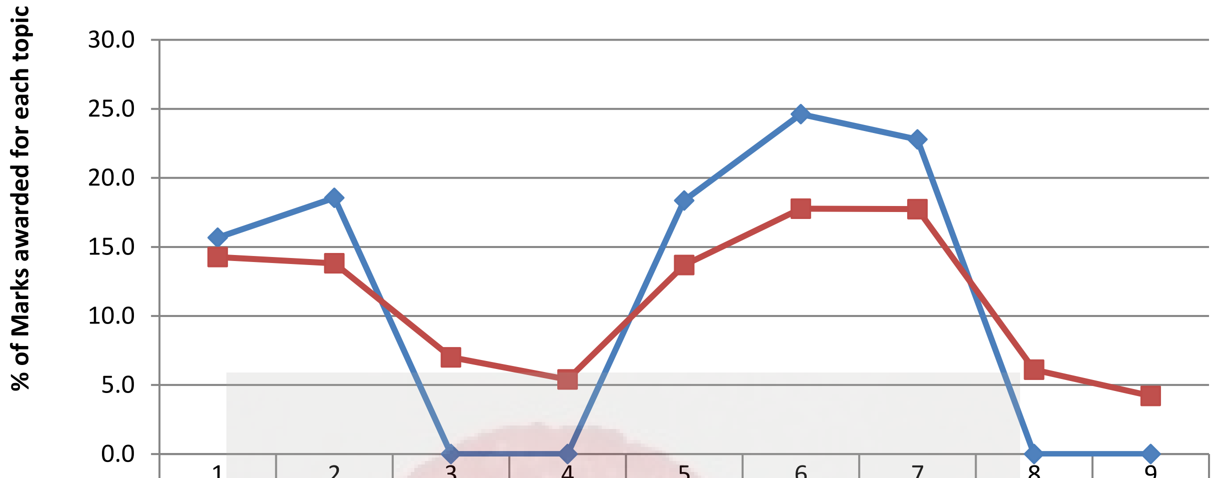
Name

iG Phx ALL EQ P6 0625 w02 to s15 328Pgs 1040marks 4Students

PAPER 6

Percentage of all marks awarded for each topic from w2001 to w2015 in Paper 6 (blue diamonds) and marks per topic for all papers (red squares)



	1	2	3	4	5	6	7	8	9
% Marks	15.7	18.6	0.0	0.0	18.4	24.6	22.8	0.0	0.0
Av Marks/Q	14.3	13.8	7.0	5.4	13.7	17.8	17.7	6.1	4.2

Paper 6 Topic Number

Contents

Topic Phx 1 **Q.1 iG Phx/2015/s/Paper 61 www.SmashingScience.org**

5 The class is investigating the oscillations of a pendulum.

Figs. 5.1 and 5.2 show the apparatus.

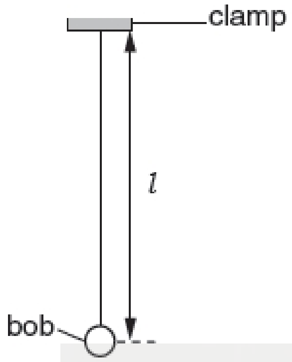


Fig. 5.1

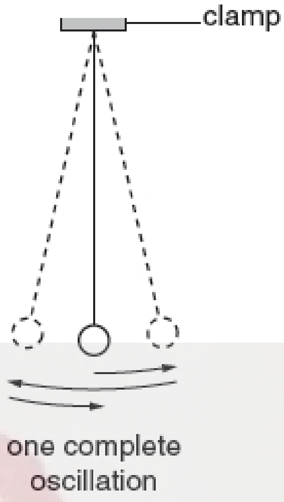


Fig. 5.2

A student measures the length l of the pendulum and takes readings of the time t for 20 complete oscillations. She calculates the period T of the pendulum. T is the time taken for one complete oscillation. She repeats the procedure for a range of lengths.

She plots a graph of T^2/s^2 against l/m. Fig. 5.3 shows the graph.

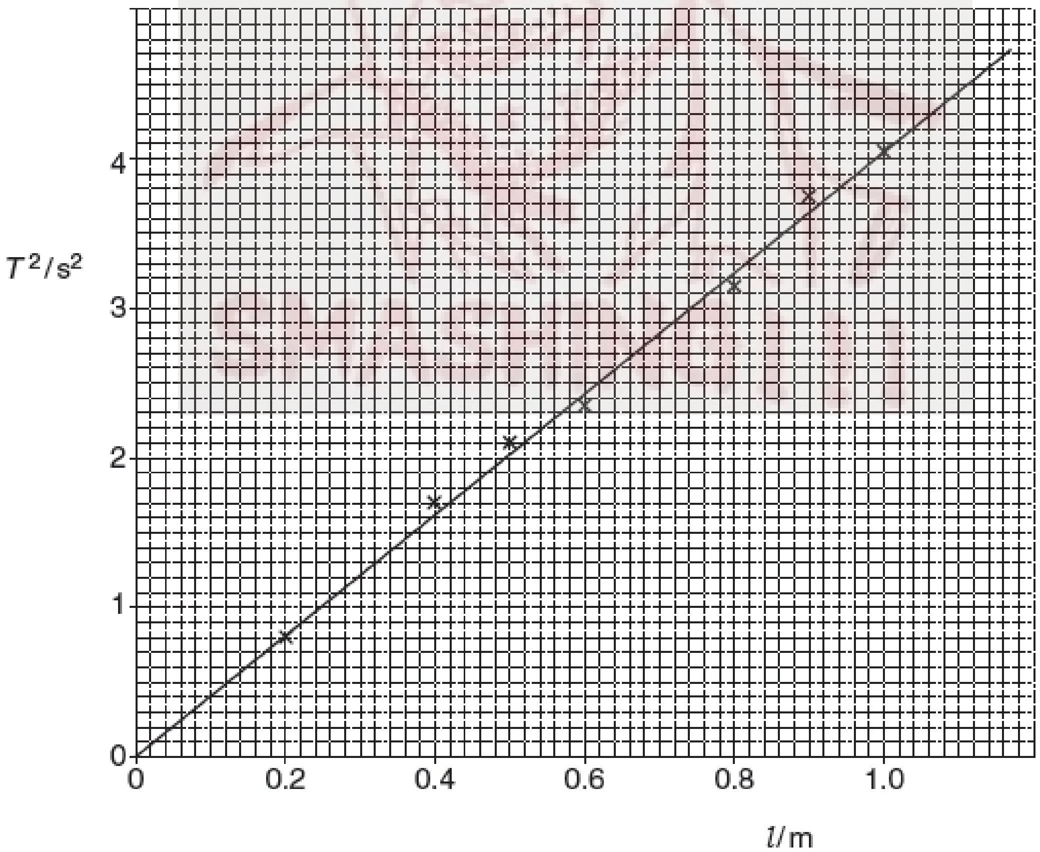


Fig. 5.3

(a) Using the graph, determine the length l of a pendulum that has a period T = 2.0 s. Show clearly on the graph how you obtained the necessary information.

l = ...[3]

(b) Explain why measuring the time for 20 swings, rather than for 1 swing, gives a more accurate value for T.

....

....[1]

(c) Another student investigates the effect that changing the mass m of the pendulum bob has on the period T of the pendulum.

(i) Suggest how many different masses the student should use for this laboratory experiment.

number of different masses = ...

(ii) Suggest a range of suitable values for the masses.

suitable range of masses = ...

[2]

[Total: 6]

5 An IGCSE student is taking measurements of a drinks cup.

Carry out the following instructions, referring to Fig. 5.1.

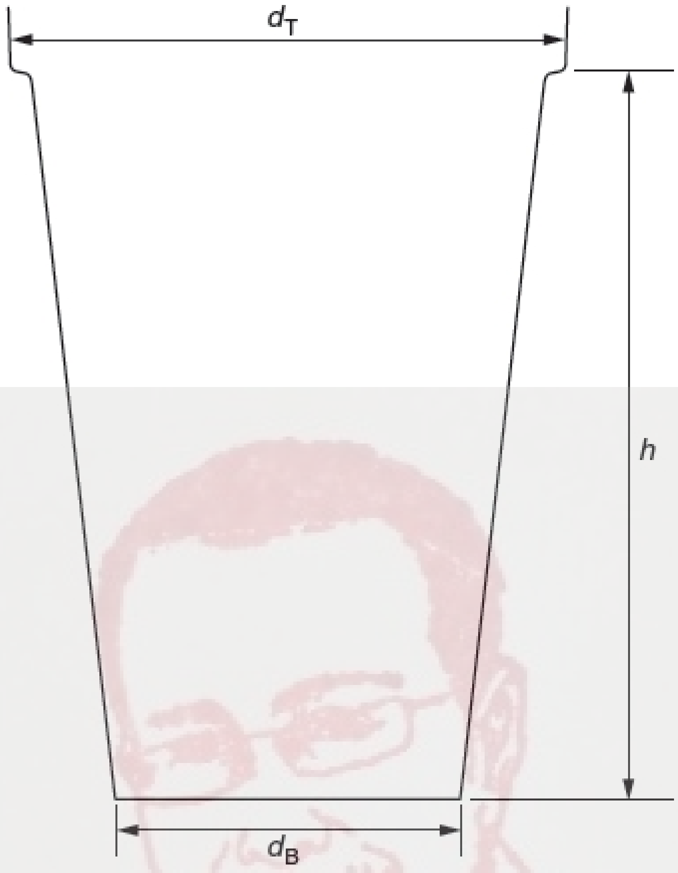


Fig. 5.1

(a) **(i)** On Fig. 5.1, measure the height h of the cup.

h = ... cm

(ii) On Fig. 5.1, measure the diameter d_T of the top of the cup.

d_T = ... cm

(iii) On Fig. 5.1, measure the diameter d_B of the bottom of the cup.

d_B = ... cm

(iv) Calculate the average diameter d_A, using the equation $d_A = \frac{d_T + d_B}{2}$.

d_A = ... cm

(v) Calculate an approximate value for the volume V of the cup, using the equation $V = \frac{\pi d_A{}^2 h}{4}$.

$V =$ ....
[3]

(b) The student determines the average circumference of the cup, using a 50 cm length of string and a metre rule.

Fig. 5.2 shows how the student used the string to determine the average circumference.

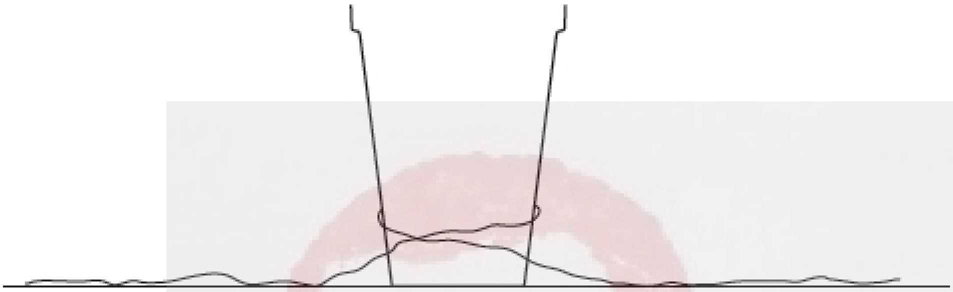


Fig. 5.2

Describe how you would use the string to obtain a more reliable value for the average circumference.

....

....

....[2]

(c) The student fills a measuring cylinder to the 500 cm^3 mark. He pours water from the measuring cylinder into the cup until the cup is full. Fig. 5.3 shows the water remaining in the measuring cylinder.

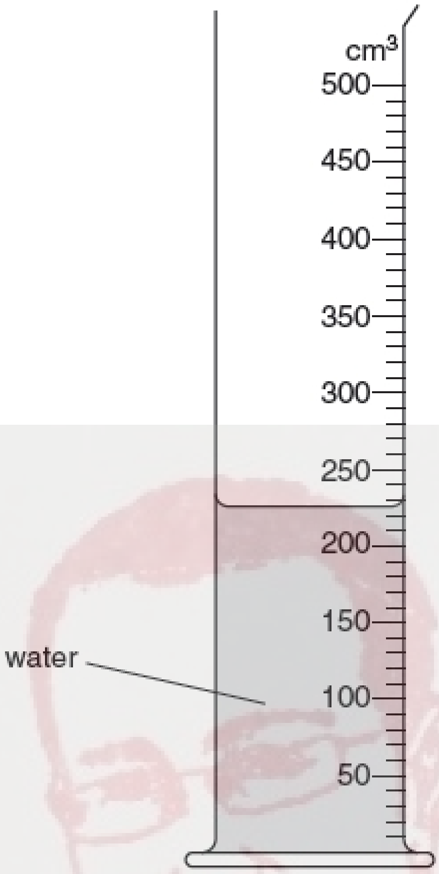


Fig. 5.3

(i) Record the volume of water V_R remaining in the measuring cylinder.

V_R = ...

(ii) Calculate the volume V_W of the water in the cup.

V_W = ...

[2]

(d) On Fig. 5.3, show clearly the line of sight required to take the reading of V_R. [1]

[Total: 8]

5 The IGCSE class is investigating the stretching of a spring.

Fig. 5.1 shows the apparatus.

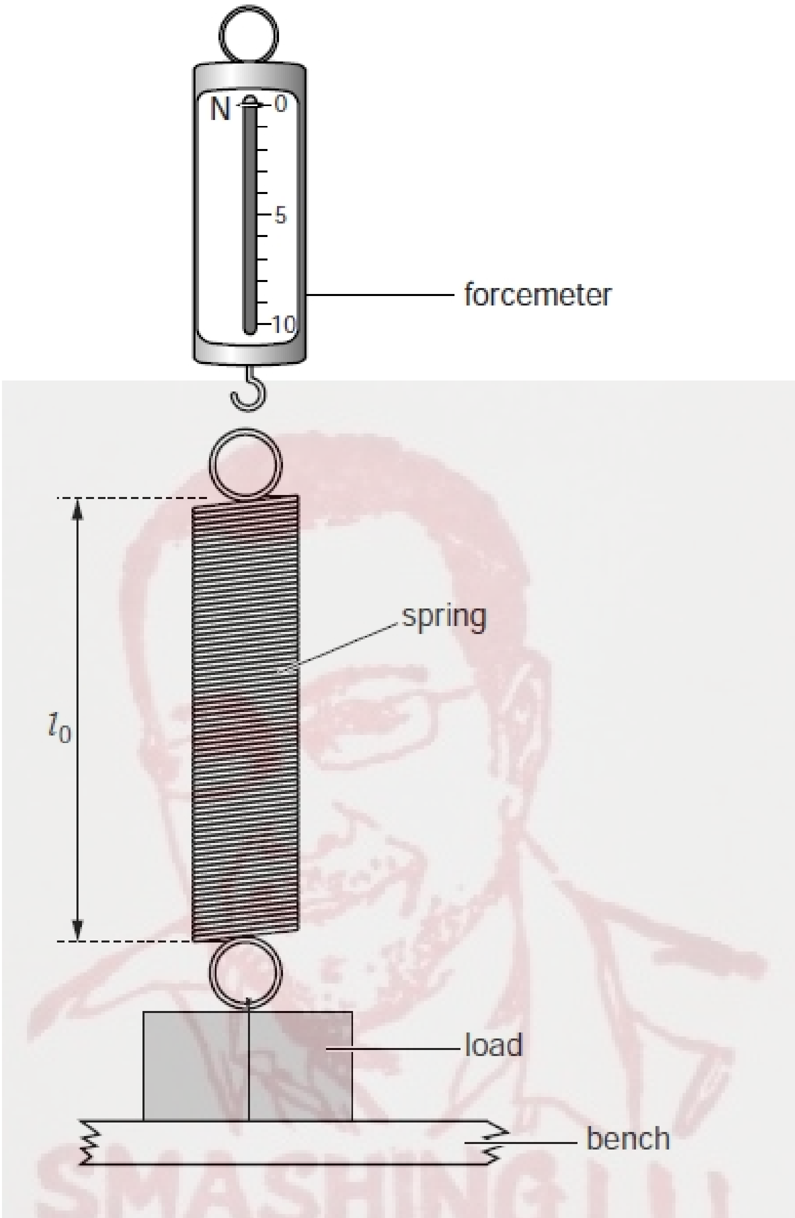


Fig. 5.1

(a) On Fig. 5.1, measure the unstretched length l_0 of the spring, in mm.

l_0 = ...mm [1]

(b) A student hangs the spring on the forcemeter with the load attached to the bottom of the spring, as shown in Fig. 5.1. The load remains on the bench.

He gently raises the forcemeter until it reads 1.0 N. He measures the new length l of the spring. He repeats the procedure using a range of forcemeter readings. The readings are recorded in Table 5.1.

F / N	l / mm	e / mm
1.0	67	
2.0	77	
3.0	91	
4.0	105	
5.0	115	

(i) Calculate the extension e of the spring, for each set of readings, using the equation $e = (l - l_0)$. Record the values of e in Table 5.1. [1]

(ii) Plot a graph of e / mm (y-axis) against F / N (x-axis).

[5]

(iii) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

[Total: 9]

1 The IGCSE class is investigating the stability of a block of wood.

Figs. 1.1 and 1.2 show the dimensions of the block.

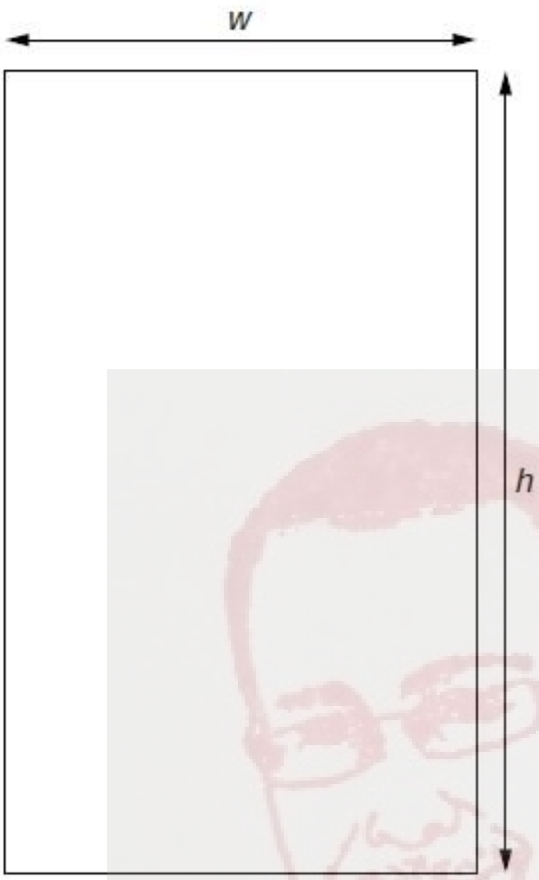


Fig. 1.1

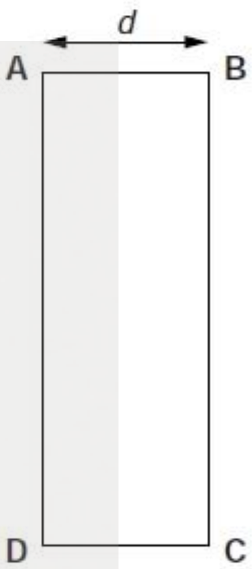


Fig. 1.2

(a) **(i)** On Figs. 1.1 and 1.2, measure the height *h*, width *w* and depth *d* of the block.

h = ...

w = ...

d = ...
[2]

(ii) On Fig. 1.2, draw the line **AC**. [1]

(iii) Measure and record the angle α between lines **AD** and **AC**.

α = ... [1]

(b) A student places the block on the edge of the bench, as shown in Fig. 1.3.

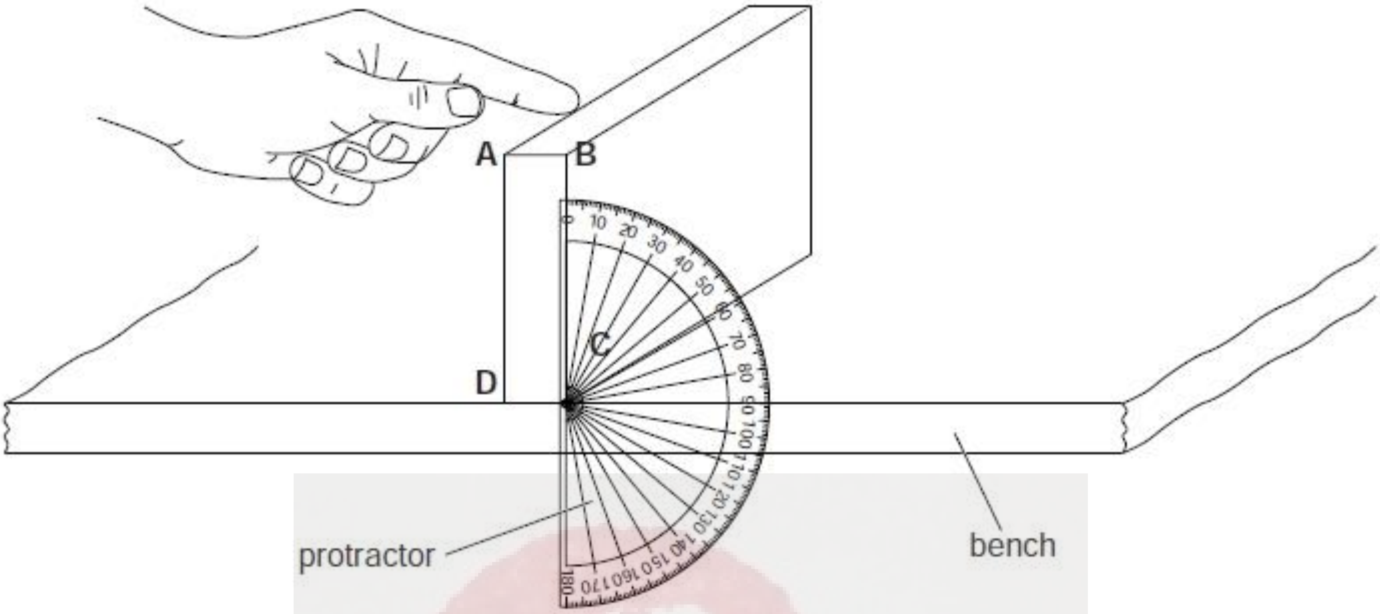


Fig. 1.3

He holds the protractor next to face **ABCD** of the block, as shown in Fig. 1.3. He gently pushes the top of the block (as indicated in Fig. 1.3) so that the block tips over.

He records the angle θ between side **BC** of the block and the vertical line on the protractor. The angle θ is when the block just tips over. He repeats this procedure a suitable number of times.

Suggest the number of measurements of θ that you think would be suitable for this experiment.

number = ... [1]

(c) The student calculates the average value θ_{av} of all his values for θ.

θ_{av} = ...20°.......................

He suggests that θ_{av} should be equal to α. State whether the results support this suggestion. Justify your statement by reference to the results.

statement ....

justification ....

....

....

[2]

[Total: 7]

5 The IGCSE class is determining the internal volume of a test-tube using two displacement methods.

The apparatus used is shown in Figs. 5.1, 5.2 and 5.3.

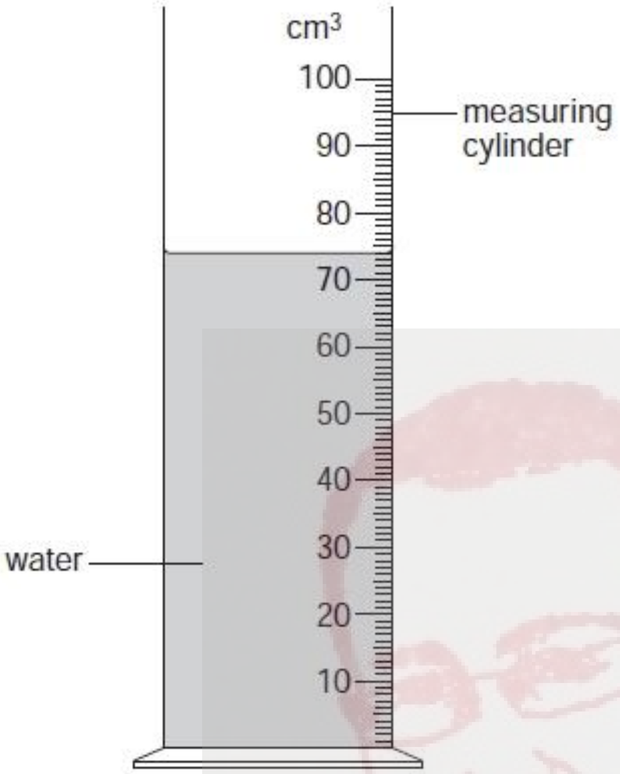


Fig. 5.1

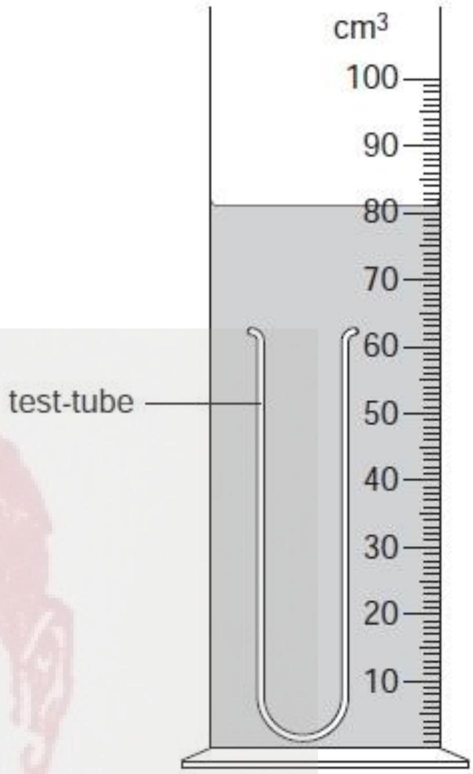


Fig. 5.2

(a) **(i)** Fig. 5.1 shows water in a measuring cylinder. Record the volume V_1 of the water.

V_1 = ... [1]

(ii) On Fig. 5.1, show clearly the line of sight that you would use to obtain an accurate volume reading. [2]

(b) **(i)** A student lowers a test-tube, closed end first, into the water in the measuring cylinder and pushes the tube down until it is filled with water. From Fig. 5.2, record the new water level V_2.

V_2 = ...

(ii) Calculate the volume V_G of the glass of the test-tube using the equation $V_G = (V_2 - V_1)$.

V_G = ...

[2]

(c) The student removes the test-tube from the measuring cylinder and empties the water back into the measuring cylinder. He then puts the test-tube, open end first, into the water in the measuring cylinder and carefully pushes it down with his finger until it is covered with water as shown in Fig. 5.3.

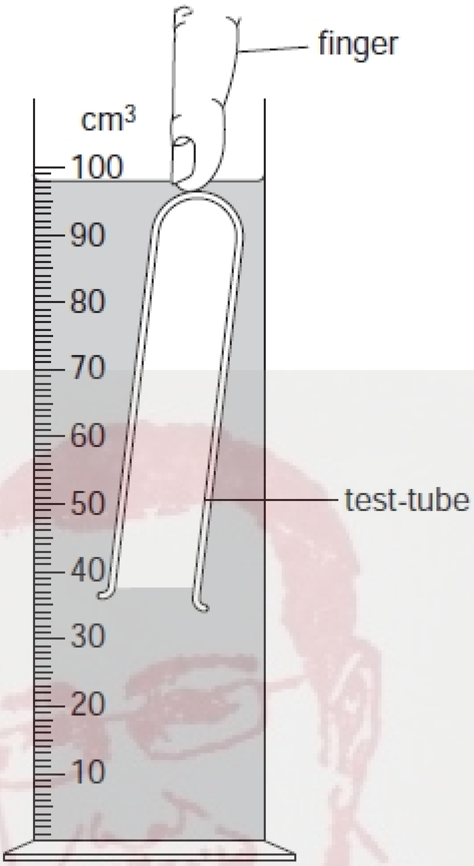


Fig. 5.3

(i) Record the new water level V_3.

V_3 = ...

(ii) Calculate the increase in water level $(V_3 - V_1)$.

$(V_3 - V_1)$ = ...

(iii) Calculate the volume V_A of air in the test-tube using the equation $V_A = (V_3 - V_1) - V_G$.

V_A = ...

[1]

(d) The student removes the test-tube from the measuring cylinder and fills the test-tube with water from a beaker. He pours the water from the test-tube into an empty measuring cylinder and records the volume V_W of water:

V_W = ...18 cm^3..

The student has attempted to determine the internal volume of the test-tube by two methods. His two values for the internal volume are V_A and V_W.

Assuming that the experiments have been carried out correctly and carefully and that the measuring cylinder scale is accurate, suggest two reasons why the value V_A may be inaccurate and two reasons why the value V_W may be inaccurate.

V_A:

reason 1 ....

....

reason 2 ....

....

V_W:

reason 1 ....

....

reason 2 ....

....

[3]

[Total: 9]

5 The IGCSE class is investigating the swing of a loaded metre rule.

The arrangement of the apparatus is shown in Fig. 5.1.

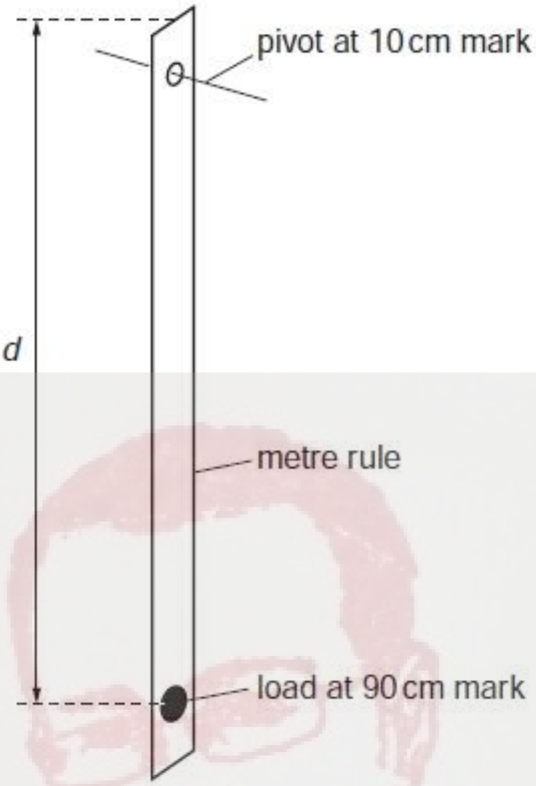


Fig. 5.1

A student displaces the rule a small distance to one side and allows it to swing. The time *t* taken for 10 complete swings is recorded. She calculates the time *T* taken for one swing. She repeats the procedure using different values of the distance *d*.

The readings are shown in the Table 5.1.

Table 5.1

0.900	18.4	1.84	
0.850	17.9	1.79	
0.800	17.5	1.75	
0.750	17.1	1.71	
0.700	16.7	1.67	

(a) Complete the column headings in the table. [3]

(b) Explain why the student takes the time for ten swings and then calculates the time for one swing, rather than just measuring the time for one swing.

....

....[1]

(c) The student tries to find a relationship between T and d. She first suggests that $T \times d$ is a constant.

(i) Calculate the values of $T \times d$ and enter the values in the final column of the table.

(ii) State whether or not the results support this suggestion and give a reason for your answer.

Statement ....

....

Reason ....

....

[2]

1 The IGCSE class is investigating the period of oscillation of a simple pendulum.

Fig. 1.1 shows the set-up.

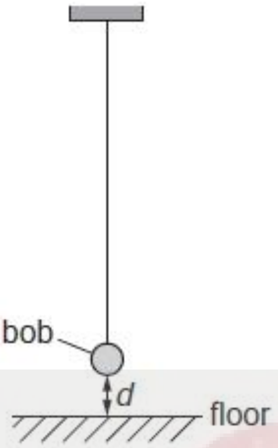


Fig. 1.1

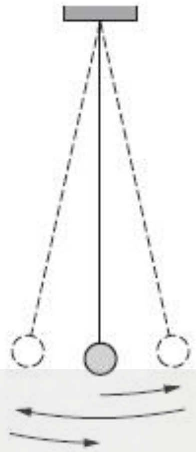


Fig. 1.2

(a) **(i)** On Fig. 1.1, measure the vertical distance *d* from the floor to the bottom of the pendulum bob.

d = ...

(ii) Fig. 1.1 is drawn one twentieth actual size. Calculate the actual distance *x* from the floor to the bottom of the pendulum bob. Enter this value in the top row of Table 1.1.

The students displace the pendulum bob slightly and release it so that it swings. They measure and record in Table 1.1 the time *t* for 20 complete oscillations of the pendulum (see Fig. 1.2).

Table 1.1

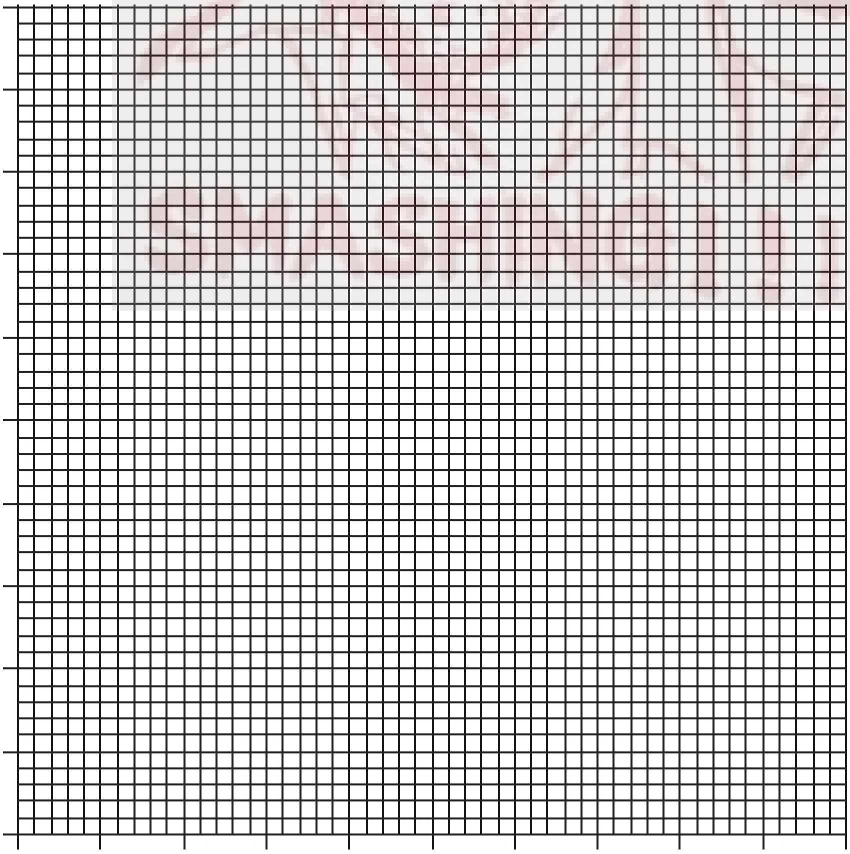
x / cm	*t* / s	*T* / s	T^2 / s^2
	20.0		
20.0	19.0		
30.0	17.9		
40.0	16.8		
50.0	15.5		

[4]

(b) **(i)** Calculate the period T of the pendulum for each set of readings. The period is the time for one complete oscillation. Enter the values in Table 1.1.

(ii) Calculate the values of T^2. Enter the T^2 values in Table 1.1.

(c) Use your values from Table 1.1 to plot a graph of T^2/s^2 (y-axis) against x/cm (x-axis). Draw the best-fit line.



[5]

(d) State whether or not your graph shows that T^2 is directly proportional to x. Justify your statement by reference to the graph.

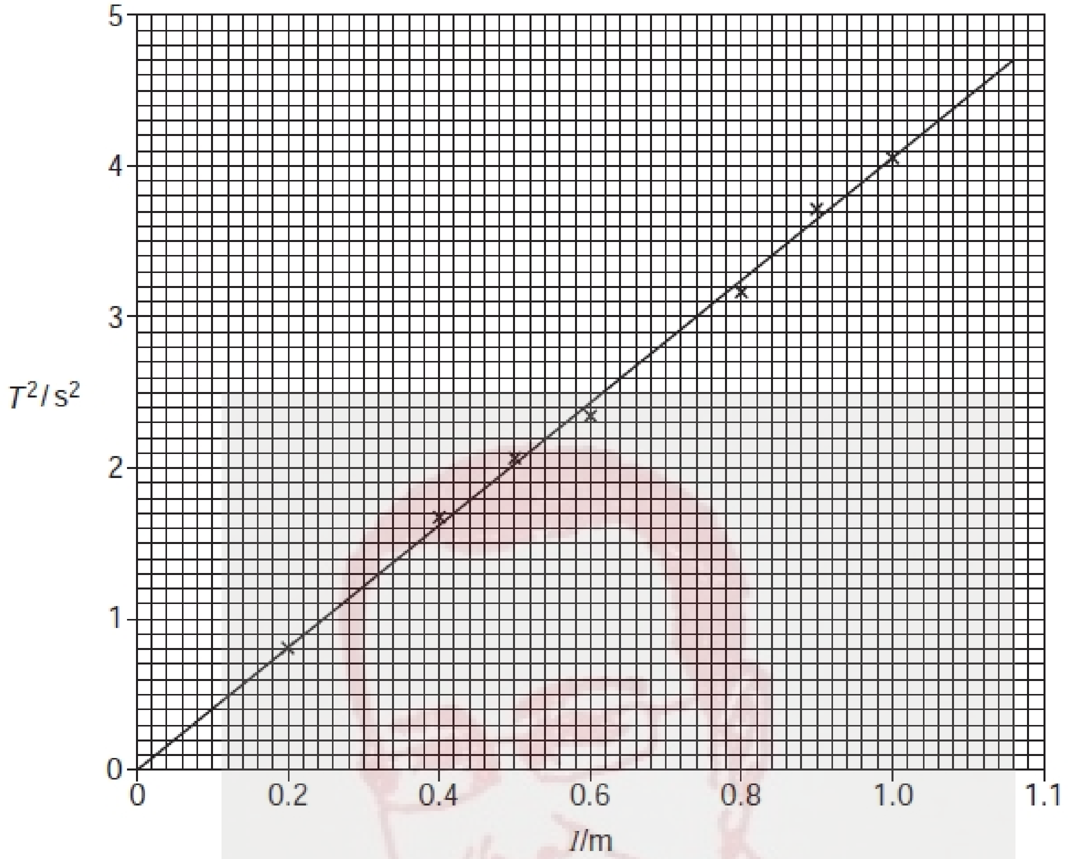
statement ....

justification ....

.... [1]

[Total: 10]

5 An IGCSE student has carried out a timing experiment using a simple pendulum. She plotted a graph of T^2/s^2 against *l*/m. *T* is the time for one swing of the pendulum and *l* is the length of the pendulum. The graph is shown below.



(a) **(i)** Determine the gradient *G* of the graph. Show clearly on the graph how you obtained the necessary information.

G = ...

(ii) Calculate the acceleration *g* of free fall using the equation

$$g = \frac{4\pi^2}{G}.$$

g = ...m/s^2

(iii) The student could have calculated the acceleration of free fall *g* from just one set of readings. State the purpose of taking sufficient readings to plot a graph.

....

....[5]

(b) The student next studies the relationship between the mass *m* of the pendulum and the time for one swing *T*. The readings are shown in Table 5.1.

Table 5.1

m/g	*T*/s
50	1.58
100	1.60
150	1.61
200	1.57
250	1.59

(i) Suggest two variables that must be kept constant to make the experiment a fair test.

1. ....

2. ....

(ii) Study the readings in the table and complete the following sentence.

Within the limits of experimental accuracy, the readings show that the mass *m* of the pendulum .... [3]

[Total: 8]

5 **(a)** An IGCSE student is investigating the differences in density of small pieces of different rocks. She is using an electronic balance to measure the mass of each sample and using the 'displacement method' to determine the volume of each sample. Fig. 5.1 shows the displacement method.

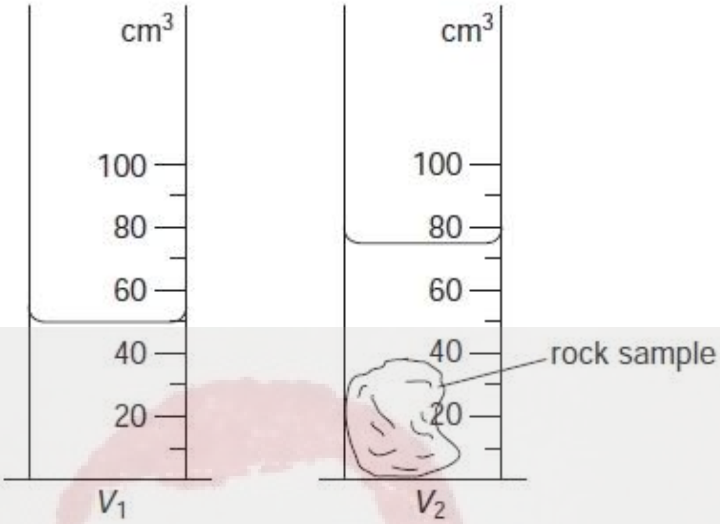


Fig. 5.1

(i) Write down the volume shown in each measuring cylinder.

V_1 = ...

V_2 = ...

(ii) Calculate the volume V of the rock sample.

V = ...

(iii) Calculate the density of sample **A** using the equation

$$density = \frac{m}{V},$$

where the mass m of the sample of rock is 109 g.

density = ...

[4]

(b) The table shows the readings that the student obtains for samples of rocks **B** and **C**. Complete the table by

(i) inserting the appropriate column headings with units,

(ii) calculating the densities using the equation *density* = $\frac{m}{V}$.

sample	*m* / g			*V* /	density /
B	193	84	50	34	
C	130	93	50	43	

[4]

(c) Explain briefly how you would determine the density of sand grains.

....

.... [1]

[Total: 9]

1 The IGCSE class is determining the density of a type of wood.

The students are provided with a bundle of wooden rods, as shown in Fig. 1.1.

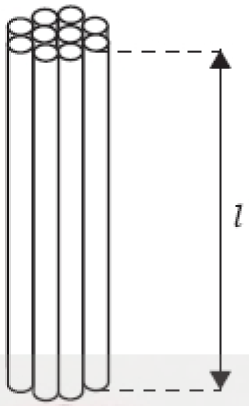


Fig. 1.1

(a) On Fig. 1.1, measure the length l of a rod.

l = ... cm [1]

(b) A student winds five turns of string round the bundle and marks the beginning and the end of the five turns. She then uses the metre rule to measure the distance x between the marks. She records that x = 24.5 cm.

(i) Determine the circumference c of the bundle of rods.

c = ...

(ii) Calculate the volume V of the bundle of rods using the equation

$$V = \frac{c^2 l}{4\pi}.$$

V = ... [4]

(c) The equation used in **(b)(ii)** assumes that the bundle is a solid cylinder. However, there are air gaps between the rods.

(i) Estimate the total volume V_r of the rods themselves.

V_r = ...

(ii) Calculate the density d of the wood using the equation

$$d = \frac{m}{V_r}$$

where the mass m of the bundle = 6.3 g.

d = ... [3]

2 The IGCSE class is investigating the swing of a loaded metre rule.

The arrangement of the apparatus is shown in Fig. 2.1.

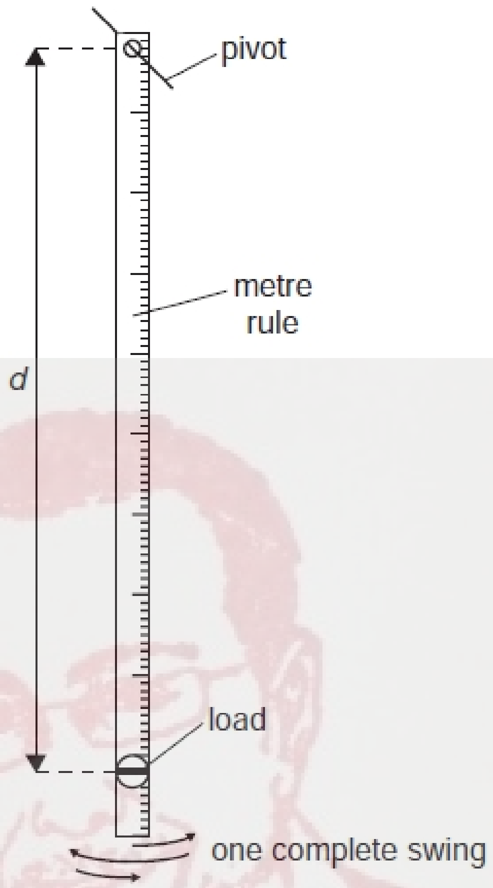


Fig. 2.1

The load is attached to the metre rule so that its centre is 90.0 cm from the pivot. The rule is displaced a small distance to one side and allowed to swing. The time t taken for 10 complete swings is recorded. This is repeated using different values of the distance d. The readings are shown in the table.

d /	t /	T /
90.0	18.35	
85.0	17.87	
80.0	17.53	
75.0	17.06	
70.0	16.72	

(a) Complete the column headings in the table. [1]

(b) Calculate the period *T* for each value of *d*. The period is the time taken for one complete swing. Enter the values in the table. [2]

(c) On the grid below, plot a graph of *T* / s (*y*-axis) against *d* / cm (*x*-axis). Start the *x*-axis at *d* = 70.0 cm and the *y*-axis at a suitable value of *T* / s to make best use of the graph grid. [5]

(d) A student suggests that *T* is proportional to *d*. State whether or not the results support this suggestion and give a reason for your answer.

statement ....

....

reason ....

.... [1]

(e) Explain why the student takes the time for ten swings and then calculates the time for one swing (the period), rather than just measuring the time for one swing.

....

.... [1]

1 The IGCSE class is determining the density of a sample of card.

Each student has a stack of ten pieces of card, as shown in Fig. 1.1.

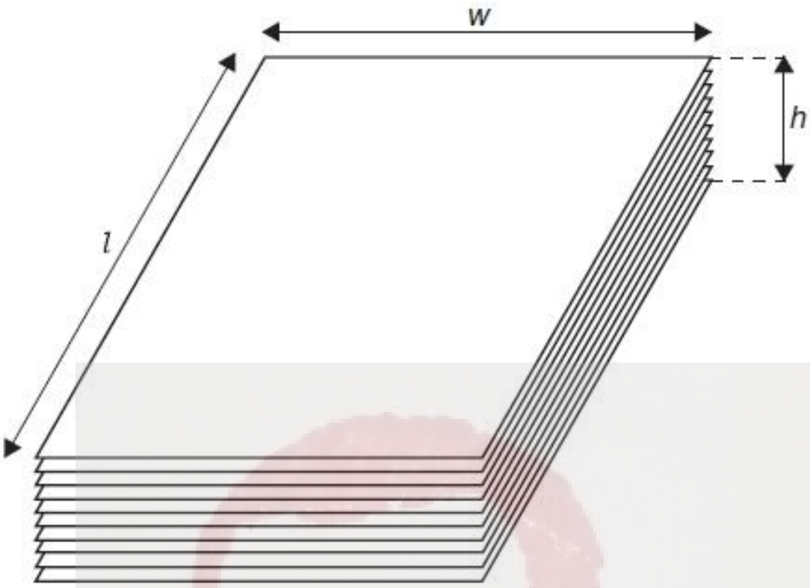


Fig. 1.1

(a) **(i)** On Fig. 1.1, measure the height *h* of the stack of card.

h = ... [1]

(ii) Calculate the average thickness *t* of one piece of card.

t = ... [2]

(b) **(i)** On Fig. 1.1, measure the length *l* and width *w* of the top piece of card.

l = ...

w = ... [1]

(ii) Calculate the volume *V* of one piece of card using the equation

$V = ltw$.

V = ... [2]

(c) Calculate the density d of the card using the equation

$$d = \frac{m}{V}$$

where the mass m of one piece of card is 1.3 g.

d = ... [2]

(d) A sample of corrugated card of the same length and width as the card in Fig. 1.1 consists of two thin sheets of card with an air gap in between. The sheets of card are separated by paper, as shown in the cross-section in Fig. 1.2. The thickness y of the air gap as shown in Fig. 1.2 is between 2 mm and 3 mm.

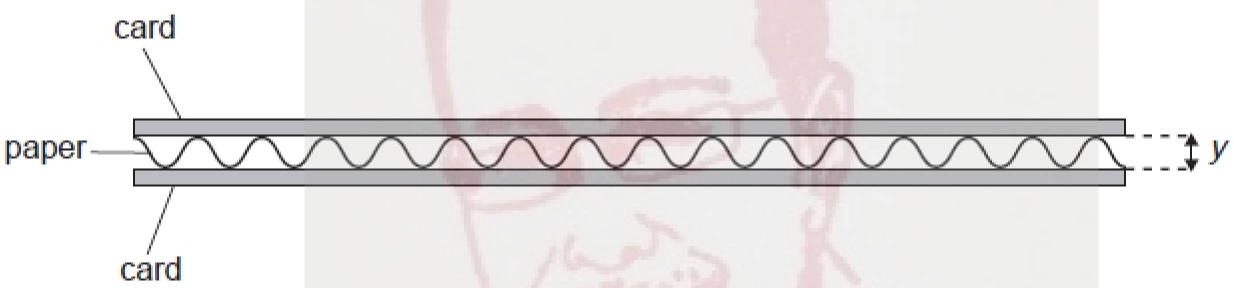


Fig. 1.2

Estimate the volume V_a of air trapped within the corrugated card shown in Fig. 1.2.

V_a = ... [1]

2 A student carries out an experiment to determine the density of plasticine. She records the mass m and the volume V of a range of differently-sized samples. These readings are plotted on a graph as shown in Fig. 2.1.

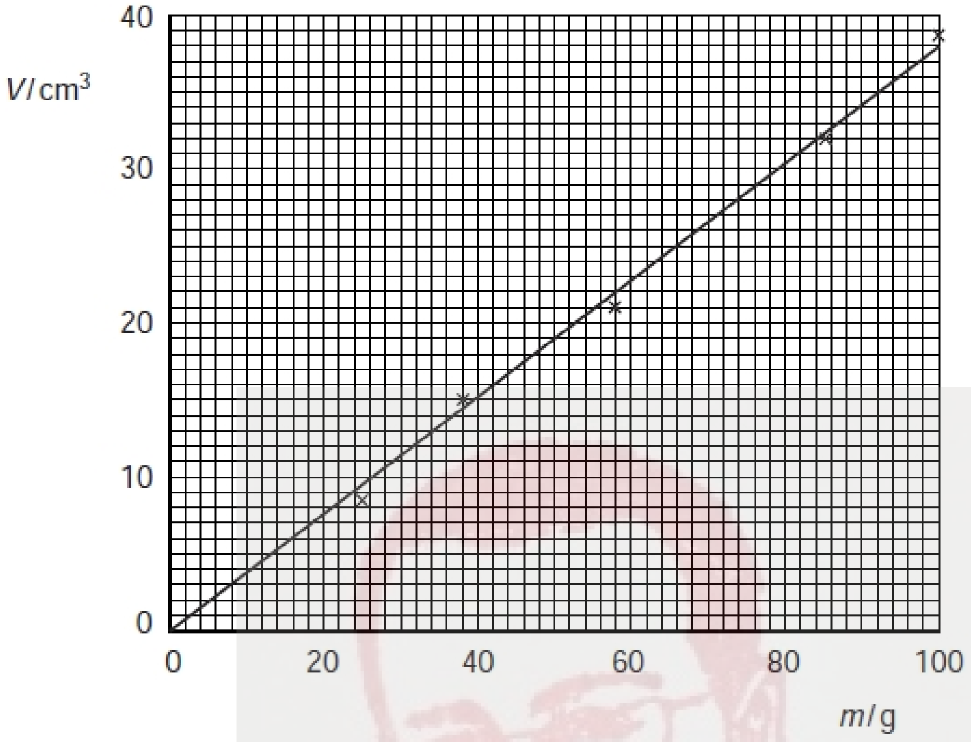


Fig. 2.1

(a) **(i)** Determine the gradient G of the line. Show clearly how you obtain the necessary information.

G = ...

(ii) Determine the density ρ of the plasticine using the equation $\rho = \frac{1}{G}$.

ρ = ...

[5]

(b) The student could calculate the density from one set of readings. Suggest why she takes more than one set of readings and plots a graph.

....

.... [1]

1 The IGCSE class is investigating the rate of cooling of water in a beaker. Some of the apparatus used is shown in Fig. 1.1.

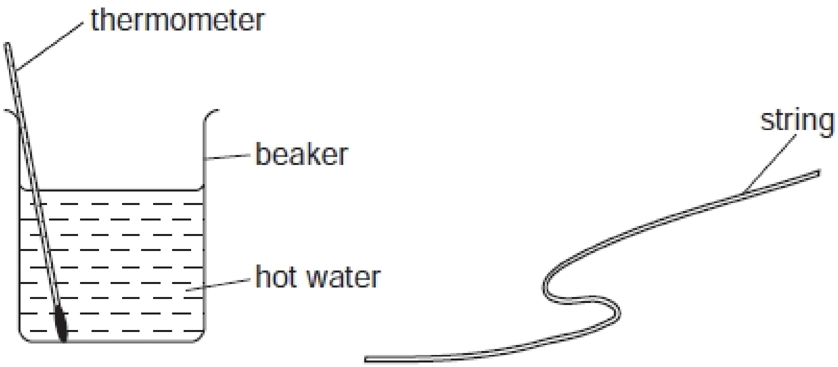


Fig. 1.1

During the experiment, a student measures the temperature of the water, its volume, the length of string wrapped round a beaker and the depth of water in the beaker.

(a) Write down the readings shown in Figs. 1.2 and 1.3. Include appropriate units.

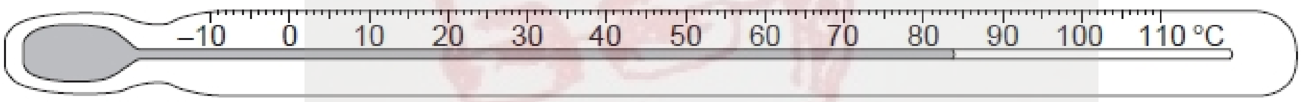


Fig. 1.2

temperature = ...

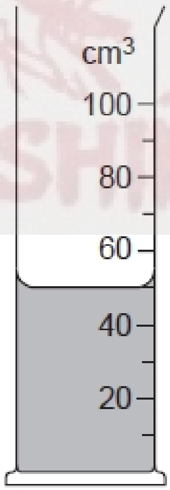


Fig. 1.3

volume of water in the measuring cylinder = ... [3]

(b) The string is wrapped 5 times round the beaker and marked as shown in Fig. 1.4.

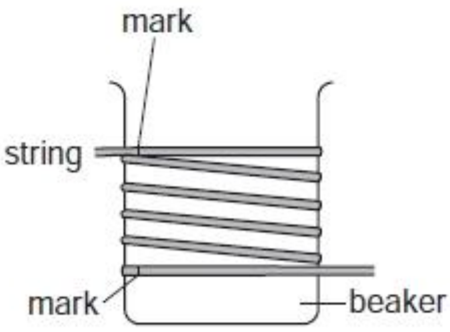


Fig. 1.4

The string is held against a metre rule as shown in Fig. 1.5.

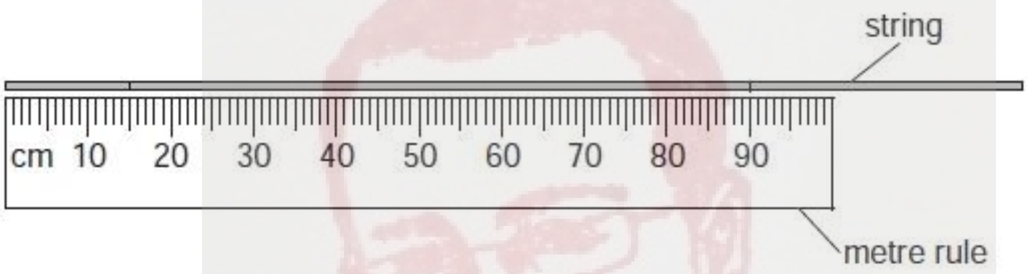


Fig. 1.5

(i) Write down the length of the string between the marks.

length = ... cm

(ii) Calculate the circumference *c* of the beaker.

c = ... cm

(iii) Suggest one source of error in this method of determining the circumference.

....

....

(iv) Suggest one improvement to this method.

....

....

[4]

(c) A rule is placed beside the beaker, as shown in Fig. 1.6.

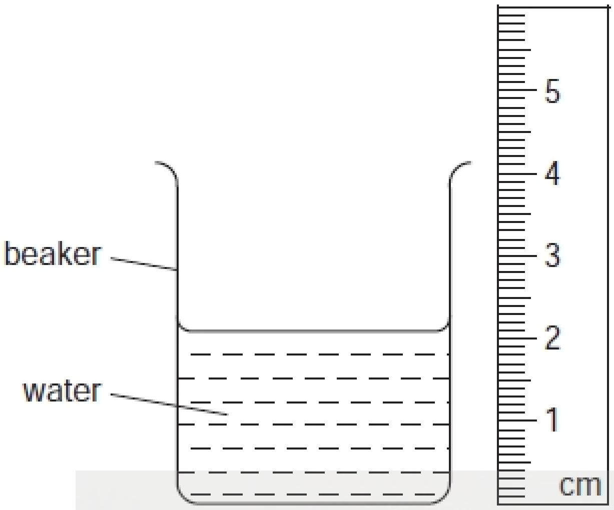


Fig. 1.6

(i) Write down the depth *d* of the water in the beaker.

d = ... cm

(ii) Calculate the surface area *A* of the curved surface of the beaker up to the water level using the equation $A = dc$.

A = ...

[2]

(d) State the other measurements that need to be taken to determine the rate of cooling of the water.

....

.... [2]

3 A student carries out an experiment using a simple pendulum. Fig. 3.1 shows the apparatus.

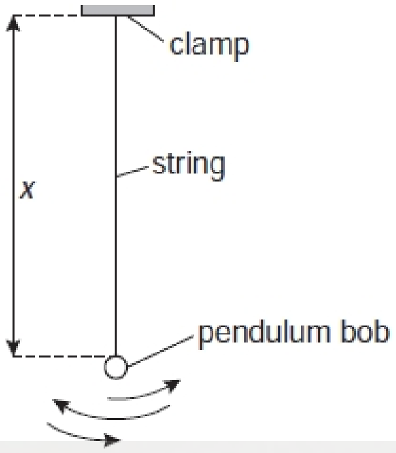


Fig. 3.1

The student records the time t taken for 20 complete oscillations for a range of different lengths x of the string. The readings are shown in the table.

x / cm	l / cm	t / s	T / s
90.0		38.5	
80.0		36.0	
70.0		33.4	
60.0		31.4	
50.0		28.2	
40.0		25.5	

The length l of the pendulum is given by the equation $l = x + r$, where r is the radius of the pendulum bob.

Fig. 3.2 shows the pendulum bob drawn actual size.

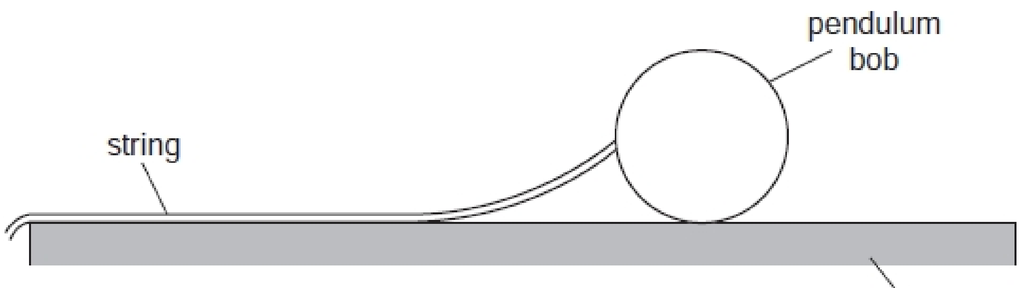


Fig. 3.2

(a) **(i)** Use your rule to measure the diameter *d* of the pendulum bob.

d = ...

(ii) Calculate the radius *r* of the pendulum bob.

r = ...

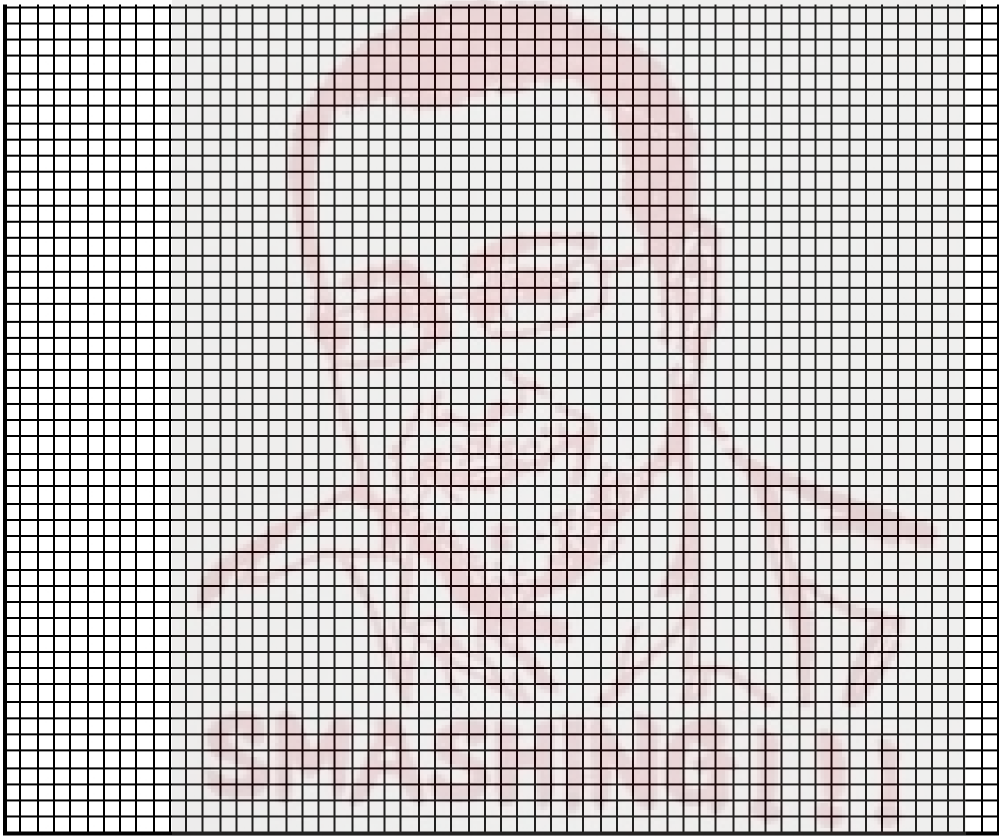
[2]

(b) **(i)** Complete the column for the length *l* / cm in the table using the equation $l = x + r$.

(ii) The period *T* is the time taken for one complete oscillation. Complete the column for the period *T* / s in the table.

[3]

(c) Plot the graph of *T* / s (*y*-axis) against *l* / cm (*x*-axis). Start the *T* / s axis at *T* = 1.0 s.



[5]

(d) Using the graph, find the length l_a of the pendulum that would have a period of 1.50 s.

l_a = ... cm [1]

1 **(a)** A student was asked to make some measurements of the test-tube shown in Fig. 1.1. He was given a 1 m length of thin string and a metre rule and instructed to determine **as accurately as possible** the circumference of the tube. The student used the rule to measure the diameter d of the tube and then calculated the circumference c using the equation

$$c = \pi d.$$

Describe how the student could have obtained a more accurate result with the apparatus given. You may draw on Fig. 1.1.

Fig. 1.1

....

....

.... [2]

(b) (i) On Fig. 1.2, show where you would place two small rectangular blocks of wood to help you make an accurate measurement of the overall length of the test-tube.

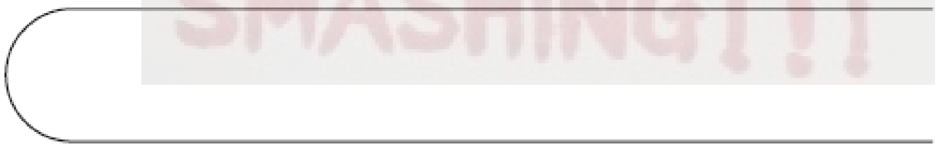


Fig. 1.2

(ii) The test-tube is shown actual size in Fig. 1.2. Use your rule to measure the length l of the test-tube.

l = ...

[2]

(c) Using another test-tube, the student obtained these readings.

$$l = 14.5\,\text{cm}$$

$$c = 5.3\,\text{cm}$$

Calculate the approximate external volume V of the test-tube using the student's readings and the equation

$$V = \frac{c^2 l}{4\pi}.$$

V = ... [2]

(d) The equation used in **(c)** assumes the test-tube to be a cylinder with flat ends. It does not allow for the rounded end of the test-tube.

(i) Estimate the volume V_m of the 'missing' part of the cylinder shown shaded in Fig. 1.3.

Fig. 1.3

V_m = ...

(ii) Using your values for V and V_m, calculate the actual external volume V_a of the test-tube.

V_a = ...

[2]

4 The IGCSE class was studying the acceleration *a* of a toy truck that was pulled along a track by a force *F*. The arrangement is shown in Fig. 4.1.

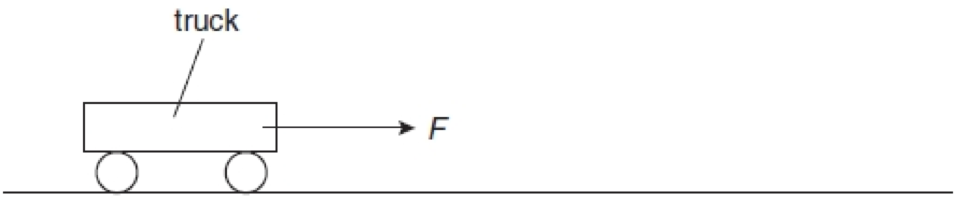
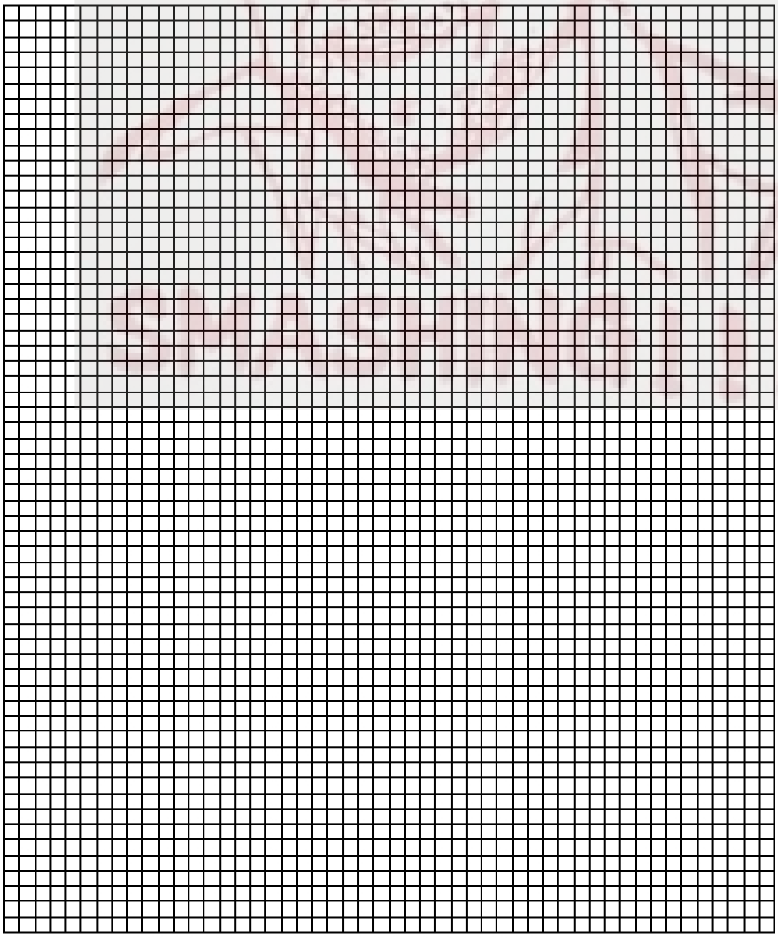


Fig. 4.1

The results obtained are shown in the table.

F / N	*a* / (m / s^2)
0.5	0.35
1.0	0.72
1.5	1.02
2.0	1.44
2.5	1.74

(a) Plot a graph of *F* / N (*y*-axis) against *a* / (m / s^2) (*x*-axis). Draw the line of best fit through your points. [6]



(b) Theory suggests that the relationship between force and acceleration is given by the equation

$$F = ma,$$

where m is the mass of the truck.

The gradient of the graph is equal to the mass of the truck.

From the graph, determine the mass m of the truck. Show clearly how you obtained the necessary information.

m = ... [4]

4 An IGCSE class watched a demonstration experiment to show that a metal rod expands when heated. The apparatus is shown in Fig. 4.1.

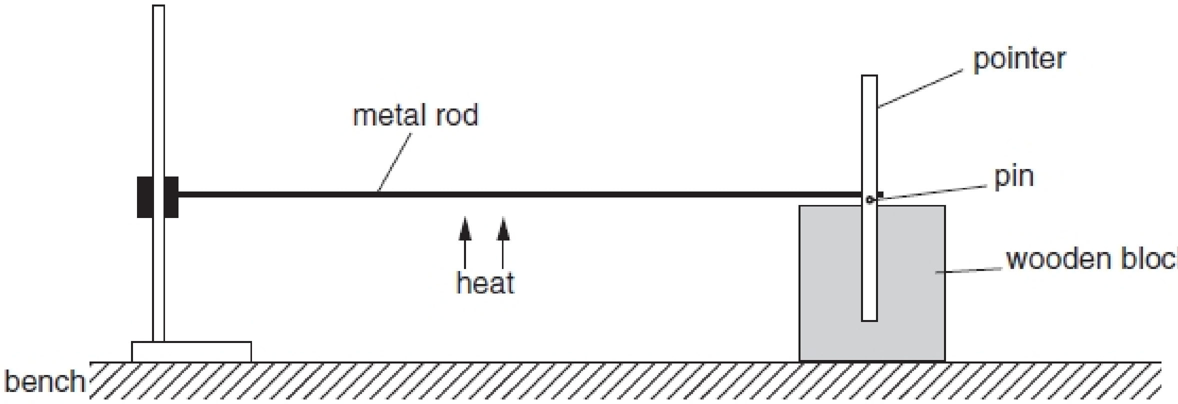


Fig. 4.1

When the rod expands, it rolls the pin which moves the pointer. So a very small expansion moves the pointer far enough to be seen clearly.

