Light

Question Paper

Course	CIE IGCSE Physics
Section	3. Waves
Topic	Light
Difficulty	Medium

Time Allowed 80

Score /59

Percentage /100

Question 1a

Some students determine the focal length of a converging lens by two different methods.
They use the apparatus shown in Fig. 2.1.

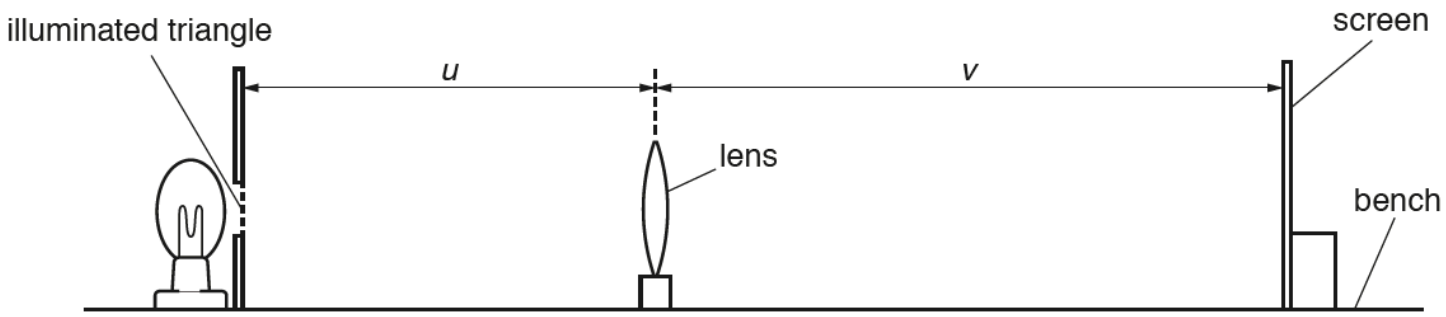


Fig. 2.1

A student sets the distance *U* between the illuminated triangle and the lens.

She moves the screen until a sharp image of the triangle is seen on the screen.

Method 1

The distance *u* between the illuminated triangle and the lens is 5.0 cm
The distance *v* between the lens and the screen is 7.5 cm

(i) Fig. 2.1 is drawn to 1/5th scale.

Calculate the actual distance *U* between the illuminated triangle and the lens in the experiment.

U = ...

Calculate the actual distance *V* between the lens and the screen in the experiment.

V = ...
[1]

(ii) Calculate a value f_1 for the focal length of the lens, using the following equation:

$$f_1 = \frac{UV}{(U+V)}$$

f_1 = ... [1]

(iii) Briefly describe a technique to obtain an image on the screen that is as sharp as possible in this experiment.

[1]

[3 marks]

Question 1b

On Fig. 2.2, the height of the illuminated triangle, h_O is measured to be 1.5 cm.

On Fig. 2.3, the height of the image, h_I, on the screen is measured to be 2.4 cm.

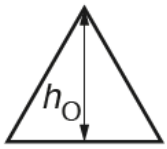


Fig. 2.2

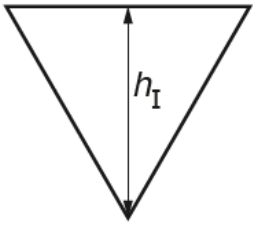


Fig. 2.3

(i) Calculate a value for the magnification *M*, using the following equation:

$$M = \frac{h_I}{h_O}$$

M = ... [1]

(ii) Calculate a second value f_2 for the focal length of the lens, using the value of *V* from **(a)(ii)** and the equation:

$$f_2 = \frac{V}{(M+1)}$$

f_2 = ... [1]

[2 marks]

Question 1c

State **one** precaution that could be taken to ensure that the measurements in the experiment are taken as reliably as possible.

[1 mark]

Question 1d

Suggest which of **Method 1** or **Method 2** is likely to give the more accurate value for the focal length.

Explain the reason for your choice.

[1 mark]

Question 2a

A student is determining the refractive index *n* of the material of a transparent block.

Fig. 3.1 shows the outline **ABCD** of the transparent block.

