Light

Question Paper 6

Level	IGCSE
Subject	Physics
Exam Board	CIE
Topic	Properties of Waves. Including Light and Sound
Sub-Topic	Light
Paper Type	Alternative to Practical
Booklet	Question Paper 6

Time Allowed: **63 minutes**

Score: **/52**

Percentage: **/100**

1 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.

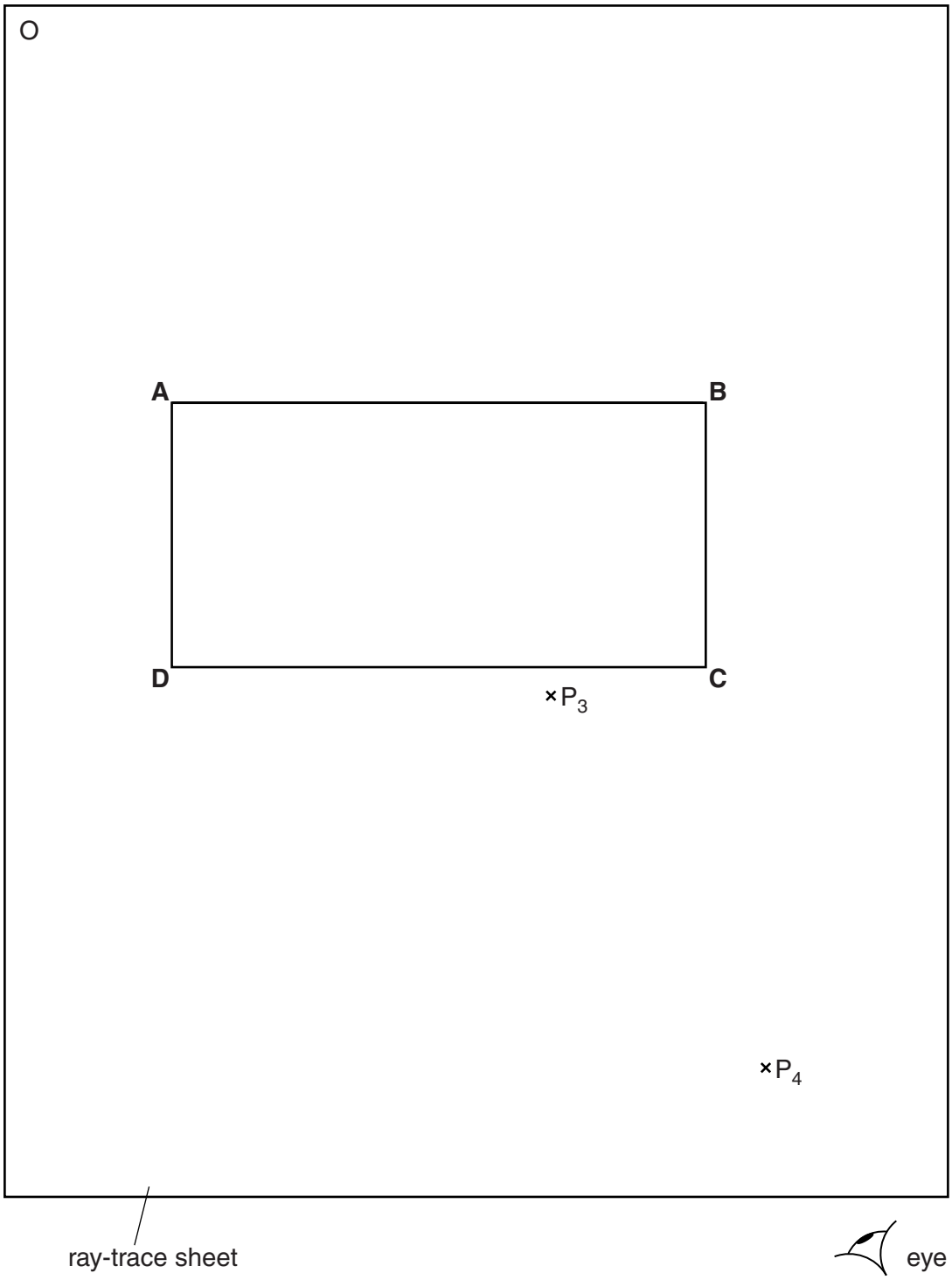


Fig. 4.1

(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]

2 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]

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

The apparatus is shown in Fig. 4.1.