(a) One student wanted to find out how much longer the rod became when heated above room temperature with a Bunsen burner. The rod was 0.750 m long at room temperature.
To find the circumference of the pin, the student wrapped a piece of string 10 times round the pin, marked the string at the beginning and end of the 10 turns, and then measured the length of the string between the marks. Fig. 4.2 shows the string actual size.

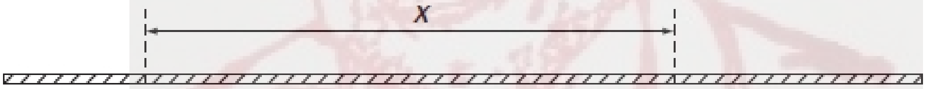


Fig. 4.2

(i) Use your rule to measure the distance x between the marks on the string on Fig. 4.2.

x = ...

(ii) Calculate the circumference c of the pin.

c = ...

[3]

(b) A second student measured the diameter d of the pin using a micrometer screw gauge.

The diameter was 1.20 mm. When the rod was heated, the pointer moved through 90°.

(i) Calculate the circumference c using the equation

$$c = \pi d.$$

c = ...[2]

(ii) Use this value of the circumference to calculate the increase e in the length of the rod when heated.

e = ...[1]

(iii) Calculate the length l of the heated rod.

l = ...[1]

(c) The micrometer screw gauge is a very accurate instrument. Suggest why the string and rule method of finding the circumference, used by the first student, was inaccurate.

....

....[1]

1 In an experiment to determine the volume of glass beads, a student used two different methods.

Method 1

The student measured the combined diameters of some beads and then calculated the volume of one bead. The end view of the apparatus used is shown in Fig. 1.1.

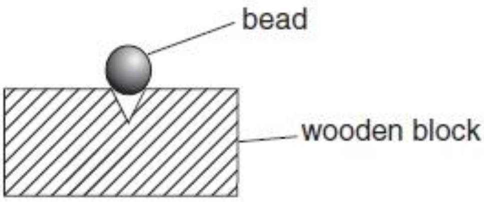


Fig. 1.1

Fig. 1.2 shows the side view of the same apparatus, drawn actual size.

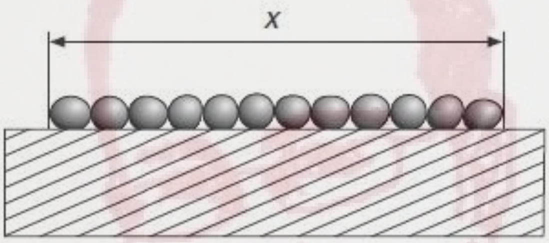


Fig. 1.2

(a) (i) On Fig. 1.2, use your rule to measure the distance *x*, in cm.

....

(ii) Calculate *d*, the average diameter in cm of one glass bead. Show your working.

d = ... cm

(iii) Calculate *V*, the volume of one glass bead using the equation

$$V = \frac{\pi d^3}{6}.$$

V = ...[6]

Method 2

The student used a displacement method to determine the volume of a glass bead. Fig. 1.3 and Fig. 1.4 show how this was done.

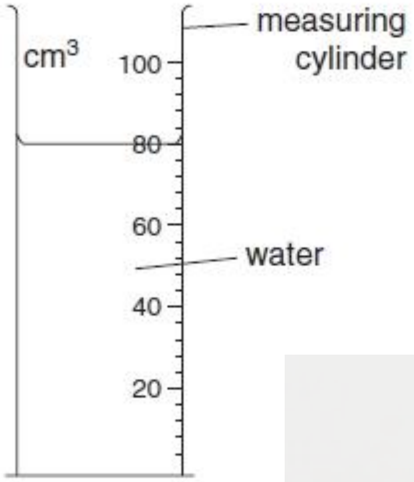


Fig. 1.3

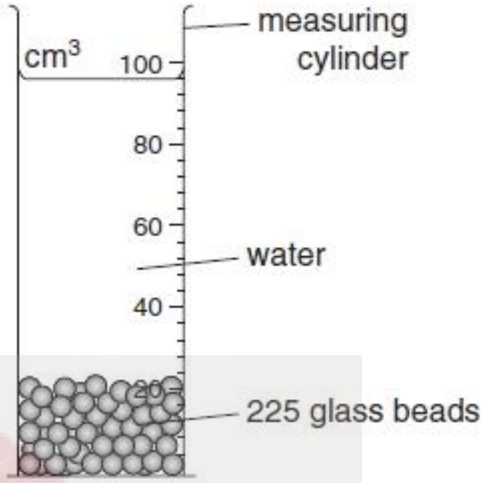


Fig. 1.4

(b) **(i)** Write down the values of the readings taken.

....

....

(ii) Calculate the volume of 225 glass beads.

volume = ...

(iii) Calculate V, the average volume of one glass bead.

V = ...

[3]

(c) Suggest which of the two methods will give the more accurate result for the volume of a glass bead. Give a reason for your answer.

....

....

....[1]

Topic_Phx 1 **Q.1 iG Phx/2015/s/Paper 61 www.SmashingScience.org**

5 **(a)** use of $T^2 = 4\ s^2$ [1]

correct method shown clearly on graph [1]

l = 0.99 (m) cao OR ecf 0.49 if $T^2 = 2\ s^2$ used [1]

(b) reduce (percentage) uncertainty OR reduce (the effect of) error due to starting/stopping [1]

(c) **(i)** 5 – 10 [1]

(ii) minimum not less than 10 g; maximum not more than 1000 g; maximum must be at least double the minimum [1]

[Total: 6]

Topic_Phx 1 **Q.2 iG Phx/2014/w/Paper 61 www.SmashingScience.org**

5 **(a)** h = 9.5cm d_T = 7.2 cm – 7.3 cm and d_B = 4.5 cm [1]

d_A = 5.85 / 5.9 cm (no mark), V rounds to 260 cm^3 (no ecf) [1]

2 or 3 significant figures and cm^3 [1]

(b) measurement of circumference half way up, or at top and bottom [1]

more than one revolution used for the measurement in at least one position, and divide [1]

(c) **(i)** 225 [1]

(ii) 275 (ecf 500 – candidate's **(c)**(i)) [1]

(d) correct line of sight clearly shown at right angles outside measuring cylinder [1]

[Total: 5]

Topic_Phx 1 **Q.3 iG Phx/2013/w/Paper 61 www.SmashingScience.org**

5 **(a)** 54 – 55 [1]

(b) **(i)** table:
e values 12, 22, 36, 50, 60 (e.c.f. from **(a)**) [1]

(ii) graph:
axes correctly labelled *e* / mm and *F* / N and correct way round [1]
suitable scales [1]
all plots correct to ½ small square [1]
good line judgement [1]
thin, single continuous line [1]

(iii) triangle method using at least half of candidate's line, shown on the graph [1]
G = 11 – 13, no e.c.f. [1]

[Total: 9]

Topic_Phx 1 **Q.4 iG Phx/2013/s/Paper 61 www.SmashingScience.org**

1 **(a)** 9.7, 5.7, 2.0 (accept 2) or 97, 57, 20 [1]
<u>all</u> given to correct unit [1]
line AC drawn correctly, corner to corner [1]
α = 18 – 20° [1]

(b) number from 3 to 20 with no unit [1]

(c) correct statement for results (expect Yes) [1]
idea of within (or beyond) experimental accuracy [1]

[Total: 7]

Topic_Phx 1 **Q.5 iG Phx/2012/s/Paper 61 www.SmashingScience.org**

5 **(a)** $V_1 = 74$ [1]
Line of sight perpendicular to scale [1]
Perpendicular line continues to measuring cylinder at surface level [1]

(b) $V_2 = 81$, $V_G = 7$ (ecf allowed) [1]
All volumes in cm^3, unit given at least once, not contradicted [1]

(c) $(V_3 - V_1) = 24$, $V_A = 17$ (ecf allowed) [1]

(d) Any three from:
V_A: Finger increases V_3 / tube not pushed in far enough
Some water in test-tube/air is compressed
V_W: Water remaining in tube
Water remaining in measuring cylinder
Tube overfilled, wtte (surface tension effect) [3]
Either V_A or V_W (accept only once):
Measuring cylinder readings not very sensitive
Subtraction produces large percentage uncertainty

[Total: 9]

Topic_Phx 1 **Q.6 iG Phx/2011/s/Paper 61 www.SmashingScience.org**

5 **(a)** column 1: d, m (or in words) [1]
columns 2 and 3: t, T (or in words) [1]
columns 2 and 3: s, s (or in words) [1]

(b) accuracy/reducing uncertainty/sensible comment on reaction time [1]

(c) **(i)** at least three correct values entered in table
1.66, 1.52, 1.40, 1.28, 1.17 (at least 2 significant figures) c.a.o [1]

(ii) statement matches result (expect NO) AND
justification matches statement and by reference to result
(expect decreasing, not equal, not constant, different, changing, wtte)
allow ecf from **(i)** [1]

[Total: 6]

Topic_Phx 1 **Q.7 iG Phx/2009/w/Paper 61 www.SmashingScience.org**

1	**(a)**	**(i)**	*d* 0.5 cm or 5mm	[1]
		(ii)	*x* 10.0	[1]
	(b)	**(i)–(iii)**		
			table: *T* 1.0, 0.95, 0.895 (0.90, 0.9), 0.84, 0.775 (0.78)	[1]
			T^2 1.00, 0.903, 0.801, 0.706, 0.601 (if *T* correct)	[1]
	(c)	graph:		
		axes labelled		[1]
		scales suitable, plots occupying at least half grid		[1]
		plots all correct to ½ square		[1]
		well judged line		[1]
		thin line, 5 neat plots		[1]
	(d)	statement NO and not through origin/ inverse/negative gradient/ *x* increases, T^2 decreases/ wtte		[1]
				[Total: 10]

Topic_Phx 1 **Q.8 iG Phx/2008/s/Paper 61 www.SmashingScience.org**

5	**(a)**	**(i)**	triangle method used (whether or not shown on graph)	[1]
			Triangle using more than half line and position indicated on graph	[1]
			Expect *G* = 4.00–4.35 (but allow correct working from points read from beyond 1.0 on x axis)	[1]
			Expect *g* = 9.07–9.87 (ecf from G)	[1]
		(ii)	greater accuracy/average value	[1]
	(b)	**(i)**	amplitude	[1]
			length	[1]
			(other possible correct responses shape/size of bob and number of swings)	
		(ii)	does not affect time	[1]
				[Total: 8]

Topic_Phx 1 **Q.9 iG Phx/2007/w/Paper 61 www.SmashingScience.org**

5 **(a)** **(i)** 50, 75/76 [1]

(ii) 25 (ecf) [1]
cm^3 (at least once and not contradicted) [1]

(iii) density 4.36 (ecf) [1]

(b) V_2, V_1 [1]
cm^3(at least once and not contradicted) [1]
density g/cm^3 [1]
5.68, 3.02 both to 2/3 sf [1]

(c) Same method, lots of grains [1]

[Total: 9]

Topic_Phx 1 **Q.10 iG Phx/2006/w/Paper 61 www.SmashingScience.org**

1 **(a)** 4.1 (cm) [1]

(b) **(i)** 4.9 (cm) [1]
both in correct unit [1]

(ii) 7.83(4) (ecf) [1]
cm^3 [1]

(c) **(i)** 7/7.0/7.1/7.2/7.3/7.4/7.5
(ecf: less than V by up to 10% with equivalent sf) [1]

(ii) correct d value (0.84 – 0.90, no ecf) [1]
1/2/3 sf and g/cm^3 [1]

[Total: 8]

Topic_Phx 1 **Q.11 iG Phx/2006/w/Paper 61 www.SmashingScience.org**

2 **(a)** cm; s; s [1]

(b) 1.835; 1.787; 1.753; 1.706; 1.672 (accept 3 sf) [1]
consistent sf (3/4) [1]

(c) Axes suitable (plots occupy at least ½ grid)
and labelled, false origin as instructed [1]
Plots correct to ½ small sq (–1 each error) [2]
Well judged best fit line [1]
line suitably thin [1]

(d) No and not a straight line through the origin [1]

(e) greater accuracy (wtte) [1]

[Total: 10]

Topic Phx 1 **Q.12 iG Phx/2006/s/Paper 61 www.SmashingScience.org**

1 **(a)** **(i)** 1.6 (cm) 16 (mm) **[1]**

(ii) 0.16 (cm) 1.6 (mm) **[1]**
both in cm (or mm) **[1]**

(b) **(i)** 1 = 5.8 cm and w = 6.0 cm (58 mm, 60 mm) **[1]**

(ii) V = 5.568 (or 5.57) **[1]**
V in cm^3 (or mm^3) **[1]**

(c) d = 0.233 (2/3 sf) **[1]**
d in g/cm^3 (or g/mm^3) **[1]**

(d) V_a = 7/8/9/10 cm^3 **[1]**

TOTAL 9

Topic Phx 1 **Q.13 iG Phx/2004/w/Paper 61 www.SmashingScience.org**

2 **(a)** **(i)** triangle seen 1

large triangle (> ½ line) 1

correct readings to ½ sq 1

G = 0.37 – 0.39 1

(ii) ρ = 2.63 (ecf) 1

2/3 sf and g/cm^3 1

(b) increased accuracy 1

TOTAL 6

1	(a) (i) 84	1
	(ii) 50	1
	both units correct ^oC and cm^3 (or ml)	1
	(b) (i) 75	1
	(ii) 15 (ecf)	1
	(iii) source of error e.g. thickness of string/extension of string/diagonal windings/identified parallax	1
	(iv) improvement e.g. thinner string/inextensible string/parallel windings/ no gaps between windings/repeats and averages	1
	(c) (i) 2.1 (cm)	1
	(ii) 31.5 or 32 cm^2 (2/3 sf and unit required)	1
	(d) time	1
	another temperature	1
		TOTAL 11

Topic_Phx 1 **Q.15 iG Phx/2004/w/Paper 61 www.SmashingScience.org**

3	(a) (i) 2.15 – 2.25	1
	(ii) 1.1 (+ both with correct unit, cm/mm) ecf	1
	(b) (i) all correct 1 values, 91.1, 81.1, 71.1, etc	1
	(ii) all correct T values, 1.93, 1.80, 1.67, 1.57, 1.41, 1.28	1
	3/4sf for T	1
	(c) Graph:	
	scales suitable T start at 1.0s, T: 10sq : 0.2s	
	1: 10sq : 20cm; both labelled	
	and correct way round	1
	plots correct to ½ sq (-1 each error)	2
	line judgement	1
	line thickness	1
	(d) 58 cm	1
		TOTAL 11

Topic_Phx 1 **Q.16 iG Phx/2003/w/Paper 61 www.SmashingScience.org**

1	(a)		wind string round more than once	1
			divide measured length by number of turns to find c	1
	(b)	(i)	correct diagram, blocks parallel, one at each end	1
		(ii)	119 mm OR 11.9 cm to 121 mm OR 12.1 cm	1
	(c)		V = 32.39 to 32.41	1
			cm^3	1
	(d)	(i)	$V_m = 0.5 – 2\ cm^3$	1
		(ii)	correct calculation and 2/3 sf (ignore unit)	1
				TOTAL 8

Topic_Phx 1 **Q.17 iG Phx/2003/w/Paper 61 www.SmashingScience.org**

4	(a)	Scales: y-axis 1N = 4 cm; x-axis 1m/s2 = 4/5 cm right way round	1
		Both axes labelled with quantity and unit	1
		Plots to ½ sq (-1 each error or omission, minimum mark zero)	2
		Line thickness less than 1 mm and no 'blob' plots	1
		Well judged best fit single straight line	1
	(b)	Large triangle used (> ½ line) clear on graph	1
		Interpolation to ½ sq (if large enough triangle present)	1
		Value 1.38 – 1.48	1
		kg and 2/3 sf	1
			TOTAL 10

Topic_Phx 1 **Q.18 iG Phx/2003/s/Paper 61 www.SmashingScience.org**

4	(a)	(i)	6.8cm (68mm)	1
		(ii)	6.8	1
			unit, mm	1
	(b)	(i)	3.8/3.77 or 0.38/0.377	1
			mm or cm as appropriate	1
		(ii)	0.94/0.95 (or evidence of division by 4)	1
		(iii)	0.75094/0.75095	1
	(c)		Thickness of string/thickness of marks on string/stretching of string/metre rule measures to 1mm	1
			TOTAL	**8**

1. (a) (i) x = 6.0 /6.1 1
   (ii) 6/12 1
   d = 0.50 1
   (iii) value 0.0654 1
   unit 1
   2/3 sf 1

(b) (i) 80
   96 1
   (ii) 96 – 80 = 16 1
   (iii) 0.0711 (ignore sf) with unit 1

(c)
   (ii) M1, difficult to measure liquid volume accurately
   M2, more beads
   M2, diameter variation
   other sensible suggestion. 1

TOTAL 10

1 The class is determining the weight of a metre rule using a balancing method.

The apparatus is shown in Fig. 1.1.

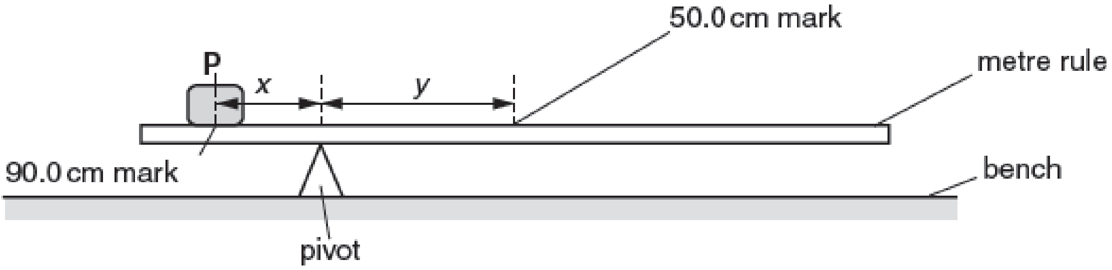


Fig. 1.1

(a) A student places a load P at the 90.0 cm mark on a metre rule and then balances the rule on a pivot.

(i) On Fig. 1.1, measure the distance *x* from the 90.0 cm mark to the pivot.

x = ... [1]

(ii) On Fig. 1.1, measure the distance *y* from the pivot to the centre of the rule.

y = ... [1]

(b) Fig. 1.1 is drawn one tenth of actual size.

(i) Calculate the actual distance *X* from the 90.0 cm mark to the pivot.

X = ...

(ii) Calculate the actual distance *Y* from the pivot to the centre of the rule.

Y = ...

[1]

(iii) Determine a value W_1 for the weight of the metre rule using the equation $W_1 = \frac{PX}{Y}$, where P = 2.0 N. P is the weight of the load P.

W_1 = ... [1]

(c) The student keeps the pivot at the same position and moves load **P** to the 95.0 cm mark. He places a load **Q** of weight Q = 1.0 N, on the metre rule. He adjusts its position so that the rule balances.

On Fig. 1.2 mark, with a letter Z, the approximate position of the load **Q**. You do not need to carry out a detailed calculation.

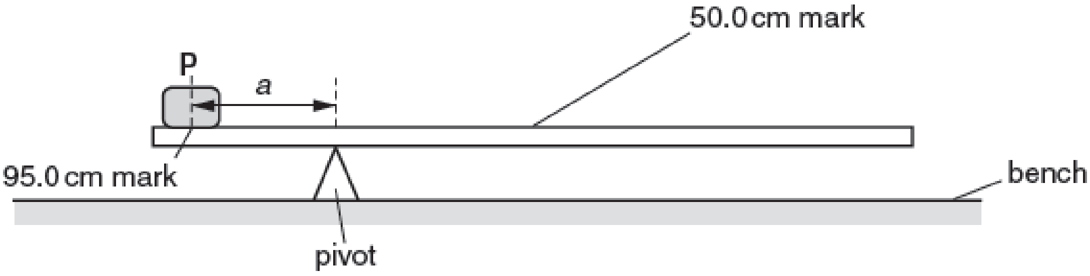


Fig. 1.2

[1]

(d) The student uses the values of **P** and **Q** and their distances from the pivot to calculate a second value W_2 for the weight of the rule.

W_2 = ...1.12 N.......................

The student expects W_1 and W_2 to be the same.

State whether the results support his idea. Justify your answer by reference to the results.

statement ....

justification ....

....

.... [2]

(e) Suggest one practical reason why it is difficult to obtain exact results with this experiment.

....

....[1]

[Total: 8]

1 The IGCSE class is investigating the motion of a mass hanging on a spring.

Fig. 1.1 shows the apparatus

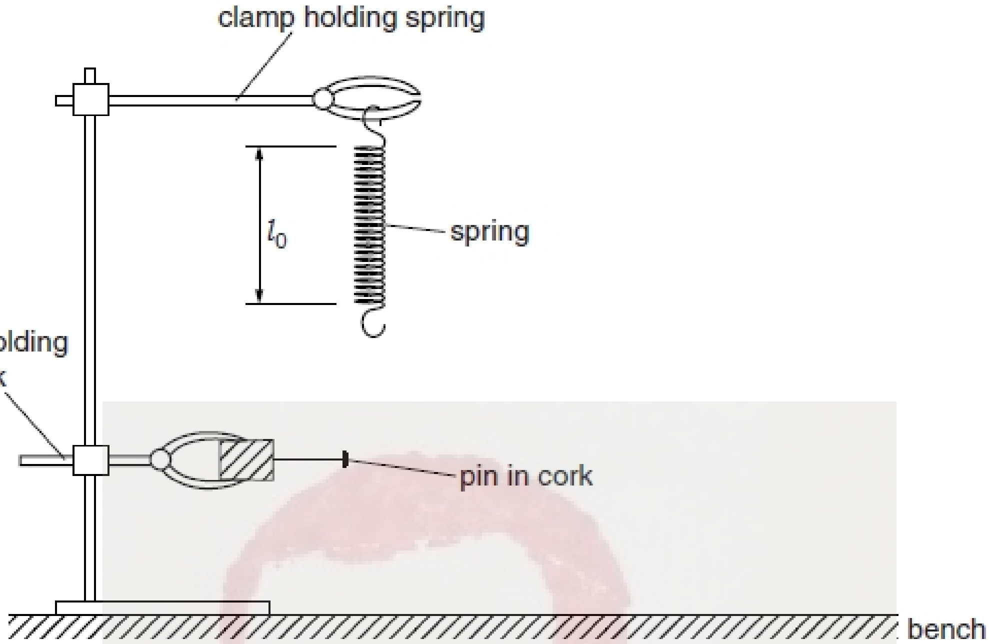


Fig. 1.1

(a) On Fig. 1.1, measure the length l_0 of the unstretched spring, in mm.

l_0 = ... mm [1]

(b) The diagram is drawn one tenth of actual size. Write down the actual length L_0 of the unstretched spring, in mm.

L_0 = ...mm [1]

A student hangs a 300 g mass on the spring and measures the new length L of the spring.

L = 255 mm

(i) Calculate the extension e of the spring using the equation $e = (L - L_0)$.

e = ...mm

(ii) Calculate a value for the spring constant k using the equation $k = \frac{F}{e}$, where F = 3.0 N. Include the appropriate unit.

k = ...

[2]

(c) The student adjusts the position of the lower clamp so that the pin is level with the bottom of the mass when the mass is not moving. She pulls the mass down a short distance and releases it so that it oscillates up and down. Fig. 1.2 shows one complete oscillation.

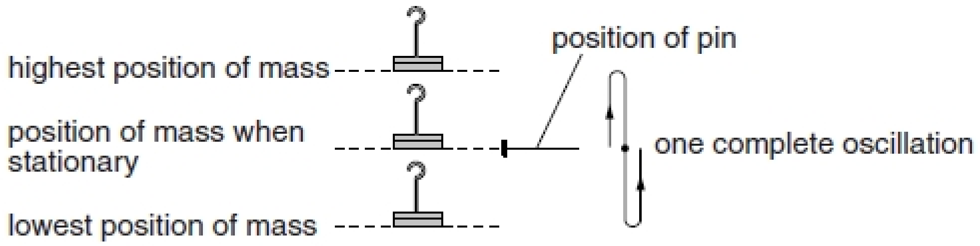


Fig. 1.2

She measures the time *t* taken for 20 complete oscillations.

t = 26.84 s ....

Calculate the time *T* taken for one complete oscillation.

T = ... [1]

(d) She replaces the 300 g mass with a 500 g mass. She repeats the timing as described in part **(c)**.

t = 34.48 s ....

(i) Calculate the time *T* taken for one complete oscillation.

T = ...

(ii) The student suggests that the time taken for the oscillations of the spring should not be affected by the change in mass.

State whether her results support this suggestion and justify your answer by reference to the results.

statement ....

justification ....

....

....
[2]

(e) Explain briefly how you avoid a line-of-sight (parallax) error when measuring the length of a spring in this type of experiment. You may draw a diagram.

....

....

....[1]

[Total: 8]

1 The IGCSE class is carrying out a moments experiment by balancing a metre rule on a small pivot.

(a) A student has a small pivot and a metre rule.

Explain briefly how the student finds the position of the centre of mass of the metre rule.

....

....

....[1]

(b) The student finds that the centre of mass is not in the middle of the rule but at the 50.2 cm mark.

Explain what the student could do to prevent this from affecting her results.

....

....[1]

(c) The student places the metre rule on a pivot so that it balances.

She places a load **P** on one side of the metre rule at a distance *x* from the pivot. She places another load **Q** on the metre rule and adjusts the position of the load **Q** so that the rule balances, as shown in Fig. 1.1.

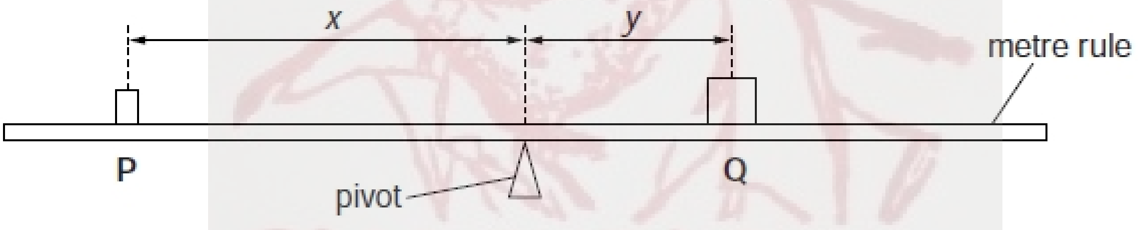


Fig. 1.1

The load **Q** is a distance *y* from the pivot.

The readings are shown in Table 1.1.

Table 1.1

weight of **P** / N	weight of **Q** / N	*x* /	*y* /
2.0	5.0	39.0	15.5

(i) Complete the column headings in the table. [1]

(ii) Calculate the clockwise moment and the anticlockwise moment using the equation

moment of a force = force × perpendicular distance to the pivot.

clockwise moment = ...

anticlockwise moment = ...

[1]

(d) In practice, it is difficult to adjust the loads to make the rule balance exactly.

Explain briefly how you would reduce the uncertainty in the position of Q required for exact balance.

....

.... [1]

[Total: 5]

5 The IGCSE class is determining the mass of a load **X** using a balancing method.

Fig. 5.1 shows the apparatus.

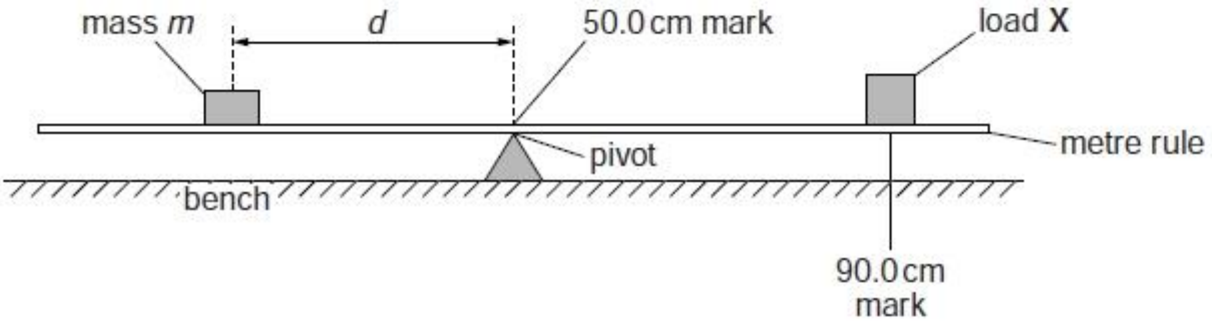


Fig. 5.1

The centre of the load **X** is fixed at the 90.0 cm mark on the rule.

A student uses a range of values of the mass *m* and determines the distance *d* from the pivot where the mass must be placed to balance the rule.
The readings are shown in Table 5.1.

Table 5.1

m / g	*d* / cm
40	30.2
50	23.9
60	20.0
70	17.1
80	15.1

(a) Calculate the distance *x* between the centre of the load **X** and the centre of the rule.

x = ... [1]

(b) Suggest a reason for the student using a range of *m* values.

....

....

.... [1]

(c) Using each set of readings and the value of *x*, the student calculates values for the mass of the load **X**.

He writes his results: 30.2 g, 29.875 g, 30 g, 29.925 g, 30.2 g.

Use these results to calculate an average value for the mass of **X** and give it to a suitable number of significant figures for this type of experiment.

average value for the mass of **X** = ... [2]

(d) This type of balancing experiment is difficult to carry out.

Suggest one practical difficulty and one way to try to overcome the difficulty. You may draw a diagram, if you wish.

practical difficulty ....

....

....

way to overcome the difficulty

....

....

[2]

[Total: 6]

1 The IGCSE class is investigating the stretching of a spring.

Fig. 1.1 shows the experimental set up.

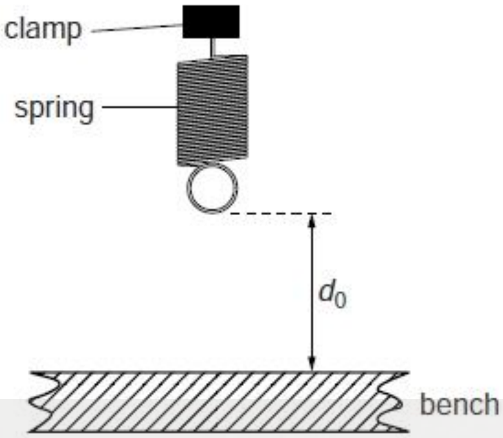


Fig. 1.1

(a) On Fig. 1.1, measure the vertical distance d_0, in mm, between the bottom of the spring and the surface of the bench.

d_0 = ... mm [1]

(b) The diagram is drawn 1/10th actual size. Calculate the actual distance D_0, in mm, between the bottom of the spring and the surface of the bench.

D_0 = ... mm [1]

(c) A student hangs a 1.0 N load on the spring. He measures and records the distance D between the bottom of the spring and the surface of the bench, and the value of the load L.

He repeats the procedure using loads of 2.0 N, 3.0 N, 4.0 N and 5.0 N. The distance readings are shown in Table 1.1.

Calculate the extension e of the spring, for each set of readings, using the equation $e = (D_0 - D)$. Record the values of L and e in Table 1.1.

Table 1.1

L / N	D / mm	e / mm
	199	
	191	
	179	
	171	
	160	

[2]

(d) Plot a graph of e / mm (y-axis) against L / N (x-axis).

[4]

(e) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

(f) When making measurements, the student is careful to avoid a line-of-sight error.

Suggest one other precaution that the student should take when measuring the distance D between the bottom of the spring and the surface of the bench.

....

.... [1]

[Total: 11]

1 An IGCSE student is determining the mass of a metre rule using a balancing method.

Fig. 1.1 shows the apparatus.

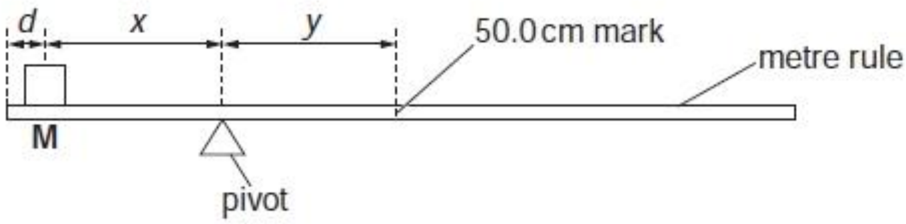


Fig. 1.1

Mass **M** is placed on the rule. The position of the pivot is adjusted until the rule balances.

(a) The student chooses a mass **M** which is similar to the mass of the metre rule. Suggest a suitable value for the mass.

suitable mass = ... [1]

(b) The mass is cylindrical and has a diameter slightly larger than the width of the metre rule.

Describe briefly how you would place the mass so that its centre of mass is exactly over the 90.0 cm mark on the metre rule. You should draw a diagram and mark the position of the centre of mass on the cylinder.

....

....

.... [2]

(c) From your experience of carrying out balancing experiments of this type, suggest one difficulty that you are likely to come across that could make the final result inaccurate.

....

....

.... [1]

(d) The student takes a reading of *x* and the corresponding reading of *y*. He then calculates the mass of the metre rule.

Suggest how you would improve the reliability of the value of the mass of the metre rule, using this method.

....

.... [1]

(e) Another student carries out a similar experiment to determine the mass of a 50 cm metal strip. She calculates the mass and writes down "mass = 234.872 g".

She checks the mass on an accurate balance. The value is 235 g. She thinks she must have made a mistake in her experiment.

Write a brief comment on the accuracy of her experimental result.

....

....

.... [1]

[Total: 6]

1 An IGCSE student is determining the weight of a metre rule.

Fig. 1.1 shows the apparatus.

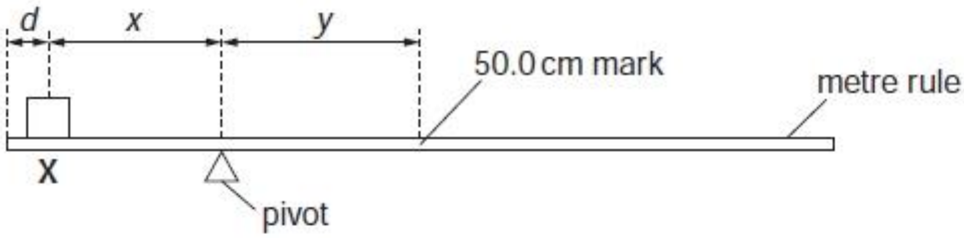


Fig. 1.1

X is a 1.0 N load.

The student places the load **X** on the rule so that its centre is at *d* = 5.0 cm from the zero end of the rule, as shown in Fig.1.1. He adjusts the position of the rule so that it is as near as possible to being balanced, with the 50.0 cm mark to the right of the pivot.

He measures and records the distance *x* from the centre of the load **X** to the pivot, and the distance *y* from the pivot to the 50.0 cm mark on the rule. He repeats the procedure using *d* values of 10.0 cm, 15.0 cm, 20.0 cm and 25.0 cm. The readings of *d*, *x* and *y* are shown in Table 1.1.

Table 1.1

d / cm	*x* / cm	*y* / cm
5.0	23.7	21.3
10.0	21.0	19.1
15.0	18.5	16.3
20.0	16.0	14.1
25.0	13.9	12.0

(a) Plot the graph of y/cm (y-axis) against x/cm (x-axis). You do not need to include the origin (0,0) on your graph.

[4]

(b) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

(c) Calculate the weight W of the metre rule using the equation $W = \frac{L}{G}$, where L = 1.0 N.

W = ... [1]

(d) The calculation of *W* is based on the assumption that the centre of mass of the rule is at the 50.0 cm mark.

(i) Describe briefly how you would determine the position of the centre of mass of the rule.

....

....

(ii) Describe how you would modify the experiment if the centre of mass was at the 49.7 cm mark.

....

....[2]

[Total: 9]

1 An IGCSE student is determining the position of the centre of mass of a triangular card.

The apparatus is shown in Fig. 1.1.

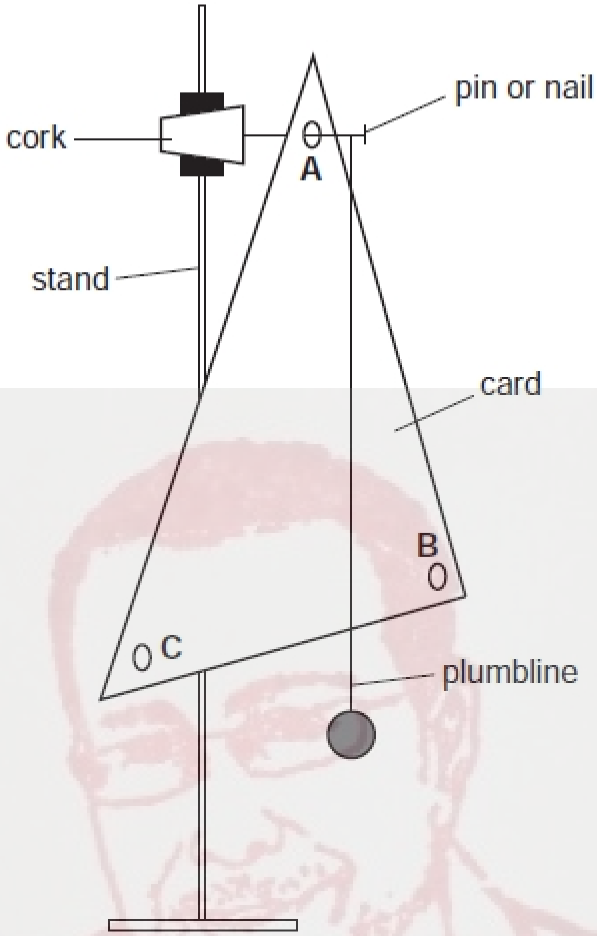


Fig. 1.1

(a) The student hangs the card on the nail through hole **A**. He checks that the card is able to swing freely and then hangs the plumbline from the nail so that it is close to, but not touching, the card. When the card and plumbline are still, he makes a small mark at the edge of the card where the plumbline crosses the edge. He removes the card and draws a line from the mark to hole **A**.

He repeats the procedure using holes **B** and **C**.

Fig.1.2 is a drawing of the card.

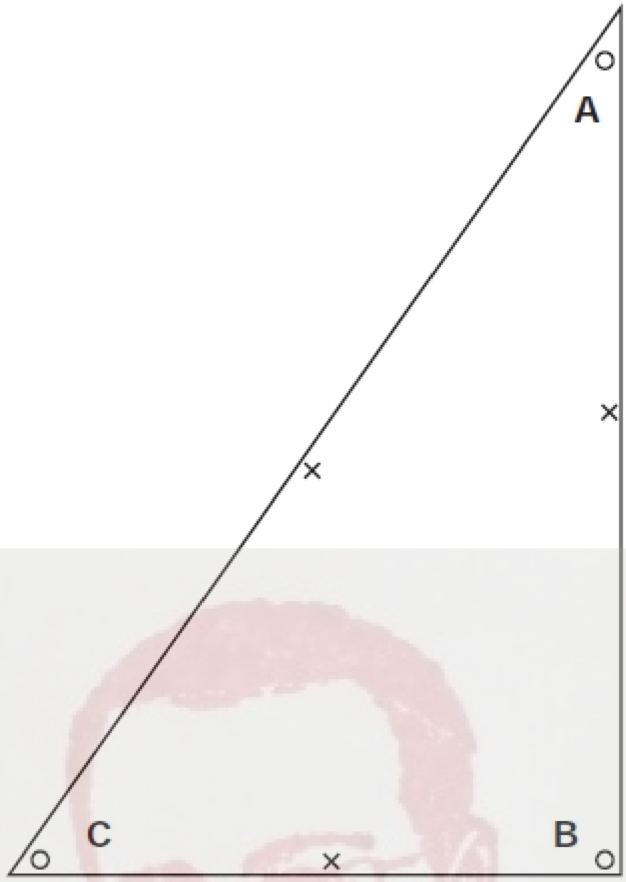


Fig.1.2

On Fig.1.2, the position of each of the marks the student makes is shown with a small cross. On Fig. 1.2, draw in the lines between the positions of the holes **A**, **B** and **C** and the corresponding crosses on the card. [2]

(b) If the experiment is completely accurate, the centre of mass of the card is at the position where the three lines meet. On Fig. 1.2, judge the best position for the centre of mass, marking it with a small cross. Draw a line from this position to the right-angled corner of the card and measure the distance *a* between the centre of mass and the right-angled corner of the card.

a = ...[3]

(c) In this experiment, it is important that the card is able to swing freely. For this reason, the plumbline should not touch the card but be a small distance from it. This could cause an inaccuracy in marking the card at the correct position. Describe how you would minimise this possible inaccuracy. You may draw a diagram.

....

....[1]

[Total: 6]

1 An IGCSE student is investigating the stretching of springs.

Fig. 1.1 shows the apparatus used for the first part of the experiment.

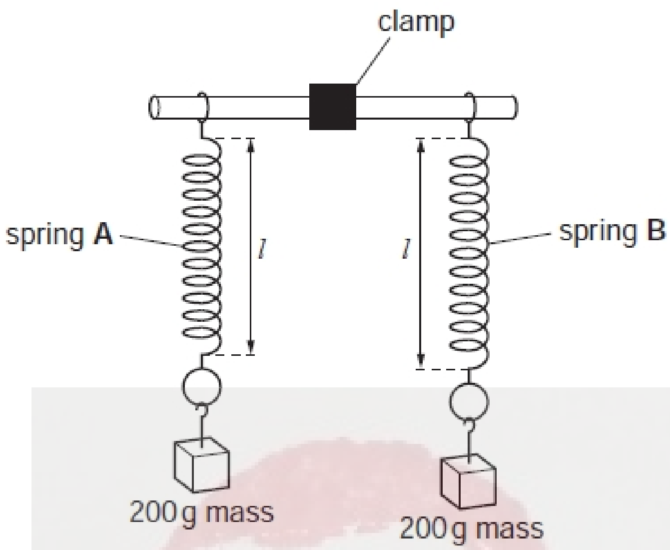


Fig. 1.1

The unstretched length l_A of spring **A** is 15 mm.

The unstretched length l_B of spring **B** is 16 mm.

(a) The student hangs a 200 g mass on each spring, as shown in Fig. 1.1.

(i) On Fig. 1.1 measure the new length l of spring **A**.

l = ... mm

(ii) Calculate the extension e_A of the spring using the equation $e_A = (l - l_A)$.

e_A = ... mm

(iii) On Fig. 1.1 measure the new length l of spring **B**.

l = ... mm

(iv) Calculate the extension e_B of the spring using the equation $e_B = (l - l_B)$.

e_B = ... mm
[2]

(b) The student then sets up the apparatus as shown in Fig. 1.2.

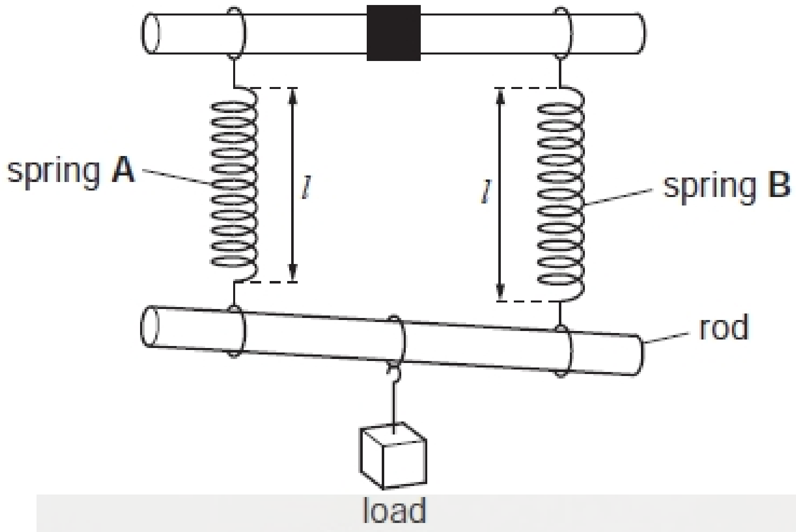


Fig. 1.2

(i) On Fig. 1.2 measure the new length of each of the springs.

spring **A**: l = ... mm

spring **B**: l = ... mm

(ii) Calculate the extension of each spring using the appropriate equation from part **(a)**.

spring **A**: e = ... mm

spring **B**: e = ... mm

(iii) Calculate the average of these two extensions e_{av}. Show your working.

e_{av} = ...mm

[3]

(c) It is suggested that $(e_{\mathbf{A}} + e_{\mathbf{B}})/4 = e_{av}$.

State whether your results support this theory and justify your answer with reference to the results.

Statement ....

Justification ....

.... [2]

(d) Describe briefly one precaution that you would take to obtain accurate length measurements.

....

1 A student is determining the position of the centre of mass of an object using a balancing method.

Fig. 1.1 shows the apparatus used.

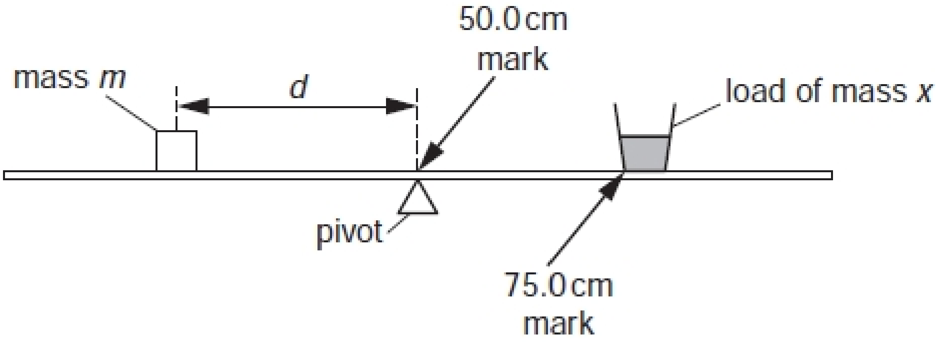


Fig. 1.1

A load of mass x is taped to the metre rule so that one side of the base is exactly on the 75.0 cm mark. The student places a mass m of 30 g on the rule and adjusts its position so that the rule is as near as possible to being balanced with the 50.0 cm mark exactly over the pivot, as shown in Fig. 1.1.

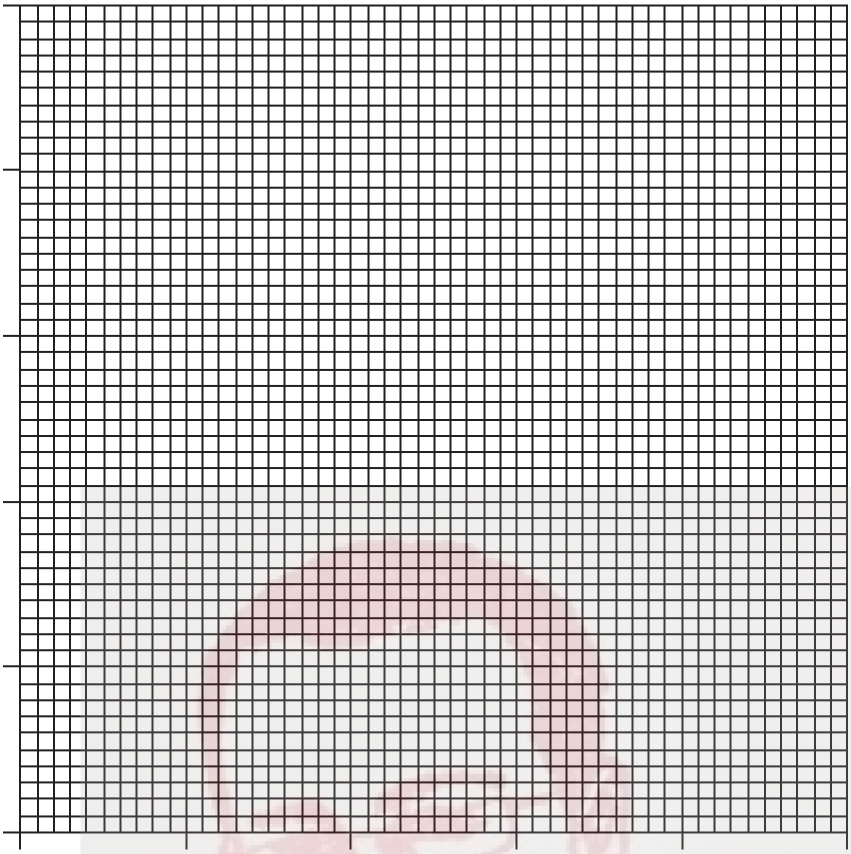
The student records the distance d from the centre of the 30 g mass to the 50.0 cm mark on the rule. He then repeats the procedure using different masses. The readings are shown in Table 1.1.

Table 1.1

m/g	d/cm	$\frac{1}{d} / \frac{1}{\text{cm}}$
30	45.0	
40	34.0	
50	27.0	
60	22.5	
70	19.3	

(a) For each value of d, calculate $1/d$ and enter the values in the table. [2]

(b) Plot a graph of m/g (y-axis) against $\frac{1}{d}\Big/\frac{1}{\text{cm}}$ (x-axis).



[4]

(c) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

(d) Determine the horizontal distance z from the 75.0 cm mark on the rule to the centre of mass of the load using the equation

$$z = \frac{G - k}{x},$$

where k = 1250 g cm and x = 50 g.

z = ... [2]

[Total: 10]

5 An IGCSE student is investigating moments using a simple balancing experiment.

He uses a pivot on a bench as shown in Fig. 5.1.

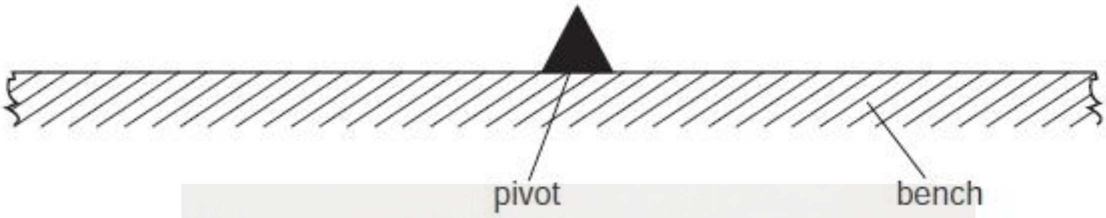


Fig. 5.1

First, the student balances the metre rule, without loads, on the pivot. He finds that it does not balance at the 50.0 cm mark, as he expects, but it balances at the 49.7 cm mark.

Load **Q** is a metal cylinder with diameter a little larger than the width of the metre rule, so that it covers the markings on the rule. Load **Q** is placed carefully on the balanced metre rule with its centre at the 84.2 cm mark. The rule does not slip on the pivot.

(a) Draw on Fig. 5.1 the metre rule with load **Q** on it. [2]

(b) Explain, using a labelled diagram, how the student would ensure that the metre rule reading at the centre of **Q** is 84.2 cm.

[2]

(c) Calculate the distance between the pivot and the centre of load **Q**.

distance = ... [1]

[Total: 5]

1 An IGCSE student is making measurements as accurately as possible in order to determine the density of glass.

Fig. 1.1 shows a glass test-tube drawn actual size.

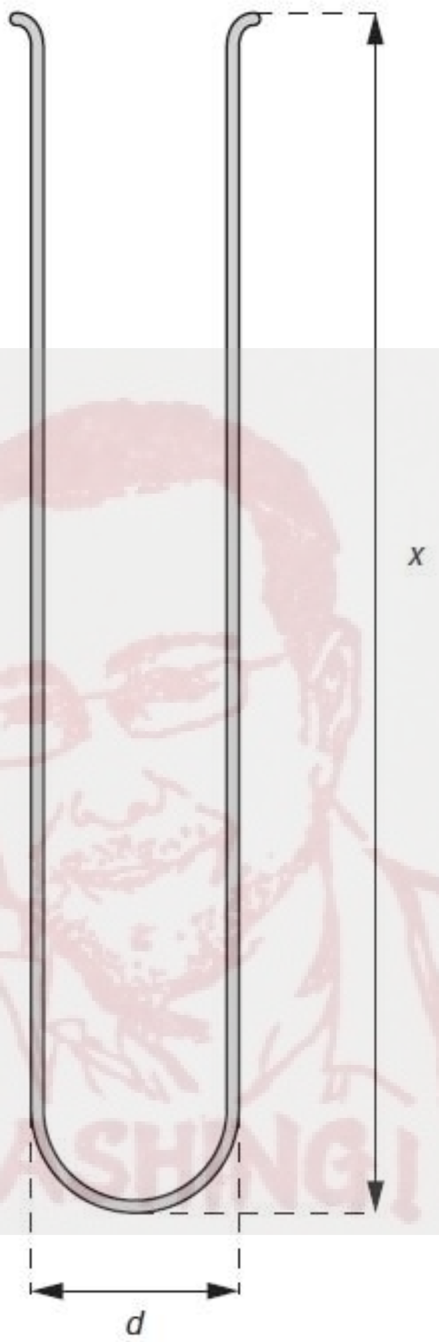


Fig. 1.1

(a) (i) Use your rule to measure, in cm, the external diameter *d* of the test-tube.

d = ... cm

(ii) Use your rule to measure, in cm, the length x of the test-tube.

x = ...

(iii) Draw a labelled diagram to show how you would use two rectangular blocks of wood and your rule to measure the length x of the test-tube as accurately as possible.

[4]

(b) The mass m of the test-tube is 31.2 g.

(i) Calculate the external volume V_e of the test-tube using the equation

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

V_e = ...

(ii) The student then fills the test-tube with water and pours the water into a measuring cylinder. Fig. 1.2 shows the measuring cylinder.

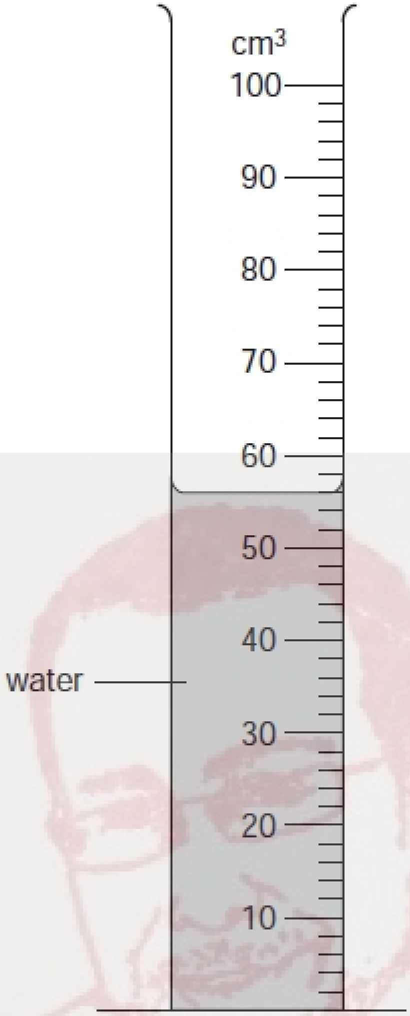


Fig. 1.2

Record the volume reading V_i from the measuring cylinder. This is the internal volume of the test-tube.

V_i = ...

(iii) Calculate the density ρ of the glass from which the test-tube is made using the equation

$$\rho = \frac{m}{(V_e - V_i)}.$$

ρ = ... [4]

[Total: 8]

1 An IGCSE student is determining the density of the metal from which a load is made.

The apparatus is shown in Fig. 1.1.

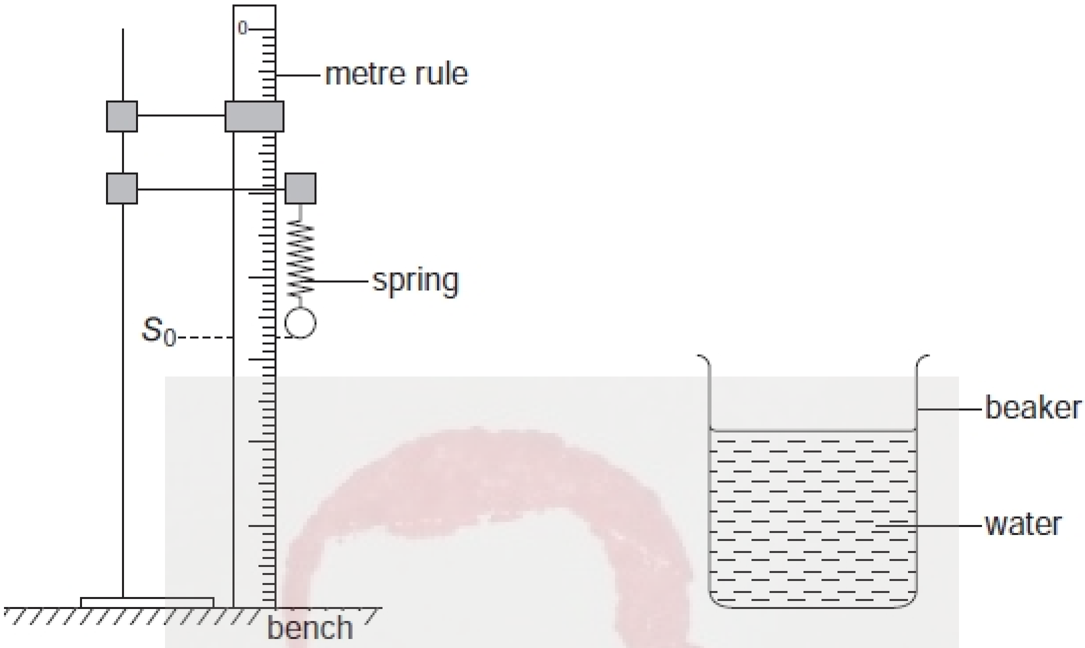


Fig. 1.1

(a) The student records the scale reading S_0 on the metre rule at the bottom of the spring, as shown in Fig. 1.1.

S_0 = 37.4 cm

Describe briefly how the student can avoid a parallax error when taking the scale reading.

....

.... [1]

(b) He then hangs the load on the spring as shown in Fig. 1.2. He records the new scale reading S_1.

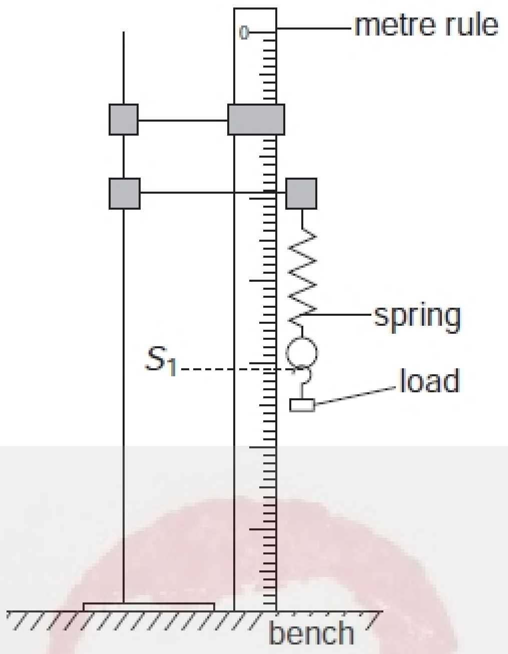


Fig. 1.2

S_1 = 40.5 cm

(i) Calculate the extension e_1 of the spring using the equation

$$e_1 = (S_1 - S_0).$$

e_1 = ...

The student carefully raises the beaker under the load until it is completely under water. The load does not touch the sides or base of the beaker. He records the new scale reading S_2.

S_2 = 39.8 cm

(ii) Calculate the extension e_2 of the spring using the equation $e_2 = (S_2 - S_0)$.

e_2 = ...

[2]

(c) Calculate the density ρ of the material of the load using the equation

$$\rho = \frac{e_1}{(e_1 - e_2)} \times k$$

where k = 1.00 g/cm^3.

ρ = ... [3]

(d) A second load, made from the same material and with the same mass, is too long to be completely submerged in the water.

Suggest whether

(i) the value obtained for e_2 would be greater, smaller or the same as that obtained in part **(b) (ii)**,

....

(ii) the value obtained for ρ would be greater, smaller or the same as that obtained in part **(c)**.

....

[2]

[Total: 8]

1 An IGCSE student is determining the density of a solid metal cylinder using a balancing method. Fig. 1.1. shows the apparatus.

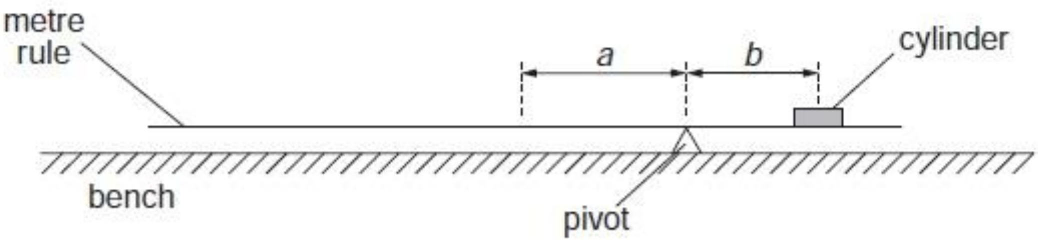


Fig. 1.1

He places the cylinder on the metre rule so that its centre is directly above the 10.0 cm mark. The rule is placed on the pivot so that the rule is as near as possible to being balanced.

He measures and records the distance *a* from the centre of the rule to the pivot and the distance *b* from the centre of the cylinder to the pivot. He repeats the experiment with the same cylinder at different positions on the rule.

The readings are shown in Table 1.1.

Table 1.1

a/	*b*/	*M*/
12.6	27.4	
11.0	24.0	
9.5	20.5	

(a) **(i)** Complete the column headings in Table 1.1.

(ii) For each set of readings, calculate the mass *M* of the cylinder using the equation

$$M = \frac{ka}{b}.$$

The value of *k* is the mass of the rule which is 108 g.

Enter the results in Table 1.1.

[3]

(b) The cylinder completely covers the marks on the metre rule. Describe, with the aid of a diagram, how you would judge that the centre of the cylinder is directly above the 10.0 cm mark.

....

....[1]

(c) Use your answers in Table 1.1 to calculate and record the average of the three values for *M*. Show your working.

average value for *M* = ...[2]

(d) Fig. 1.2 shows the cylinder placed flat on the bench and viewed from one side.

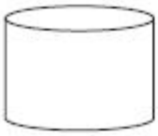


Fig. 1.2

(i) On the diagram, measure the diameter *d* and the thickness *t* of the cylinder.

d = ...

t = ...

(ii) Calculate the volume *V* of the cylinder using the equation

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

V = ...

(iii) Calculate the density ρ of the cylinder using the equation

$$\rho = \frac{M}{V}.$$

ρ = ... [3]

[Total: 9]

2 The IGCSE class is investigating a simple balance.

The diagram below shows the apparatus.

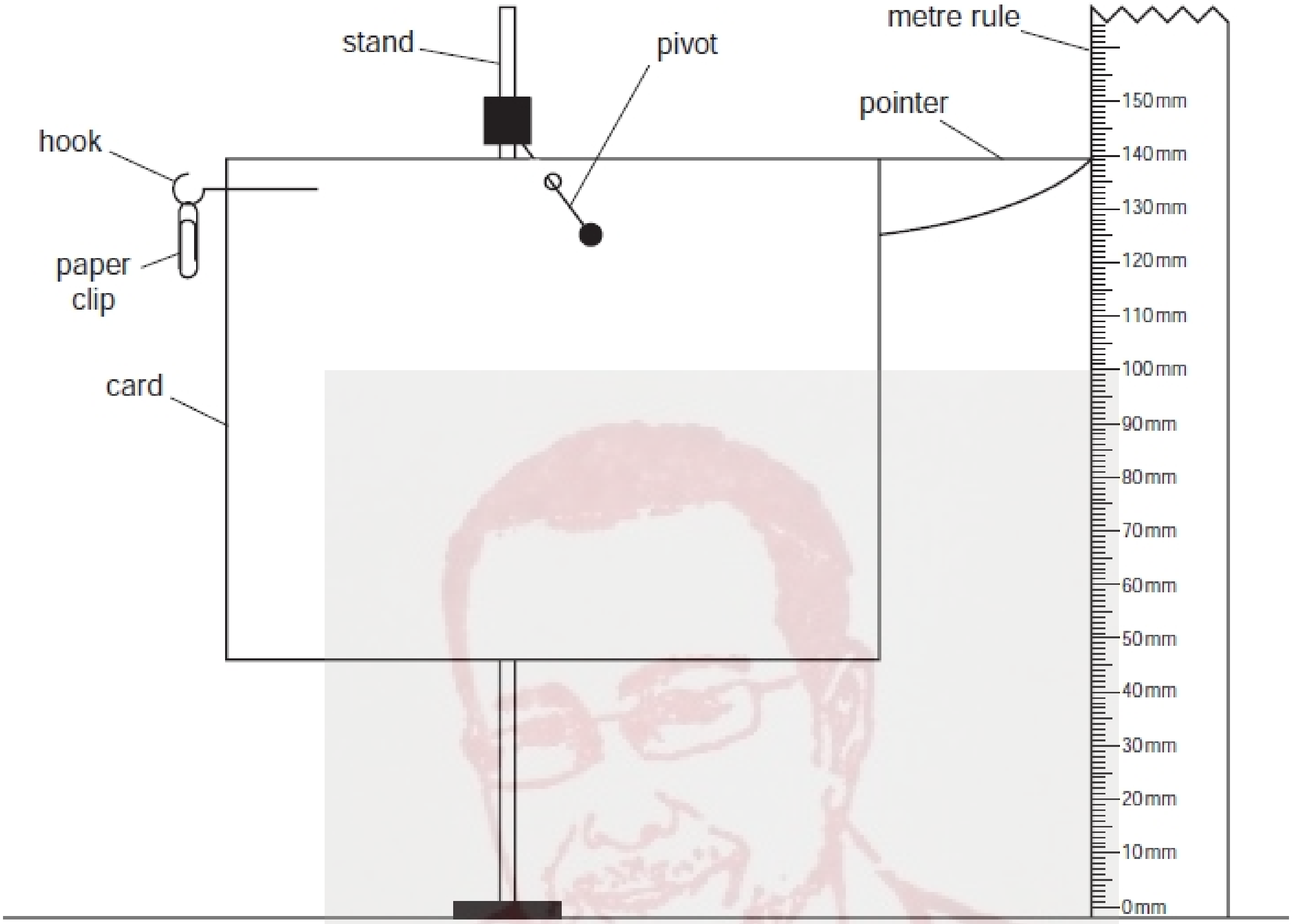


Fig. 2.1

(a) A student records the height h_0 of the pointer above the bench. She then hangs a paper clip on the hook and records the new height h of the pointer above the bench. Next she records the heights of the pointer above the bench using different numbers N of paper clips. The readings are shown in the table below.

$h_0 = 100\,\text{mm}$

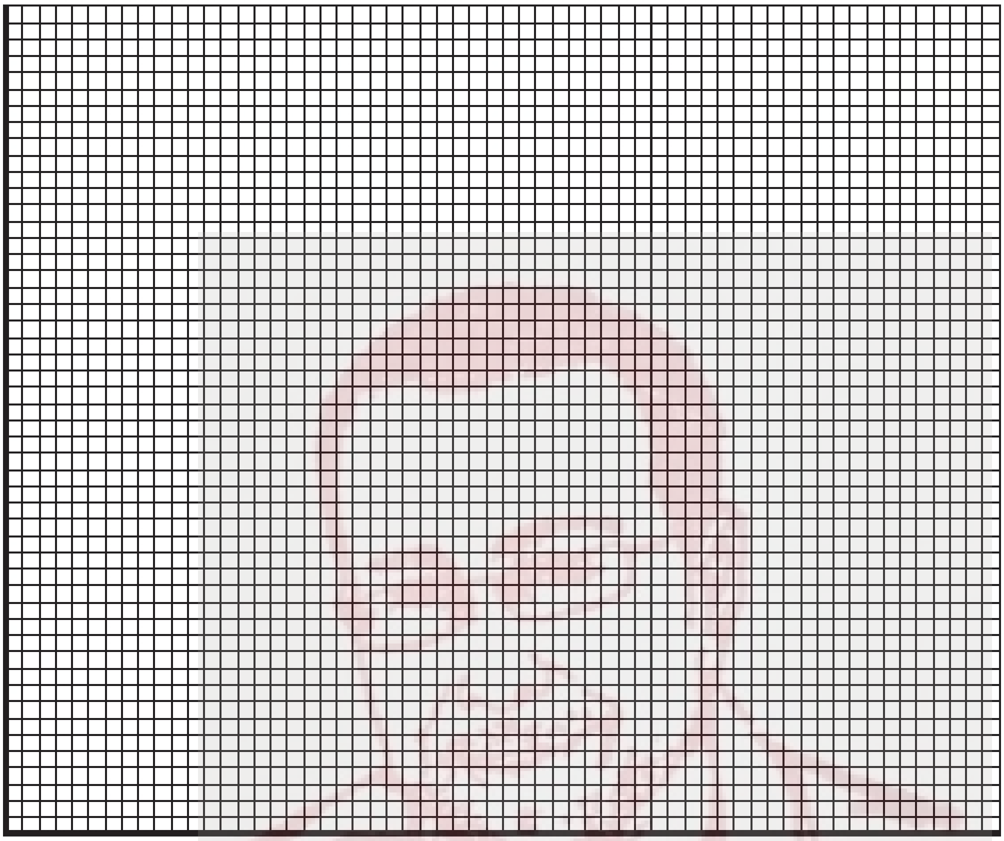
N	h/mm	d/mm
1	108	
2	114	
3	120	
4	125	
5	134	
6	141	

Calculate the height differences *d* using the equation

$$d = (h - h_0)$$

and enter them in the table. [2]

(b) **(i)** Plot the graph of *d*/mm (*y*-axis) against *N* (*x*-axis).



