Topical Practice

IGCSE PHYSICS

Paper 4

Chapter 10

EDITION • Volum • STUDENT

CONTENTS

Chapter 10: Light and Waves

1 The IGCSE class is determining the focal length of a lens.

The apparatus is shown in Fig. 4.1.

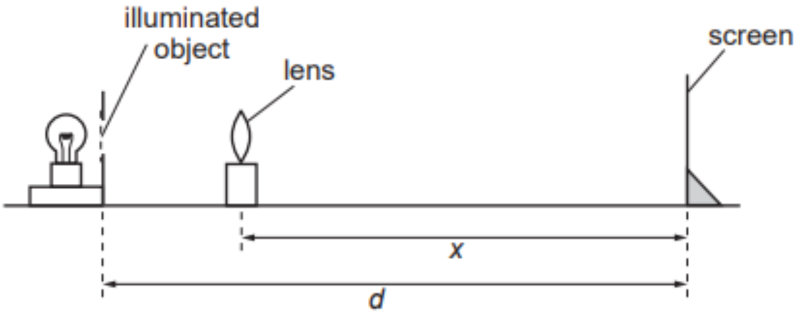


Fig. 4.1

(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.

(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]

2 The IGCSE class is determining the refractive index of the material of a transparent block.

Fig. 5.1 shows a student's ray-trace sheet.

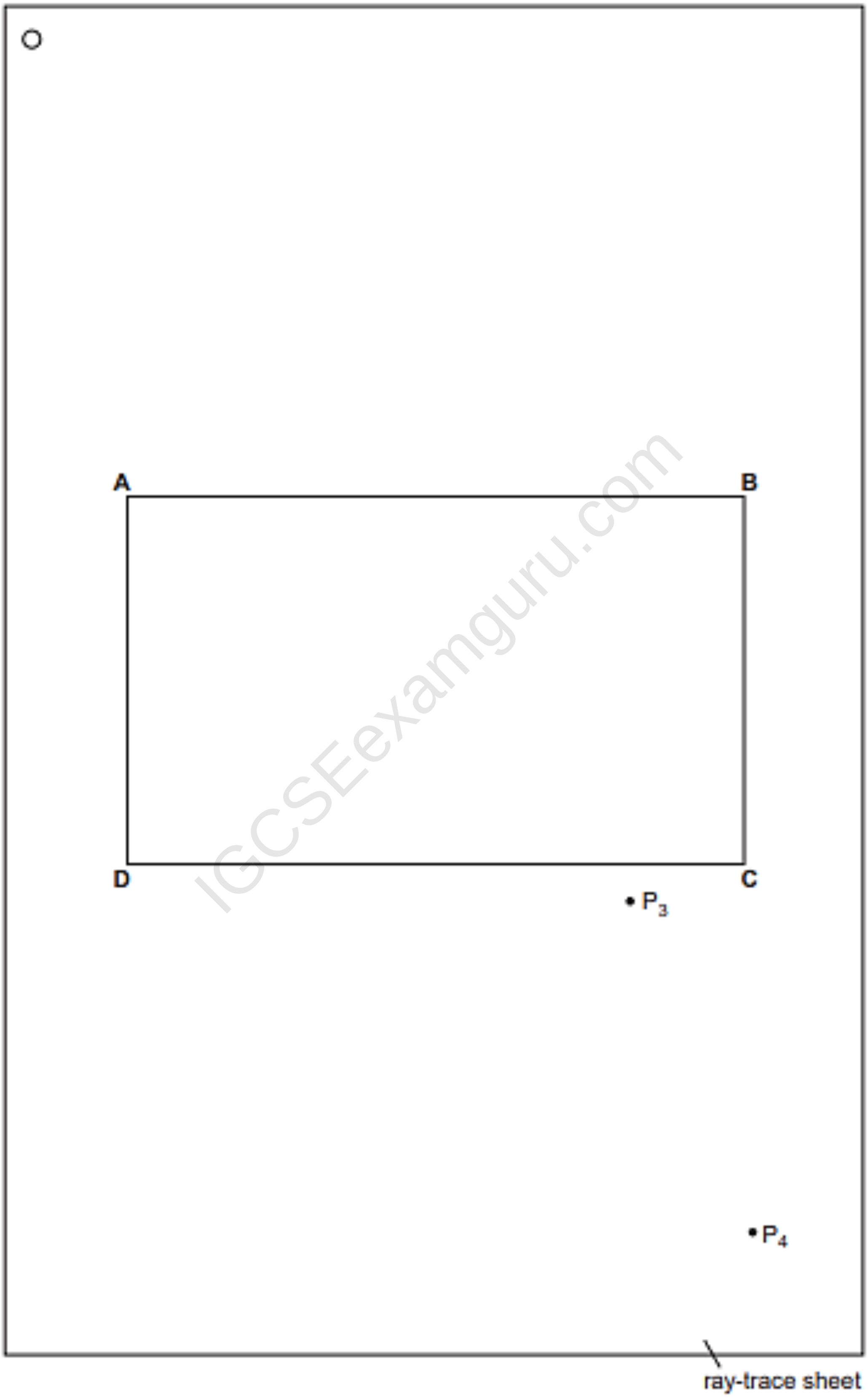


Fig. 5.1

(a) **ABCD** is a transparent block placed, largest face down, on the ray-trace sheet.

(i) On Fig. 5.1, draw a normal at the centre of side **AB**. Label the point **E** where the normal crosses **AB**. Mark a point **N** on the normal 4.0 cm from **E** and outside the outline of the block. [1]

(ii) Draw a line **NF** from **N** to the block. This line must be to the right of the normal and at an angle of 20° to the normal. Mark the point **F** where the line meets **AB**. Measure and record the length *a* of the line **NF**.

a = ... [2]

(b) The student places two pins P_1 and P_2 on the line through **F** and **N**. 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. The positions of P_3 and P_4 are marked on Fig. 5.1.

(i) Draw a line joining the positions of P_3 and P_4. Continue the line until it meets **CD**. Label this point **G**.

(ii) Draw the line **GF** and continue it until it meets the normal. Label this point **H**.

(iii) Measure and record the length *b* of the line **FH**.

b = ...

[3]

(iv) Calculate the refractive index *n* of the material of the block, using the equation $n = \frac{b}{a}$.

n = ...[2]

(c) Suggest one precaution that you would take in this experiment to obtain readings that are as accurate as possible.

....

....[1]

[Total: 9]

3 The IGCSE class is carrying out refraction experiments using a rectangular glass block and optical pins.

(a) In the middle of the space below, draw a line, 10 cm long, across the page and label it **AB**. This line represents one side of the glass block.

[1]

(b) Draw a normal to this line at the centre of **AB**. [1]

(c) Draw a line at 30° to the normal to represent an incident ray. This line should be at least 6 cm long. Label this line **EF**. [1]

(d) Mark the positions of two pins P_1 and P_2 on line **EF**. They should be positioned at suitable places on the line in order carry out a ray-tracing experiment as accurately as possible. [1]

(e) A student finds that his completed results from the refraction experiment do not quite match the theory. The student carried out the experiment correctly and with reasonable care.

Suggest a practical reason why the results could differ slightly from the results expected from the theory.

....

....

....[1]

[Total: 5]

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.

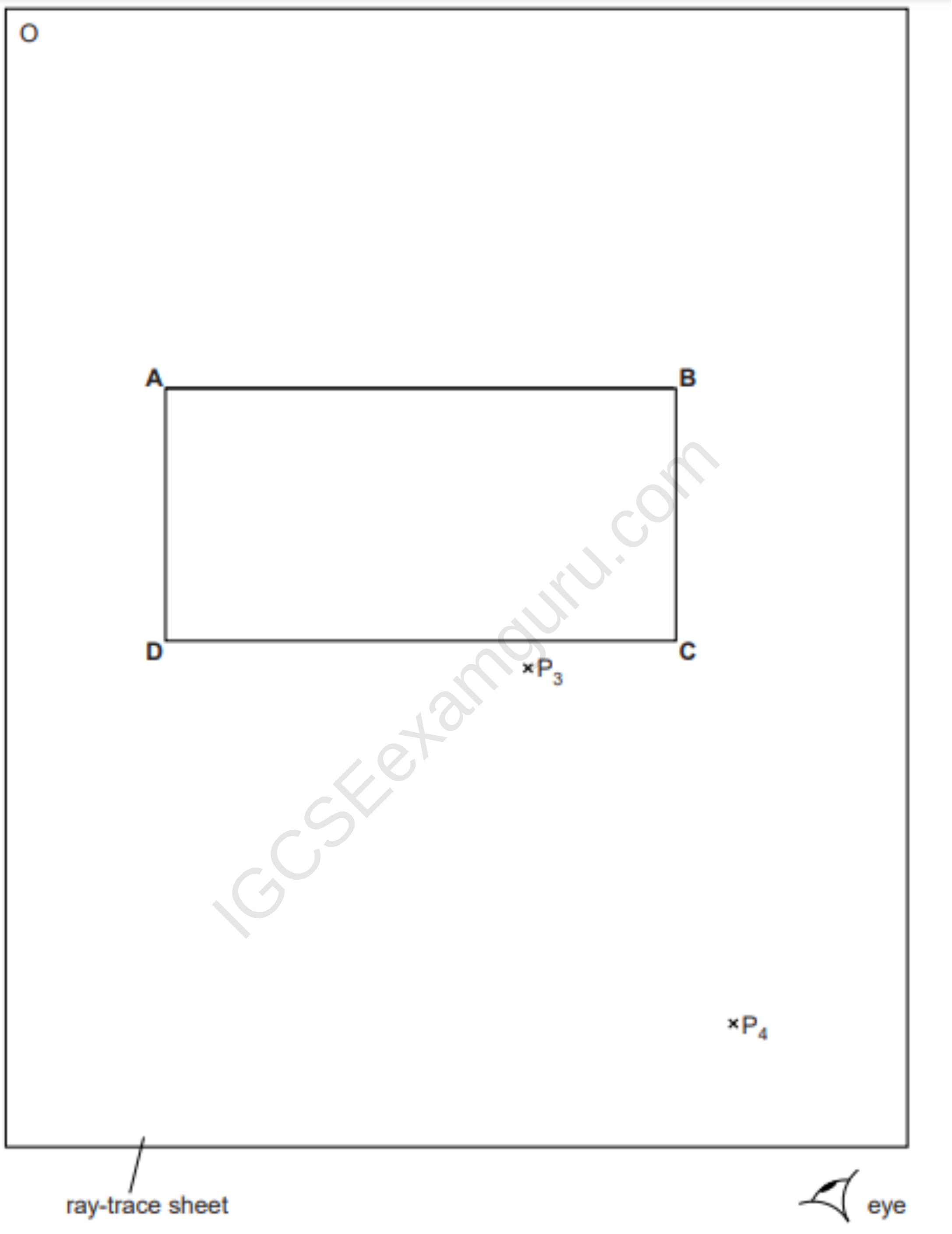


Fig. 4.1

(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]

5 The IGCSE class is determining the focal length of a lens.

The apparatus is shown in Fig. 4.1.

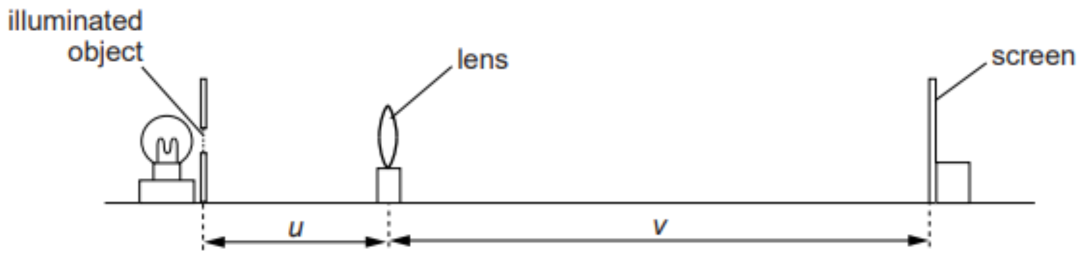


Fig. 4.1

A student places a lens at a distance u = 30.0 cm from an illuminated object. She moves the screen until a sharply focused image of the object is seen on the screen.

