3 A student investigates the image produced by a converging lens.

He uses the equipment shown in Fig. 3.1.

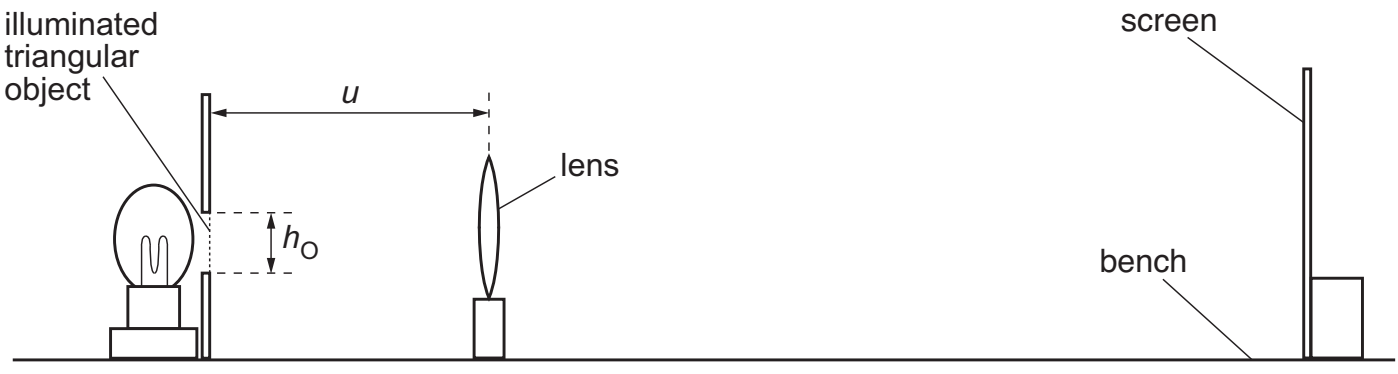


Fig. 3.1 (not to scale)

(a) The student sets the distance u between the illuminated triangular object and the lens to 20.0 cm. He moves the screen until a sharp image of the illuminated triangular object is seen on the screen.

Briefly describe **one** technique to obtain an image on the screen which is as sharp as possible in this experiment.

.....

..... [1]

(b) **(i)** The screen is shown full size in Fig. 3.2.
Measure, and record in the first line of Table 3.1, the height h_I of the image on the screen, as shown in Fig. 3.2.

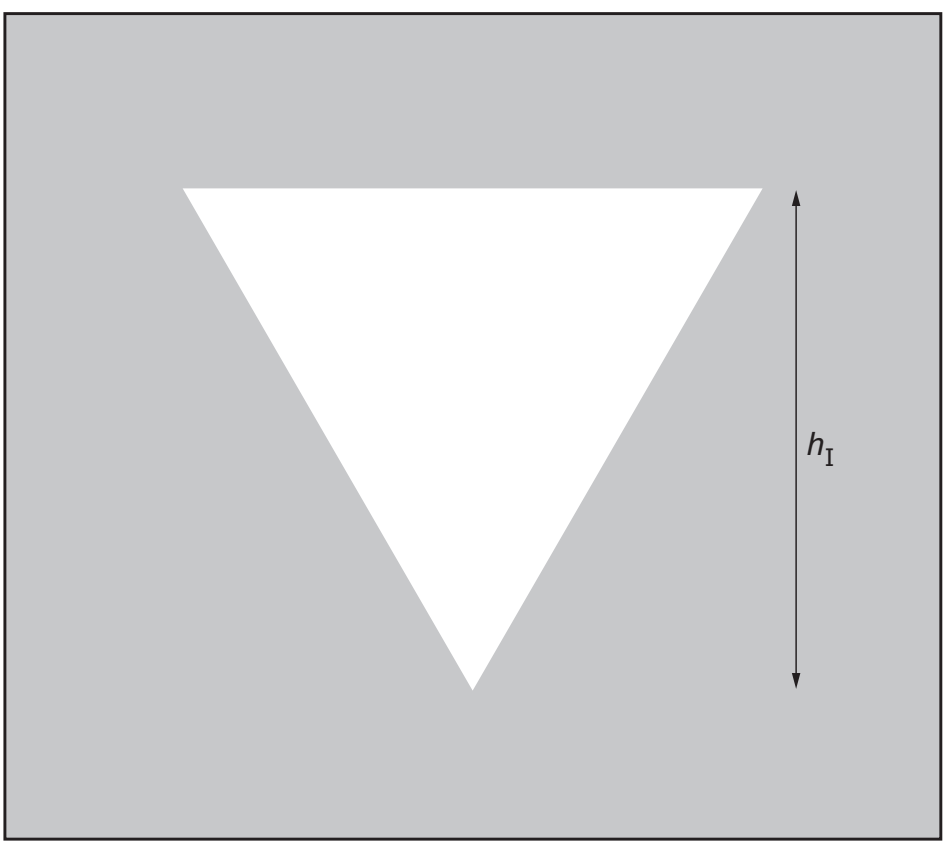


Fig. 3.2

Table 3.1

u/cm	h_I/cm	$D / \frac{1}{\text{cm}}$
20.0		
25.0	2.8	0.36
30.0	2.0	0.50
35.0	1.6	0.63
40.0	1.2	0.83