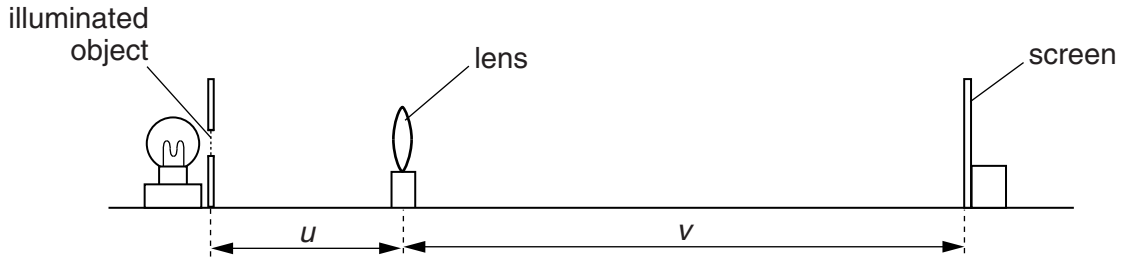


Fig. 4.1

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

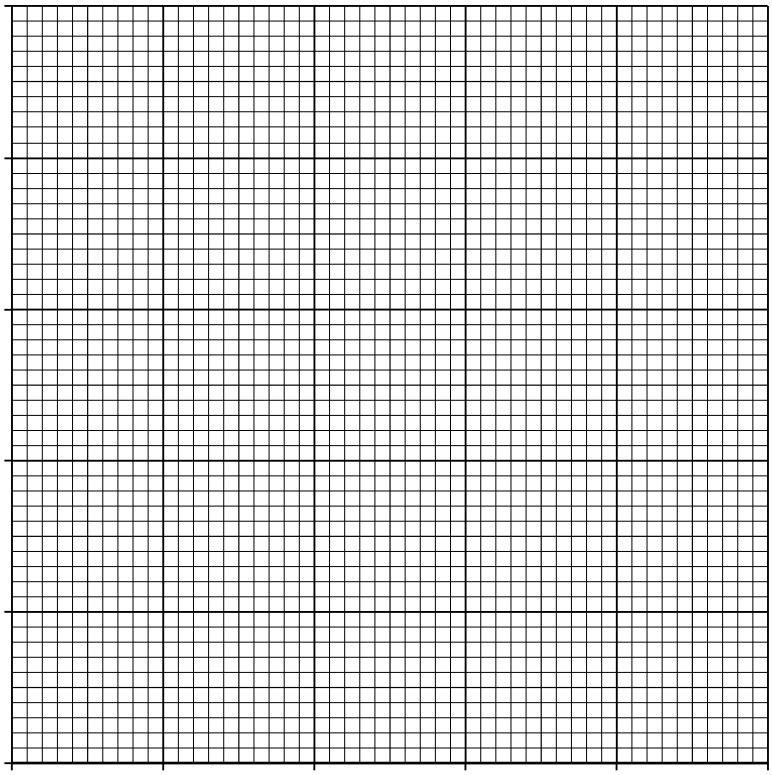
u/cm	v/cm	uv/	d/
30.0	29.8		59.8
45.0	22.0		67.0
50.0	21.8		71.8
55.0	21.0		76.0
60.0	19.9		79.9

(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]

4 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.