She measures the distance v between the centre of the lens and the screen. She calculates d, using the equation $d = u + v$.

She repeats the procedure using a range of values of u. The values of u, v and d are shown in Table 4.1.

Table 4.1

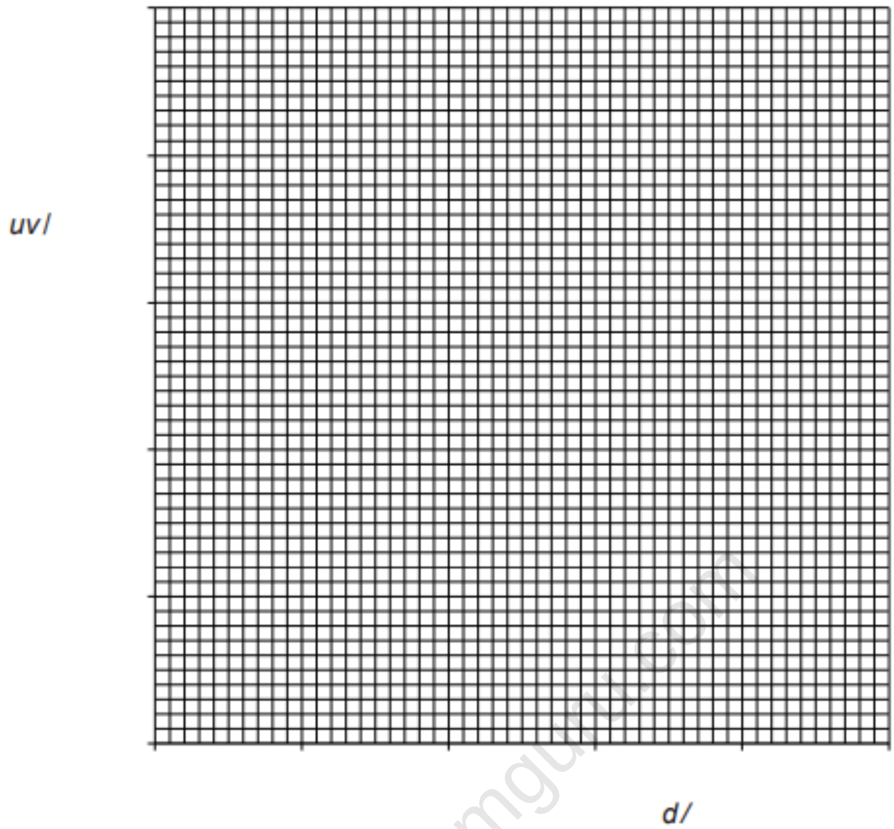
u / cm	v / cm	uv /	d /
30.0	29.8		59.8
45.0	22.0		67.0
50.0	21.8		71.8
55.0	21.0		76.0
60.0	19.9		79.9

(a) **(i)** Calculate the value of uv for each set of readings and enter the values in the table.

(ii) Complete the column headings in the table by inserting the units for uv and d.

[2]

(b) Complete the labelling of the axes below, and plot the graph using data from the table. You do **not** need to begin the axes at the origin (0,0).



[4]

(c) The gradient of the graph is numerically equal to the focal length of the lens.

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

G = ...[2]

(ii) State 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]

[Total: 10]

6 An IGCSE class is carrying out an experiment to determine the focal length of a converging lens.

The apparatus is set up as shown in Fig. 4.1.

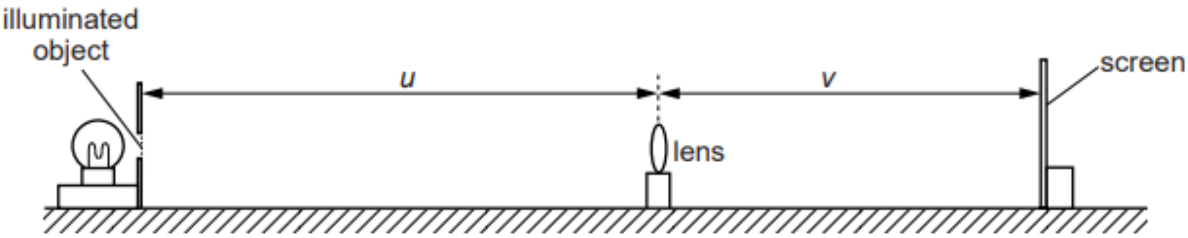


Fig. 4.1

(a) The object distance *u* is set and a sharp image is obtained on the screen.

(i) Measure the object distance *u* on Fig. 4.1.

u = ...

(ii) Measure the image distance *v* on Fig. 4.1.

v = ...

[1]

(iii) The diagram is drawn to $\frac{1}{5}^{\text{th}}$ full size. Determine the actual values, in metres, of *u* and *v*. Record these values in Table 4.1.

(b) Four more object distances are set up and these and the corresponding image distances are recorded in Table 4.1.

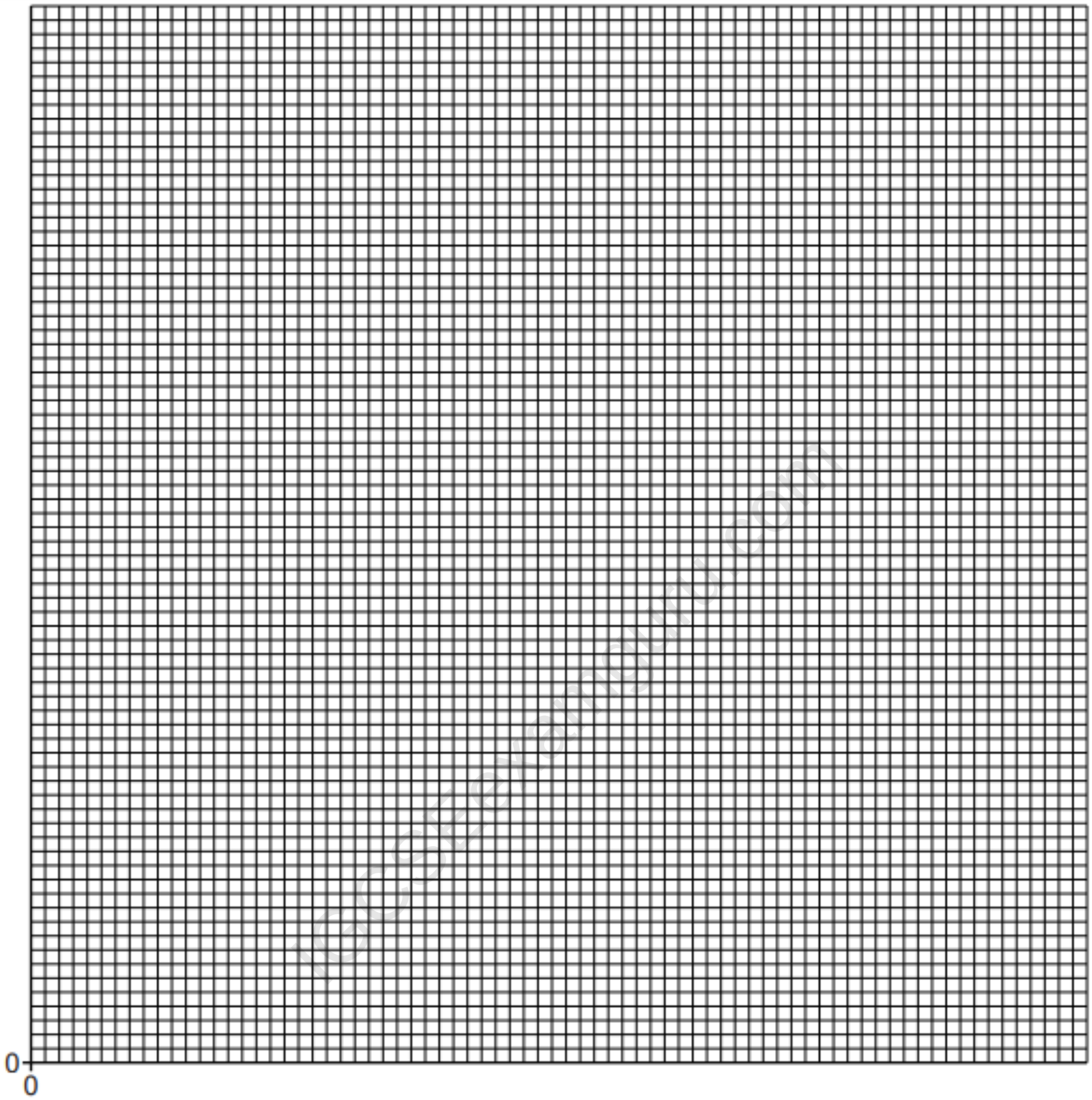
Complete the table by calculating values of $\frac{1}{u}$ and $\frac{1}{v}$ as necessary.

Table 4.1

u / m	$\frac{1}{u}\Big/\frac{1}{\text{m}}$	v / m	$\frac{1}{v}\Big/\frac{1}{\text{m}}$
0.200	5.00	0.600	
0.250	4.00	0.392	
0.450	2.22	0.222	
0.600	1.67	0.196	

[2]

(c) Plot a graph of $\frac{1}{v} \Big/ \frac{1}{\text{m}}$ (*y*-axis) against $\frac{1}{u} \Big/ \frac{1}{\text{m}}$ (*x*-axis). Begin both axes at the origin (0,0). The scale must allow the best-fit line, when extended beyond the range of the data, to cross both axes.



[4]

(d) **(i)** From the graph, determine the value *p* of $\frac{1}{u}$ when $\frac{1}{v}$ is zero (the *x*-intercept).

p = ...

(ii) From the graph, determine the value *q* of $\frac{1}{v}$ when $\frac{1}{u}$ is zero (the *y*-intercept).

q = ...[1]

(e) (i) Calculate z, where z is the average value of p and q.

z = ...

(ii) Calculate the focal length f of the lens where $f = \frac{1}{z}$.

f = ...
[2]

[Total: 10]

7 (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]

8 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.