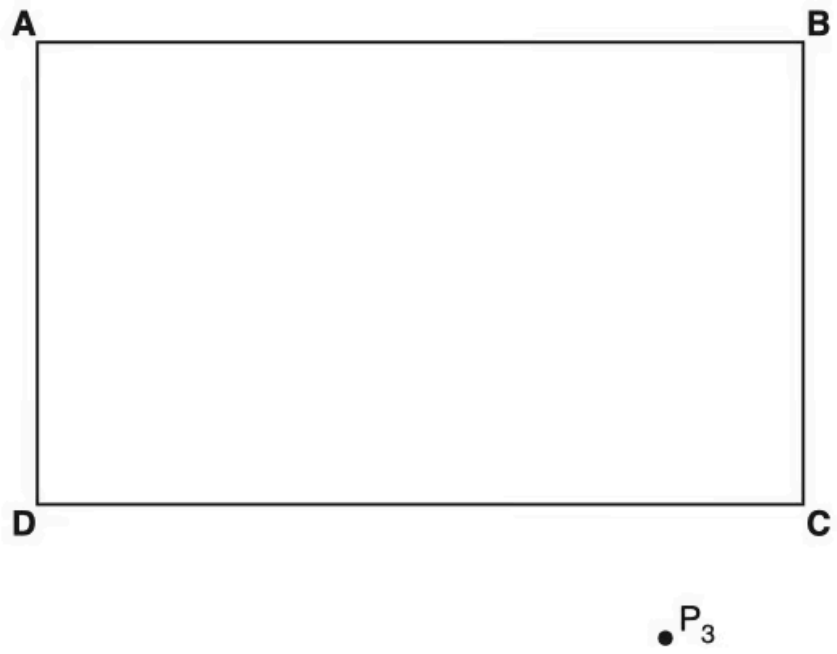


Fig. 3.1

(i) On Fig. 3.1:

- draw a normal **NL** at the centre of side **AB**
- continue the normal so that it passes through side **CD** of the block
- label the point **F** where **NL** crosses **AB**
- label the point **G** where **NL** crosses **CD**.

[1]

(ii) Draw a line **EF** at an angle $i = 30°$ to the left of the normal and above side **AB**.

[1]

(iii) Mark the positions of two pins P_1 and P_2 on line **EF** placed at a suitable distance apart for this type of ray-tracing experiment.

[1]

[3 marks]

Question 2b

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.

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.

The positions of P_3 and P_4 are marked on Fig. 3.1.

- (i) Draw a line joining the positions of P_3 and P_4. Continue the line until it meets the normal **NL**.
- Label the point **H** where the line meets side **CD**. Draw the line **FH**.

[1]

(ii) Measure and record the length *a* of the line **GH**.

a = ... [1]

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

b = ... [1]

(iv) Calculate the refractive index *n* using the following equation:

$$n = \frac{0.5b}{a}.$$

n = ... [1]

[4 marks]

Question 2c

Extended tier only

The student repeats the procedure using the angle of incidence $i = 45°$.

$a = 3.2$ cm

$b = 6.9$ cm

Calculate the refractive index n, using the equation $n = \frac{0.71b}{a}$.

n = ...

[1 mark]

Question 2d

The student expected the two values of refractive index n obtained in this experiment to be equal.

State **two** difficulties with this type of experiment that could explain any difference in the two values of n.

[2 marks]

Question 2e

A student suggests precautions to take in this experiment to obtain reliable results.
Tick **one** box to indicate the most sensible suggestion.

- ☐ Carry out the experiment in a darkened room.
- ☐ Use pins that are taller than the height of the block.
- ☐ View the bases of the pins.
- ☐ View the pins with one eye closed.

[1 mark]

Question 3a

A student investigates the position of the image in a plane mirror.