(ii) Use your graph to predict the value of *d* if a nail with the same mass as 4.6 paper clips were to be hung from the hook in place of the paper clips. Show clearly on the graph how you obtained your value.

d = ... [6]

[Total: 8]

5 (a) An IGCSE student is investigating the relationship between the extension of a spring of unstretched length l_0 and the load hung on the spring. The apparatus is shown in Fig. 5.1 below. The spring is shown larger than its actual size.

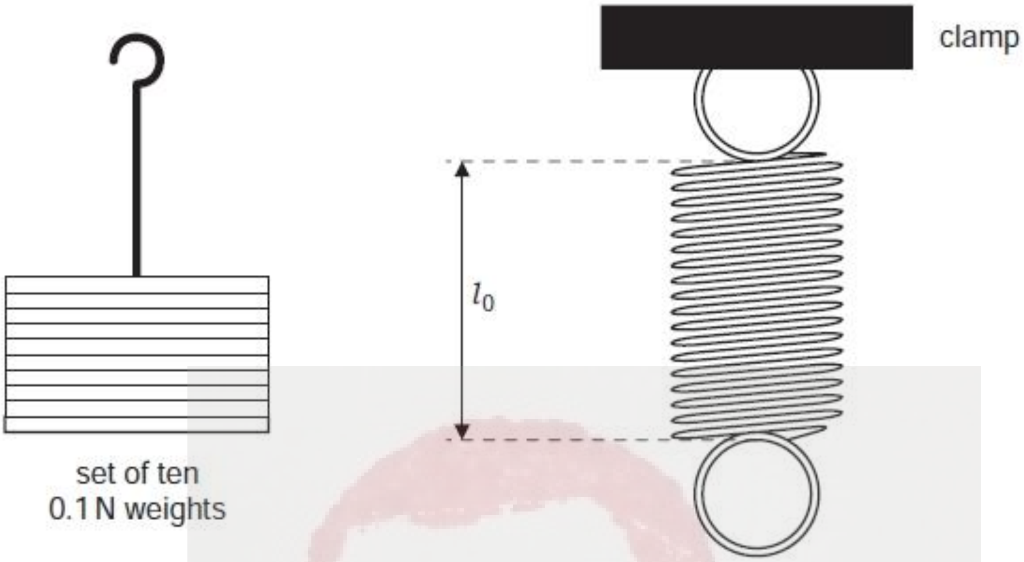


Fig. 5.1

Consider the readings that the student should take and write appropriate column headings, with units, in the table below.

l_0 = 25 mm

0.0	25	0
0.1	30	5
0.2	36	11
0.3	43	18
0.4	50	25

[4]

(b) The student decides to repeat the experiment using a spring made of a different metal in order to study how the extension may be affected by the metal from which the spring is made. To make a fair comparison, other variables must be kept constant. Suggest three variables that the student should keep constant.

1. ....

2. ....

3. .... [3]

[Total: 7]

2 A student is investigating the position of a sheet of card that is hanging from a pivot.

Fig. 2.1 shows the apparatus drawn full size.

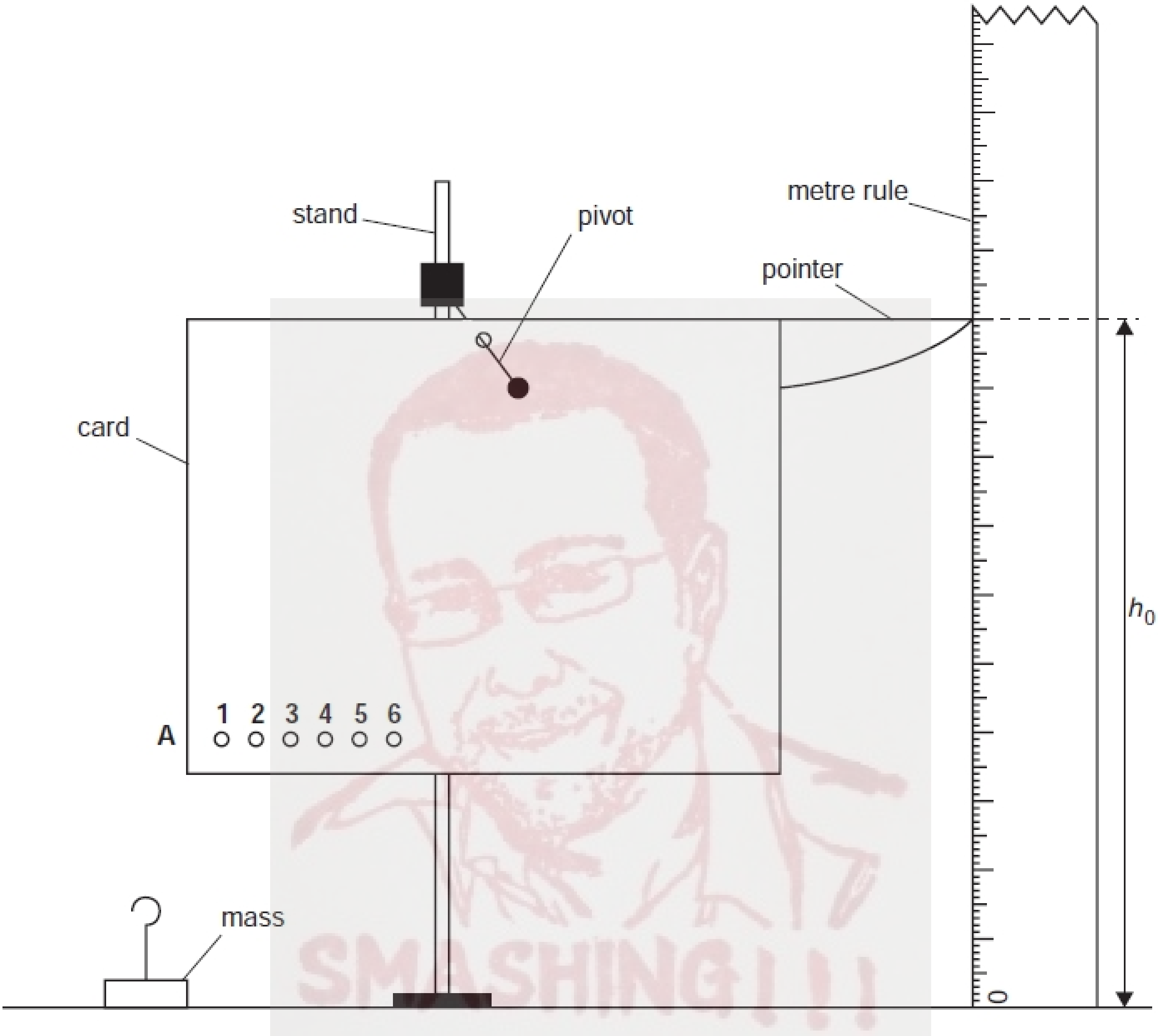


Fig. 2.1

(a) On Fig. 2.1 measure the distance *d* between the centre of the hole labelled **1** and the edge of the card at **A**. Record this value in the table.

hole	*d* / mm	*h* / mm	*b* / mm
1		140	
2		135	
3		132	
4		128	
5		124	
6		120	

[3]

(b) Repeat step **(a)** for each of the remaining holes **2** – **6**.

(c) On Fig. 2.1 measure the height h_0 of the pointer above the bench.

h_0 = ...

[1]

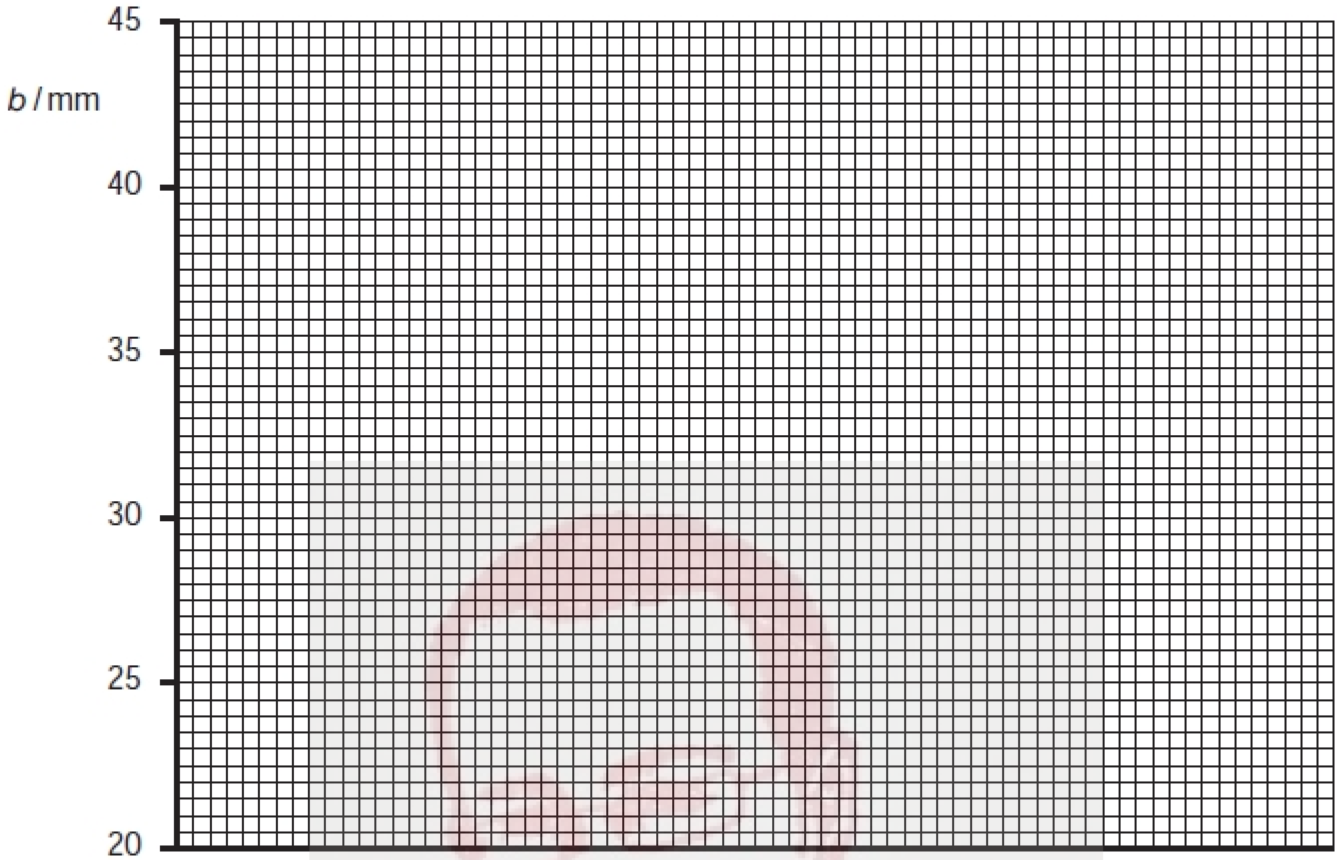
(d) A student hangs a 10 g mass from the hole **1** in the card. She records the height *h* of the end of the pointer above the bench. She then repeats this procedure by hanging the mass from each hole in turn. Her results are shown in the table above.

(e) Calculate the differences in heights *b* using the equation

$$b = (h - h_0)$$

and record the results in the table above.

(f) Plot the graph of *b* / mm (*y*-axis) against *d* / mm (*x*-axis).



[4]

(g) The student suggests that *b* is directly proportional to *d*. By reference to your graph, state whether or not the results support the student's suggestion. Give a reason for your answer.

Statement ....

Reason ....

....

.... [2]

(h) It is important when recording the heights that the rule is vertical. State briefly how you would check that the rule is vertical.

....

.... [1]

[Total: 11]

5 The IGCSE class is determining the weight of a metre rule.

The apparatus is shown in Fig. 5.1.

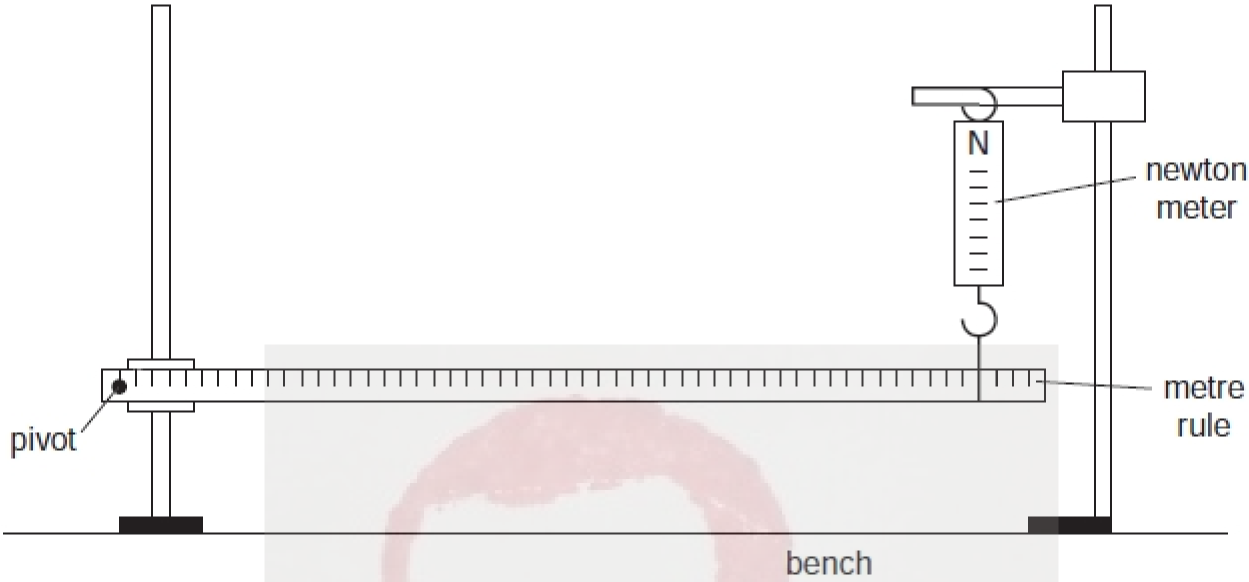


Fig. 5.1

A metre rule is supported at one end by a pivot through the 1.0 cm mark. The other end is supported at the 91.0 cm mark by a newton meter hanging from a clamp.

(a) Describe how you would check that the metre rule is horizontal. You may draw a diagram if you wish.

....

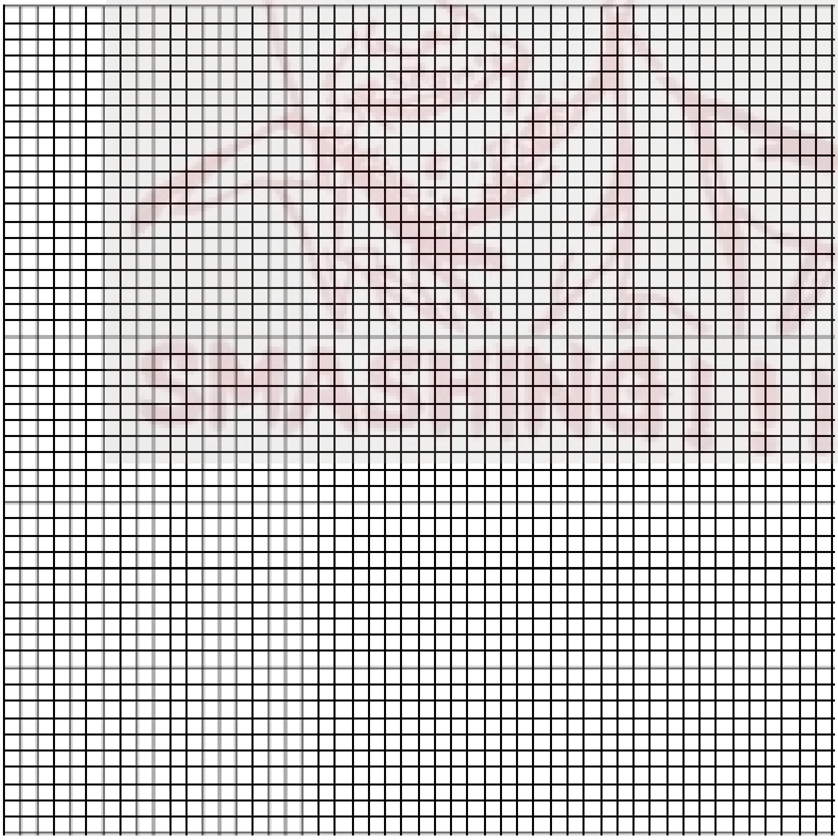
.... [1]

(b) The students record the force F shown on the newton meter and the distance d from the pivot to the 91 cm mark. They then repeat the experiment several times using a range of values of the distance d. The readings are shown in the table.

F / N	d / m	$\frac{1}{d}$ / $\frac{1}{m}$
0.74	0.900	
0.78	0.850	
0.81	0.800	
0.86	0.750	
0.92	0.700	

Calculate and record in the table the values of $\frac{1}{d}$. [1]

(c) **(i)** On the graph grid below, plot a graph of F / N (y-axis) against $\frac{1}{d}$ / $\frac{1}{\text{m}}$ (x-axis). Start the y-axis at 0.7 and the x-axis at 1.0. [2]



(ii) Draw the line of best fit on your graph. [2]

Question 5 continues on the next page.

(iii) Determine the gradient G of the line.

G = ... [3]

(d) Calculate the weight of the metre rule using the equation

$$W = \frac{G}{k}$$

where k = 0.490 m.

W = ... [2]

1 The IGCSE class is investigating the effect of a load on a rule attached to a spring.

The apparatus used is shown in Fig. 1.1.

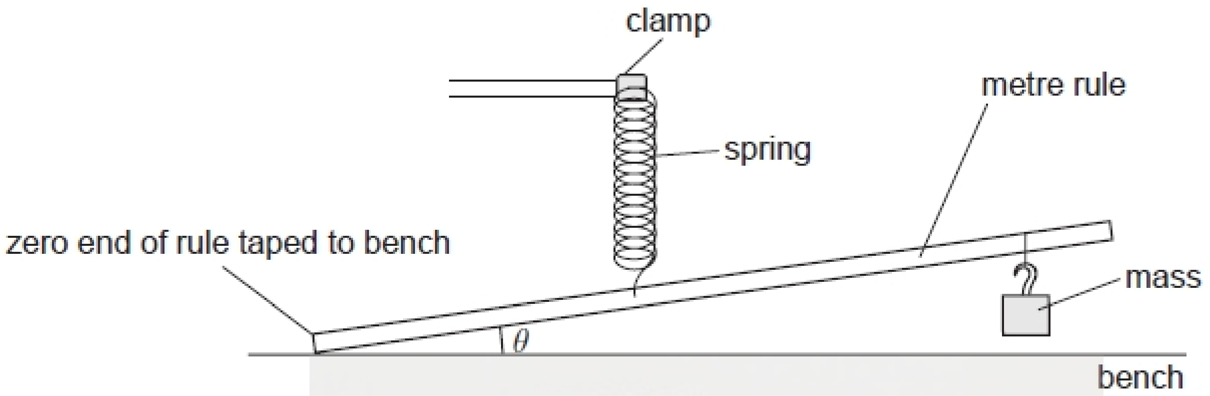


Fig. 1.1

The rule has the zero end taped to the bench so that it does not slip. The rule is attached to a spring at the 40.0 cm mark. The students hang masses, starting with a 10 g mass, on the rule at the 90.0 cm mark. For each mass, they measure the angle θ between the rule and the bench.

One student's readings are shown in the table.

m /	θ /
0	29
10	28
20	26
30	25
40	22
50	19

(a) Complete the column headings in the table. [1]

(b) A student suggests that θ should be directly proportional to m. State, with a reason, whether the readings in the table support this suggestion.

statement ....

reason ....

.... [2]

(c) A student carries out this experiment using the 360 ° protractor shown in Fig. 1.2.

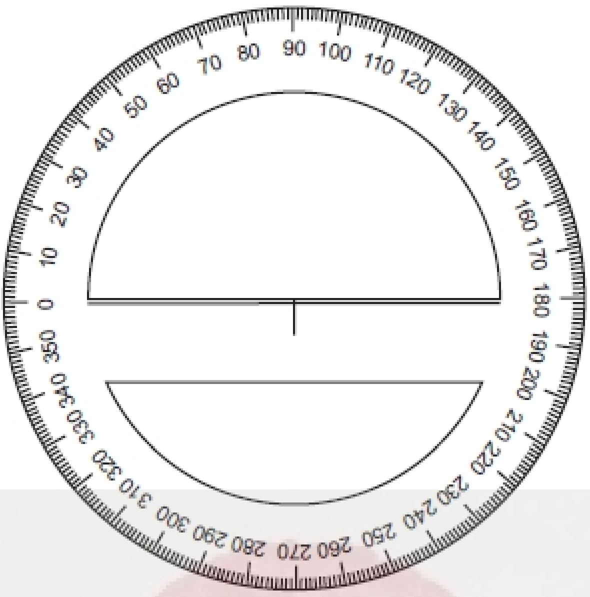


Fig. 1.2

Explain how the student could use this protractor to measure the angle θ between the metre rule and the bench. You may draw a diagram if you wish.

....

.... [2]

(d) The range of angles measured in this experiment may be quite small. Using the same apparatus and with the masses and spring in the same positions, suggest another method of investigating as reliably as possible the extent by which the rule is pulled down by the masses. This method must not use a protractor but an additional rule may be used. You may draw a diagram if you wish.

....

.... [2]

4 A student investigates the period of oscillation of a mass attached between two springs.

The apparatus used is shown in Fig. 4.1.

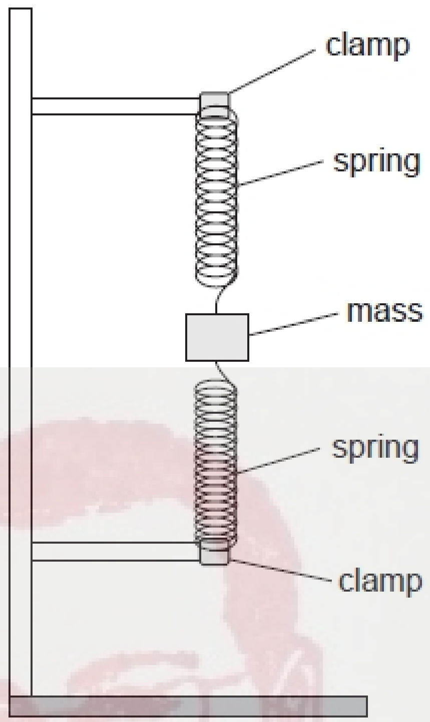


Fig. 4.1

A 400 g mass *m* is attached between two springs, displaced a small distance downwards, and then released so that it oscillates. The time *t* taken for 10 complete oscillations of the mass is recorded. The experiment is repeated using values for *m* of 300 g and 200 g. The readings are shown in the table below.

m / g	*t* / s	*T* / s	$\frac{T}{m}$ / $\frac{s}{g}$
400	9.0		
300	7.8		
200	6.3		

(a) Calculate the period *T* of the oscillations. *T* is the time for one complete oscillation. Enter the values in the table. [2]

(b) Calculate and enter in the table the values of $\frac{T}{m}$. [2]

(c) The student suggests that T should be directly proportional to m. State with a reason whether the results in the table support this suggestion.

statement ....

reason ....

.... [2]

(d) In this experiment, the mass oscillates rapidly so that it is difficult to take the times accurately. A technique has been included in this experiment to obtain an accurate value for the period T. State, briefly, what this technique is and any calculation involved to obtain the T value.

....

....

.... [2]

(e) Another student carried out the same experiment using a wider range of masses. Suggest why, when the mass was 900 g, it could not oscillate freely.

.... [1]

2 A student is investigating the oscillation of a metre rule that has one end resting on the laboratory bench. The other end is held above the level of the bench by a spring attached at the 90.0 cm mark. The arrangement is shown in Fig. 2.1.

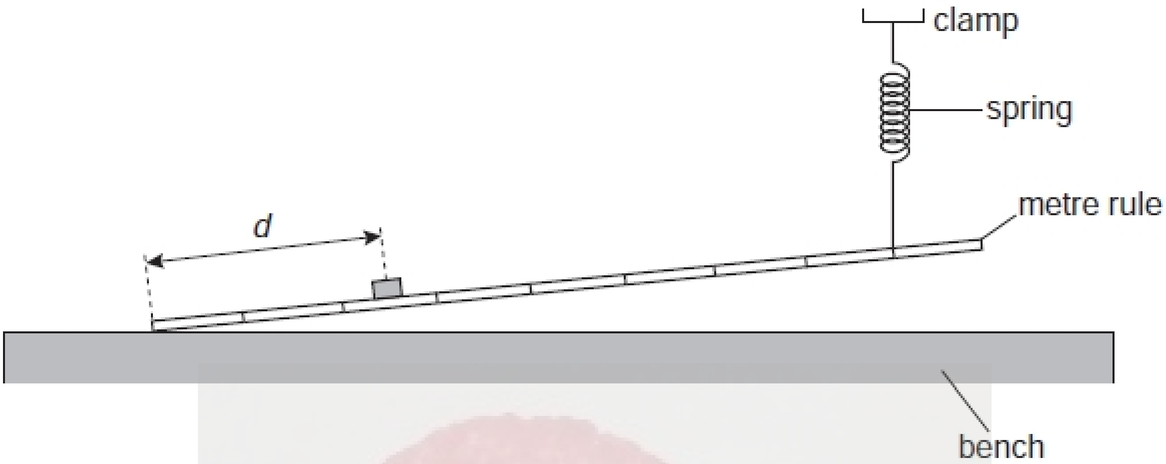


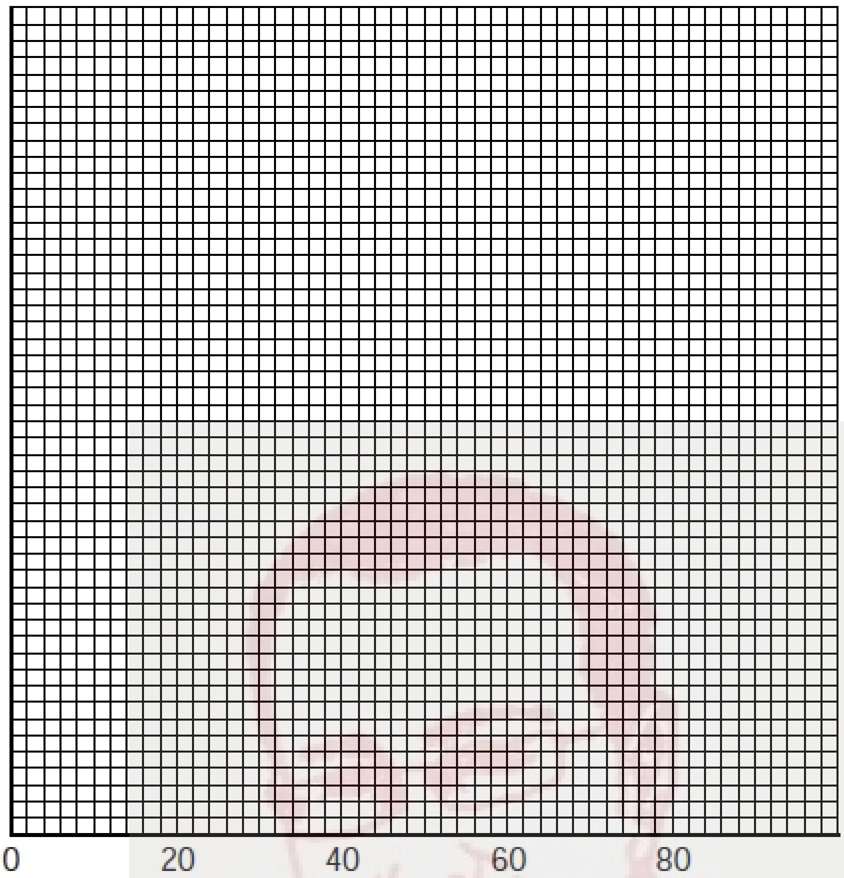
Fig. 2.1

The period of oscillation is changed by moving a 200 g mass to different positions along the rule. The student records the time *t* taken for 10 oscillations of the end of the rule for each position of the mass. He measures the distance *d* from the end of the rule to the mark under the centre of the mass. The readings are shown in the table.

d / cm	*t* / s	*T* / s
20.0	3.4	
40.0	4.4	
50.0	4.9	
60.0	5.3	
70.0	6.0	
80.0	6.3	

(a) Calculate the period *T* for each set of readings and enter the values in the table. [2]

(b) Plot a graph of *d* / cm (*x*-axis) against *T* / s (*y*-axis). The scale on the *x*-axis has been started for you. [5]



(c) Using the graph, determine the period *T* when the distance *d* is 55.0 cm.

T = ... [2]

(d) The student suggests that *T* should be proportional to *d*. State with a reason whether your results support this suggestion.

statement ....

reason ....

.... [2]

1 A student carried out an experiment to find the spring constant of a steel spring. The apparatus is shown in Fig. 1.1.

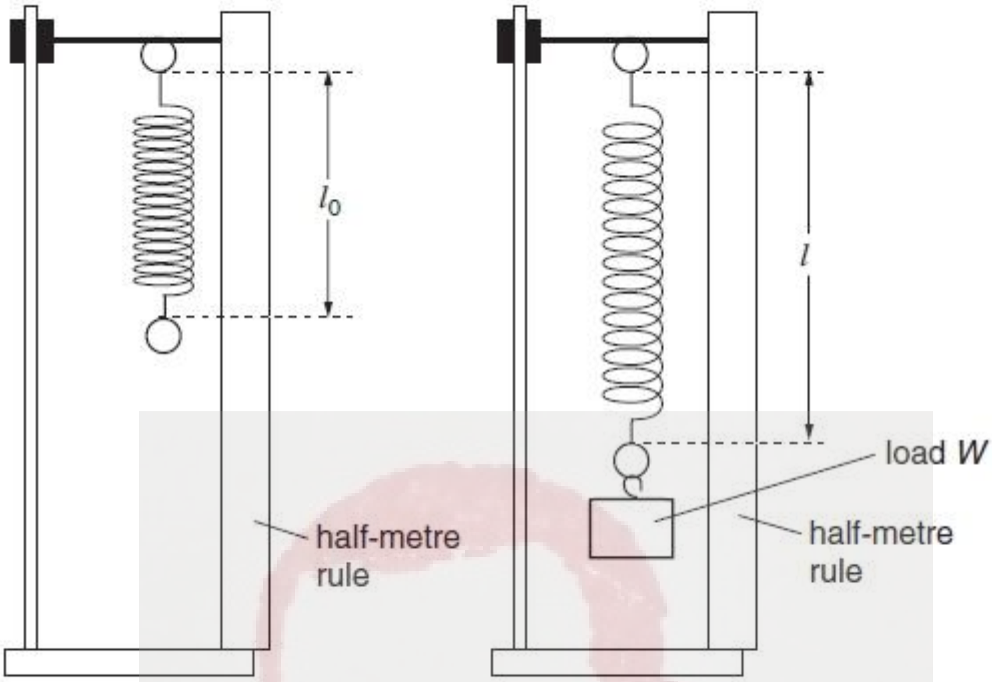


Fig. 1.1

The student recorded the unstretched length l_0 of the spring. Then she added loads W to the spring, recording the new length l each time. The readings are shown in the table below.

W/N	l/mm	e/mm
0	30	
1	32	
2	33	
3	36	
4	39	
5	40	
6	42	

l_0 = 30 mm

(a) Calculate the extension e of the spring produced by each load, using the equation

$$e = (l - l_0).$$

Record the values of e in the table. [2]

(b) Plot the graph of e / mm (y-axis) against W / N (x-axis). [4]

(c) Draw the best-fit straight line for the points you have plotted. Calculate the gradient of the line. Show clearly on the graph how you obtained the necessary information.

gradient = ...[4]

3 A student carried out a 'principle of moments' experiment using a metre rule placed on a pivot at the 50.0 cm mark. The aim was to determine an unknown weight. The arrangement of the apparatus is shown in Fig. 3.1.

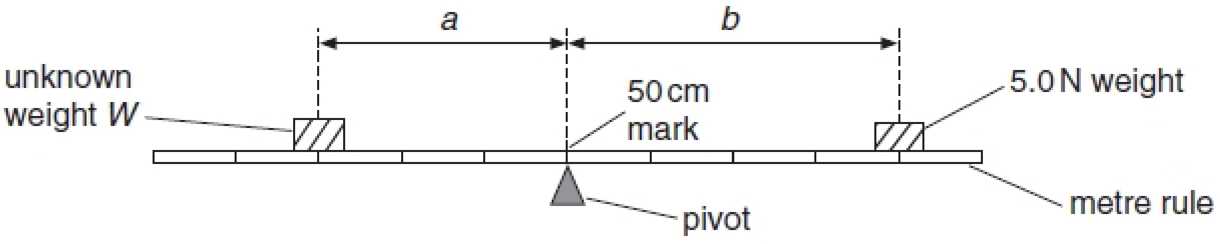


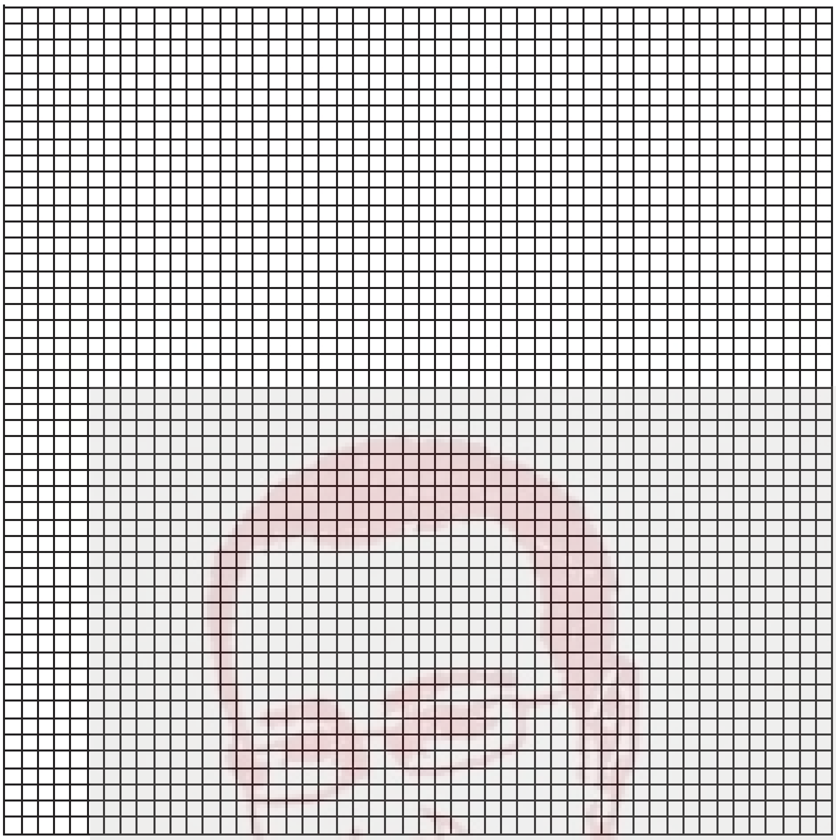
Fig. 3.1

The student placed the unknown weight W at a convenient distance a from the pivot. He found b, the distance from the pivot that the 5.0 N weight must be placed so that the rule balanced horizontally. He then repeated the experiment using different values of a.
The readings are shown in the table below.

a/m	b/m
0.100	0.122
0.200	0.238
0.250	0.302
0.300	0.360
0.350	0.435
0.400	0.470

(a) **(i)** Plot the graph of b/m (y-axis) against a/m (x-axis).

(ii) Draw the best-fit straight line.



[6]

(iii) Determine G, the gradient of the line.

G = ...

(iv) Determine W, the unknown weight, using the equation

$$W = XG$$

where X = 5.0 N.

W = ...

Topic_Phx 2 **Q.20 iG Phx/2015/s/Paper 61 www.SmashingScience.org**

1 (a) x = 1.4 (cm) or 14 (mm) or 0.014 (m)
AND y = 2.6 (cm) or 26 (mm) or 0.026 (m) [1]

correct unit for x and y [1]

(b) X and Y both 10 × x and y, ecf **(a)** [1]

W = 1.08 (N), to 2 or more significant figures (ecf allowed) [1]

(c) sensible position indicated for Z, between pivot and centre of rule [1]

(d) statement matches results
(expect Yes, ecf from **(b)** only if difference >10%) [1]

justified with reference to results; must include idea of being close enough to be within limits of experimental accuracy, ecf **(b)** [1]

(e) difficulty in achieving balance OR difficulty in positioning load exactly, e.g. load covers rule markings or uncertainty about position of centre of mass of load [1]

[Total: 8]

Topic_Phx 2 **Q.21 iG Phx/2014/s/Paper 61 www.SmashingScience.org**

1 (a) (b) 21 (mm) [1]

210 (mm) ecf from l_0 [1]

(b) 45 (mm) <u>and</u>
0.067 or 0.0667 (N/mm), 2 or 3 sig. figs.
ecf from l_0 and L_0 [1]

correct unit N/mm or N/m or N/cm as appropriate [1]

(c) T = 1.342 (s) or 1.34 (s) [1]

(d) T = 1.724 s (no mark)
statement NO (ecf from **(c)**) [1]

difference <u>too</u> large (for experimental inaccuracy) (ecf) [1]

(e) clear diagram or explanation that indicates:
perpendicular viewing of spring or scale
OR appropriate use of horizontal pointer/set square/rule, etc.
OR rule touching/very close to spring [1]

[Total: 8]

Topic_Phx 2 **Q.22 iG Phx/2013/w/Paper 61 www.SmashingScience.org**

1 **(a)** rule balanced <u>and</u> pivot at centre of mass [1]

(b) EITHER take readings from 50.2 cm mark
OR add mass/weight/load
OR place pivot at 50.2 cm mark [1]

(c) **(i)** cm, cm [1]

(ii) clockwise 77.5 (or 78) (N cm)
anticlockwise 78 (N cm) [1]

(d) EITHER repeats
OR estimate between two best positions that almost balance but tip opposite sides o.w.t.t.e
OR suitable method to locate centre of mass **Q** [1]

[Total: 5]

Topic_Phx 2 **Q.23 iG Phx/2013/s/Paper 61 www.SmashingScience.org**

5 **(a)** 40.0 or 40(cm) [1]

(b) accuracy / reliability / check readings / spot anomaly / o.w.t.t.e. [1]

(c) correct method used [1]
30 or 30.0(g) [1]

(d) rule never quite balances, o.w.t.t.e. [1]
take average position / nearest to balance, o.w.t.t.e. [1]

[Total: 6]

1 (a) $d_0 = 21$ (mm) [1]

(b) $D_o = 210$ (mm) or 10 × candidate's **(a)** [1]

(c) L values 1.0, 2.0, 3.0, 4.0, 5.0 [1]
e values 1.0, 9.0, 21.0, 29.0, 40.0 [1]

(d) Graph:
Axes correctly labelled with quantity and unit and correct way around [1]
Suitable scales [1]
All plots correct to ½ small square
Good line judgement and a single, thin, continuous line [1]

(e) Triangle method used and shown on the graph [1]
Using at least half of line [1]

(f) Any one from:
Always measure from same point on spring (top or bottom of ring)
Wait for spring/weight to stop bouncing
Use of horizontal aid/ensure ruler is vertical
Bench surface not uniform [1]

[Total: 11]

Topic_Phx 2 **Q.25 iG Phx/2012/s/Paper 61 www.SmashingScience.org**

1 **(a)** 50–250g (or 0.05–0.25 kg) correct unit required [1]

(b) Centre of mass marked close to centre of cylinder [1]
Clear indication of how centre of mass is placed above the 90.0 cm mark [1]

(c) Rule unlikely to exactly balance/ difficult to balance
OR rule could slide on pivot
OR mass could slide
OR centre of mass of rule not at 50.0 cm mark
OR rule not uniform1

Do not accept comments about poor/careless technique [1]

(d) Repeat readings (wtte) [1]
OR a reference to finding exact position of centre of mass of metre rule
OR a reference to dealing with centre of mass of rule not being at 50.0 cm mark

(e) Good/ fine/ reasonable/ same to 3 significant figures
OR Within limits of experimental accuracy (wtte)
OR Too many significant figures in experimental result [1]

[Total: 6]

Topic_Phx 2 **Q.26 iG Phx/2011/w/Paper 61 www.SmashingScience.org**

1 **(a)** graph:
axes: the right way round, labelled *x* and *y* with unit cm [1]
scale: both 10 small squares = 2 cm
(either or both 20 small squares = 5 cm also acceptable) [1]
plots: all correct to ½ small square [1]
line: well-judged, best-fit, straight, thin, continuous line [1]

(b) correct triangle method using at least ½ candidate's line, with method clearly indicated on graph [1]
G = 0.94 – 1.00, no ecf [1]

(c) 1.0/(candidate's *G*) calculation correct, 2 or 3 significant figures and unit N [1]

(d) **(i)** (where rule) balances on pivot o.w.t.t.e. [1]

(ii) take readings from 49.7 OR
adjust rule by adding weight until it balances at 50.0 cm mark [1]

[Total: 9]

Topic_Phx 2 **Q.27** **iG Phx/2011/s/Paper 61 www.SmashingScience.org**

1. **(a)** Three straight lines in correct positions [1]
All lines continuous, straight, neat and thin [1]

(b) a = 4.2 – 4.4 (cm) no ecf [1]
Well-judged position in triangle [1]
Line correctly drawn [1]

(c) Viewing line directly in front of card (owtte) [1]

[Total: 6]

Topic_Phx 2 **Q.28** **iG Phx/2011/s/Paper 61 www.SmashingScience.org**

1 **(a)** **(i)** l = 29 (mm) and l = 31 (mm) (allow 2.9 cm, 3.1 cm) [1]
e_A = 14 (mm) and e_B = 15 (mm) (ecf) (ignore minus signs) [1]

(b) **(i)** both l correct to (21.5 – 22) and 24 [1]

(ii) (6.5 – 7) and 8 (ecf) (ignore minus signs) [1]

(iii) e_{av} = 7.5 (c.a.o.) [1]

(c) statement matches readings (expect YES) (ecf NO) [1]
justification matches statement and by reference to results
(expect within limits of experimental accuracy, wtte) (too different, wtte) [1]

(d) any one of:
avoidance of parallax error explained
use of horizontal aid
measuring to same point each time
repeats
wait for springs to stop moving [1]

[Total: 8]

Topic_Phx 2 **Q.29 iG Phx/2010/w/Paper 61 www.SmashingScience.org**

1 (a) correct 1/*d* values 0.0222, 0.0294, 0.0370, 0.0444, 0.0518 [1]
all to 2 significant figures or all to 3 consistent significant figures [1]

(b) graph:
axes suitable and labelled [1]
all plots correct to ½ small square [1]
good line judgement (position) [1]
thin line, single, no blobs (quality) [1]

(c) gradient by triangle method using at least ½ candidate's line [1]
clear, on graph, how obtained [1]

(d) *z* value 0.9 – 2.5 [1]
2 or 3 significant figures and unit cm given [1]

[Total: 10]

Topic_Phx 2 **Q.30 iG Phx/2009/s/Paper 61 www.SmashingScience.org**

5 (a) Q correct position with suitable number(s) [1]
Rule correctly tilted, and on bench (or arrow to indicate) [1]

(b) Any two from:
Readings taken at either side/diameter of cylinder
Position of mid point found
Mark position of centre [2]

(c) 34.5 <u>cm</u> [1]

[Total: 5]

Topic_Phx 2 **Q.31 iG Phx/2009/s/Paper 61 www.SmashingScience.org**

1 (a) *d* 2.5 (cm) [1]
x 14.5 (cm) [1]
diagram showing blocks correctly placed across the ends [1]
rule position (or distance) shown correctly [1]

(b) (i) V_e 71.1 - 71.2 (cm^3) ecf allowed [1]

(ii) measuring cylinder reading 56 (cm^3) [1]

(iii) ρ 2.05–2.08 (or 2.1) ecf allowed [1]
g/cm^3 <u>and</u> 2 or 3 significant figures [1]

[Total: 8]

Topic_Phx 2 **Q.32** **iG Phx/2008/w/Paper 61 www.SmashingScience.org**

1 (a) view perpendicular to (or straight in front of rule)/use of set square [1]

(b) (i) correct e_1 value 3.1 and correct e_2 value 2.4 [1]
e in cm [1]

(c) density 4.43 (ecf) [1]
2/3 significant figures [1]
g/cm^3 [1]

(d) e_2 greater [1]
ρ greater (or identical to e_2 answer) (ecf) [1]

[Total: 8]

Topic_Phx 2 **Q.33** **iG Phx/2008/s/Paper 61 www.SmashingScience.org**

1 (a) (i) cm, cm, g [1]

(ii) 49.66 (or 49.7), 49.50 (or 49.5), 50.05 (or 50.0) [1]
consistent significant figures (3 or 4) [1]

(b) clear explanation/diagram [1]

(c) correct method [1]
value 49.7 (ignore a fourth significant figure)
and allow ecf from (ii) [1]

(d) d = 1.8 (cm), t = 1.2 (cm) [1]
V = 3.05 (cm^3) (ecf) [1]
ρ = 16.3 unit g/cm^3, 2/3 significant figures (ecf) [1]

[Total: 9]

Topic_Phx 2 **Q.34** **iG Phx/2007/w/Paper 61 www.SmashingScience.org**

2 (a) 8, 14, 20, 25, 34, 41 (-1 each error) [2]

(b) (i) Graph:
suitable scales labelled symbol/unit [1]
all plots to nearest ½ sq (-1 each error or omission) [2]
line thin and straight [1]

(ii) correct value (29mm – 31mm)to nearest ½ sq. [1]
clear how obtained [1]

[Total: 8]

Topic_Phx 2 **Q.35 iG Phx/2007/s/Paper 61 www.SmashingScience.org**

5 **(a)** weight / load / force / W / L / F [1]
length / l [1]
extension / e / x / $(l - l_0)$ [1]
units N, mm, mm [1]

(b) any three from
length of spring / l_0
diameter/thickness of spring
range of loads
length of wire
diameter / thickness of wire
number of coils
coil spacing [3]
do NOT allow 'size' or room temperature

[Total: 7]

Topic_Phx 2 **Q.36 iG Phx/2007/s/Paper 61 www.SmashingScience.org**

2 **(a)** and **(b)** 6 d values [1]
correct values for d 5, 10, 15, 20, 25, 30 [1]

(c) h_0 = 100mm (including unit, cm/m allowed) [1]

(e) correct values for b 40, 35, 32, 28, 24, 20 (ecf) [1]

(f) Graph:
correct d axis labelled with symbol / unit [1]
plots to nearest ½ sq (-1 each error or omission) [2]
best fit straight line [1]
single line, thin and best fit [1]

(g) no
line not through origin
OR when b increases, d decreases
OR negative gradient [1]

(h) use of set square / protractor / spirit level / plumbline [1]

[Total: 11]

Topic_Phx 2 **Q.37 iG Phx/2006/s/Paper 61 www.SmashingScience.org**

5 **(a)** description / diagram showing 2 equal heights from bench **[1]**

(b) 1.11(1); 1.18(1.176); 1.25(0); 1.33(3); 1.43(1.428) **[1]**

(c) **(i)** Axes suitable and labelled, false origin as instructed **[1]**
Plots correct to ½ small sq **[1]**

(ii) Well judged best fit line **[1]**
line suitably thin **[1]**

(iii) triangle method seen **[1]**
More than ½ line used **[1]**
Gradient value correct **[1]**

(d) Correct W value using cand's G **[1]**
2/3 sf and in N **[1]**

TOTAL 11

Topic_Phx 2 **Q.38 iG Phx/2005/w/Paper 61 www.SmashingScience.org**

1 **(a)** m in g and θ in degrees 1

(b) θ *not* directly proportional to m 1
as m increases θ decreases 1

(c) clear in words or diagram that 'centre point' of protractor
is at point where bottom edge of rule meets protractor
and 0 – 180 line is horizontal 1
similarly clear how 'dead space' is dealt with, e.g. protractor
stuck to edge of bench with 0 – 180 line at top of bench level
OR rule placed on block that is same height as 'dead space' 1

(d) words or diagram to show rule at end of metre rule
to measure height above bench level 1
clear that rule is vertical (e.g. use set square)
OR clamped at constant angle 1

TOTAL 7

Topic_Phx 2 **Q.39** **iG Phx/2005/s/Paper 61 www.SmashingScience.org**

4	**(a)**	0.90; 0.78; 0.63 (-1 each error, ignore sf)	**[2]**
	(b)	0.00225; 0.00260; 0.00315 all correct (ecf)	**[1]**
		all to 2sf or all to 3sf	**[1]**
	(c)	NO	**[1]**
		T/m increases as m decreases (wtte) - if statement (no) correct	**[1]**
	(d)	time n oscillations	**[1]**
		divide by n (n at least 3)	**[1]**
	(e)	lower spring fully compressed (wtte)	**[1]**
			[total: 9]

Topic_Phx 2 **Q.40** **iG Phx/2004/s/Paper 61 www.SmashingScience.org**

2	**(a)**	All T values correct (0.34, 0.44, 0,49, 0.53, 0.60, 0.63)	1
		All T values to 2 sf OR all to 3sf	1
	(b)	Graph:	
		Scales suitable	1
		Scales labeled and with units	1
		Plots correct to ½ sq (-1 each error)	2
		Line judgement	1
		Line thickness (and small, neat plots)	1
	(c)	T = 0.51 (s) correct answer only; NO ecf	1
	(d)	Statement: NO	1
		Reason: line not through origin (or equivalent)	1
		(allow mark if candidate describes str. line or constant gradient)	
		TOTAL	**11**

Topic_Phx 2 **Q.41** **iG Phx/2003/s/Paper 61 www.SmashingScience.org**

1	**(a)**	Seven correct values: 0, 2, 3, 6, 9, 10, 12 (-1 each error)	2
	(b)	Graph:	
		Scales, labelled, suitable size	1
		Axes, right way round	1
		Plots to ½ sq (-1 each error)	2
	(c)	Line shape	1
		Line thickness	1
		Triangle greater than ½ line and method used	1
		Correct interpolation to ½ sq	1
		TOTAL	**10**

3. (a) (i) & (ii) scales	1
labels	1
plots (-1 each error)	2
line judgement –str line thin & neat & good plots	1
- best fit	1
(iii) large triangle (> ½ line) seen	1
G = 1.15 – 1.25	1
(iv) correct value (ecf) (= 6.0)	1
unit & 2/3 sf	1
(v) weight off end of rule	1
(b) add plasticine to end or balance at 50.3 cm and take measurements accordingly	
OR move pivot to 50.3 mark	
OR no action – result will still be correct	1
	TOTAL 12

2 The class is investigating the cooling of water.

Fig. 2.1 shows some of the apparatus used.

(a) A student measures the initial temperature of hot water in a beaker, as indicated by the thermometer in Fig. 2.1.

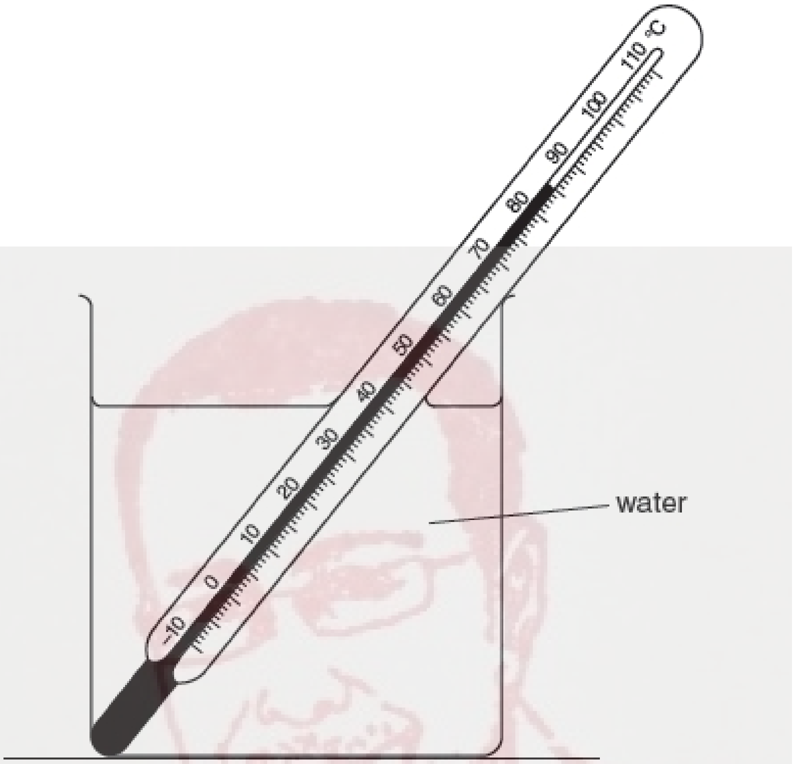


Fig. 2.1

Record this initial temperature in the first row of Table 2.1.

(b) The student allows the water in the beaker to cool and records the temperature at 30 s intervals. The readings are shown in the table.

Complete the column headings in the table.

Table 2.1

t /	θ /
0	
30	72
60	64
90	60
120	57
150	56

[2]

(c) Plot a graph of θ/°C (y-axis) against t/s (x-axis).

[5]

(d) **(i)** State whether the rate of cooling of the water in the beaker increases, decreases or stays approximately constant during the period of cooling.

The rate of cooling of the water ....[1]

(ii) Justify your statement by reference to the graph.

....

....

....[1]

[Total: 9]

2 The IGCSE class is investigating the cooling of hot water under different conditions.

Figs. 2.1 and 2.2 show the apparatus used.

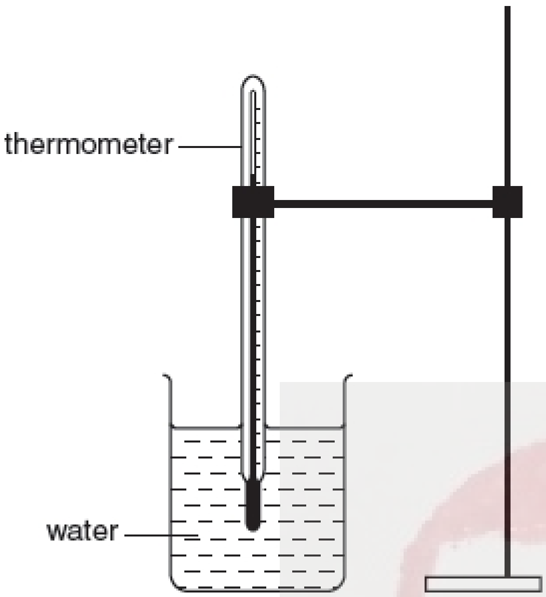


Fig. 2.1

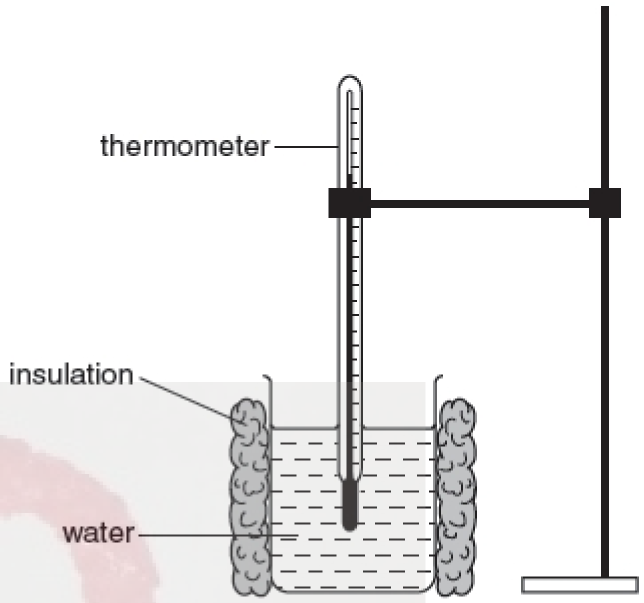


Fig. 2.2

(a) Record room temperature θ_R as shown on the thermometer in Fig. 2.3.

Fig. 2.3

θ_R = ... [1]

(b) A student pours hot water into the uninsulated beaker shown in Fig. 2.1 until it is about two-thirds full. She measures the temperature and immediately starts a stopclock. She records the temperature every 30 s. She repeats the procedure using the insulated beaker as shown in Fig. 2.2. The readings are shown in Table 2.1.

Table 2.1

	without insulation	with insulation
t /	*θ* /	*θ* /
0	80	79
30	77	76
60	74	73
90	72	71
120	70	70
150	69	69

Complete the column headings in the table. [1]

(c) State whether the cotton wool insulation increases, decreases, or has no significant effect on the rate of cooling of the water, compared with the rate of cooling with no insulation. Justify your answer by reference to the results.

statement ....

justification ....

....

....

[2]

(d) The student suggests that a significant cause of loss of thermal energy from the beakers is evaporation.

Suggest how you would reduce the evaporation in this experiment.

....[1]

(e) Suggest one condition that should not be changed when this experiment is repeated.

....[1]

[Total: 6]

3 The IGCSE class is investigating the cooling of a thermometer bulb under different conditions.

A student places a thermometer in a beaker of hot water, as shown in Fig. 3.1.

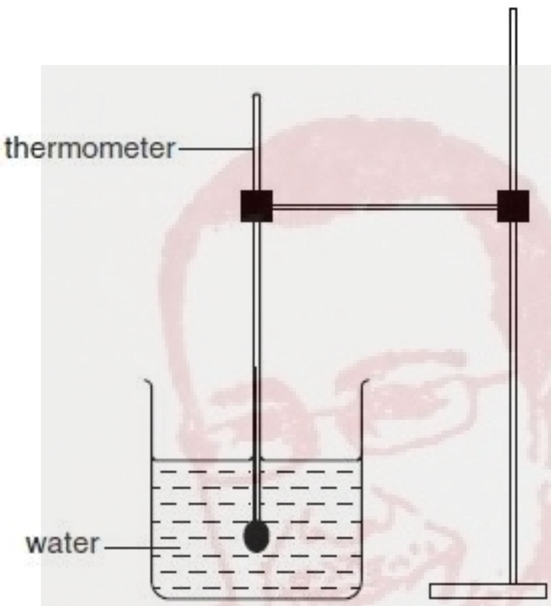


Fig. 3.1

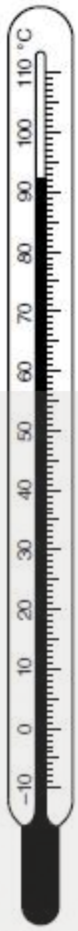


Fig. 3.2

(a) Write down the temperature θ_H of the hot water, as shown on the thermometer in Fig. 3.2.

θ_H .... [1]

(b) The student removes the thermometer from the beaker of water. He immediately starts a stopclock. He records the temperature θ every 30 s. The readings are shown in Table 3.1.

Table 3.1

	without insulation	with insulation
t/	θ/	θ/
30	78	84
60	71	79
90	67	76
120	65	74
150	63	73

He replaces the thermometer in the beaker of hot water and records its temperature.

θ_H ....90 °C........

He removes the thermometer from the beaker of hot water and places it in a beaker containing only dry cotton wool. The thermometer bulb is completely surrounded by cotton wool. He immediately starts a stopclock, and records the temperature θ every 30 s. The readings are shown in Table 3.1.

(i) Complete the column headings in the table. [1]

(ii) State whether the cotton wool insulation increases, decreases, or has no significant effect on the rate of cooling of the thermometer bulb, compared with the rate of cooling with no insulation. Justify your answer by reference to the results.

statement ....

justification ....

.... [2]

(c) Suggest two conditions that should be kept constant when this experiment is repeated.

1. ....

....

2. ....

.... [2]

[Total: 6]

2 A student carries out an experiment to compare how quickly thermal energy is conducted along rods made from different metals. Each rod is heated at one end with a Bunsen burner flame.

Each rod carries a marker held on the rod with a little wax. When the wax melts, the marker falls.

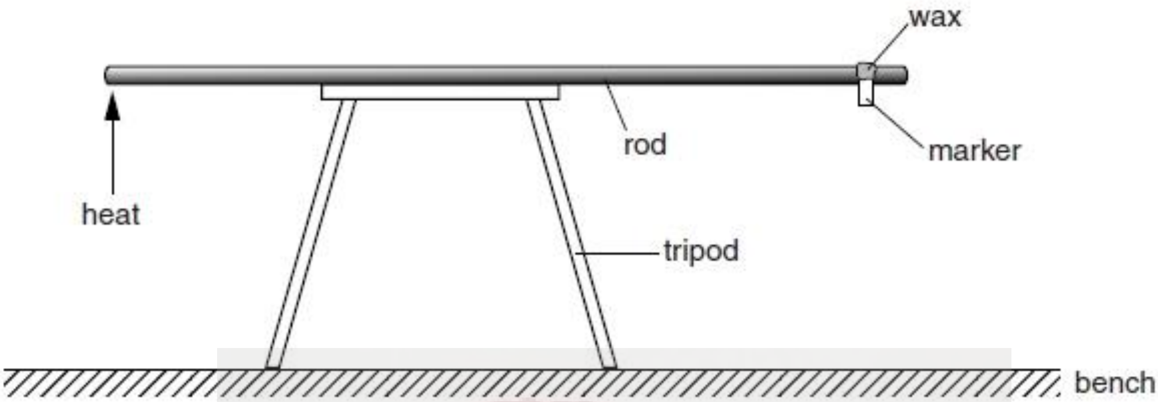


Fig. 2.1

(a) One other piece of equipment is required to compare how quickly thermal energy is conducted. Name this piece of equipment.

....[1]

(b) Suggest **three** possible variables that the student should keep constant in order to make a fair comparison between the different metals.

1. ....

2. ....

3. ....

[3]

(c) Another student suggests that it would be helpful to measure the temperatures at both ends of the rod. He suggests using a liquid-in-glass thermometer, normally used for measuring the temperature of hot water.

Suggest two reasons why a liquid-in-glass thermometer is **not** suitable.

1. ....

2. ....

[2]

[Total: 6]

2 An IGCSE student is investigating the cooling of a thermometer bulb.

The apparatus used is shown in Figs. 2.1, 2.2 and 2.3.

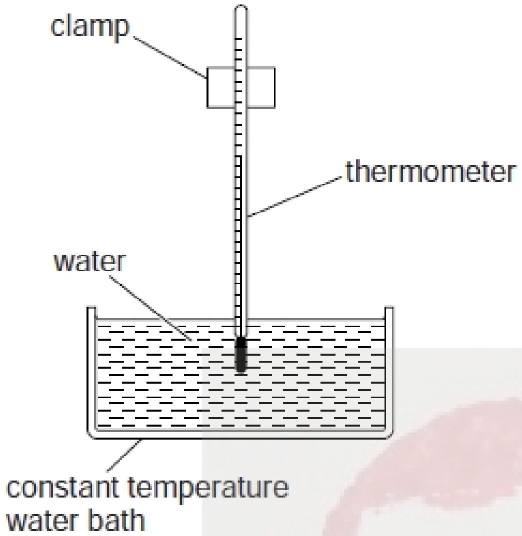


Fig. 2.1

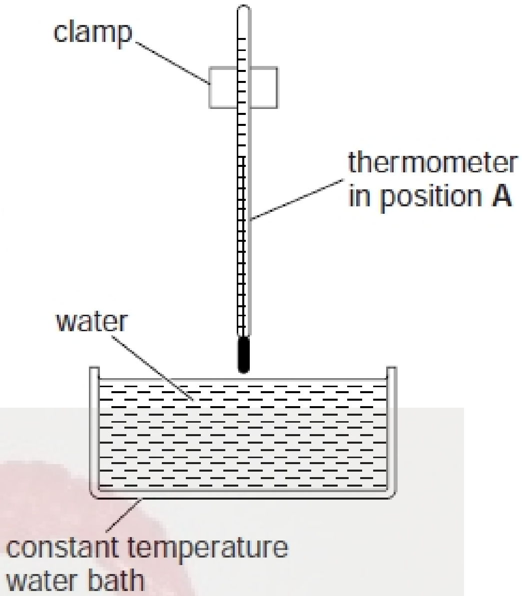


Fig. 2.2

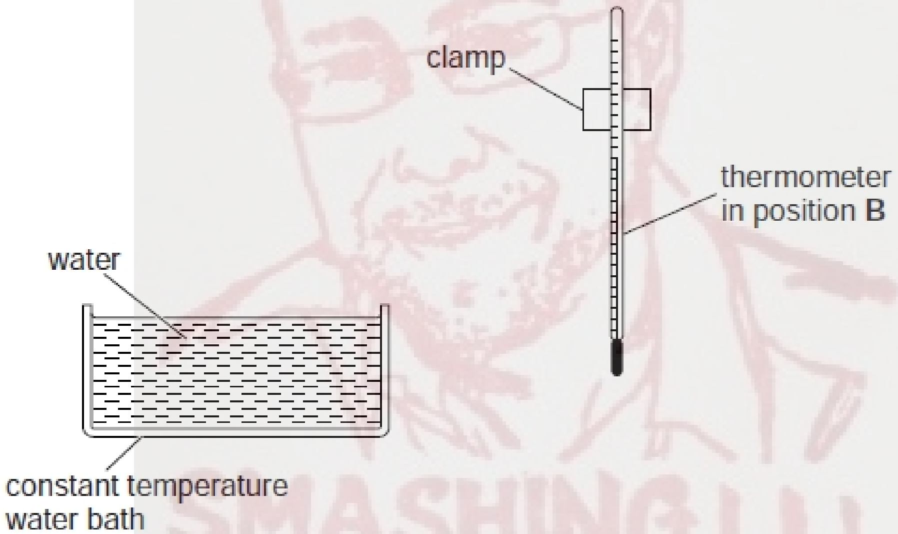


Fig. 2.3

(a) The student places the thermometer in the water bath, as shown in Fig. 2.1.

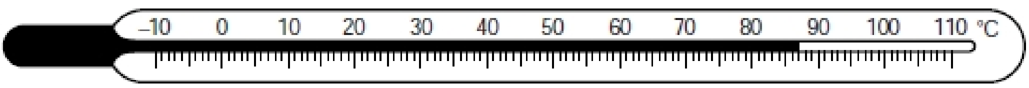


Fig. 2.4

Write down the temperature θ_H of the water bath, shown on the thermometer in Fig. 2.4.

θ_H = ... [1]

(b) The student moves the thermometer until the thermometer bulb is in position **A** above the surface of the water, as shown in Fig. 2.2. She starts a stopclock. She records the time and temperature readings every 30 s.

She replaces the thermometer in the water bath, still at temperature θ_H.

She then moves the thermometer to position **B**, as shown in Fig. 2.3. She records the time and temperature readings every 30 s.

All the readings are shown in Table 2.1.

Table 2.1

	position **A**	position **B**
t /	θ /	θ /
30	79	66
60	74	42
90	70	29
120	66	27
150	61	26
180	56	26

(i) Complete the column headings in the table. [1]

(ii) State in which position, **A** or **B**, the thermometer has the greater rate of cooling **in the first 30 s**.

position .... [1]

(iii) Explain briefly how you reached this conclusion.

....

....

....[1]

(iv) Calculate the temperature difference from 30 s to 180 s for each set of readings.

temperature difference for position **A** = ...

temperature difference for position **B** = ...
[1]

(v) Estimate room temperature θ_R.

θ_R = ... [1]

(c) Describe briefly a precaution you would take to make the temperature readings reliable.

....

.... [1]

(d) A scientist is using this experiment as part of research into convection currents above hot water.

Suggest two conditions that should be kept constant when this experiment is repeated.

1. ....

2. ....

[2]

[Total: 8]

2 The IGCSE class is investigating the scale of a thermometer.

(a) Record room temperature θ_R as shown on the thermometer in Fig. 2.1.

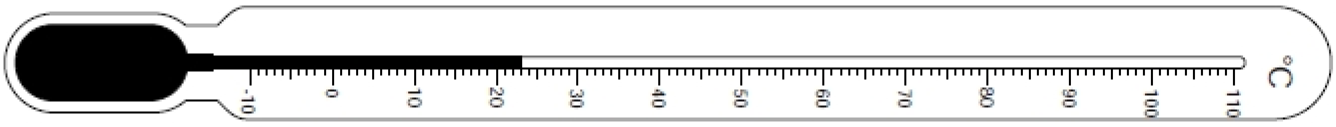


Fig. 2.1

θ_R = ... [1]

A student pours hot water into a beaker. She measures the temperature θ of the water in the beaker every 30 s. The readings are shown in Table 2.1.

Table 2.1

t /	θ /	d /
0	80	
30	74	
60	69	
90	65	
120	63	
150	61	
180	60	

(b) **(i)** Using Fig. 2.2, measure, and record in the table, the distance d from the end of the thermometer to the position of the liquid in the thermometer at the first temperature reading in the table.

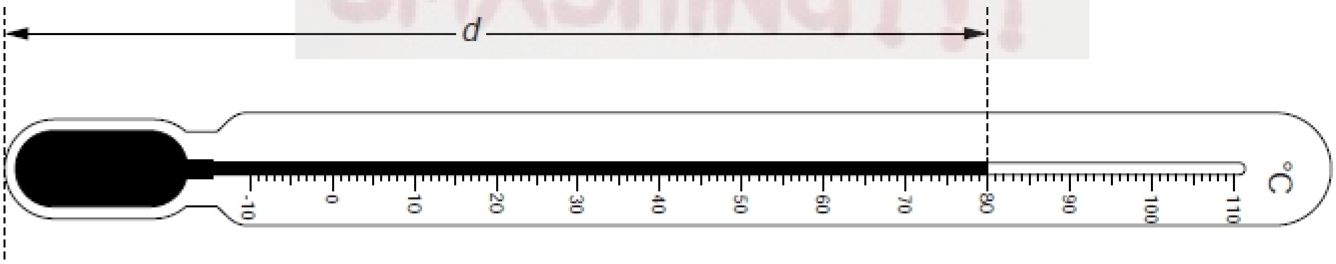


Fig. 2.2

(ii) Repeat the measurement in **(b)(i)** for all the other temperature readings. [2]

(iii) Complete the column headings in the table. [1]

(c) The student plotted a graph of θ against d. A sketch of the graph obtained is shown in Fig. 2.3.

