traces a ray of light that reflects off both the mirrors.

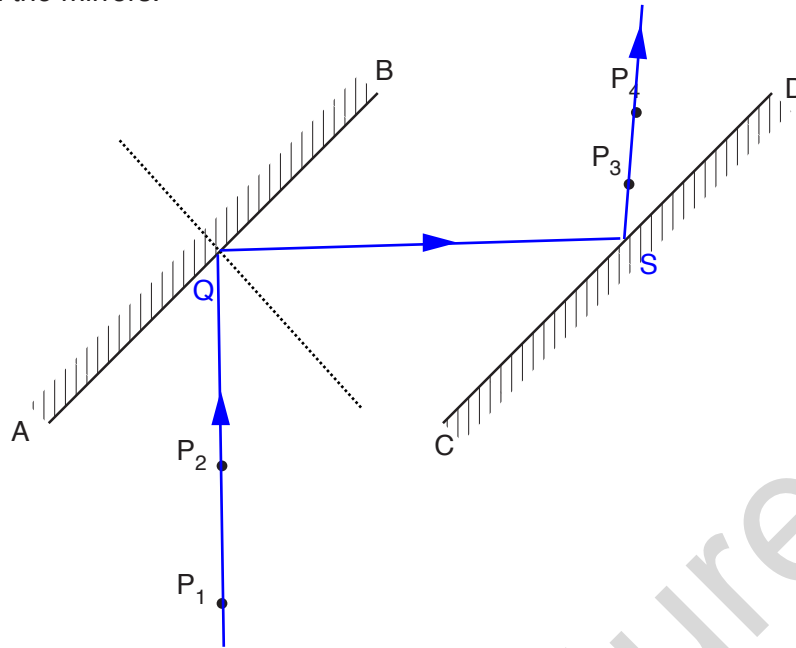


Fig. 3.1

The student places two optics pins  $P_1$  and  $P_2$  on the ray that is incident on the mirror AB. The student places two other optics pins  $P_3$  and  $P_4$  on the ray after reflection by the mirror CD.

- (a) (i) On Fig. 3.1, using the positions of pins  $P_1$ ,  $P_2$ ,  $P_3$  and  $P_4$ , draw lines to show the path of the ray through the mirror system. [1]

- (ii) Describe the steps that you took to draw these lines.

*With the help of a ruler, I drew a line joining the points  $P_1$  and  $P_2$  and extended it to point Q on mirror AB. I drew another line through  $P_3$  and  $P_4$  and extended to point S on mirror CD. Finally I joined the points Q and S.* [2]

- (iii) State a precaution that you took to ensure that the lines are drawn accurately.

*I drew a thin line with the help of a sharp pencil.* [1]

(b) The ray meets mirror AB at Q.

On Fig. 3.1,

(i) label Q,

(ii) draw the normal at Q,

(iii) measure the angle of incidence  $i$  at Q,

$$i = \dots 44^\circ \dots$$

(iv) measure the angle of reflection  $r$  at Q.

$$r = \dots 47^\circ \dots$$

[3]

(c) Explain how the student could improve the positions of  $P_3$  and  $P_4$  to achieve a more accurate value for the angle  $r$ .

*He should increase the distance between  $P_3$  and  $P_4$ .*

[1]

Mega Lecture

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4 A student determines the resistance  $R$  of a resistor. Fig. 4.1 shows the circuit used.

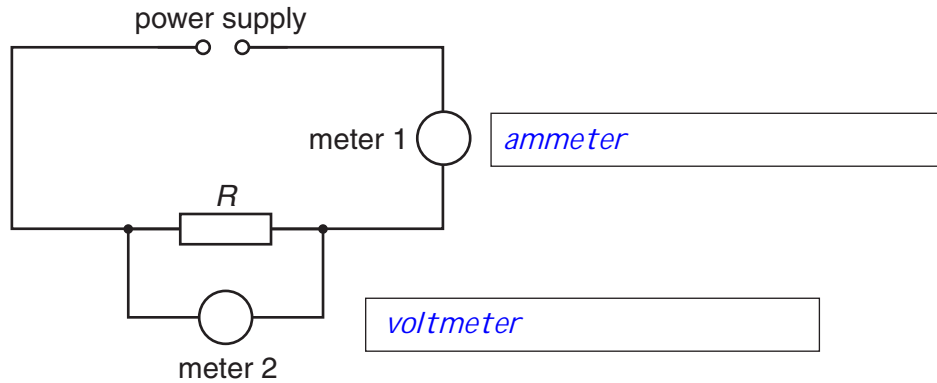


Fig. 4.1

(a) He uses two meters. In the boxes above, write the names of the meters. [1]

(b) State the quantities that are measured by these meters.

meter 1 measures *electric current*.....

meter 2 measures *potential difference*..... [1]

(c) Fig. 4.2 shows the readings on the meters.

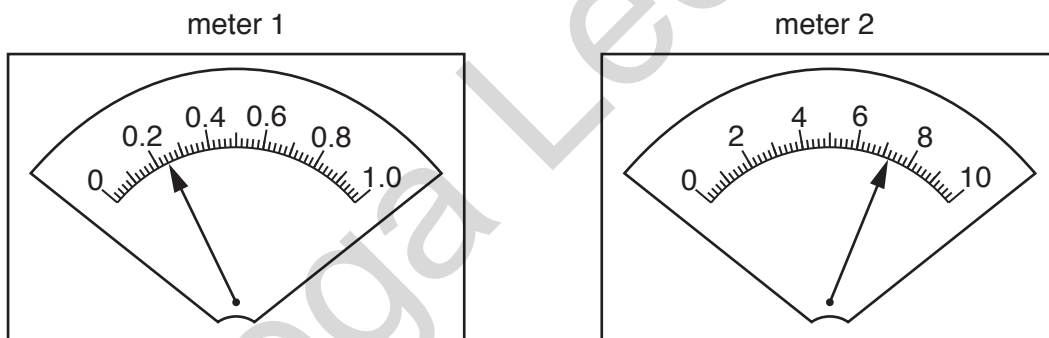


Fig. 4.2

Record the readings below.

meter 1 *0.24 A*.....

meter 2 *7.2 V*..... [2]

(d) Use your readings to find the value of the resistance  $R$  using the equation

$$R = \frac{V}{I}$$

$$= \frac{0.24}{7.2}$$

$R =$  *30  $\Omega$* ..... [1]

(e) Describe a precaution the student should take to ensure that the value for  $R$  is accurate.

*He should place his eyes at correct position while taking reading in order to avoid parallax error.*..... [1]

Cambridge  
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Cambridge Ordinary Level

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- 1 A student measures the acceleration of free-fall  $g$ . He drops a metal ball from a height of 1.000 m onto the floor, and measures the time  $t$  it takes to hit the floor.

Fig. 1.1 shows the ball and a metre rule, held vertically in a clamp.

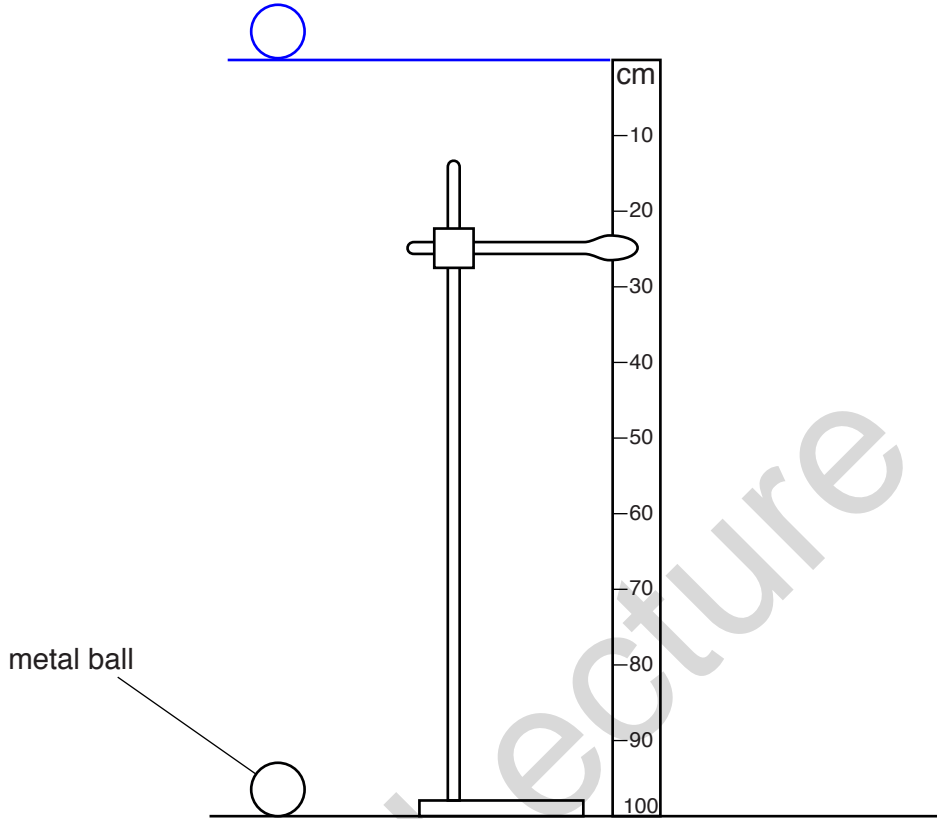


Fig. 1.1

- (a) On Fig. 1.1, draw the position of the ball at its point of release. [1]

- (b) He repeats the experiment and obtains the following five values of  $t$ , measured in seconds.