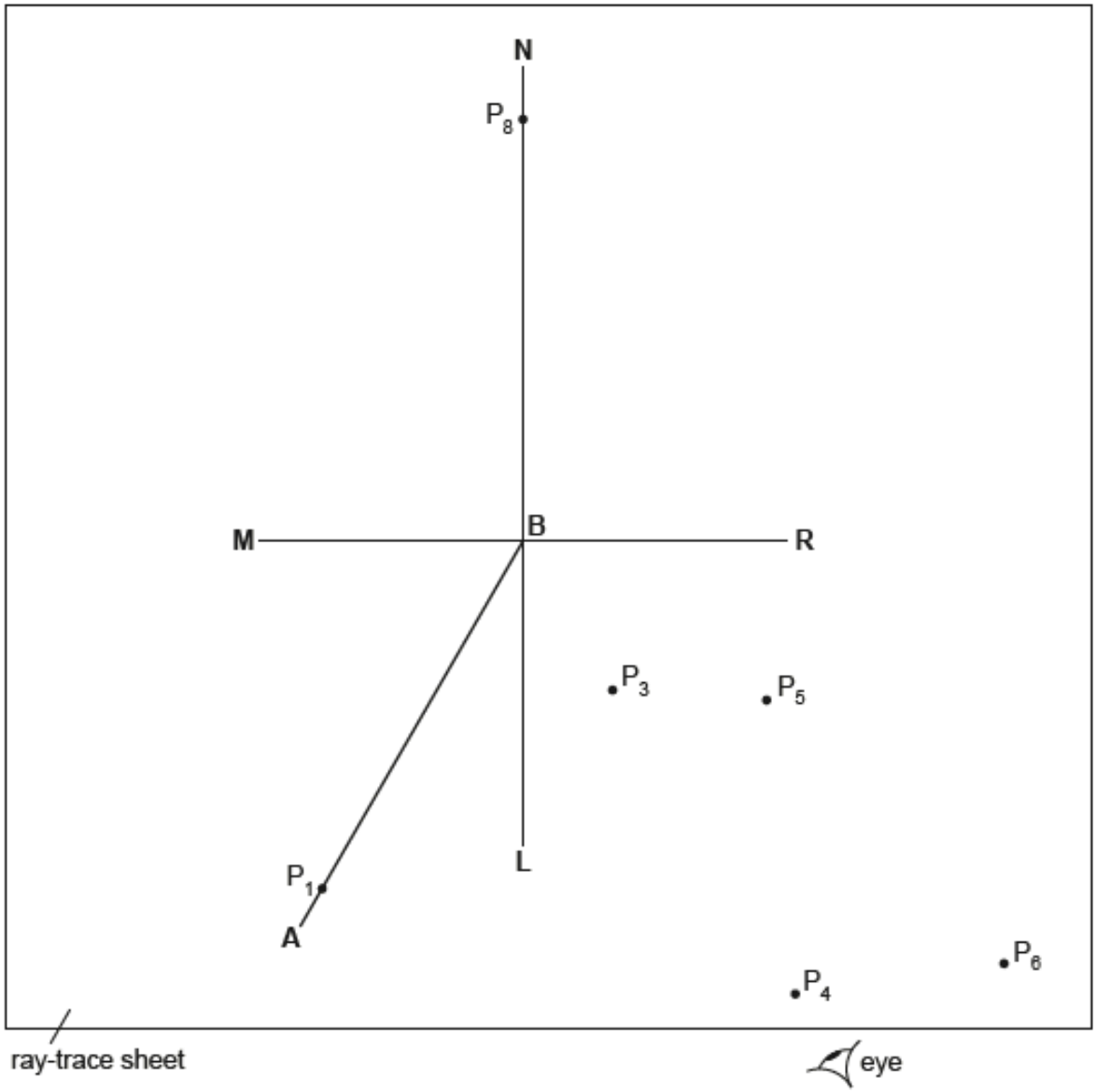


Fig. 3.1

Fig. 3.1 shows the ray-trace sheet he uses.

The student draws the line **MR**.

- He draws a normal NL to this line that passes through the centre of MR.
- He labels the point at which **NL** crosses **MR** with the letter **B**.
- He draws a line from **B** at an angle of incidence $i = 30°$ to the normal below **MR** and to the left of the normal. He labels the end of this line **A**.
- He places a pin P_1 on line **AB**, as shown in Fig. 3.1. He places another pin P_2 on the line **AB**.
- He places the reflecting face of the mirror vertically on the line **MR**.
- He views the images of pins P_1 and P_2 from the direction indicated by the eye in Fig. 3.1.

(i) On Fig. 3.1, mark with a cross a suitable position for pin P_2 in this experiment.

[1]

(ii) He places two pins P_3 and P_4 some distance apart so that pin P_3 and the images of P_2 and P_1 all appear exactly behind pin P_4. The positions of P_3 and P_4 are shown on Fig. 3.1.