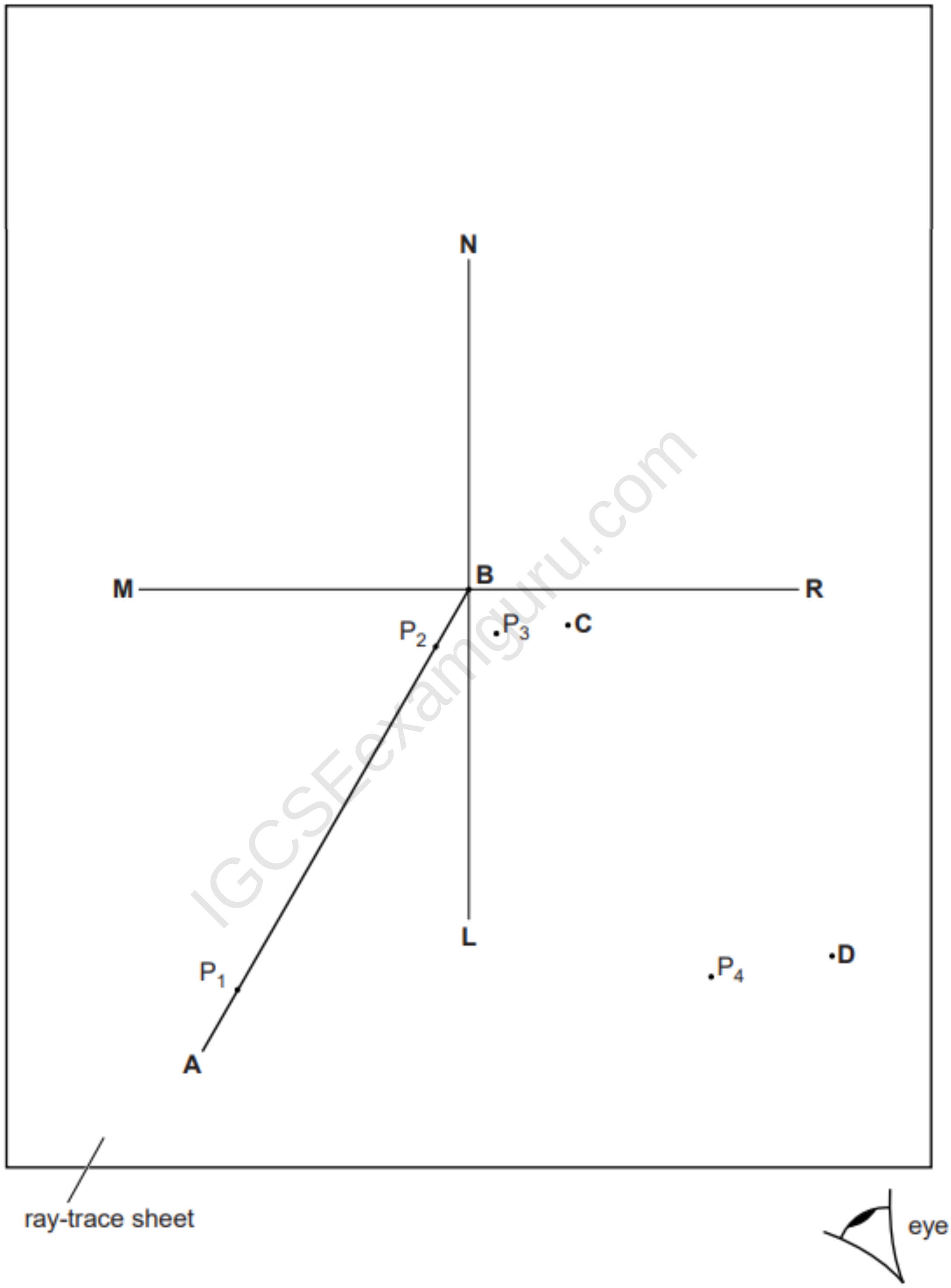


Fig. 4.1

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]

9 The IGCSE class is determining the focal length of a lens.

The apparatus is shown in Fig. 5.1.

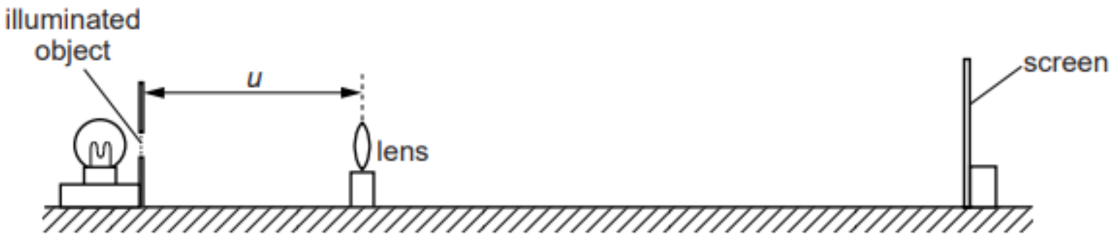


Fig. 5.1

A student places the lens a distance u = 25.0 cm from an illuminated object of height 1.5 cm. She moves the screen until a sharply focused image of the object is seen on the screen.

She measures the height h of the image on the screen. She calculates $\frac{1}{h}$.

She repeats the procedure using a range of u values. Her results are shown in Table 5.1.

Table 5.1

u/cm	h/cm	$\frac{1}{h} \Big/ \frac{1}{\text{cm}}$
25.0	2.2	0.45
30.0	1.5	0.67
35.0	1.1	0.91
40.0	0.9	1.1
45.0	0.8	1.3

(a) Plot a graph of u/cm (y-axis) against $\frac{1}{h} / \frac{1}{\text{cm}}$ (x-axis). You do not need to begin the axes at the origin (0,0).

[5]

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

G = ...[2]

(c) Calculate the focal length f of the lens, using the equation $f = \frac{G}{1.5}$ cm. Give your answer to a suitable number of significant figures for this experiment.

f = ...[2]

(d) State two precautions that you would take in this experiment in order to obtain reliable results.

1. ....

....

2. ....

.... [2]

[Total: 11]

10 IGCSE students are investigating the magnification produced by a converging lens.

The apparatus is set up as shown below.

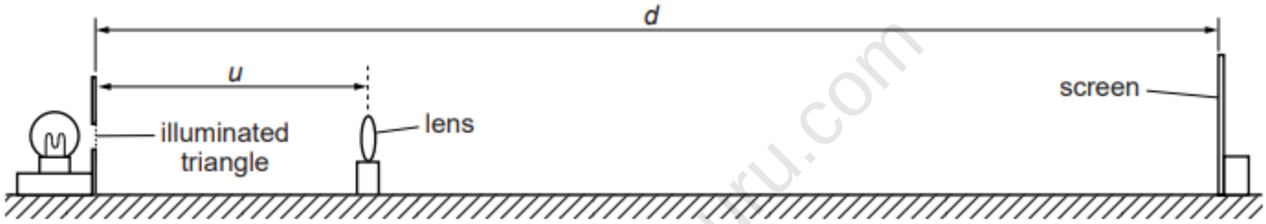


Fig. 5.1

The screen is moved until a sharp image of the object is seen on the screen.

(a) **(i)** On Fig. 5.1, carefully measure *u* and record the value.

u = ...

(ii) On Fig. 5.1, carefully measure *d*, the distance between the illuminated triangle and the screen when the image is sharp, and record the value.

d = ...

(iii) Calculate a value *m* for the magnification, using your answers to **(a)(i)** and **(a)(ii)**, and the equation $m = \frac{d-u}{u}$.

m = ...
[2]

(b) The illuminated triangle is shown in Fig. 5.2. The image of the triangle seen on the screen is shown in Fig. 5.3.

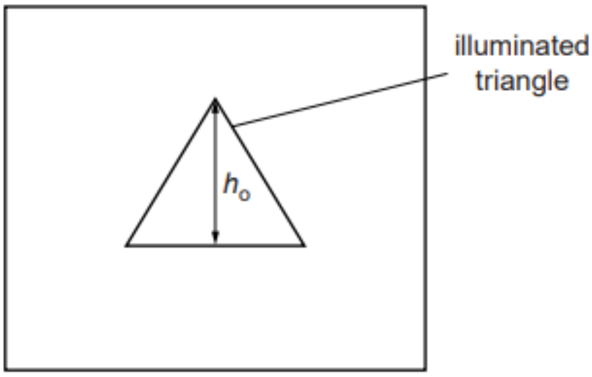


Fig. 5.2

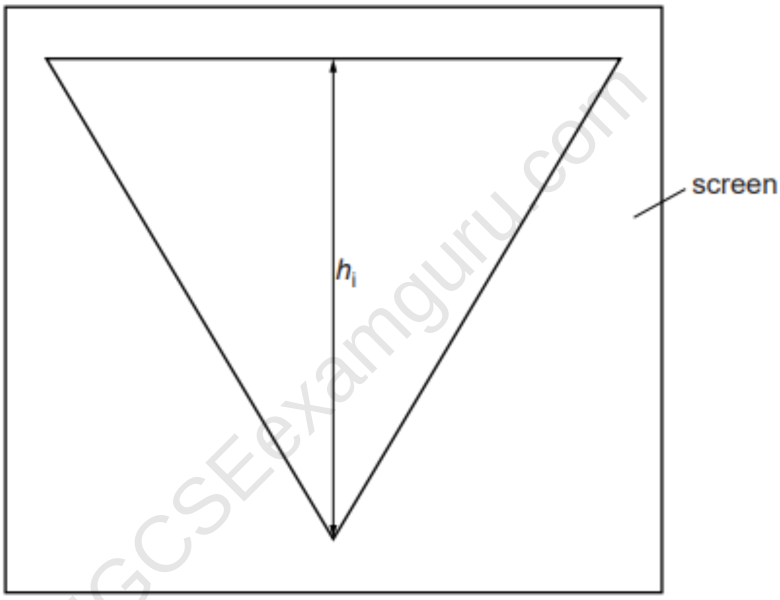


Fig. 5.3

(i) Measure h_o, the height of the illuminated triangle, as shown in Fig. 5.2, and record the value.

h_o = ...

(ii) Measure h_i, the height of the image on the screen, as shown in Fig. 5.3, and record the value.

h_i = ...

(iii) Calculate M, another value for the magnification, using your answers to **(b)(i)** and **(b)(ii)**, and the equation $M = \frac{h_i}{h_o}$.

M = ...

[2]

(c) A student says that the values of *m* and *M* should be the same.

State whether your findings support this. Justify your answer by reference to your results for *m* and *M*.

statement ....

....

justification ....

....

.... [2]

(d) **(i)** Describe one difficulty the students might have found when measuring the height of the image on the screen.

Suggest a solution for the problem.

difficulty ....

....

solution ....

.... [2]

(ii) Suggest one further precaution which should be taken to make the experiment reliable.

....

....

....[1]

[Total: 9]

11 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.

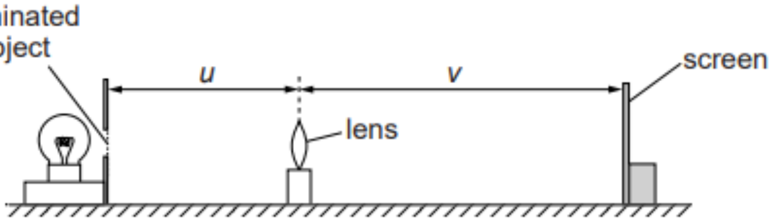


Fig. 4.1

(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]

12 An IGCSE class is investigating the reflection of light by a plane mirror.

One student's ray-trace sheet is shown in Fig. 4.1.