0.65      0.60      0.68      0.59      0.61

- (i) Calculate  $t_{av}$ , the average value for  $t$ . Give your answer to two decimal places.

$t_{av} = 0.63 \text{ s}$ .....[2]

- (ii) Suggest why the value for  $t_{av}$  is not given to more than two decimal places.

*The experimental values of  $t$  also contain two decimal places.*  
 .....[1]

(c) The acceleration due to free-fall  $g$  is given by the equation

$$g = \frac{2h}{t_{av}^2},$$

where  $h = 1.000$  m.

(i) Calculate a value for  $g$ .

$$g = \frac{2 (1.000)}{(0.63)^2}$$
$$= 5.04$$

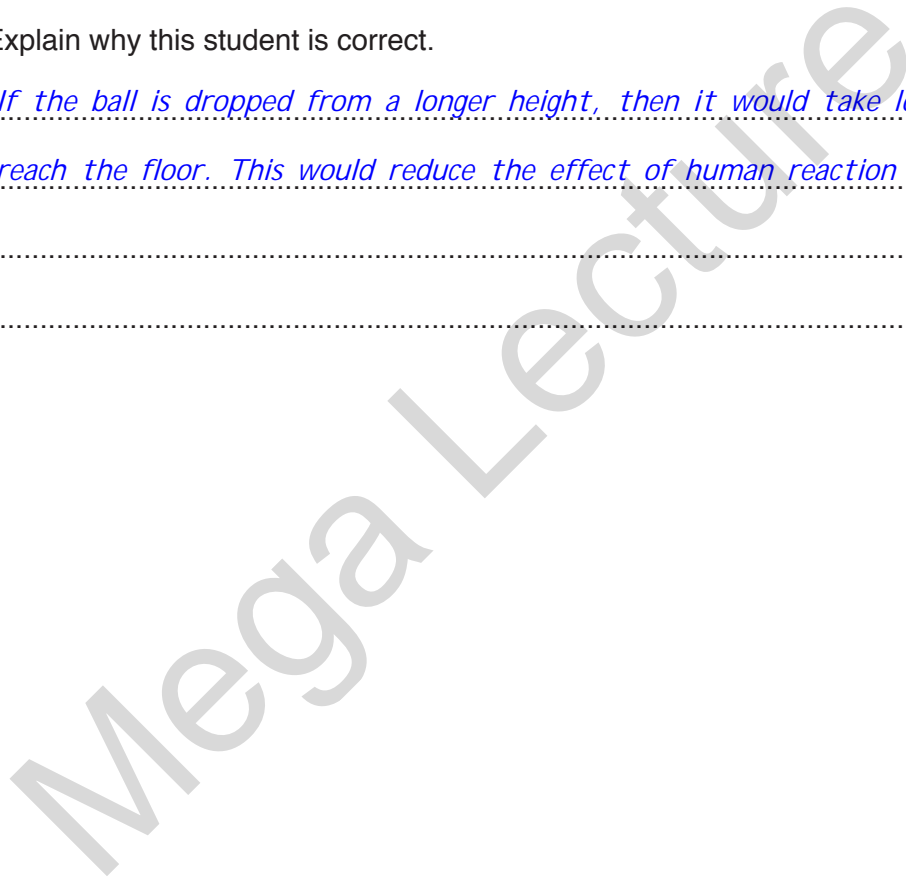
$$g = \dots 5.04 \dots \text{ m/s}^2 \text{ [1]}$$

(ii) Another student suggests that, to obtain a better value for  $g$ , the ball should be dropped from a height greater than 1.000 m.

Explain why this student is correct.

*If the ball is dropped from a longer height, then it would take longer time to reach the floor. This would reduce the effect of human reaction error.*

.....  
..... [2]



- 2 A student investigates a series circuit containing two non-identical lamps P and Q. Both lamps need a working voltage of 2.5 V to be at full brightness.

She sets up the circuit shown in Fig. 2.1.

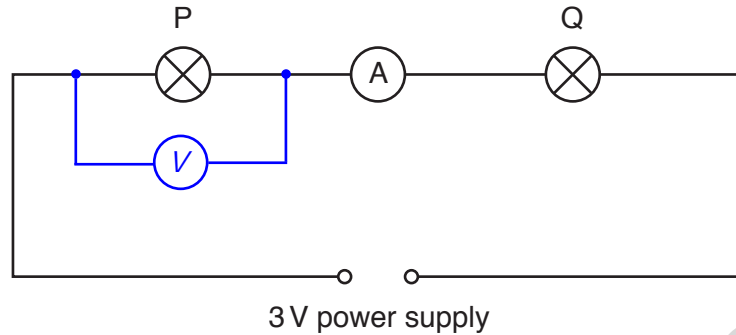


Fig. 2.1

The student adds a voltmeter to the circuit to measure the potential difference (p.d.) across lamp P.

- (a) (i) On Fig. 2.1, draw the symbol for a voltmeter to show where it is connected. [1]  
(ii) Fig. 2.2 shows the reading on the voltmeter.

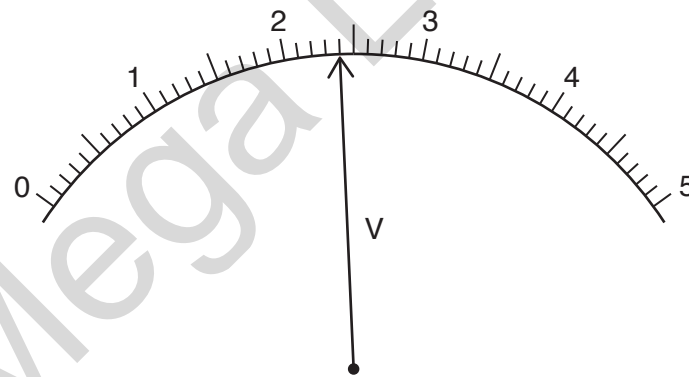


Fig. 2.2

State the voltmeter reading  $V_P$  shown on Fig. 2.2.

$V_P = \dots 2.4 \dots \dots \dots V$  [1]

(b) She measures the p.d. across lamp Q and records the value in Fig. 2.3, together with the brightness of the lamps.

lamp	potential difference / V	brightness
P	2.4	bright
Q	0.6	not lit

Fig. 2.3

- (i) Add your result from (a)(ii) to the table in Fig. 2.3.
- (ii) Fig. 2.4 shows the reading on the ammeter in the circuit of Fig. 2.1.

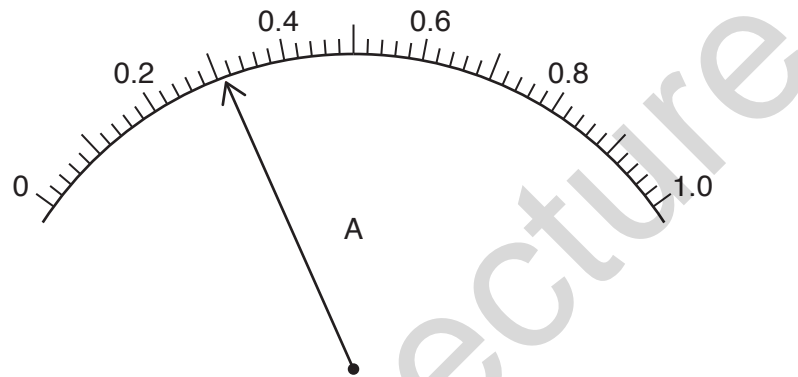


Fig. 2.4

State the ammeter reading  $I$  shown on Fig. 2.4.

$I = 0.31 \dots \dots \dots$  A [1]

(iii) The student states that, because lamp Q is not lit, its filament is broken. Explain how the results show that this statement is incorrect.

*Lamp Q is in series with the lamp P. Since lamp P is working, so there must also be a current through lamp Q.* [1]

(iv) Suggest one reason why lamp Q does not glow.

*The p.d across lamp Q is too small (0.6 V) to make it glow.* [1]

- 3 A student investigates the effect of three different insulating materials on the cooling of hot water in a beaker.