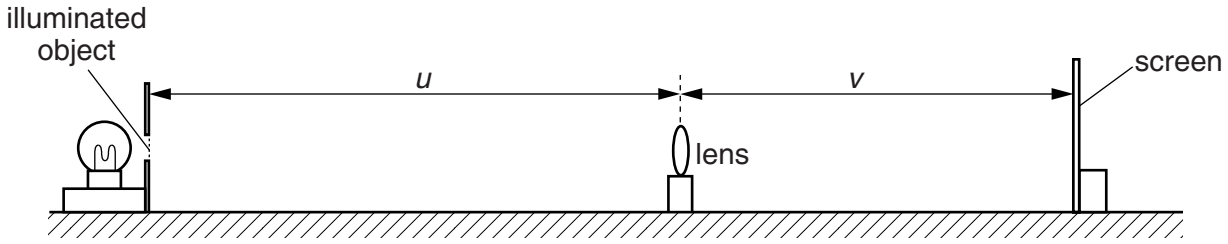


Fig. 4.1

(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.

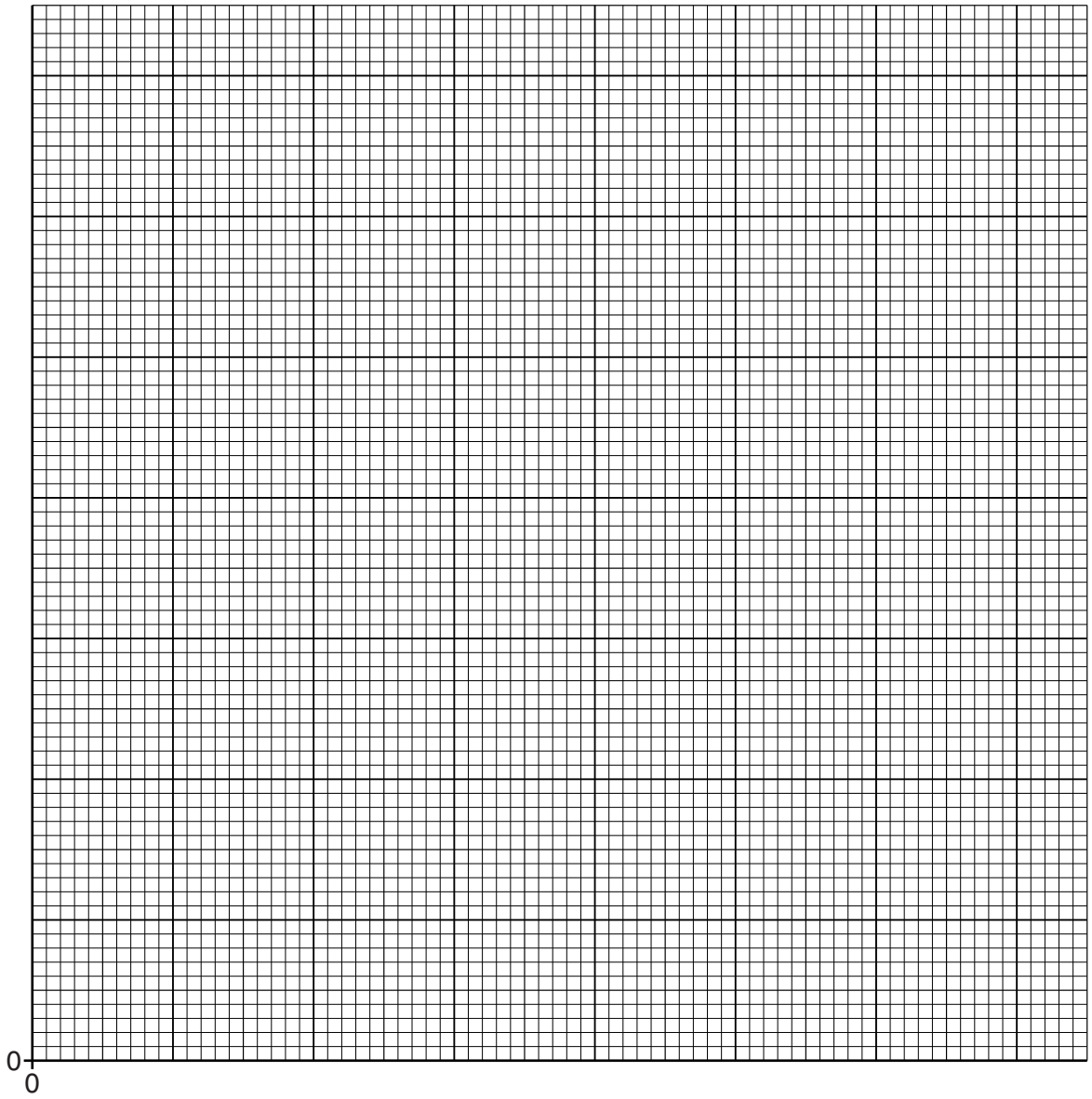
Complete the table by calculating values of $\frac{1}{u}$ and $\frac{1}{v}$ as necessary.

