Q7. A card sheet divided into squares each of size 1 mm^2 is being viewed at a distance of 9 cm through a magnifying glass (a converging lens of focal length 10 cm) held close to the eye.

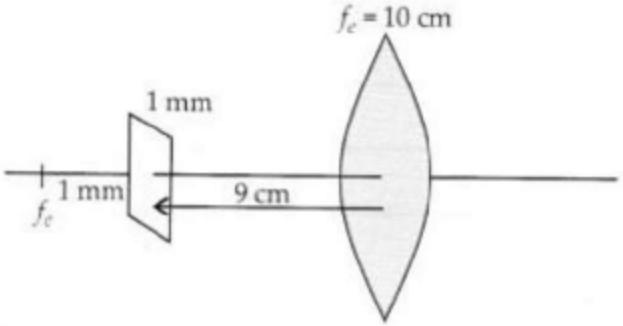
(a) What is the magnification produced by the lens? How much is the area of each square in the virtual image?

(b) What is the angular magnification (magnifying power) of the lens?

(c) Is the magnification in (a) equal to the magnifying power in (b)? Explain.

Solution:

(a) For magnification by the magnifying lens.



Let us use lens formula

$u = -9$ cm, $f = +10$ cm

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \quad \text{or} \quad \frac{1}{v} - \frac{1}{-9} = \frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{9} = -\frac{1}{90}$$

Image position $v = -90$ cm

Magnification $m = \frac{I}{O} = \frac{v}{u}$ or $m = \frac{-90}{-9} = 10$

For area 1 mm^2, consider the height of object 1 mm, so height of image.

$$\frac{I}{O} = \frac{v}{u}, \quad \frac{I}{1\text{ mm}} = 10$$

$I = 10$ mm

Area of image $A = 10 \times 10$ mm^2 $= 100$ mm^2 $= 1$ cm^2

(b) Angular magnification,

$$m = \frac{D}{u} = \frac{25}{9} = 2.78$$

(c) No, the linear magnification by a lens and magnifying power (angular magnification) of magnifying glass have different values. The linear magnification is calculated using

$m = \frac{v}{u}$, whereas angular magnification is

$m = \frac{D}{u} = \frac{\beta}{\alpha}$, the ratio of angle subtended by

image of object at eye lens 'p' to the angle subtended by object assumed to be at least distance at eye lens 'a'.

The linear magnification and angular magnification in microscope have similar magnitude when image is at least distance of distinct vision i.e., 25 cm.