The following apparatus is available:

- thermometer
- stopwatch
- 250 cm<sup>3</sup> glass beaker
- 250 cm<sup>3</sup> measuring cylinder
- cardboard
- cotton wool
- cloth
- boss, clamp and stand

A supply of hot water is also available.

Write a plan for the experiment.

You should:

- (a) explain how to carry out the experiment; a diagram is not required, but you may draw one if it helps to explain your plan,

*With the help of a measuring cylinder, put a fixed quantity of hot water in a beaker already covered with an insulating material such as cotton. Clamp a thermometer on stand in such a way that its bulb is dipped in hot water. Now put an insulating material carefully in the beaker. Cover the top of beaker with a cardboard in order to prevent heat loss. Note down the initial temperature reading. Now using a stop watch take final temperature reading for a fixed time interval. Repeat the experiment with other insulating materials.*.....[2]

(b) state any quantities that need to be kept constant,

*amount of hot water for each experiment should be the same*

*hot water should have same initial temperature*

*the time for cooling of hot water should be the same*

[1]

(c) draw a table, with headings, to show how to display the results,

<i>insulating material</i>	<i>temperature drop / °C</i>
<i>A</i>	
<i>B</i>	
<i>C</i>	

[1]

(d) explain how the readings can be used to reach a conclusion.

*A conclusion can be reached by comparing the temperature drops in equal intervals*

*of time. The material with the largest temperature drop will be the best conductor.*

[1]



- 4 An object is moved between a lamp and a screen. A student investigates how the height of the shadow cast by the object on the screen changes.

The apparatus is shown in Fig. 4.1.

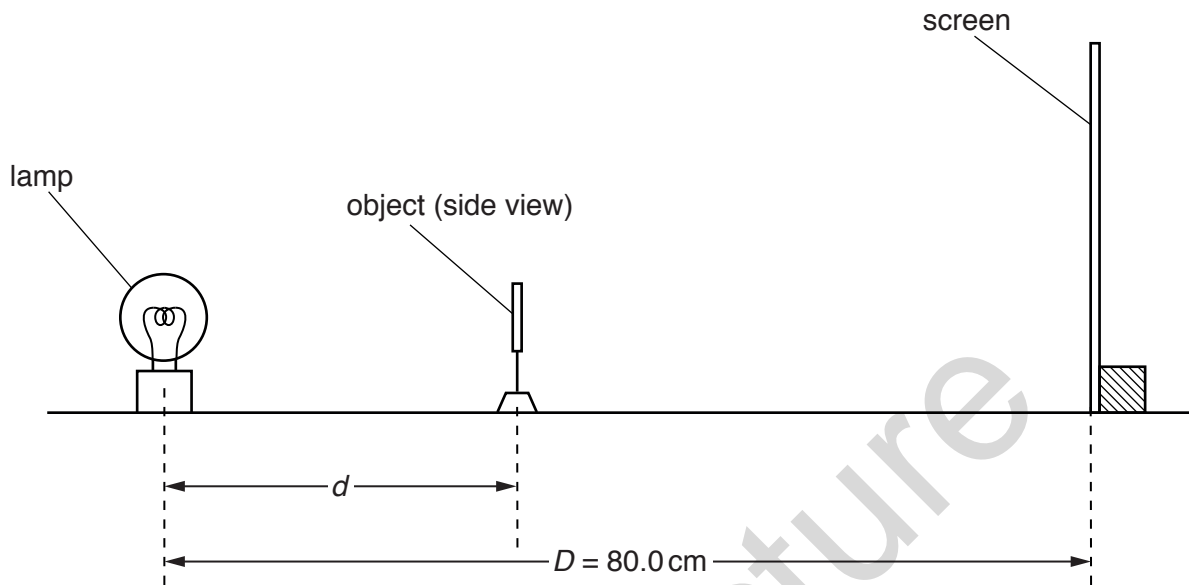


Fig. 4.1 (not to scale)

The object is a square sheet of white card. The length of each side is  $H$ . The object is attached to a pin and supported by a cork, as shown in Fig. 4.2.

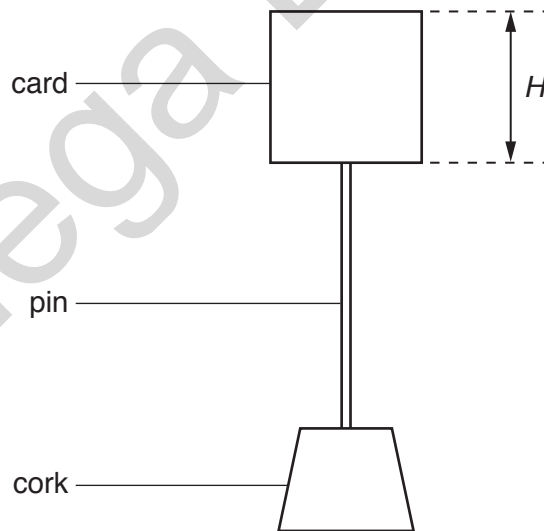


Fig. 4.2 (full size)

- (a) Measure and record the length  $H$  as shown in Fig. 4.2.

$H = 2.0 \dots\dots\dots$  cm [1]

(b) The screen is placed at a distance  $D = 80.0$  cm from the centre of the lamp.

She places the object at a distance  $d = 70.0$  cm from the centre of the lamp and observes the shadow made by the object on the screen. The shadow is shown in Fig. 4.3.

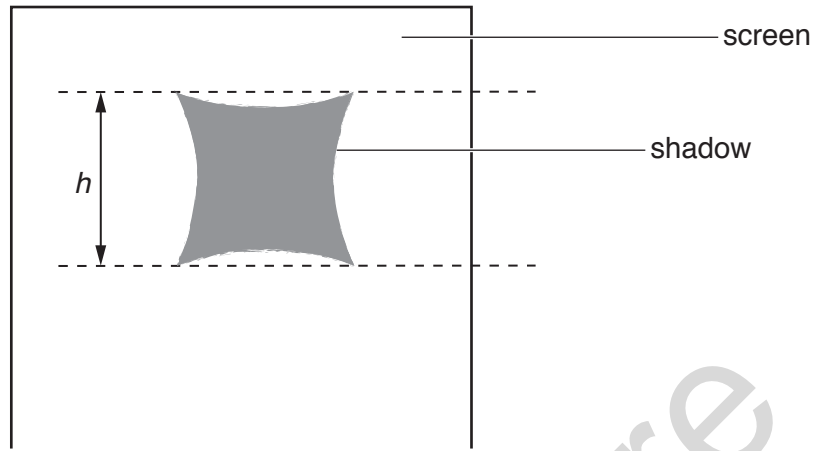


Fig. 4.3 (full size)

(i) Measure and record the length  $h$  of the shadow shown in Fig. 4.3.

$h = 2.3$  ..... cm [1]

(ii) Suggest why it would be difficult to measure accurately the length of the shadow.

*The shadow has not distinct edges so it would be difficult to measure its length accurately.* ..... [1]

- (c) She repeats the procedure for values of  $d$  of 60.0 cm, 55.0 cm, 45.0 cm, 30.0 cm and 25.0 cm. Her results are recorded in the table of Fig. 4.4.

$d/\text{cm}$	$h/\text{cm}$
70.0	2.3
60.0	2.7
55.0	2.9
45.0	3.6
30.0	5.3
25.0	6.4

Fig. 4.4

- (i) Add your value of  $h$  from (b)(i) to the table in Fig. 4.4.
- (ii) On Fig. 4.5, plot a graph of  $h/\text{cm}$  on the  $y$ -axis against  $d/\text{cm}$  on the  $x$ -axis. Start both axes from the origin. Draw the smooth curve of best fit.

Question 4 continues on page 12.

