Light

Question Paper 1

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 1

Time Allowed: **62 minutes**

Score: **/51**

Percentage: **/100**

1 A student determines the focal length of a lens.

The apparatus is shown in Fig. 5.1.

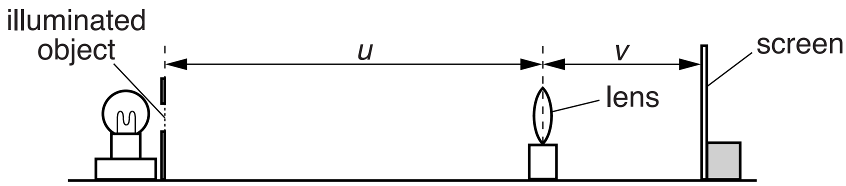

Fig. 5.1

(a) The student places the lens at a distance u from the illuminated object. He moves the screen until a sharply focused image of the object is seen on the screen.

On Fig. 5.1,

- measure the distance u from the illuminated object to the centre of the lens,

u = ... mm

- measure the distance v from the screen to the centre of the lens.

v = ... mm
[1]

(b) Fig. 5.1 is drawn 1/10th actual size.

(i) • Calculate the actual distance U from the illuminated object to the centre of the lens.

U = ... mm

• Calculate the actual distance V from the screen to the centre of the lens.

V = ... mm
[1]

(ii) Calculate a value f_1 for the focal length of the lens using the equation $f_1 = \frac{UV}{(U + V)}$.

f_1 = ... mm
[2]

(c) A second student repeats the experiment three times using a different lens. His values for the focal length of his lens are shown in Table 5.1.

Table 5.1

	1	2	
focal length / mm	132	141	135

Calculate the average value f_2 for the focal length of this student's lens.

f_2 = ... mm [1]

(d) A third student, using the same method, finds that the focal length f of her lens is 200 mm.

She reads in a book that when $u = 2f$, the distances u and v, as shown in Fig. 5.1, are equal.

- Calculate $2f$ for this student's lens.

$2f$ = ... mm

The student sets up the apparatus as shown in Fig. 5.2. She adjusts both x and y to be 400 mm.

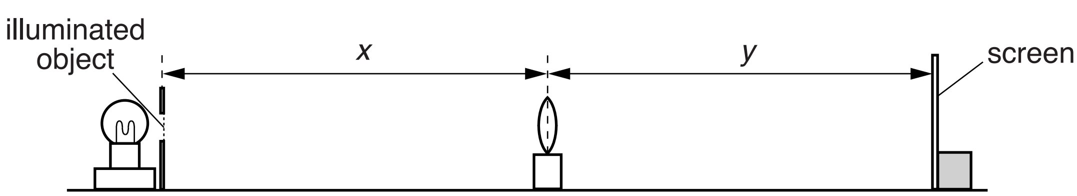

Fig. 5.2

She observes that the image is blurred. The student slowly increases the distance y, and obtains a sharply focused image when y = 406 mm.

Discuss whether the student's results confirm the statement in the book.

....

....

....
[2]

(e) Suggest two precautions that you would take in this investigation in order to obtain reliable results.

1. ....

....

2. ....

....
[2]

[Total: 9]

2 A student is investigating the magnification of images produced by a lens.

The apparatus is shown in Fig. 3.1.