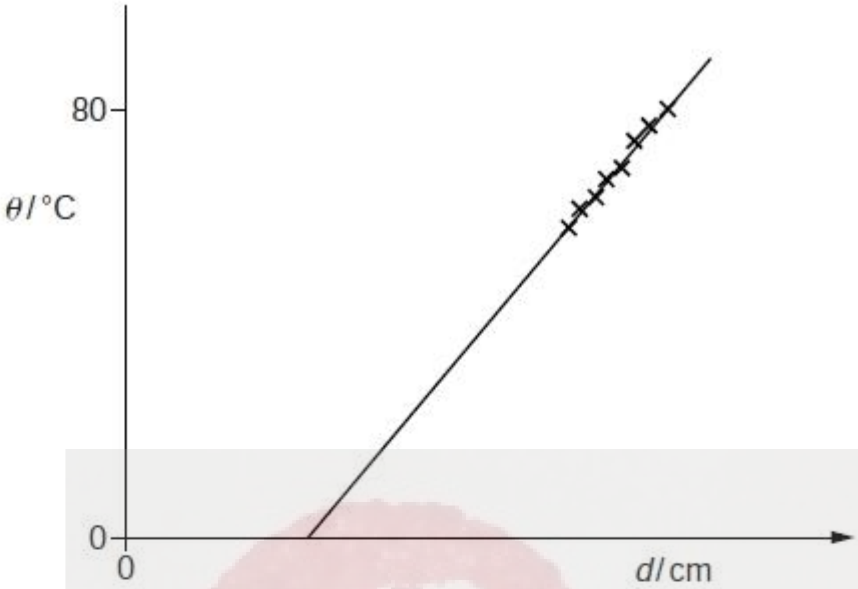


Fig. 2.3

(i) Explain how the graph line shows that θ is not directly proportional to d.

....

....[1]

(ii) Suggest why, when $\theta = 0$ °C, the value of d is not zero.

....

....

....

[1]

(d) Determine, as accurately as possible, the distance x between the 1 °C marks on the thermometer shown in Fig. 2.2. Show your working.

x = ...[3]

[Total: 9]

2 The IGCSE class is investigating the rate of cooling of water under different conditions.

The apparatus is shown in Fig. 2.1.

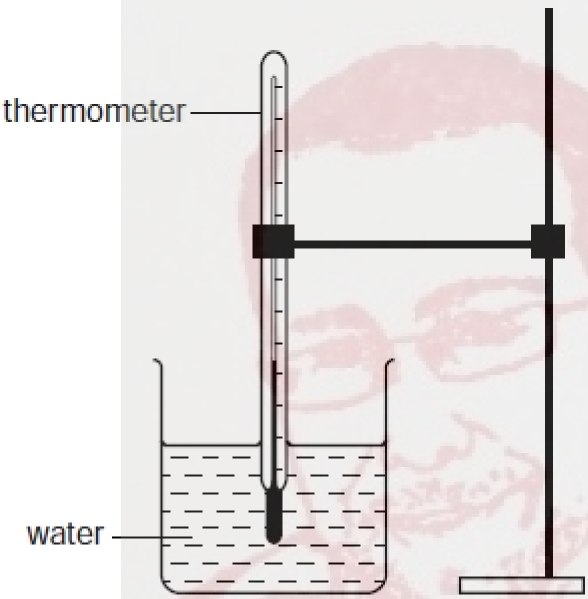


Fig. 2.1

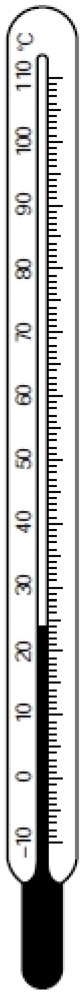


Fig. 2.2

(a) Record the value of room temperature θ_R shown on the thermometer in Fig. 2.2.

θ_R = ... [1]

(b) A student pours 150 cm^3 of hot water into a beaker. She measures the temperature θ of the water at time $t = 0$ and records it in a table.

She starts a stopclock and records the temperature of the water at 30 s intervals until she has a total of six values up to time $t = 150$ s. The readings are shown in Table 2.1.

She repeats the procedure, using 250 cm^3 of hot water.

Table 2.1

	volume of water	
	150 cm^3	250 cm^3
t /	θ /	θ /
0	84	85
30	79	79
60	74	75
90	70	72
120	68	70
150	66	68

(i) Complete the column headings in the table. [1]

(ii) State whether the rate of cooling is significantly faster, slower, or about the same when using the larger volume of hot water. Justify your answer by reference to the readings.

statement ....

justification ....

....

.... [2]

(c) If this experiment were to be repeated in order to check the results, it would be important to control the conditions. Suggest two such conditions that should be controlled.

1. ....

2. .... [2]

[Total: 6]

2 The IGCSE class is investigating the heating of a thermometer bulb.

The apparatus is shown in Figs. 2.1, 2.2 and 2.3.

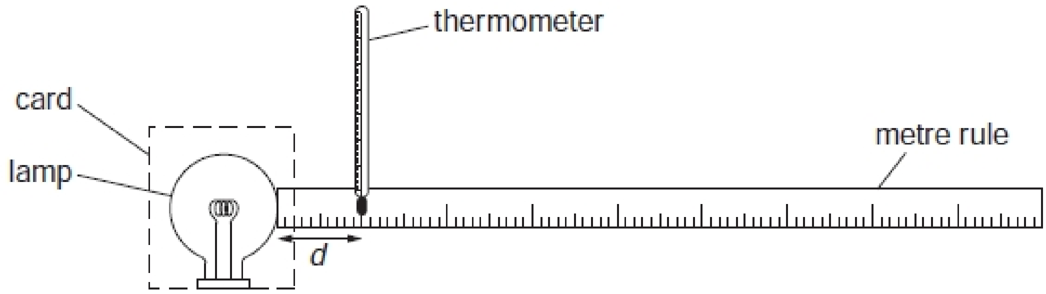


Fig. 2.1

(a) Record the value of room temperature θ_R shown on the thermometer.

Fig. 2.2

θ_R = ... [1]

(b) A student switches on the lamp and places the thermometer so that its bulb is a horizontal distance d = 100 mm from the surface of the lamp, as shown in Fig. 2.1. She records the distance d between the thermometer bulb and the surface of the lamp. She also records the temperature θ shown on the thermometer. She repeats the procedure using values of d of 80 mm, 60 mm, 40 mm, 20 mm and 10 mm. The temperature readings are shown in Table 2.1.

(i) Record the d values in the table.

(ii) Complete the column headings in the table.

Table 2.1

d /	θ /
	52
	56
	61
	67
	75
	86

[2]

(c) The student moves the thermometer away from the lamp and waits for about a minute for the thermometer to cool. She places the thermometer so that its bulb is a vertical distance d_V = 100 mm from the top surface of the lamp, as shown in Fig. 2.3.

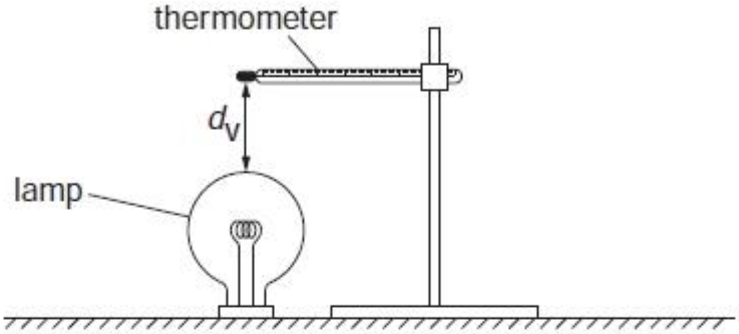


Fig. 2.3

She records the temperature θ_V shown on the thermometer: θ_V = 55 °C.

Calculate the difference between θ_V and the thermometer reading θ_H at a horizontal distance of 100 mm from the lamp. State whether θ_V is higher, lower or the same as θ_H.

temperature difference = ...

θ_V is .... [1]

(d) A student suggests that θ_V will be higher than the thermometer reading θ_H because thermal energy will travel by infra-red radiation and convection to the thermometer bulb above the lamp but by infra-red radiation only when the bulb is to one side of the lamp.

If the experiment were to be repeated in order to investigate this suggestion it would be important to control the conditions. Suggest two such conditions, relevant to this investigation, that should be controlled.

1. ....

2. ....

[2]

(e) Briefly describe a precaution that you would take in this experiment in order to obtain a reliable result.

....

....

.... [1]

[Total: 7]

2 The IGCSE class is investigating temperature changes when cold water and hot water are mixed.

(a) A student records the temperature θ_c of 100 cm^3 of cold water and the temperature θ_h of 100 cm^3 of hot water.

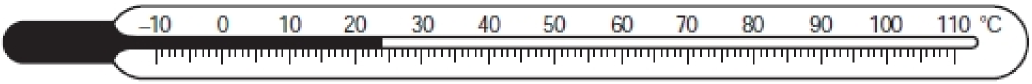


Fig. 2.1

Write down the temperature θ_c shown on the thermometer in Fig. 2.1.

θ_c = ... [2]

(b) The hot water is at a temperature θ_h = 86 °C.

Calculate θ_{av}, the average of θ_c and θ_h.

average θ_{av} = ... [1]

(c) The student adds 100 cm^3 of the hot water to the cold water. She records the temperature θ_m of the mixture of hot and cold water, θ_m = 48 °C.

State two precautions (other than repeating the experiment) that the student could take to ensure the reliability of her value of the temperature θ_m.

1. ....

2. ....
[2]

(d) Suggest a practical reason in this experiment for the temperature of the mixture θ_m being different from the average value θ_{av}, even when the student has taken the precautions you suggested in **(c)**.

....

....[1]

(e) Suggest a modification to the experiment which should reduce the difference between θ_m and θ_{av}.

....

....[1]

(f) The student decides to repeat the experiment to check the readings. Suggest one possible variable that she should keep constant.

....[1]

[Total: 8]

2 The IGCSE class is investigating the cooling of water.

Fig. 2.1. shows the apparatus used.

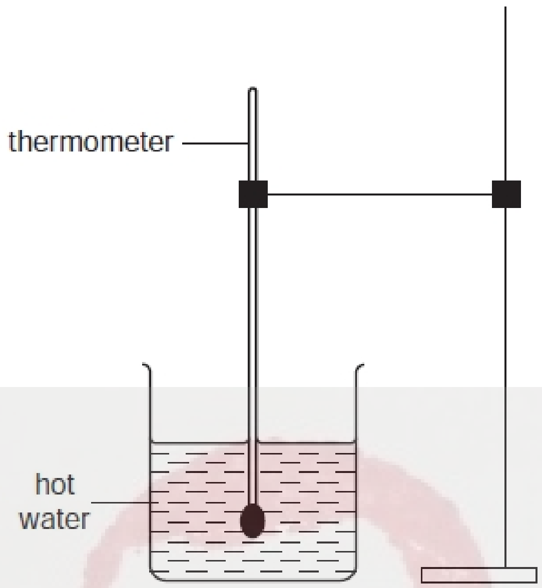


Fig. 2.1

Hot water is poured into the beaker and temperature readings are taken as the water cools.

Table 2.1 shows the readings taken by one student.

Table 2.1

t / s	θ / °C
0	85
30	78
60	74
90	71
120	69
150	67
300	63

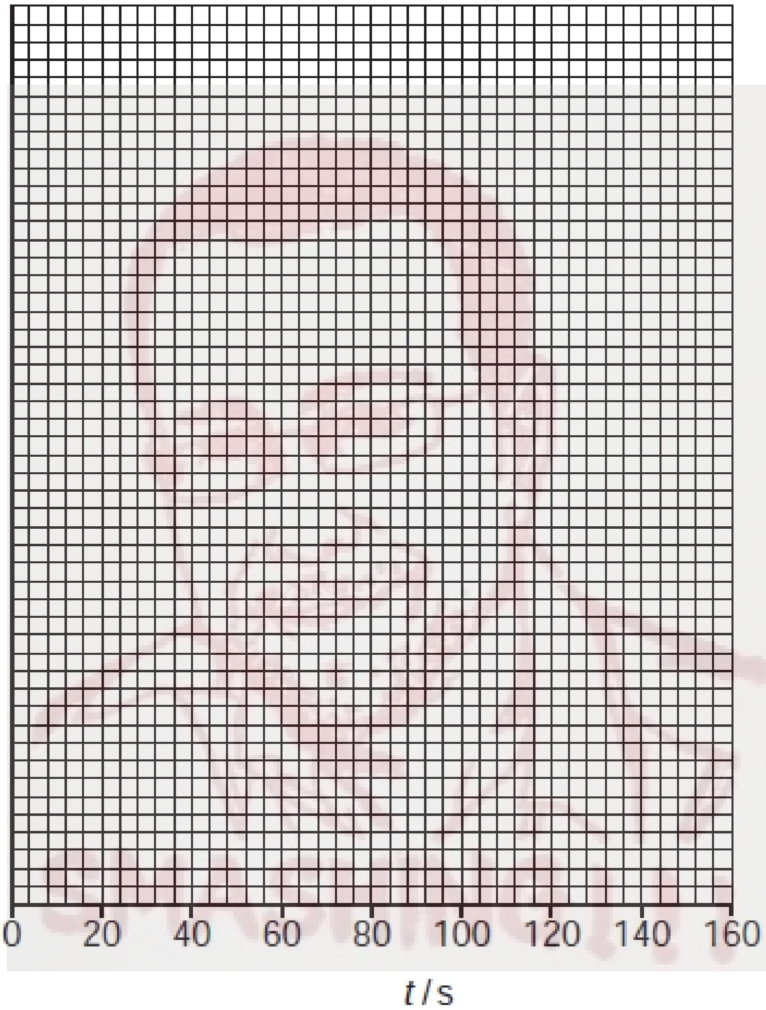
(a) **(i)** Using the information in the table, calculate the temperature change T_1 of the water in the first 150 s.

T_1 = ...

(ii) Using the information in the table, calculate the temperature change T_2 of the water in the final 150 s.

T_2 = ...
[3]

(b) Plot a graph of θ / °C (*y*-axis) against *t* / s (*x*-axis) for the first 150 s. [5]



(c) During the experiment the rate of temperature change decreases.

(i) Describe briefly how the results that you have calculated in part **(a)** show this trend.

....

....

(ii) Describe briefly how the graph line shows this trend.

....

....

2 The IGCSE class is investigating the rate of cooling of water.

The apparatus is shown in Fig. 2.1.

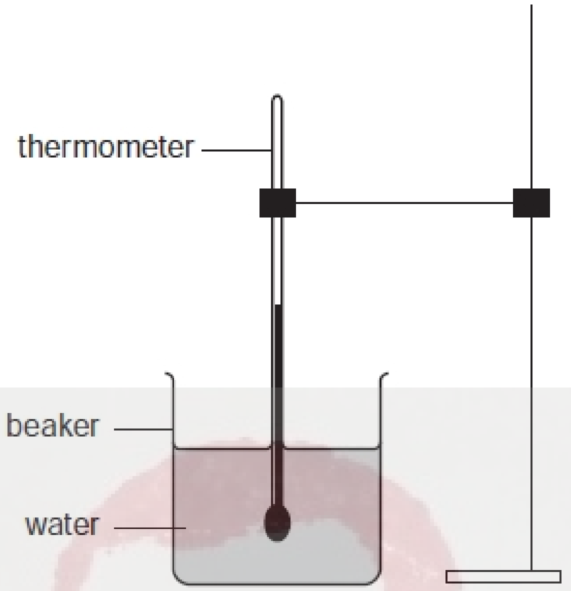


Fig. 2.1

(a) Record room temperature θ_R as shown on the thermometer in Fig. 2.2.

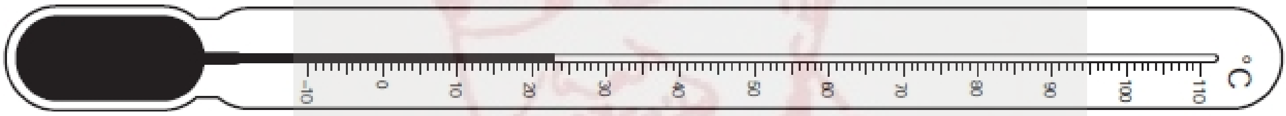


Fig. 2.2

θ_R = ...[1]

(b) The beaker contains 200 cm^3 of hot water. A student takes temperature readings as the water cools, as shown in Table 2.1.

Table 2.1

t /	*θ* /
0	79
30	65
60	58
90	55
120	53
150	52
180	51

(i) Complete the column headings in Table 2.1.

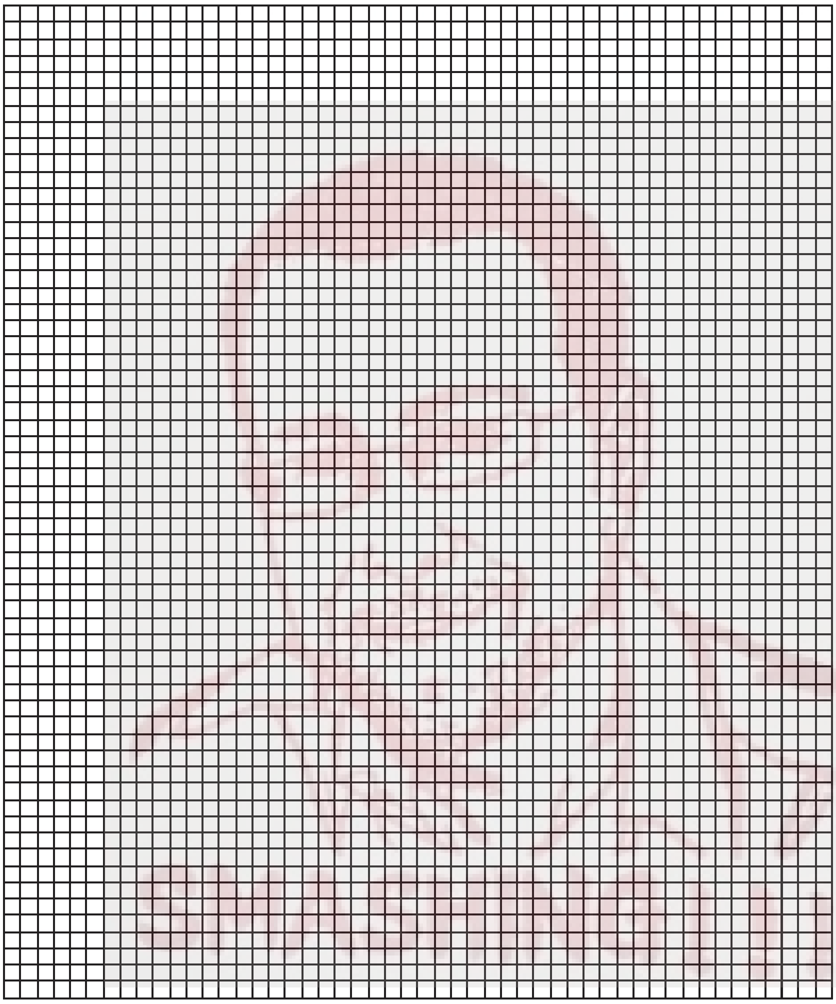
(ii) Calculate the temperature fall T_1 during the first 30 s of cooling.

T_1 = ...

(iii) Calculate the temperature fall T_2 during the final 30 s of cooling.

T_2 = ... [3]

(c) Plot the graph of temperature (*y*-axis) against time (*x*-axis).



[5]

(d) (i) State how the rate of cooling in the first 30 s differs from that in the final 30 s.

....

....

(ii) Explain how the graph line shows this difference.

....

.... [2]

[Total: 11]

2 The IGCSE class is investigating the rate of heating and cooling of a thermometer bulb.

The apparatus used is shown in Fig. 2.1.

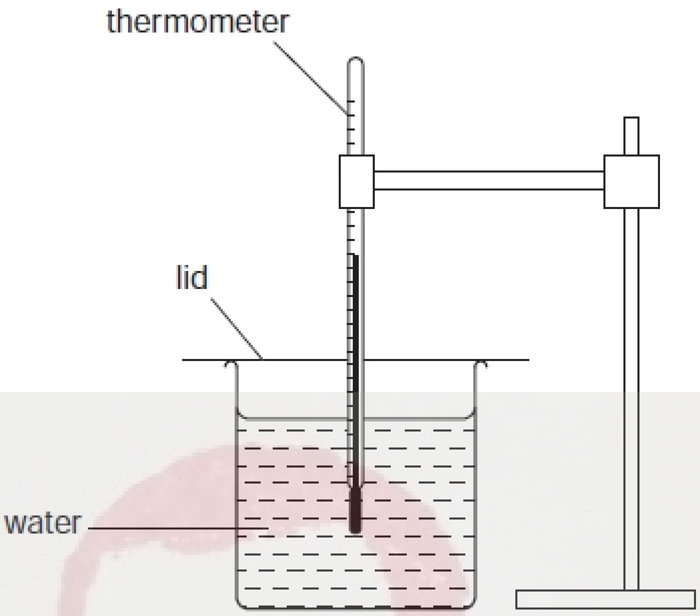


Fig. 2.1

(a) Record the room temperature θ_r shown on the thermometer.

θ_r = ... [1]

(b) For the cooling experiment, a student places the thermometer into hot water as shown in Fig. 2.1. When the temperature shown on the thermometer stops rising, she records the temperature θ at time t = 0 s. She removes the thermometer from the water, immediately starts a stopclock, and records the temperature shown on the thermometer at 30 s intervals. The readings are shown in Table 2.1.

For the heating experiment, the student takes another thermometer and records the temperature θ shown on the thermometer at time t = 0 s. She places the thermometer in the beaker of hot water, immediately starts the stopclock, and records the temperature shown by the thermometer at 10 s intervals. The readings are shown in Table 2.2.

Table 2.1

t /	θ /
0	74
30	60
60	52
90	45
120	39
150	35
180	33

Table 2.2

t /	θ /
0	25
10	69
20	80
30	81
40	81
50	82
60	82

(i) Complete the column headings in both tables. [1]

(ii) Estimate the time that would be taken in the cooling experiment for the thermometer to cool from the reading at time t = 0 s to room temperature θ_r.

estimated time = ... [1]

(c) State in which table the initial rate of temperature change is the greater. Justify your answer by reference to your readings.

The initial rate of temperature change is greater in Table ....

justification ....

....[1]

(d) If one of these experiments were to be repeated in order to determine an average temperature for each time, it would be important to control the conditions. Suggest two such conditions that should be controlled.

1. ....

2. ....[2]

[Total: 6]

5 The IGCSE class is investigating the time taken for ice cubes to melt when placed in water.

Each student is able to use
glass beakers,
a thermometer,
a stopclock,
a measuring cylinder,
an electronic balance,
a supply of ice cubes of different sizes,
a supply of cold water,
a stirrer,
a method of heating the water
and any other common laboratory apparatus that may be useful.

A student decides to investigate the effect of the mass of ice cubes on the time they take to melt in water.

(a) Suggest three possible variables that should be kept constant in this investigation.

1. ....

2. ....

3. .... [3]

(b) In the table below, write the names of three items of apparatus that are necessary in order to take readings in this investigation. In the second column of the table write the quantity that the item measures.

item of apparatus	quantity measured

[3]

[Total: 6]

2 An IGCSE student is investigating the cooling of thermometer bulbs under different conditions.

He places a thermometer in a beaker of hot water and records the temperature θ_h of the hot water.

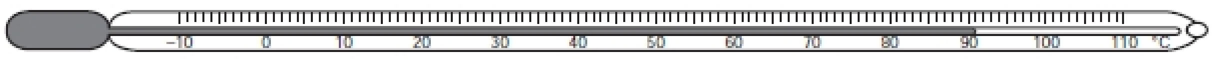


Fig. 2.1

(a) Fig. 2.1 shows the thermometer. Write down the value of θ_h that it shows.

θ_h .... [1]

He then moves the thermometer until the thermometer bulb is just above the surface of the water (position **A**) and immediately starts a stopclock.

He records the time t and the temperature reading θ every 30 s. The readings are shown in Table 2.1.

Table 2.1

	Position A	Position B
t/	θ/	θ/
30	65	56
60	58	47
90	54	40
120	52	35
150	50	32
180	48	30

(b) Complete the column headings in the table. [1]

The student replaces the thermometer in the hot water and then moves the thermometer 15 cm away from the beaker to position **B** and immediately starts the stopclock. He records the time t and the temperature reading θ every 30 s. The readings are shown in Table 2.1.

(c) State in which position the thermometer bulb cooled more quickly. Justify your answer by reference to the readings.

statement ....

justification ....

.... [1]

(d) To make a fair comparison between the rates of cooling of the thermometer bulbs in the two positions, it is important to control other experimental conditions. Suggest two conditions that should be controlled in this experiment.

1. ....

2. .... [2]

[Total: 5]

2 The IGCSE class is investigating the cooling of thermometer bulbs under different conditions.

The students are provided with two thermometers **A** and **B**. Thermometer **B** has cotton wool wrapped around the bulb. Fig. 2.1 shows thermometer **A**.

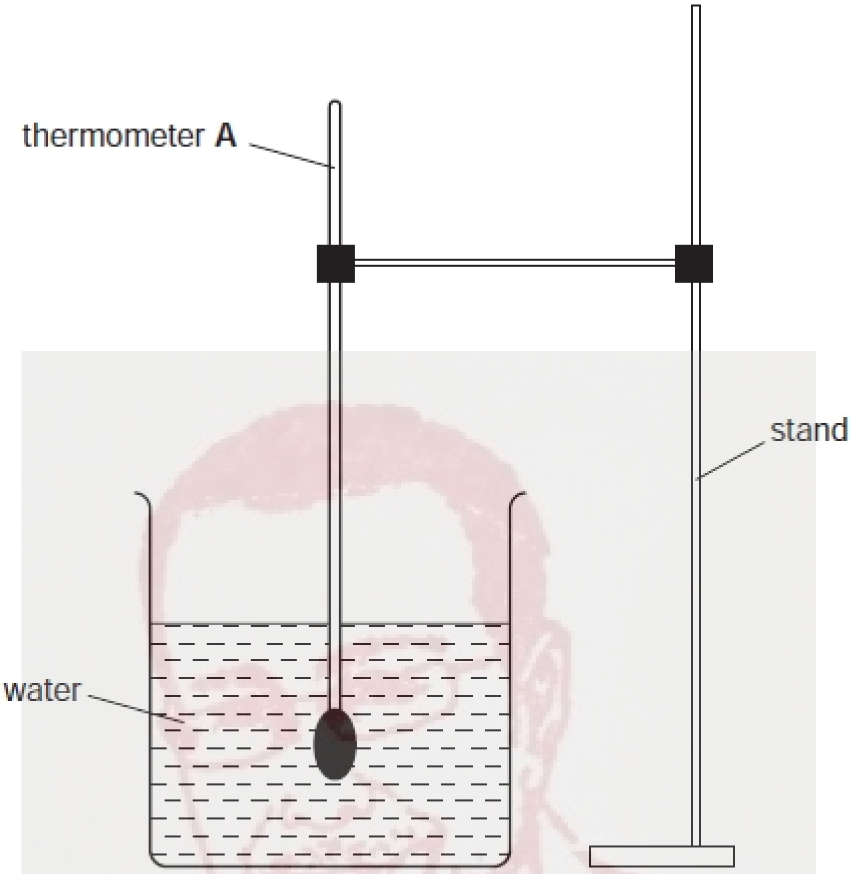


Fig. 2.1

The students measure the temperature θ of the hot water in the beaker. Fig. 2.2 shows the thermometer reading.

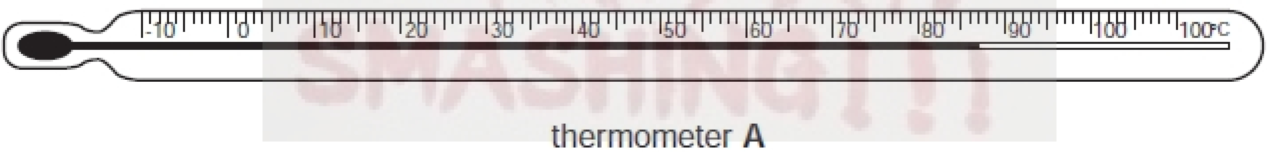


Fig. 2.2

(a) Record in Table 2.1 at time t = 0 s the temperature θ shown in Fig. 2.2.

(b) The students remove the thermometer from the water, starting the stopclock at the same time. Table 2.1 shows the temperature of the thermometer bulb at 30 s intervals. The experiment is repeated using thermometer **B** which has cotton wool wrapped around the thermometer bulb.

Complete Table 2.1 by inserting the appropriate unit in the time and in the temperature column headings.

Table 2.1

	Thermometer **A**	Thermometer **B**
t /	θ/	θ/
0		81
30	51	72
60	43	58
90	37	49
120	34	43
150	30	38
180	28	34
210	27	31

[2]

(c) Suggest which thermometer cooled more quickly at first. Justify your answer by reference to the readings.

statement ....

justification ....

.... [2]

(d) To make a fair comparison between the rates of cooling of the two thermometer bulbs under different conditions (in this experiment one thermometer bulb is covered with cotton wool), it is important to control other experimental conditions. Suggest two conditions that should be controlled in this experiment.

1. ....

2. .... [2]

[Total: 6]

3 The IGCSE class is investigating the change in temperature of hot water as cold water is added to the hot water.

A student measures and records the temperature θ of the hot water before adding any of the cold water available.

He then pours 20 cm^3 of the cold water into the beaker containing the hot water. He measures and records the temperature θ of the mixture of hot and cold water.

He repeats this procedure four times until he has added a total of 100 cm^3 of cold water.

The temperature readings are shown in Table 3.1. V is the volume of cold water added.

Table 3.1

V /	θ /
0	82
	68
	58
	50
	45
	42

(a) **(i)** Complete the column headings in the table.

(ii) Enter the values for the volume of cold water added.

[2]

(b) Use the data in the table to plot a graph of temperature (*y*-axis) against volume (*x*-axis). Draw the best-fit curve.

[4]

(c) During this experiment, some heat is lost from the hot water to the surroundings. Also, each time the cold water is added, it is added in quite large volumes and at random times.

Suggest two improvements you could make to the procedure to give a graph that more accurately shows the pattern of temperature change of the hot water, due to addition of cold water alone.

1. ....

....

2. ....

.... [2]

[Total: 8]

3 A student is investigating the effect of surface area exposed to the air on the rate of cooling of hot water.

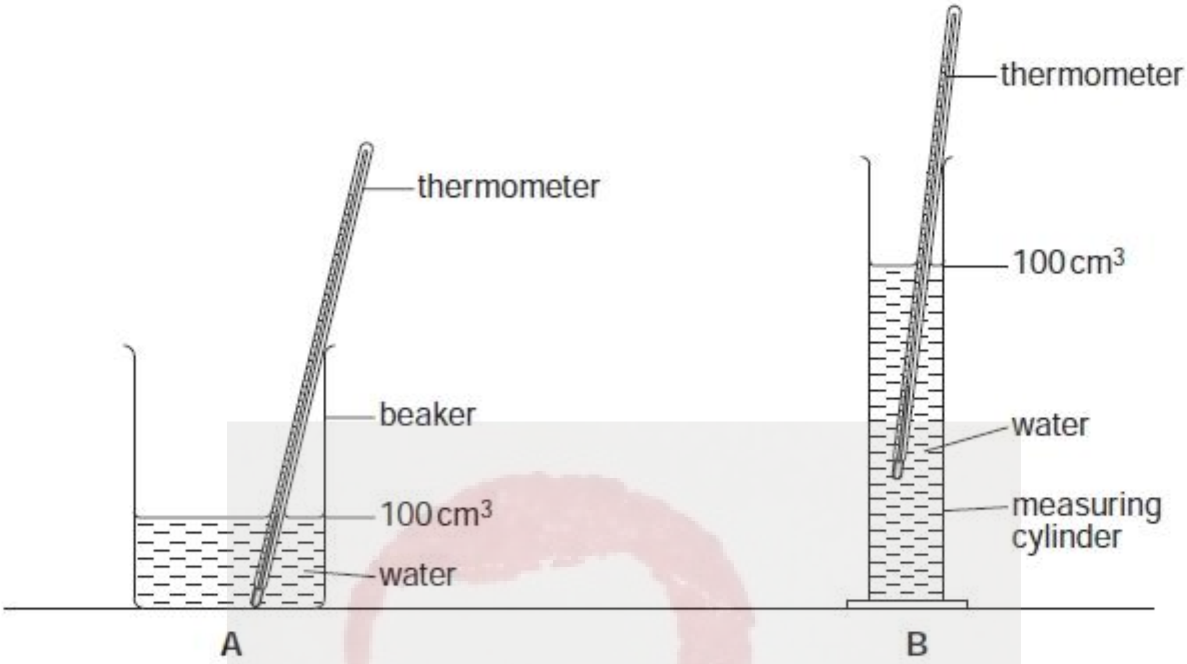


Fig. 3.1

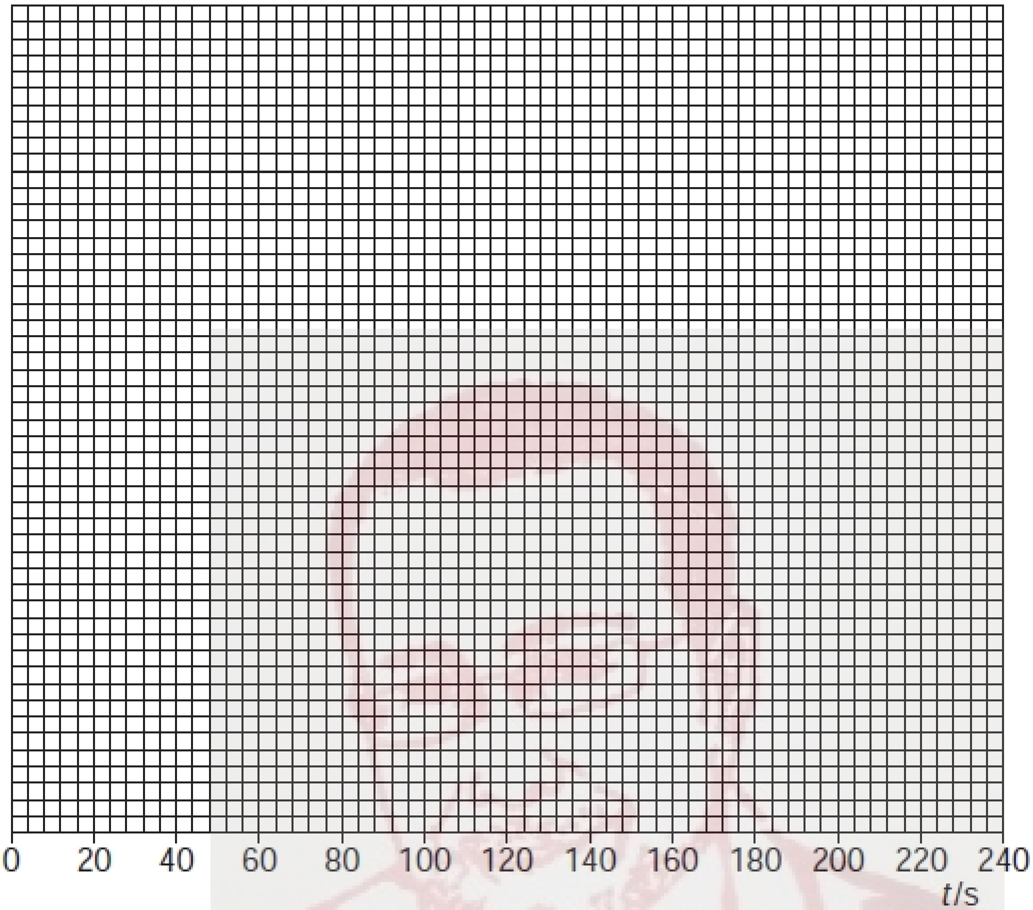
The student is provided with two containers. The beaker is labelled **A** and the measuring cylinder is labelled **B**. Each container contains 100 cm^3 of hot water. He records the temperature of the water at 30 s intervals for a total of four minutes. Table 3.1 shows the readings of time *t* and temperature θ.

Table 3.1

	container **A** (beaker)	container **B** (measuring cylinder)
t/s	θ/°C	θ/°C
0	85	85
30	76	79
60	68	74
90	63	69
120	59	66
150	56	63
180	54	61
210	52	59
240	51	58

(a) **(i)** Use the data in Table 3.1 to plot a graph of θ/°C (y-axis) against t/s (x-axis) **for the beaker**. Draw the best-fit curve.

(ii) Use the data for the measuring cylinder to plot another curve on the same graph axes that you used for part **(a)(i)**.



[6]

(b) The experiment is designed to investigate the effect of the surface area exposed to the air on the rate of cooling. State briefly the effect of a larger surface area on the rate of cooling. Justify your answer by reference to your graph.

statement ....

justification ....

.... [2]

[Total: 8]

1 The IGCSE class is investigating the rate of cooling of hot water.

(a) A student measures room temperature. Write down the value of room temperature θ_0 shown on the thermometer in Fig. 1.1.

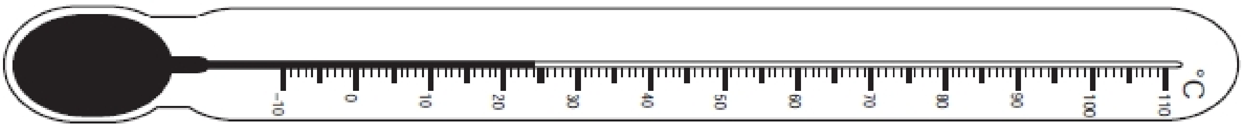


Fig. 1.1

θ_0 = ... [1]

(b) He then pours hot water into a beaker until it is about two-thirds full. He measures and records the temperature θ of the hot water and at the same time starts a stopwatch. As the water cools, he records the temperature every 30 s for a total of five minutes. His readings are shown in the table below.

t/	θ/
0	68.0
30	53.0
60	45.0
90	40.0
120	36.5
150	33.5
180	32.0
210	30.0
240	29.0
270	28.5
300	28.0

(i) Complete the column headings in the table.

(ii) Calculate the temperature fall T_1 in the first minute of the experiment.

T_1 = ...

(iii) Calculate the temperature fall T_2 in the final minute of the experiment.

T_2 = ...

[3]

(c) Theory suggests that the rate of cooling of the hot water at any time depends on the difference between the temperature of the water at that time and room temperature.

(i) State and explain whether your answers in **(b)** support this theory.

Statement ....

Explanation ....

.... [1]

(ii) Suggest three variables that you would attempt to keep constant if this theory were to be investigated further.

1. ....

2. ....

3. .... [3]

(d) Suggest one addition you could make to the apparatus provided in order to reduce the rate of evaporation of the water in the beaker.

.... [1]

[Total: 9]

1 The IGCSE class is investigating the temperature changes that occur when hot and cold water are mixed.

(a) A student pours 50 cm^3 of water into a beaker. He then measures the temperature θ_1 of the water in the beaker. Write down the value of θ_1 shown on the thermometer in Fig. 1.1.

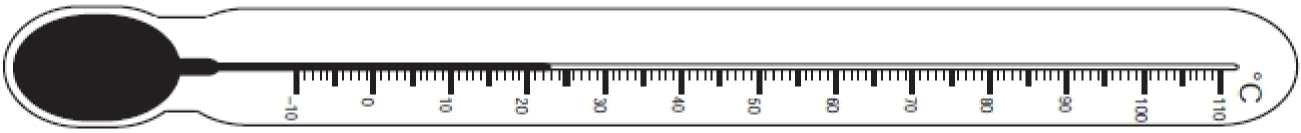


Fig. 1.1

θ_1 = ... [2]

(b) The student then measures the temperature θ_2 of some hot water. He pours 50 cm^3 of this hot water into the beaker of water at room temperature. He then records the temperature θ_3 of the water in the beaker. His readings are

θ_2 = 76 °C,

θ_3 = 42 °C.

Calculate

(i) the temperature rise of the cold water, ...

(ii) the temperature fall of the hot water. ....

[2]

(c) A theoretical calculation based on the equation

thermal energy lost by hot water = thermal energy gained by cold water

predicts a higher value for the temperature θ_3 than the value that is obtained by this experiment. Suggest

(i) a practical explanation for the difference in values,

....

(ii) two practical improvements that you could make to the procedure for this experiment to obtain a result that is closer to the theoretical result.

1. ....

2. .... [3]

[Total: 7]

4 The IGCSE class is investigating conditions affecting the rate of cooling of a beaker of hot water.

(a) The students start by measuring room temperature. Record the value of room temperature as shown on the thermometer in Fig. 4.1.

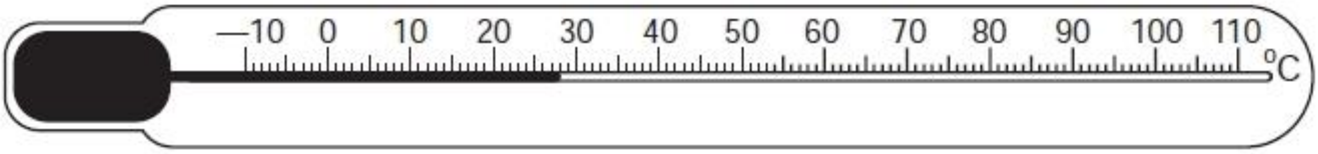


Fig. 4.1

temperature = ... [2]

(b) The students are provided with hot water in beakers as shown in Fig. 4.2. Beaker **A** is insulated and beaker **B** has a lid.

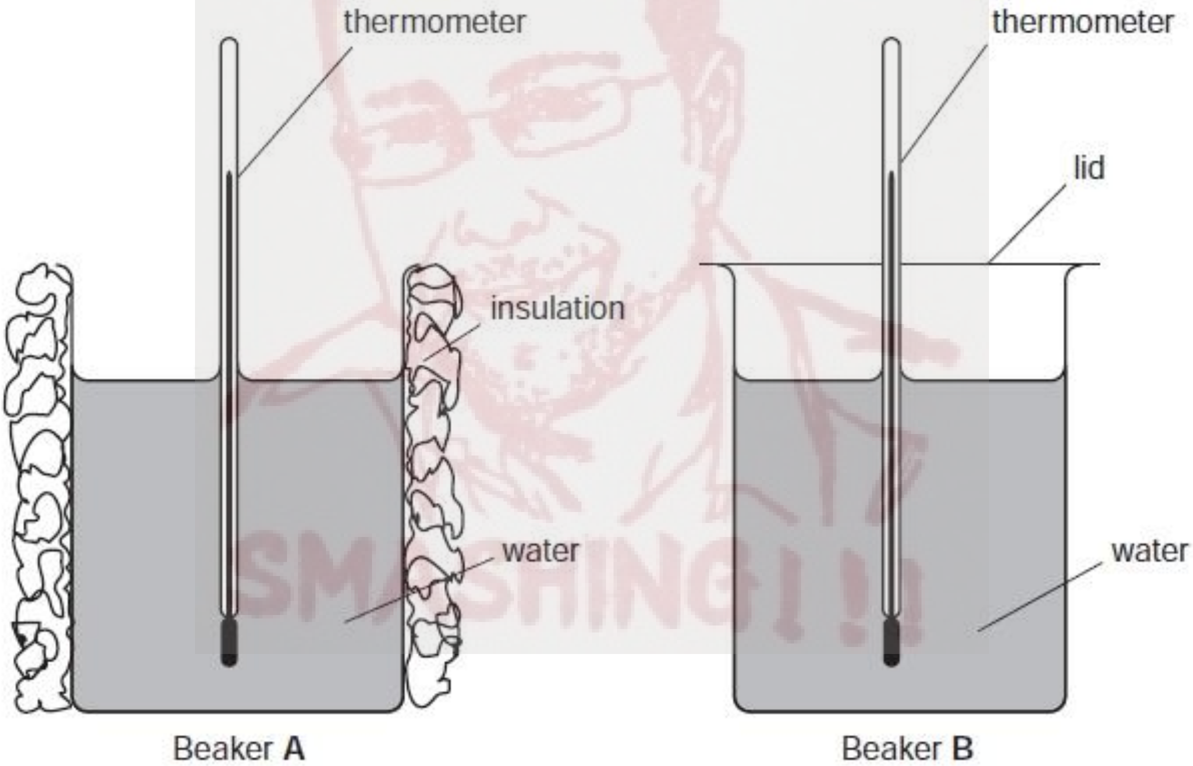


Fig. 4.2

The students measure and record the temperature θ of the water in each beaker every 30 s for a total of five minutes. One student's readings are shown in the tables.

beaker **A**

time / s	θ / °C
0	83.0
30	82.0
60	81.0
90	79.5
120	79.0
150	77.0
180	75.0
210	74.0
240	72.0
270	71.0
300	70.0

beaker **B**

time / s	θ / °C
0	82.0
30	82.0
60	81.0
90	80.0
120	79.0
150	78.0
180	76.0
210	75.0
240	74.0
270	73.0
300	72.0

(i) Look at the temperature readings in the tables. State whether the insulation round beaker A or the lid on beaker B or neither is most effective in keeping the water hot. By reference to readings in the tables, justify your answer.

statement ....

justification ....

.... [2]

(ii) Suggest a suitable material for the insulation around beaker A.

.... [1]

(iii) To obtain reliable results in this experiment, it is important that variables are controlled. State three variables that should be controlled in this experiment.

variable 1 ....

variable 2 ....

variable 3 .... [3]

4 An IGCSE student is investigating the temperature rise of water in beakers heated by different methods. The apparatus is shown in Fig. 4.1. Beaker A is heated electrically and beaker B is heated with a Bunsen burner.

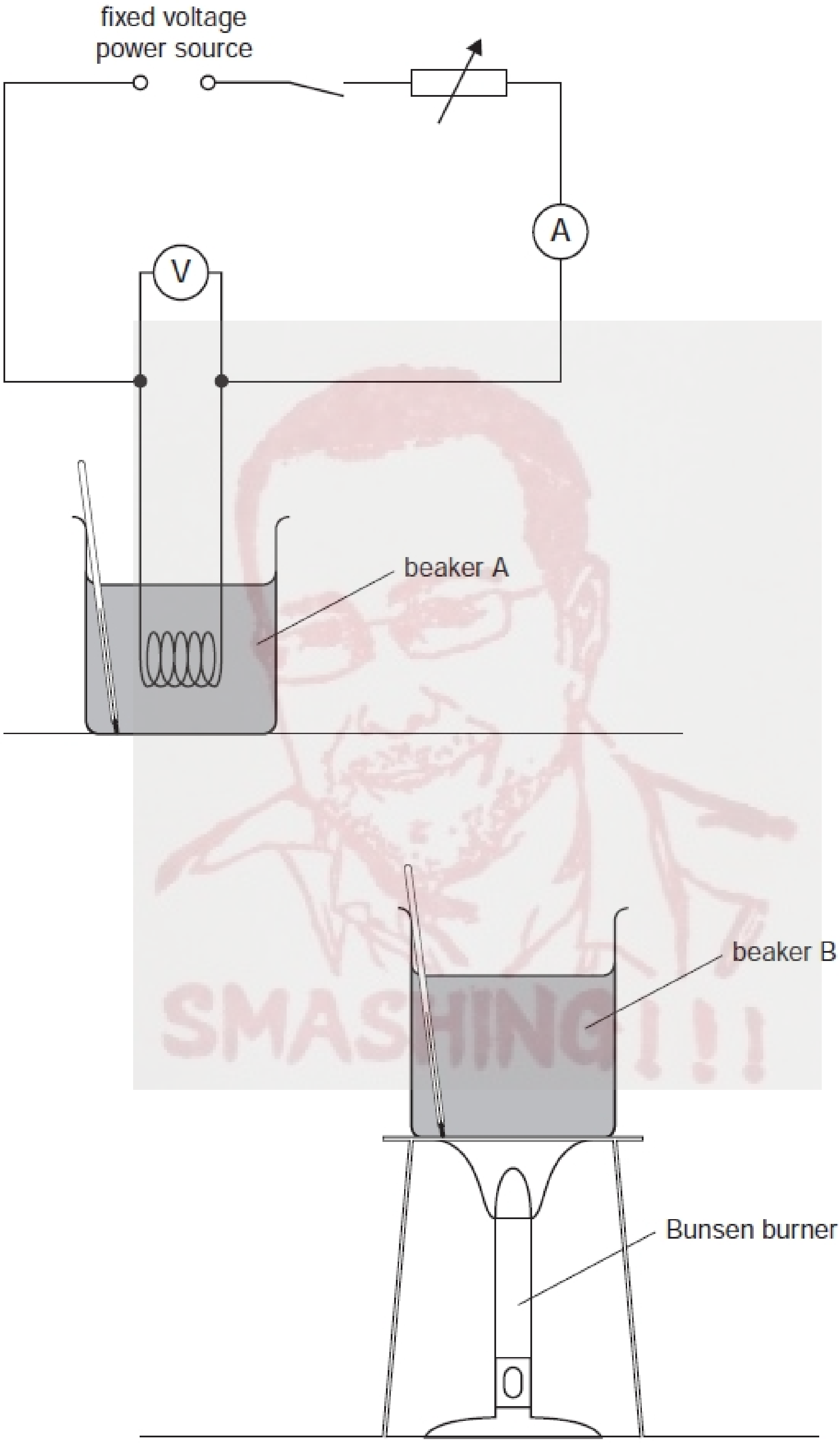


Fig. 4.1

The student first records room temperature.

(a) Fig. 4.2 shows the thermometer at room temperature.

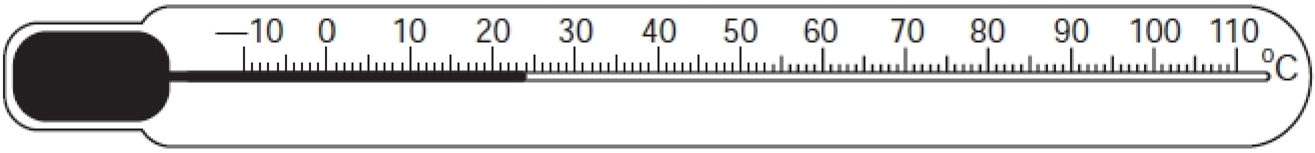


Fig. 4.2

(i) Write down the value of room temperature.

room temperature = ... [1]

(ii) The two beakers are heated from room temperature for the same length of time. The new water temperature for beaker A is 30 °C and for beaker B is 28 °C.

Calculate the temperature rise of the water in each beaker.

temperature rise in beaker A = ...

temperature rise in beaker B = ... [1]

(b) The electrical heater and the Bunsen burner both have the same power and both beakers were heated from room temperature for the same length of time. Suggest why there is a difference in temperature rise between beaker A and beaker B.

....

....

.... [2]

(c) In order to keep the heating effect of the electrical heater constant throughout the heating period, the student adjusts the current. Name the component in the circuit that the student uses for this purpose.

.... [1]

3 The IGCSE class carries out an experiment to investigate the effect of insulation on the rate of cooling of hot water.

The apparatus is shown in Fig. 3.1.

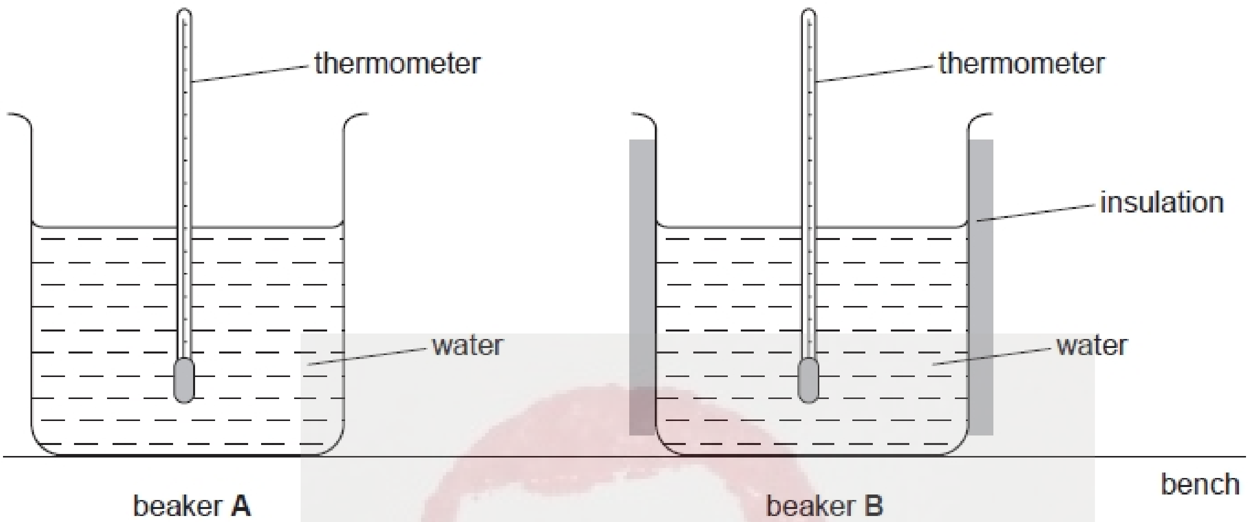


Fig. 3.1

The students each have two glass beakers **A** and **B**. Beaker **B** is insulated. They also have a supply of hot water.

A student pours hot water into beaker **A** until it is approximately two thirds full and then measures the temperature θ of the hot water. He records this temperature in the table at time t = 0 s. He then starts a stopwatch and records the temperature of the water at 30 s intervals for a total of four minutes.

He repeats the experiment using beaker **B**. All the readings are shown in the tables below.

beaker **A**

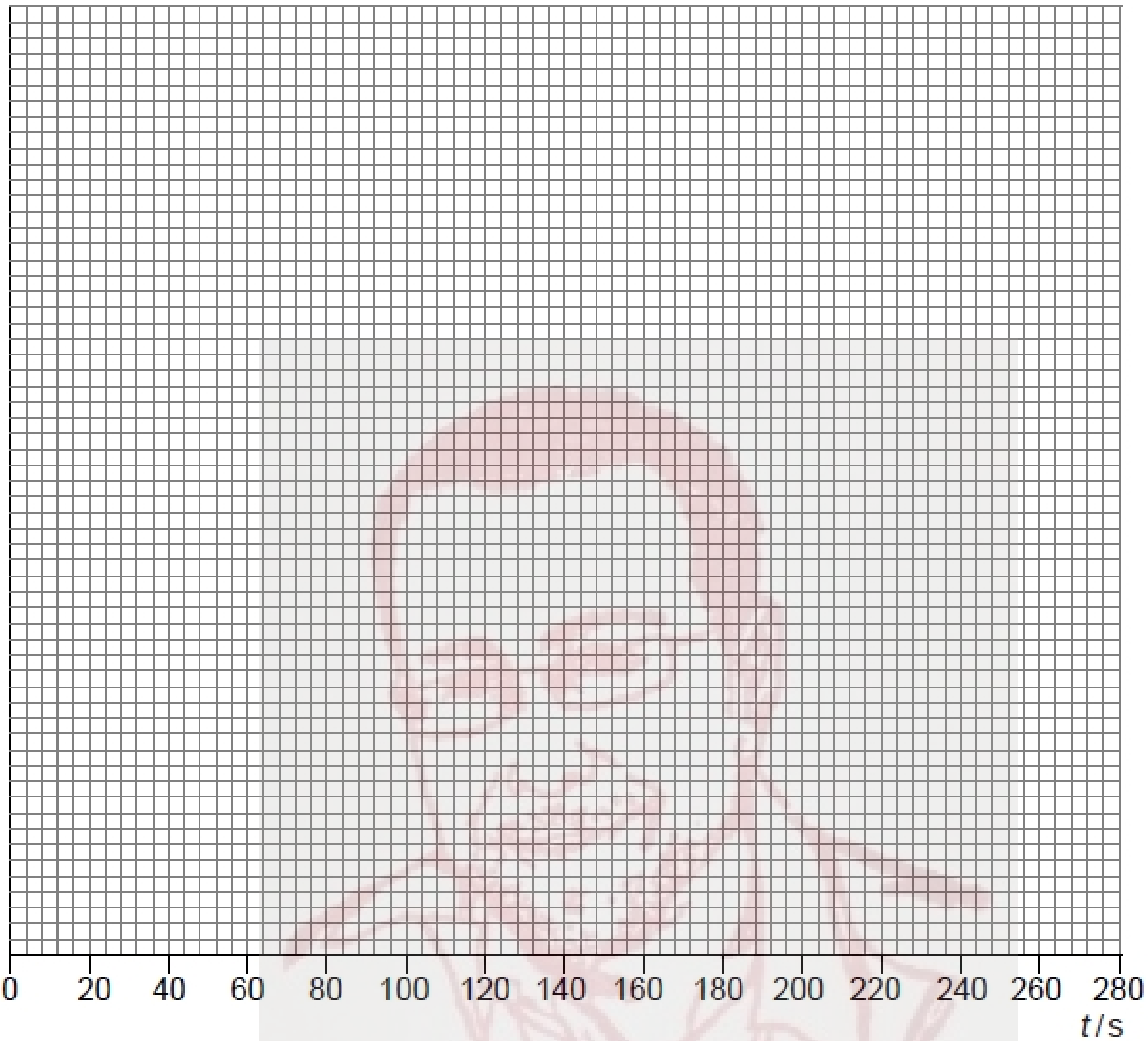
t /	θ /
0	80
30	67
60	59
90	54
120	51
150	48
180	47
210	46
240	45

beaker **B**

t /	θ /
0	80
30	69
60	62
90	57
120	53
150	50
180	48
210	47
240	46

(a) Complete the column headings in the tables. [1]

(b) Use the readings for beaker **A** to plot a graph of temperature θ (y-axis) against time t (x-axis). Start the temperature scale at 40 °C. Draw the best-fit curve. [4]



(c) Use the readings for beaker **B** to plot another curve on the same graph axes that you used in part **(b)**. [2]

(d) The experiment you have just done was designed to investigate the effect of insulation on the rate of cooling. Suggest two improvements that could be made to the design of the experiment.

1. ....

....

2. ....

.... [2]

1 The IGCSE class is investigating the change in temperature of hot water as cold water is added to it.

The students are provided with 100 cm^3 of hot water and a supply of cold water at room temperature.

(a) The thermometer in Fig. 1.1 shows the temperature of the cold water.

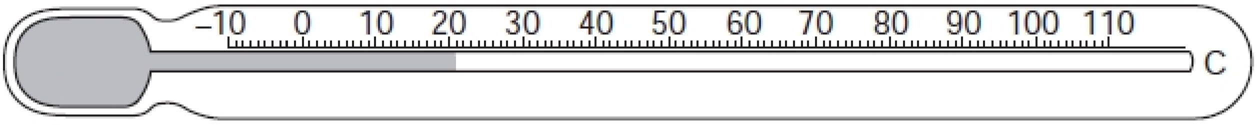


Fig. 1.1

Record the temperature of the cold water, as shown in Fig. 1.1.

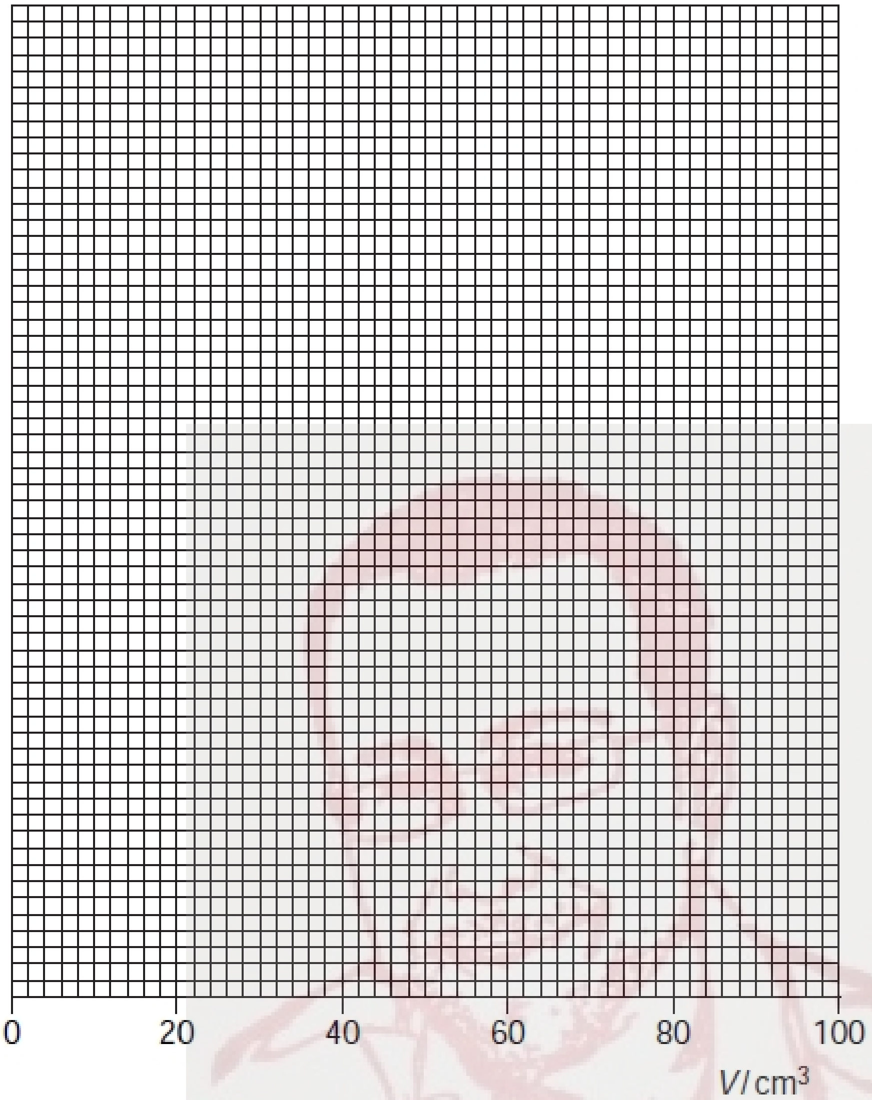
.... [1]

(b) A student records the temperature of the hot water. He then pours 20 cm^3 of the cold water into the beaker containing the hot water. He records the temperature θ of the mixture of hot and cold water and the volume V of cold water added. He then repeats the process four times until he has added a total of 100 cm^3 of cold water. The table shows the readings.

V /	θ /
0	80.0
20	58.0
40	48.0
60	40.5
80	34.0
100	29.0

(i) Complete the column headings in the table. [1]

(ii) Use the data in the table to plot a graph of temperature θ (y-axis) against volume V (x-axis).



[5]

(c) A sketch graph of the readings taken by another student carrying out a similar experiment is shown in Fig. 1.2.

The theoretical line shows the results expected by the student after calculating the values of θ. The student assumed that all the heat lost by the hot water was gained by the cold water when the cold water was poured into the beaker.

The other line shows the experimental results.

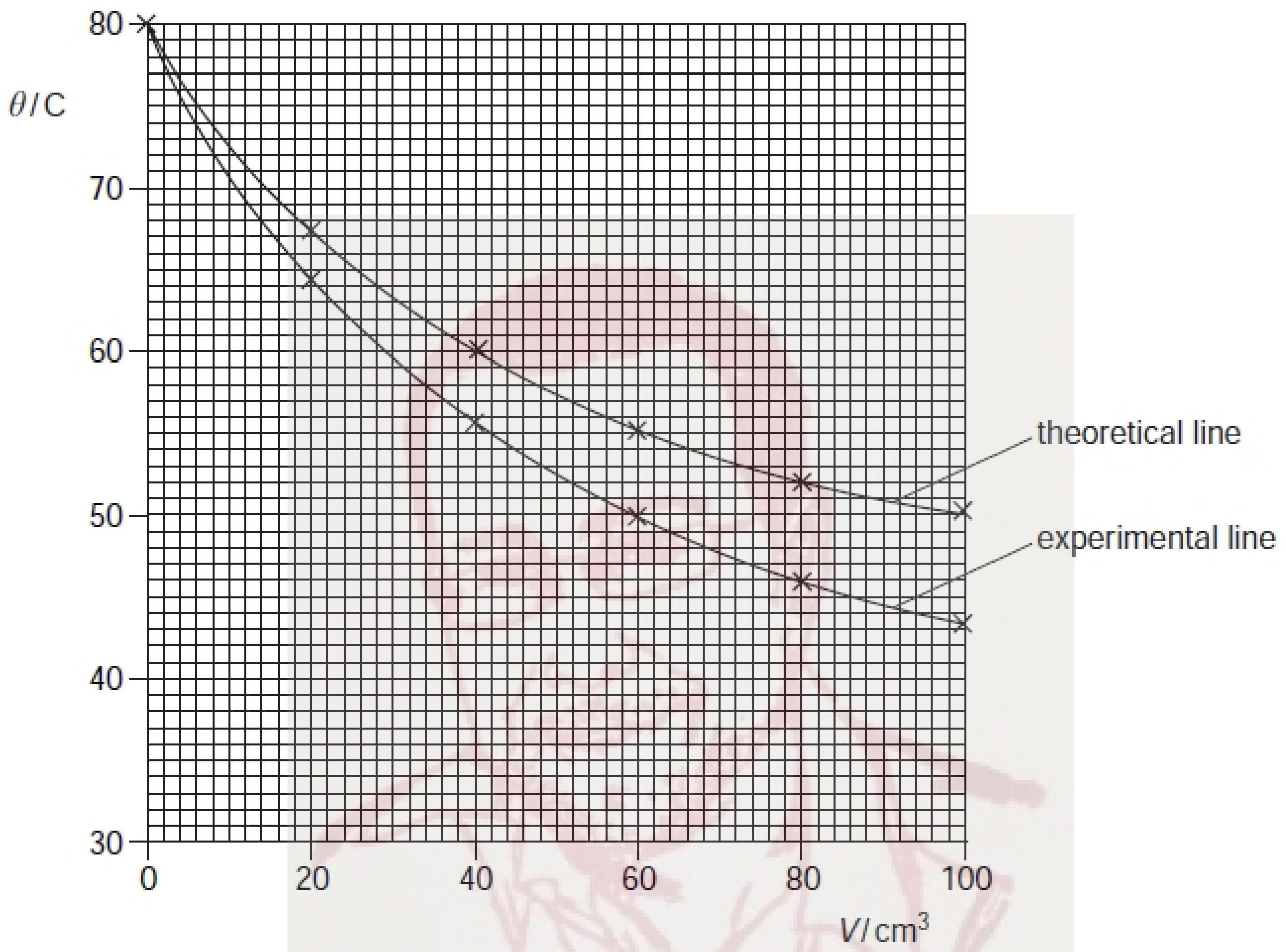


Fig. 1.2

The student carried out the experiment with care. Suggest a practical reason why the experimental line differs from the theoretical line.

....

.... [1]

5 In a heating experiment, a student takes the temperature of a beaker B containing water at room temperature. Fig. 5.1 shows the thermometer used.

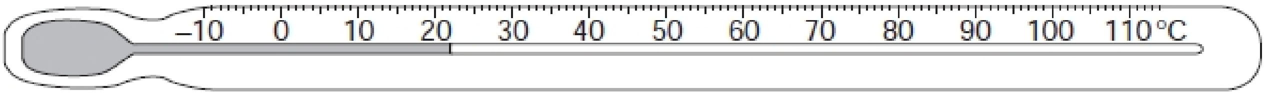


Fig. 5.1

(a) State the temperature reading shown on the thermometer.

temperature reading = ... [1]

(b) The student then transfers a small metal cylinder from beaker A of boiling water to the beaker B of water at room temperature, as shown in Fig. 5.2.

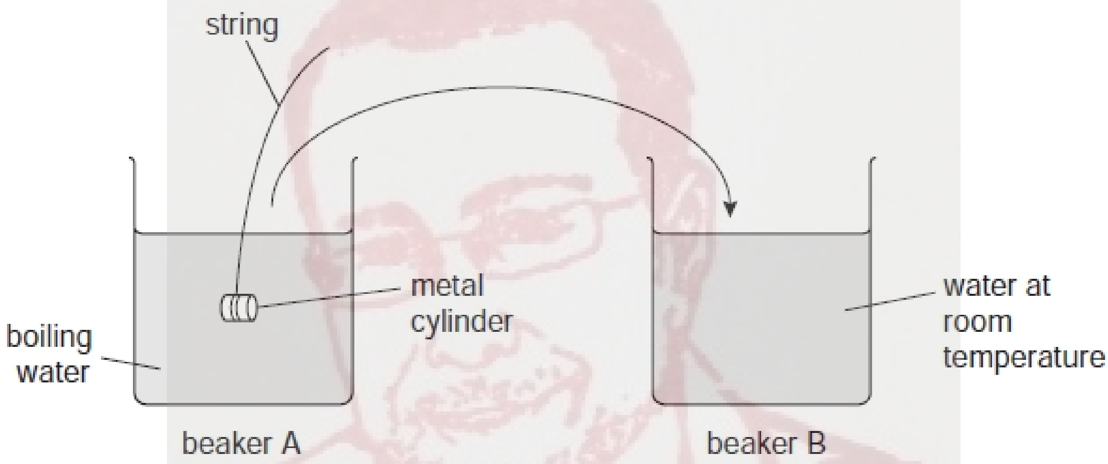


Fig. 5.2

The student assumes that the metal is at a temperature of 100 °C when it enters the water in beaker B.

The temperature of the water in beaker B rises to 36 °C.

(i) Calculate the temperature rise of the water in beaker B.

temperature rise = ...

(ii) Calculate the temperature fall of the metal cylinder.

temperature fall = ...

[3]

(c) The student uses these readings and some other information to calculate the specific heat capacity of the metal.

Why is it important to transfer the metal between the beakers as quickly as possible?

....

.... [1]

5 A student wants to find out which of the three materials is the best thermal insulator.

The student's apparatus at the beginning of each test is as shown in Fig. 5.1.