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]

5 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.

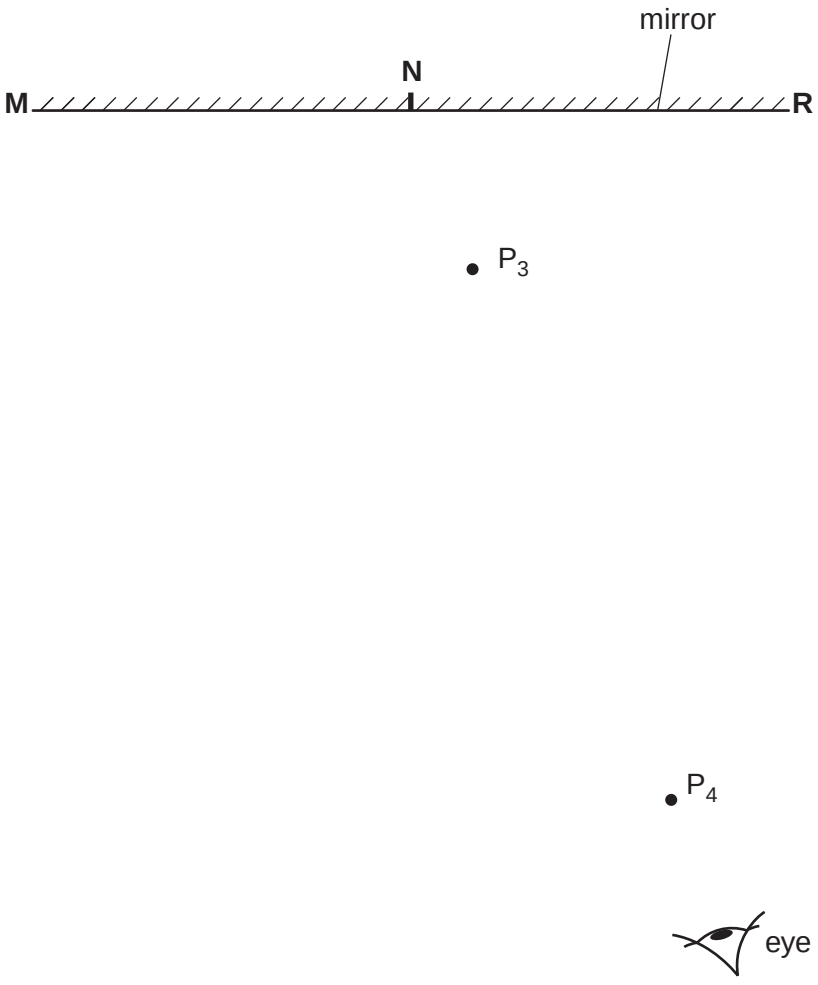


Fig. 4.1

(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]

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

Fig. 4.1 shows a student's ray trace sheet. It is not drawn full size.