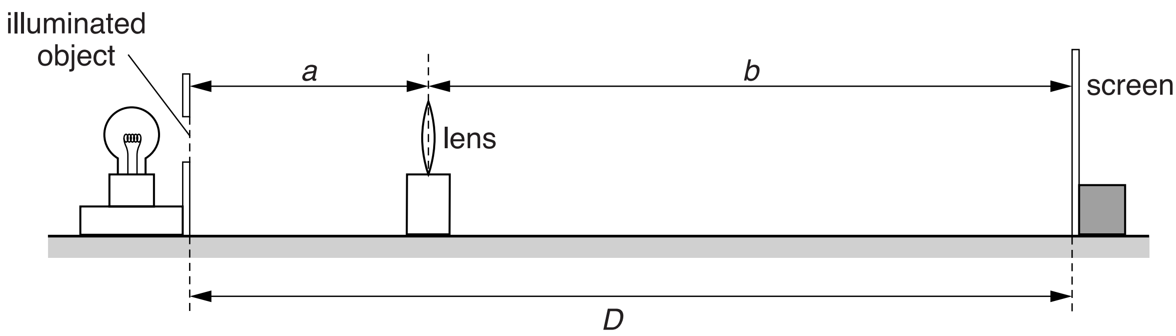

Fig. 3.1

The student places a screen at a distance D = 80.0 cm from an illuminated object. The screen and the illuminated object remain in the same positions throughout the experiment.

(a) She places the lens close to the illuminated object. She moves the lens until she sees a sharply focused, **enlarged** image of the object on the screen.

She measures the distance a from the illuminated object to the centre of the lens.

a = ...20.3 cm........

She measures the distance b from the centre of the lens to the screen.

b = ...59.7 cm........

Calculate the magnification m_1 of the image, using the equation $m_1 = \frac{b}{a}$.

m_1 = ... [1]

(b) The student then moves the lens towards the screen until a **smaller**, sharply focused image of the object is seen on the screen.

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

x = 60.2 cm

She measures the distance *y* from the centre of the lens to the screen.

y = 19.8 cm

Calculate the magnification m_2 of the image, using the equation $m_2 = \frac{y}{x}$.

m_2 = ... [1]

(c) A student suggests that $m_1 \times m_2$ should equal 1.

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

statement ....

justification ....

.... [2]

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

1. ....

....

2. ....

.... [2]

(e) Suggest one reason why it is difficult, in this type of experiment, to decide on the best position of the lens to obtain a sharply focused image on the screen.

....

....[1]

[Total: 7]

3 A student notices that the size of the image produced by a converging lens changes when the lens is moved further away from an object.

Plan an experiment to investigate how the size of the image varies with the object distance for a converging lens suitable for school experiments.

Write a plan for the experiment, including:

- a labelled diagram of the apparatus needed
- instructions for carrying out the experiment
- the factors that will limit the range of object distances
- the graph you will plot
- one precaution you will take to ensure reliable results, explaining what might be the effect of not taking this precaution.

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....[7]

[Total: 7]

4 A student is investigating the refraction of light by a transparent block. She uses her results to determine a quantity known as the refractive index for the material of the block.

The student's ray-trace sheet is shown in Fig. 3.1.

