hence number of images you see = $n = \left(\frac{360}{\theta} - 1\right)$
= 4 – 1 = 3

SPHERICAL MIRROR

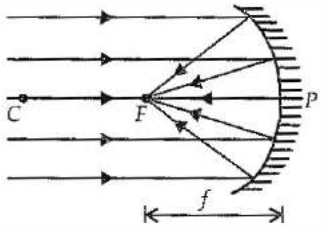
- A spherical mirror is part of a spherical reflecting surface.
  Spherical mirror is of two types :
  - Concave mirror
  - Convex mirror

Concave Mirror

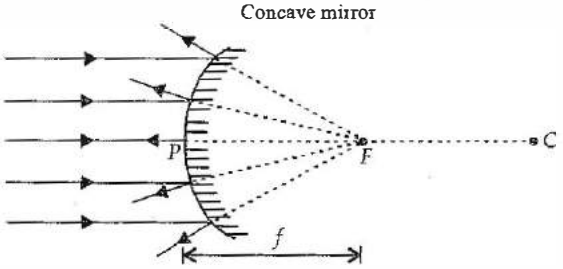
- When the reflection takes place from inner surface and outer surface is polished, the mirror is known as concave mirror.

Convex Mirror

- When the reflection takes place from outer surface and inner surface is polished, the mirror is known as convex mirror.



Concave mirror



Convex mirror

where
P = Pole of mirror
F = Principal focus
C = Centre of curvature
$PC = R$ = Radius of curvature
$PF = f$ = Focal length

Sign Conventions

- All distances have to be measured from the pole of the mirror.
- Distances measured in the direction of incident light are positive, and those measured in opposite direction are taken as negative.
- Heights measured upwards and normal to the principal axis of the mirror are taken as positive, while those measured downwards are taken as negative.

Spherical Mirror Formula

- The focal length of a spherical mirror of radius R is given by

$$f = \frac{R}{2}$$

- f (or R) is negative for concave or converging mirror and positive for convex or diverging mirror.

Transverse or linear magnification

$$m = \frac{\text{size of image}}{\text{size of object}} = -\frac{v}{u}$$

- Here –ve magnification implies that image is inverted with respect to object while +ve magnification means that image is erect with respect to object.
- **Longitudinal magnification :** When an object lies along the principal axis, then its magnification is known as longitudinal magnification. For small object, it is given by

$$m_L = -\frac{dv}{du}$$

- **Superficial magnification :** When a two dimensional object is placed with its plane perpendicular to principal axis, then its magnification is known as superficial magnification or areal magnification and is given by

$$m_S = \frac{\text{area of image}}{\text{area of object}} = m^2$$

- Mirror's formula, $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$

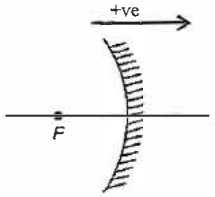
where
u = distance of object from the pole of the mirror
v = distance of image from the pole of the mirror.

- Newton's formula is $f^2 = xy$, where x is distance of object from the focus and y is distance of image from the focus of the mirror.

Illustration 3

Assume that a concave mirror has a focal length of 10 cm. Locate the images for object distances,
(a) 25 cm (b) 20 cm (c) 15 cm
(d) 10 cm (e) 5 cm.
Describe the image in each case.

Soln.: (a) $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$



$u = -25$ cm
and $f = -10$ cm

$\Rightarrow \frac{1}{v} + \frac{1}{-25} = \frac{1}{-10}$;

$v = -16.7$ cm

$$m = \frac{-v}{u} = -\left(\frac{-16.7}{-25}\right) = -0.667$$

v is –ve, means image is formed on the same side of the mirror as the object, image is real. The magnification is –ve, implies the image is inverted. The magnification is less than 1, hence image is diminished.

(b) $u = -20$ cm, $f = -10$ cm $\Rightarrow \frac{1}{v} + \frac{1}{-20} = \frac{1}{-10}$

$v = -20$ cm

$$m = \frac{-v}{u} = -\left(\frac{-20}{-20}\right) = -1.$$

The image is real and formed at the same position as the object. When object is at the centre of curvature