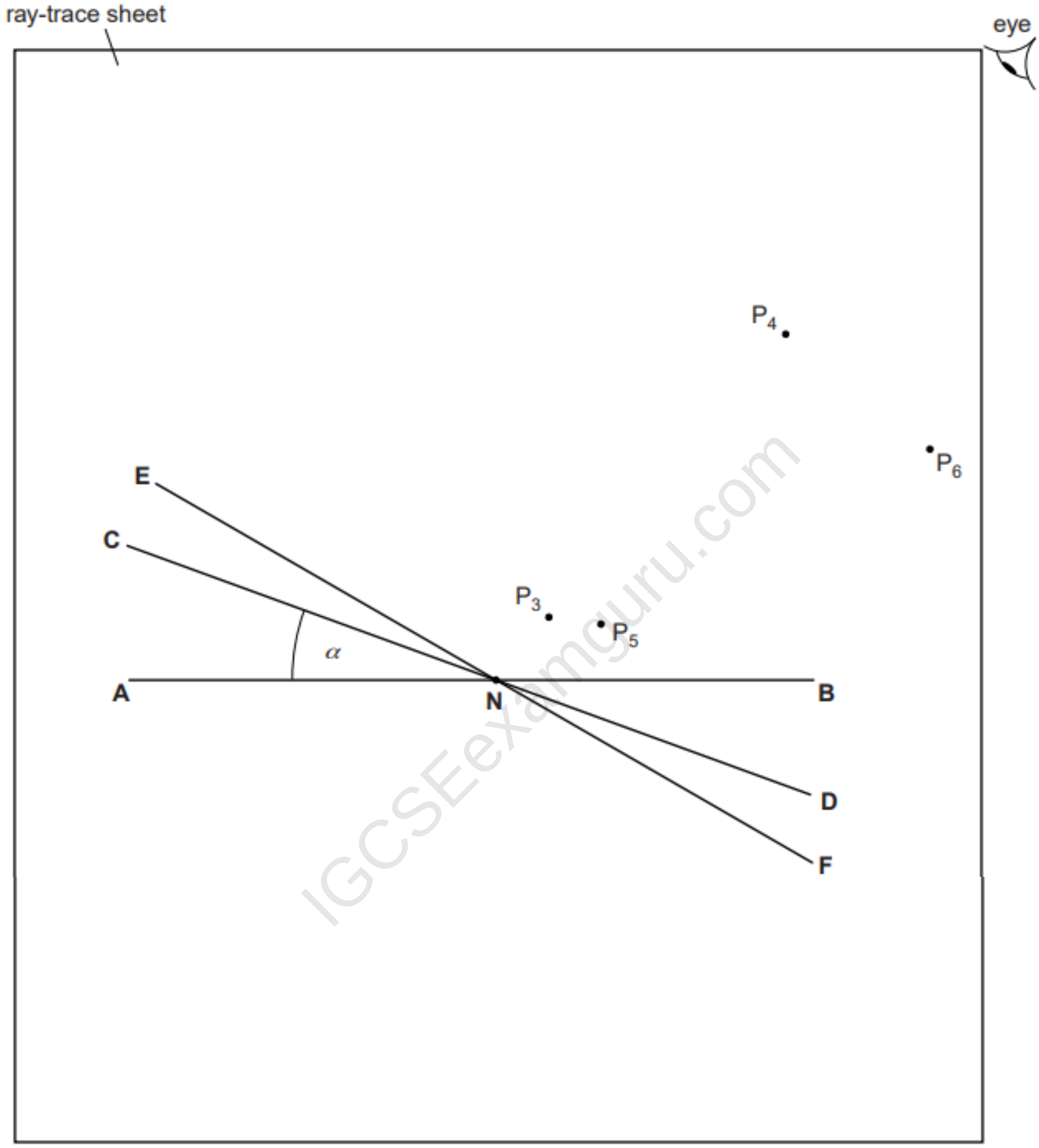


Fig. 4.1

(a) In the first part of the experiment, a plane mirror is to be placed on line **CD**.

(i) Draw a normal to **AB** at point **N**, towards the top of the page. Label the other end of this normal **L**.

(ii) Two pins P_1 and P_2 are placed on line **LN**. Label suitable positions for P_1 and P_2.

[1]

(b) The mirror is placed on line **CD** and the images of P_1 and P_2 are viewed from the direction indicated by the eye in Fig. 4.1.

Two pins P_3 and P_4 are placed so that the images of P_1 and P_2, and the pin P_3 all appear exactly in line with P_4.

(i) Draw a line passing through P_3 and P_4 and reaching **AB**.

(ii) Measure the angle θ between this line and the normal **NL**. Record this value in Table 4.1. [1]

(c) The mirror is then moved to line **EF** and pins P_5 and P_6 are placed in line with the new images.

Repeat steps **(b)(i)** and **(b)(ii)** using the new mirror line and pin positions. [1]

Table 4.1

	α / °	θ / °
mirror on **CD**	20	
mirror on **EF**	30	

[1]

(d) A student suggests that θ should always be equal to 2α.

State whether the experimental results support this idea. Justify your answer with reference to the results.

statement ....

....

justification ....

....

....
[2]

(e) Suggest two precautions that could be taken to ensure accurate results from this experiment.

1. ....

....

2. ....

....
[2]

[Total: 8]

13 An IGCSE student is determining the focal length of a lens.

Fig. 4.1 shows the apparatus.

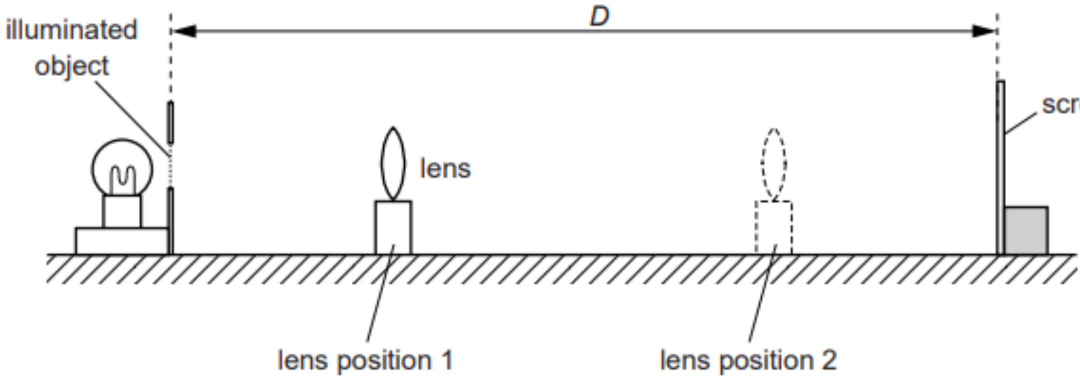


Fig. 4.1

(a) The student places the screen at a distance D = 80.0 cm from the illuminated object. He places the lens close to the illuminated object. He moves the lens until a sharply-focused image of the object is seen on the screen (lens position 1).

He measures the distance x from the illuminated object to the centre of the lens.

x = 19.5 cm

He does not move the object or the screen, but moves the lens towards the screen until another sharply-focused image of the object is seen on the screen (lens position 2). He measures the distance y from the illuminated object to the centre of the lens.

y = 60.4 cm

(i) On Fig. 4.1, carefully mark and label the distances x and y. [1]

(ii) Calculate d using the equation $d = (y - x)$.

d = ...

(iii) Calculate d^2.

d^2 = ...

(iv) Calculate the focal length *f* of the lens, using the equation $f = \dfrac{D^2 - d^2}{4D}$.

f = ...
[2]

(b) State two precautions that you would take in this experiment to obtain reliable results.

1. ....

....

2. ....

....
[2]

(c) In the experiment, the student produces two images on the screen. They are both sharply focused.

(i) Suggest two differences between the two images.

1. ....

2. ....

(ii) Suggest one similarity between the two images.

....

....
[3]

(d) Suggest a variable that could be changed when repeating this experiment to check the accuracy of the value obtained for the focal length *f*.

....[1]

[Total: 9]

14 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.

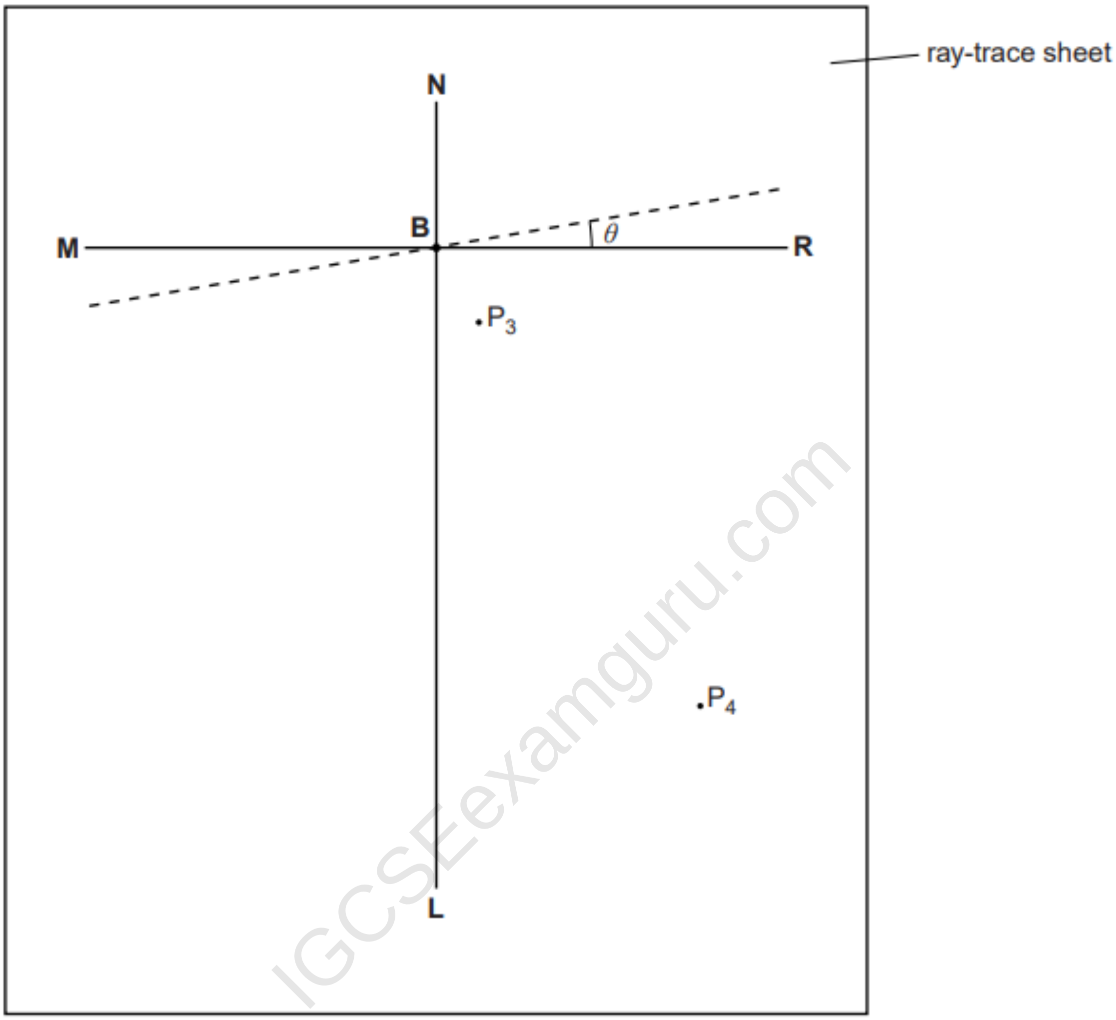


Fig. 5.1

(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°.

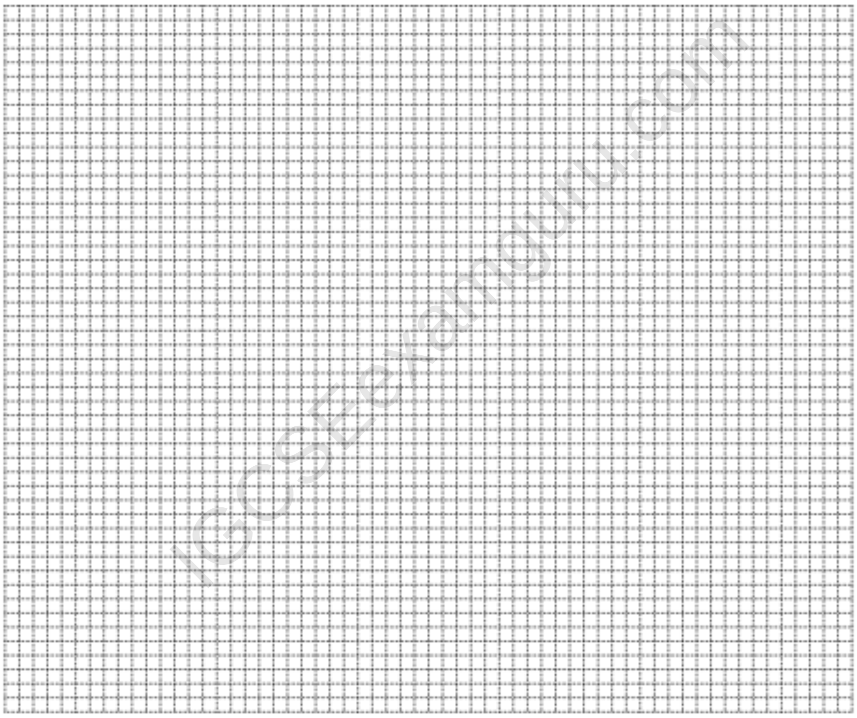
α_0 = ... [2]

(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

θ / °	α / °	$(\alpha - \alpha_0)$/°
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]

15 An IGCSE student is investigating shadows.

The apparatus she is using is shown in Fig. 5.1.
The object and the screen are square, with dimensions as shown in Fig. 5.1.