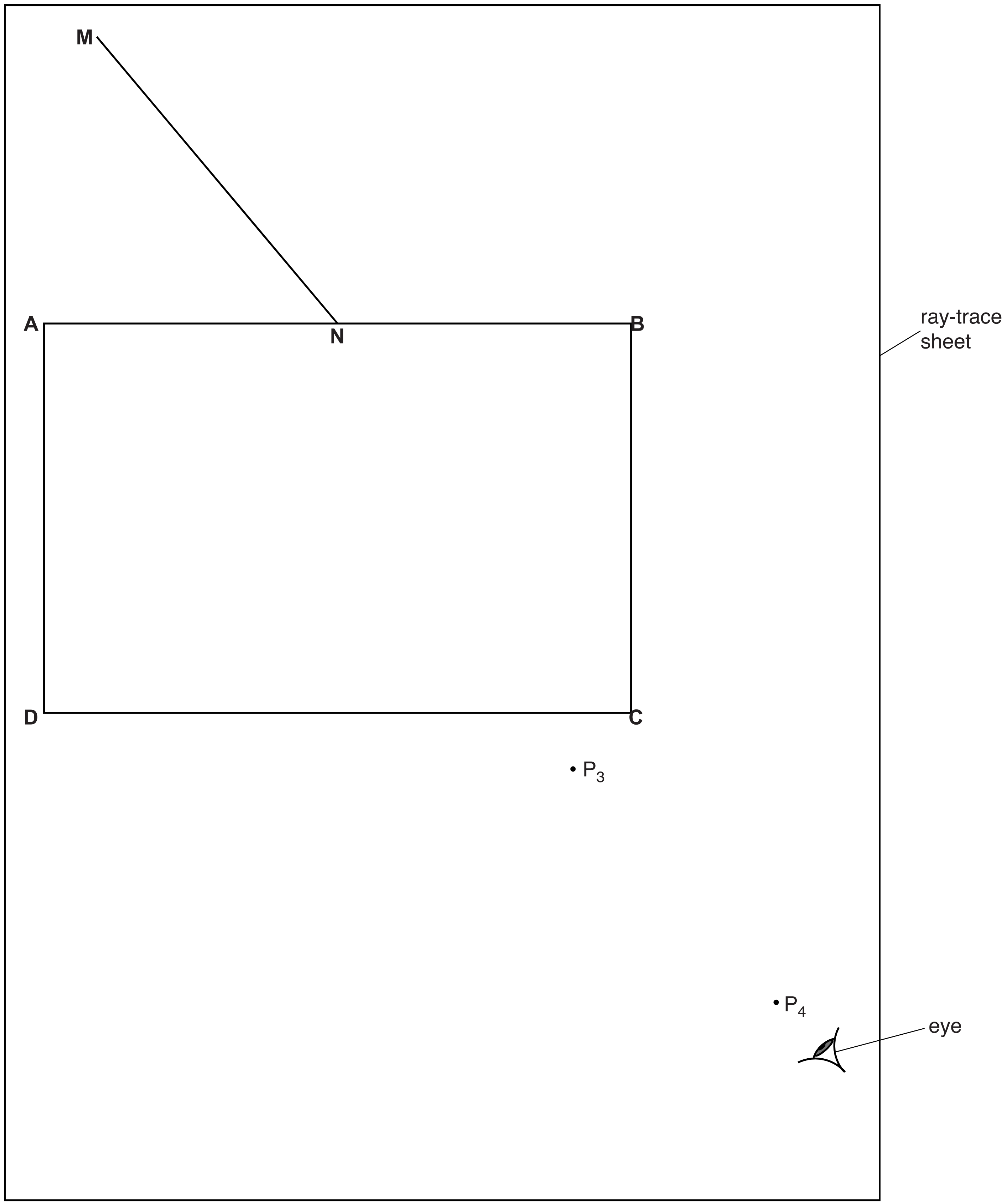

Fig. 3.1

(a) The student places a transparent block **ABCD** on the ray-trace sheet, as indicated in Fig. 3.1. She draws a line **NM**.

(i) • Draw a normal to line **AB** at point **N**. The normal should start above **AB** and extend below **AB** so that it crosses line **CD**.

• Label the point at which the normal crosses **CD** with the letter **L**.

[1]

(ii) Measure the angle θ between the normal and line **NM**.

θ = ...[1]

(b) The student places two pins P_1 and P_2 on line **NM**, a suitable distance apart.

On Fig. 3.1, mark and label appropriate positions for P_1 and P_2. [1]

(c) The student views the images of P_1 and P_2 through the block, from the direction indicated by the eye in Fig. 3.1.

She places two pins P_3 and P_4, as shown in Fig. 3.1, so that pins P_3 and P_4, and the images of P_1 and P_2, all appear exactly one behind the other.

(i) • Draw a line joining P_3 and P_4. Extend this line until it meets **NL**.

• Label the point at which this line crosses **CD** with the letter **E**, and the point at which it meets **NL** with the letter **F**.

• Draw a line joining points **N** and **E**.

• Measure the length a of line **NE**.

a = ...

• Measure the length b of line **FE**.

b = ...

[2]

(ii) Calculate a value n for the refractive index, using the equation $n = \frac{a}{b}$.

n = ...[2]

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

1. ....

....

2. ....

....