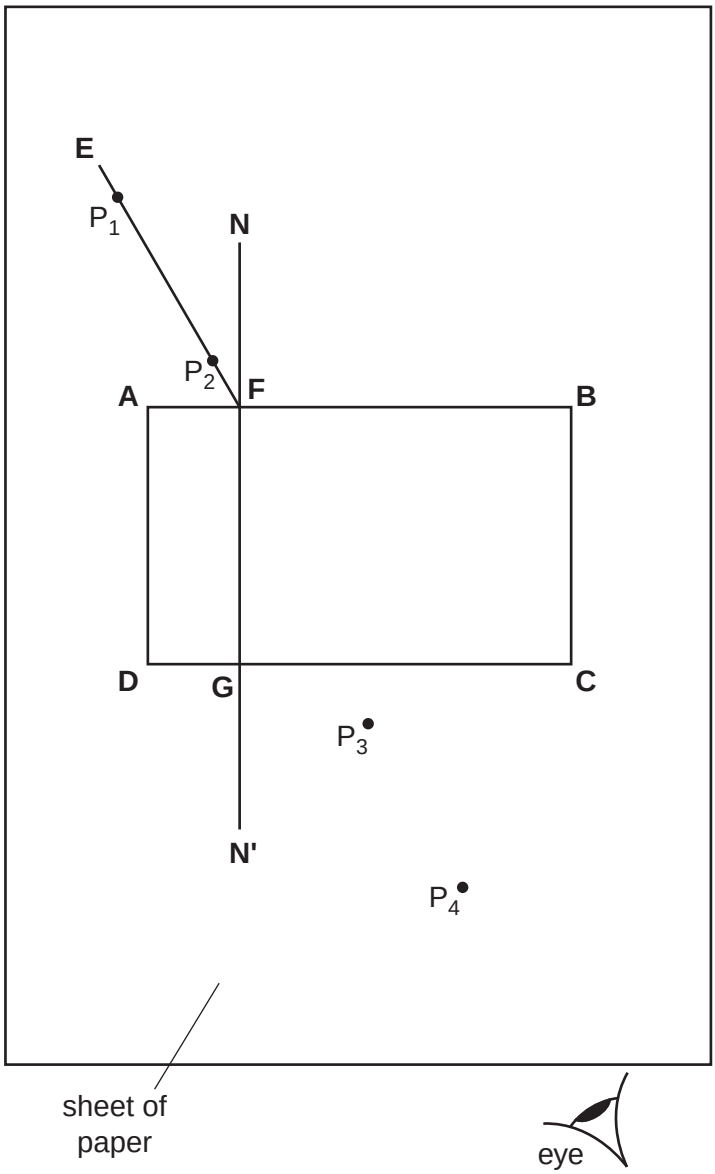


Fig. 4.1

(a) The student places a transparent block, largest face down, on a sheet of plain paper and draws the outline **ABCD** of the block. She removes the block and draws the normal **NN'** to side **AB**. She then draws the line **EF** at an angle of incidence *i*.

On Fig. 4.1, measure the angle of incidence *i*.

i = ...[1]

(b) She places two pins P_1 and P_2 on line **EF**, as shown in Fig. 4.1, and replaces the block. 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, 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, 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 = ...

(v) Calculate the refractive index *n* of the material of the block using the equation $n = \frac{b}{2a}$.

n = ...
[5]

(c) **(i)** Suggest how far apart you would place the pins P_3 and P_4 if you were carrying out this experiment using a ray trace sheet the same size as this page.

suggested distance = ...

(ii) Give a reason for your answer to **(i)**.

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

(d) This experiment may be carried out using a ray of light, produced by a ray box, instead of by using optical pins. A student suggests that the ray box method will be more accurate. Assuming that the experiment is carried out with care, suggest one possible cause of inaccuracy using the optical pin method and one using the ray box method.

optical pin method .....

.....

ray box method .....

.....[2]

[Total: 10]