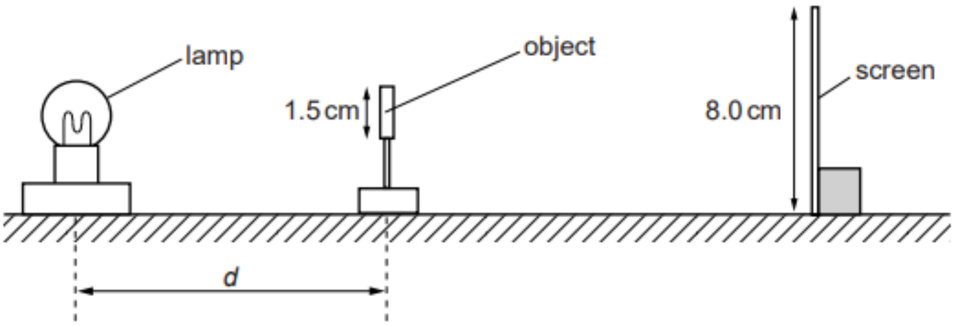


Fig. 5.1

She places the object at a distance *d* from the centre of the lamp so that it produces a shadow on the screen.

For various values of *d*, she measures the width *w* and height *h* of the shadow and records them in Table 5.1.

For each distance *d*, she calculates a value *s*, the average side length of the shadow, using her readings for *w* and *h* and the equation $s = \frac{w + h}{2}$.

(a) Fig. 5.2 shows the shadow produced on the screen when *d* = 35 cm. The shadow and screen are shown full size.

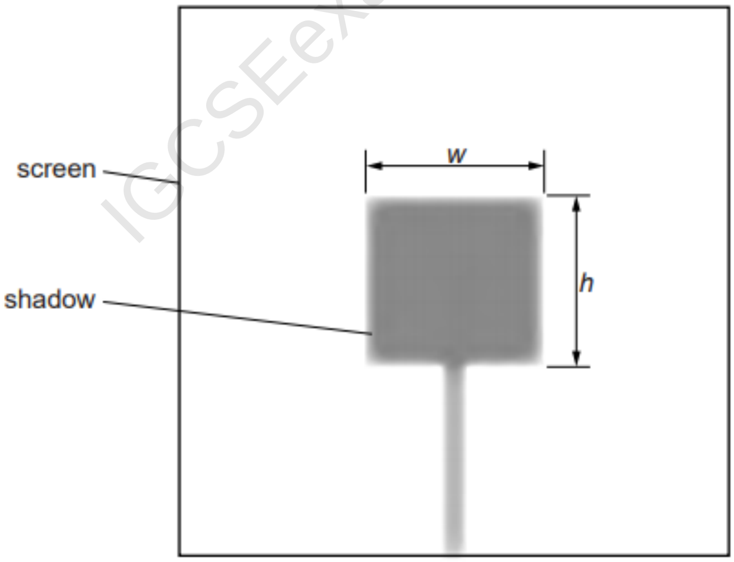


Fig. 5.2

(i) Measure, and record in Table 5.1, the width w and the height h of the shadow.

Table 5.1

d / cm	w / cm	h / cm	s / cm
55	1.7	1.7	1.7
45	2.0	2.0	2.0
35			
25	3.8	3.9	3.9
20	4.4	4.6	4.5
15	5.8	6.2	6.0

[2]

(ii) Calculate, and record in the table, the value of s when d = 35 cm.

(iii) The object is square in shape. State a practical reason why it is useful to calculate s rather than just rely on w or h to show the size of the shadow.

....

....[1]

(b) Plot a graph of s / cm (y-axis) against d / cm (x-axis).

[5]

(c) A value of d = 20 cm has been inserted between d = 25 cm and d = 15 cm. This does not follow the pattern of the gaps of 10 cm between the other distances.

Explain why it is useful to have this value when drawing the line on the graph.

....

....[1]

(d) A student suggests that the distance between the lamp and the object in this experiment should be no less than 15 cm.

From your observations of the readings and the apparatus being used, give a reason why this is a sensible suggestion.

....

....[1]

[Total: 10]

16 The IGCSE class is investigating the reflection of light by a plane mirror. Fig. 1.1 shows a student's ray-trace sheet.

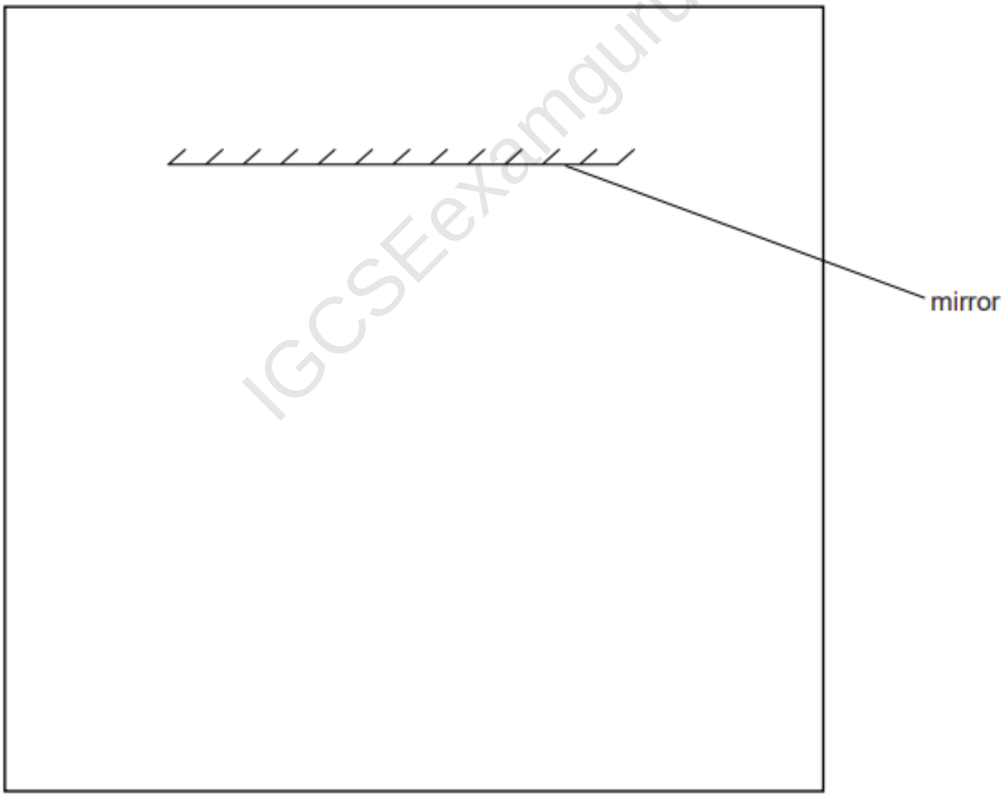


Fig. 1.1

(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.

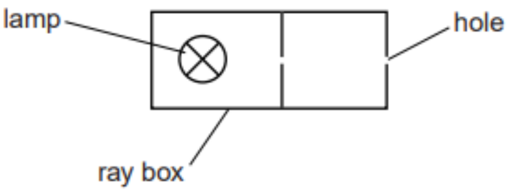


Fig. 1.2

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]

17 The IGCSE class is investigating the magnification produced by a converging lens.

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

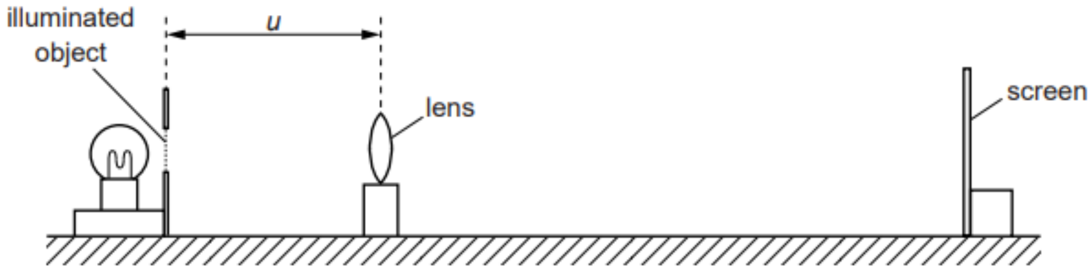


Fig. 3.1

(a) On Fig. 3.2, measure and record the height h_0 of the triangular object.

h_0 = ... cm [1]

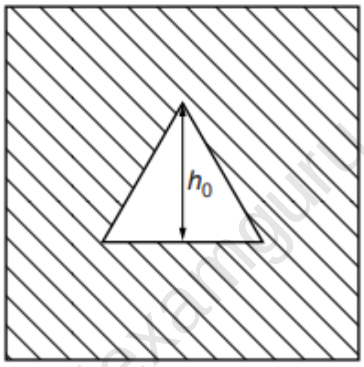


Fig. 3.2

(b) The distance u between the illuminated object and the lens is set to 30.0 cm. The screen is moved until a sharp image of the illuminated object is seen, as shown in Fig. 3.3.

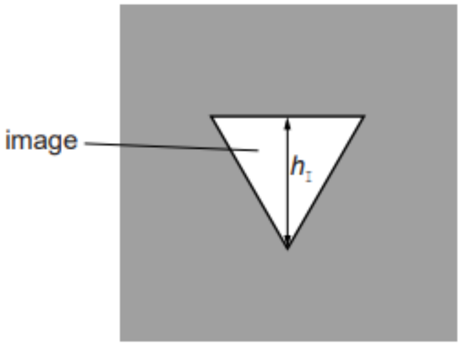


Fig. 3.3

Measure, and record in the first row of Table 3.1, the height h_I of the image.

Table 3.1

u / cm	h_I / cm	S
30.0		
35.0	1.5	
40.0	1.2	
45.0	1.0	
50.0	0.9	
55.0	0.8	

[2]

(c) The process is repeated for u values of 35.0 cm, 40.0 cm, 45.0 cm, 50.0 cm and 55.0 cm. The h_I values obtained are shown in the table.

Complete Table 3.1 by calculating the values of S, using your result from **(a)** and the equation $S = \frac{h_O}{h_I}$.

(d) Plot a graph of S (y-axis) against u / cm (x-axis).

[5]

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

G = ... [1]

(ii) Calculate the focal length f of the lens, where $f = \frac{1}{G}$ cm.

f = ... [1]

[Total: 10]

18 The IGCSE class is determining the magnification of an image produced by a lens.

The apparatus is shown in Fig. 4.1.

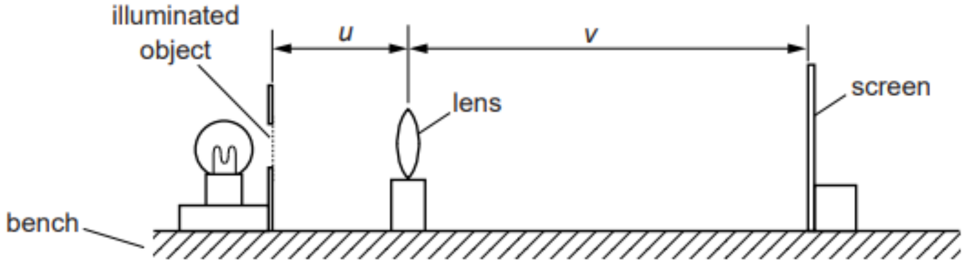


Fig. 4.1

(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.