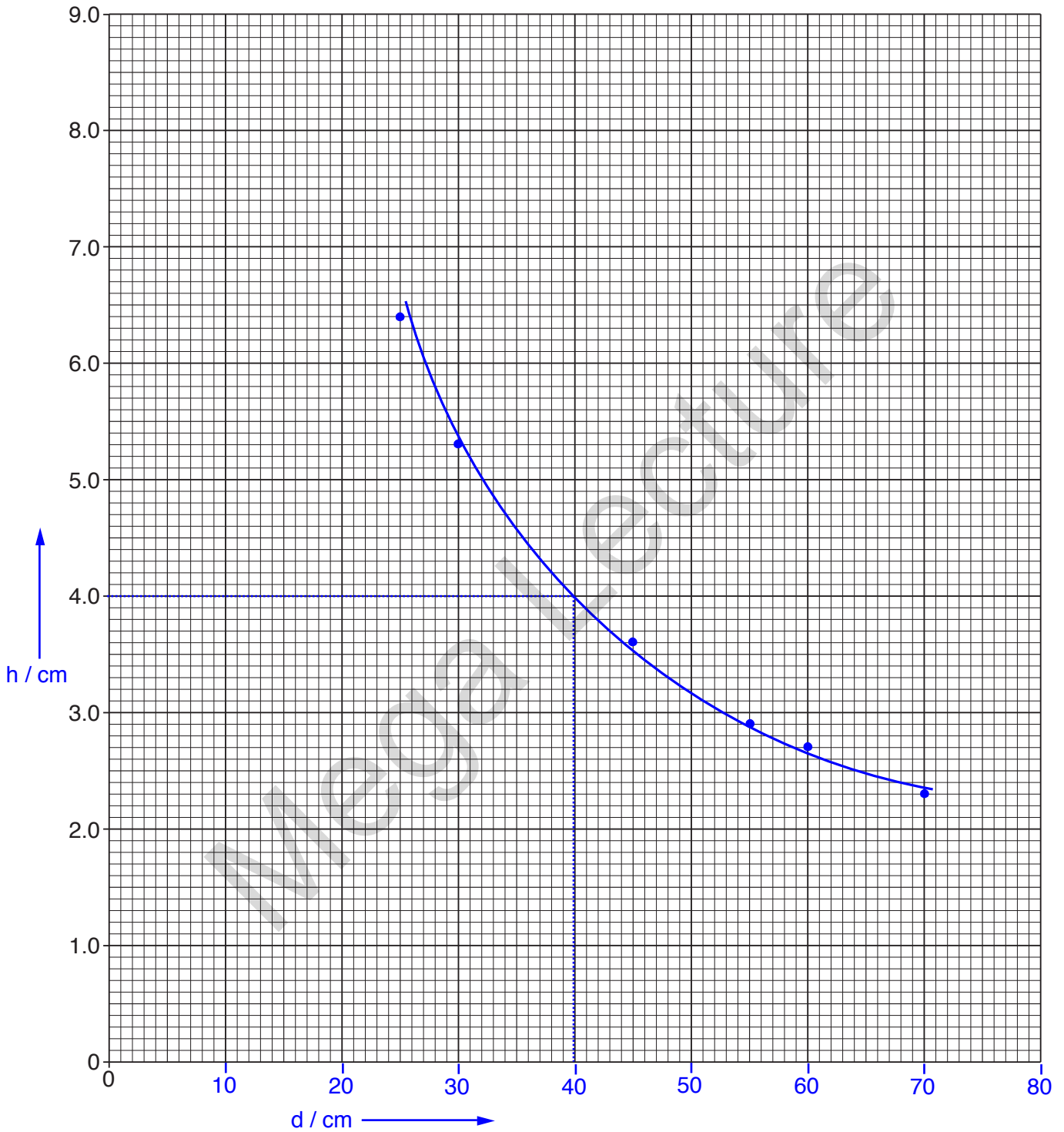


Fig. 4.5

[4]

- (d) (i) Use your graph to find  $h_{40}$ , the value of  $h$  when the object is 40.0 cm from the centre of the lamp.

$$h_{40} = \dots 4.0 \dots \text{ cm [1]}$$

- (ii) The student suggests that the value of  $h_{40}$ , is related to the length  $H$  of the object by the equation

$$h_{40} = 2H.$$

Calculate the length  $H$  of the object using this equation.

$$H = \dots 2.0 \dots \text{ cm [1]}$$

- (iii) Compare the value for  $H$  calculated in (d)(ii) with the value that you measured in (a).

State whether your results support the student's suggestion and justify your answer by reference to the results.

statement *Yes, my results support the student's suggestion.*

justification *The height of the shadow gets doubled when the object is placed midway between lamp and screen.*

[1]

- (e) (i) Extend your graph to predict the length  $h_{20}$  of the shadow when  $d = 20.0$  cm.

$$h_{20} = \dots 8 \dots \text{ cm [1]}$$

- (ii) The student suggests that the distance  $d$  should not be less than 10.0 cm. Give **one** reason why this is a sensible suggestion.

*The size of the shadow becomes too large to fit on the screen.*

[1]

- (f)  $D$  was kept constant throughout the investigation. Suggest why.

*$D$  was kept constant in order to make it a fair test.*

[1]

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- 1 A student finds the mass of a table-tennis ball using a top-pan balance, as shown in Fig. 1.1. The top-pan balance reads to the nearest gram.

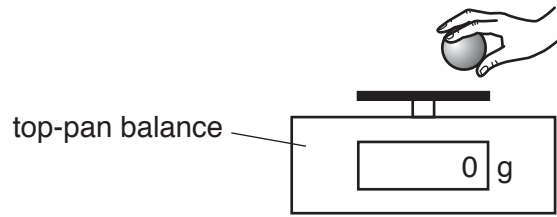


Fig. 1.1

- (a) The mass of the ball is about 2.5 g.

Suggest a reason why placing the ball on the top-pan balance does not give an accurate value for the mass of the ball.

*The ball will roll about because of the flat surface of the top-pan balance.*

.....[1]

- (b) The student uses ten identical balls and a glass beaker to hold them, as shown in Fig. 1.2.

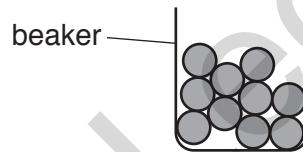


Fig. 1.2

Explain in detail how the student can obtain a more accurate value for the mass of one ball.

*He can first find the mass ( $m_1$ ) of an empty beaker using top-pan balance. Next he can put the ten balls in the beaker, and find the total mass ( $m_2$ ) of the balls and beaker. Now he can find the mass of one ball using the formula given as follows:*

$$\text{mass of one ball} = \frac{m_2 - m_1}{10}$$

.....[3]

- 2 A student investigates how high a table-tennis ball bounces. He drops the ball from a height of 60 cm onto a tiled floor, as shown in Fig. 2.1. He records the height  $h$  of the bounce using a metre rule with millimetre divisions.

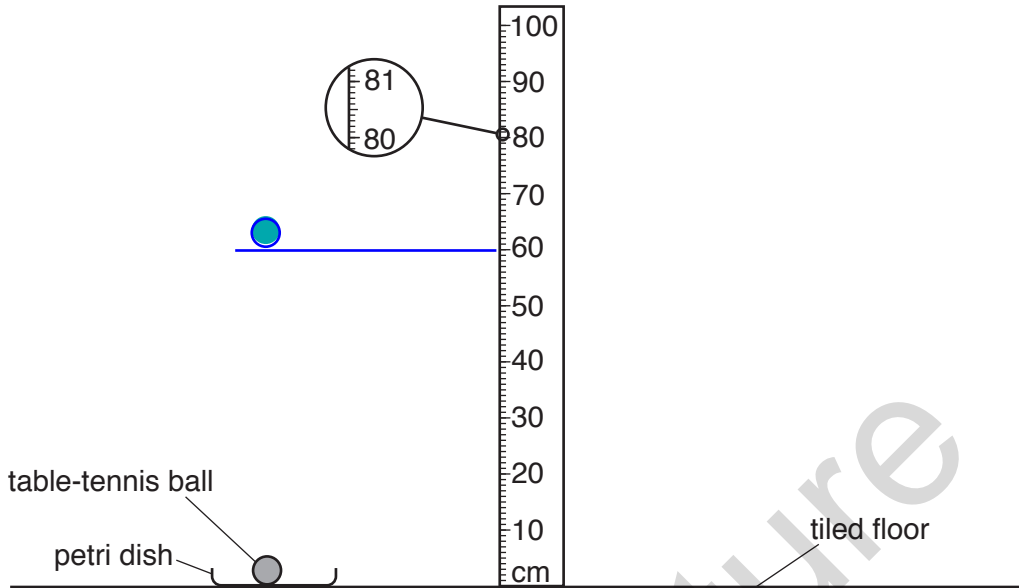


Fig. 2.1

- (a) The ball is placed near the metre rule so that, when released, it falls 60 cm before it hits the floor.

On Fig. 2.1, draw the ball in its starting position. [1]

- (b) Before recording any values for the height of the bounce, the student performs a trial drop.

Suggest a reason for doing this trial drop.

*A trial drop is needed so that the observer can find the approximate position where to place the eye when the ball bounces off the floor.* [1]

- (c) He drops the ball five times from 60 cm and records the following values of  $h$ .

40 cm      39 cm      40 cm      42 cm      40 cm

- (i) Suggest a reason why  $h$  is recorded to the nearest cm.

*$h$  is recorded to the nearest cm because it is not possible to measure the exact height in millimeters merely using eyes.* [1]

- (ii) Calculate the average bounce height  $h_{av}$ . Give your answer to the nearest centimetre.

$$h_{av} = \frac{40 + 39 + 40 + 42 + 40}{5} = 40.2$$

$h_{av} = 40 \text{ cm}$  [2]



- (d) The student extends the investigation to find the average bounce height  $h_{av}$  from other drop heights  $H$ . Fig. 2.2 shows the results obtained.

drop height $H/cm$	bounce height $h_{av}/cm$
60	40
100	56
140	74
180	86
220	94
260	96

Fig. 2.2

- (i) On Fig. 2.2, add your value of  $h_{av}$  at  $H = 60$  cm.  
 (ii) To get the larger values of  $H$ , the student changes his apparatus and method. Suggest how he does this.