[2]

[Total: 9]

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

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

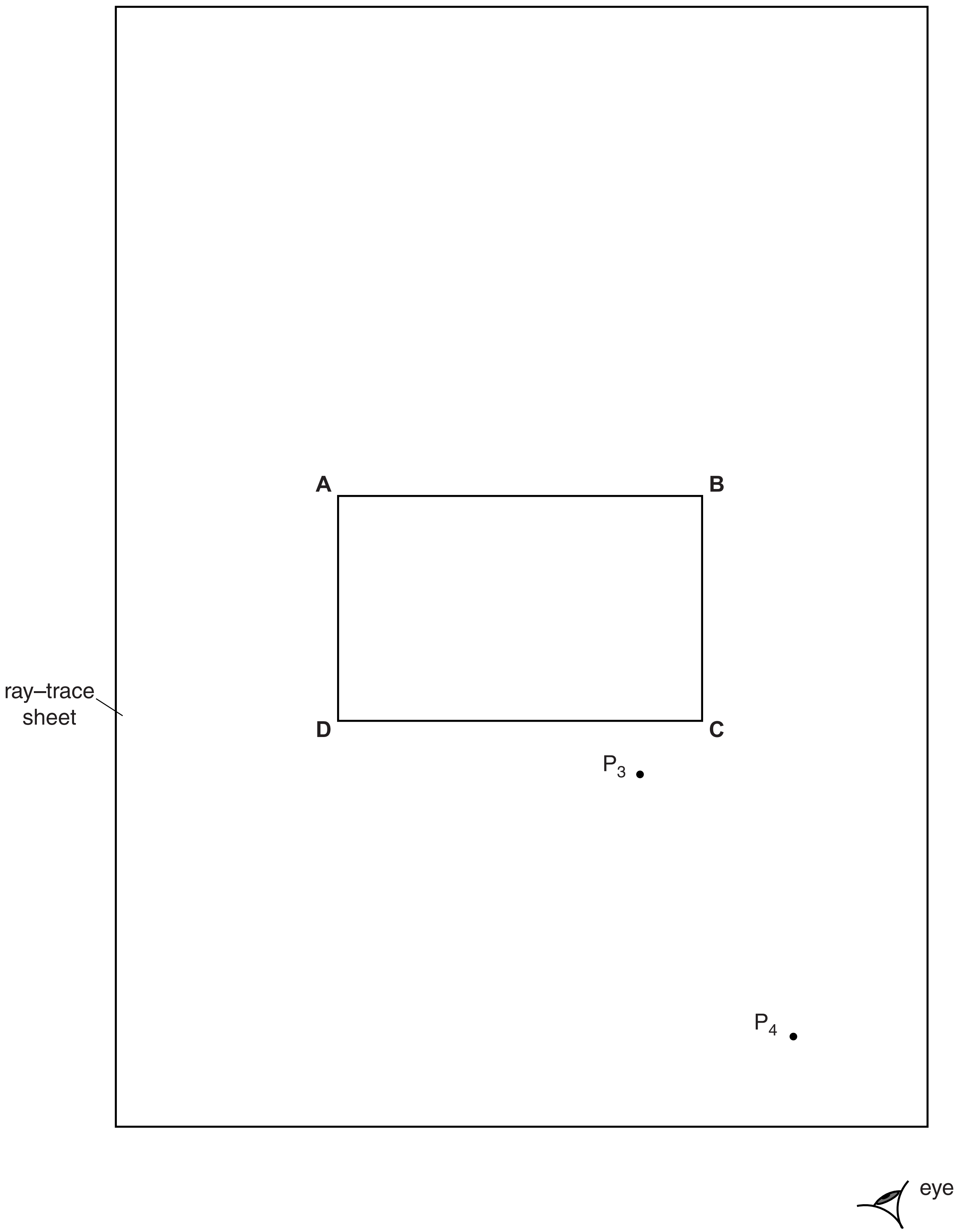

Fig. 4.1

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.

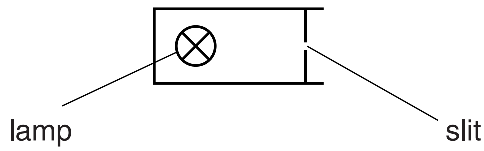

Fig. 4.2

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]

6 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.