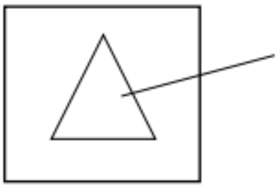


Fig. 4.2 (full size)

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]

19 The IGCSE class is investigating refraction of light through a transparent block.

Fig. 4.1 shows a student's ray-trace sheet.

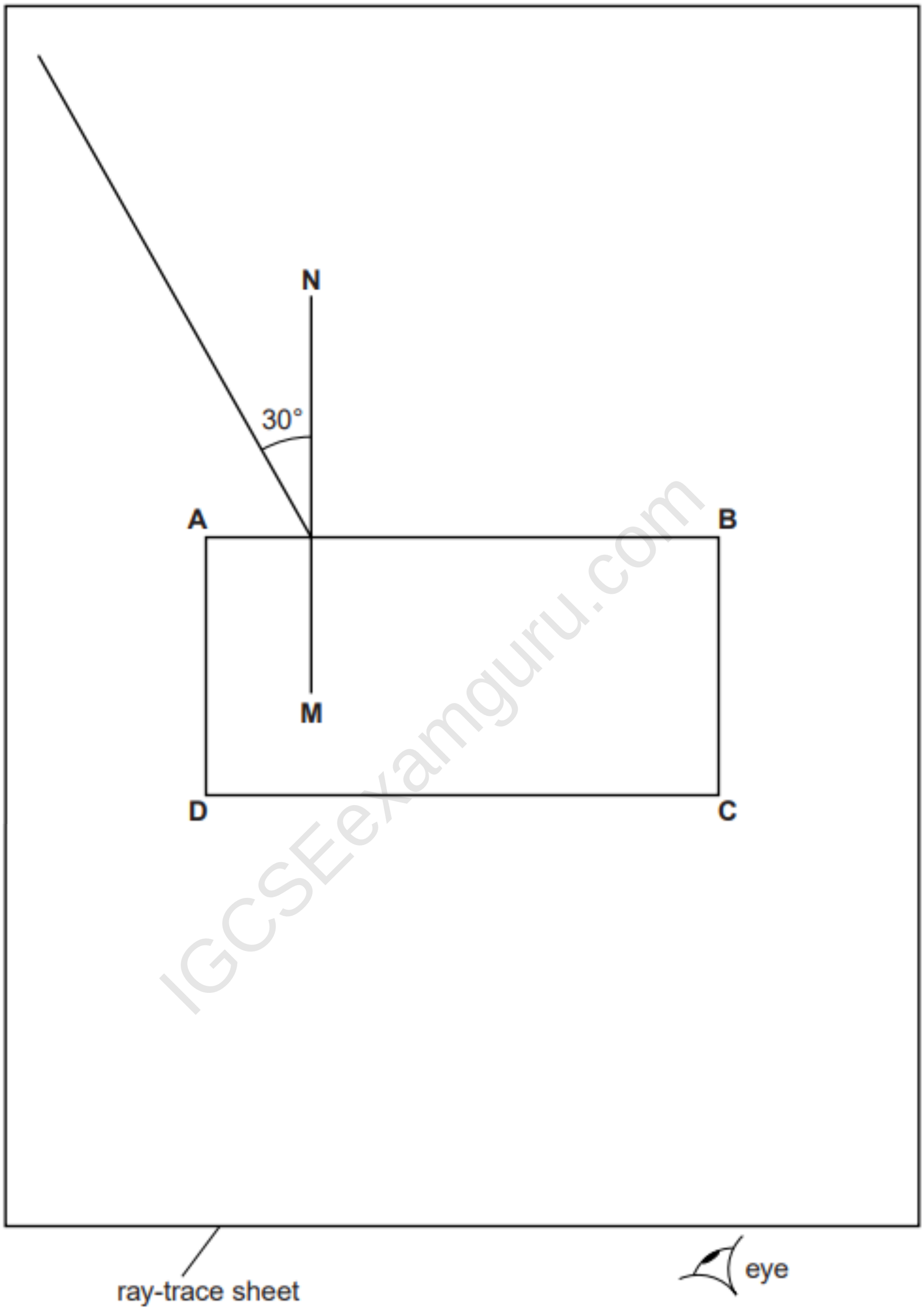


Fig. 4.1

(a) **(i)** On Fig. 4.1, label the point **F** at which the incident ray crosses the normal **NM**. Label the other end of the ray **E**.

(ii) On Fig. 4.1, draw a refracted ray from **F**, at an angle of refraction $r = 20°$, to meet side **CD** of the block. Label the point **G** at which this ray meets side **CD** of the block.

[1]

(b) Predict and draw on Fig. 4.1 the line of the ray that emerges from the block at point **G**. Label the end of your line **H**. [2]

(c) To obtain the correct positions for the emergent ray in this experiment, the student places two pins P_1 and P_2 on line **EF**. He 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.

He places two pins P_3 and P_4 between his eye and the block so that P_3, 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 the positions of the pins P_3 and P_4 at a suitable distance apart for this experiment. [1]

(ii) State two precautions that you should take in this experiment to obtain reliable results.

1. ....

....

2. ....

....

[2]

(d) The student repeats the experiment with the block turned through 90°, as shown in Fig. 4.2. He measures the angle of refraction *r*.

r = ...22°...................... .

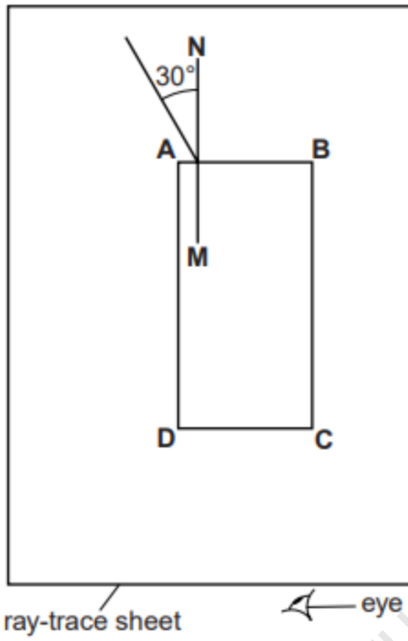


Fig. 4.2

He suggests that the value of *r* should be the same in both experiments because the material of the block has not changed.

State whether the results support this suggestion. Justify your answer by reference to the results.

statement ....

justification ....

....

[1]

[Total: 7]

20 The class is investigating the refraction of light passing through a transparent block.

Fig. 4.1 shows a student's ray-trace sheet.

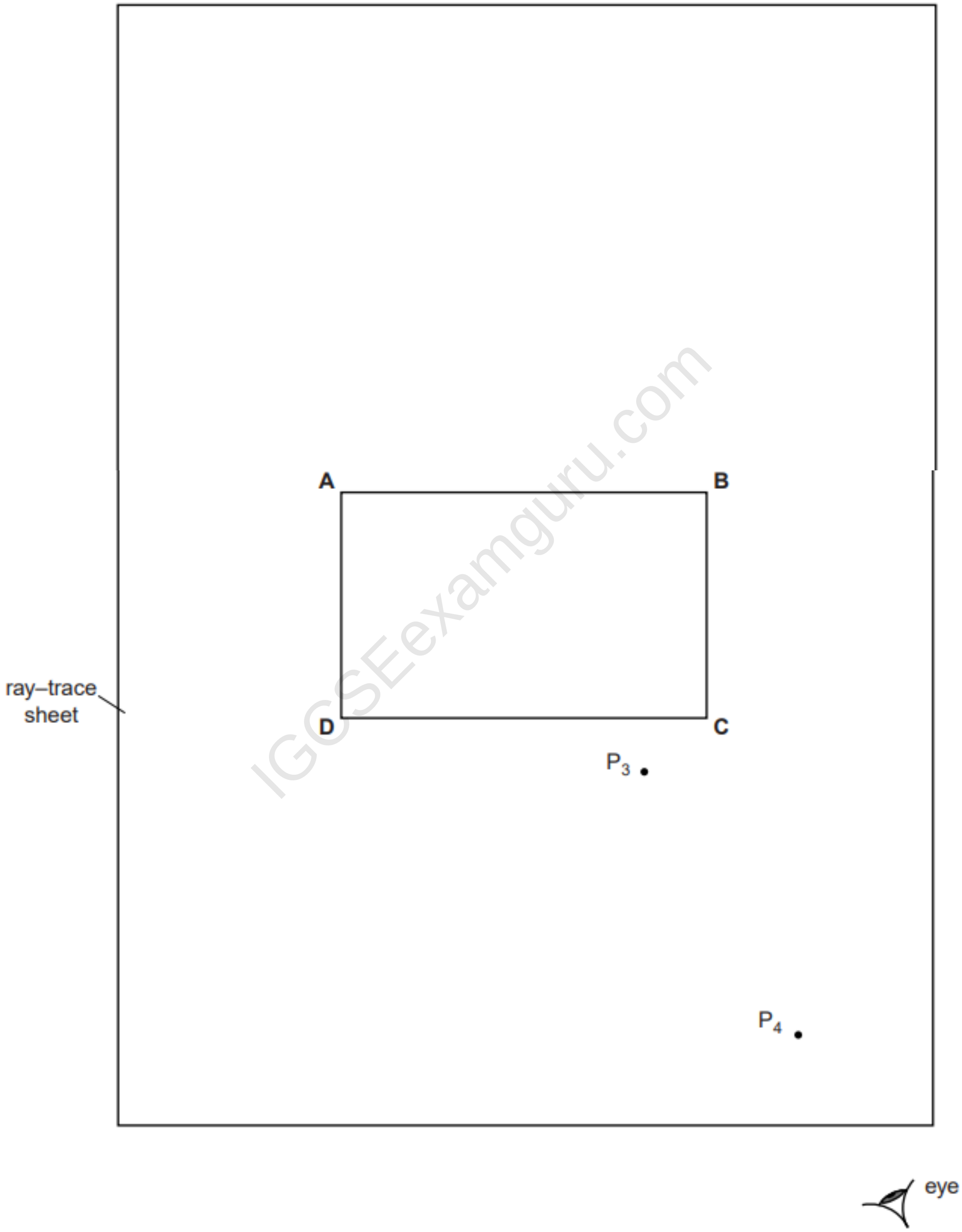


Fig. 4.1

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.

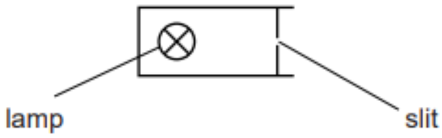


Fig. 4.2

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]

21 The class is investigating reflection using a plane mirror.

Fig. 4.1 shows a student's ray-trace sheet. The student uses an A4 sheet of plain paper.

