# LIGHT - REFLECTION AND REFRACTION

## CONVEX MIRROR

### CONCAVE AND CONVEX MIRROR:

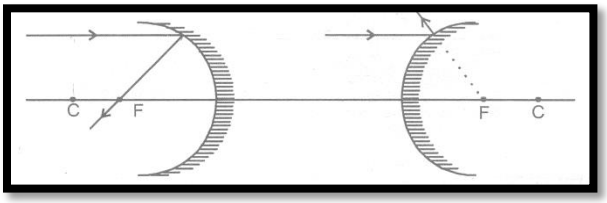
Convex mirror is a spherical mirror, whose inner (cave type) surface is silvered and

Reflection takes place at the outer (convex) surface.

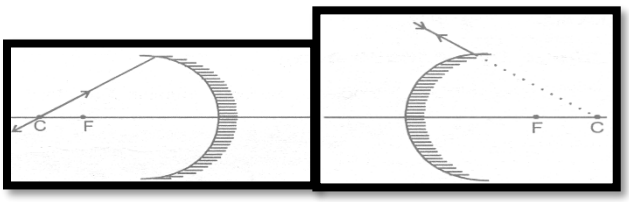
Concave mirror is a spherical mirror, whose outer bulged surface is silvered and reflection takes place from the inner hollow (cave type) surface.

### (a) Rules for the formation of images by concave & convex mirrors :

**(i)** A ray incident parallel to the principal axis actually passes (concave) or appears to pass (convex) through the focus.

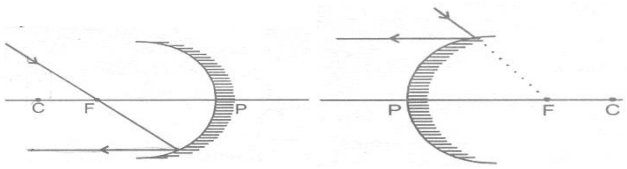



**(ii)** A ray incident through the centre of curvature (C) falls normally and is reflected back along the same path.




Concave Convex

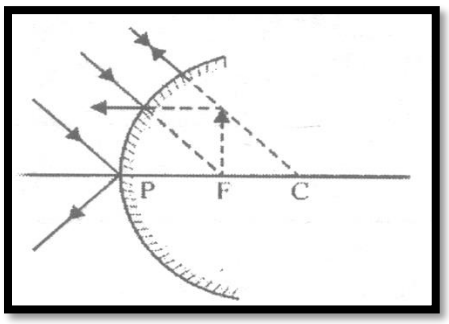
**(iii)** A ray incident through the focus is reflected parallel to the principal axis.



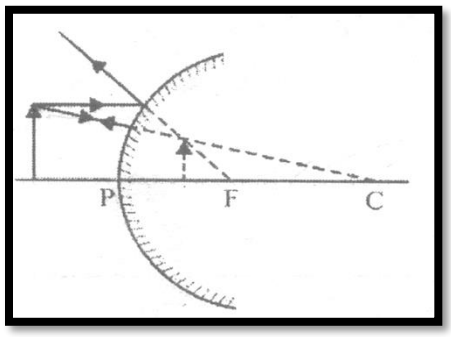

Concave Convex

**(b) Formation of image by convex mirror:**

**(i)** When the object is placed at infinity then image is formed at the focus. The image formed is virtual, erect and extremely demised.




**(ii)** When the object is placed between infinity and the pole then the image is formed between the focus and the pole. The image formed is virtual, erect and diminished.

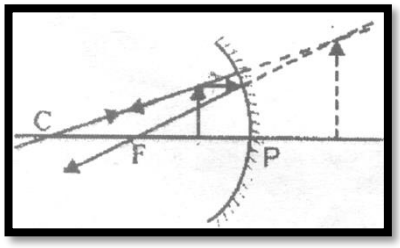



**Uses of convex mirror :**

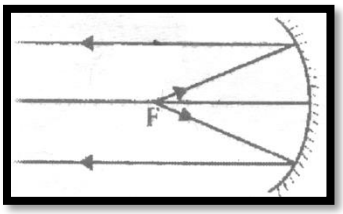
Convex mirror is used as rear view mirror is automobiles like cars, trucks and buses to see the traffic at the back side.