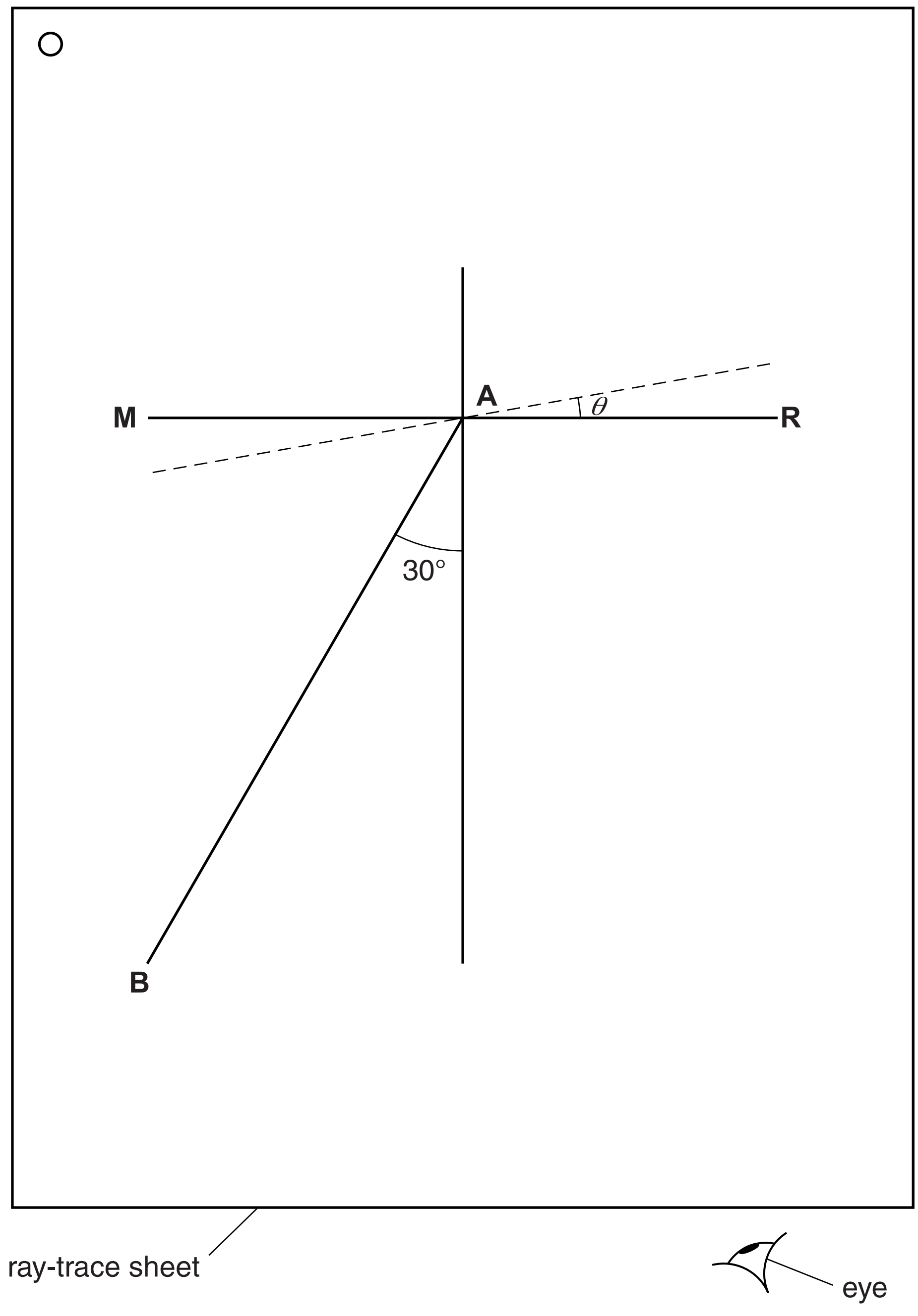

Fig. 4.1

(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 $\theta = 10°$ to **MR**. She repeats the procedure with pins P_3 and P_4.

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

Table 4.1

θ / °	α / °
0	2
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]