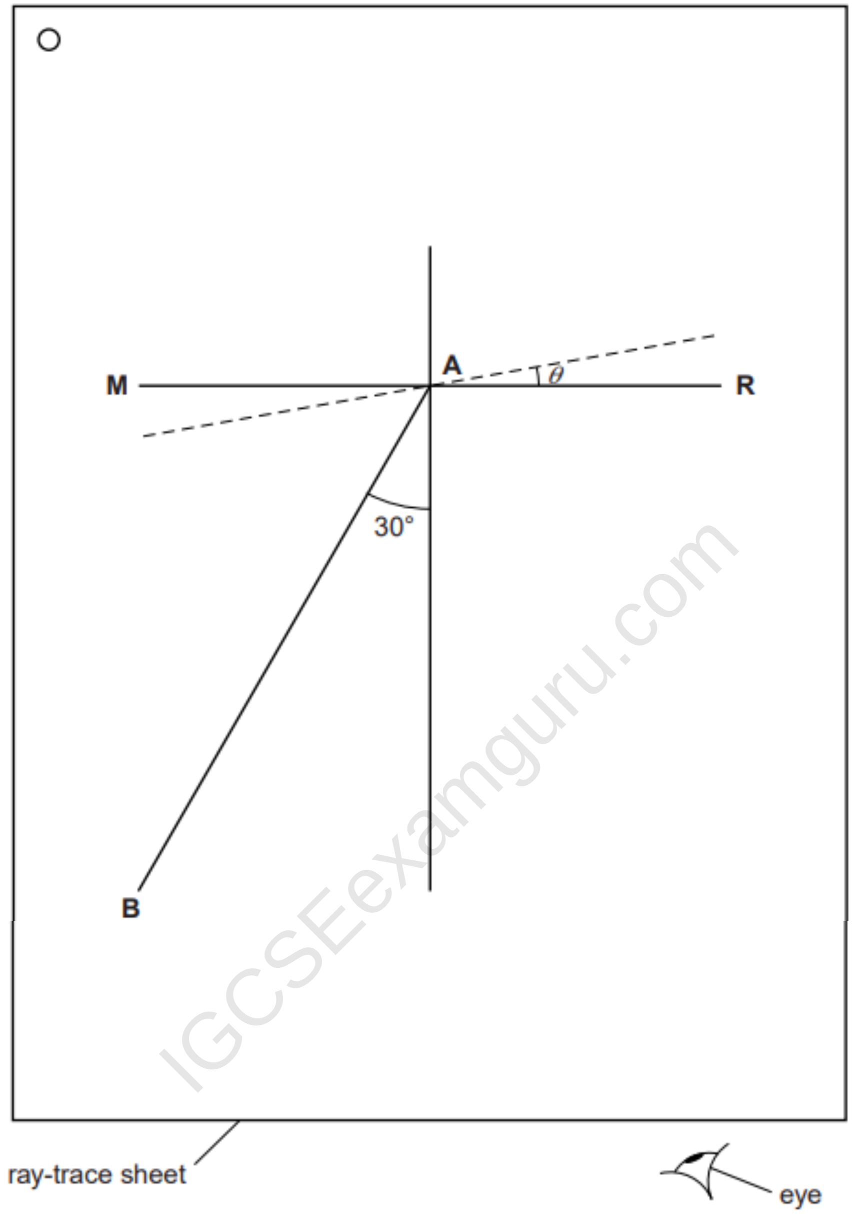


Fig. 4.1

(a) On Fig. 4.1, the mirror is placed along the line **MR**. Label the normal **NL**. [1]

(b) The student places two pins P_1 and P_2 on line **AB** at a suitable distance apart, so that she can accurately observe the reflection of line **AB**.

Suggest a suitable distance between the two pins.

distance = ...[1]

(c) The student determines the angle between the reflected ray and the normal by viewing 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_3 and P_4, and the images of P_2 and P_1, all appear exactly one behind the other. She draws a line joining the positions of P_3 and P_4.

She measures the angle α between the normal 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°, as shown in Table 4.1.

She moves the mirror to a new position, shown by the dotted line on Fig. 4.1, at an angle θ = 10° to **MR**. She repeats the procedure with pins P_3 and P_4.

She continues using angles θ = 20°, 30° and 40°. The readings are shown in Table 4.1.

Table 4.1

θ/°	α/°
0	32
10	50
20	69
30	92
40	108

(i) Plot a graph of α/° (*y*-axis) against θ/° (*x*-axis).

[5]

(ii) State whether your graph line shows that the angle α is directly proportional to the angle θ. Justify your statement by reference to your graph line.

statement ....

justification ....

.... [2]

(iii) Suggest why, when this experiment is carried out carefully, the points plotted may not all lie on the graph line.

....

.... [1]

[Total: 10]

22 A student is determining the focal length of a converging lens by two methods.

First, he uses the apparatus shown in Fig. 4.1.

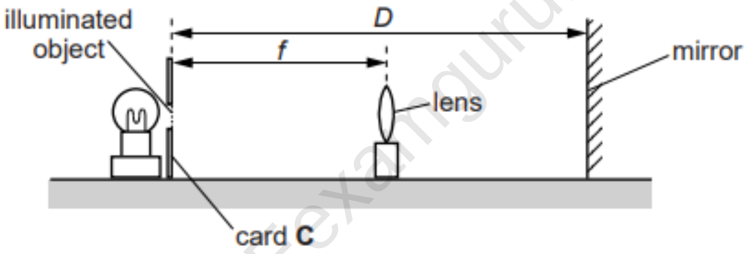


Fig. 4.1

(a) He sets the distance *D* between the mirror and the illuminated object to 30.0 cm.

He then moves the lens until a sharp image appears on card **C** by the side of the illuminated object.

(i) On Fig. 4.1, measure the distance *f* between the illuminated object and the lens.

f = ...[1]

(ii) Fig. 4.1 is drawn to 1/5th scale.

Calculate, and record in Table 4.1, the actual distance *F* between the illuminated object and the lens. *F* is a value for the focal length of the lens in this experiment.

Table 4.1

D / cm	*F* / cm
30.0	
50.0	15.7

[1]

(b) The student repeats the procedure for a distance D = 50.0 cm. His result is shown in the table.

Use the results from the table to calculate F_1, an average value of F.

F_1 = ...[1]

(c) The student arranges the lens, illuminated object and a screen as shown in Fig. 4.2.

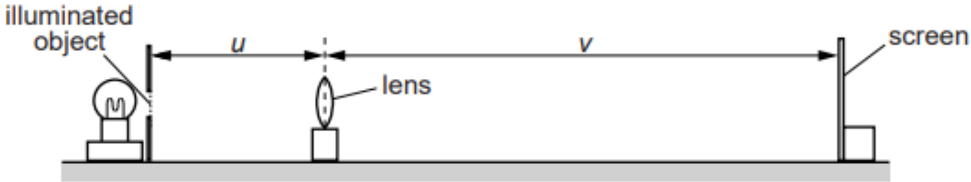


Fig. 4.2

He measures the distance u between the illuminated object and the lens.

He moves the screen until a sharp image of the illuminated object appears on the screen, and measures the distance v between the lens and the screen.

His readings are: u = 20.0 cm

v = 72.5 cm

(i) Calculate F_2, another value for the focal length of the lens, using the student's results and the equation $F_2 = \frac{uv}{(u + v)}$.

F_2 = ...[1]

(ii) A student suggests that F_1 and F_2 should be equal.

State whether your findings support this idea. Justify your statement by reference to the results.

statement ....

justification ....

....

[2]

(d) Describe a precaution that you would take in order to obtain reliable results in this experiment.

....

....[1]

[Total: 7]

23 The class is investigating the image formed by a converging lens.

Fig. 5.1 shows the experimental set up.

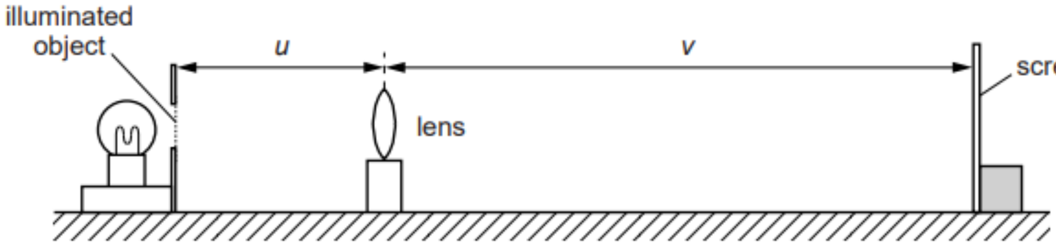


Fig. 5.1

A 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.

The student measures the distances *u* and *v*, as shown in Fig. 5.1.

u = ...25.8 cm..........

v = ...36.2 cm..........

(a) Calculate the focal length *f* of the lens using the equation $f = \frac{uv}{(u + v)}$. Give your answer to a suitable number of significant figures for this experiment.

f = ...[2]

(b) State two precautions you would take in the laboratory in order to obtain reliable measurements when doing this experiment.

1. ....

2. ....

[2]

(c) The object in Fig. 5.1 is an illuminated triangle, as shown in Fig. 5.2.

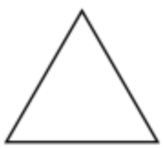


Fig. 5.2

Suggest two differences between the appearance of the illuminated object and the well-focused image on the screen.

1. ....

2. ....

[2]

[Total: 6]

24 The class is investigating reflection using a plane mirror.

Fig. 3.1. shows a student's ray-trace sheet.

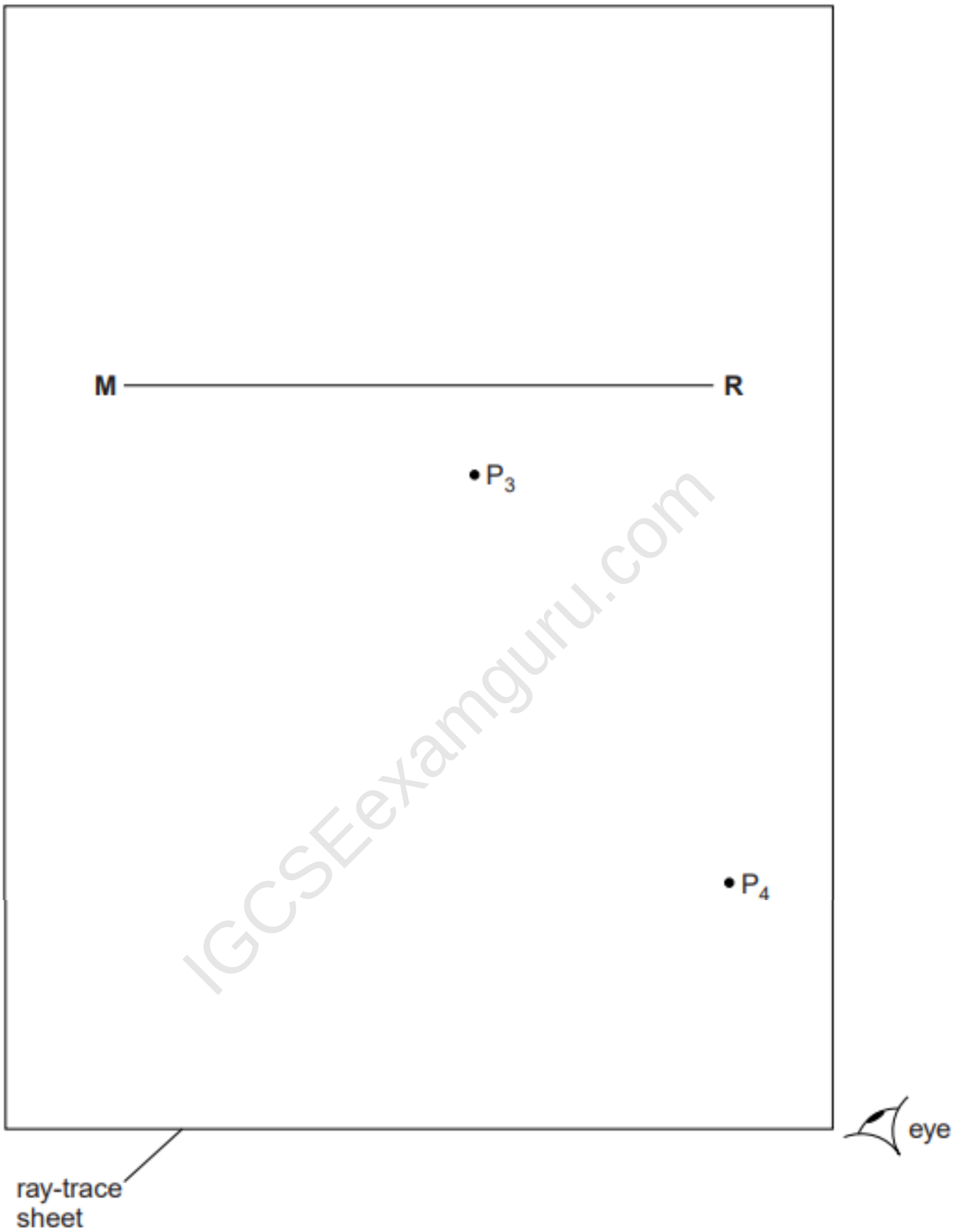


Fig. 3.1

(a) The student draws the line **MR** to mark the position of a plane 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 **A**.