Draw the line joining the positions of P_3 and P_4. Continue the line until it extends at least 7.0 cm beyond **MR**.

[2]

[1 mark]

Question 3b

The student keeps pin P_1 in the same position but moves pin P_2 so that the angle of incidence $i = 40°$.

- The pin positions P_5 and P_6 for the reflected ray are marked on Fig. 3.1.

(i) Draw the line joining the positions of P_5 and P_6. Continue the line until it extends at least 7.0 cm beyond **MR**.

Label with the letter **Y** the point where the two lines cross beyond **MR**.

[1]

(ii) 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 = ... [1]

(iii) 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 = ... [1]

[3 marks]

Question 3c

The student removes all the pins. He places pin P_7 on the normal at a distance 6.0 cm from the front of the mirror.

- He views the image of P_7 in the mirror.
- He places pin P_8 on the normal behind the mirror.
- He adjusts the position of P_8 so that the image of the bottom of the pin P_7 and the top of pin P_8 seen over the mirror appear as one pin when viewed from all angles in front of the mirror.

(i) On Fig. 3.1, measure the distance *x* along the normal between P_8 and the mirror.

x = ... [1]

(ii) Complete the diagram in Fig. 3.2 to show the appearance of the image of pin P_7 and pin P_8 as described in (c).

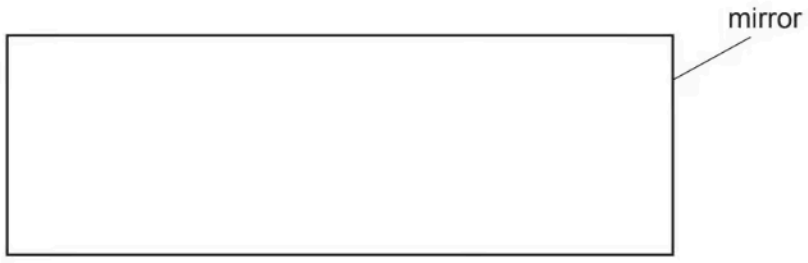


Fig. 3.2

[1]

[2 marks]

Question 3d

The student expects the readings to show that the image formed in a plane mirror is the same distance behind the mirror as the object is in front of the mirror. Readings of $a = b$ and $x = 6.0$ cm will show this.

State whether your readings show that the image formed in a plane mirror is the same distance behind the mirror as the object is in front of the mirror. Justify your statement by reference to the readings.

statement:

justification:

[2 marks]

Question 3e

The student carries out this experiment with care. Suggest a practical reason why the results may not be accurate.

[1 mark]

Question 4a

A student is investigating the reflection of light by a plane mirror.

Fig. 1.1 shows his ray-trace sheet at full size.