*For larger values of  $H$ , the student can use a retractable tape measure. He also needs another person to help him drop the ball.*

.....  
 .....[2]

- (iii) On Fig. 2.3, plot a graph of  $h_{av}/cm$  on the  $y$ -axis against  $H/cm$  on the  $x$ -axis. Start your axes from (0,0). Draw a smooth curve of best fit.

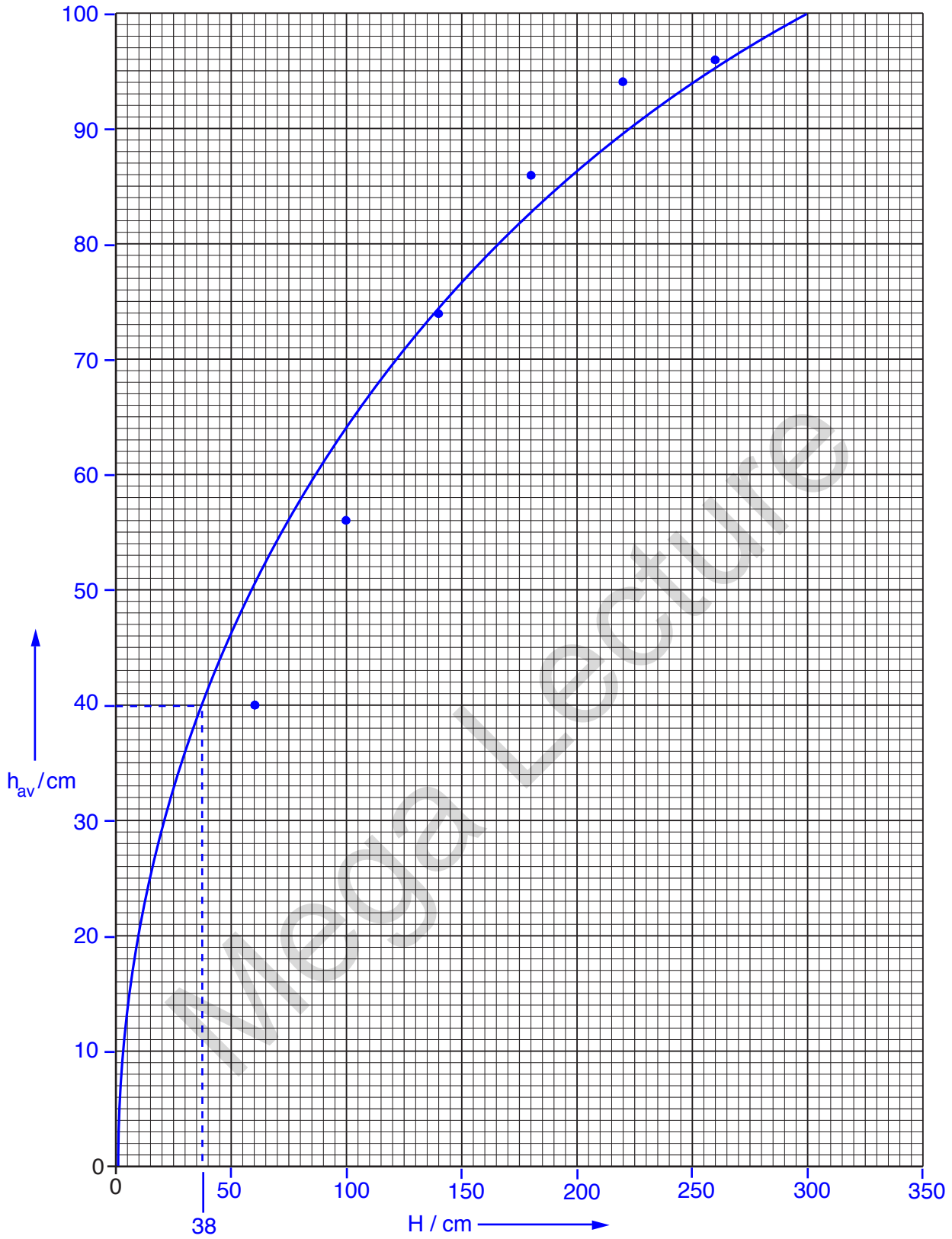
- (e) (i) The student does not take any readings of  $h_{av}$  for  $H$  less than 60 cm. Suggest why these readings are difficult to take.

*These readings are difficult to take as bouncing occurs too close to the floor and the student has to lie down with his head on the floor.*

.....[1]

- (ii) Use your graph to estimate the value of  $h_{av}$  when  $H$  is 40 cm.

$h_{av} = 38 \text{ cm}$ .....[1]



[4]

Fig. 2.3

- 3 Fig. 3.1 shows a thermistor. A thermistor is a type of resistor whose resistance is affected by changes in temperature.

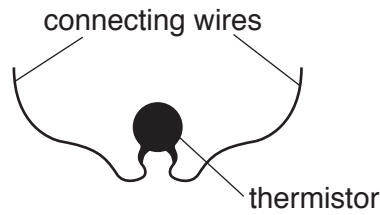


Fig. 3.1

Fig. 3.2 shows a partially completed circuit.

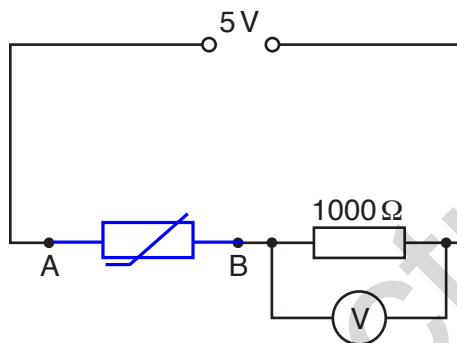


Fig. 3.2

- (a) The thermistor is connected between A and B in the circuit.

On Fig. 3.2, draw the correct circuit symbol for the thermistor between A and B. [1]

- (b) The thermistor is at room temperature and the reading on the voltmeter is shown in Fig. 3.3.

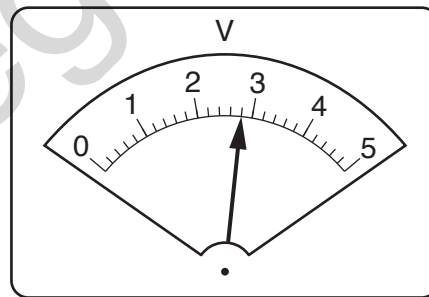


Fig. 3.3

- (i) State the reading  $V$  on the voltmeter.

$V = 2.8 \text{ V}$ .....[1]

- (ii) The student then records the reading on the voltmeter when the thermistor is at a steady temperature of 0 °C.

Suggest how she can reduce the temperature of the thermistor from room temperature to 0 °C in the laboratory.

*She can place the thermistor in a beaker of melting ice.*

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

- (iii) At 0 °C, the reading  $V$  on the voltmeter is 1.8 V.

The resistance  $R$  of the thermistor, measured in ohms, can be found using

$$R = \frac{5000}{V} - 1000.$$

Calculate  $R$  at room temperature and at 0 °C. Give both answers to 2 significant figures.

at room temperature,  $R = 790 \Omega$  .....

at 0 °C,  $R = 1800 \Omega$  .....

[2]

- (iv) Use your results to state how the resistance of the thermistor changes with temperature.

*As temperature decreases, the resistance of thermistor increases.*

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

- 4 In Fig. 4.1, AB represents a converging lens. An object PQ is placed with end Q on the principal axis ST of the lens.