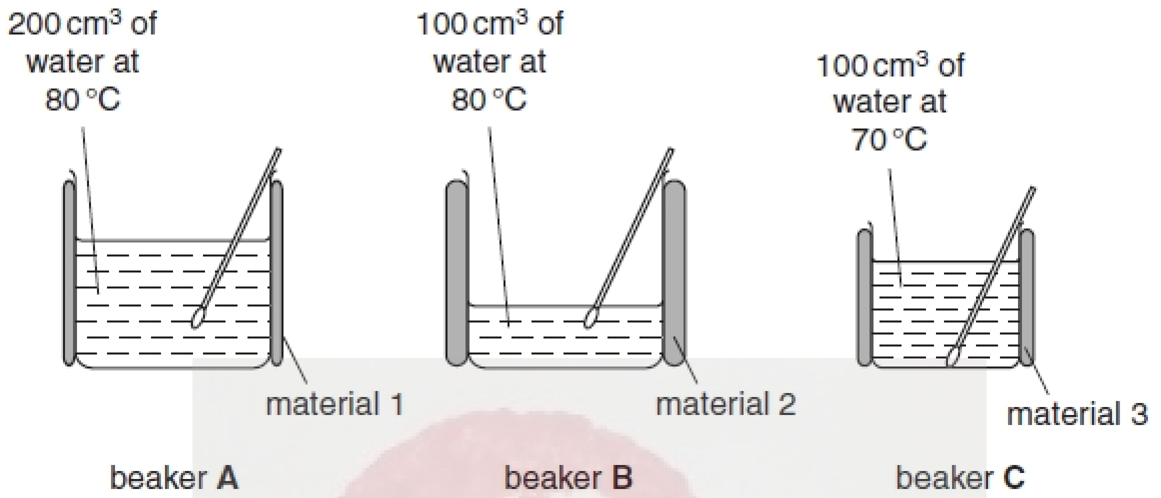


Fig. 5.1

Each beaker is surrounded by a different insulating material. The water is allowed to cool and the temperatures are recorded at different times. The student is unable to write a correct conclusion because the variables have not been controlled.

(a) Study Fig. 5.1 and then state **two** ways in which you would improve the control of variables.

1. ....

....

2. ....

.... [2]

(b) State the reading shown on the thermometer shown in Fig. 5.2.

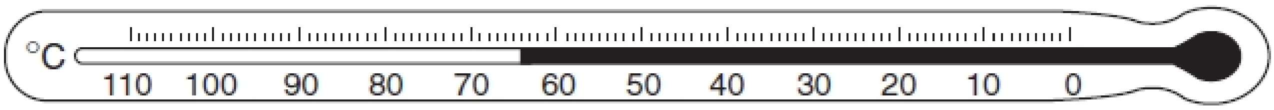


Fig. 5.2

temperature reading .... [1]

(c) The graph of Fig. 5.3 shows the results obtained by the student.

The graph lines **A**, **B** and **C** correspond to the beakers **A**, **B** and **C**.

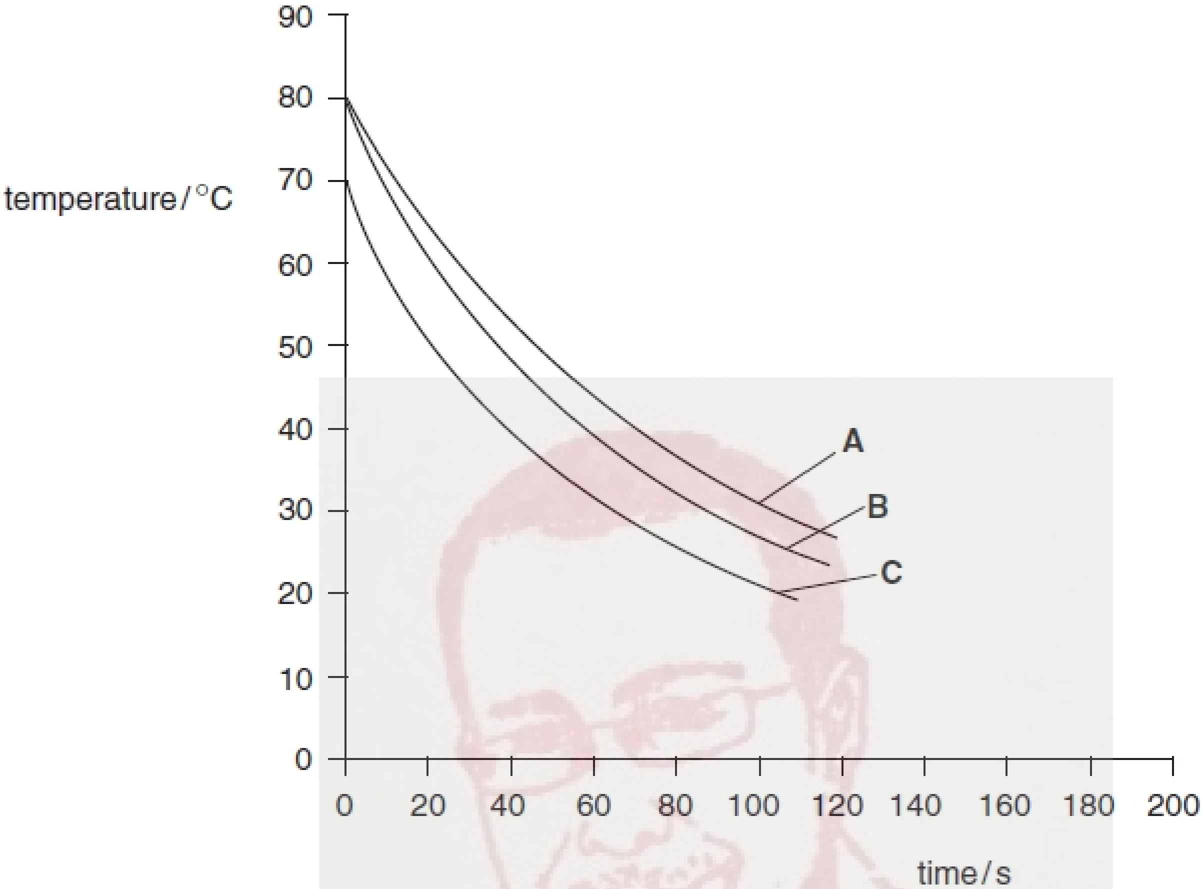


Fig. 5.3

Which beaker cools the most quickly in the first 60 s?

.... [1]

5 A student was asked to carry out an experiment to compare the insulating properties of cotton wool, cardboard and polystyrene. The apparatus provided was hot water, a thermometer, a stopclock and a copper can with a lid, as shown in Fig. 5.1.

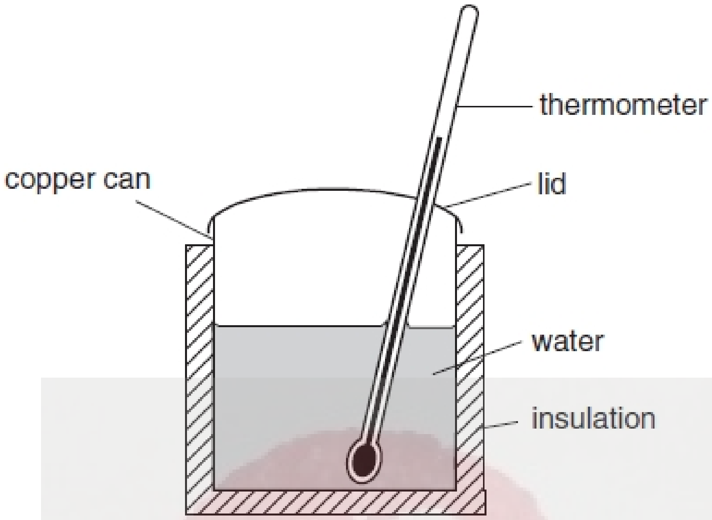


Fig. 5.1

The student wrapped one of the insulators around the can, poured hot water into the can, and then took temperature and time readings as the water cooled. This was then repeated for each insulator. The graph in Fig. 5.2 shows how the student displayed his readings.

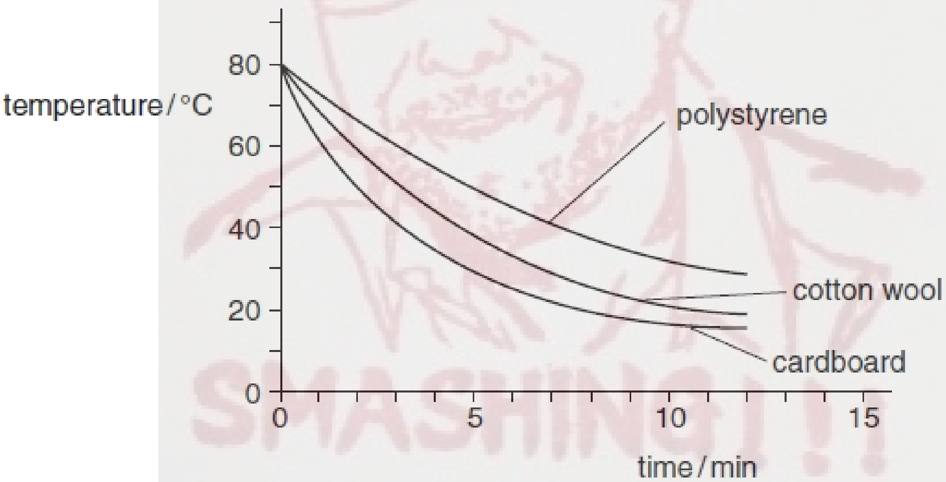


Fig. 5.2

(a) **(i)** Using the information on the graph, which material appears to be the best insulator?

....

(ii) Justify your answer by referring to the information on the graph.

....

....

[2]

(b) In this experiment, it is important to control the variables. Suggest three variables that the student should keep constant for this experiment.

1. ....

2. ....

3. ....
[3]

Topic Phx 5 **Q.69 iG Phx/2002/w/Paper 61 www.SmashingScience.org**

4 The IGCSE class was performing a heating experiment. The apparatus is shown in Fig. 4.1. The aim was to determine the rate at which the temperature of 200 cm^3 of water increased when heated with an electric immersion heater.

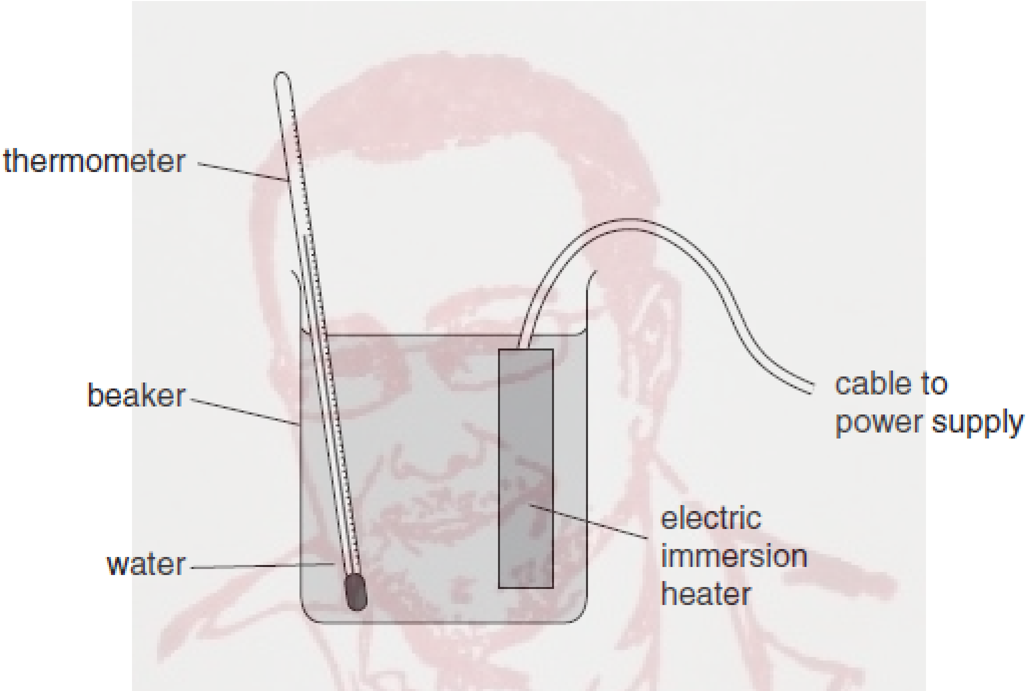


Fig. 4.1

The water was heated from room temperature up to 60 °C. The teacher measured the power of the immersion heater and calculated (correctly) the time required to raise the temperature of 200 cm^3 of water from 21 °C to 60 °C.
The students found that the water must be heated for longer than the calculated time.

(a) **(i)** What is the most likely cause of the longer time recorded?

Tick the appropriate box.

☐ an inaccurate thermometer

☐ errors in reading the stopwatch

☐ heat loss during the experiment

(ii) Suggest two precautions that could be taken to obtain more accurate results.

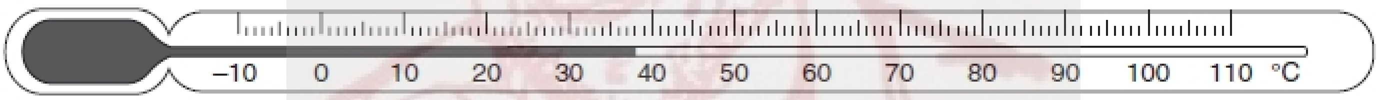
....

....

....

....[3]

(b) What is the reading on the thermometer shown in Fig. 4.2?



reading = ... [1]

Fig. 4.2

(c) The power *P* of the immersion heater is calculated using the equation $P = VI$

Calculate the power of an immersion heater in which the current is 5.5 A when the p.d. across it is 12.0 V.

....

....[2]

Topic_Phx 5 **Q.43 iG Phx/2015/s/Paper 61 www.SmashingScience.org**

2 **(a)** 85 (recorded in table) [1]

(b) s, °C [1]

(c) Graph:
- axes correctly labelled, right way round and with units [1]
- suitable scales, plots occupying at least half grid in both directions [1]
- all plots correct to within ½ small square [1]
- good best-fit line judgement [1]
- single, thin, continuous line [1]

(d) **(i)** decreases owtte, no ecf [1]

(ii) statement justified by reference to the graph [1]

[Total: 9]

Topic_Phx 5 **Q.44 iG Phx/2014/w/Paper 61 www.SmashingScience.org**

2 **(a)** 21 (°C) [1]

(b) table: s, °C, °C [1]

(c) no significant effect, justified by some reference to results [1]

wording that communicates the idea that the temperatures are the same within the limits of experimental accuracy OR almost the same rate [1]

(d) lid/cover/smaller cross-sectional area [1]

(e) any one from:
room temperature (or equivalent environmental condition)
initial water temperature
volume of water
same/dry insulation [1]

[Total: 6]

3 (a) θ_H = 92 (°C) [1]

(b) (i) table: s, °C, °C [1]

(ii) decreases [1]

justified by reference to results, giving numbers referring to temperature drops [1]

(c) any two from:

- room temperature / air conditioning / draughts / environmental conditions
- starting temperature (of thermometer) / temperature of (hot) water
- density of packing / amount of cotton wool / dryness of cotton wool [max 2]

[Total: 6]

2 (a) stopwatch / stopclock [1]

(b) any three from:

- length of rod
- diameter / thickness / area (of cross-section) of rod
- amount of wax / type of wax
- weight / size/mass of marker
- position for the markers
- (Bunsen) flame / (rate of) heating
- position of Bunsen / flame
- position of rod on tripod [max 3]

(c) temperature too high
or thermometer only measures up to about 100 °C
or small range [1]

thermometer / bulb can't make proper contact [1]

[Total: 6]

Topic Phx 5 **Q.47 iG Phx/2013/w/Paper 61 www.SmashingScience.org**

2 **(a)** 87 (°C) [1]

(b) **(i)** s, °C, °C [1]

(ii)(iii) **B** <u>and</u> greater temperature difference
OR numbers quoted, *must see* 21 and 8 or 24 and 5 [1]

(iv) **A** 23(°C) and **B** 40(°C) [1]

(v) 20 – 26 (°C) [1]

(c) EITHER viewing thermometer at right angles
OR reference to being ready on time [1]

(d) any two from:
room temperature
water / starting temperature
distance of thermometer bulb from water surface
relevant reference to draughts / fans / air conditioning [2]

[Total: 8]

Topic Phx 5 **Q.48 iG Phx/2013/s/Paper 61 www.SmashingScience.org**

2 **(a)** θ_R = 23(°C) [1]

(b) table:
d values 11.9, 11.3, 10.8, 10.4, 10.2, 10.0, 9.9 [1]
all *d* values to nearest mm [1]
s, °C, cm or mm [1]

(c) **(i)** does not go through the origin [1]

(ii) *d* not measured from 0 °C mark (o.w.t.t.e.) [1]

(d) any l divided by any number of divisions [1]
l value between 89 and 119 [1]
x = 0.98 mm to 1.00 mm (with unit) [1]

[Total: 9]

Topic_Phx 5 **Q.49 iG Phx/2012/w/Paper 61 www.SmashingScience.org**

2 **(a)** $\theta_R = 24(°C)$ [1]

(b) **(i)** Table:
s, °C, °C [1]

(ii) About the same [1]
Justified with reference to numbers in table [1]

(c) Any two from:
Volumes of water
Room temperature/draughts
Same beaker
Initial water temperature [2]

[Total: 6]

Topic_Phx 5 **Q.50 iG Phx/2012/s/Paper 61 www.SmashingScience.org**

2 **(a)** $\theta_R = 22(°C)$ [1]

(b) Table:
mm, °C [1]
Correct *d* values 100, 80, 60, 40, 20, 10 [1]

(c) Temperature difference = 3(°C), higher [1]

(d) Draughts [1]
Room temperature/humidity [1]

(e) One from:
Relevant avoidance of parallax explained, in using rule or thermometer
Waiting time between readings
Wait for steady thermometer reading
Allow lamp to cool/warm up
Repeats and average [1]

[Total: 7]

Topic_Phx 5 **Q.51 iG Phx/2011/w/Paper 61 www.SmashingScience.org**

2 **(a)** $\theta_c = 24$ [1]
°C [1]

(b) $\theta_{av} = 55$ (°C) ecf from **(a)** [1]

(c) any two from:
stirring
waiting for temperature (to stabilise)
view thermometer at right angles o.w.t.t.e. [2]

(d) heat loss (to surroundings) o.w.t.t.e. [1]

(e) one from:
lagging beakers o.w.t.t.e.
use of lid
swifter transfer of water [1]

(f) one from:
amount of stirring o.w.t.t.e.
hot water temperature
cold water temperature
room temperature o.w.t.t.e.
transfer time [1]

[Total: 8]

Topic_Phx 5 **Q.52 iG Phx/2011/s/Paper 61 www.SmashingScience.org**

2 **(a)** **(i)** T_1 correct 18 [1]

(ii) T_2 correct 4 [1]
unit °C (either position and not contradicted) [1]

(b) graph:
y-axis labelled [1]
plots occupying at least half of grid on suitable scale [1]
all plots correct to ½ square [1]
well judged single, smooth curve line, not 'point-to-point' [1]
thin line [1]

(c) **(i)** $T_2 < T_1$ (wtte) [1]

(ii) decreasing gradient (wtte) [1]

[Total: 10]

Topic_Phx 5 **Q.53 iG Phx/2011/s/Paper 61 www.SmashingScience.org**

2. **(a)** 23 (°C) [1]

(b) *t* in s, θ in °C [1]

T_1= 14 [1]
T_2 = 1 [1]

(c) Graph:
Axes the right way round, both labelled with quantity, ignore unit [1]
Use of the scale temperature 50 – 80 and time 0 – 200 or 0 – 250, using the whole grid [1]
All seven plots correct to ½ small square [1]
Good line judgement [1]
Thin line [1]

(d) Greater rate of cooling in first 30 s (owtte) ecf possible [1]
Decreasing slope of graph (owtte) ecf possible [1]

[Total: 11]

Topic_Phx 5 **Q.54 iG Phx/2010/w/Paper 61 www.SmashingScience.org**

2 **(a)** θ_r 26 [1]

(b) **(i)** s and °C in both tables [1]

(ii) at least 300s and given to nearest 10s or in mins [1]

(c) Table 2.2 (heating) justified by two temperature differences compared, must see 14 and 44/56 OR 74 to 60 and 25 to 69/81 [1]

(d) any two from:
same starting temperature
constant room temperature/avoid draughts/same place
same time intervals
same thermometer (wtte)
same mass/amount/volume of water
same beaker
lid always used [2]

[Total: 6]

Topic_Phx 5 **Q.55 iG Phx/2010/w/Paper 61 www.SmashingScience.org**

5 **(a)** any three from:
mass/volume/amount of water
room temperature
temperature of water
amount of stirring
size/shape of beaker
temperature of ice cube
number/mass/size of cubes [3]

(b) any three from:

stopclock:	time
balance:	mass
thermometer:	temperature
measuring cylinder:	volume (of water)

[3]

[Total 6]

Topic_Phx 5 **Q.56 iG Phx/2009/w/Paper 61 www.SmashingScience.org**

2 **(a)** 91 (°C) [1]

(b) t in s, both θ in °C [1]

(c) statement B and justified by reference to readings [1]

(d) any two from:
same starting temperature/temperature of hot water
constant room temperature/keep away from draughts/out of direct sunlight
same time intervals [2]

[Total: 5]

Topic_Phx 5 **Q.57 iG Phx/2009/s/Paper 61 www.SmashingScience.org**

2 **(a)** 87 (°C) [1]

(b) s, °C, °C [1]

(c) A ecf allowed [1]
justified by reference to readings (up to 90s) with comparison of drops in temperatures (with numbers) given (ecf allowed) [1]

(d) Any two from:
starting temperature
room temperature
carry out at same time
same thermometer (words to that effect)
same position of thermometers
same time intervals [2]

[Total: 6]

Topic_Phx 5 **Q.58 iG Phx/2008/w/Paper 61 www.SmashingScience.org**

3 Table
θ in °C, V in cm^3 [1]
correct V 0, 20, 40, 60, 80, 100 [1]

Graph: axes labelled with symbol and unit [1]
axes suitable (e.g. not '3' scale) and plots occupy more than ½ grid [1]
all plots correct (better than ½ sq) [1]
well judged, thin best fit line [1]

(c) 1. sensible comment about heat loss to the surroundings, e.g. use of insulation/lid [1]
2. sensible comment about adding water in a regulated, timed flow (including smaller volumes/set time intervals/shorter intervals [1]

[Total: 8]

Topic_Phx 5 **Q.59 iG Phx/2008/s/Paper 61 www.SmashingScience.org**

3 Graph:
Temperature axis labelled θ/°C [1]
Suitable scales (plots occupy at least ½ grid) [1]
Plots correct to nearest ½ square (–1 each error) [2]
Lines well judged curves [1]
Lines thin [1]

(b) Statement:
larger surface area increases rate of cooling [1]
Justification:
Correct reference to gradients of lines or readings [1]

[Total: 8]

1 (a) 24 [1]

(b) s, °C [1]
23, 1 (-1 each error) [2]

(c) (i) reason consistent with results [1]

(ii) Three from:
room temp/draughts etc
volume
beaker
liquid
amount of stirring
surface area [3]

(d) lid [1]

[Total: 9]

Topic_Phx 5 **Q.61 iG Phx/2007/s/Paper 61 www.SmashingScience.org**

1 (a) $\theta_1 = 23$ [1]
unit °C correctly written [1]

(b) 19 (°C) ecf [1]
34 (°C) ecf [1]

(c) (i) heat loss (to surroundings) [1]

(ii) any two from:
insulation / mat / foil
lid
speedier transfer
repeats
wait to record max temperature
stirring
include beaker in calculation [2]

[Total: 7]

Topic_Phx 5 **Q.62 iG Phx/2006/w/Paper 61 www.SmashingScience.org**

4	(a)	28°C value	[1]
		unit	[1]
	(b)	B	[1]
		smaller temp drop	[1]
		(OR neither, insignificant difference)	
	(c)	any suitable insulator	[1]
	(d)	Any 3 from initial temp volume of water size/shape of beaker room temp/draughts/simultaneous timings material of beaker beakers on same surface	[3]
			[Total: 8]

Topic_Phx 5 **Q.63 iG Phx/2006/s/Paper 61 www.SmashingScience.org**

4	**(a)** **(i)**	24(°C)	**[1]**
	(ii)	6(°C); 4(°C) (ecf)	**[1]**
	(b)	Heat lost to surroundings	**[1]**
		round flame/to gauze/tripod	**[1]**
	(c)	Variable resistor	**[1]**
			TOTAL 5

Topic_Phx 5 **Q.64 iG Phx/2005/w/Paper 61 www.SmashingScience.org**

3	**(a)**	θ in °C, t in s	1
	(b) & **(c)**	θ axis labelled	1
		scale starts at 40 °C and 2 cm to 10 °C	1
		plots correct to ½ sq (–1 each error)	2
		well judged best fit curves	1
		lines not too thick	1
	(d)	Two from: e.g. use a lid insulate the bottom of the beaker use a container that is a good conductor (metal)	2
			TOTAL 9

Topic_Phx 5 **Q.65 iG Phx/2005/s/Paper 61 www.SmashingScience.org**

1	(a)		21°C (ignore unit) (20.9 acceptable)	[1]
	(b)	(i)	t in °C and V in cm^3	[1]
		(ii)	θ axis labelled, with unit	[1]
			scale 10°C to 1 cm or 0 - 100 in 25 sq steps or 20 - 80 in 10 sq steps	[1]
			correct plots to ½ sq (-1 each error)	[2]
			well judged best fit line	[1]
	(c)		heat lost to surroundings or by evaporation	[1]
				[total: 8]

Topic_Phx 5 **Q.66 iG Phx/2004/s/Paper 61 www.SmashingScience.org**

5	(a)		22	1
	(b)	(i)	14 (ecf)	1
		(ii)	64	1
			units all correct	1
	(c)		So that heat is not lost (wtte)	1
			TOTAL	5

Topic_Phx 5 **Q.67 iG Phx/2003/w/Paper 61 www.SmashingScience.org**

5	(a)	Two from: same volume of water same starting temperature of water same size/shape/type beakers same thickness/mass/volume of insulator same room temp	2
	(b)	64°C (with unit)	1
	(c)	B	1
			TOTAL 4

Topic_Phx 5 **Q.68 iG Phx/2003/s/Paper 61 www.SmashingScience.org**

5	(a)	(i)	polystyrene	1
		(ii)	Least steep curve (or numbers suitably quoted)	1
	(b)		Three from: Thickness of insulator Room temp. Starting temp. Mass/vol./amount of water Using same can	3
			TOTAL	5

4. (a) (i) heat loss during the experiment (third box) 1

(ii) insulation, repeats, stirring, use dig thermometer, lid (any 2) 1
1

(b) 38°C 1

(c) value 66 1

W 1

TOTAL 6

4 The class is investigating the refraction of light passing through a transparent block.

Fig. 4.1 shows a student's ray-trace sheet.

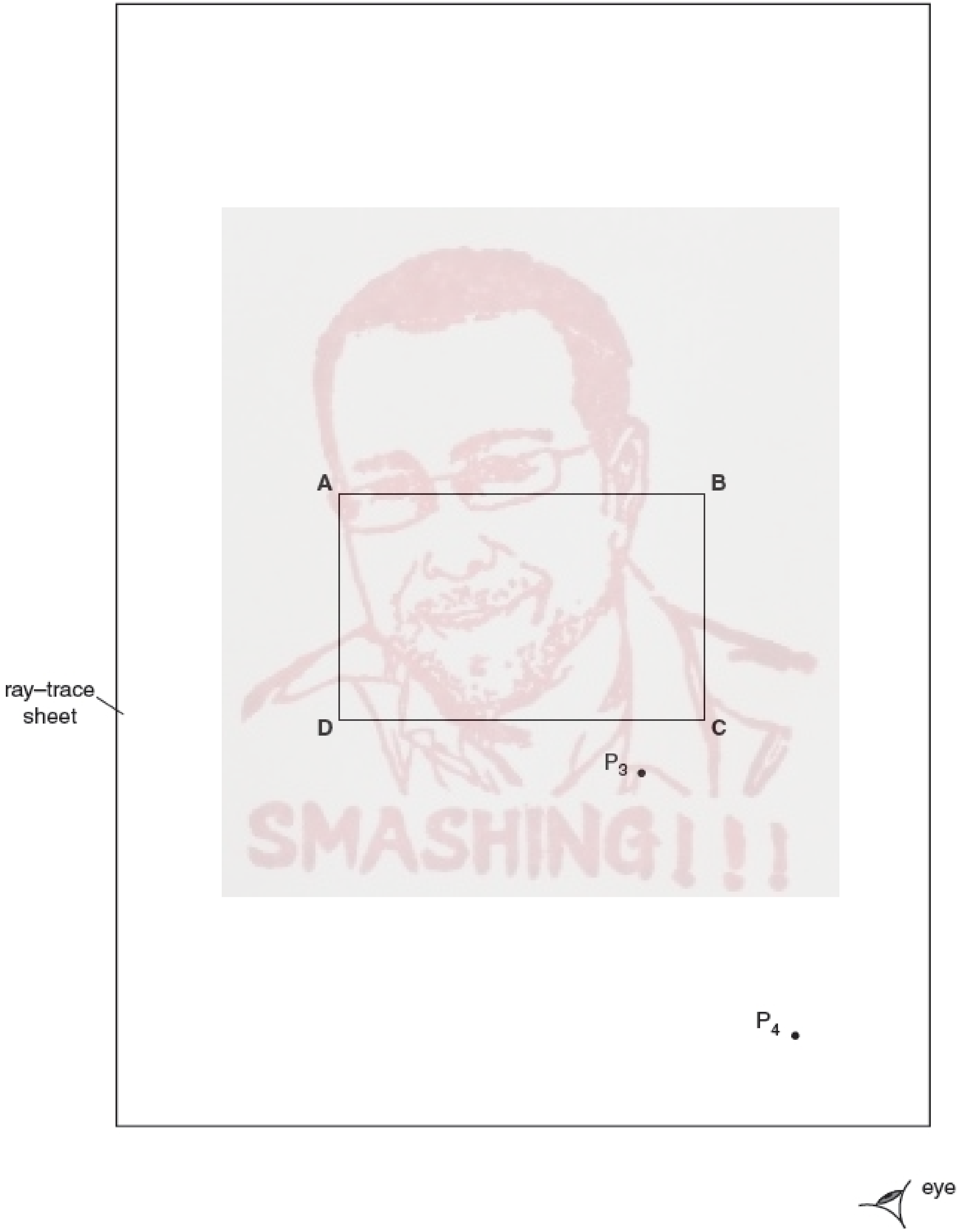


Fig. 4.1

A student draws the outline **ABCD** of a transparent block.

(a) **(i)** Draw a normal **NL** at the centre of side **AB**. Label the point **E** where the normal crosses **AB**. Label the point **M** where the normal crosses **CD**.

(ii) Draw a line **GH**, parallel to **AB** and 6.0 cm above **AB**. Label the point **J** where the normal crosses **GH**.

(iii) Draw a line, starting at **E**, to the left of the normal and at an angle of incidence $i = 30°$ to the normal. Label the point **F** where the line meets **GH**.

[3]

(b) The student places two pins P_1 and P_2 on the line **FE**.

On Fig. 4.1, label suitable positions for pins P_1 and P_2. [1]

(c) The student observes the images of P_1 and P_2 through side **CD** of the block so that the images of P_1 and P_2 appear one behind the other.

She places two pins P_3 and P_4 between her eye and the block so that P_3 and P_4, and the images of P_1 and P_2 seen through the block, appear one behind the other. The positions of P_3 and P_4 are shown on Fig. 4.1.

(i) Draw a line joining the positions of P_3 and P_4. Continue the line until it meets **CD** and label this point **K**.

(ii) Draw the line **KE**.

[1]

(d) **(i)** Measure and record the length *a* between points **F** and **J**.

a = ...

(ii) Measure and record the length *b* between points **F** and **E**.

b = ...

(iii) Measure and record the length *c* between points **E** and **K**.

c = ...

(iv) Measure and record the length *d* between points **M** and **K**.

d = ...

[1]

(v) Calculate *n*, the refractive index of the material of the block, using the equation $n = \frac{ac}{bd}$.

n = ...[1]

(e) Suggest one precaution that you would take with this experiment to obtain reliable results.

....

....

....[1]

(f) Fig. 4.2 shows a ray box.

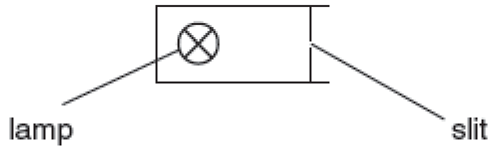


Fig. 4.2

This experiment can be carried out using a ray box instead of the pins.

On Fig. 4.1, draw a ray box in a suitable position for this experiment. [1]

[Total: 9]

1 The IGCSE class is investigating the reflection of light by a plane mirror. Fig. 1.1 shows a student's ray-trace sheet.

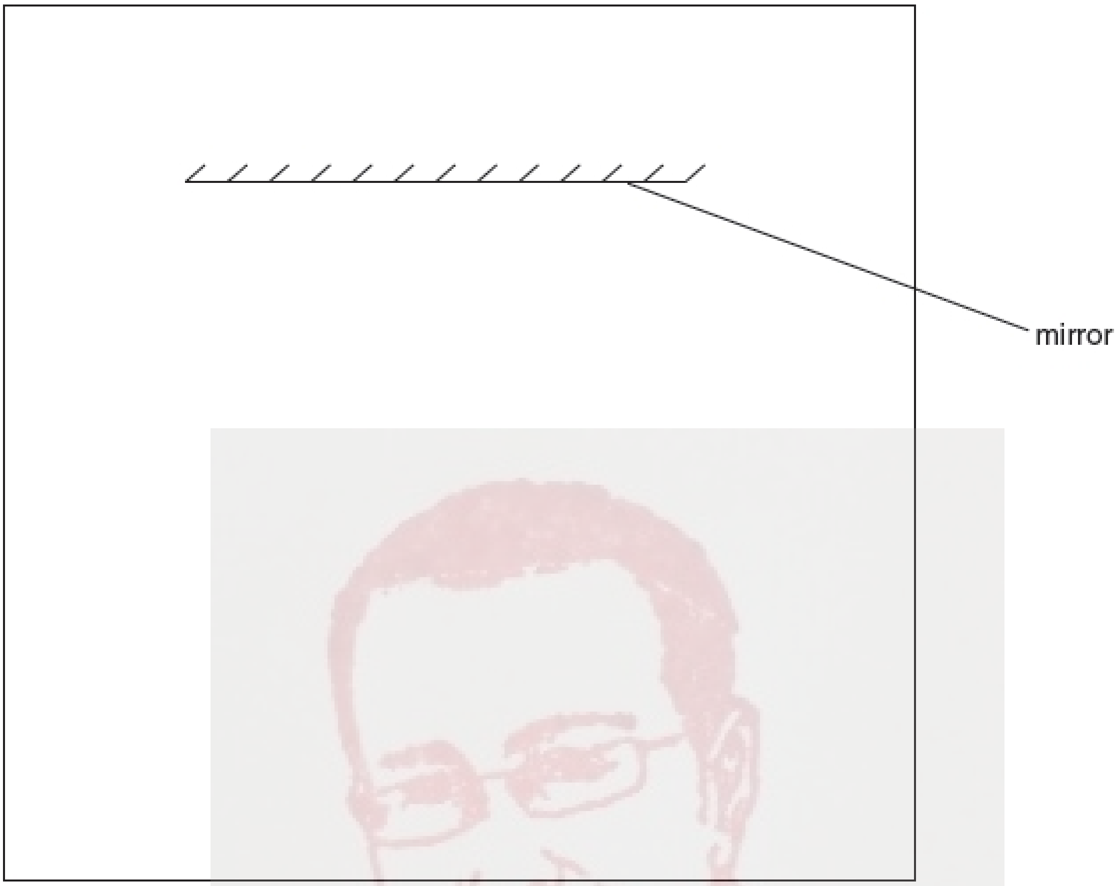


Fig. 1.1

(a) On Fig. 1.1, draw a normal to the centre of the mirror. [1]

(b) On Fig. 1.1, draw an incident ray at 30° to the normal and to the left of the normal. [1]

(c) Fig. 1.2 shows a diagram of a ray box.

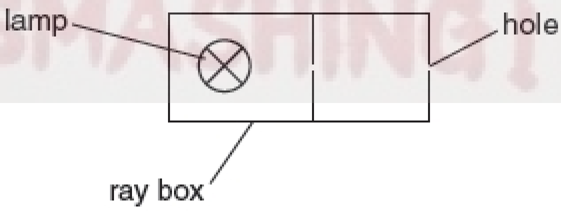


Fig. 1.2

On Fig. 1.1, draw the ray box in a suitable position to produce the incident ray that you have drawn. [1]

(d) On Fig. 1.1, draw a reflected ray in the position you would expect it to be using the incident ray that you have drawn. [1]

(e) State two precautions that you could take in this experiment to obtain reliable results.

1. ....

....

2. ....

....

[2]

[Total: 6]

4 The IGCSE class is determining the magnification of an image produced by a lens.

The apparatus is shown in Fig. 4.1.

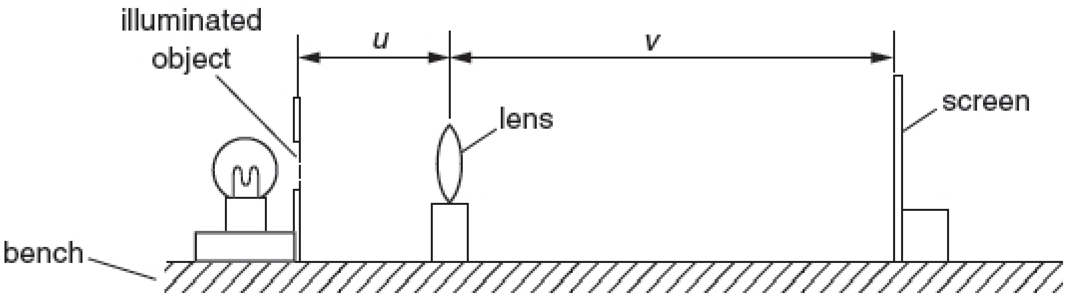


Fig. 4.1

(a) **(i)** On Fig. 4.1, measure and record in mm the distance *u* from the illuminated object to the centre of the lens.

u = ... mm

(ii) On Fig. 4.1, measure and record in mm the distance *v* from the centre of the lens to the screen.

v = ... mm
[1]

(b) Calculate the ratio $\frac{v}{u}$.

$\frac{v}{u}$ = ... [1]

(c) The diagram is drawn one tenth of actual size.

(i) Calculate the actual distance *U* from the illuminated object to the centre of the lens.

U = ... mm

(ii) Calculate the actual distance *V* from the centre of the lens to the screen.

V = ... mm
[1]

(d) The student measures the height *h* from the top to the bottom of the image on the screen.

h = ...4.5..................... cm

(i) On Fig. 4.2, measure the height x of the illuminated object.

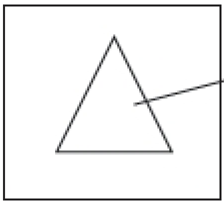


Fig. 4.2 (full size)

x = ...

(ii) Calculate $\frac{h}{x}$.

$\frac{h}{x}$ = ...
[1]

(e) The magnification m of the image is given by the equation $m = \frac{h}{x}$. The student suggests that the ratio $\frac{V}{U}$ also gives the magnification m. State whether the results support this suggestion and justify your answer by reference to the results.

statement ....

justification ....

....
[2]

(f) State two precautions that you could take in this experiment to obtain reliable results.

1. ....

....

2. ....

....
[2]

(g) The image on the screen in this experiment is magnified and dimmer than the object.

State one other difference that you would expect to see between the image and the illuminated object.

....[1]

(h) Suggest one precaution that you would take in this experiment in order to focus the image as clearly as possible.

....

....[1]

[Total: 10]

5 The IGCSE class is investigating reflection using a plane mirror.

Fig. 5.1 shows a student's ray-trace sheet with a line **MR** drawn on it. In the experiment the reflecting face of a mirror is placed vertically on the line **MR**. The additional dashed line shows a second mirror position.

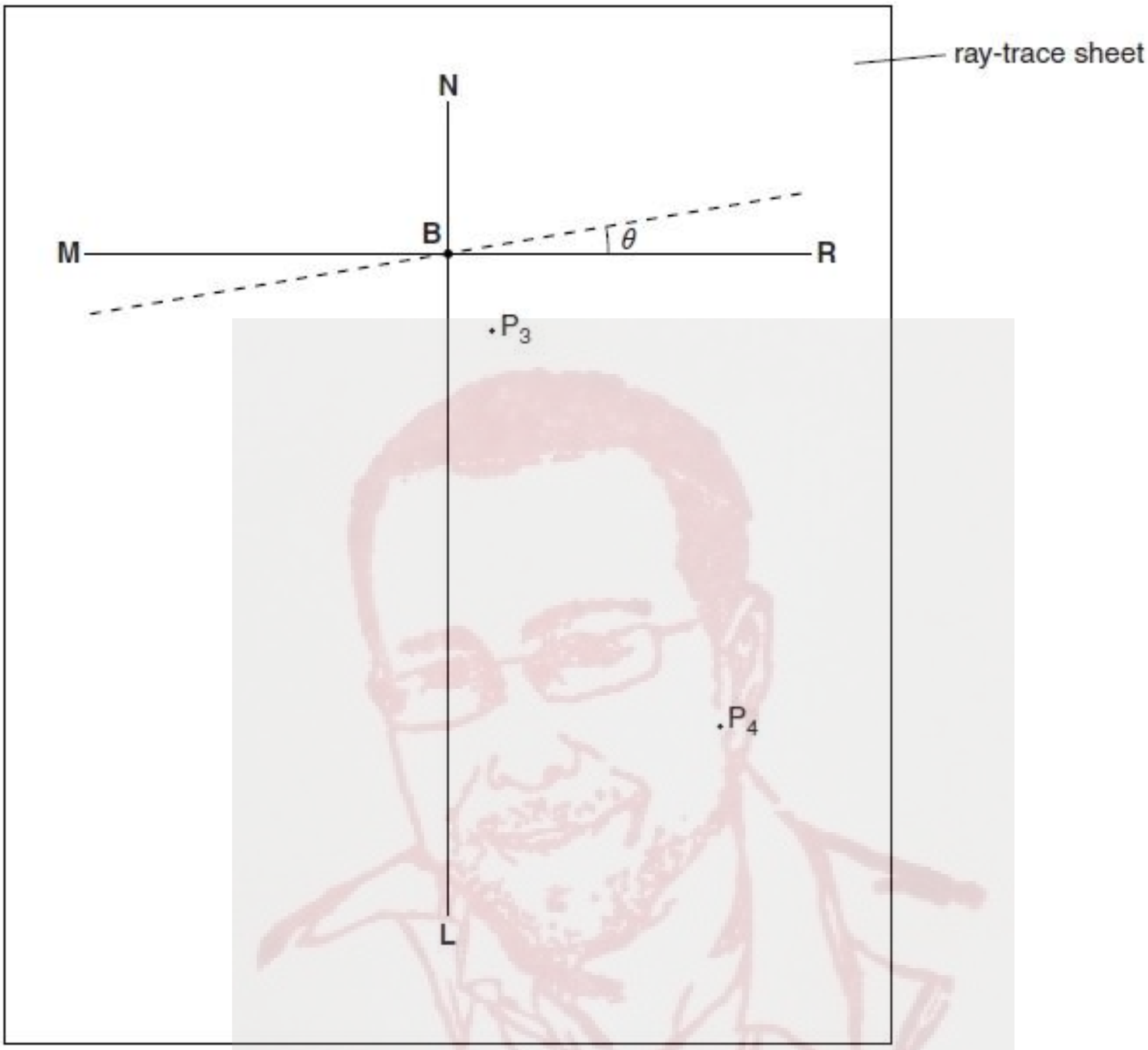


Fig. 5.1

(a) **NL** is a normal to line **MR**. Draw a line 8.0 cm long from **B** at an angle of incidence i = 30° to the normal, below **MR** and to the left of the normal. Label the end of this line **A**. [1]

(b) The student places two pins, P_1 and P_2, on line **AB** a suitable distance apart for this ray tracing experiment. He views the images of pins P_1 and P_2 in the mirror and places two pins P_3 and P_4 so that pins P_3 and P_4, and the images of P_2 and P_1, all appear exactly one behind the other. The positions of P_3 and P_4 are shown in Fig. 5.1.

(i) Draw the line joining the positions of P_3 and P_4. Extend the line until it meets **NL**.

(ii) Measure the angle α_0 between **NL** and the line joining the positions of P_3 and P_4. At this stage the angle θ between the mirror and line **MR** is 0°.

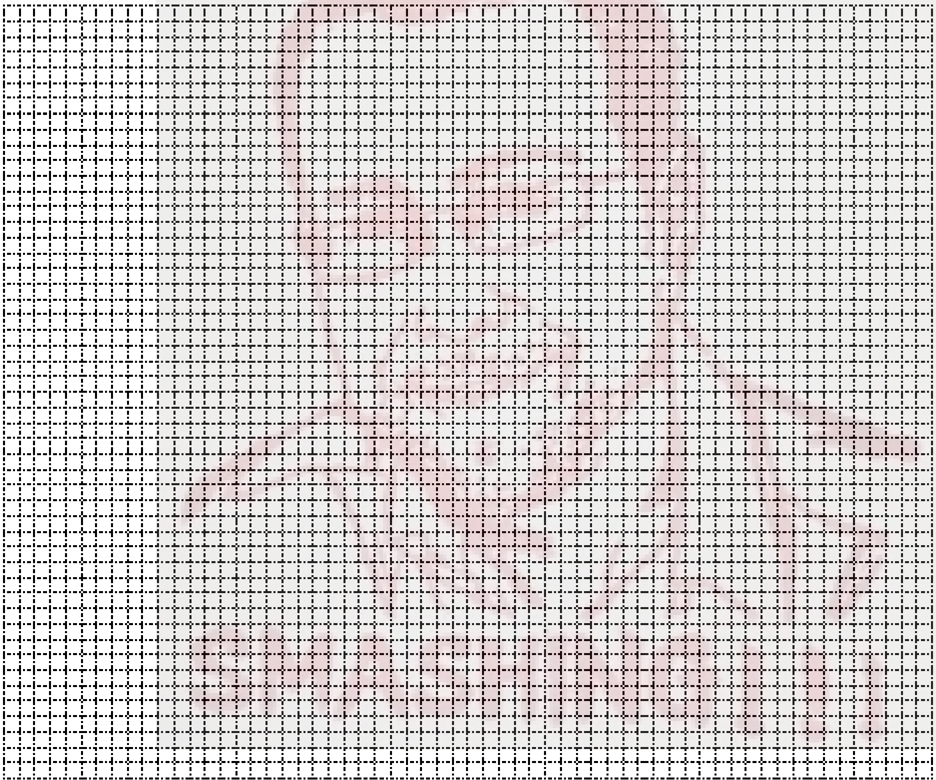
α_0 = ... [2]

(c) The student draws lines at angles θ = 10°, 20°, 30°, and 40° to **MR**. The first line, at 10° to **MR**, is shown in Fig. 5.1. He repeats the procedure described in part **(b)**, placing the mirror on each of the new lines in turn. The readings are shown in Table 5.1.

Table 5.1

θ/°	α/°
10	51
20	69
30	90
40	111
50	130

Plot a graph of α/° (y-axis) against θ/° (x-axis).



[5]

(d) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

(e) In this experiment, when the mirror is moved though an angle θ, the reflected ray moves through an angle $(\alpha - \alpha_0)$.

Table 5.2

$\theta/°$	$\alpha/°$	$(\alpha - \alpha_0)/°$
10	51	
20	69	
30	90	
40	111	
50	130	

(i) Complete Table 5.2.

(ii) Suggest the relationship between $(\alpha - \alpha_0)$ and θ. You may express the relationship in words or as an equation.

....

.... [1]

(f) State **one** precaution, to improve accuracy, which you would take in this experiment.

....

....[1]

[Total: 12]

4 The IGCSE class is determining the focal length of a converging lens.

Fig. 4.1 shows the apparatus used to produce an image on the screen.

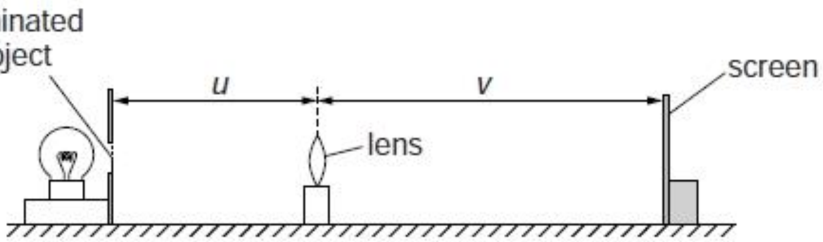


Fig. 4.1

(a) **(i)** On Fig. 4.1, measure the distance u between the illuminated object and the centre of the lens.

u = ...

(ii) On Fig. 4.1, measure the distance v between the centre of the lens and the screen.

v = ...
[2]

(b) **(i)** Calculate uv.

uv = ...

(ii) Calculate $u + v$.

$u + v$ = ...
[1]

(iii) Calculate x using the equation $x = \frac{uv}{(u + v)}$.

x = ... [1]

(c) Fig. 4.1 is drawn 1/10th of actual size. The focal length f of the lens is given by the equation $f = 10x$.

Calculate a value for the focal length f of the lens, giving your answer to a suitable number of significant figures for this experiment.

f = ... [2]

(d) A student carrying out this experiment changes the position of the lens and then moves the screen to produce a well-focused image.

She records the distance *v* between the centre of the lens and the screen as *v* = 18.2 cm. She finds it difficult to decide the exact point at which the image is sharpest.

Suggest a range of *v* values for which the image may appear well-focused.

range of *v* values = ... to .... [1]

(e) State two precautions that you could take in this experiment to obtain reliable results.

1. ....

....

2. ....

....

[2]

[Total: 9]

4 The IGCSE class is investigating the position of the image in a plane mirror.

A student's ray-trace sheet is shown in Fig. 4.1.

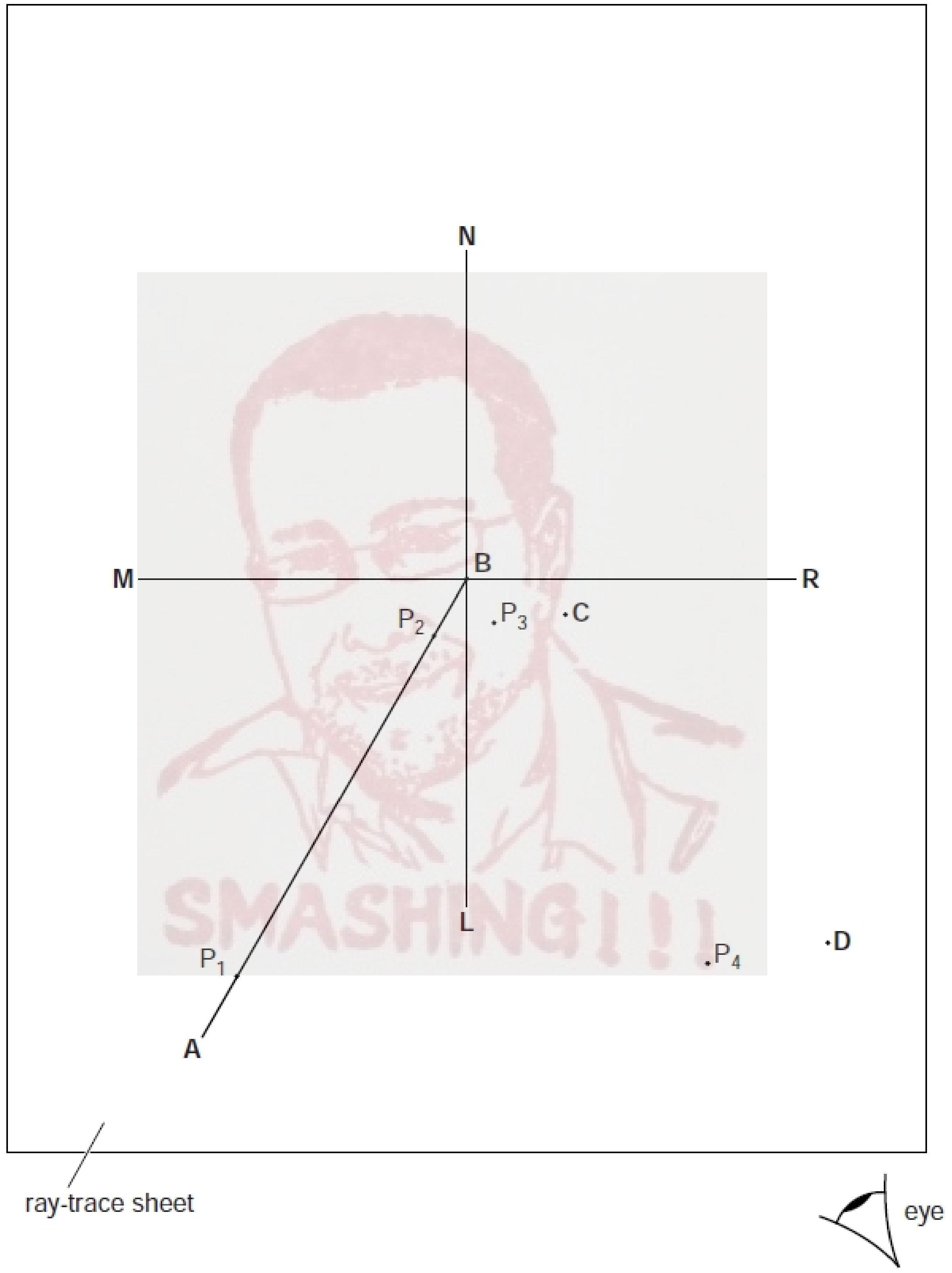


Fig. 4.1

The line **MR** shows the position of a plane mirror. **NL** is the normal at the centre of the mirror.

AB marks the position of an incident ray.

The student pushes two pins, P_1 and P_2 into this line. She views the images of pins P_1 and P_2 from the direction indicated by the eye in Fig. 4.1.

She places two pins P_3 and P_4 some distance apart so that pins P_4 and P_3, and the images of P_2 and of P_1, all appear exactly one behind the other. The positions of P_3 and P_4 are labelled.

(a) Draw in the line joining the positions of P_3 and P_4. Continue the line until it crosses **MR** and extends at least 8.0 cm beyond **MR**. [1]

(b) The student repeats the procedure without moving pin P_1 but using a different angle of incidence. On Fig. 4.1, the new positions of pins P_3 and P_4 are marked **C** and **D**.

(i) Draw in the line joining the positions **C** and **D**. Continue the line until it extends at least 8.0 cm beyond **MR**.

(ii) Label with a **Y** the point where the two lines beyond **MR** cross. [1]

(c) **(i)** Draw a line from P_1 to **MR** that meets **MR** at a right angle. Measure and record the length *a* of this line.

a = ...

(ii) Draw a line from the point labelled **Y** to **MR** that meets **MR** at a right angle. Measure and record the length *b* of this line.

b = ...

[2]

(d) A student suggests that the length of *a* should equal the length of *b*.

State whether your results support this suggestion. Justify your statement by reference to your results.

statement ....

justification ....

....

....

[2]

(e) Suggest a precaution that you would take, when placing the pins, in order to obtain reliable results.

....

.... [1]

[Total: 7]

5 **(a)** The IGCSE class has a range of apparatus available. Here is a list of some of the apparatus.

ammeter

barometer

beaker

electronic balance

manometer

measuring cylinder

metre rule

newtonmeter (spring balance)

stopwatch

tape measure

thermometer

voltmeter

Complete Table 5.1 by inserting the name of one piece of apparatus from the list that is the most suitable for measuring each quantity described.

Table 5.1

quantity to be measured	most suitable apparatus
volume of water	
a distance of about 50 m	
the force required to lift a laboratory stool	
the mass of a coin	
the pressure of the laboratory gas supply	

[5]

(b) The IGCSE class is carrying out a lens experiment. This involves using an illuminated object, a screen and a lens.

Firstly, the distance between the illuminated object and the lens is measured with a metre rule. Next, a clearly focused image is obtained on the screen.

(i) Explain briefly how you would avoid a parallax (line-of-sight) error when using the metre rule.

....

....

.... [1]

(ii) State a precaution that you would take to ensure that the image is well focused.

....

....

.... [1]

[Total: 7]

4 The IGCSE class is investigating the refraction of light passing through a transparent block.

The apparatus and ray-trace sheet are shown in Fig. 4.1.

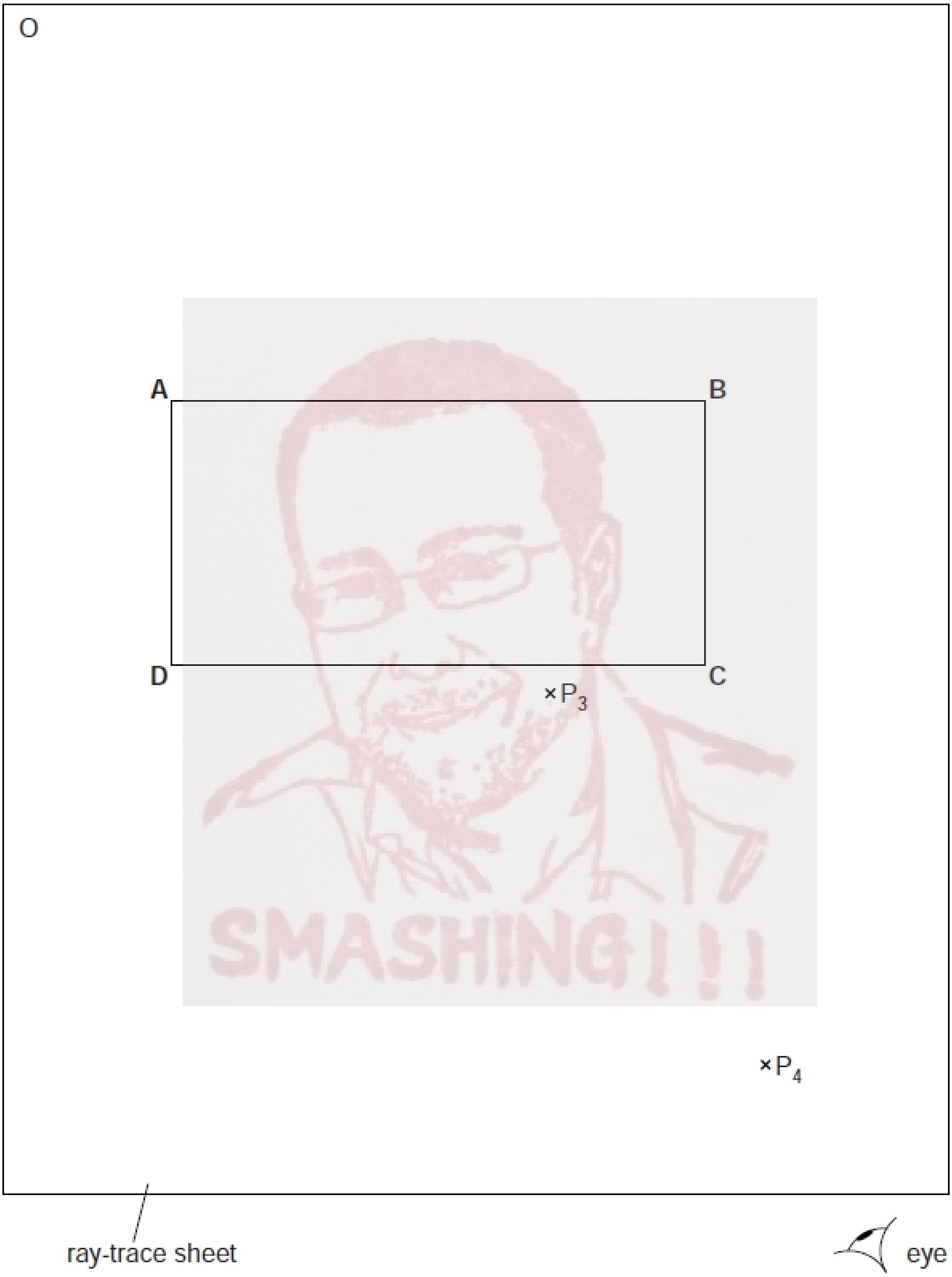


Fig. 4.1

(a) A student places the transparent block, largest face down, on the ray-trace sheet. She draws the outline of the block **ABCD**.

(i) On Fig. 4.1, draw a normal at the centre of side **AB**. Label the point **E** where the normal crosses **AB**.

(ii) Draw a line **FE** to the left of the normal and at an angle of incidence i = 30° to the normal. [2]

(b) The student places two pins P_1 and P_2 on the line **FE**, placing one pin close to **E**. She observes the images of P_1 and P_2 through side **CD** of the block so that the images of P_1 and P_2 appear one behind the other. She places two pins P_3 and P_4 between her eye and the block so that P_3 and P_4, and the images of P_1 and P_2 seen through the block, appear one behind the other.

(i) On Fig. 4.1, mark suitable positions for the pins P_1 and P_2. [1]

(ii) Draw a line joining the positions of P_3 and P_4. Continue the line until it meets **CD** and label this point **G**.

(iii) Draw the line **GE**.

[1]

(c) **(i)** Measure and record the angle of refraction r between the line **GE** and the normal.

r = ... [1]

(ii) Calculate the ratio $\frac{i}{r}$.

$\frac{i}{r}$ = ... [1]

(d) The student repeats the procedure but with the angle of incidence i = 40°. The angle of refraction r = 26°.

(i) Calculate the ratio $\frac{i}{r}$.

$\frac{i}{r}$ = ... [1]

(ii) A student suggests that the ratio $\frac{i}{r}$ should be a constant.

State and explain briefly whether your results support this suggestion.

....

....

.... [1]

[Total: 8]

4 The IGCSE class is determining the focal length of a lens.

The apparatus is shown in Fig. 4.1.

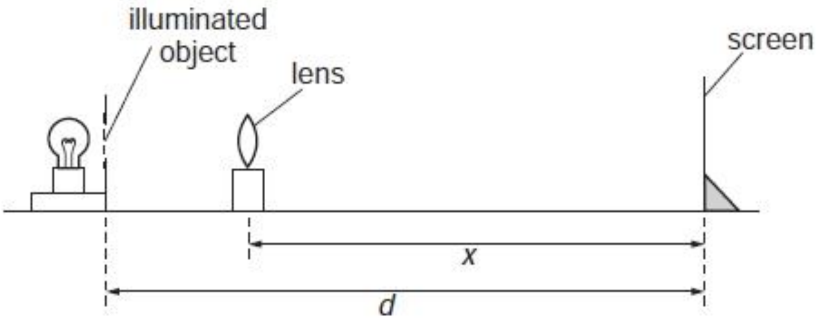


Fig. 4.1

(a) A student places the lens between the object and the screen and close to the object. She moves the lens towards the screen until a clearly focused, **enlarged** image is formed on the screen.

(i) On Fig. 4.1, measure and record the distance *d* between the object and the screen.

d = ...

(ii) On Fig. 4.1, measure and record the distance *x* between the centre of the lens and the screen.

x = ...

[2]

(iii) Fig. 4.1 is drawn one tenth actual size.

1. Calculate the actual distance *D* between the object and the screen.

D = ...

2. Calculate the actual distance *X* between the centre of the lens and the screen.

X = ...

[1]

(b) Without moving the illuminated object or the screen, the student moves the lens towards the screen until a clearly focused, **diminished** image is formed on the screen. She measures the distance *Y* between the centre of the lens and the screen: Y = 19.0 cm.

Calculate the focal length *f* of the lens using the equation $f = \frac{XY}{D}$.

f = ... [2]

(c) The student turns the lens through an angle of 180° and repeats the procedure obtaining a value for the focal length $f = 14.7$ cm.

Theory suggests that the two values of the focal length f should be the same. State whether the results support this theory and justify your answer by reference to the results.

statement ....

justification ....

.... [2]

(d) Briefly describe a precaution that you would take in this experiment in order to obtain a reliable result.

....

....

.... [1]

[Total: 8]

5 The IGCSE class is carrying out an experiment to determine the speed of sound in air.

Fig. 5.1 indicates the method used. The experiment is conducted outside the school building.

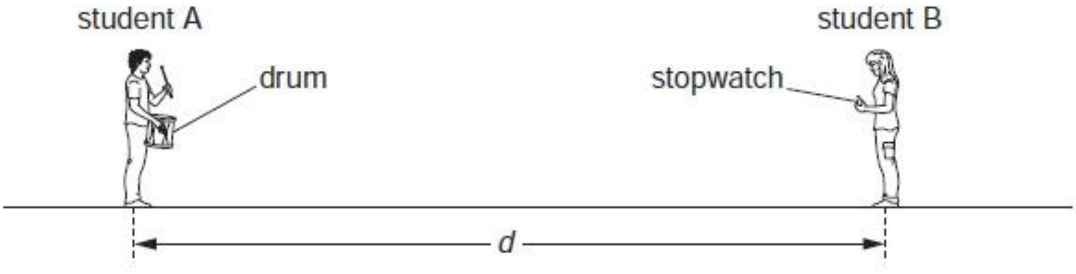


Fig. 5.1 (not to scale)

Student A strikes a drum once as loudly as possible. Student B stands some distance away from student A and starts a stopwatch when she sees the drum being hit. She stops the stopwatch when she hears the sound. She records the time interval *t* in Table 5.1. The experiment is repeated several times. She calculates the speed of sound *v* and enters the values in the table.

Table 5.1

t / s	*v* / (m / s)
0.87	344.83
0.92	326.09
0.84	357.14
0.83	361.45
0.86	338.84

(a) Suggest a suitable distance *d* for students to use when carrying out this experiment.

d = ... [1]

(b) Suggest a suitable instrument for measuring the distance *d*.

....[1]

(c) Calculate the average value v_{av} for the speed of sound from the results in the table. Show your working.

v_{av} = ... [2]

(d) The student has recorded the values for the speed of sound v to five significant figures. State whether this is a suitable number of significant figures for the speed of sound in air in this experiment. Give a reason for your answer.

statement ....

reason ....

....[1]

[Total: 5]

4 An IGCSE student is investigating reflection of light in a plane mirror.

Fig. 4.1 shows the student's ray trace sheet.

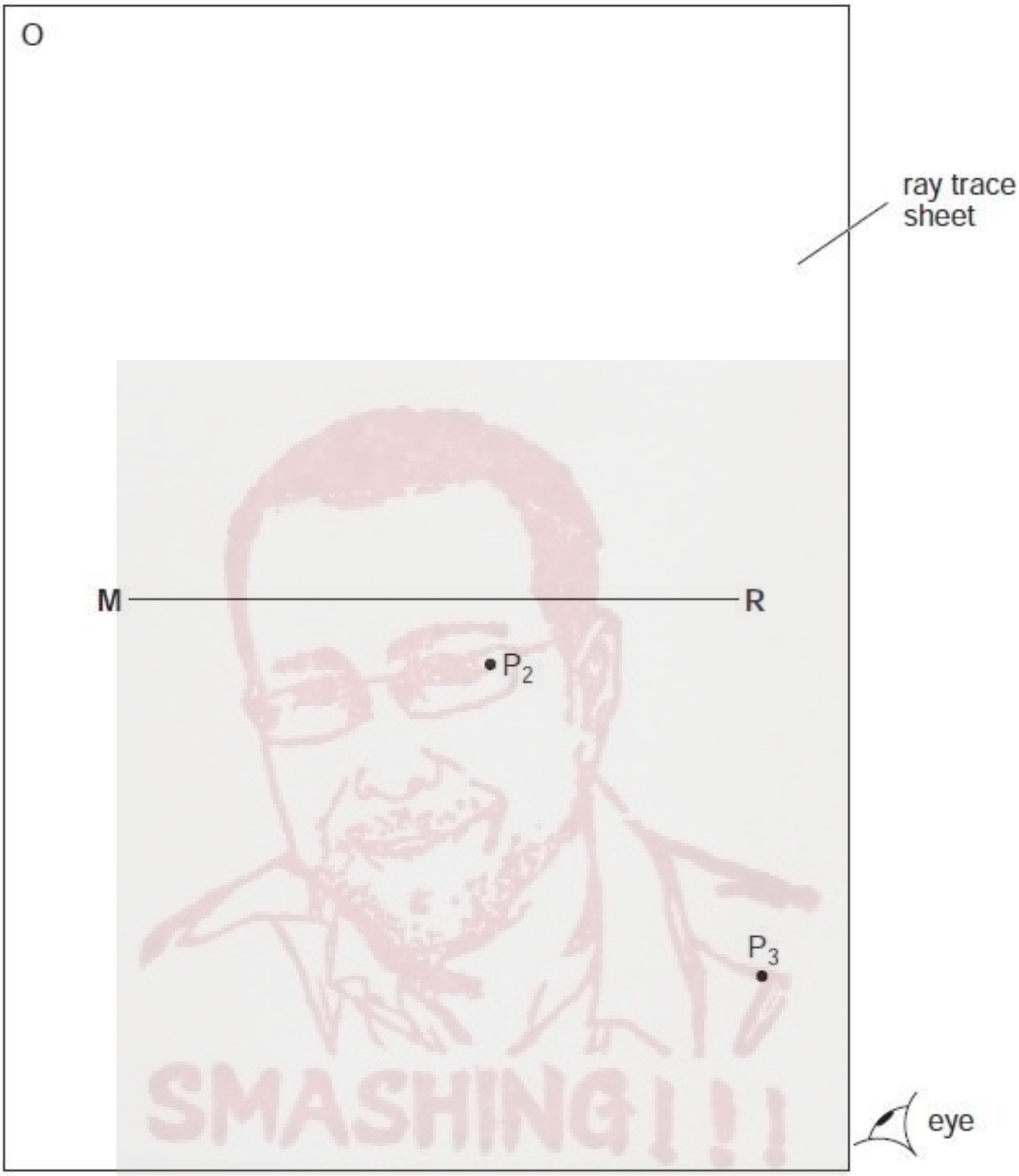


Fig. 4.1

(a) The line **MR** shows the position of a mirror.

(i) Draw a normal to this line that passes through its centre. Label the normal **NL**. Label the point at which **NL** crosses **MR** with the letter **B**.