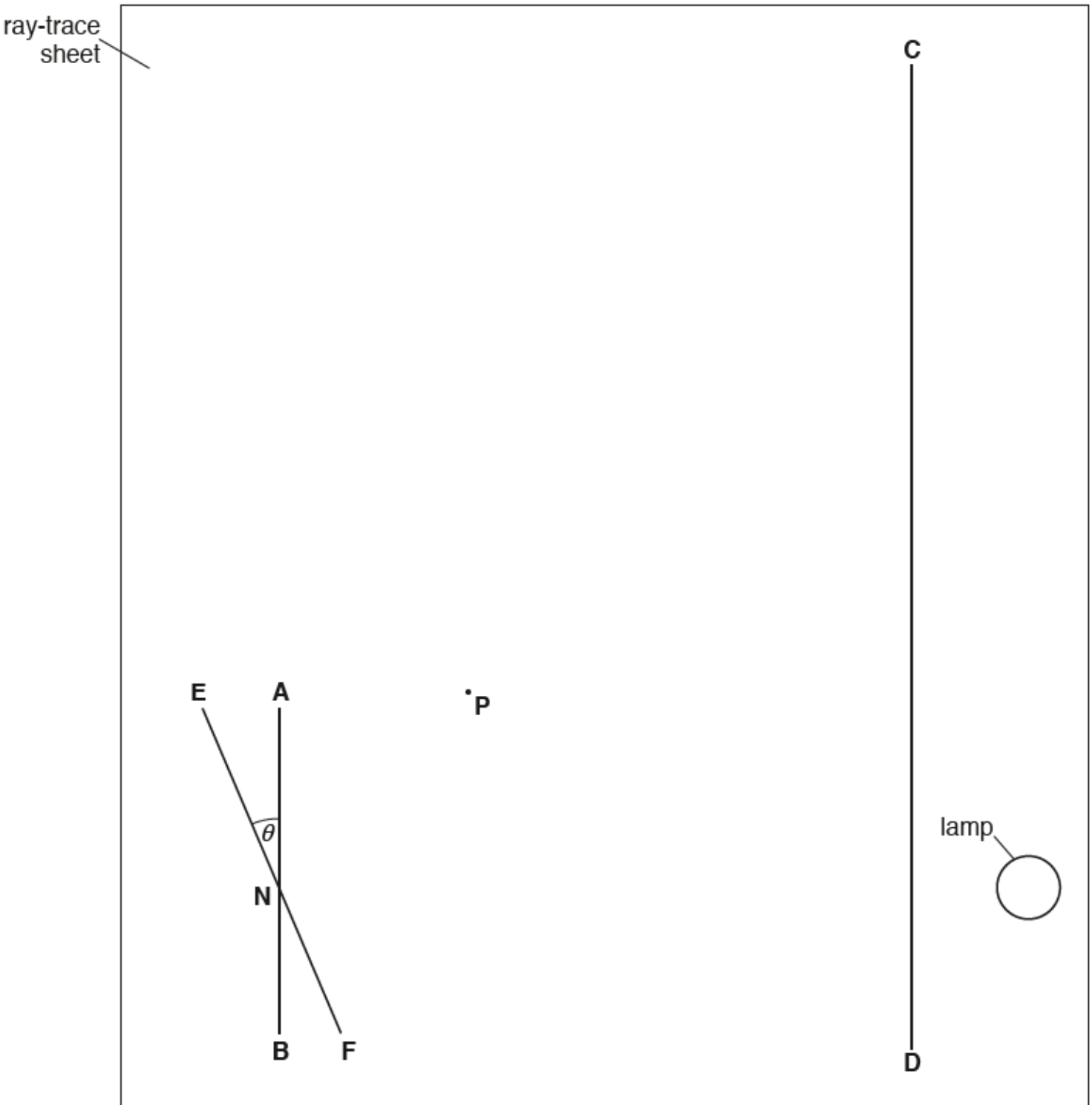


Fig. 1.1

The student carries out an initial experiment.
He draws lines **AB** and **CD** as shown in Fig. 1.1.
He then draws a line **EF** through a point **N** as shown in Fig. 1.1 and at an angle θ to line **AB**.

The angle θ is

measured to be 23° ±1°

Draw a normal to line **AB** at point **N** and extend the normal to line **CD**. Label the point at which the normal crosses line **CD** with the letter **L**.

[1 mark]

Question 4b

The student places a plane mirror on line **EF** and a screen with a 2 mm slit on line **CD**. He arranges the screen so that a ray of light shines along line **LN**.
The ray reflected from the mirror passes through point **P**.

State and explain whether point **P**, shown on Fig. 1.1, is at a suitable distance from point **N** for this investigation.

[1 mark]

Question 4c

(i) Draw a line joining point **N** and point **P**. Extend this line until it meets line **CD**.

Label the point at which this line meets line **CD** with the letter **G**.

[1]

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

a = ... cm [1]

[2 marks]