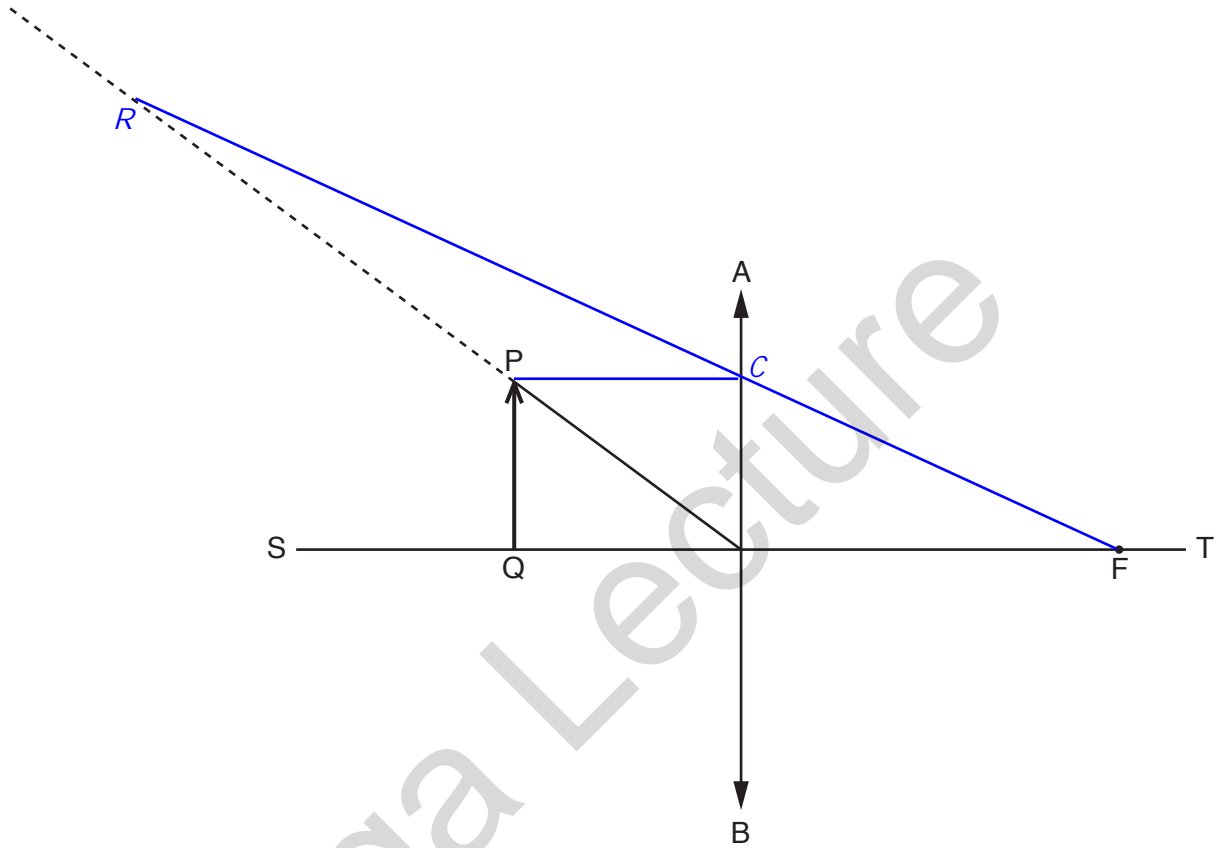


Fig. 4.1 (full scale)

- (a) The point F is a focal point (principal focus) of the lens.

Measure the focal length of the lens.

focal length = 5.0 cm.....[1]

- (b) (i) Draw a line from P, parallel to ST, to meet the lens AB at point C. Label C. [1]

- (ii) Explain how you ensured that this line is parallel to ST.

*Using set squares, measure the length PQ with its other edge along the line ST.  
Now place the set squares, along the lens AB with its other edge along the line  
ST. Mark C on AB at the same distance as measured for PQ. Now join P and C.*[1]

(c) Draw a straight line from F to C and extend this line until it meets the dotted line at point R.

Label R. [1]

(d) Measure the angle  $\theta$  between the lines RC and CP.

$$\theta = \dots 23^\circ \dots [1]$$

(e) Determine the length  $l$  in centimetres where

$$l = \frac{2.2}{\sin \theta}.$$

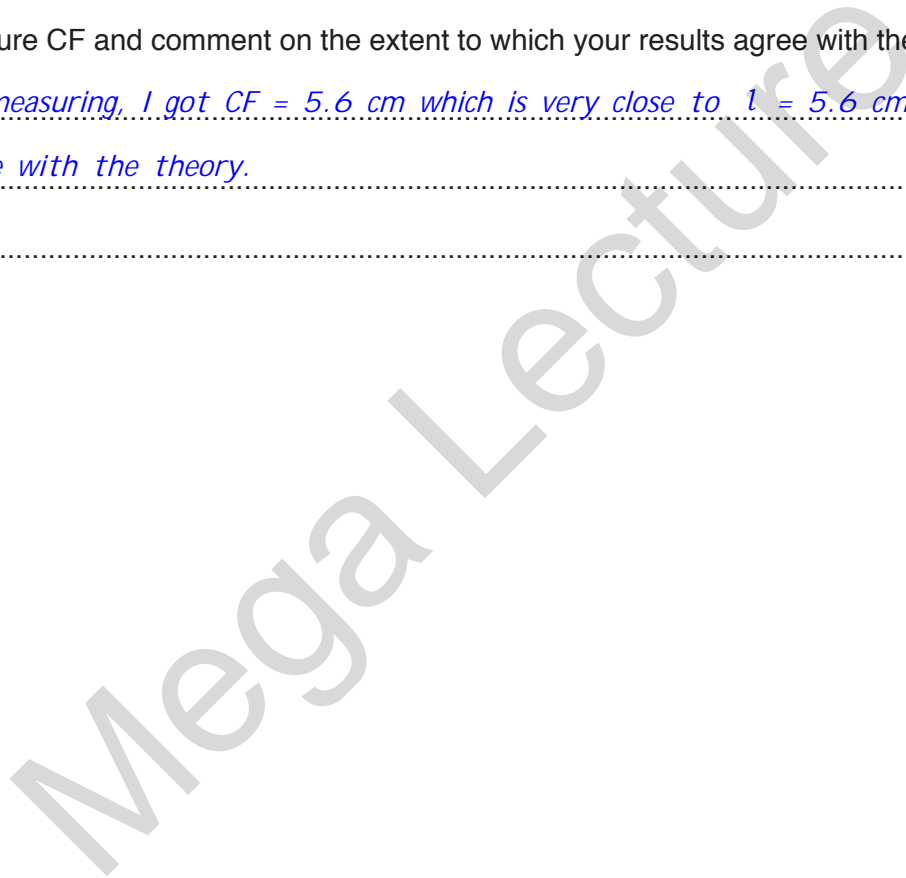
$$l = \dots 5.6 \text{ cm} \dots [1]$$

(f) Theory suggests that  $l$  is equal to the distance CF.

Measure CF and comment on the extent to which your results agree with the theory.

*On measuring, I got CF = 5.6 cm which is very close to  $l = 5.6$  cm. So the results agree with the theory.*

..... [1]



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**PHYSICS**

**5054/42**

Paper 4 Alternative to Practical

**October/November 2017**

**1 hour**

Candidates answer on the Question Paper.

No Additional Materials are required.

**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 **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

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.

This document consists of **12** printed pages and **4** blank pages.

- 1 A student investigates the period of a simple pendulum. The period  $T$  is the time taken for one complete oscillation of the pendulum.

She sets up the pendulum with its point of support a fixed height above the surface of the bench. She **does not change** this height, or the position of the clamp during the investigation.

A scale diagram of her experimental set-up is shown in Fig. 1.1.

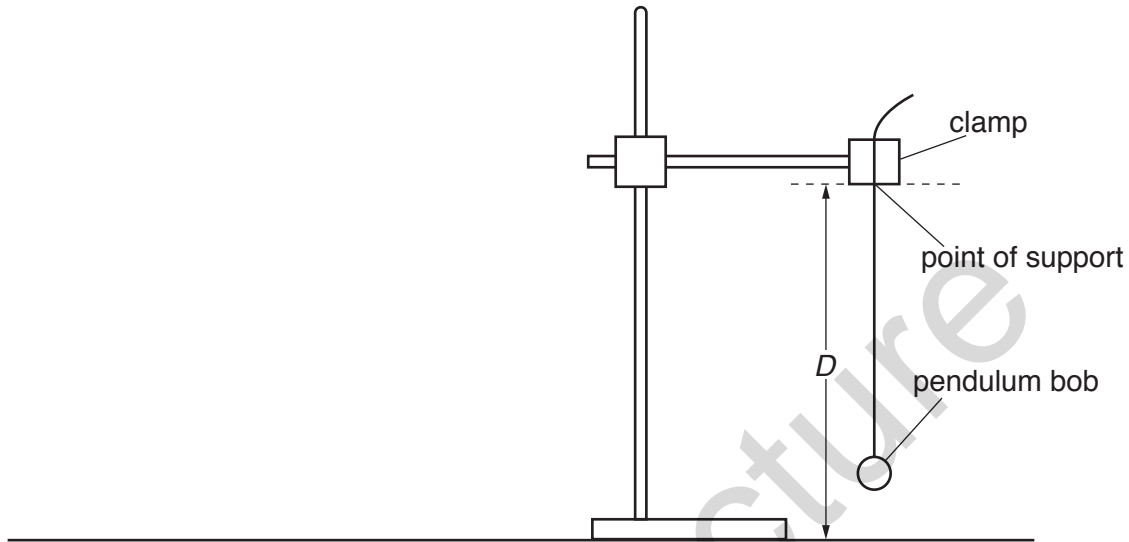


Fig. 1.1

- (a) (i) Measure the distance  $D$  on Fig. 1.1 to the nearest millimetre. Record your result.