[1]

(ii) Draw a line 8 cm long from **B** at an angle of incidence i = 40° to the normal below **MR** and to the left of the normal. Label the end of this line **A**. Record the angle of incidence i in the first row of Table 4.1.

Table 4.1

i / °	r / °
34	33

[2]

(b) Fig. 4.2 shows the mirror which is made of polished metal and has a vertical line drawn on it.

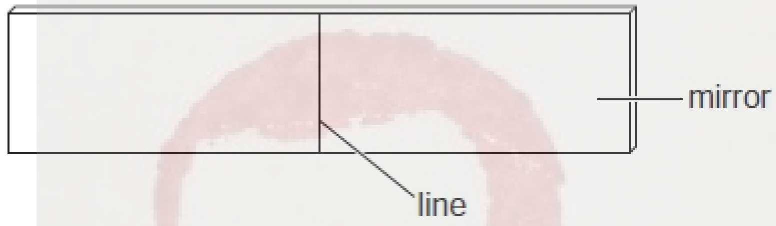


Fig. 4.2

The student places the mirror, with its reflecting face vertical, on **MR**. The lower end of the line on the mirror is at point **B**. He places a pin P_1 at **A**. He views the line on the mirror and the image of pin P_1 from the direction indicated by the eye in Fig. 4.1. He places two pins P_2 and P_3 some distance apart so that pins P_3, P_2, the image of P_1, and the line on the mirror all appear exactly one behind the other. The positions of P_2 and P_3 are shown.

(i) Draw the line joining the positions of P_2 and P_3. Continue the line until it meets the normal.

(ii) Measure, and record in the first row of Table 4.1, the angle of reflection r between the normal and the line passing through P_2 and P_3.

[2]

(c) The student draws a line parallel to **MR** and 2 cm above it. He places the mirror on this line and repeats the procedure without changing the position of pin P_1. His readings for i and r are shown in the table.

In spite of carrying out this experiment with reasonable care, it is possible that the values of the angle of reflection r will not be exactly the same as the values obtained from theory. Suggest two possible causes of this inaccuracy.

1. ....

....

2. ....

.... [2]

(d) The student was asked to list precautions that should be taken with this experiment in order to obtain readings that are as accurate as possible. Table 4.2 shows the suggestions.

Place a tick (✓) in the second column of the table next to each correctly suggested precaution.

Table 4.2

suggested precaution	
avoid parallax (line of sight) errors when taking readings with the protractor	
carry out the experiment in a darkened room	
draw the lines so that they are as thin as possible	
keep room temperature constant	
place pins P_2 and P_3 as far apart as possible	
use only two or three significant figures for the final answers	

[3]

[Total: 10]

4 An IGCSE student is investigating reflection from a plane mirror.

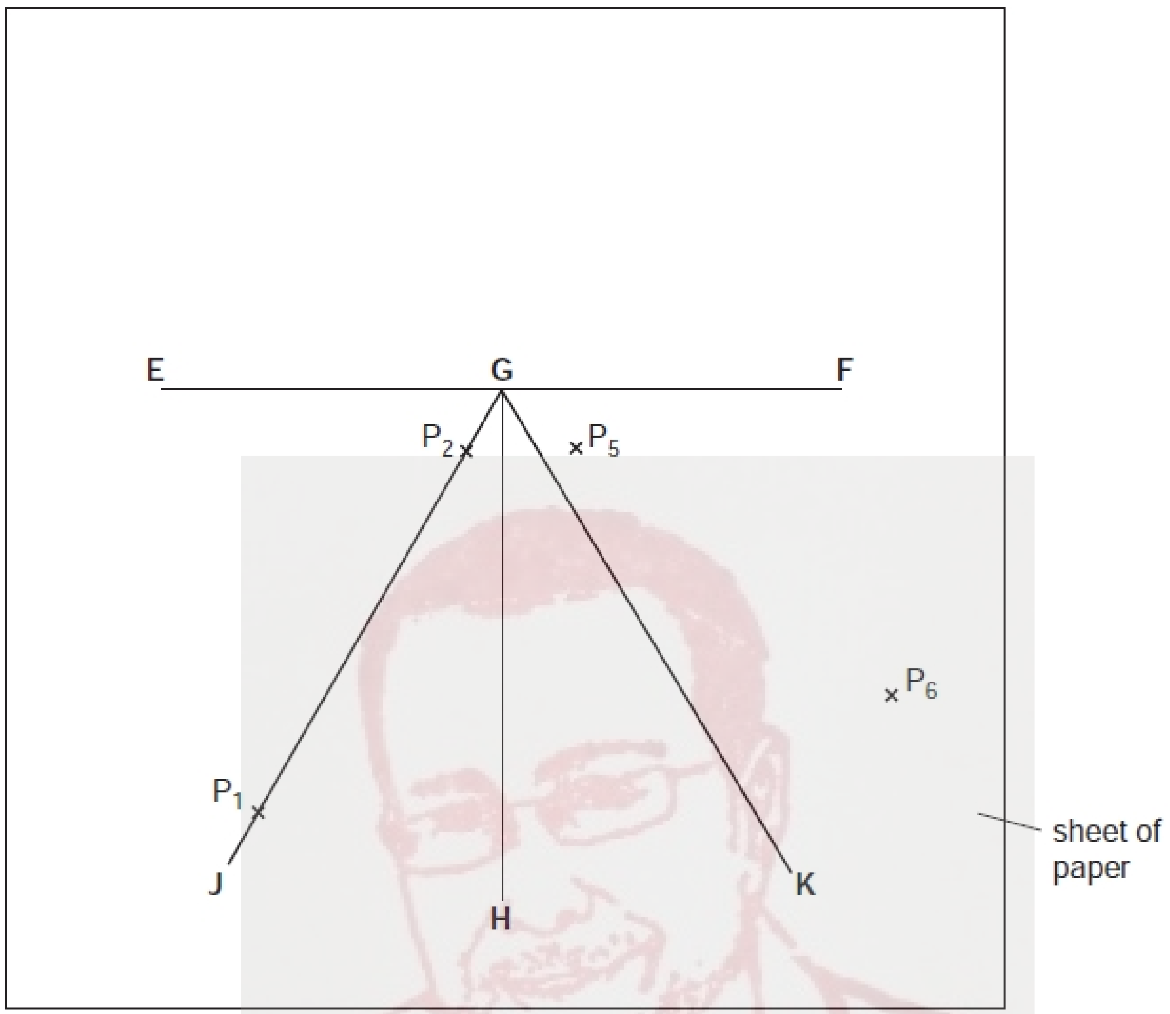


Fig. 4.1

The student is using a sheet of plain paper on a pin board. Fig. 4.1 shows the sheet of paper. The straight line **EF** shows the position of the reflecting surface of a plane mirror standing vertically on the sheet of paper. Line **GH** is a normal to line **EF**. Line **JG** marks an incident ray and line **GK** is the corresponding reflected ray. The student marks the position of the incident ray with two pins (P_1 and P_2) and uses two more pins (P_3 and P_4) to find the direction of the reflected ray.

(a) **(i)** On Fig. 4.1 mark with two neat crosses, labelled P_3 and P_4, suitable positions for the pins to find the direction of the reflected ray.

(ii) On Fig. 4.1 measure the angle of incidence *i*.

i = ...

(iii) On Fig. 4.1 measure the angle of reflection r_1.

r_1 = ...

[3]

(b) **(i)** On Fig. 4.1 draw a line **E'GF'** such that the angle θ between this line and the line **EGF** is 10°. Start with **E'** below the line **EGF**. The straight line **E'F'** shows a new position of the reflecting surface of the plane mirror standing vertically on the sheet of paper.
The points labelled P_5 and P_6 mark the positions of two pins placed so that P_5, P_6 and the images of P_1 and P_2 appear in line with each other. P_1 and P_2 have not been moved since the original set-up.

(ii) Using a ruler, draw a line joining the points labelled P_5 and P_6, and continue this line to meet the line **E'F'**.

(iii) Measure the angle of reflection r_2 between line **GH** and the line joining the points labelled P_5 and P_6.

r_2 = ...

(iv) Calculate the angle α through which the reflected ray has moved.

α = ...

(v) Calculate the difference between 2θ and α.
θ is the angle between the two positions of the mirror.

difference between 2θ and α = ...
[3]

(c) Theory suggests that if the mirror is moved through an angle θ then the reflected ray will move through an angle of 2θ.
State whether your result supports the theory and justify your answer by reference to the result.

Statement ....

Justification ....

....[2]

4 The IGCSE class is investigating reflection of light using a plane mirror.

A student has set up a ray trace sheet and this is shown in Fig. 4.1. The line **MR** shows the position of a plane mirror.

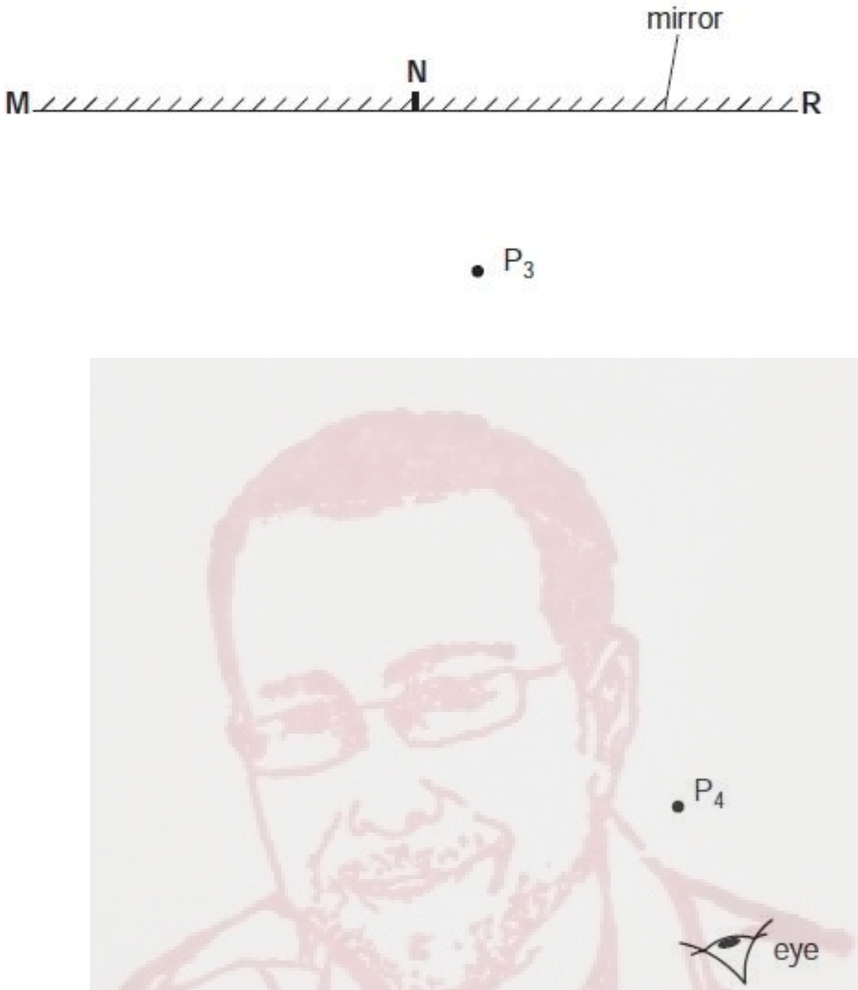


Fig. 4.1

(a) **(i)** Draw a normal to line **MR** at **N**.

(ii) Draw a line 10 cm long that is parallel to line **MR** and 12 cm below it. The ends of this line must be at the same distance from the edges of the page as the ends of line **MR**. Label this line **CD** with **C** directly below **M**. [3]

(b) The student places a pin P_1 so that it stands vertically at **C**. He places another pin P_2 as close as possible to the point **N**.

(i) Draw a line from **C** to **N**.

(ii) Measure and record the angle of incidence *i* between the line **CN** and the normal.

i = ...[2]

(c) The student views the image in the mirror of the pin P_1 from the direction indicated by the eye in Fig. 4.1. He places two pins P_3 and P_4 some distance apart so that pins P_4, P_3, P_2 and the image of P_1 all appear exactly one behind the other. The positions of P_3 and P_4 are shown on Fig. 4.1.

(i) Draw in the line joining the positions of P_3 and P_4. Continue the line until it meets the normal.

(ii) Measure and record the angle of reflection *r* between the normal and line P_3P_4.

r = ...[2]

(d) Several students found that, in spite of carrying out this experiment with reasonable care, the measured value of the angle of reflection *r* was not exactly the same as the value obtained from theory.

Suggest two possible causes of this inaccuracy.

1. ....

....

2. ....

....[2]

[Total: 9]

4 The IGCSE class is investigating the reflection of light by a mirror as seen through a transparent block.

Fig. 4.1 shows a student's ray-trace sheet.

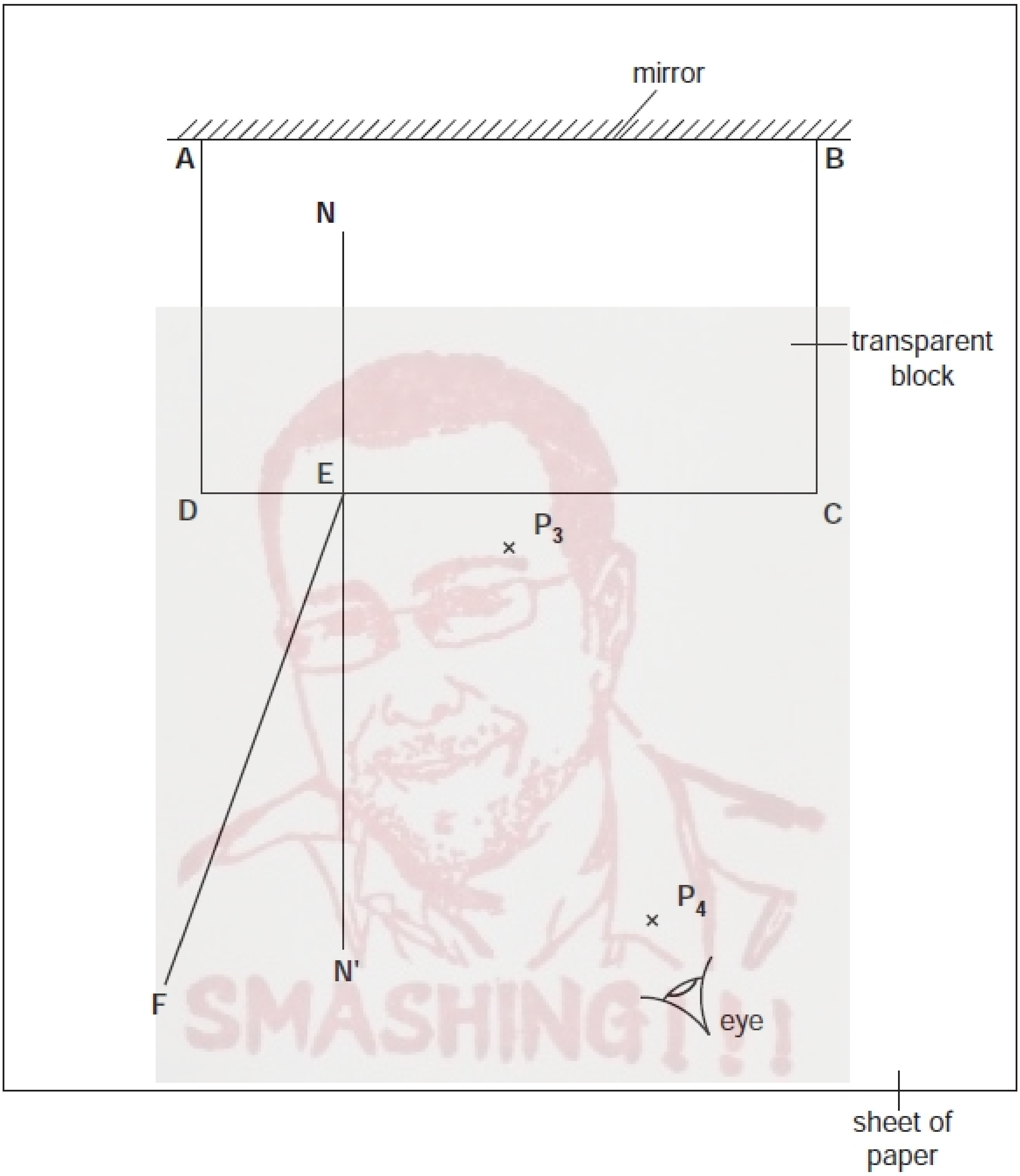


Fig. 4.1

(a) A student draws the outline of the transparent block **ABCD** on the ray-trace sheet. He draws the normal **NN'** to side **CD**. He draws the incident ray **EF** at an angle of incidence $i = 20°$. He pushes two pins $\mathbf{P_1}$ and $\mathbf{P_2}$ into line **EF** and places the block on the sheet of paper. He then observes the images of $\mathbf{P_1}$ and $\mathbf{P_2}$ through side **CD** of the block from the direction indicated by the eye in Fig. 4.1 so that the images of $\mathbf{P_1}$ and $\mathbf{P_2}$ appear one behind the other. He pushes two pins $\mathbf{P_3}$ and $\mathbf{P_4}$ into the surface, between his eye and the block, so that $\mathbf{P_3}$, $\mathbf{P_4}$ and the images of $\mathbf{P_1}$ and $\mathbf{P_2}$, seen through the block, appear in line. (The plane mirror along side **AB** of the block reflects the light.)

The positions of $\mathbf{P_3}$ and $\mathbf{P_4}$ are marked on Fig. 4.1.

(i) On line **EF**, mark with neat crosses (x) suitable positions for the pins $\mathbf{P_1}$ and $\mathbf{P_2}$.

(ii) Continue the line **EF** so that it crosses **CD** and extends as far as side **AB**.

(iii) Draw a line joining the positions of $\mathbf{P_4}$ and $\mathbf{P_3}$. Continue the line so that it crosses **CD** and extends as far as side **AB**. Label the point **G** where this line crosses the line from $\mathbf{P_1}$ and $\mathbf{P_2}$. [4]

(iv) Measure the acute angle θ between the lines meeting at **G**.

θ = ...

(v) Calculate the difference $(\theta - 2i)$.

$(\theta - 2i)$ = ... [2]

(b) The student repeats the procedure using an angle of incidence $i = 30°$ and records the value of θ as 62°.

(i) Calculate the difference $(\theta - 2i)$.

$(\theta - 2i)$ = ...

(ii) Theory suggests that $\theta = 2i$. State whether the results support the theory and justify your answer by reference to the results.

statement ....

justification ....

....[3]

(c) To place the pins as accurately as possible, the student views the bases of the pins. Explain briefly why viewing the bases of the pins, rather than the tops of the pins, improves the accuracy of the experiment.

....

....

....[1]

[Total: 10]

4 An IGCSE student is determining the focal length of a lens by two different methods.

The set-up for Method 1 is shown in Fig. 4.1.

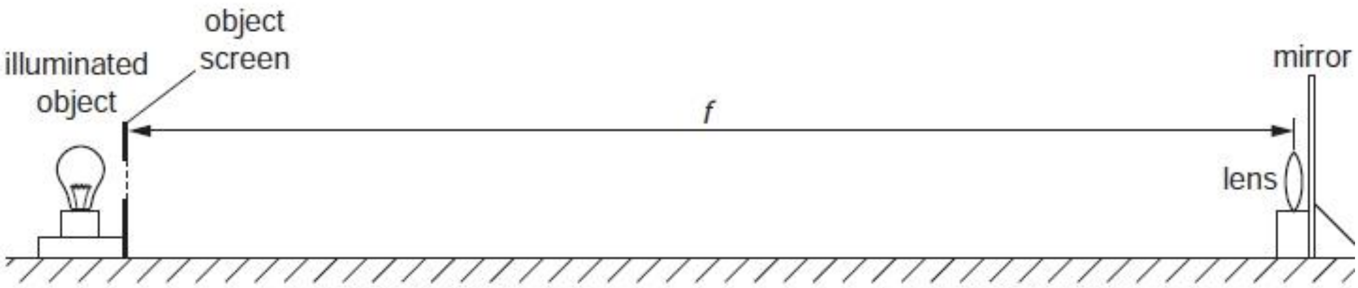


Fig. 4.1

The student moves the lens and the mirror slowly towards the object screen until a sharply focused image is obtained on the object screen as shown in Fig. 4.2.

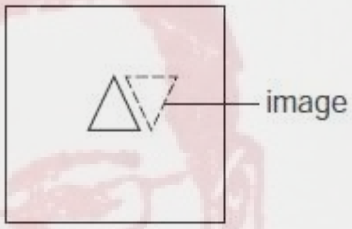


Fig. 4.2

(a) On Fig. 4.1, use your rule to measure the distance *f* between the lens and the object screen. This is the focal length of the lens.

f = ... [2]

(b) For Method 2, the student takes measurements of the diameter *d* and maximum thickness *t* of the lens. Use your rule to take measurements on Fig. 4.3.

Fig. 4.3

(i) Determine an average value for the diameter *d* of the lens. Record your readings in the space below.

d = ...

(ii) Measure the maximum thickness *t* of the lens.

t = ...

(iii) Draw a diagram to show how, in the laboratory you would use two rectangular blocks of wood and a metre rule to measure the thickness of the lens as accurately as possible.

(iv) Theory shows that, for a perfectly formed lens, the focal length is given by the formula

$$f = \frac{d^2}{kt} \qquad \text{where } k = 4.16.$$

Calculate the focal length *f* of the lens using this formula.

f = ...

[7]

(c) Explain whether your results from Methods 1 and 2 support the theory in part **(b)(iv)**.

....

....

.... [1]

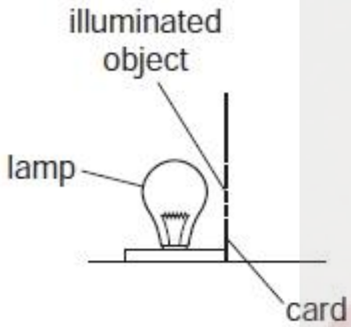
[Total: 10]

Topic **5 Q.85 iG Phx/2009/w/Paper 61 www.SmashingScience.org**

5 An IGCSE student is carrying out an optics experiment.

The experiment involves using a lens to focus the image of an illuminated object onto a screen.

(a) Complete the diagram below to show the apparatus you would use. Include a metre rule to measure the distances between the object and the lens and between the lens and the screen. The illuminated object is drawn for you.



[3]

(b) State two precautions that you would take to obtain accurate results in this experiment.

1. ....

....

2. ....

.... [2]

[Total: 5]

4 An IGCSE student is determining the focal length of a lens.

Fig. 4.1 shows the experimental set-up. The student positions the illuminated object and the lens and then moves the screen away from the lens until a sharply focused image of the object is formed on the screen.

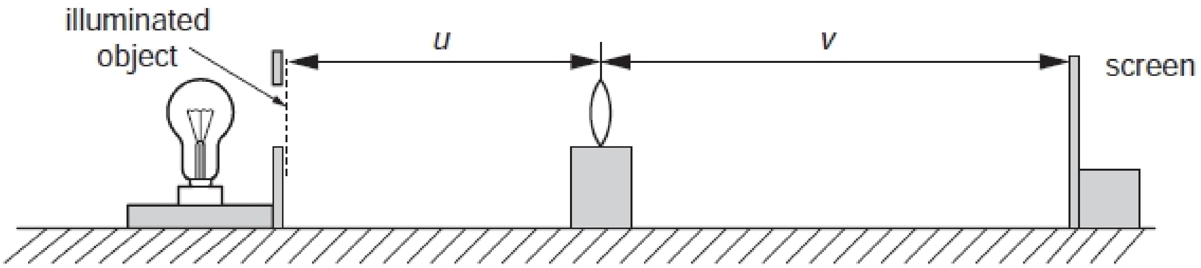


Fig. 4.1

(a) Using your rule, measure on Fig. 4.1 the distance u, in cm, from the centre of the lens to the illuminated object and the distance v from the centre of the lens to the screen.

u = ...

v =... [2]

(b) (i) Fig. 4.1 is drawn one fifth actual size. Calculate the actual distance x from the illuminated object to the centre of the lens and the actual distance y from the centre of the lens to the screen.

Record these values in Table 4.1. The first pair of readings obtained by the student has already been entered in the table.

Table 4.1

x / cm	y / cm	f / cm
57.0	15.0	

[3]

(ii) Calculate for both pairs of readings the focal length f of the lens using the equation

$$f = \frac{xy}{(x + y)}.$$

Record the values of f in Table 4.1.

(c) Calculate the average value of the focal length.

average value for the focal length = ... [2]

(d) State two precautions you would take in the laboratory in order to obtain reliable measurements.

1. ....

2. .... [2]

[Total: 9]

2 The IGCSE class is investigating the potential difference across, and the current in, wires.

The apparatus is shown in Fig. 2.1.

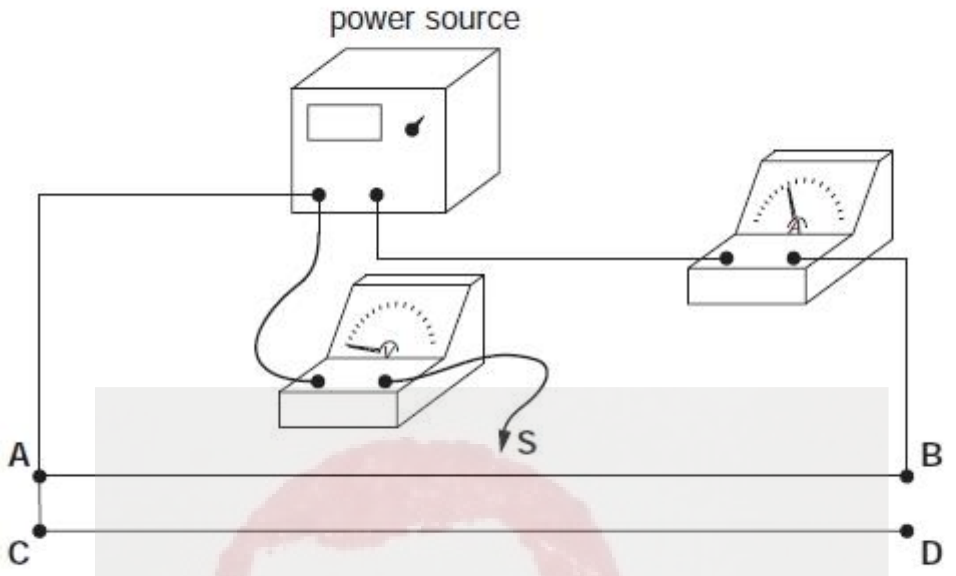


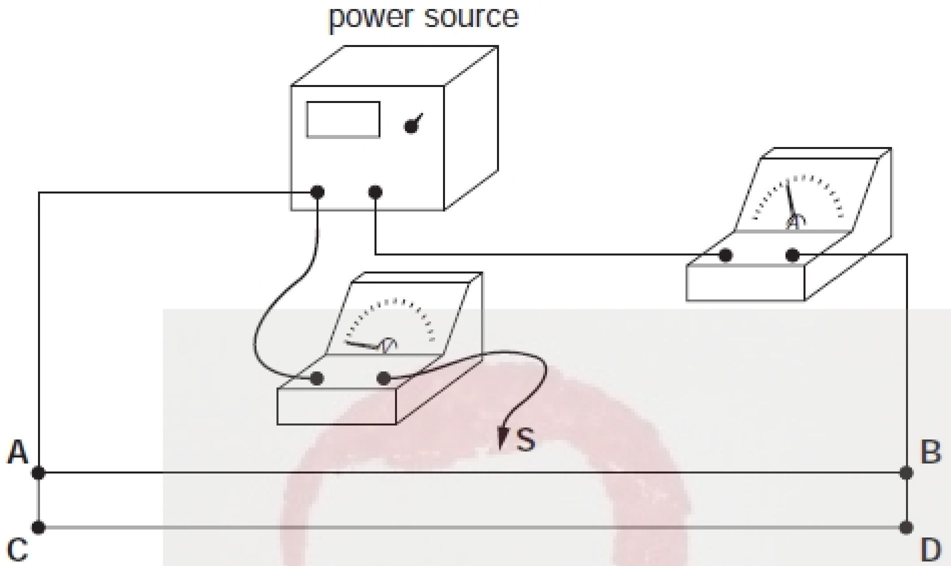
Fig. 2.1

(a) Draw a circuit diagram of the apparatus. Use standard circuit symbols.
(The circuit includes two identical resistance wires **AB** and **CD**. Use the standard symbol for a resistance to represent each of these wires.)
This circuit is called circuit 1.

[3]

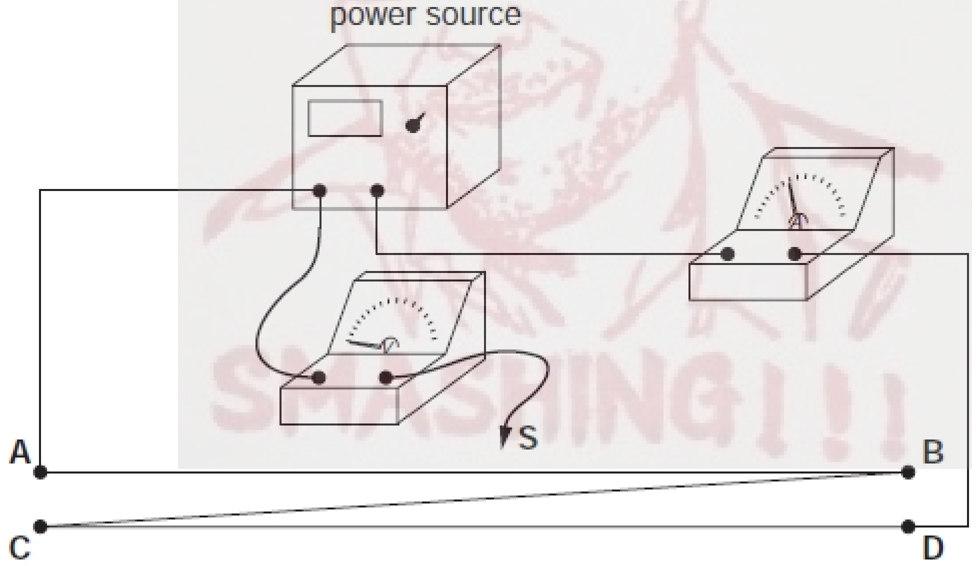
For circuit 1, the student places the contact **S** on the resistance wire **AB** at a distance of 0.500 m from **A**. He measures the p.d. V across the wire between **A** and **S** and the current I in the circuit.

The student then records the measurements for circuits 2 and 3, shown in Fig. 2.2 and Fig. 2.3.



circuit 2

Fig. 2.2



circuit 3

Fig. 2.3

The voltage V and current I for all three circuits are shown in Table 2.1.

Table 2.1

Circuit	V /	I /
1	0.83	0.53
2	0.75	0.95
3	0.41	0.28

(b) Complete the column headings in the table. [1]

(c) Theory suggests that,

1. in circuits 1 and 2, the values of potential difference V will be equal,
2. the value of potential difference V in circuit 3 will be half that in circuit 1 or circuit 2.

(i) State whether, within the limits of experimental accuracy, the results support these predictions.

Justify your statement by reference to the results.

Prediction 1 ....

....

Prediction 2 ....

.... [2]

(ii) Suggest one reason, other than a change in temperature of the wires, why the results may not support the theory.

....

.... [1]

[Total: 7]

4 An IGCSE student is determining the focal length of a converging lens. The apparatus is shown in Fig. 4.1.

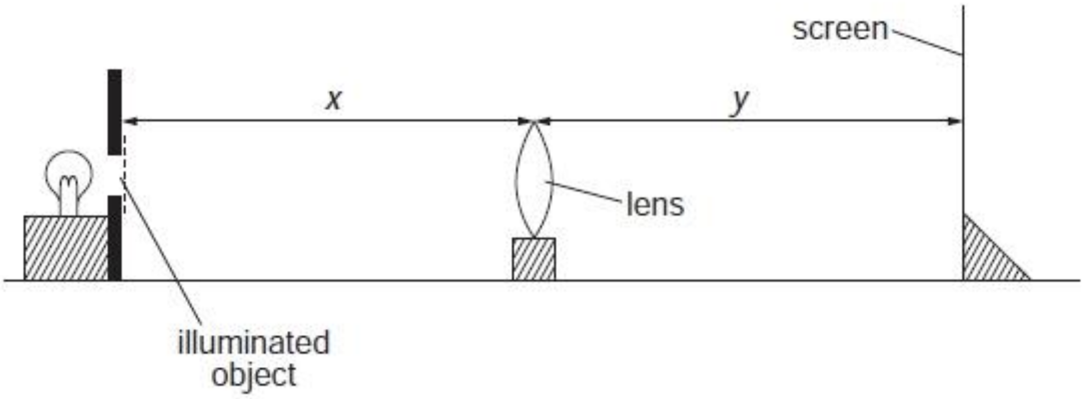


Fig. 4.1

(a) The student places the lens at a distance x = 25.0 cm from the illuminated object. She places the screen close to the lens and then moves it away from the lens until a sharply focused image is formed on the screen. She measures and records the distance y between the lens and the screen.

y = 37.1 cm

Calculate the focal length f of the lens using the equation

$$f = \frac{xy}{(x + y)}.$$

f = ... [2]

(b) She then repeats the procedure with the lens at a distance x = 30.0 cm from the illuminated object.

Fig. 4.1 shows this position of the apparatus. It is a scale diagram.

(i) On Fig. 4.1, measure the distance x_s between the lens and the illuminated object. Also on Fig. 4.1, measure the distance y_s between the lens and the screen.

x_s = ...

y_s = ...

(ii) Calculate the actual distance *y* between the lens and the screen.

y = ...

(iii) Calculate the focal length *f* using the new values of *x* and *y*.

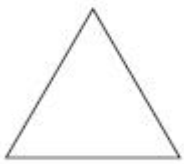
f = ...

(iv) Calculate the average value of *f*. Show your working.

average value of *f* = ...

[7]

(c) The illuminated object has the shape shown below.



Draw a diagram to show the appearance of the focused image in **(b)** on the screen.

[1]

[Total: 10]

4 A student is determining a quantity called the refractive index of the material of a transparent block.

Fig. 4.1 shows the ray-tracing sheet that the student is producing. **ABCD** is the outline of the transparent block, drawn on the ray-tracing sheet.

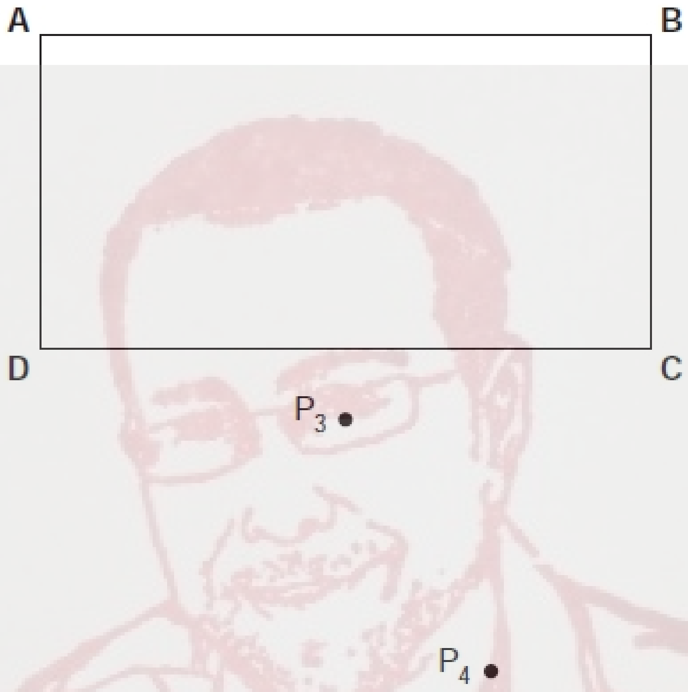


Fig. 4.1

(a) (i) Draw the normal **NN'** to side **AB**, extended to cross side **DC**, so that the normal is 2.0 cm from **A**. Label the point **F** where **NN'** crosses **AB**. Label the point **G** where **NN'** crosses **DC**.

(ii) Draw the line **EF** at an angle of 30° to the normal and to the left of the normal **NN'**. **E** is a point outside the block and above **AB** on the ray-tracing sheet.

[3]

(b) Read the following passage, taken from the student's notebook and then answer the questions that follow.

> I placed two pins P_1 and P_2 on line **EF**.
> I observed the images of P_1 and P_2 through side **CD** of the block so that the images of P_1 and P_2 appeared one behind the other. I placed two more pins P_3 and P_4 between my eye and the block so that P_3, P_4 and the images of P_1 and P_2, seen through the block, appeared one behind the other. I marked the positions of P_1, P_2, P_3 and P_4.

(i) Draw a line joining the positions of P_3 and P_4. Continue the line until it meets **CD**. Label this point **H**.

(ii) Measure and record the length *a* of the line **GH**.

a = ...

(iii) Draw the line **HF**.

(iv) Measure and record the length *b* of the line **HF**.

b = ...[3]

(c) Extend the straight line **EF** through the outline of the block to a point **J**. The point **J** must be at least 5 cm from the block. The line **EJ** crosses the line **CD**. Label this point **K**.

(i) Measure and record the length *c* of the line **GK**.

c = ...

(ii) Measure and record the length *d* of the line **FK**.

d = ...

(iii) Calculate the refractive index *n* of the material of the block using the equation

$$n = \frac{cb}{ad}.$$

n = ...[3]

[Total: 9]

4 The IGCSE class is investigating the refraction of light through a transparent block.

Fig. 4.1 shows the apparatus used.

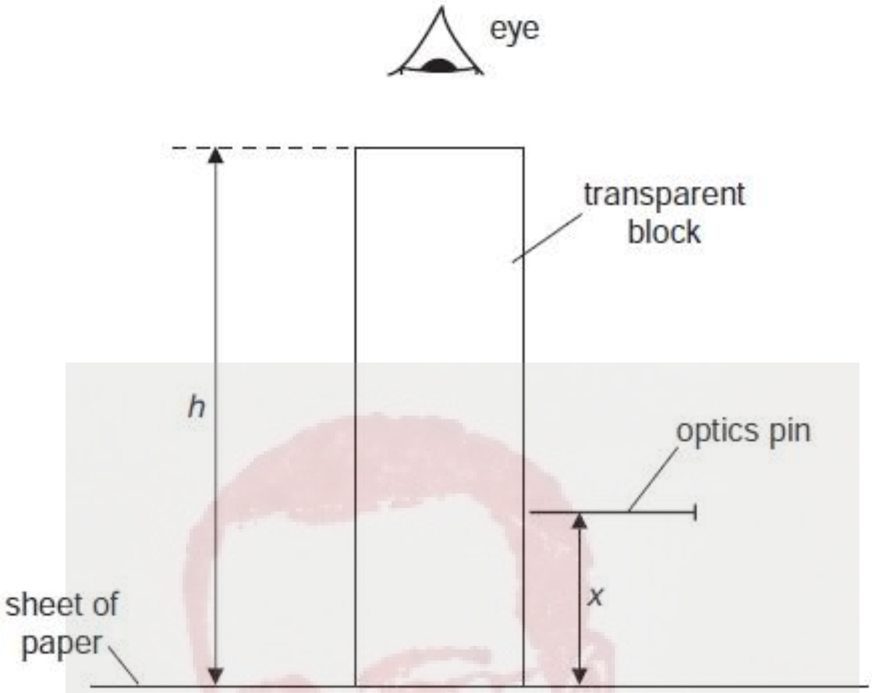


Fig. 4.1

(a) A student looks down through the transparent block at the image of a line drawn on the sheet of paper. She carefully places the point of the optics pin exactly in line with the image.

(i) On Fig. 4.1, measure the vertical distance *x* between the paper and the pin.

x = ...

(ii) On Fig. 4.1, measure the height *h* of the transparent block.

h = ...

(iii) Calculate the refractive index *n* of the material of the block using the equation

$$n = \frac{h}{h - x}.$$

n = ... [5]

(b) To obtain a reliable value for the vertical distance *x* between the paper and the pin, it is important that the pin is horizontal. Explain briefly with the aid of a diagram how you would check that the pin is horizontal.

....

.... [1]

[Total: 6]

4 The IGCSE class is investigating the formation of images by a lens.

Fig. 4.1 shows the apparatus that is being used.

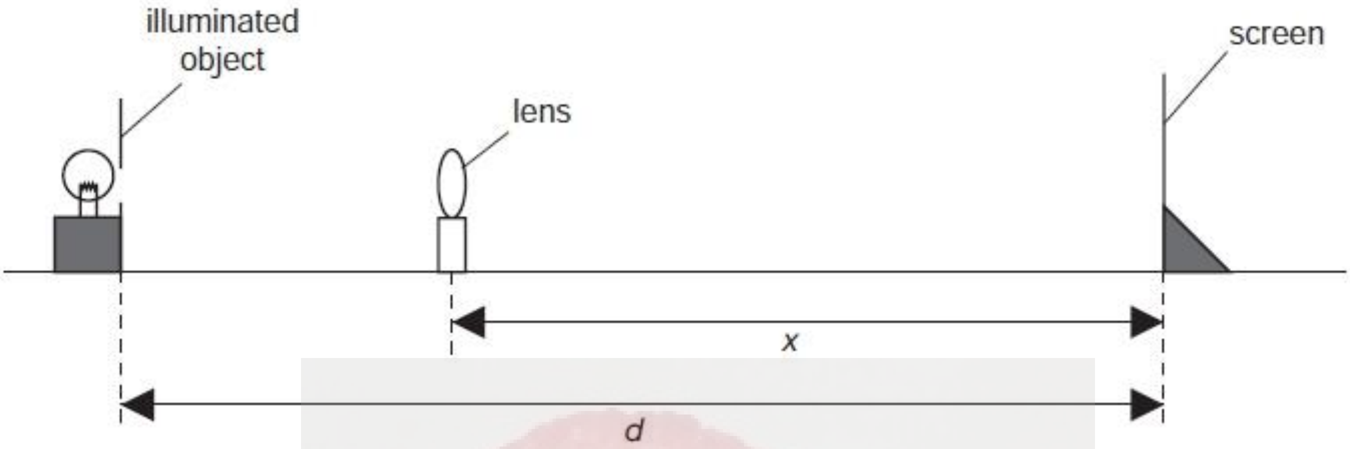


Fig. 4.1

(a) A student places the screen at a distance d = 0.800 m from the illuminated object. She adjusts the position of the lens until a clearly focused magnified image is formed on the screen. She measures the distance x between the centre of the lens and the screen. Without moving the illuminated object or the screen, she moves the lens towards the screen until a second clearly focused (but diminished) image is formed on the screen. She measures the distance y between the centre of the lens and the screen. She repeats the experiment with the distance d increased to 0.900 m. The readings are shown in the table.

x/m	y/m	d/m	f/m
0.205	0.600	0.800	
0.180	0.720	0.900	

(i) For each set of readings calculate the focal length f of the lens using the equation

$$f = \frac{xy}{d}.$$

(ii) Calculate the average value of the focal length f.

average value of the focal length f = ... [4]

(b) Suggest two precautions that can be taken in this experiment in order to obtain an accurate result.

1. ....

....

2. ....

.... [2]

(c) The illuminated object is triangular in shape, as shown in Fig. 4.2.

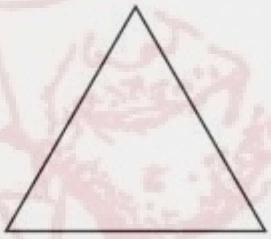


Fig. 4.2

In the space below, sketch the appearance of one of the images on the screen.

[1]

[Total: 7]

3 The IGCSE class is investigating reflection in a plane mirror. Fig. 3.1 shows a ray diagram that a student is constructing.

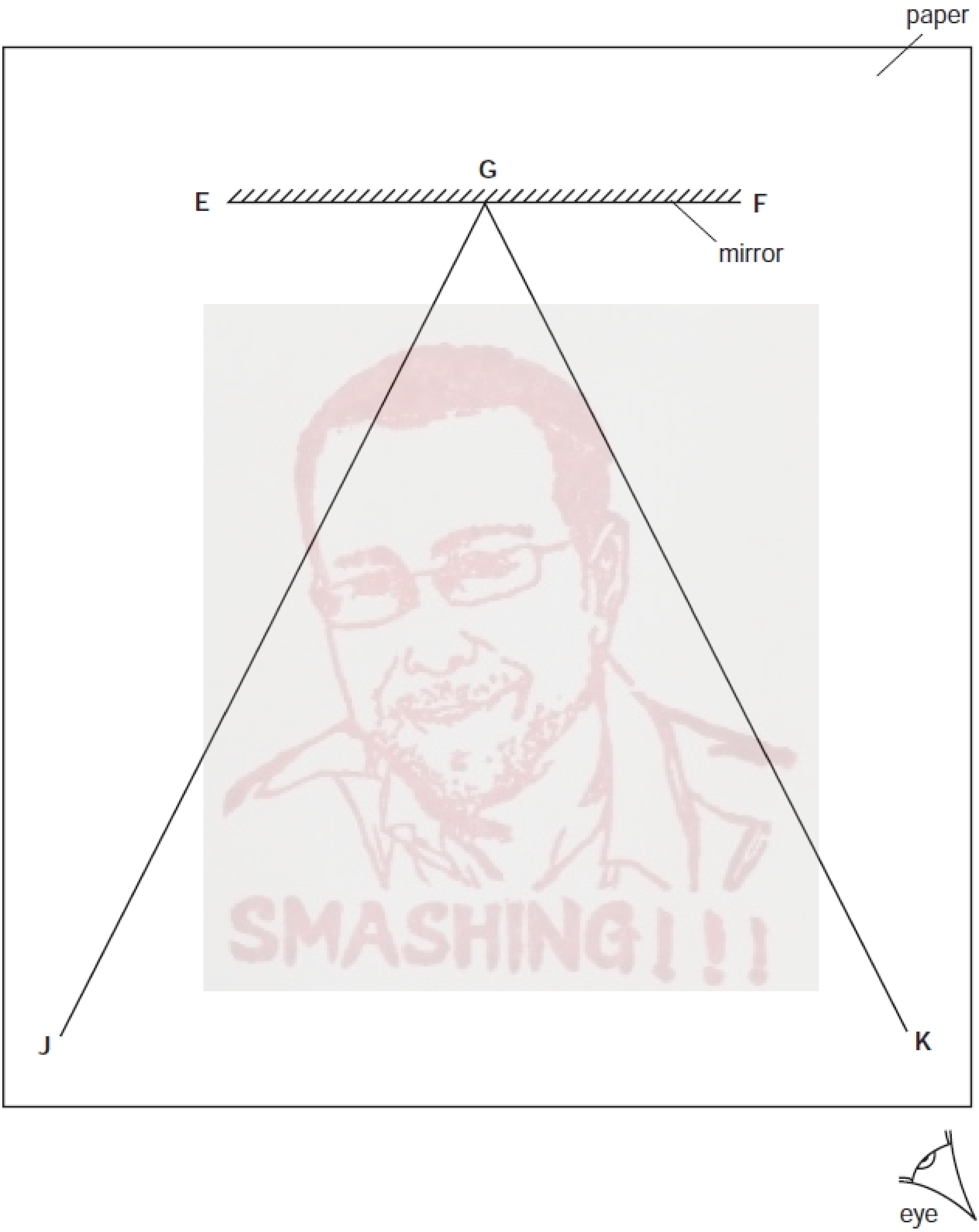


Fig. 3.1

(a) **(i)** Draw a normal GH to line EF.

(ii) Mark a point A on line GJ so that the distance AG is 11.5 cm.

(iii) Measure the angle of incidence *i* between line GJ and the normal.

i = ... [3]

(b) The student pushes two pins into the paper on line GJ, one at point A, and the other at a point B nearer to the mirror. He views the images of the pins from the direction indicated in Fig. 3.1. He then pushes in two pins on line GK between his eye and the mirror so that these two pins and the images of the pins on line GJ appear exactly one behind the other.

(i) On Fig. 3.1, mark suitable positions for the pins on lines GJ and GK. Label the marks with letters B, C and D.

(ii) To obtain an accurate result for this experiment, would you view the tops, bases or central parts of the pins when lining them up? Give a reason for your answer.

I would view ....

reason ....

....

.... [3]

3 The IGCSE class is determining the refractive index of the material of a transparent block. Fig. 3.1. shows the drawing that a student makes.

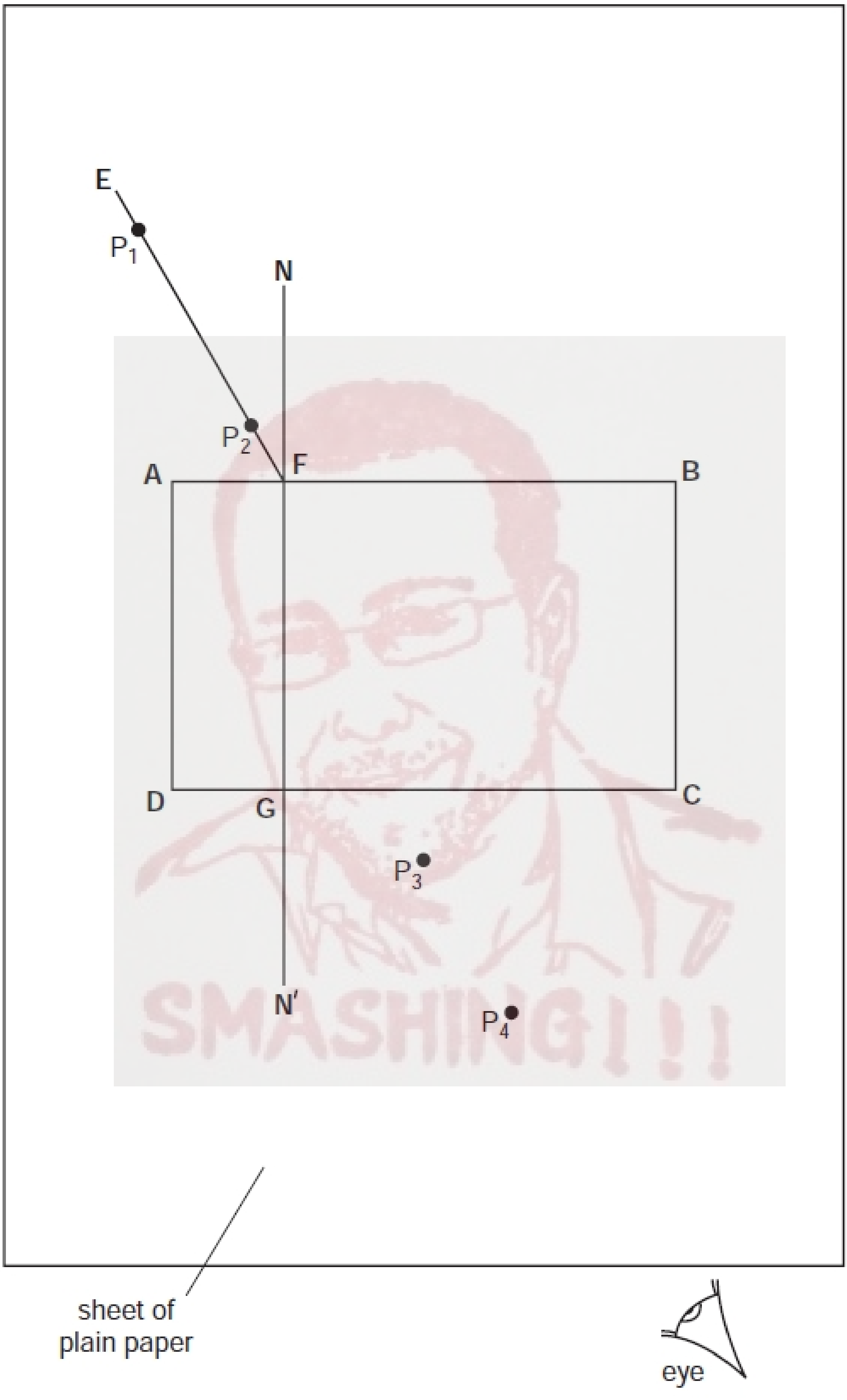


Fig. 3.1

The student places two pins P_1 and P_2 on line **EF** to mark an incident ray. Then she places the block on the paper and observes the images of P_1 and P_2 through side **CD** of the block so that the images of P_1 and P_2 appear one behind the other. She places two pins P_3 and P_4 between her eye and the block so that P_3 and P_4 and the images of P_1 and P_2, seen through the block, appear one behind the other.

(a) **(i)** Draw a line joining the positions of P_3 and P_4. Continue the line until it meets **CD**. Label this point **H**.

(ii) Measure the distance a between **G** and **H**.

a = ... [1]

(iii) Draw the line **HF**.

(iv) Measure the length b of the line **HF**.

b = ... [1]

(v) Extend the straight line **EF** within the outline of the block to a point **I**. The distance **FI** must be exactly equal to b.

(vi) From **I** draw a line that meets **NN′** at a right angle. Label this position **J**.

(vii) Measure the length c of the line **JI**.

c = ... [3]

(viii) Calculate the refractive index n of the material of the block using the equation

$$n = \frac{c}{a} .$$

n = ... [2]

(b) Suggest two improvements you would make to this experiment to ensure an accurate result for the refractive index n.

1 ....

....

2 ....

.... [2]

4 An IGCSE student is investigating the reflection of light by a plane mirror.

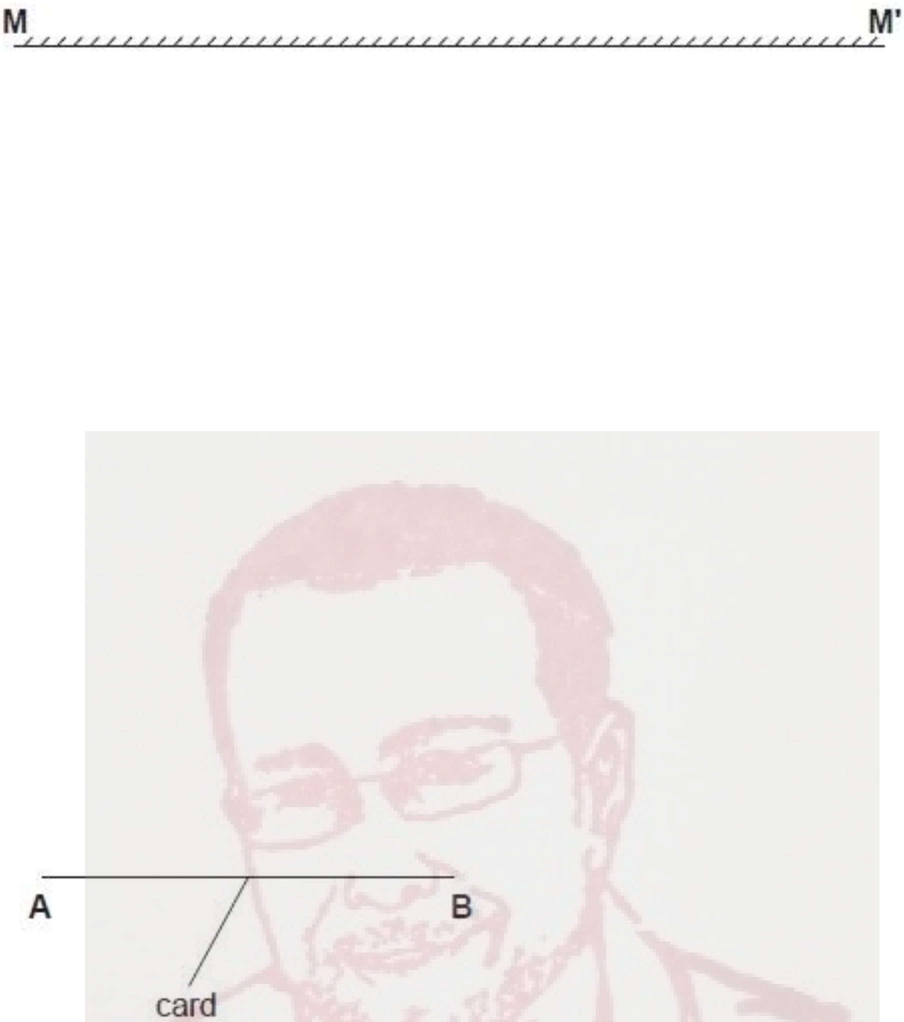


Fig. 4.1

On Fig. 4.1, the line **MM'** shows the position of the mirror that is standing on a sheet of paper. The reflecting surface of the mirror is vertical. **AB** is a card that is standing vertically and is parallel to the reflecting surface of the mirror.

(a) Draw a normal to the mirror such that the edge **B** of the card lies on the normal. [1]

(b) Measure the distance x along the normal between the line **MM'** and the edge **B** of the card.

x = ... [1]

(c) Draw a line from the edge **A** of the card to the point where the normal meets the line **MM'**. This represents an incident ray from the edge of the card. [1]

(d) Measure the angle i between the incident ray and the normal.

i = ... [1]

(e) Calculate the ratio $\frac{x}{y}$ where y = 5.0 cm, the length of the card.

$\frac{x}{y}$ = ... [2]

(f) The angle of reflection is to be determined as accurately as possible. On Fig. 4.1, mark with the letters **X**, **Y** and **Z** the points where the student would place three pins in order to plot the reflected ray. [4]

5 A student investigates the refraction of light through a transparent block.

He places the transparent block on a sheet of plain paper, largest face down, and draws a line round the block. He draws a line to represent an incident ray and places two pins **W** and **X** in the line. Fig. 5.1 shows the outline of the block and the incident ray.

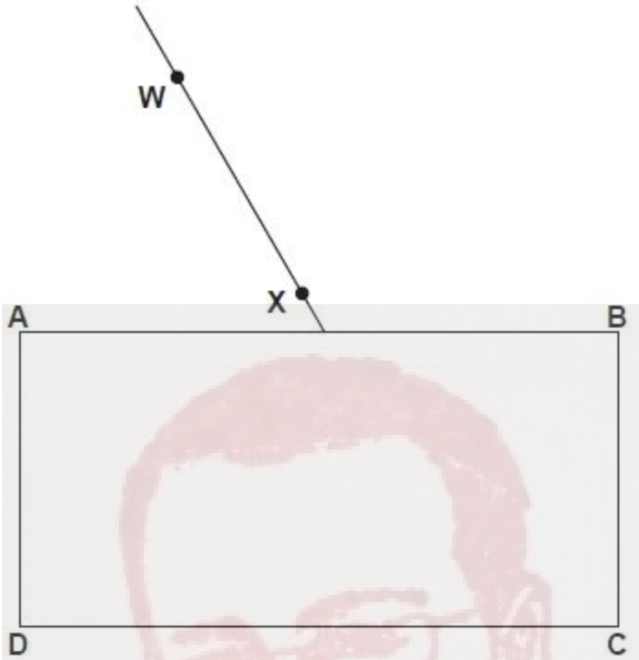


Fig. 5.1

(a) On Fig. 5.1, draw a normal to line **AB** at the point where the incident ray meets the block. The incident ray is drawn on the diagram. The positions of the two pins **W** and **X** that mark the incident ray are shown. [1]

(b) Measure the angle of incidence *i*.

i = ... [1]

(c) Draw in the refracted ray with an angle of refraction of 20°. Continue this line until it meets the line **CD**. [2]

(d) The ray emerges from the block in a direction that is parallel to the incident ray. Draw in this emergent ray. [2]

(e) Two pins **Y** and **Z** are placed so that the pins **W** and **X**, viewed through the block, and the pins **Y** and **Z** all appear exactly in line with each other. Mark on the diagram, with the letters **Y** and **Z**, where you would place these two pins. [2]

4 A student is investigating the passage of light through a transparent block, as shown in Fig. 4.1.

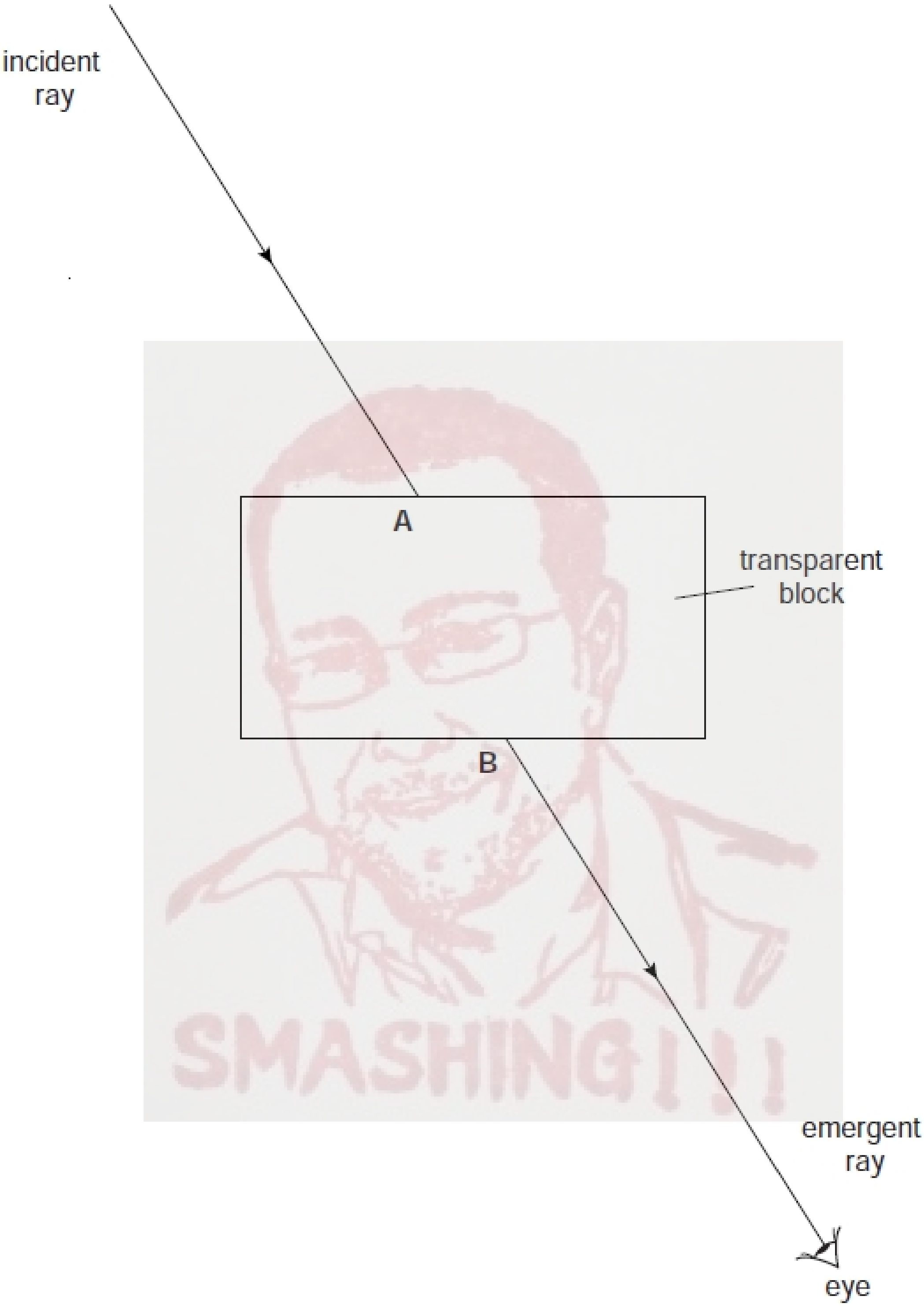


Fig. 4.1

The student looks through the block. He places pins so that two pins marking the incident ray and two pins marking the emergent ray all appear to be exactly one behind the other.

(a) On Fig. 4.1, mark suitable positions for the four pins, two on the incident ray and two on the emergent ray. [1]

(b) **(i)** On Fig. 4.1, draw the normal at point **A**.

(ii) On Fig. 4.1, draw in the line **AB**. Measure and record the angle of refraction *r* between the line **AB** and the normal.

r = ...

(iii) Measure and record the angle of incidence *i* between the incident ray and the normal.

i = ...

[4]

4 The IGCSE class carries out an experiment using a convex lens, an illuminated object and a screen. Fig. 4.1 shows the apparatus. A sharp image is obtained on the screen.

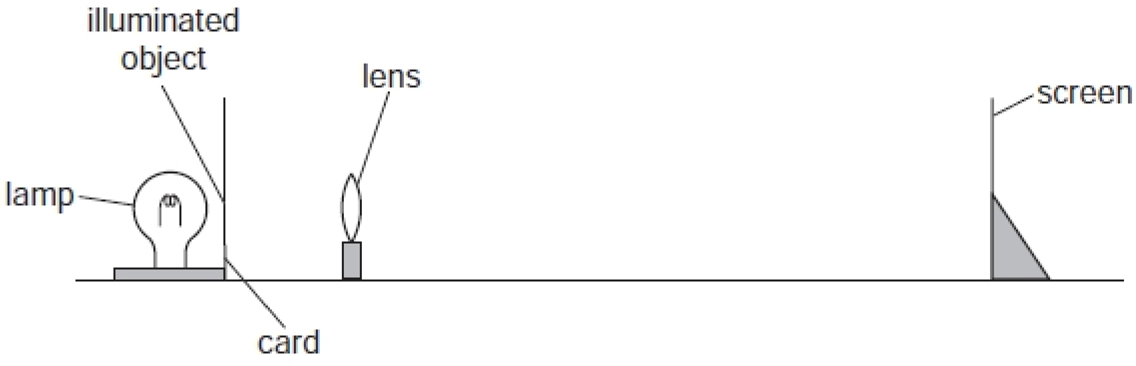


Fig. 4.1

(a) **(i)** Use your rule to measure, on Fig. 4.1, the distance *x* from the illuminated object to the centre of the lens.

x = ...

(ii) Use your rule to measure, on Fig. 4.1, the distance *y* from the centre of the lens to the screen.

y = ...

(iii) Fig. 4.1 shows the apparatus drawn to 1/5th of actual size. Calculate the actual distance *u* between the object and the lens, and the actual distance *v* between the lens and the screen.

u = ...

v = ...

(iv) Calculate the magnification *m* using the equation $m = \frac{v}{u}$.

m = ...

[5]

(b) The illuminated object is triangular in shape, as shown in Fig. 4.2.

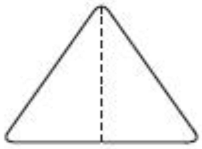


Fig. 4.2

Draw a diagram of the image as it would appear on the screen.

[1]

(c) State two precautions that the IGCSE class should take to obtain experimental readings that are as accurate as possible.

1. ....

....

2. ....

.... [2]

1 The IGCSE class is investigating the conduction of electric current through copper sulphate solution. The circuit used is shown in Fig. 1.1.

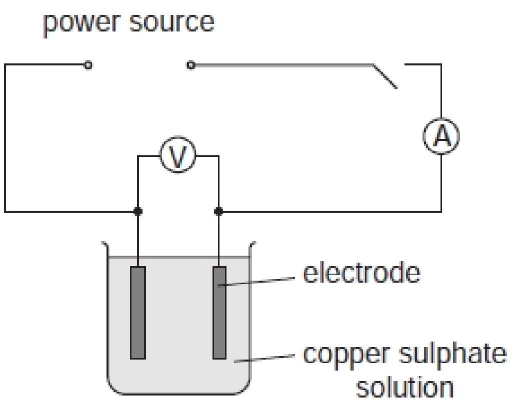


Fig. 1.1

During the experimental work, the students measure the volume of water, the mass of copper sulphate that is dissolved in the water, the current in the solution, the potential difference across the electrodes and the gap between the electrodes.

One set of readings is shown in Figs. 1.2 – 1.6.

(a) Write down the readings shown. Include appropriate units.

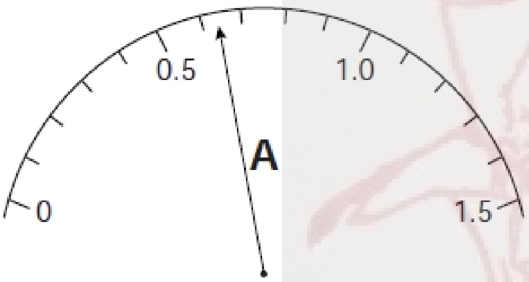


Fig. 1.2

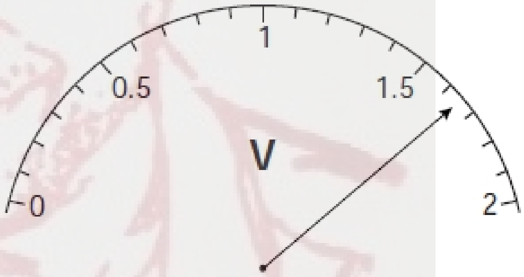


Fig. 1.3

current = ...

potential difference = ...

Fig. 1.4

mass of copper sulphate = ...

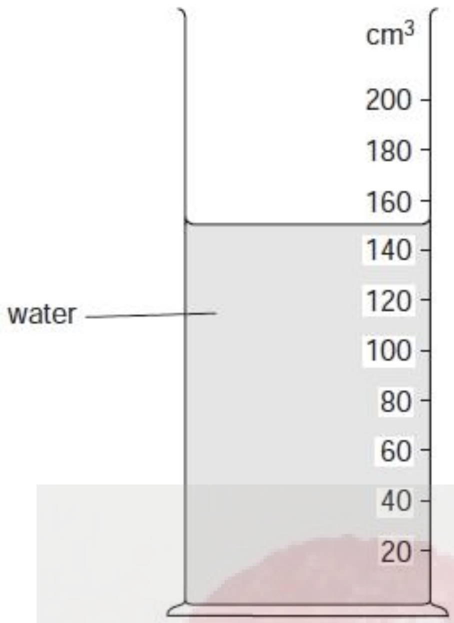


Fig. 1.5

volume of water = ...