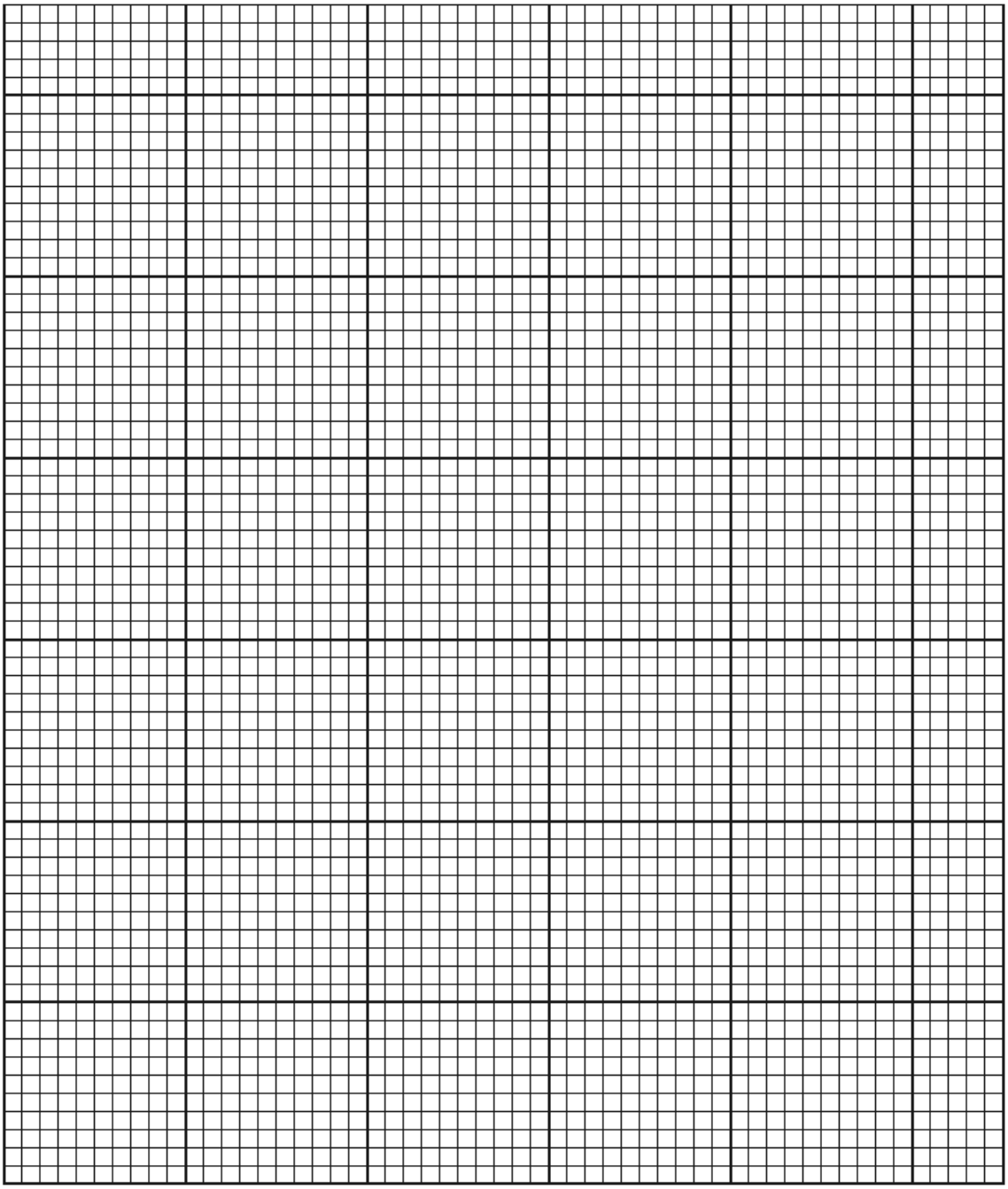
Question 4d

The student repeats the procedure for values of $\theta = 25°, 20°, 15°, 10°$ and $5°$.
His values for a are shown in Table 1.1.

Table 1.1

θ / °	a /cm
25	12.2
20	8.3
15	5.7
10	3.6
5	1.8

Use the values from Table 1.1 to plot a graph of a / cm (y-axis) against θ / ° (x-axis).



[4 marks]

Question 4e

Suggest a possible source of inaccuracy in this experiment, even if it is carried out carefully.

[1 mark]

Question 4f

A student wishes to check if his values for *a* are reliable.

Suggest how he could improve the experiment, using the same apparatus, to check the reliability of his results.

[1 mark]

Question 5a

A student is determining the focal length *f* of a lens.

Fig. 3.1 shows the apparatus.