$D = 4.7$  ..... cm [1]

- (ii) Fig. 1.1 is drawn to a scale of one-tenth full size.

Write down the actual height  $H$  of the point of support above the bench.

$H = 47$  cm ..... [1]



- (b) She adjusts the length of the thread until the height  $h$  of the centre of the bob above the bench is 15.0 cm. She gives the ball a small sideways displacement and releases it so that it oscillates. She records the time for 20 oscillations in the table in Fig. 1.2.

$h/\text{cm}$	time for 20 oscillations /s	$T/\text{s}$	$T^2/\text{s}^2$
15.0	22.8	1.14	1.30
20.0	20.8	1.04	1.08
25.0	18.8	0.94	0.88
30.0	16.6	0.83	0.69
40.0	10.6	0.53	0.28

Fig. 1.2

She repeats the procedure for heights  $h$  of 20.0 cm, 25.0 cm, 30.0 cm and 40.0 cm.

She uses her results to calculate the period  $T$  for one oscillation and  $T^2$  for each set of readings.

- (i) Complete the table in Fig. 1.2. [1]
- (ii) Explain why measuring the time for 20 oscillations, rather than for 1 oscillation, gives a more accurate value for  $T$ .

*This reduces the effect of error in starting and stopping the stop watch.*.....  
 .....  
 .....[1]

(c) (i) On Fig. 1.3, plot a graph of  $T^2/s^2$  on the  $y$ -axis against  $h/cm$  on the  $x$ -axis.

Start your axes from the origin (0,0). Draw the straight line of best fit.

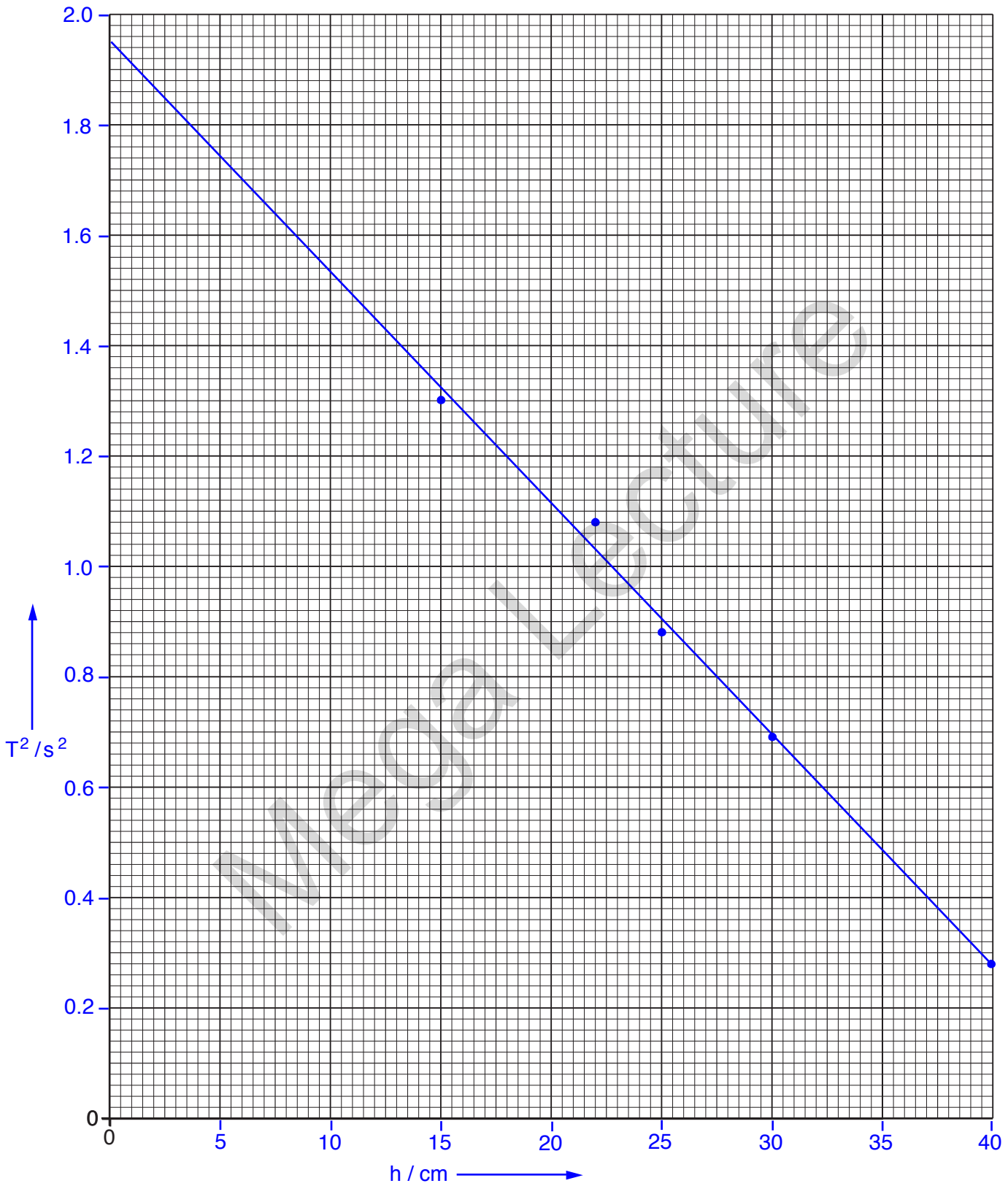


Fig. 1.3

[4]

(ii) Extend your line so that it cuts the  $y$ -axis.

State the value of the intercept  $c$  on the  $y$ -axis.

$$c = 1.95 \dots\dots\dots \text{s}^2 \text{ [1]}$$

(iii) Calculate the gradient  $m$  of your line. Show your working and indicate on your graph the values you use to calculate the gradient.

$$\begin{aligned} m &= \frac{1.95 - 0.28}{0 - 40} \\ &= -0.04175 \end{aligned}$$

$$m = -0.04175 \dots\dots\dots \text{s}^2/\text{cm} \text{ [2]}$$

(d) Theory suggests that  $H$  is given by the equation

$$H = \frac{c}{m}.$$

Use this equation to calculate  $H$ .

$$\begin{aligned} H &= \frac{1.95}{0.04175} \\ &= 46.7 \end{aligned}$$

$$H = 46.7 \dots\dots\dots \text{cm} \text{ [1]}$$

(e) Compare your measured value for  $H$  from (a)(ii) with your result in (d).

State whether the two values agree with each other and justify your answer.

*On comparing, the two values are very close to each other and thus the results are justified.*

.....[1]

2 A student investigates the effect of insulation on the rate of cooling of hot water in a beaker.

He pours  $250\text{ cm}^3$  of hot water into a beaker and places a thermometer in the water, as shown in Fig. 2.1.

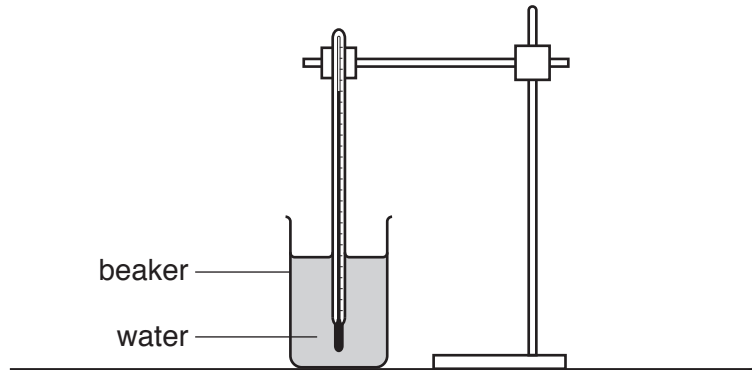


Fig. 2.1

He waits for a short time. He then starts a stopwatch as he records the temperature  $\theta$  of the hot water. This is at time  $t = 0$ .

Fig. 2.2 shows the thermometer at  $t = 0$ .

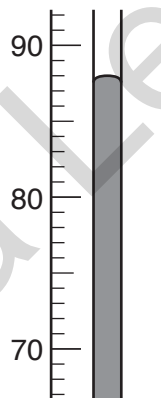


Fig. 2.2

(a) (i) Read the thermometer and record the temperature  $\theta$ .

$\theta = 88^{\circ}\text{C}$ ..... [1]

(ii) Explain why the student waits a short time before recording the temperature of the water at  $t = 0$ .

*The student waits a short time so that the temperature of the thermometer gets equal to the temperature of the hot water.*

.....[1]

(b) The student records the temperature of the water in the beaker after 3.0 minutes.

He then pours 250 cm<sup>3</sup> of hot water into an identical beaker that is insulated with cotton wool, as shown in Fig. 2.3. He repeats the procedure.

