TENDER HEART HIGH SCHOOL; Sec-33B, CHD

CLASS-IX

Ch-5(c) Sign Convention and Lens formula (Numericals), Power of a lens, Magnification

Sign Convention :→ (1) All distances are measured from the Optical centre of lens.

(2) distances measured in the direction of incident ray are taken positive, while distances opposite to the direction of incident ray are taken negative.

(3) distances above the principal axis are positive while below the principal axis are negative.

* **Lens formula :—**

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

v = Image distance
u = Object distance
f = Focal length.

Note for Convex lens :→ Focal length = Positive
Object distance (u) = −ve
Image distance (v) = +ve for Real Image.
Image distance (v) = −ve for Virtual Image.

for Concave lens :→ Focal length (f) = negative
Object distance = −ve
Image distance (v) = −ve (always virtual image is formed)

* It means u, v, f all are negative for a Concave lens.

Linear Magnification (m): →

The ratio of length of image I to the length of Object O perpendicular to principal axis is called as Linear magnification (m).

So, m or Linear magnification $= \frac{I}{O} = \frac{v}{u}$

for Convex lens: →

v = +ve (Real image)

v = −ve (Virtual image)

u = −ve

So m = +ve (for Virtual image) $\left[m = \frac{-v}{-u} = \frac{v}{u}\right]$

m = −ve (for Real image) $\left[m = \frac{v}{-u} = \frac{-v}{u}\right]$

* So Convex lens has positive and negative value of magnification

for Concave lens; Virtual image always formed.

So $m = \frac{-v}{-u} = \frac{v}{u}$

So magnification is always positive for Concave lens.

⇒ m < 1 (for Concave lens ∵ It always formed diminished image

i.e $\frac{v}{u} < 1$ or $v < u$

and $I < O$

⇒ m > 1, m = 1, m < 1 for a Convex lens ∵ It can form Same size, magnified and diminished image.

Numericals: →

(1) A Concave lens forms the image of an Object kept at a distance of 2cm in front of it, at a distance of 1cm on other

Side of an object.
(a) What is the nature of image?
(b) find the focal length of the lens.

Solution:→ Concave lens:— So $u = -ve$, $v = -ve$, $f = -ve$

So
$u = -20\,cm$
$v = -10\,cm$

by lens formula; $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{-10} - \frac{1}{-20} = \frac{1}{f}$$

$$\frac{-1}{10} + \frac{1}{20} = \frac{1}{f}$$

$$\text{or } \frac{1}{f} = \frac{-2+1}{20}$$

$$\frac{1}{f} = \frac{-1}{20}$$

$$\text{or } \boxed{f = -20\,cm}$$

∴ So Image is Virtual, Erect and diminished

(2) The focal length of Convex lens is 25cm. At what distance from the Optical Centre of the lens an object be placed to obtain an virtual image of twice the size of object?

Solution:→ $f = 25\,cm$ [Convex lens]

$v = ?$, $I = 20$ (Given) or $\frac{I}{O} = 2$

$m = \frac{v}{u} = \frac{I}{O} = 2$ or $\frac{v}{u} = 2$

$$\boxed{v = 2u}$$

Using lens formula; $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

as $v = 2u$, $f = 25cm$

$$\text{So } \frac{1}{2u} - \frac{1}{u} = \frac{1}{25}$$

$$\frac{1-2}{2u} = \frac{1}{25}$$

$$\Rightarrow \frac{-1}{2u} = \frac{1}{25}$$

$$\text{or } -2u = 25$$

$$u = -\frac{25}{2} = -12.5$$

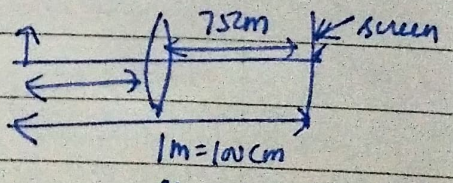
$$\boxed{u = -12.5\,cm}$$

Object must be placed in front of the lens.

(3) An illuminated Object lies at a distance 1 m from the screen. A Convex lens is used to form an image of the object on the screen placed at a distance of 75cm from the lens. Find (i) focal length of the lens (ii) the magnification.

Solution :→ Image is formed on Screen; $v = 75cm$, $f = ?$, $m = ?$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \qquad u = -25cm$$



$u = 100 - 75 = 25cm$

$$\frac{1}{75} - \frac{1}{(-25)} = \frac{1}{f} \Rightarrow \frac{1}{75} + \frac{1}{25} = \frac{1}{f}$$

$$\frac{1+3}{75} = \frac{1}{f} \quad \text{or} \quad \frac{4}{75} = \frac{1}{f} \quad \text{or} \quad \frac{1}{f} = \frac{75}{4} = 18.75\,cm$$

$$m = \frac{v}{u} = \frac{75}{-25} = -3 \quad \text{so} \quad \boxed{m = -3}$$

Teacher's Signature :