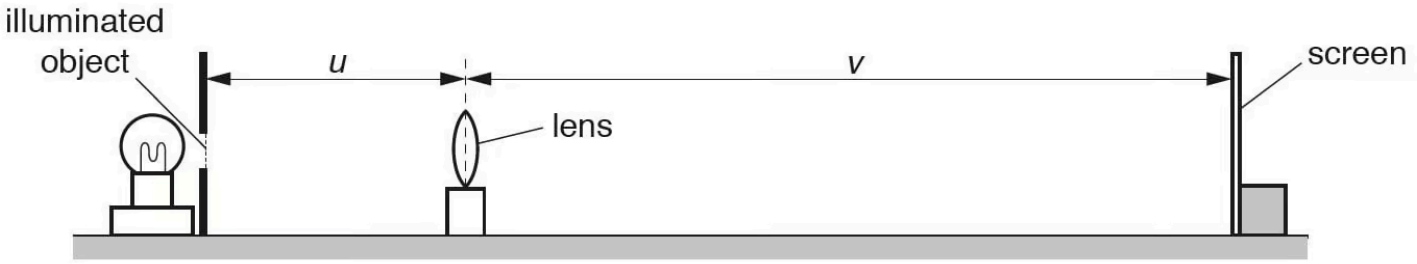


Fig. 3.1

The student places the screen a distance *D* = 70.0 cm from the illuminated object.

He places the lens close to the screen and moves the lens slowly away from the screen until a clearly focused image is formed on the screen.

He measures the distance *u* between the centre of the lens and the illuminated object.

He measures the distance *v* between the centre of the lens and the screen.

He repeats the procedure using values for *D* of 75.0 cm, 80.0 cm, 85.0 cm and 90.0 cm.

The readings are shown in Table 3.1.

Calculate, and record in Table 3.1, *uv* for each value of *D*.