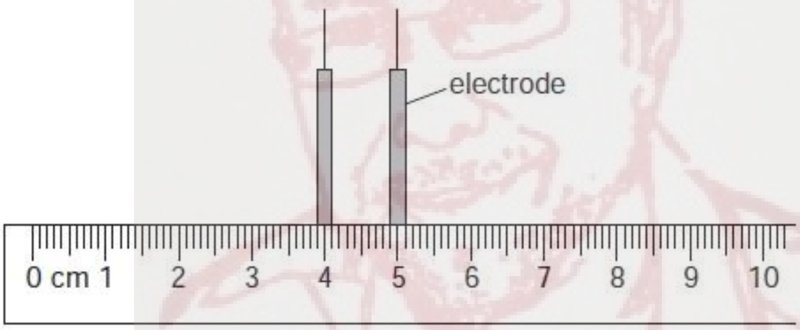


Fig. 1.6

gap between electrodes = ...

[6]

(b) It is not possible to put the rule inside the beaker to measure the gap between the electrodes. Explain how you would overcome this problem.

....

....

....

.... [2]

(c) Suggest a variable, which is not measured in Figs. 1.2 – 1.6, that might affect the value of the current.

.... [1]

2 Fig. 2.1 shows a ray tracing sheet obtained by a student carrying out a reflection of light experiment using pins and a plane mirror.

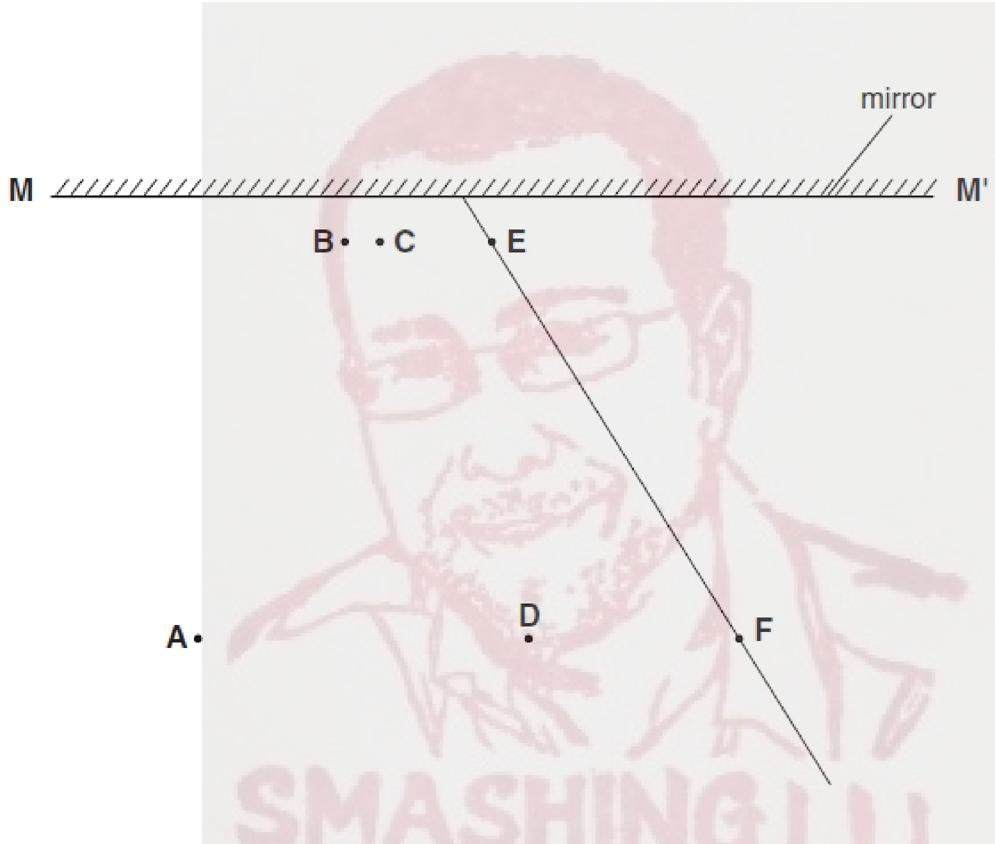


Fig. 2.1

The student looks into the mirror **MM'** and views the images of pins **A** and **B**. He then places pins **C** and **D** so that pins **C** and **D** and the images of pins **A** and **B** appear to be in line.

(a) On Fig. 2.1,

(i) draw the incident ray in this experiment,

(ii) draw the reflected ray,

(iii) draw a normal at the point where the incident ray meets the mirror,

(iv) measure the angle of incidence *i*.

i = ...

[3]

(b) The student moves pin **B** and then repeats the experiment, obtaining the reflected ray **EF**.

(i) On Fig. 2.1, continue the lines **CD** and **EF** behind the mirror to find the point where they meet. Label this point **X**.

(ii) Draw the line **AX**. Label with the letter **Y** the point where line **AX** crosses the mirror **MM'**.

(iii) Use your rule to measure the distances **AY** and **YX**.

AY = ...

YX = ...

[2]

(c) According to theory, **AY** = **YX**. Suggest why, in spite of very careful work, the student's values may have been slightly different.

....

.... [1]

2 An IGCSE student was investigating the passage of red light through a prism. Fig. 2.1 shows the outline of the prism and an incident ray.

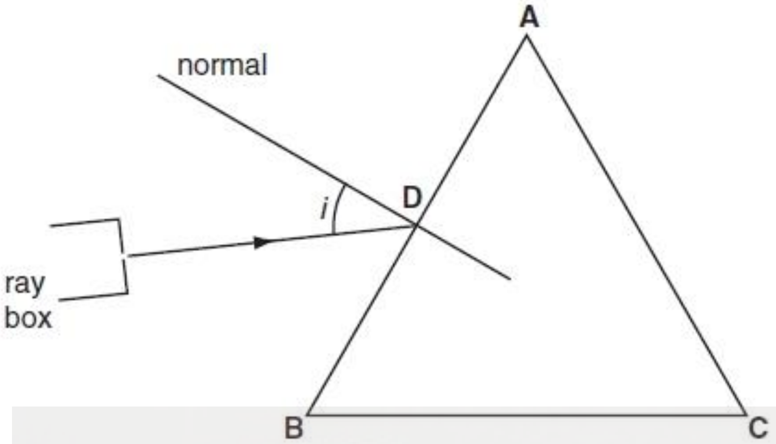


Fig. 2.1

(a) Measure the angle of incidence *i* shown in Fig. 2.1.

i = ...[1]

(b) The angle of refraction as the ray entered side **AB** of the prism was 22°.

(i) On Fig. 2.1, draw in the refracted ray from point **D** as accurately as possible.

(ii) Mark the point **E**, where the ray meets side **AC**. Draw the normal at point **E**.

[4]

(c) At point **E** the ray came out of the prism with an angle of refraction of 75°. On Fig. 2.1, draw as accurately as possible the ray coming out of the prism. [1]

(d) Another student used four optics pins to trace the passage of a ray through a prism. Fig. 2.2 shows the prism, the position of the student's eye and the directions of the ray.

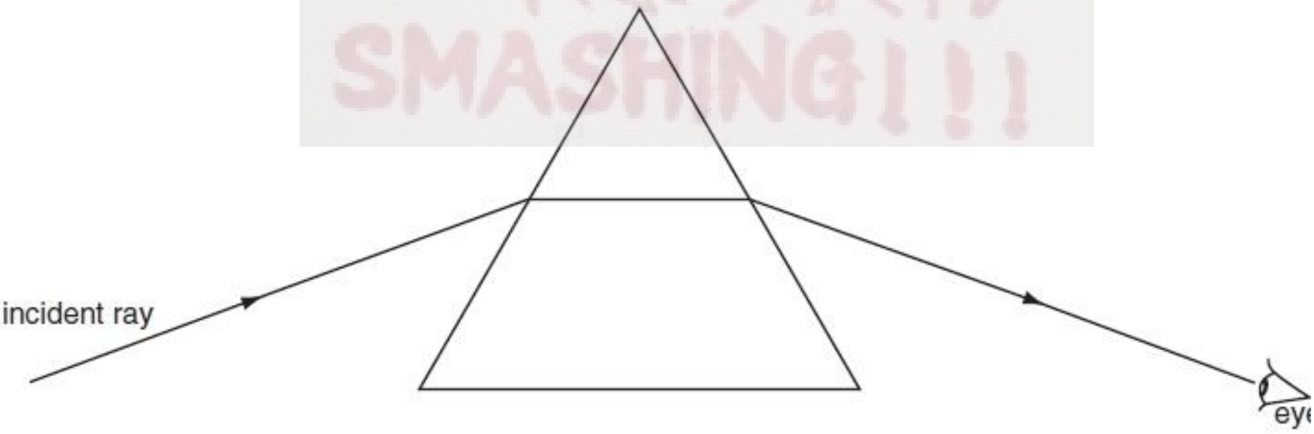


Fig. 2.2

On Fig. 2.2, show positions of the four optics pins, placed to obtain as accurate a result as possible. Mark each position clearly with a cross (X). [2]

5 A student carried out a lens experiment to investigate the magnification of an image. The apparatus is shown in Fig. 5.1.

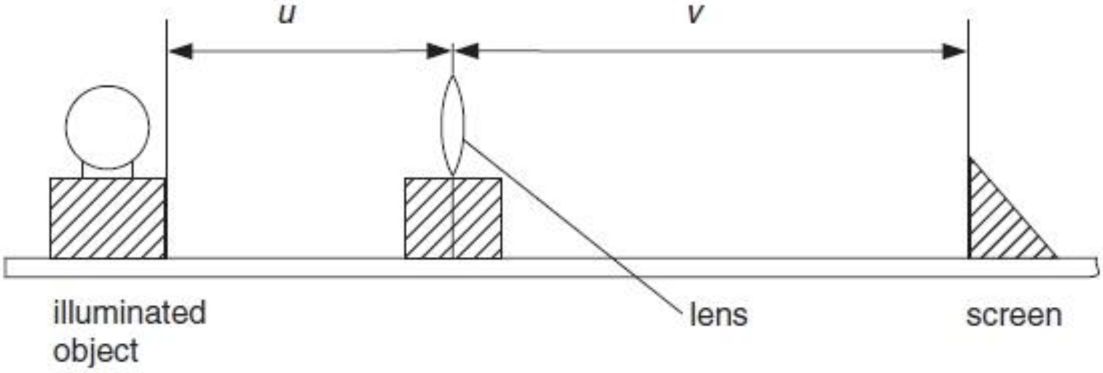


Fig. 5.1

The object is a triangular hole in a screen. Fig. 5.2 shows this, actual size.

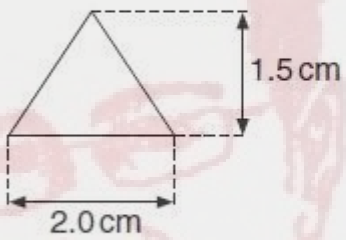


Fig. 5.2

The student set the distance u at 35.0 cm and moved the screen to obtain a sharply focused image. The image distance v was 72.3 cm.

(a) (i) Calculate m, the magnification, using the equation

$$m = v/u.$$

m = ...

(ii) Draw a diagram of the image, actual size, for a magnification $m = 2.0$.

[5]

(b) The image distance v is the distance from the screen to the **centre** of the lens.
Explain briefly how you would position a metre rule to obtain an accurate value for v.
You may draw a diagram.

....

....

....[1]

Topic_Phx 6 **Q.70** **iG Phx/2015/s/Paper 61 www.SmashingScience.org**

4 (a) (i) normal at centre of AB and through block [1]

(ii) GH parallel to AB AND 6 cm ± 2 mm above AB [1]

(iii) $i = 30° \pm 2°$ to left of normal [1]

(b) P_1P_2 distance ≥ 5.0 cm [1]

(c) line KE correct, single and straight, emergent ray through P_3 and P_4 [1]

(d) $a = 3.3 – 3.7$ (cm); $b = 6.8 – 7.2$ (cm); $c = 4.0 – 4.4$ (cm); $d = 1.4 – 1.8$ (cm) [1]

n in range 1.2–1.5, no unit, 2 or 3 significant figures [1]

(e) any one from:
- large pin separation
- ensure pins are vertical
- view bases of pins
- drawing thin lines / use a sharp pencil
- use thin pins [1]

(f) ray box near start of incident ray or anywhere on incident ray; pointing in correct direction [1]

[Total: 9]

Topic_Phx 6 **Q.71** **iG Phx/2014/w/Paper 61 www.SmashingScience.org**

1 (a) normal at 90°, straight, at centre [1]

(b) incident ray at 30° on left of normal, straight [1]

(c) ray box near beginning of incident ray and pointing along it [1]

(d) reflected ray at angle of reflection approximately 30° [1]

(e) any two from:
darkened room / brighter ray box owtte
mark rays at centre / edge of beam
use sharp pencil
thin ray / small slit in ray box
perpendicular viewing of protractor [2]

[Total: 6]

4 **(a)** u = 20 mm AND v = 58 mm [1]

(b) v/u = 2.9 e.c.f. from **(a)** no unit [1]

(c) U = 200, V = 580 e.c.f. from **(a)** [1]

(d) 1.5 cm OR 15 mm [1]

(e) statement to match results (expect yes) [1]

justified by reference to results, communicating idea of within (beyond, ecf) limits of experimental accuracy [1]

(f) any two from:
use of darkened room / brighter lamp
mark position of centre of lens on holder
place metre rule on bench (or clamp in position)
ensure object and (centre of) lens are same height (from the bench)
repeats and average
moving lens / object / screen back and forth (to find sharpest image) owtte
screen and lens and object all perpendicular to bench [2]

(g) image inverted [1]

(h) any one from:
darkened room / brighter lamp
moving lens / object / screen back and forth owtte
use object with fine detail e.g. cross-wires
measure at middle of range where image is sharp [1]

[Total: 10]

5 **(a)** angle of incidence 30° and **AB** 8.0 cm single, continuous, straight line [1]

(b) P_3P_4 line correct and neat [1]

$\alpha_o = 30 \pm 1°$ [1]

(c) **graph:**
axes correctly labelled and correct way round [1]

suitable scales, i.e. *y*-axis 2 cm = 20°, *x*-axis 2 cm = 10° [1]

all plots correct to ½ small square [1]

good line judgement [1]

single, thin, continuous line, neat points [1]

(d) triangle method seen on graph with triangle using at least half of line [1]

G between 1.9 and 2.1, ecf for axes wrong way round [1]

(e) $(\alpha - \alpha_o) = 2\theta$ or words to that effect, no ecf [1]

(f) any one from:
large(r) pin separation
view bases of pins (or ensure pins vertical)
repeat and average
thin(ner) pins
thin(ner) lines / sharp(er) pencil [max 1]

[Total: 12]

Topic_Phx 6 **Q.74 iG Phx/2013/w/Paper 61 www.SmashingScience.org**

4 **(a)** (i)(ii) u = 26 (mm) or 2.6 (cm) [1]
v = 44 (mm) or 4.4 (cm) [1]

(b) (i)(ii) 1144 mm^2 and 70 mm
OR 11.44 cm^2 and 7.0 (or 7) cm [1]
e.c.f. from **(a)**

(iii) x = 16 or 16.3 or 16.34 (1.6 or 1.63 or 1.634)
e.c.f. from **(b)**(i) and (ii) [1]

(c) f = 16 or 16.3 or 16.34 cm (160 or 163 or 163.4 mm) [1]
f given to 2 or 3 significant figures [1]

(d) up to 0.5 cm either side of 18.2 cm [1]

(e) any two from:
use of darkened room / brighter lamp / no other light interfering
mark position of centre of lens on holder
place metre rule on bench (or clamp in position)
ensure object and lens are same height from the bench
lens / object / screen perpendicular to bench
repeats
avoidance of parallax with action and reason [2]

[Total: 9]

Topic_Phx 6 **Q.75 iG Phx/2013/s/Paper 61 www.SmashingScience.org**

4 on ray trace:
one line drawn accurately through P_3P_4 or CD [1]
both lines in correct place, neat, thin and intersecting [1]
normals Y to MR and P_1 to MR correct [1]
b = 55 – 65 (mm) [1]

(d) statement matches results (expect Yes) [1]
idea of within (or beyond) experimental accuracy [1]

(e) any one from:
large spaces between pins
make sure pins are vertical
observe bases of pins [1]

[Total: 7]

Topic_Phx 6 **Q.76 iG Phx/2012/w/Paper 61 www.SmashingScience.org**

5 (a) Measuring cylinder
Tape measure
Newtonmeter (spring balance)
Electronic balance
Manometer

1 mark each [5]

(b) (i) Viewing scale perpendicularly (owtte) [1]

(ii) Any one from:
Moving lens back and forth
Dark area (owtte)
Object and lens at same height from bench
Object lens and screen at right angles to bench [1]

[Total: 7]

Topic_Phx 6 **Q.77 iG Phx/2012/w/Paper 61 www.SmashingScience.org**

4 (a) Trace:
Normal at 90° in correct position [1]
Angle of incidence = 30° (± 2°) [1]

(b) P_1P_2 distance ⩾ 5.0 cm [1]
P_3P_4 line and line **GE** correctly and neatly drawn [1]

(c) (i) *r* = 18 or 19 or 20 [1]

(ii) *i/r* value correct [1]

(d) (i) *i/r* value 1.54 and both *i/r* values with no unit <u>and</u> to 2 or 3 significant figures [1]

(ii) Idea of within (or beyond) limits of experimental accuracy [1]

[Total: 8]

Topic_Phx 6 **Q.78 iG Phx/2012/s/Paper 61 www.SmashingScience.org**

4 **(a)** *d* in range 79 to 80 (mm), 7.9 to 8.0 (cm) [1]
x = 61 (mm) and consistent correct unit for both (mm or cm) [1]
D = 80 (cm), *X* = 61 (cm) ecf from (i) and (ii) [1]

(b) *f* = 14.5(cm) allow ecf from **(a)** [1]
2 or 3 significant figures and correct unit [1]

(c) Correct statement for results (expect Yes or wtte) [1]
Idea of within (or beyond) experimental accuracy or wtte [1]
Can only score if previous mark is scored

(d) Any one from:
Use of darkened room
How to avoid parallax when taking readings
Movement of lens back and forth to obtain clearest image
Mark lens holder to show position of centre of lens
Metre rule clamped or on bench
Object, lens and screen all perpendicular to bench
Object and lens same height above bench [1]

[Total: 8]

Topic_Phx 6 **Q.79 iG Phx/2011/w/Paper 61 www.SmashingScience.org**

5 **(a)** 200 m or more with unit [1]

(b) tape measure, trundle wheel or gps device [1]

(c) correct working seen [1]
345.67 (accept 345.66, 345, 346, 350) [1]

(d) (No), <u>readings</u> (time or distance) too inaccurate [1]

[Total: 5]

4 **(a)** (i) normal at 90°, at centre of **MR** and crossing **MR** [1]

(ii) **AB** is a continuous line from **B**, 8 cm long [1]
AB is at 40° to normal [1]

(b) (i) continuous, thin line that reaches normal and at least touches P_2 and P_3 dots [1]

(ii) r = 40 – 43(°) (no ecf) [1]

(c) any two from:
thickness of lines
thickness of protractor o.w.t.t.e. / accuracy of reading protractor
thickness of pins / pin holes [2]
accept thickness of mirror / glass in front of mirror

(d) ticks in boxes 1, 3, 5 (1 mark each)
(if more than 3 ticks, –1 for each tick in a wrong box to minimum of 0) [3]

[Total: 10]

4 **(a)** (i) pins at least 5 cm apart [1]

(ii) i = 30 [1]

(iii) r_1 = 31 [1]

(b) (i) & (ii) both lines correct area [1]

(iii)–(v) r_2 correct to ± 1° with unit [1]
difference = 1 or –1 (c.a.o.) [1]

(c) statement matches result (expect YES) (ecf NO) [1]
justification matches statement and by reference to result
(expect within limits of experimental accuracy, wtte) (too different, wtte) [1]

[Total: 8]

Topic_Phx 6 **Q.82 iG Phx/2011/s/Paper 61 www.SmashingScience.org**

4. **(a)** Normal in centre at 90° to **MR** [1]
CD drawn correctly [1]
Both neat and thin [1]

(b) **(i)** **CN** drawn correctly [1]

(ii) $i = 23(^\circ) \pm 1(^\circ)$ (ecf allowed) [1]

(c) **(i)** Line through P_3 and P_4 correct [1]
$r = 21(^\circ) \pm 1(^\circ)$ [1]

(d) Any two:
Thickness of lines
Thickness of mirror
Protractor can only be read to $\pm$ 1° OR protractors are not that precise (owtte)
Thickness of pins [2]

[Total: 9]

Topic_Phx 6 **Q.83 iG Phx/2010/w/Paper 61 www.SmashingScience.org**

4 **(a)** **(i) – (iii)**
EF extended correctly and neat [1]
P_3P_4 line drawn correctly and neat [1]
G labelled [1]
P_1 and P_2 at least 5cm apart [1]

(iv) and **(v)** 40 – 42 (ecf) [1]
$(\theta - 2i)$ correct (ecf) [1]

(b) **(i)** 2 and unit (°) present at least once [1]

(ii) yes (or No, ecf) [1]
reference to 'within limits of experimental accuracy'
(or close enough or wtte) [1]

(c) no concern about pins being vertical (or wtte) [1]

[Total: 10]

4 **(a)** *f* 14.95 ± 0.05 (cm) [1]
unit to match number [1]

(b) more than one value shown [1]
d 6.5 ± 0.1 [1]

(c) *t* 0.85 ± 0.05 (cm) [1]
d and *t* both with correct unit [1]

(d) diagram showing blocks correctly placed [1]
rule shown correctly touching both blocks [1]

(e) *f* 10.9 – 13.1 (cm) (or 109 – 131 (mm)) [1]
no, too far out to be explained by experimental inaccuracy (wtte) [1]

[Total: 10]

5 **(a)** lens between object and screen (not mirror) [1]
lens at least 2 cm from object and screen [1]
metre rule on bench or clamped [1]

(b) any two from:
use of darkened room/brighter object
slowly moving lens back and forth to obtain good image
avoid parallax, action given
lining up object and lens
object and lens at same height from bench/object on principal axis
repeats
screen/lens perpendicular to bench
mark centre of lens position on block [2]

[Total: 5]

Topic_Phx 6 **Q.86 iG Phx/2009/s/Paper 61 www.SmashingScience.org**

4 (a) 4.0 (cm) [1]
6.0 (cm) [1]

(b) 20, 30 ecf allowed [1]
f values 11.88 (11.9), 12.00 (12.0) [1]
f consistent 3 or more significant figures [1]

(c) average *f* 11.9, 11.94, 11.95, 12.0, 12 (cm) ecf allowed [1]
2/3 significant figures [1]

(h) Any two from
use of darkened room
slowly moving lens back and forth to get good image
clamp rule or place on bench
avoid parallax action given
object/lens/screen perpendicular to bench
object and lens same height from bench
repeats [2]

[Total: 9]

Topic_Phx 6 **Q.87 iG Phx/2008/w/Paper 61 www.SmashingScience.org**

2 Diagram: correct symbols for ammeter and voltmeter [1]
correct symbols for resistor [1]
correct circuit arrangement [1]

Table: units V, A (symbol/word) [1]

(c) Prediction 1 Yes – close enough (or words to that effect)
OR No – not close enough (or words to that effect) [1]
Prediction 2 Yes – approximately half (or words to that effect) [1]

Resistance at connections
Internal resistance of source/other sensible suggestion [1]

[Total: 7]

4 **(a)** f = 14.9(4), or 15 [1]
correct unit for f [1]

(b) **(i)** x_s = 5.0(cm) and y_s = 5.2(cm) [1]

(ii) factor of ×6 [1]
y = 31.2(cm) (ecf) [1]

(iii) 15.29, 15.3, 15 (ecf) [1]

(iv) correct method [1]
2 or 3 significant figures and correct unit [1]
average f 15.1 (correct answer only) [1]

(c) inverted image [1]

[Total: 10]

4 Trace:

(a) all lines present, thin, neat and in correct area [1]
normal at 90° (by eye)
and EF at 30° to normal (by eye) [1]
line KJ to at least beyond P_4 [1]

(b) **(i)** a = 12–13 (mm) no ecf [1]

(ii) b = 40 (mm) no ecf [1]
a and b both with appropriate unit [1]

(c) **(i)** **& (ii)** c recorded and d = 44 (mm) [1]

(iii) correct calculation of n, value 1.43 (ecf) [1]
2/3 significant figures with no unit [1]

[Total: 9]

Topic_Phx 6 **Q.90** **iG Phx/2007/w/Paper 61 www.SmashingScience.org**

4 **(a)** **(i)** x = 2.1, 2.2 [1]

(ii) h = 6.5, 6.6 [1]
x and h with same unit [1]

(iii) correct arithmetic for n1.47 – 1.51 (ecf) [1]
2/3 sf and no unit [1]

(b) two equal heights from bench (or other valid method) [1]

[Total: 6]

Topic_Phx 6 **Q.91** **iG Phx/2007/s/Paper 61 www.SmashingScience.org**

4 **(a)** correct arithmetic for f, 0.154, 0.144 (any sf) [1]
correct average f (0.149, ecf) [1]
average f to 2/3 sf [1]
correct unit for average f (m) [1]

(b) precautions:
any two from:
use darkened area (wtte)
metre rule on bench or clamped
object and lens same height from bench
mark on lens holder to show position of lens centre
take more readings
choosing mid point between acceptable positions
parallax, action and reason
lens/screen perpendicular to bench [2]

(c) inverted [1]

[Total: 7]

Topic_Phx 6 **Q.92** **iG Phx/2006/w/Paper 61 www.SmashingScience.org**

3 **(a)** **(i)** normal correct (by eye) (single, thin line) [1]

(ii) AG = 11.5 cm (± 0.1) [1]

(iii) i = 26°/27°/28° (ignore unit) [1]

(b) **(i)** CD pin separation ≥ 5 cm [1]

(ii) bases [1]
pins may not be vertical [1]

[Total: 6]

Topic_Phx 6 **Q.93 iG Phx/2006/s/Paper 61 www.SmashingScience.org**

3 (a) All lines present and neat, a = 1.5 cm **[1]**

(iv) b = 4.3 cm **[1]**

(iv) FI = 4.3 cm (or cand's a value) **[1]**

(v) IJ meets NN' at right angle (by eye) **[1]**

(vi) c correct to ± 1 mm, 2.1 cm **[1]**

(vii) n calculation correct **[1]**
2/3 sf and no unit (1.4) **[1]**

(b) repeats and averages **[1]**
greater pin spacing **[1]**

TOTAL 9

Topic_Phx 6 **Q.94 iG Phx/2005/w/Paper 61 www.SmashingScience.org**

4 (a) normal in correct position and at 90° (by eye) 1

(b) 9.9 – 10.2 cm 1

(c) incident ray drawn in correctly 1

(d) 27° (± 2°) 1

(e) 2.0 (or correct from candidates x value) 1
2 or 3 sf and no unit 1

(f) X on incident ray close to mirror 1
Y and Z on reflected ray 1
Y – Z distance at least 5 cm 1
i = r (by eye) 1

TOTAL 10

Topic_Phx 6 **Q.95 iG Phx/2005/s/Paper 61 www.SmashingScience.org**

5 (a) normal in correct position and at 90° (by eye) **[1]**

(b) i = 29 - 31 **[1]**

(c) refracted ray correct side of normal and at angle < i **[1]**
r = 18 - 22 **[1]**

(d) ray displaced and parallel to incident ray (by eye) **[1]**
all correct lines drawn neatly, not too thick, and forming continuous path **[1]**

(e) two pins on emerging ray, labelled Y and Z **[1]**
pins at least 3 cm apart **[1]**

[total: 8]

Topic Phx 6 **Q.96 iG Phx/2004/w/Paper 61 www.SmashingScience.org**

4	**(a)**	4 pins at least one separation, separation ≥ 5 cm	1
		normal at 90° (by eye)	1
		r = 19 – 21	1
		i = 31 – 33	1
		unit given for both	1
		TOTAL	**5**

Topic Phx 6 **Q.97 iG Phx/2004/s/Paper 61 www.SmashingScience.org**

4	**(a)**	**(i)**	x = 14 – 16mm	1
		(ii)	y = 76.5 – 78.5 mm	1
		(iii)	u = 75mm (ecf) and v = 390mm (ecf)	1
			x,y,u and v all correct and with no unit	1
		(iv)	m = 5.2 (ecf) 2/3 sf and with no unit	1
	(b)		Upside down	1
			Precaution 1	1
			Precaution 2	1
			(e.g. repeats, use mark on block supporting lens to show centre of lens, place metre rule on bench to take readings or clamp rule in position, use a dark area, explanation of how to avoid parallax error, vertical screen/lens/both, centres of lens and object in line)	
			TOTAL	**8**

Topic Phx 6 **Q.98 iG Phx/2004/s/Paper 61 www.SmashingScience.org**

1	**(a)**	0.63 – 0.65 (A) (strictly)	1
		1.64 – 1.66 (V) (strictly)	1
		3.32 (g)	1
		150 (cm^3)	1
		8 (mm) or 0.8 (cm)	1
		All units correct	1
	(b)	Remove electrodes from beaker	1
		A method to ensure gap remains the same	1
		(or other suitable suggestion e.g. measurement arrangement that the beaker sits on)	
	(c)	New variable (e.g. temperature, surface area / vol / size of electrodes, power source setting, depth of immersion)	1
		TOTAL	**9**

Topic_Phx 6 **Q.99 iG Phx/2003/w/Paper 61 www.SmashingScience.org**

2	**(a) (i)(ii)**	2 neat continuous rays	(thickness up to as EF)	1
	(iii)	normal where incident ray meets mirror (90° by eye)		1
	(iv)	i = 20° ± 1° (allow e.c.f. if mark for normal not scored)		1
	(b) (i)(ii)	lines complete and neat with AX correctly intersecting		1
	(iii)	AY = 5.9 – 6.1 cm AND YX = 5.5 + 0.3 cm		1
	(c)	any one from: thickness of mirror thickness of lines thickness of pins judgement of where lines cross		1

TOTAL 6

Topic_Phx 6 **Q.100 iG Phx/2003/s/Paper 61 www.SmashingScience.org**

2	**(a)**	36° (±1°)	1
	(b)	Refracted ray drawn	1
		22° (±1°)	1
		normal correct (by eye)	1
		neat, thin, correct lines	1
	(c)	Correct refracted ray (by eye) with arrow	1
	(d)	Separation (LHS) at least 5cm	1
		Separation (RHS) at least 5cm	1

TOTAL 8

Topic_Phx 6 **Q.101 iG Phx/2002/w/Paper 61 www.SmashingScience.org**

5. (a) (i) 2.07	1
2/3 sf	1
no unit	1
(ii) upside down	1
3 cm high	1
(b) metre rule on bench or clamped above lens	1

TOTAL 6

3 The class is investigating the resistance of lamp filaments in series and parallel circuits.

Fig. 3.1 shows the first circuit used.

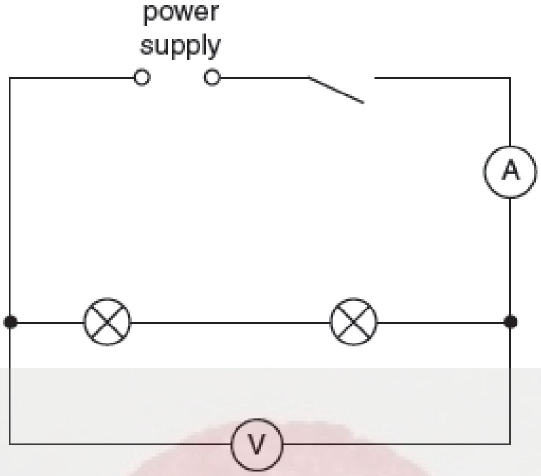


Fig. 3.1

(a) (i) Write down the readings shown on the meters in Figs. 3.2 and 3.3.

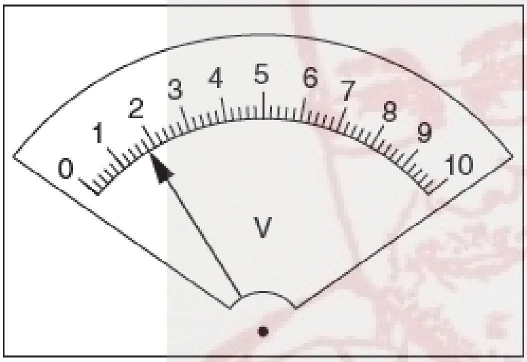


Fig. 3.2

V_S = ...

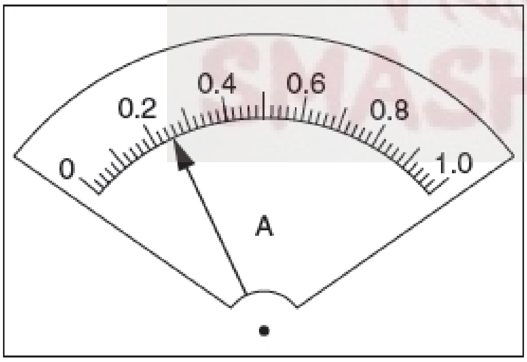


Fig. 3.3

I_S = ... [2]

(ii) Calculate the resistance R_S of the lamp filaments using the equation $R_S = \frac{V_S}{I_S}$.

R_S = ...[1]

(b) The student rearranges the circuit so that

- the lamps are in parallel
- the ammeter will measure the total current in the circuit
- the voltmeter will measure the potential difference across the lamps.

(i) Draw a diagram of this circuit using standard circuit symbols.

[2]

(ii) The student measures the potential difference V_P across the lamps and the current I_P in the circuit.

V_P = 2.0V

I_P = 0.60 A

Calculate the resistance R_P of the lamp filaments using the equation $R_P = \frac{V_P}{I_P}$.

R_P = ...

(iii) Calculate the ratio $\frac{R_S}{R_P}$.

$\frac{R_S}{R_P}$ = ...

[1]

(c) A student wishes to investigate whether the ratio $\frac{R_S}{R_P}$ for the two lamps is the same under all conditions.

(i) Suggest a variable that you could change in order to obtain further sets of readings.

....

(ii) Explain briefly how you would change this variable.

....

.... [2]

[Total: 8]

3 The IGCSE class is investigating the resistance of a wire.

The circuit used is shown in Fig. 3.1.

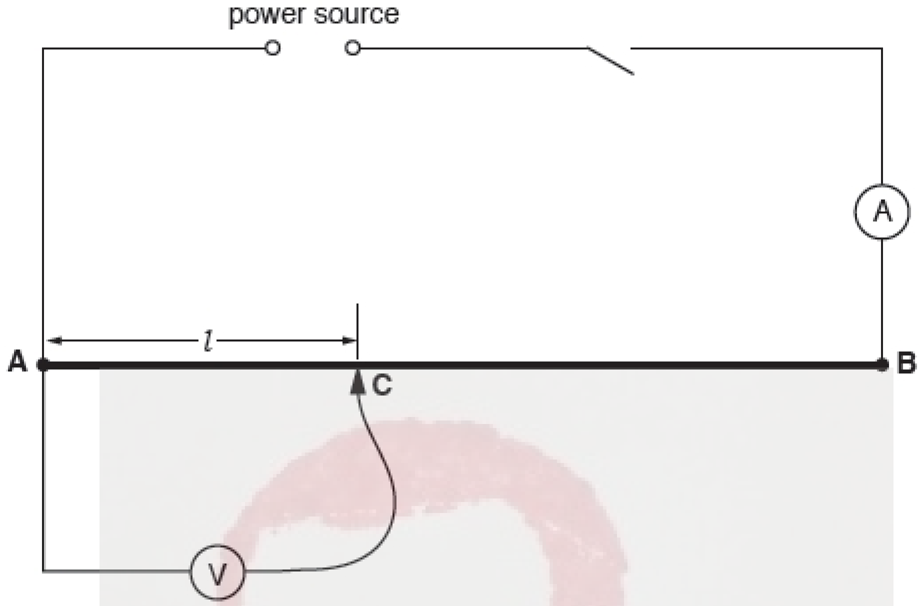


Fig. 3.1

(a) A student measures the potential difference V across different lengths l of the wire **AB** and the current I in the wire. The wire **AB** is 1.00 m long. The readings are shown in Table 3.1.

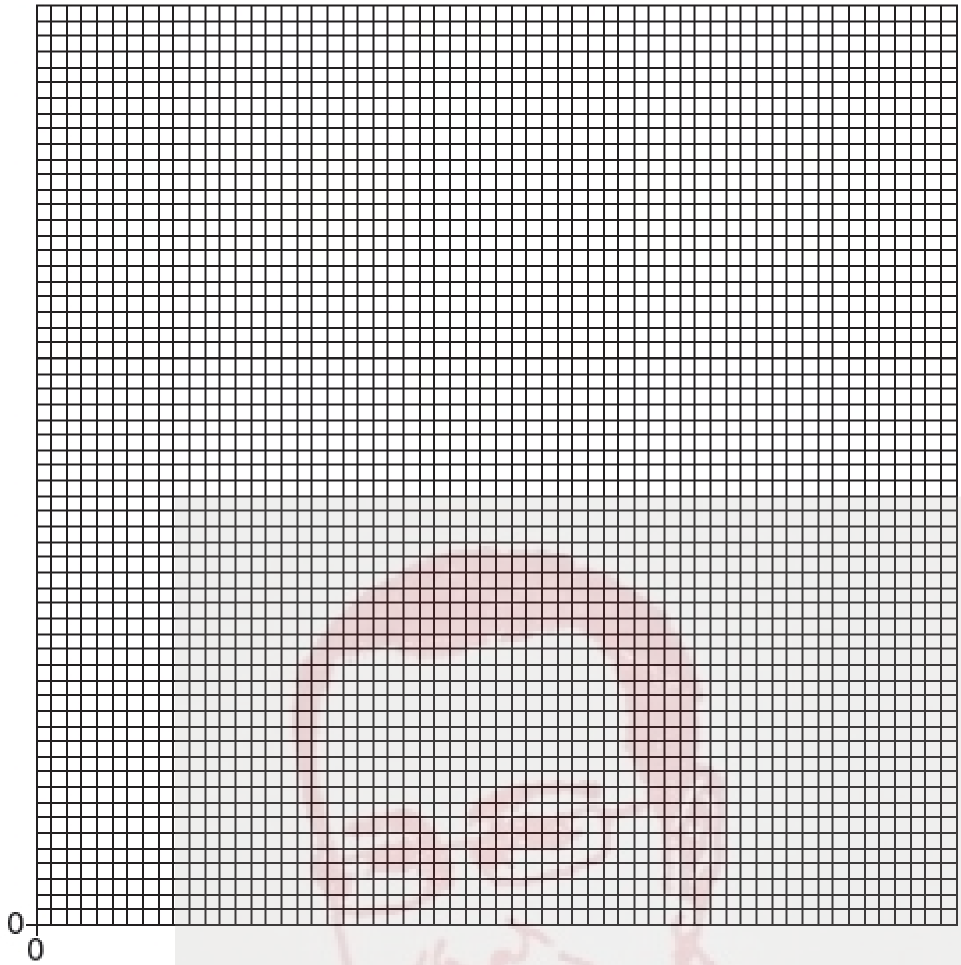
Calculate the resistance R of each length l of the wire **AB**, using the equation $R = \frac{V}{I}$. Record the values of R in the table.

Table 3.1

l/cm	V/V	I/A	R/Ω
10.0	0.36	0.73	
20.0	0.70	0.71	
30.0	1.10	0.73	
40.0	1.45	0.73	
50.0	1.80	0.72	

[2]

(b) Plot a graph of R/Ω (y-axis) against l/cm (x-axis). Start both axes at the origin (0,0).



[5]

(c) State whether your graph shows that the resistance R is proportional to the length l. Justify your answer by reference to the graph.

statement ....

justification ....

....
[2]

(d) Suggest how you could further test your statement in **(c)**, using the same apparatus.

....

....[1]

[Total: 10]

4 The IGCSE class is investigating the resistance of a lamp filament.

The circuit is shown in Fig. 4.1.

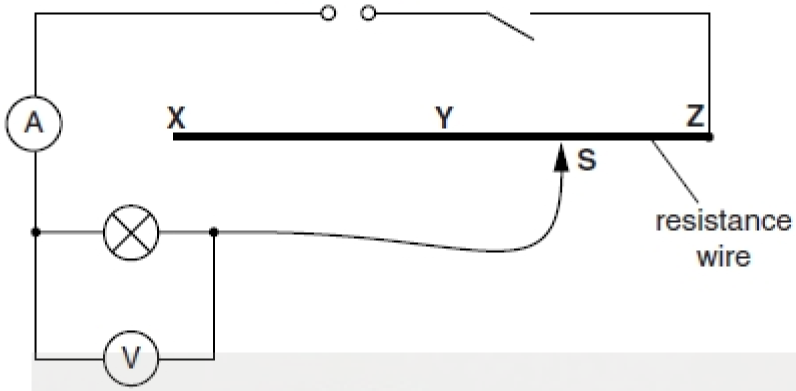


Fig. 4.1

(a) A student connects the sliding contact **S** to point **X** in the circuit. She measures the potential difference *V* across the lamp and the current *I* in the circuit. The meters are shown in Fig. 4.2.

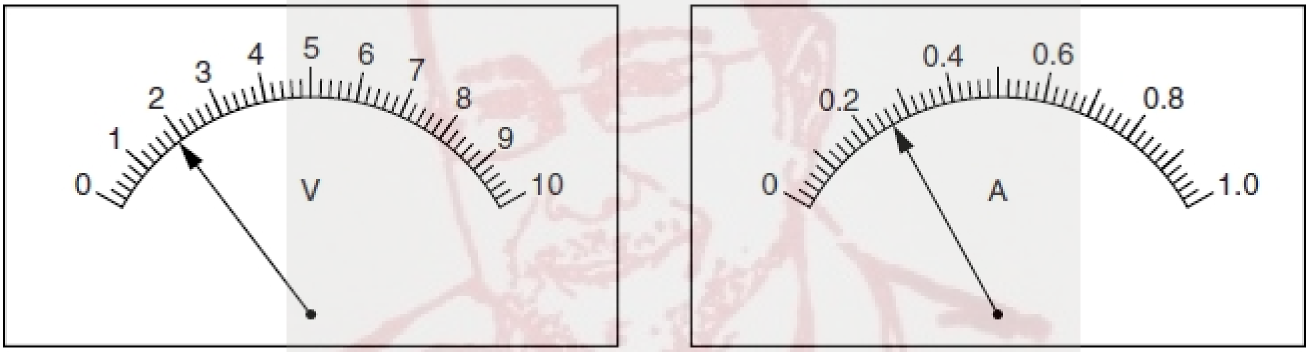


Fig. 4.2

(i) Write down the readings shown on the meters in Fig. 4.2.

V = ...

I = ...

[2]

(ii) Calculate the resistance R of the lamp filament using the equation $R = \frac{V}{I}$.

R = ... [2]

(b) The student repeats the steps in **(a)** with the sliding contact **S** at point **Y** and then at point **Z**.

Comment on the effect, if any, on the brightness of the lamp that you would expect to see when the sliding contact is moved from **X** to **Y** to **Z**.

....

....[1]

(c) The student moves the sliding contact **S** back to point **X**.

Suggest one practical reason why the new meter readings might be slightly different from those shown in Fig. 4.2.

....

....[1]

(d) Another student carries out the experiment using a different lamp. He takes readings using various lengths of resistance wire in the circuit. He plots a graph of V/V against I/A.

Fig. 4.3 is a sketch of the graph.

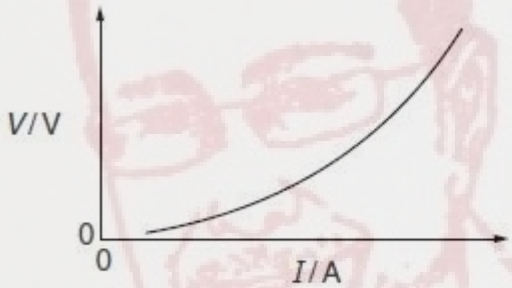


Fig. 4.3

State whether the graph shows that the resistance increases, decreases or remains constant as the current increases. Justify your conclusion by reference to the graph.

The resistance ....

justification ....

....
[2]

[Total: 8]

3 The IGCSE class is investigating the power of lamps in a circuit.

Fig. 3.1 shows the circuit used.

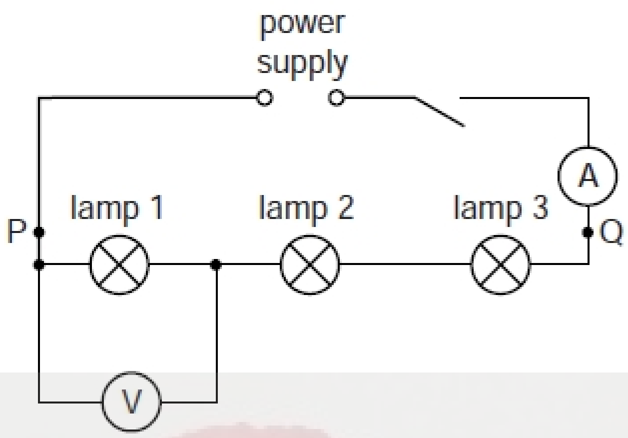


Fig. 3.1

(a) A student measures the potential difference V_1 across lamp 1 and the current I in the circuit. The meters are shown in Fig. 3.2.

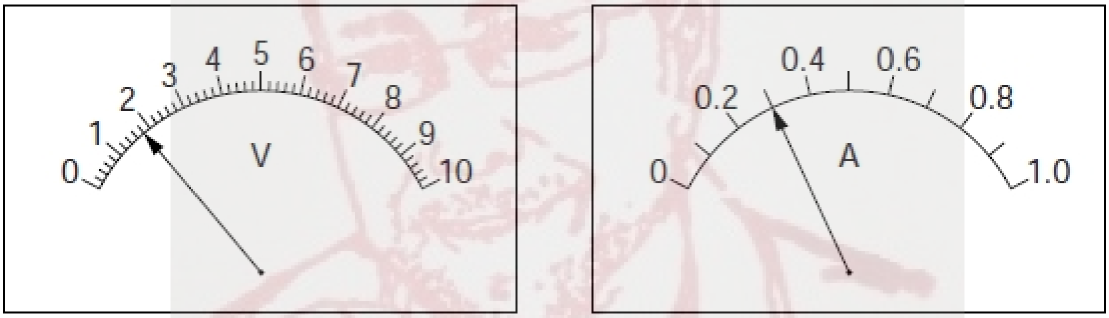


Fig. 3.2

(i) Write down the readings shown on the meters in Fig. 3.2.

V_1 = ...

I = ...

(ii) Calculate the power P_1 of lamp 1 using the equation $P_1 = IV_1$.

P_1 = ...

(iii) The student reconnects the voltmeter to measure the potential difference V_2 across lamp 2 and then V_3 across lamp 3.

Write down the readings shown on the meters in Figs. 3.3 and 3.4.

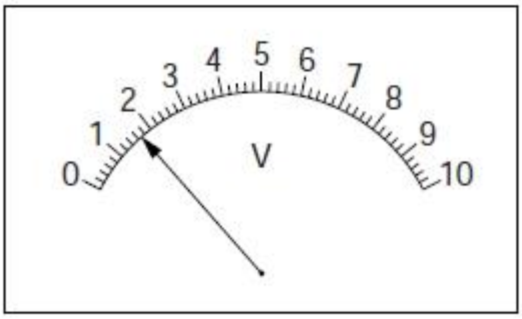


Fig. 3.3

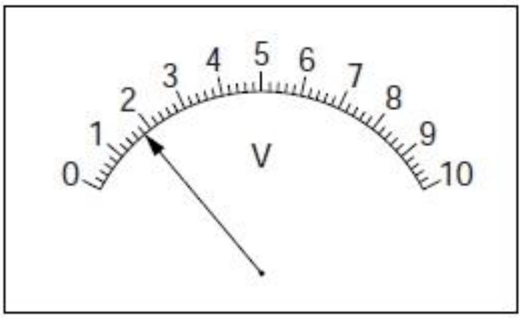


Fig. 3.4

V_2 = ... V_3 = ...

(iv) Calculate the power for each lamp using the equation $P = IV$.

P_2 = ...

P_3 = ...

[3]

(v) Calculate the total power P_T for the three lamps using the equation $P_T = P_1 + P_2 + P_3$.

P_T = ... [1]

(b) The student connects the voltmeter across the three lamps and records the potential difference. He calculates the power P.

P = ... 1.61 W ....

Another student suggests that P_T should be equal to P.

State whether the results support this suggestion and justify your answer by reference to the results.

statement ....

justification ....

....

[2]

(c) **(i)** Draw a circuit diagram, similar to that in Fig. 3.1, to show:

- a variable resistor in series with the power supply,
- three lamps in parallel with each other between **P** and **Q**,
- a voltmeter connected to measure the potential difference across the lamps.

Use standard symbols.

[2]

(ii) State the purpose of the variable resistor in this circuit.

....

.... [1]

[Total: 9]

3 The IGCSE class is investigating the resistance of a wire.

The circuit used is shown in Fig. 3.1.

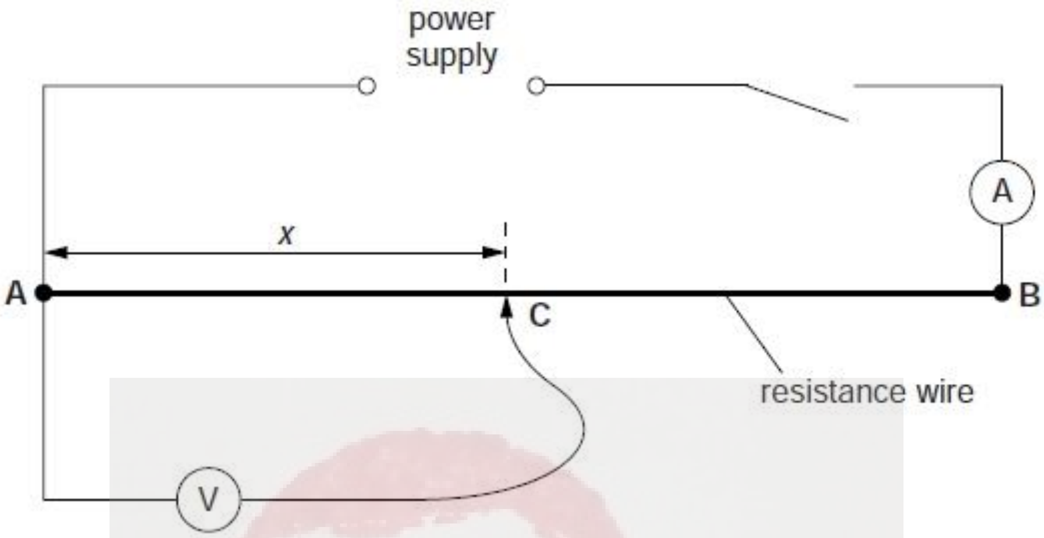


Fig. 3.1

A student moves contact **C** to give a range of values of the length *x*. For each length *x*, the current *I* and potential difference *V* are measured and recorded in Table 3.1.

(a) **(i)** Calculate the resistance *R* of 10.0 cm of the resistance wire using the equation $R = \frac{V}{I}$. Record this value of *R* in the table.

(ii) Repeat step **(i)** for each of the other values of *x*.

(iii) Complete the column headings in the table.

Table 3.1

x /	V /	I /	R /
10.0	0.20	0.33	
30.0	0.60	0.33	
50.0	1.01	0.32	
70.0	1.41	0.33	
90.0	1.81	0.33	

[3]

(b) Plot a graph of *V*/V (*y*-axis) against *R*/Ω (*x*-axis).

[5]

(c) Determine the gradient *G* of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [3]

[Total: 11]

3 The IGCSE class is investigating the potential differences across circuit components.

Fig. 3.1 shows the apparatus used.

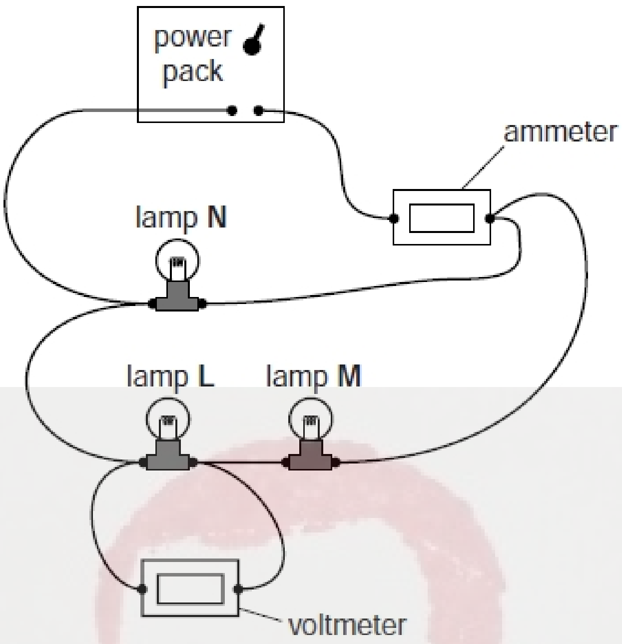


Fig. 3.1

(a) Draw a circuit diagram of the circuit shown in Fig. 3.1, using standard symbols.

[3]

(b) A student records the current I_A, the potential difference V_L across lamp **L** and the potential difference V_M across lamp **M**.

I_A = ...0.65 A..............

V_L = ...0.9V..............

V_M = ...1.0V..............

(i) Calculate the potential difference V_A across lamps **L** and **M** using the equation $V_A = V_L + V_M$.

V_A = ...

(ii) Calculate R_A, the combined resistance of lamps **L**, **M** and **N**, using the equation $R_A = \dfrac{V_A}{I_A}$.

R_A = ...

[2]

(iii) On Fig. 3.2, draw a pointer showing the current I_A = 0.65 A.

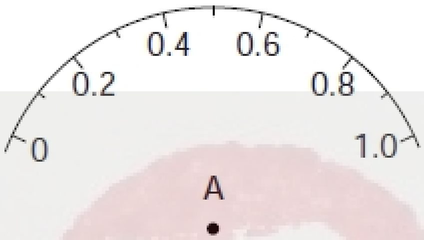


Fig. 3.2

[1]

(c) The student rearranges the circuit so that the three lamps are in **series** with each other. He records the potential difference across each lamp in turn.

V_L = 0.6V

V_M = 0.7V

V_N = 0.7V

Calculate the potential difference V_B across the three lamps using the equation $V_B = V_L + V_M + V_N$.

V_B = ...

(d) A student suggests that V_A should be equal to V_B.

State whether the results support this suggestion and justify your answer with reference to the results.

statement ....

justification ....

....

[2]

[Total: 8]

3 The IGCSE class is determining the resistance of a fixed resistor in a circuit.

The circuit is shown in Fig. 3.1.

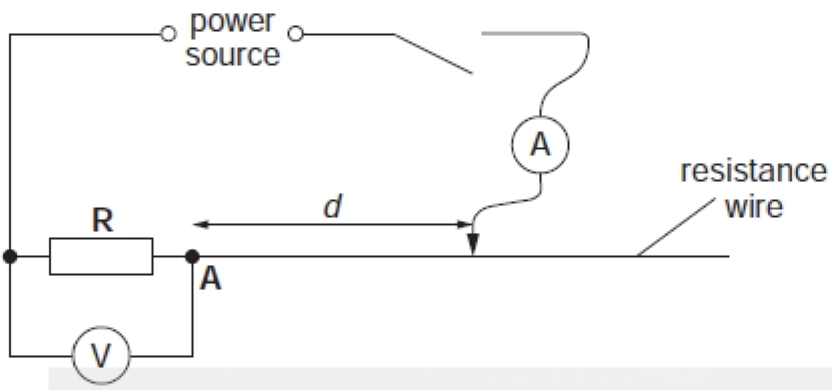


Fig. 3.1

(a) A student places the sliding contact on the resistance wire at a distance d = 10.0 cm from point **A**. He measures the current I in the circuit and the p.d. V across the resistor **R**. He repeats the procedure using d values of 30.0 cm, 50.0 cm, 70.0 cm and 90.0 cm.

The readings are shown in Table 3.1.

Table 3.1

	V/V	I/A
10.0	1.7	1.13
30.0	1.3	0.87
50.0	1.0	0.67
70.0	0.8	0.53
90.0	0.7	0.47

(i) Complete the column headings in the table.

(ii) Plot a graph of V/V (y-axis) against I/A (x-axis). You do not need to include the origin (0, 0) on your graph.

[5]

(iii) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [3]

(b) The gradient G of the graph is numerically equal to the resistance R of the resistor **R**.

Write a value for the resistance R to a suitable number of significant figures for this experiment.

R = ... [2]

[Total: 10]

3 The IGCSE class is investigating the current in resistors in a circuit.

The circuit is shown in Fig. 3.1.

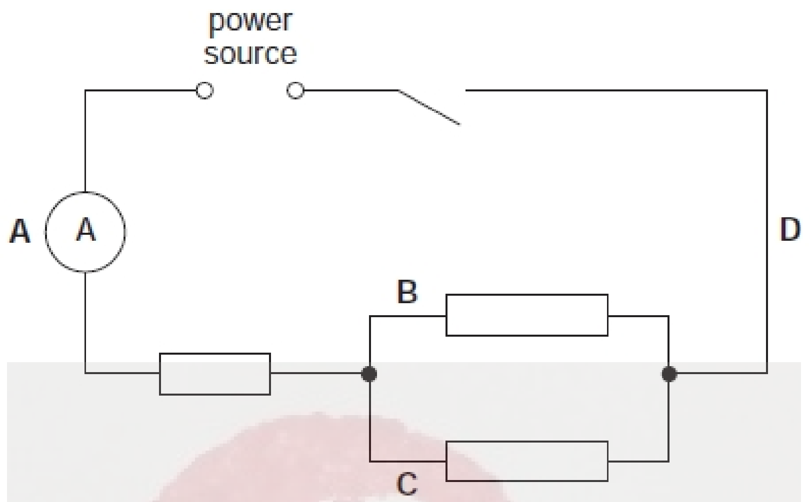


Fig. 3.1

(a) A student measures the current I_A at the position **A** shown by the ammeter, and then at positions **B** (I_B), **C** (I_C) and **D** (I_D).

The readings are:

$I_A = 0.28\,A$ $I_B = 0.13\,A$ $I_C = 0.14\,A$ $I_D = 0.27\,A$

Theory suggests that $I_A = I_B + I_C$ and $I_D = I_B + I_C$.

(i) Calculate $I_B + I_C$.

$I_B + I_C$ = ...

(ii) State whether the experimental results support the theory. Justify your statement by reference to the readings.

statement ....

justification ....

....

....

[3]

(b) The student suggests repeating the experiment to confirm her conclusion. She connects a variable resistor (rheostat) in series with the switch. State the purpose of the variable resistor.

....

....[1]

(c) The student connects a voltmeter and records the potential difference V across the combination of the three resistors.

(i) On Fig. 3.1, draw in the voltmeter connected as described, using the standard symbol for a voltmeter. [1]

(ii) Write down the voltmeter reading shown on Fig. 3.2.

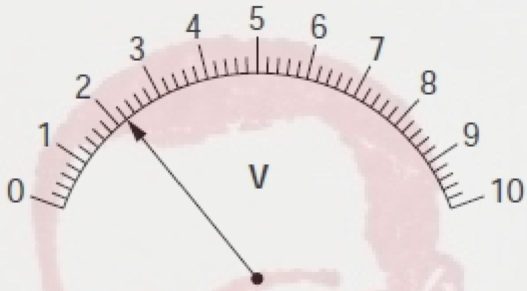


Fig. 3.2

V = ... [1]

(iii) Calculate the resistance R of the combination of the three resistors using the equation $R = \frac{V}{I}$.

R = ... [2]

[Total: 8]

3 The IGCSE class is investigating the effect of the length of resistance wire in a circuit on the potential difference across a lamp.

(a) Fig. 3.1 shows the circuit without the voltmeter. Complete the circuit diagram to show the voltmeter connected in the circuit to measure the potential difference across the lamp.

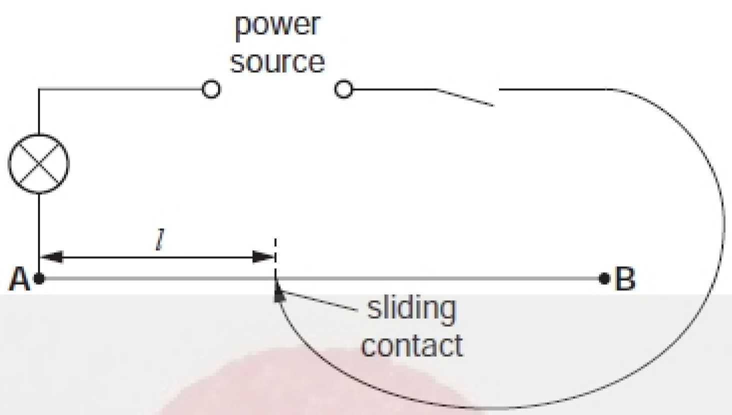


Fig. 3.1

[2]

(b) A student switches on and places the sliding contact on the resistance wire at a distance $l = 0.200$ m from end **A**. He records the value of l and the potential difference V across the lamp.
He then repeats the procedure using a range of values of l. Table 3.1 shows the readings.

Table 3.1

l/m	V/V	$\frac{V}{l}$/
0.200	1.67	
0.400	1.43	
0.600	1.25	
0.800	1.11	
1.00	1.00	

(i) For each pair of readings in the table calculate and record in the table the value of $\frac{V}{l}$.

(ii) Complete the table by writing in the unit for $\frac{V}{l}$.

[3]

(c) A student suggests that the potential difference *V* across the lamp is directly proportional to the length *l* of resistance wire in the circuit. State whether or not you agree with this suggestion and justify your answer by reference to the results.

Statement ....

Justification ....

....[2]

(d) State one precaution that you would take in order to obtain accurate readings of *V* in this experiment.

....

....

....[1]

3 The IGCSE class is measuring the currents in lamps in different circuits.

The first circuit is shown in Fig. 3.1.

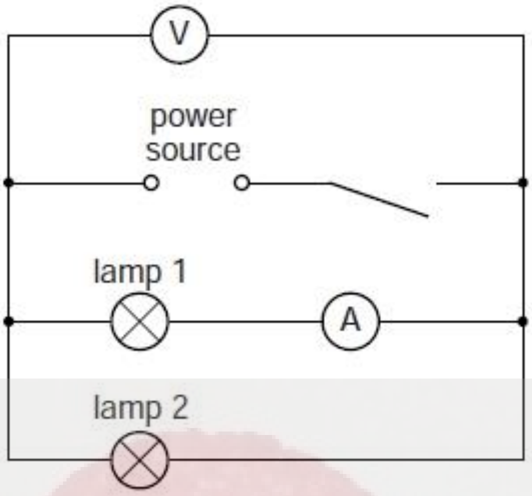


Fig. 3.1

(a) A student records the potential difference V across the lamps and the current I in lamp 1. She rearranges the circuit so that the ammeter is connected in series with lamp 2 and again records the potential difference V across the lamps and the current I in lamp 2.

The readings are shown in Table 3.1.

Table 3.1

	V /	I /	R /
lamp 1	1.9	0.35	
lamp 2	1.9	0.32	

(i) Calculate the resistance R of each lamp, using the equation $R = \frac{V}{I}$, and enter the results in the table.

(ii) Add together the two values of R to calculate R_S, the sum of the resistances of the two lamps.

R_S = ...

(iii) Complete the column headings in the table.

[3]

(b) The student rearranges the circuit so that the lamps and the ammeter are in series. She does not change the position of the voltmeter.

She records the readings on the voltmeter and the ammeter.

voltmeter reading.......1.9 V

ammeter reading.......0.23 A

(i) Draw a circuit diagram of the rearranged circuit using conventional symbols.

(ii) Use the voltmeter and ammeter readings to calculate R_T, the combined resistance of the two lamps in series.

R_T = ...[3]

(c) A student suggests that the values of R_S and R_T should be equal. State whether the results support this suggestion and justify your statement by reference to the calculated values.

statement ....

justification ....

....[2]

(d) State, without reference to the values of resistance that you have calculated, one piece of evidence that the student can observe during the experiment that shows that the temperature of the lamp filaments changes.

....

....[1]

[Total: 9]

5 Table 5.1 shows some measurements taken by three IGCSE students. The second column shows the values recorded by the three students. For each quantity, underline the value most likely to be correct.

The first one is done for you.

Table 5.1

quantity measured	recorded values
the mass of a wooden metre rule	0.112 kg 1.12 kg 11.2 kg
the diameter of a test tube	0.15 cm 1.5 cm 15 cm
the volume of a coffee cup	10 cm^3 100 cm^3 1000 cm^3
the area of a computer keyboard	0.07 m^2 0.70 m^2 7.0 m^2
the current in a 1.5 V torch lamp at normal brightness	0.12 A 12 A 120 A
the circumference of a 250 cm^3 beaker	2.3 cm 23 cm 230 cm

[5]

[Total: 5]

3 The IGCSE class is investigating the current in a circuit when different resistors are connected in the circuit.

The circuit is shown in Fig. 3.1. The circuit contains a resistor **X**, and there is a gap in the circuit between points **A** and **B** that is used for adding extra resistors to the circuit.

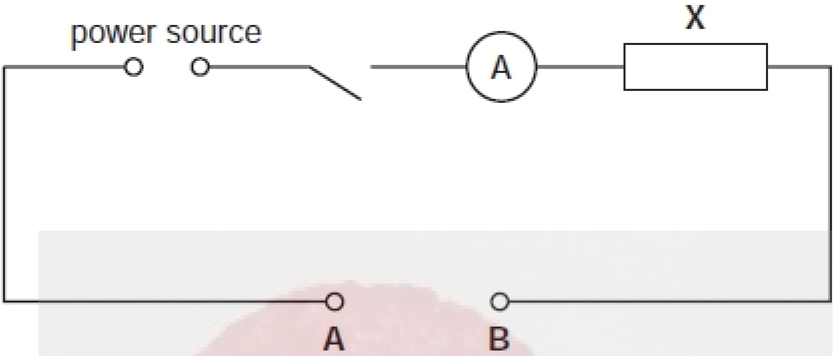


Fig. 3.1

(a) A student connects points **A** and **B** together, switches on and measures the current I_0 in the circuit.

The reading is shown on the ammeter in Fig. 3.2.

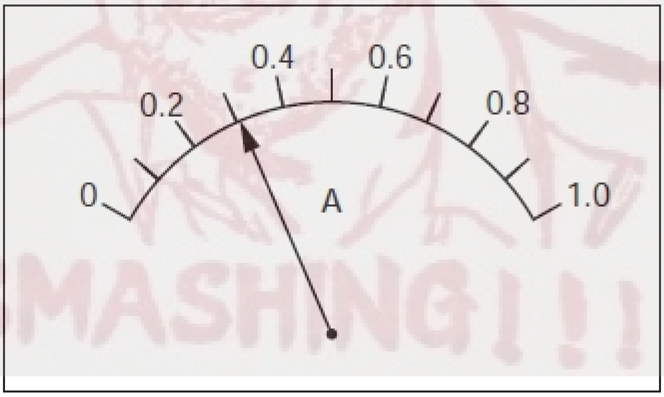


Fig. 3.2

Write down the ammeter reading.

I_0 = ... [1]

(b) The student connects a 3.3 Ω resistor between points **A** and **B**, switches on and records the current I. He repeats the procedure with a 4.7 Ω resistor and then a 6.8 Ω resistor.

Finally he connects the 3.3 Ω resistor and the 6.8 Ω resistor in series between points **A** and **B**, and records the current I.

(i) Complete the column headings in the table. [1]

R/	I/
3.3	0.23
4.7	0.21
6.8	0.18
	0.15

(ii) Write the combined resistance of the 3.3 Ω resistor and the 6.8 Ω resistor in series in the space in the resistance column of the table. [1]

(c) Theory suggests that the current will be 0.5 I_0 when the total resistance in the circuit is twice the value of the resistance of resistor **X**. Use the readings in the table, and the value of I_0 from **(a)**, to estimate the resistance of resistor **X**.

estimate of the resistance of resistor **X** = ... [2]

(d) On Fig. 3.1 draw two resistors in parallel connected between **A** and **B** and also a voltmeter connected to measure the potential difference across resistor **X**. [3]

[Total: 8]

3 The IGCSE class is comparing the combined resistance of lamps arranged either in series or in parallel.

The circuit shown in Fig. 3.1 is used.

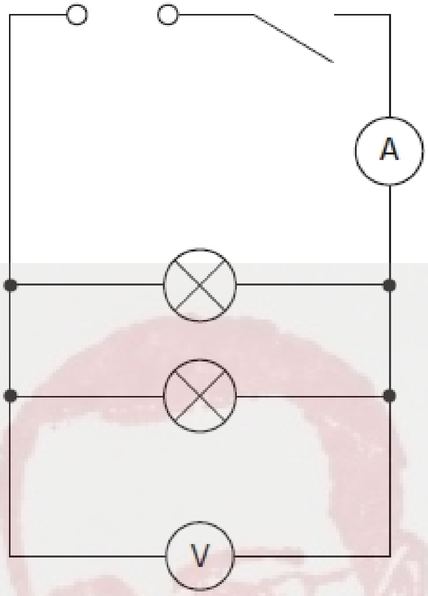


Fig. 3.1

A student measures and records the current I in the circuit and the p.d. V across the two lamps.

Fig. 3.2 shows the readings on the two meters.

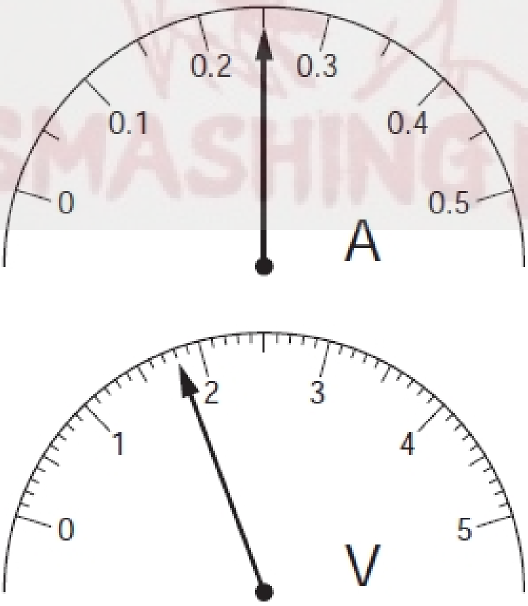


Fig. 3.2

(a) (i) Write the voltage and current readings in Table 3.1, below.