(ii) Draw a line 8.0 cm long from **A** 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 **B**.

[3]

(b) The student places a pin P_1 at point **B**. He places a second pin P_2 on line **AB**.

Label a position **X** on line **AB** to show a suitable position for pin P_2. [1]

(c) He views the images of pins P_1 and P_2 from the direction indicated by the eye in Fig. 3.1. He places two pins P_3 and P_4, a suitable distance apart, 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. 3.1.

(i) Draw the line joining the positions of P_3 and P_4. Extend the line until it meets **NL**.

(ii) Measure the angle r between **NL** and the line joining the positions of P_3 and P_4.

r = ...

[2]

(d) State two precautions that you would take in this experiment in order to obtain reliable readings.

1. ....

....

2. ....

....

[2]

(e) A student has done this experiment very carefully, taking these precautions.

She is disappointed to find that her line for the reflected ray is not exactly where she predicts from the theory.

Suggest a practical reason for this.

....

....[1]

[Total: 9]

25 The class is doing a lens experiment.

Fig. 5.1 shows some of the apparatus used.

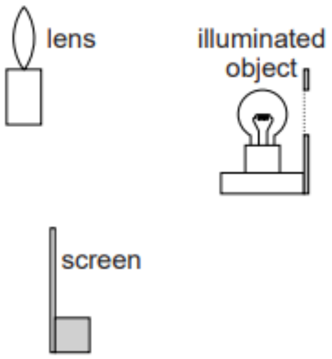


Fig. 5.1

(a) Draw a diagram to show how the apparatus shown in Fig. 5.1 is arranged for an experiment to determine the focal length of the lens. The laboratory bench is drawn for you.

[2]

(b) The focal length of the lens is known to be approximately 15 cm.

Suggest a suitable distance *d* between the illuminated object and the screen so that a well-focused image can be seen on the screen.

d = ... cm [1]

(c) Suggest two practical difficulties that may cause inaccuracy in the value of focal length obtained.

1. ....

....

2. ....

....

[2]

(d) Fig. 5.2 shows the shape of the illuminated object.

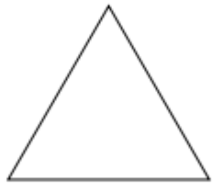


Fig. 5.2

In the space below, draw a diagram to show the focused image that you would expect to see on the screen. [1]

[Total: 6]

26 A student is investigating the refraction of light in a transparent block. Her ray-trace will be used to determine a quantity known as the refractive index of the material of the block.

Fig. 5.1 shows her ray-trace sheet.

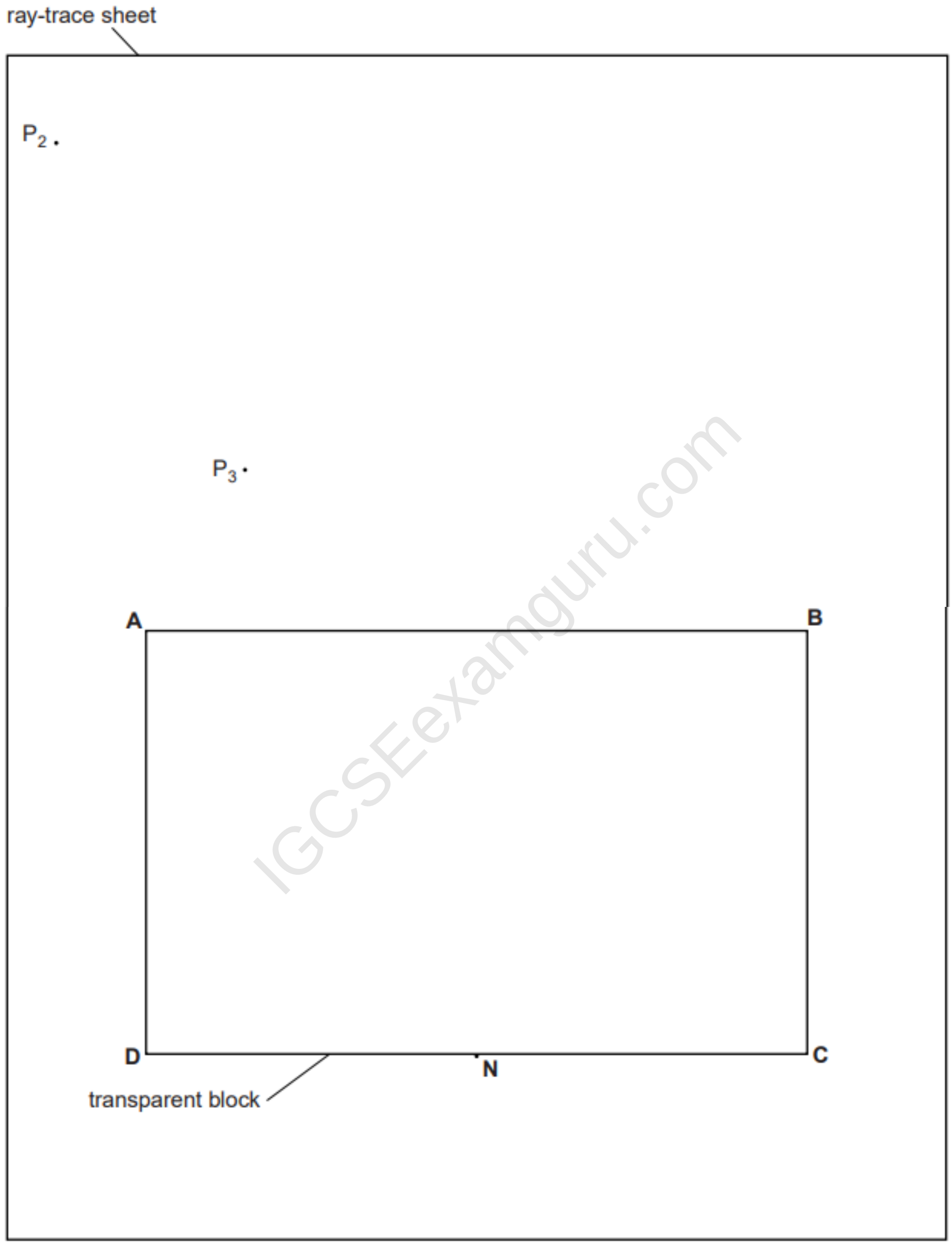


Fig. 5.1

The student draws the outline **ABCD** of the transparent block.

(a) Draw a normal to the line **DC** through point **N**. Extend the normal beyond line **AB**.

Label the upper end of the normal with the letter **L**. Label the point at which **NL** crosses **AB** with the letter **E**. [1]

(b) The student places a pin P_1 against the block at point **N** and views the image of P_1 through the side **AB** of the block.

She places two pins P_2 and P_3, as shown in Fig. 5.1, so that pins P_2 and P_3, and the image of P_1, all appear exactly one behind the other.

(i) Draw a line joining the positions of P_2 and P_3. Extend this line until it crosses **NL**. Label the point at which the line crosses **NL** with the letter **F**. [1]

(ii) Measure the length *a* of line **EN**.

a = ...

(iii) Measure the length *b* of line **EF**.

b = ...
[2]

(c) Calculate a value *n* for the refractive index of the block, using your values from **(b)(ii)** and **(b)(iii)** and the equation $n = \frac{a}{b}$.

n = ...[1]

(d) Suggest a practical precaution that you would take to ensure a reliable result in this type of experiment.

....

....[1]

(e) The student obtains a second value for the refractive index *n* by repeating the experiment with the block standing on edge, as shown in Fig. 5.2.

She views the image of P_1 from the direction indicated by the arrow. The block is 1.5 cm thick.

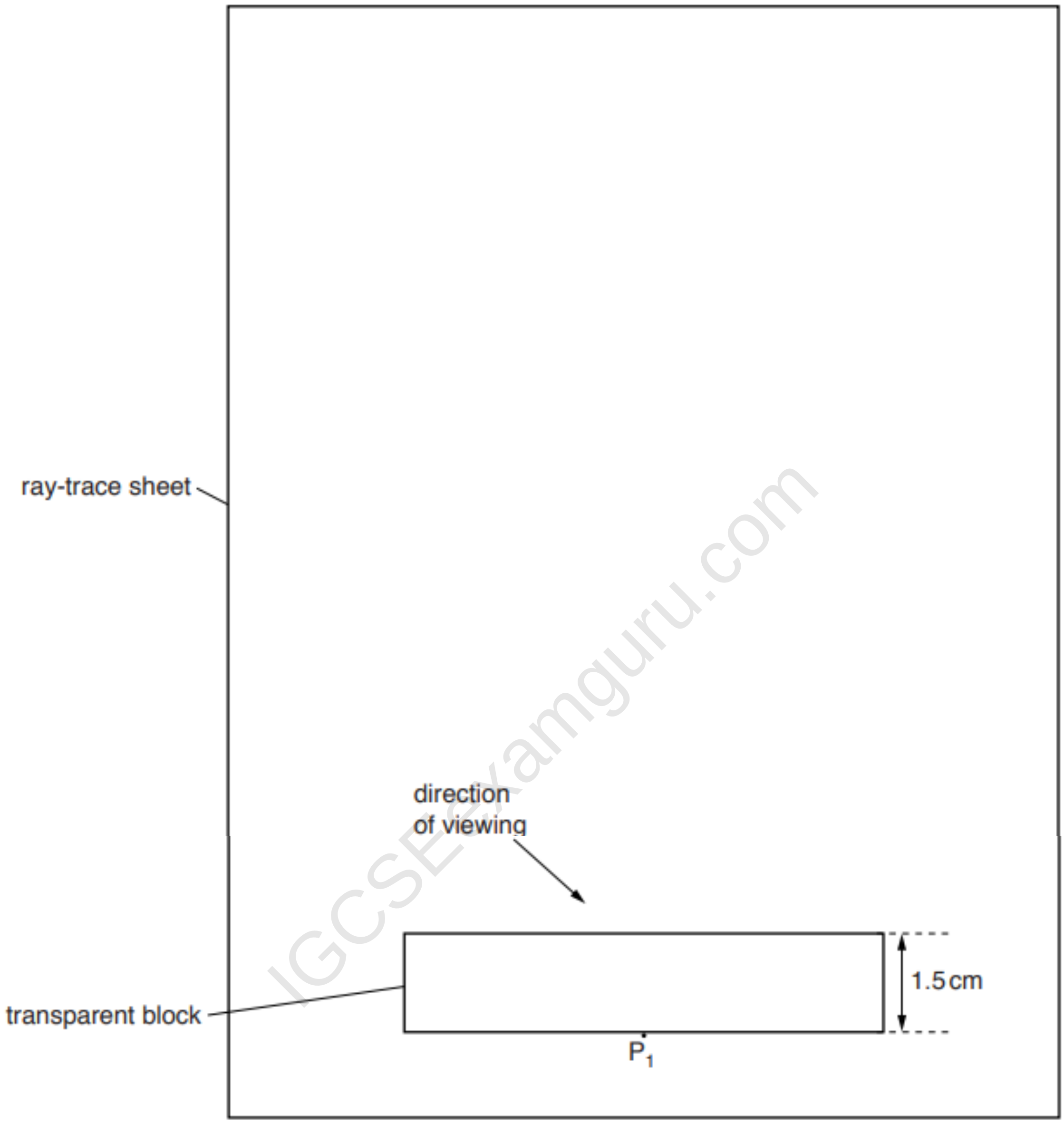


Fig. 5.2

State and explain whether this value for the refractive index is likely to be more or less reliable than the value *n* obtained for the refractive index in part **(c)**.

statement ....

explanation ....

....

....

[2]

[Total: 8]