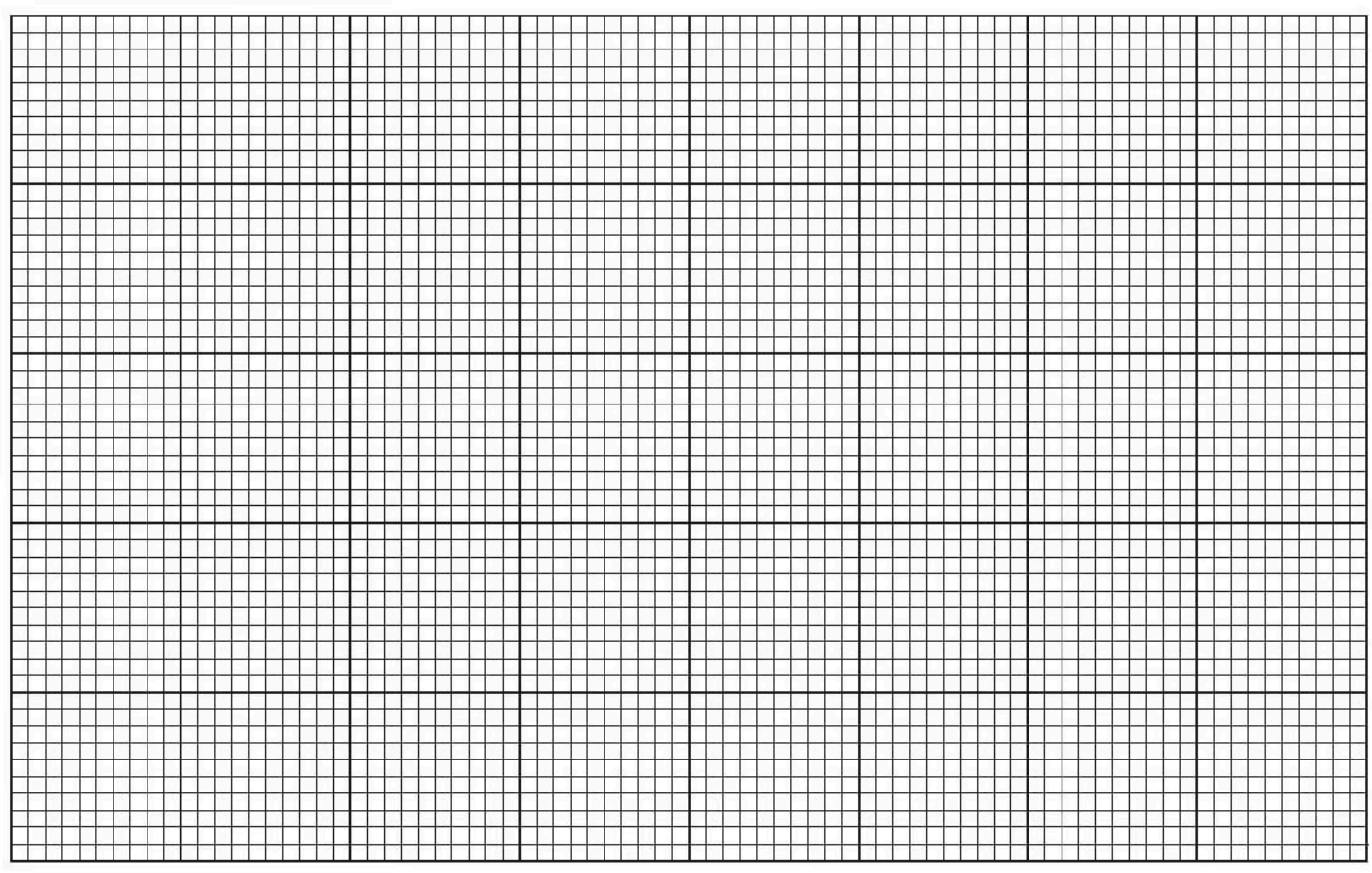
Table 3.1

D/cm	u/cm	v/cm	uv/cm^2
70.0	22.0	48.4	
75.0	20.7	54.5	
80.0	20.0	60.0	
85.0	19.5	65.8	
90.0	19.0	71.2	

[3 marks]

Question 5b

Plot a graph of uv/cm^2 (y-axis) against D/cm (x-axis). You do not need to start your axes at the origin (0,0).



[4 marks]

Question 5c

Determine the gradient *G* of the line. Show clearly on the graph how you obtained the necessary information.

G = ...

[2 marks]

Question 5d

The focal length *f* of the lens is numerically equal to the gradient *G* of the graph. Write down a value for the focal length *f* of the lens. Give your answer to a suitable number of significant figures for this experiment.

f = ...

[2 marks]

Question 5e

Suggest **two** difficulties in this experiment when trying to obtain accurate readings.

[2 marks]

Question 6a

A student is determining the focal length of a lens.

Fig. 3.1 shows the apparatus used.

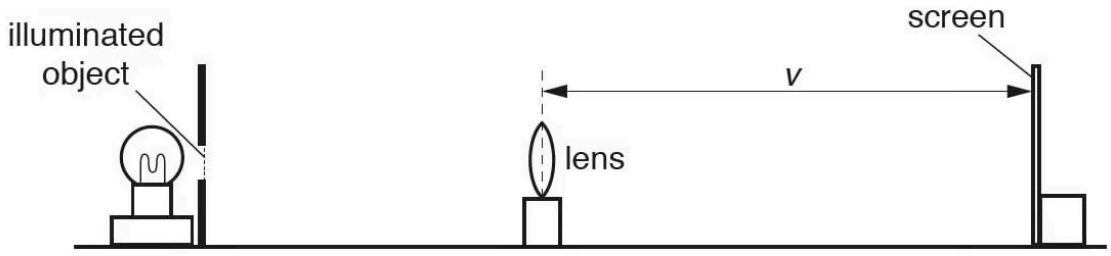


Fig. 3.1

The student adjusts the position of the screen until a clearly focused image is formed on the screen.

The distance *v* on Fig. 3.1 is measured to be 5.80 cm.

(i) Fig. 3.1 is drawn 1/5th actual size.

Calculate *V*, the actual distance from the lens to the screen

V = ... [1]

(ii) With a clearly focused image formed on the screen, the actual distance from the centre of the lens to the illuminated object, *U* is 20.0 cm.

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

f_1 = ... [2]

[3 marks]

Question 6b

The student repeats the procedure in **(a)**, using a different distance U. She obtains another value for the focal length f_2.

$$f_2 = 12.2 \text{ cm}$$

Calculate the average value f_A of the focal length of the lens, using f_2 and your value for f_1 in **(a)(ii)**. Give your answer to a suitable number of significant figures for this experiment.

f_A = ...

[2 marks]

Question 6c

The student states that taking more measurements improves the reliability of the value obtained for f_A.

Suggest additional values for U that you would use.

[2 marks]

Question 6d

State **two** precautions that you would take in this experiment to obtain accurate readings.

[2 marks]