(ii) Complete the column headings in Table 3.1.

[3]

(b) The student then sets up the circuit shown in Fig. 3.3 and records the readings. These readings have already been entered in Table 3.1.

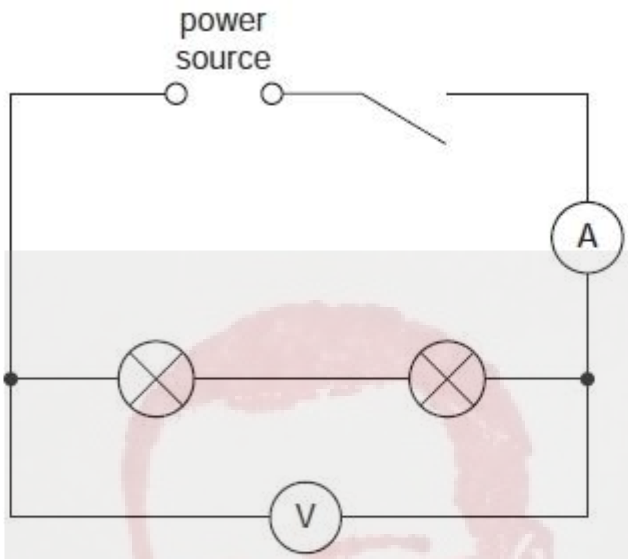


Fig. 3.3

For each set of readings in the table, calculate the combined resistance R of the two lamps using the equation $R = V/I$. Record the values of R in Table 3.1. [2]

Table 3.1

	V/	I/	R/
Circuit of Fig. 3.1			
Circuit of Fig. 3.3	1.8	0.52	

(c) Using the values of resistance you have obtained, calculate the ratio y of the resistances using the equation

$$y = \frac{\text{resistance of lamps in series}}{\text{resistance of lamps in parallel}}.$$

y = ...

[2]

(d) Fig. 3.4 shows a circuit including two motors **A** and **B**.

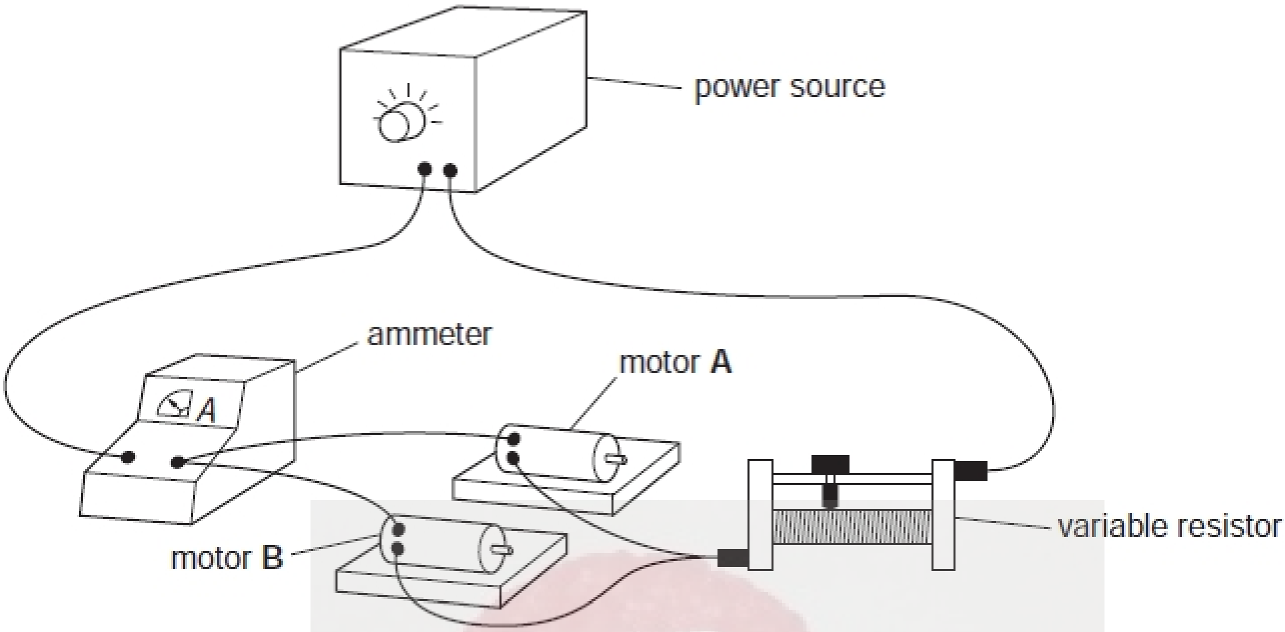
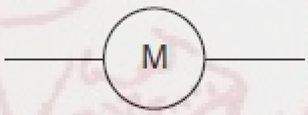


Fig. 3.4

(i) Draw a diagram of the circuit using standard circuit symbols. The circuit symbol for a motor is:



(ii) An engineer wishes to measure the voltage across motor **A**.

1. On Fig. 3.4, mark with the letters **X** and **Y** where the engineer should connect the voltmeter.

2. State the purpose of the variable resistor.

....

....
[3]

[Total: 10]

3 The IGCSE class is investigating the resistance of a wire.

The circuit is shown in Fig. 3.1.

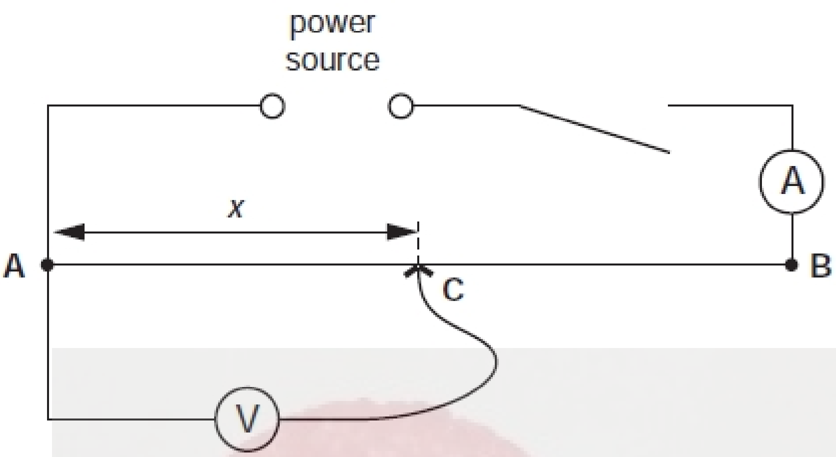


Fig. 3.1

AB is a resistance wire. The students place the sliding contact **C** on the resistance wire **AB** at a distance x = 0.100 m from **A**. They switch on and measure the p.d. V across the wire between **A** and **C**. They also measure the current I in the wire. The value of I is 0.38 A.

They repeat the procedure several times using different values of x. The readings are shown in Table 3.1. The current I is 0.38 A for each value of x.

Table 3.1

x / m	V / V	R / Ω
0.100	0.21	
0.300	0.59	
0.500	1.04	
0.700	1.42	
0.900	1.87	

[2]

(a) Calculate the resistance R of the section **AC** of the wire for each value of x using the equation $R = \frac{V}{I}$. Record the values of R in the table.

(b) Use the results in Table 3.1 to plot a graph of R/Ω (y-axis) against x/m (x-axis). Draw the best fit line.

[5]

(c) Within the limits of experimental accuracy, what do you conclude about the variation of resistance with distance along the wire? Justify your conclusion by reference to your graph.

statement ....

justification ....

.... [2]

(d) Using your graph, determine the value for R when x = 0.750 m. Show clearly on your graph how you obtained the necessary information.

R = ... [2]

(e) A variable that may be difficult to control in this experiment is the heating effect of the current, which affects the resistance of the wire. Suggest how you would minimise the heating effect.

....

.... [1]

5 **(a)** Table 5.1 shows some measurements taken by three IGCSE students. The second column shows the values recorded by the three students. For each quantity, underline the value most likely to be correct.

The first one is done for you.

Table 5.1

Quantity measured	Recorded values
The mass of a wooden metre rule	0.112 kg 1.12 kg 11.2 kg
The weight of an empty 250 cm^3 glass beaker	0.7 N 7.0 N 70 N
The volume of one sheet of this examination paper	0.6 cm^3 6.0 cm^3 60 cm^3
The time taken for one swing of a simple pendulum of length 0.5 m	0.14 s 1.4 s 14 s
The pressure exerted on the ground by a student standing on one foot	0.4 N/cm^2 4.0 N/cm^2 40 N/cm^2

[4]

(b) **(i)** A student is to find the value of the resistance of a wire by experiment. Potential difference V and current I can be recorded. The resistance is then calculated using the equation $R = V/I$.

The student knows that an increase in temperature will affect the resistance of the wire. Assuming that variations in room temperature will not have a significant effect, suggest two ways by which the student could minimise temperature increases in the wire during the experiment.

1. ....

2. .... [2]

(ii) Name the circuit component that the student could use to control the current.

.... [1]

[Total: 7]

2 The IGCSE class is comparing the combined resistance of resistors in different circuit arrangements. The first circuit is shown in Fig. 2.1.

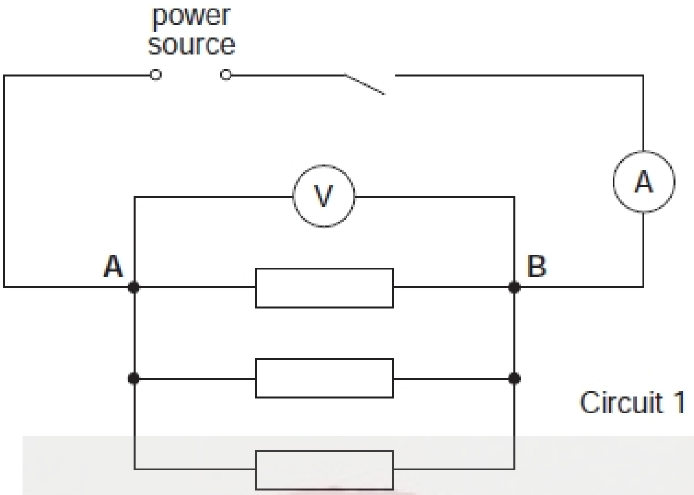


Fig. 2.1

(a) The current I in the circuit and the p.d. V across the three resistors are measured and recorded. Three more circuit arrangements are used. For each arrangement, a student disconnects the resistors and then reconnects them between points **A** and **B** as shown in Figs. 2.2–2.4.

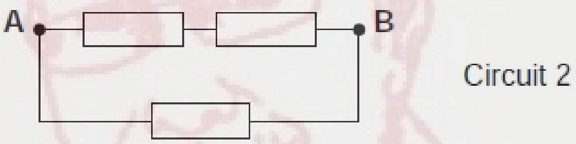


Fig. 2.2

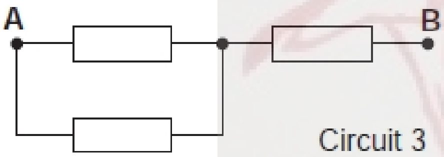


Fig. 2.3

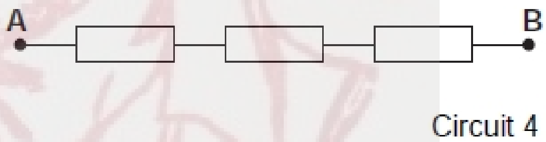


Fig. 2.4

The voltage and current readings are shown in the Table 2.1.

Table 2.1

Circuit	***V*/**	***I*/**	***R*/**
1	1.87	1.68	
2	1.84	0.84	
3	1.87	0.37	
4	1.91	0.20	

(i) Complete the column headings for each of the V, I and R columns of Table 2.1.

(ii) For each circuit, calculate the combined resistance R of the three resistors using the equation

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

Record these values of R in Table 2.1. [3]

(b) Theory suggests that, if all three resistors have the same resistance under all conditions, the combined resistance in circuit 1 will be one half of the combined resistance in circuit 2.

(i) State whether, within the limits of experimental accuracy, your results support this theory. Justify your answer by reference to the results.

statement ....

justification ....

....

(ii) Suggest one precaution you could take to ensure that the readings are as accurate as possible.

....

....[3]

[Total: 6]

3 The IGCSE class is investigating the potential difference across lamps and the currents in the lamps.

Fig. 3.1 shows the circuit that is being used.

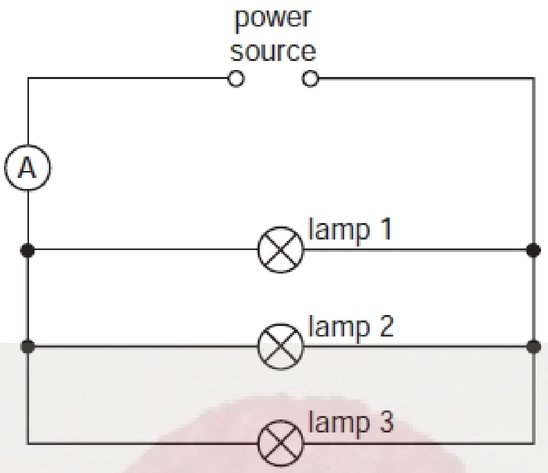
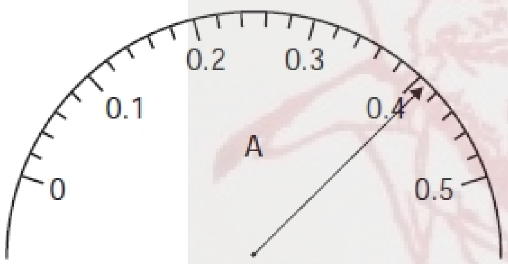


Fig. 3.1

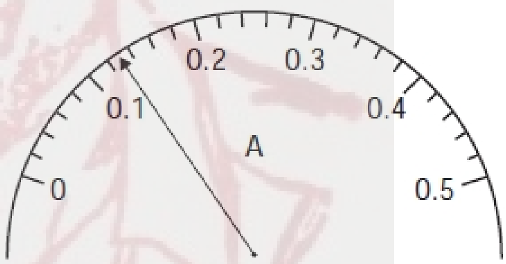
(a) A student uses the ammeter to record the current I in the wire connecting the power source to the rest of the circuit. He then moves the ammeter to new positions in the circuit and measures the current in each lamp in turn. The positions of the pointer on the ammeter scale are shown below.

(i)



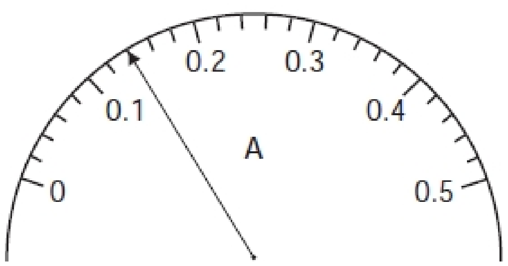
current I = ...

(ii)



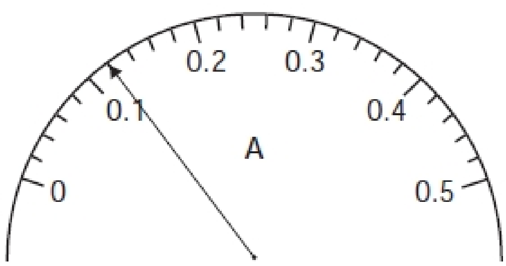
current I_1 in lamp 1 = ...

(iii)



current I_2 in lamp 2 = ...

(iv)



current I_3 in lamp 3 = ...

Write down the ammeter readings I, I_1, I_2 and I_3. [3]

(b) Theory suggests that $I = I_1 + I_2 + I_3$. State whether or not your readings support this theory. Give a reason for your answer.

Statement ....

Reason ....

....

.... [1]

(c) To test the theory further, you would need to vary the value of I. State how you would vary I.

....

.... [1]

(d) The student uses a voltmeter to measure the potential difference V across the lamps.

His reading is $V = 1.6$V.

(i) Calculate the resistance R of the lamps arranged in parallel, using the equation

$$R = V / I,$$

where I is the value of the current in **(a)(i)**.

R = ...

(ii) On Fig. 3.1, add the symbol for the voltmeter connected to measure the potential difference across the lamps. [3]

[Total: 8]

3 The IGCSE class is investigating the resistance of a wire. The circuit is as shown in Fig. 3.1.

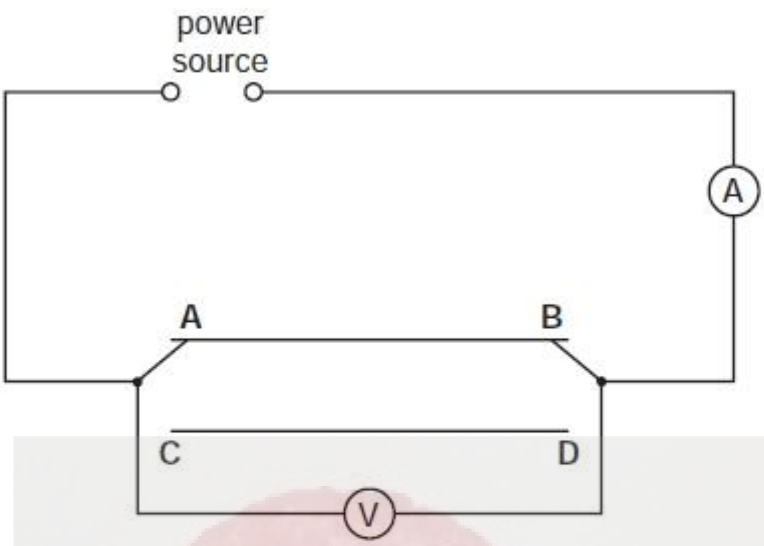


Fig. 3.1

(a) A student uses the switches to connect the wire **AB** into the circuit and records the p.d. V across the wire between **A** and **B**. He also records the current I in the wire.

The student then repeats the measurements using the wire **CD** in place of wire **AB**.

The readings are shown in the table below.

wire	V/	I/	R/
AB	1.9	0.24	
CD	1.9	0.96	

[3]

(i) Calculate the resistance R of each wire, using the equation

$$R = V/I.$$

Record the values in the table.

(ii) Complete the column headings in the table.

(b) The two wires **AB** and **CD** are made of the same material and are of the same length. The diameter of wire **CD** is twice the diameter of wire **AB**.

(i) Look at the results in the table. Below are four possible relationships between *R* and the diameter *d* of the wire. Tick the relationship that best matches the results.

R is proportional to d ☐

R is proportional to $\frac{1}{d}$ ☐

R is proportional to d^2 ☐

R is proportional to $\frac{1}{d^2}$ ☐

(ii) Explain briefly how the results support your answer in part **(b)(i)**.

....

....

....

.... [2]

(c) Following this experiment, the student wishes to investigate whether two lamps in parallel with each other have a smaller combined resistance than the two lamps in series. Draw one circuit diagram showing

(i) two lamps in parallel with each other connected to a power source,

(ii) an ammeter to measure the total current in the circuit,

(iii) a voltmeter to measure the potential difference across the two lamps.

[3]

[Total: 8]

5 A student is investigating the relationship between potential difference V across a resistor and the current I in it. Fig. 5.1 shows the apparatus that the student is using.

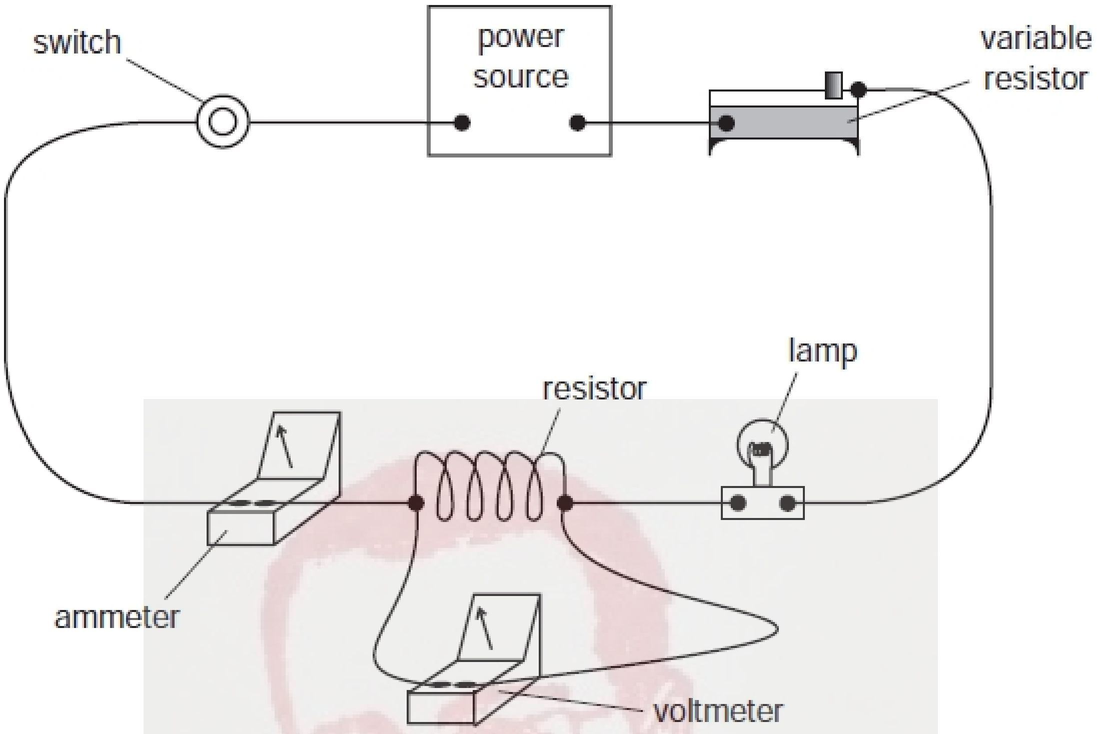


Fig. 5.1

(a) Draw the circuit diagram of the circuit shown in Fig. 5.1. Use standard circuit symbols.

[3]

(b) The student is using a lamp to show when the current is switched on.

Why is it unnecessary to use the lamp?

....

.... [1]

(c) State which piece of apparatus in the circuit is used to control the size of the current.

.... [1]

(d) The student removes the lamp from the circuit. He is told that the resistance of a conductor is constant if the temperature of the conductor is constant. He knows that the current in the resistor has a heating effect. Suggest two ways in which the student could minimise the heating effect of the current in the resistor.

1. ....

2. .... [2]

(e) Fig. 5.2 shows a variable resistor with the sliding contact in two different positions.

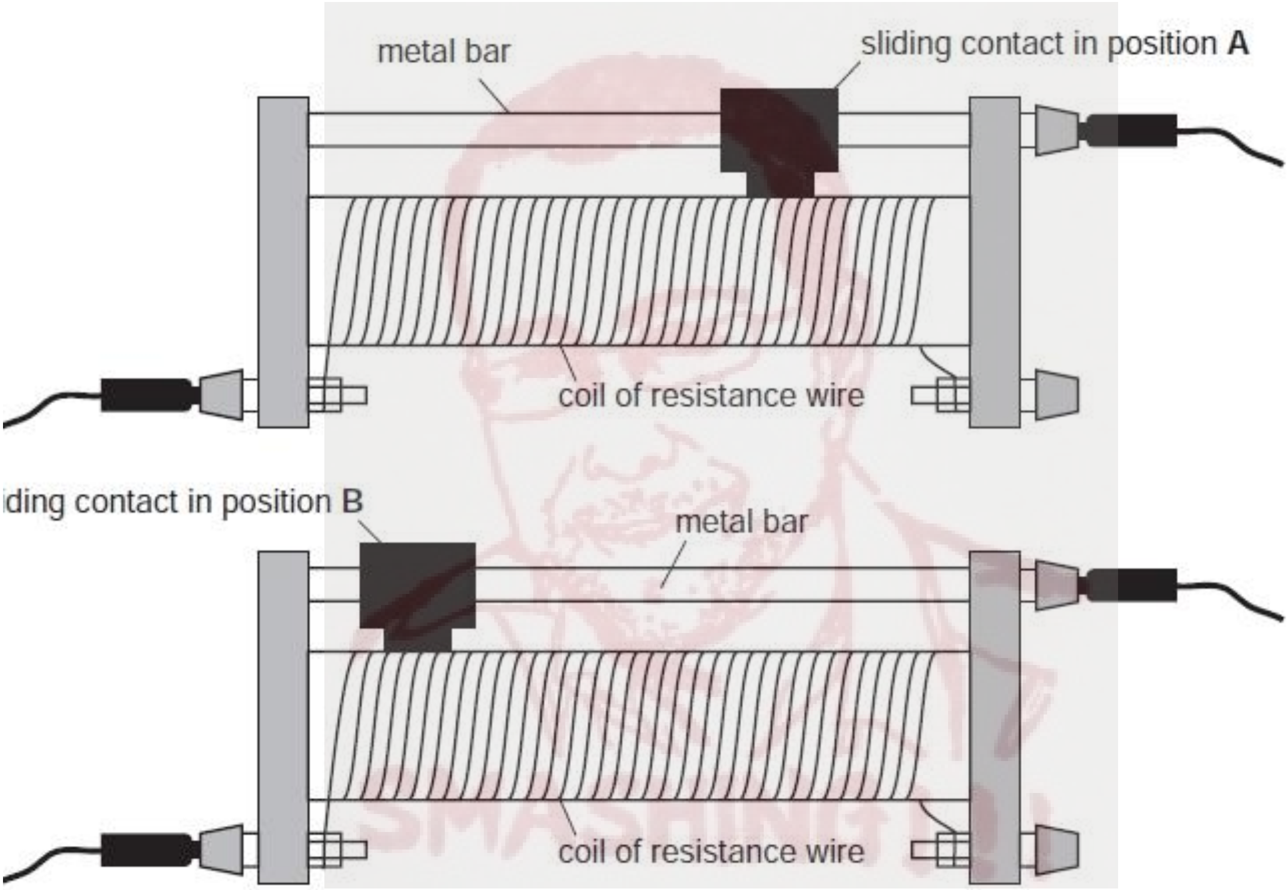


Fig. 5.2

State which position, A or B, shows the higher resistance setting. Explain your answer.

statement ....

explanation ....

.... [1]

2 The IGCSE class is investigating the resistance of lamps in different circuit arrangements.

Fig. 2.1 shows a picture of the circuit.

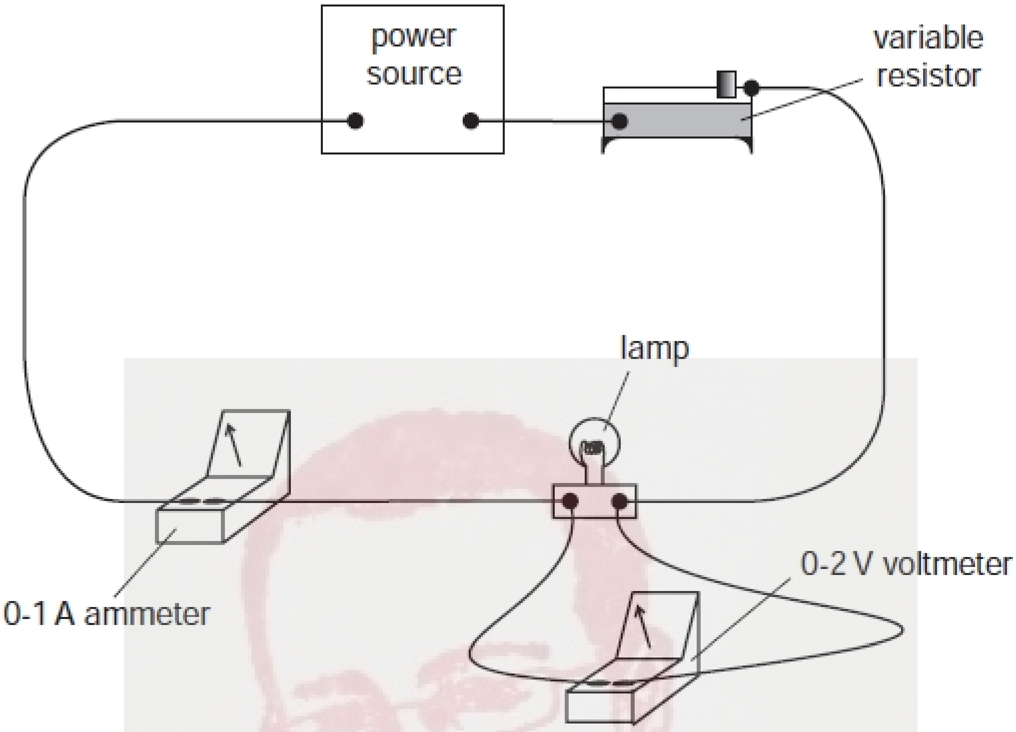


Fig. 2.1

(a) Draw a circuit diagram of the circuit shown in Fig. 2.1. Use standard circuit symbols.

[3]

(b) The current I through the lamp and the voltage V across the lamp are measured. Then a second lamp is connected in parallel with the first. The total current I in the circuit and the voltage V across the lamps are measured. The table below shows the readings.

I /	V /	R /
0.24	1.39	
0.45	1.30	

(i) Complete the column headings for each of the I, V and R columns of the table. [1]

(ii) Calculate the resistance R in each case using the equation

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

Enter the results in the table. [2]

5 **(a)** The IGCSE class carries out an experiment to investigate the rate of cooling from 100 °C of a range of hot liquids. Underline any of the following variables that are likely to have a significant effect on the temperature readings. (You may underline one, two or all three of the suggested variables.)

type and size of container

volume of liquid

temperature of the surroundings [2]

(b) In an experiment to find the resistance of a wire, the students record the current in the wire and the potential difference across it. They then calculate the resistance. Underline any of the following variables that are likely to have a significant effect on the current and/or potential difference readings. (You may underline one, two or all three of the suggested variables.)

atmospheric pressure

temperature of the wire

length of wire [2]

(c) In an experiment, a short pendulum oscillates rapidly. A student is asked to find the period of oscillation T of the pendulum using a stopwatch. The student sets the pendulum swinging and records the time for one oscillation. A technique for improving the accuracy of the value obtained for the period T should be used in this experiment. State, briefly, what this technique is and any calculation involved to obtain the value of T.

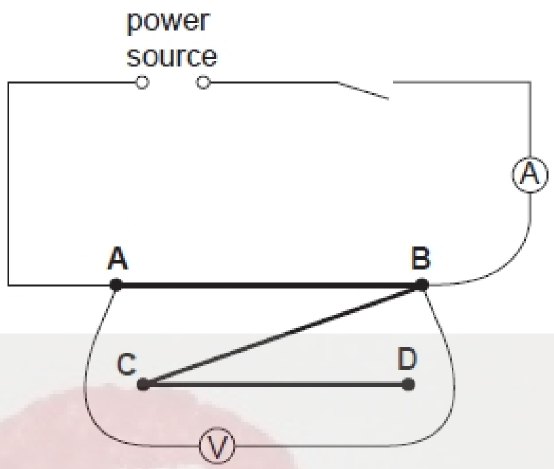
....

....

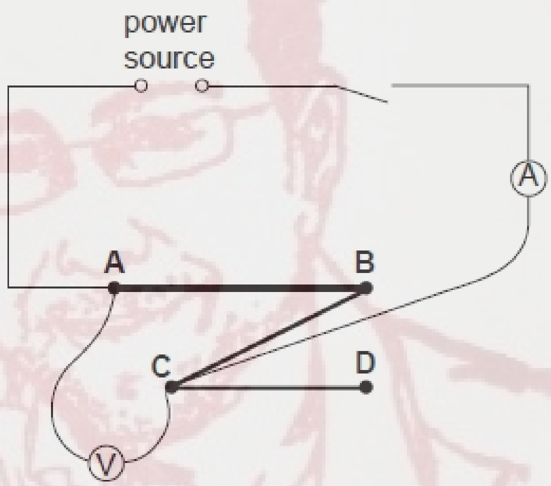
.... [2]

2 An IGCSE student investigates the resistance of resistance wire **ABCD** in three different circuit arrangements.

The circuits are shown in Fig. 2.1.



circuit (i)



circuit (ii)

circuit (iii)

Fig. 2.1

(a) Circuit **(iii)** is the same as circuit **(ii)** but with an additional connecting lead between **A** and **D**.

On Fig. 2.1, complete the circuit diagram for circuit **(iii)** using the standard symbol for a resistor to represent each section **AB**, **BC** and **CD** of the resistance wire. [3]

(b) The student measures and records the current I and the p.d. V in each circuit. The student's readings are shown in the table.

circuit	I /	V /	R /
(i)	0.91	1.80	
(ii)	0.45	1.80	
(iii)	1.37	1.85	

(i) Complete the column headings for each of the I, V and R columns of the table. [1]

(ii) Calculate the resistance R for each circuit using the equation

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

Record in the table the values of R to an appropriate number of significant figures. [2]

(c) Look at the resistance values for circuits **(i)** and **(ii)**. The sections of resistance wire **AB**, **BC** and **CD** are all of the same length. Suggest a value for the resistance of the whole wire **ABCD**. Explain briefly how you obtained your value.

value ....

explanation ....

.... [2]

2 **(a)** The table below shows some measurements taken by three IGCSE students. The second column shows the values recorded by the three students. For each quantity, underline the value most likely to be correct. The first one is done for you.

quantity measured	recorded values
thickness of a metre rule	0.25 mm 2.5 mm 25 mm
volume of a test-tube	12 mm^3 12 cm^3 12 m^3
current in a 12 V ray box lamp at less than normal brightness	0.5 A 5.0 A 50 A
the surface area of the base of a 250 cm^3 beaker	0.3 cm^2 3 cm^2 30 cm^2
the mass of a wooden metre rule	0.112 kg 1.12 kg 11.2 kg
the weight of an IGCSE student	6 N 60 N 600 N

[5]

(b) A student is to find a value of the resistance of a wire by experiment. Potential difference V and current I can be recorded. The resistance is then calculated using the equation

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

State, with a reason, one example of good experimental practice that the student could use to obtain a reliable result.

statement ....

reason .... [2]

3 A student investigates the resistance of wire in different circuit arrangements.

The circuit shown in Fig. 3.1 is used.

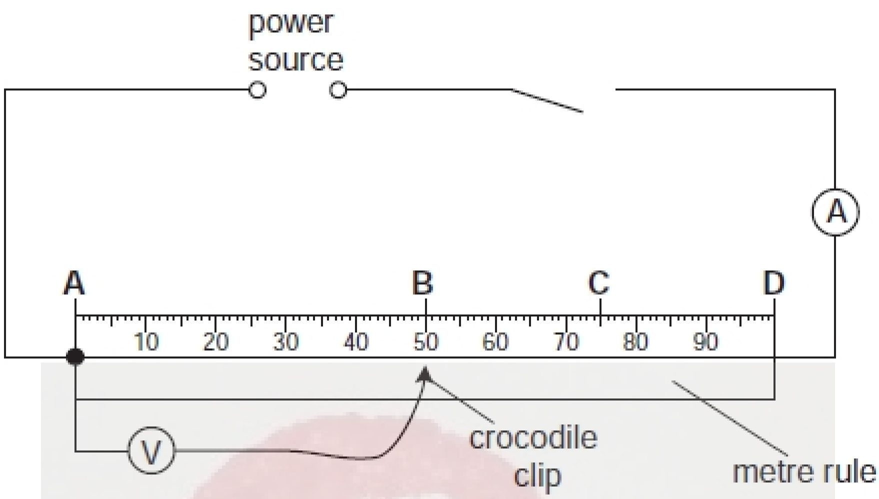


Fig. 3.1

The student measures the current *I* in the wire. She then measures the p.d. *V* across **AB**, **AC** and **AD**.

The student's readings are shown in the table below.

section of wire	*l* / cm	*I* / A	*V* / V	*R* /
AB		0.375	0.95	
AC		0.375	1.50	
AD		0.375	1.95	

(a) Using Fig. 3.1, record in the table the length *l* of each section of wire. [1]

(b) On Fig. 3.2, show the positions of the pointers of the ammeter reading 0.375 A, and the voltmeter reading 1.50 V.

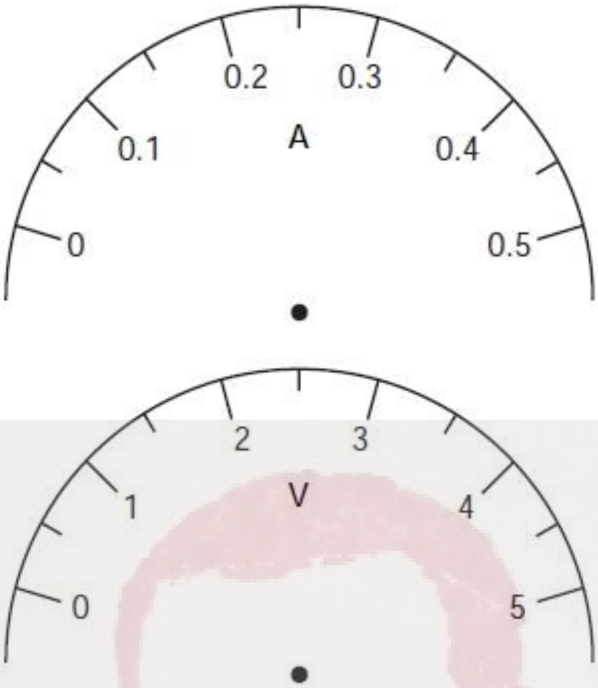


Fig. 3.2

[2]

(c) Calculate the resistance *R* of the sections of wire **AB**, **AC** and **AD** using the equation

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

Record these values of *R*, to a suitable number of significant figures, in the table. [2]

(d) Complete the column heading for the *R* column of the table. [1]

(e) Use your results to predict the resistance of a 1.50 m length of the same wire. Show your working.

resistance = ... [2]

5 The IGCSE class is carrying out investigations of the resistance of bare resistance wires. Fig. 5.1 shows the circuit used.

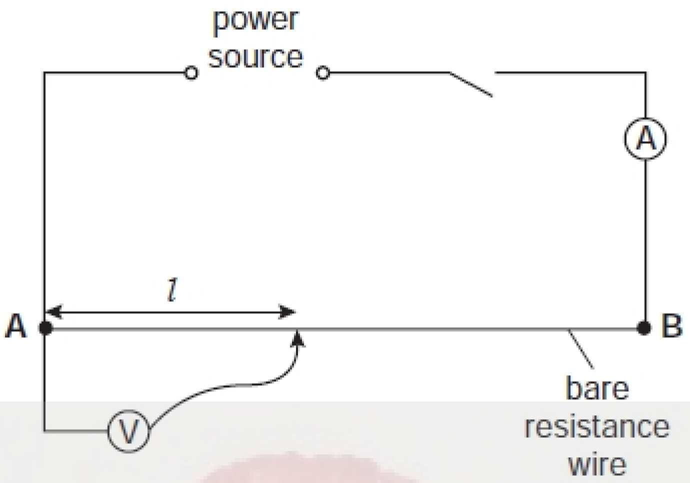


Fig. 5.1

The students record the current I in the circuit and then record the p.d. V across different lengths l of the bare resistance wire. The length of wire from **A** to **B** is 100.0 cm. The readings obtained by one student are shown in the table.

I = 0.84 A

V /	l /	R /
0.39	20.0	
0.82	40.0	
1.22	60.0	
1.58	80.0	
1.89	100.0	

(a) **(i)** Calculate the resistance of each length l of wire using the equation $R = \frac{V}{I}$. Write the resistance values in the table.

(ii) Complete the column headings in the table.

[3]

(b) In a second experiment, the students use wires of the same material but with different diameters *d*. The p.d. is measured across the same length of wire each time. Fig. 5.2 shows the circuit used.

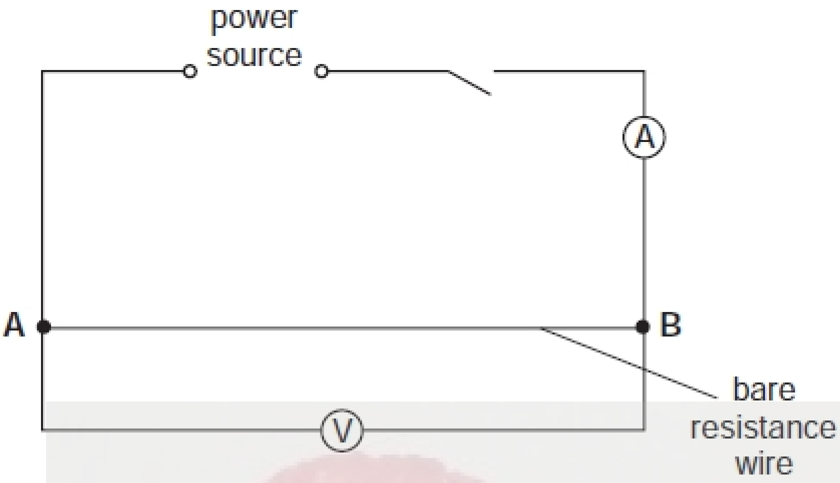


Fig. 5.2

These are the readings correctly obtained by one student.

Wire 1	$I = 0.1\,\text{A}$	Wire 2	$I = 0.4\,\text{A}$
	$V = 1.8\,\text{V}$		$V = 1.8\,\text{V}$
	$d = 0.24\,\text{mm}$		$d = 0.48\,\text{mm}$

(i) Calculate the resistance *R* of each wire, using the equation $R = \frac{V}{I}$.

wire 1, R = ...

wire 2, R = ... [1]

(ii) Based on the results for the two wires, which of the following statements is a correct conclusion? Tick one box.

A wire with half the diameter has half the resistance. ☐

A wire with half the diameter has twice the resistance. ☐

A wire with half the diameter has one quarter the resistance. ☐

A wire with half the diameter has four times the resistance. ☐

[1]

(iii) Using your answers to **(i)** and **(ii)**, calculate the expected resistance of a wire **AB** of the same material if it has a diameter of 0.12 mm.

expected resistance = ... [1]

(c) What instrument would you use to measure the diameter of the wires as accurately as possible?

.... [1]

3 Fig. 3.1 shows the circuit that a student uses to find the resistance of a combination of three lamps.

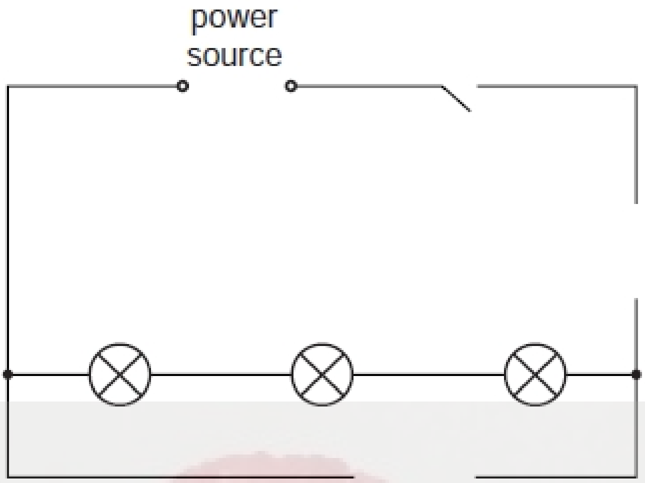


Fig. 3.1

The voltmeter and the ammeter have not been drawn in.

(a) Complete Fig. 3.1 by drawing in the voltmeter and the ammeter, using conventional symbols. [2]

(b) The student obtains these readings.

current I = 0.54 A

potential difference V = 1.8 V

Calculate the resistance R using the equation $R = \frac{V}{I}$.

R = ... [2]

(c) The three lamps are now connected in parallel with one another. Draw a circuit diagram of the three lamps connected to the power supply. Include in your circuit diagram

(i) an ammeter to record the total current through the lamps,

(ii) a variable resistor to vary the brightness of all three lamps,

(iii) a voltmeter to record the potential difference across the lamps.

[3]

3 **(a)** Fig. 3.1 shows the scale of an ammeter. Draw the position of the pointer when the ammeter reading is 0.35 A. [1]

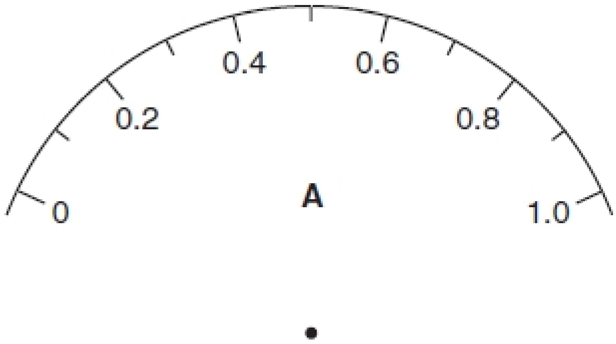


Fig. 3.1

(b) The ammeter was used in the circuit shown in Fig. 3.2 to investigate the current in a lamp.

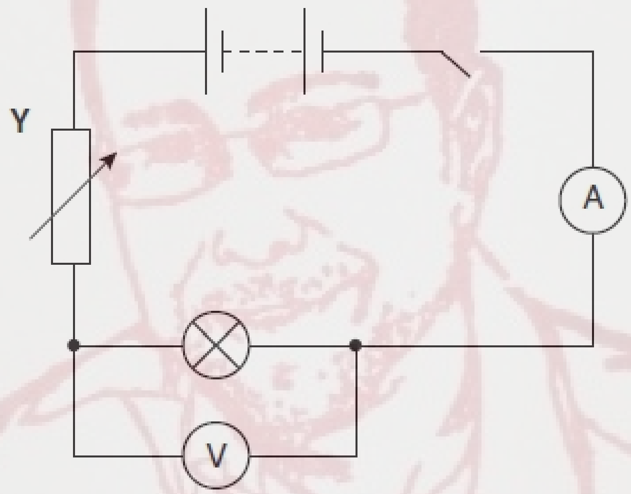


Fig. 3.2

(i) Name the component labelled **Y**.

....

(ii) The table shows the current I in the lamp for different values of the p.d. V across the lamp.

V /	I /	R /
1.9	0.31	
1.5	0.26	
0.8	0.20	

1. Calculate the values for the resistance R of the lamp, using the equation

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

Write your answers in the table.

2. Complete the column headings in the table.

(iii) Suggest how the value of V could be varied.

....

....
[8]

(c) Fig. 3.3 shows a power source connected to three resistors labelled **X**, **Y** and **Z**.

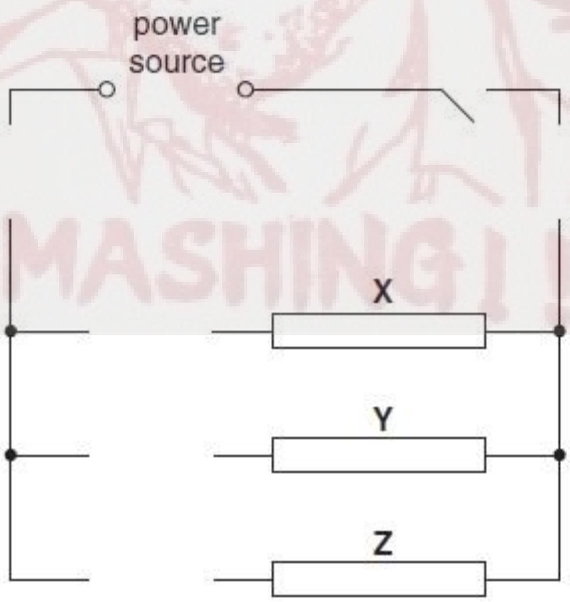


Fig. 3.3

Complete the diagram to show

(i) a voltmeter connected to measure the voltage across the resistors,

(ii) an ammeter connected to measure the current in resistor **X** only,

(iii) connecting wires to complete the circuit.

[3]

3 In an electrical experiment, a student set up a circuit to measure current and potential difference. Part of the circuit is shown in Fig. 3.1.

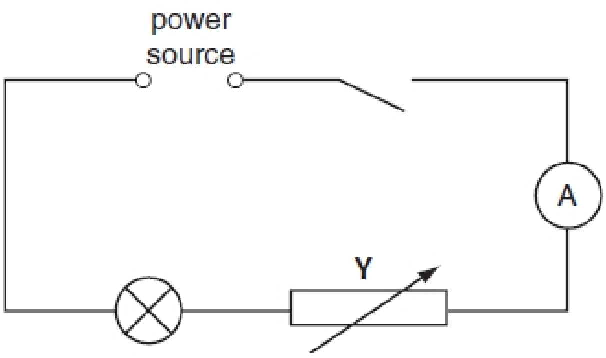


Fig. 3.1

(a) (i) Complete the circuit diagram by drawing in a voltmeter connected across the lamp.

(ii) Name the component labelled **Y**. .... [2]

(b) The first reading on the voltmeter was 2.2 V. On the voltmeter face shown in Fig. 3.2, show the position of the pointer giving the reading 2.2 V.

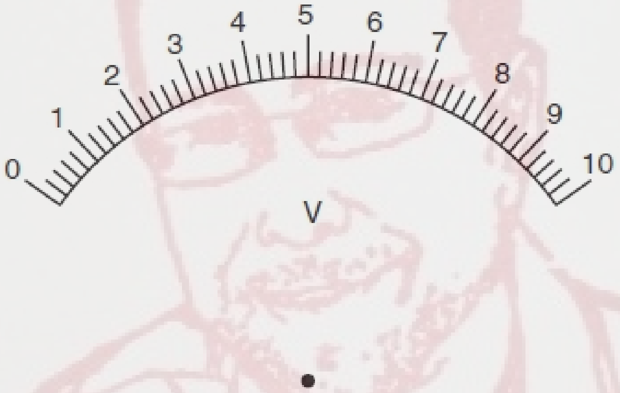


Fig. 3.2

[1]

(c) The readings of *V* and *I* obtained by the student are given in the table below.

V /	*I* /	*R* /
2.2	0.36	
4.1	0.62	
6.0	0.86	
7.9	0.98	
9.8	1.20	

(i) Calculate the resistance *R* of the lamp filament for each set of *V* and *I* readings and write the values in the table. Use the equation

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

(ii) Complete the column headings in the table. [6]

2 The IGCSE class is investigating electromagnets. The electromagnets are made by wrapping insulated wire around a soft-iron core. The wire is connected to a power pack. Fig. 2.1 shows the arrangement.

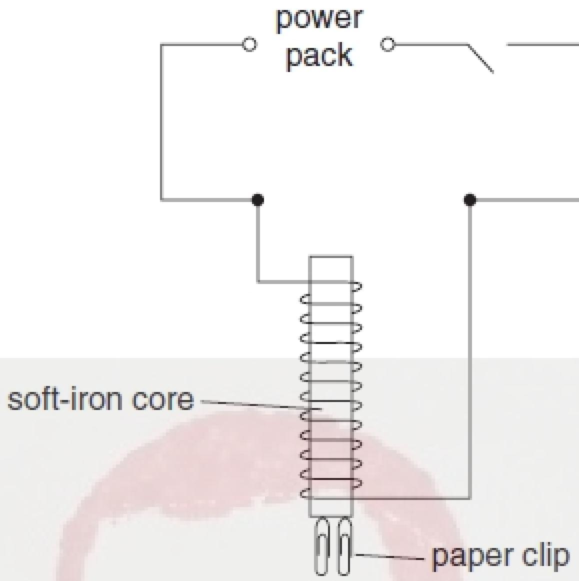


Fig. 2.1

Two students studied how the number of paper clips that an electromagnet can hold up depends on the potential difference across the coil.

(a) Complete Fig. 2.1 by adding a voltmeter, connected to measure the p.d. across the coil. [2]

(b) Student A used the control on the power pack to obtain set values of p.d. and recorded the **maximum** number of paper clips that the electromagnet could hold at each p.d. The results are shown below.

Student A

p.d./V	number of paper clips
0	0
2	0
4	1
6	2
8	3
10	4
12	5

Student B connected a variable resistor into the circuit and used it to change the across the coil. She recorded the **minimum** p.d. required to hold 1 paper clip, th paper clips, etc. The results are shown below.

Student B

p.d./V	number of paper clips
0	0
2.2	1
4.5	2
6.6	3
8.7	4
11.0	5

(i) Which set of results gives the more accurate indication of the strength c electromagnet at different potential differences? Tick the correct box.

Student A ☐

Student B ☐

(ii) Justify your answer to part **(b)**(i).

....

....

....

Draw the circuit symbol for a variable resistor.

Student B connected a variable resistor into the circuit and used it to change the p.d. across the coil. She recorded the **minimum** p.d. required to hold 1 paper clip, then 2 paper clips, etc. The results are shown below.

Student B

p.d. / V	number of paper clips
0	0
2.2	1
4.5	2
6.6	3
8.7	4
11.0	5

(i) Which set of results gives the more accurate indication of the strength of the electromagnet at different potential differences? Tick the correct box.

Student A ☐

Student B ☐

(ii) Justify your answer to part **(b)(i)**.

....

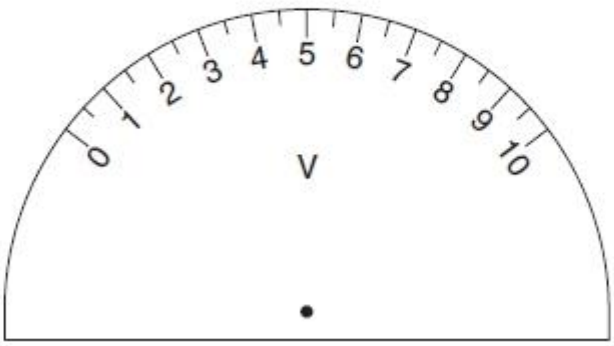
....

....[2]

(c) Draw the circuit symbol for a variable resistor.

[1]

(d) On the diagram below, show the position of the pointer on the voltmeter when the voltmeter reading is 8.7 V.



[1]

Topic_Phx 7 **Q.102 iG Phx/2015/s/Paper 61 www.SmashingScience.org**

3 (a) (i) $V = 1.8$ [1]

$I = 0.25$ AND both units correct, V and A [1]

(ii) R_S calculated correctly, e.c.f. **(i)**, expect 7.2 (Ω) [1]

(b) (i) lamps in parallel and ammeter in a correct position [1]

voltmeter in correct position, with rest of circuit and symbols correct [1]

(ii)(iii) $R_P = 3.3$ or 3.33 with unit Ω and 2 or 3 significant figures AND R_S/R_P calculated [1]

(c) (i) voltage or p.d., accept current [1]

(ii) adjust power supply OR add resistor / variable resistor [1]

[Total: 8]

Topic_Phx 7 **Q.103 iG Phx/2014/w/Paper 61 www.SmashingScience.org**

3 (a) R calculated correctly:
0.49, 0.99, 1.5(1), 1.99 or 2.0, 2.5(0)
note: accept more significant figures for this mark [1]

all R values expressed to suitable precision, expect 2 decimal places
OR 2 significant figures used throughout OR 3 significant figures used throughout [1]

(b) graph:
axes correctly labelled and right way round [1]
suitable scales, with plots using at least half of grid [1]
all plots correct to ½ small square [1]
good line judgement [1]
single, thin, continuous line, no large 'blobs' greater than ½ small square [1]

(c) statement to match graph (expect yes) [1]

justified by reference to straight line through the origin
OR when l doubles, R doubles owtte [1]

(d) additional readings with greater l values [1]

[Total: 10]

4 (a) (i) 1.9 (V) [1]

0.26 (A) [1]

(ii) R = 7.3 (7.3077) (Ω) accept any sig. figs. > 2, ecf allowed [1]

all units V, A, Ω correct, symbols or words [1]

(b) brightness increases (from X to Z) [1]

(c) one from:

- exact placement of S
- width of S
- battery running down / voltage changed
- wire/lamp getting hot
- resistance of lamp / wire changed [max 1]

(d) increases (note: if this mark is not scored, the next mark cannot be scored) [1]

V increases more quickly than I (accept greater rate)
or V increases proportionately more than I
or doubling V causes I to increase by less than double
allow gradient is increasing [1]

[Total: 8]

Topic_Phx 7 **Q.105** iG Phx/2013/w/Paper 61 www.SmashingScience.org

3 (a) (i) 1.8 (V) [1]
0.3 (A) [1]

(ii) P_1 = 0.54 (W) e.c.f. allowed [1]

(iii)(iv)(v) P_T = 1.59 (or 1.6) W [1]

(b) statement matches results (expect YES) e.c.f. allowed [1]
justification in terms of within or beyond limits of experimental accuracy o.w.t.t.e. [1]

(c) (i) diagram:
lamps in parallel, variable resistor in series with power supply, with correct symbols for variable resistor, lamps and voltmeter [1]
one voltmeter correctly positioned [1]

(ii) vary current (or p.d.) [1]

[Total: 9]

Topic_Phx 7 **Q.106 iG Phx/2013/s/Paper 61 www.SmashingScience.org**

3 **(a)** table:

R values correct 0.61, 1.82, 3.16, 4.27, 5.48 [1]
all *R* values to 2 or 3 significant figures [1]
cm, V, A, Ω [1]

(b) graph:

axes correctly labelled [1]
suitable scales [1]
all plots correct to ½ small square [1]
good line judgement [1]
single, thin, continuous line [1]

(c) triangle method shown on graph [1]
using at least half of line [1]
G = 0.31to 0.35 2 or 3 significant figures [1]

[Total: 11]

Topic_Phx 7 **Q.107 iG Phx/2012/w/Paper 61 www.SmashingScience.org**

3 **(a)** Correct symbols for ammeter, voltmeter and lamps [1]
Ammeter and voltmeter in correct positions [1]
Correct parallel circuit [1]

(b) (i) and (ii) V_A = 1.9(V) R_A = 2.9(2) (Ω) [1]
Units V and Ω [1]

(iii) Pointer at correct position (0.65) [1]

(c) No mark awarded

(d) Statement matches readings (expect YES) [1]
Justified with idea of experimental inaccuracy [1]
(expect 'close enough', owtte)

[Total: 8]

Topic_Phx 7 **Q.108** **iG Phx/2012/s/Paper 61 www.SmashingScience.org**

3 (a) (i) (cm, V, A) [no mark awarded]

(ii) Graph:
Axes correctly labelled with quantity and unit and correct way around [1]
Suitable scales – plots occupy at least half the grid [1]
All plots correct to ½ small square [1]
Good line judgement (ecf for curve if *d* plotted) [1]
Single, thin, continuous line [1]

(iii) Triangle using at least half of candidate's line clearly indicated on graph [1]
Evidence of subtraction seen [1]
G value 1.5 when rounded to 2 significant figures [1]

(b) Same as *G*, rounded to 2 or 3 significant figures [1]
unit Ω/ohms [1]

[Total: 10]

Topic_Phx 7 **Q.109** **iG Phx/2011/w/Paper 61 www.SmashingScience.org**

3 (a) (i) 0.27 (A) [1]

(ii) expect YES (ecf: no) [1]
expect close enough / within limits of experimental accuracy o.w.t.t.e.
ecf: beyond limits of experimental accuracy o.w.t.t.e. [1]

(b) vary/control current/voltage [1]

(c) (i) voltmeter symbol correct and correctly connected across all three resistors [1]

(ii) 2.2 (V) [1]

(iii) *R* correctly evaluated
ecf from (ii) [1]
2 or 3 significant figures and unit Ω [1]

[Total: 8]

Topic_Phx 7 **Q.110 iG Phx/2011/s/Paper 61 www.SmashingScience.org**

3 (a) correct symbol [1]
correct position [1]

(b) table:
V / l values correct 8.35, 3.58, 2.08, 1.39, 1.00 [1]
consistent 2 or 3 significant figures [1]
unit V/m [1]

(c) statement matches readings (expect NO) [1]
justification matches statement and by reference to results
V / l not constant, as l increases V decreases [1]

(d) any one of:
check for zero error
avoidance of parallax error explained
switch off between readings
repeats [1]

[Total: 8]

Topic_Phx 7 **Q.111 iG Phx/2011/s/Paper 61 www.SmashingScience.org**

3. (a) (i) 5.4 or 5.43 or 5.429 AND 5.9 or 5.94 or 5.938 [1]
R values both to 2 significant figures OR both to 3 significant figures, in table [1]

(iii) V, A , Ω [1]

(b) (i) Correct series circuit [1]
Correct symbols for ammeter, voltmeter and lamps [1]

(ii) R_T = 8.26(Ω) [1]

(c) Statement: expect No (ecf available for Yes) [1]
Outside limits of experimental accuracy (owtte) [1]

(d) Brightness changes (owtte) [1]

[Total: 9]

Topic_Phx 7 **Q.112 iG Phx/2011/s/Paper 61 www.SmashingScience.org**

5. 1.5 cm [1]
100 cm^3 [1]
0.07 m^2 [1]
0.12 A [1]
23 cm [1]

[Total: 5]

Topic_Phx 7 **Q.113 iG Phx/2010/w/Paper 61 www.SmashingScience.org**

3 **(a)** 0.3 – 0.31 [1]

(b) Ω, A [1]
10.1 [1]

(c) correct calculation of $0.5I_o$ shown (ecf) [1]
10(Ω) [1]

(d) diagram:
resistors in parallel [1]
voltmeter symbol [1]
voltmeter position [1]

[Total 8]

Topic_Phx 7 **Q.114 iG Phx/2009/w/Paper 61 www.SmashingScience.org**

3 **(a)–(c)**
table:
V, A, Ω [1]
V 1.8 [1]
I 0.25 [1]
R values 7.20, 3.46(3.5) [1]
consistent significant figures for *R* (2 or more) [1]

(d) *y* 0.48, 0.49, 0.5 (ecf) [1]
2/3 significant figures and no unit [1]

(e) **(i)** correct symbols and circuit (ignore power source symbol) [1]

(ii) voltmeter position correct [1]

(iii) control current/voltage/resistance/speed of motor [1]

[Total: 10]

Topic Phx 7 **Q.115 iG Phx/2009/s/Paper 61 www.SmashingScience.org**

3 (a) *R* values 0.553, 1.55, 2.74, 3.74, 4.92
(2,3,4 or more significant figures) [1]
Consistent 3 or consistent 4 significant figures for final four entries [1]

(b) Graph:
Axes labelled and scales suitable (must include origin) [1]
Plots correct to ½ square (–1 each error or omission) [2]
Well judged str. line taking account of all points and reaching an axis [1]
Thin line [1]

(c) Statement proportional (wtte) or as *x* increases, *R* increases [1]
Justification straight line through origin [1]

(d) Clear indication of method on graph [1]
Correct value to ½ square [1]

(e) low current/switch off between readings
or add (variable) resistor/lamp
or reduce voltage/power [1]

[Total: 12]

Topic Phx 7 **Q.116 iG Phx/2008/w/Paper 61 www.SmashingScience.org**

5 (a) 0.7 N [1]
6 cm^3 [1]
1.4 s [1]
4.0 N/cm^2 [1]

(b) (i) minimum current/turn down power supply/increase resistance [1]
switch off between readings/carry out without delay [1]

(ii) variable resistor/rheostat [1]

[Total: 7]

Topic_Phx 7 **Q.117 iG Phx/2008/s/Paper 61 www.SmashingScience.org**

2 Table:

(a) Units V, A, Ω (symbol/word) [1]
R values 1.11, 2.19, 5.05, 9.55 [1]
Consistent 2 or consistent 3 sig fig for R [1]

(b) **(i)** Yes (if within 10%) No (if not) [M1]
Circuit 1 and circuit 2 compared [A1]

(ii) limit current (so temperature not increased)
OR switch off between readings
OR check for zero error
OR Repeats
OR Parallax error explained
OR Tapping meter [1]

[Total: 6]

Topic_Phx 7 **Q.118 iG Phx/2007/w/Paper 61 www.SmashingScience.org**

3 **(a)** 0.41, 0.13, 0.14, 0.12(-1 each error) [2]
I in A at least once [1]

(b) statement (yes)
Reason – correct within limits of experimental accuracy [1]

(c) variable resistor/extra cell/variable power source/potential divider/potentiometer [1]

(d) **(i)** correct arithmetic for *R* 3.90 (ecf) [1]
unit and 2/3 sf [1]

(ii) voltmeter correct position and symbol [1]

[Total: 8]

Topic_Phx 7 **Q.119 iG Phx/2007/s/Paper 61 www.SmashingScience.org**

3 **(a)** correct arithmetic for *R* values 7.92, 1.98 [1]
both *R* to 2sf OR both to 3sf [1]
all correct units: *V*, *A*, Ω [1]

(b) final box (ecf) [1]
second *R* (or *I*) about ¼ of first [1]

(c) lamp symbol correct [1]
ammeter and voltmeter symbols correct [1]
correct parallel circuit (ONE ammeter and ONE voltmeter, no extra components, but accept switch if present, ignore power source or lack of) [1]

[Total: 8]

Topic_Phx 7 **Q.120 iG Phx/2006/w/Paper 61 www.SmashingScience.org**

5	(a)	correct symbols for ammeter and voltmeter		[1]
		correct symbols for variable resistor, lamp and resistor		[1]
		circuit correct		[1]
	(b)	ammeter will show current/voltmeter shows reading		[1]
	(c)	variable resistor		[1]
	(d)	(i)	low current/increase R of variable resistor/ lower voltage/add another lamp	[1]
		(ii)	switch off between readings	[1]
	(e)	A, more resistance in circuit		[1]
				[Total: 8]

Topic_Phx 7 **Q.121 iG Phx/2006/s/Paper 61 www.SmashingScience.org**

2	(a)	correct ammeter and voltmeter symbols		[1]
		correct power source, variable resistor and lamp symbols		[1]
		correct circuit		[1]
	(b)	(i)	A; V; Ω	[1]
		(ii)	5.8 or 5.79 or 5.792; 2.9 or 2.89 or 2.889	[1]
			consistent 2/3 sf	[1]
				TOTAL 6

Topic_Phx 7 **Q.122 iG Phx/2005/w/Paper 61 www.SmashingScience.org**

5	(a)	1, 2 and 3 (–1 each error or omission)	2
	(b)	2 and 3 (–1 each error or omission)	2
	(c)	time a number (n) oscillations	1
		divide time by n	1
			TOTAL 6

Topic_Phx 7 **Q.123 iG Phx/2005/w/Paper 61 www.SmashingScience.org**

2	**(a)**	correct symbols for resistor, voltmeter and ammeter	1
		correct connections between resistors AB and BC in series with CD in parallel with both	1
		voltmeter and ammeter correctly positioned	1
	(b)	I in A, V in V, R in Ω	1
		1.98 or 2.0; 4.00 or 4.0; 1.06 or 1.1	1
		all to 2 sf or 3 sf	1
	(c)	5.9Ω – 6.1Ω	1
		resistance proportional to length/ doubling length, doubled resistance/ 3 x length will have 3 x resistance/ wtte	1

TOTAL 8

Topic_Phx 7 **Q.124 iG Phx/2005/s/Paper 61 www.SmashingScience.org**

2	**(a)**	12 cm^3	[1]
		0.5 A	[1]
		30 cm^2	[1]
		0.112 kg	[1]
		600 N	[1]
	(b)	repeats	[1]
		to spot anomalous results/to calculate average	[1]
		or series of different V and I, plot graph	
		or switch on/off, prevent temp rise	
		or low current, minimise temp rise	
		or avoidance of parallax, action and reason	
		or clean wires, resistance caused by dirt	
		or tap meter, prevent sticking	
		or check zero error, accuracy	
		(in each case the reason must support the statement to gain the second mark)	

[total: 7]

Topic_Phx 7 **Q.125 iG Phx/2005/s/Paper 61 www.SmashingScience.org**

3	**(a)**	*l* values 50, 75, 100	[1]
	(b)	1.50 V shown correctly	[1]
		0.375 A shown correctly	[1]
	(c)	2.5(3); 4.0(0); 5.2(0) all correct	[1]
		all to 2sf or all to 3sf	[1]
	(d)	Ω	[1]
	(e)	R = 7.50 - 8.00	[2]
		(or R = 6.60 - 7.49)	

[total: 8]

Topic_Phx 7 **Q.126 iG Phx/2004/w/Paper 61 www.SmashingScience.org**

5	(a)	(i)	all R correct, 0.464, 0.976, 1.45, 1.88, 2.25	1
			2/3 sf for R	1
		(ii)	V, cm, Ω	1
	(b)	(i)	18, 4.5 (ignore unit)	1
		(ii)	answer 4	1
		(iii)	72	1
	(c)		micrometer	1
			TOTAL	7

Topic_Phx 7 **Q.127 iG Phx/2004/s/Paper 61 www.SmashingScience.org**

3	(a)	Correct voltmeter	1
		Correct ammeter	1
	(b)	R = 3.3, 2/3 sf	1
		Unit Ω or ohm	1
	(c)	Circuit with correct parallel connections	1
		Ammeter and ONE voltmeter correct	1
		Variable resistor correct	1
		TOTAL	7

Topic_Phx 7 **Q.128 iG Phx/2003/w/Paper 61 www.SmashingScience.org**

3	(a)		pointer at 0.35 A		1
	(b)	(i)	variable resistor/rheostat/potentiometer		1
		(ii)	V		1
			A		1
			Ω		1
			One R correct		1
			All R correct	(6.129, 5.769, 4, correctly rounded)	1
			Consistent sf for R (either all 2 sf or all 3 sf)		1
		(iii)	variable resistor/number of cells		1
	(c)		Voltmeter in parallel with resistors (or power source)		1
			Ammeter next to X		1
			Symbols correct and all connections drawn in		1
			TOTAL		12

Topic_Phx 7 **Q.129** **iG Phx/2003/s/Paper 61 www.SmashingScience.org**

3	**(a)**	**(i)**	Voltmeter across lamp	1
		(ii)	Variable resistor/rheostat	1
	(b)		Correct position	1
	(c)		V	1
			A	1
			Ω	1
			correct R at 9.8V = 8.16666 (any sf)	1
			all R to 2/3 sf	1
			consistent 2 sf or consistent 3 sf	1
			TOTAL	**9**

Topic_Phx 7 **Q.130** **iG Phx/2002/w/Paper 61 www.SmashingScience.org**

2. (a) symbol	1
position	1
(b) (i) student B	
(ii) B gives exact p.d.	1
or A gives p.d. to nearest 2V	1
(c) correct symbol	1
(d) correct position (± 0.1V)	1
	TOTAL 6