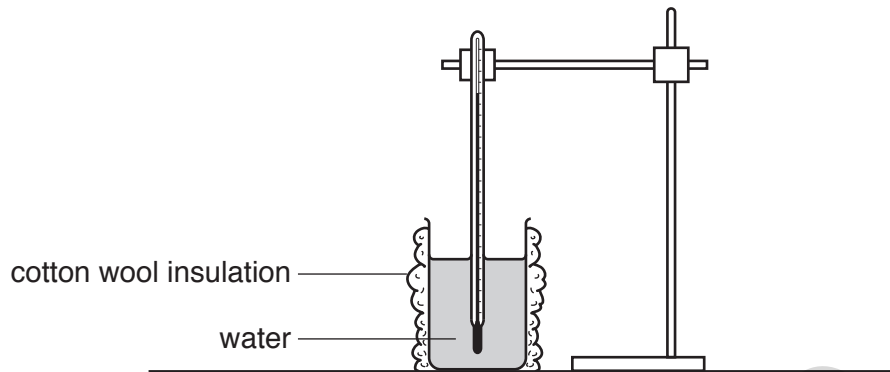


Fig. 2.3

His results are shown in the table in Fig. 2.4.

	without insulation	with insulation
time $t / .s.....$	temperature $\theta / \dots^{\circ}C.....$	temperature $\theta / \dots^{\circ}C....$
0	88	85
180	75	75

Fig. 2.4

- (i) Complete the column headings in the table in Fig. 2.4. [1]
- (ii) Add your value of  $\theta$  in (a)(i) to the table in Fig. 2.4.
- (iii) State whether the insulation has any significant effect on the rate of cooling in the first 3.0 minutes.

Justify your answer by reference to the results.

statement *Yes, the insulation has a significant effect on the rate of cooling in the first 3.0 minutes*

justification *In the absence of insulation the temperature is dropped by 13 °C while in the presence of insulation the temperature is dropped by 10 °C.* [1]

(c) (i) Initially, the main cause of heat loss from the beaker is evaporation.

Suggest how the student can reduce heat loss by evaporation.

*The student can reduce the heat loss by evaporation by covering the beaker  
with a lid.*..... [1]

(ii) State one other modification to the apparatus in Fig. 2.3 that reduces further the loss of heat.

*The bottem of the beaker can also be made insulated using cotton.*  
.....[1]

(d) State one quantity that is kept constant to make a fair comparison between the rate of cooling of the two beakers.

*The volume of hot water should be kept the same.*.....[1]

Mega Lecture

- 3 A student measures the refractive index of the material of a transparent block ABCD by tracing the path of a ray of light through it.

The experiment is set up as shown in Fig. 3.1.

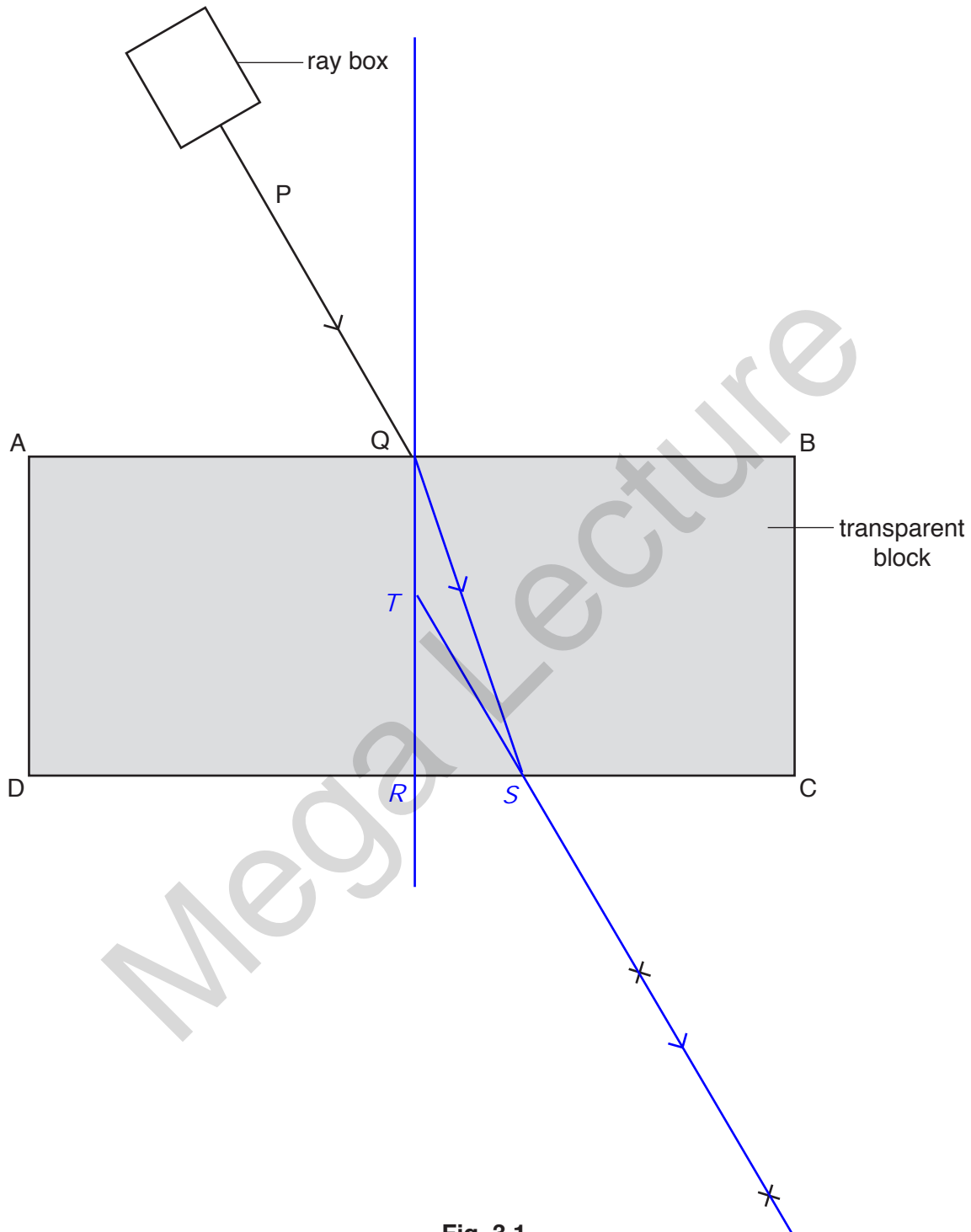


Fig. 3.1

(a) She directs a ray of light PQ from the ray box on to side AB of the block.

(i) On Fig. 3.1, draw a normal to side AB at point Q. Extend the normal so that it crosses side CD. Label the point at which the normal crosses CD with the letter R. [1]

(ii) Measure the angle of incidence  $\alpha$  of the ray PQ on side AB.

$$\alpha = \dots 30^\circ \dots [1]$$

(b) She marks, with crosses, two points on the emergent ray from CD, as shown on Fig. 3.1.

- On Fig. 3.1 draw a line joining the two crosses and continue this line until it meets QR.
- Label the point where the line crosses CD with the letter S and the point where it crosses QR with the letter T.
- Draw a straight line from Q to S.

(i) Measure the length  $x$  of QS.

$$x = \dots 5.3 \text{ cm} \dots$$

(ii) Measure the length  $y$  of ST.

$$y = \dots 3.5 \text{ cm} \dots$$

[2]

(c) The refractive index  $n$  of the material of the block is given by the equation

$$n = \frac{x}{y}.$$

Calculate  $n$ .

$$n = \frac{5.3}{3.5}$$

$$n = \dots 1.5 \dots [1]$$



4 A student investigates how the resistance of a wire depends upon its length.

He uses the equation

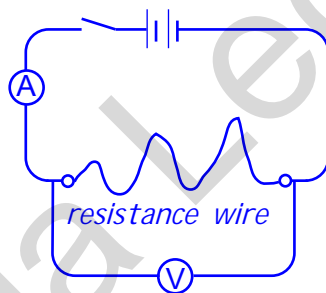
$$\text{resistance } R = \frac{\text{potential difference } V}{\text{current } I}.$$

The following apparatus is available:

- power supply
- ammeter
- voltmeter
- switch
- connecting leads and crocodile clips
- a length of resistance wire
- metre rule
- wire cutters.

Write a plan for the investigation.

(a) Draw a circuit diagram in the space below.



[2]

(b) Explain briefly how the student carries out the investigation.

*The student can measure the potential difference  $V$  across the wire using voltmeter*  
.....  
*Then he can measure the electric current through the wire using ammeter. He can*  
.....  
*use the formula  $R = \frac{V}{I}$  to find the resistance of the wire.*  
.....  
*He can repeat the experiment using different lengths of wire.*  
.....

[2]

(c) Explain how the student can use the readings to reach a conclusion.

*He can plot a graph of R against l in order to reach a conclusion.*  
.....  
.....  
.....  
.....[1]

Mega Lecture

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