[1]

(ii) For distance u = 20.0 cm, calculate, and record in Table 3.1, a value D.
Use your value of h_I from Table 3.1 and the equation:

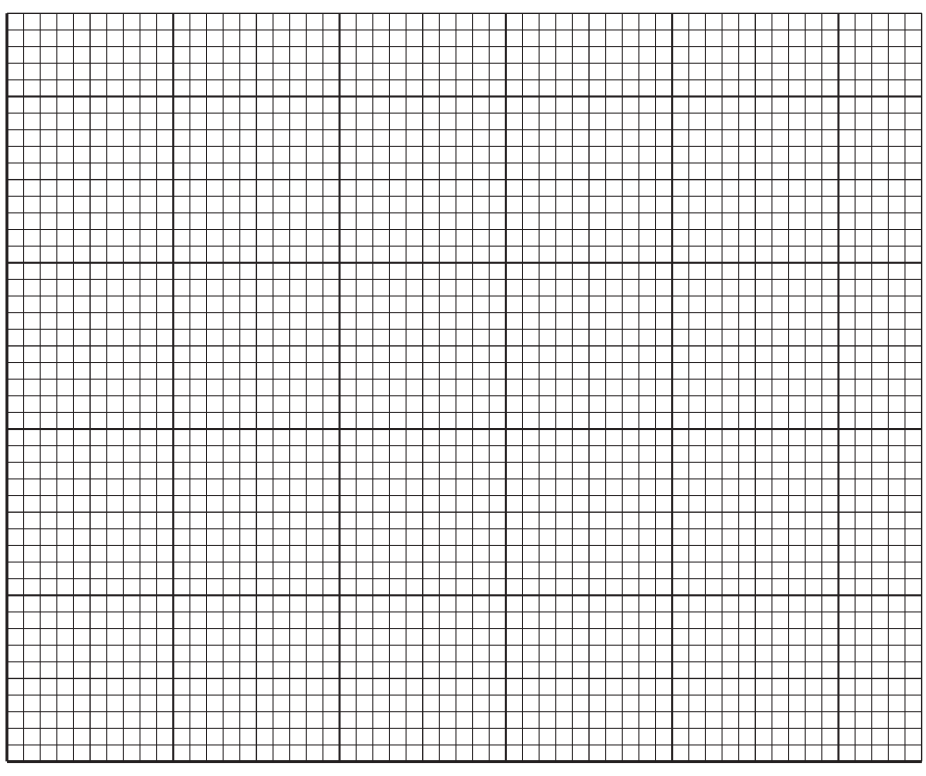
$$D = \frac{1}{h_I}.$$

[1]

(c) The student repeats the procedure for u = 25.0 cm, u = 30.0 cm, u = 35.0 cm and u = 40.0 cm.
His results are shown in Table 3.1.

Plot a graph of u / cm (y-axis) against $D / \frac{1}{\text{cm}}$ (x-axis). Start the axes at the origin (0,0).

Draw a best-fit straight line.



[4]

(d) **(i)** From your graph, determine u_0, the value of u when D is zero.

u_0 = ... cm [1]

(ii) Determine the gradient G of the graph.

Show clearly on the graph how you obtained the necessary information.

G = ... [1]

(e) The illuminated object is shown full size in Fig. 3.3.

Measure and record the height h_O of the illuminated triangular object shown in Fig. 3.3.

h_O = ... cm

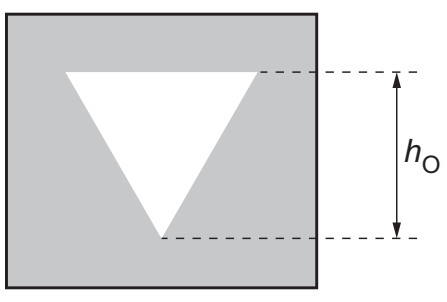


Fig. 3.3

Calculate the focal length f of the lens. Use your value of h_O, your value of G from **(d)(ii)** and the equation:

$$f = \frac{G}{h_O} \times k, \quad \text{where } k = 1.0\,\text{cm}^2.$$

f = ... cm
[1]

(f) Describe **one** difficulty that can be experienced when measuring the height of the image in this experiment.

Suggest an improvement to overcome this difficulty.

difficulty .....

.....

improvement .....

.....
[1]

[Total: 11]