**(c) Formation of image by concave mirror**

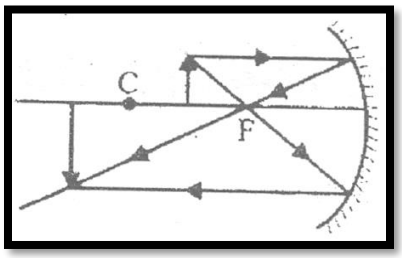
**(i)** When the object is placed between the pole and the focus, then the image formed is virtual, erect and magnified.



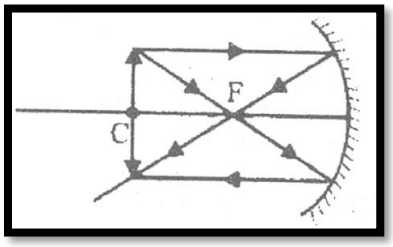

**(ii)** When the object is placed at the focus then the image is formed at infinity. The image is externally magnified.



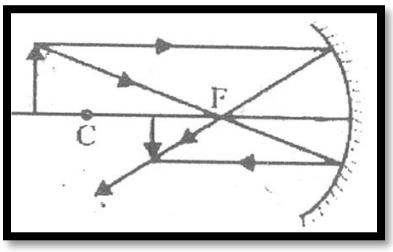

**(iii)** When the object is placed between the focus and the centre of curvature then the image is formed beyond the centre of curvature. The image formed is real, inverted and bigger than the object.



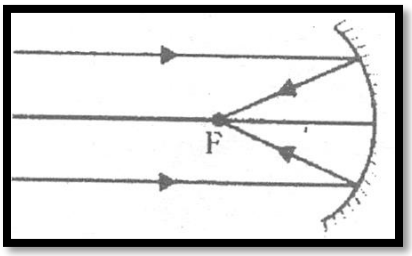

**(iv)** When the object is placed at the centre of curvature, then the image is formed at the centre of curvature. The image formed is real, inverted and equal to the size of the object.



**(v)** When the object is placed beyond the centre of curvature, then the image is formed between the focus and centre of curvature. The image formed is real, inverted and diminished.




**(vi)** When the object is placed at infinity then the image is formed at the focus. The image formed is real, inverted and extremely diminished is size.




**(D) Used of concave mirror :**

**(i)** They are used as shaving mirrors.

**(ii)** They are used as reflectors in car head-lights, search lights, torches and table lamps.

**(iii)** They are used by doctors to concentrate light on body parts like ears and eyes which are to be examined.

**(iv)** Large concave mirrors are used in the field of solar energy to focus sun-rays on the objects to the heated.

**Q.** How to distinguish between a plane mirror, a concave mirror and a convex mirror without touching them?

**Ans.** We can distinguish between them by bringing our face close to each of them. All of them will produce different types of image of our face.

A plane mirror will produce an image of same size as our face. A concave mirror will produce a magnified image and our face will look much bigger. A convex mirror will produce a diminished image and our face will look small.

**SIGN CONVENTION FOR MEASURING DISTANCE IN CONCAVE & CONVEX MIRROR :**

**(i)** All distances are measured from the pole.

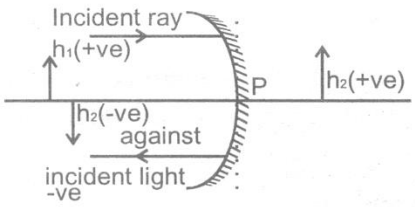
**(ii)** The incident ray is taken from left to right.

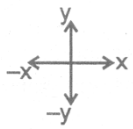
**(iii)** Distances measured in the same direction as that of the incident ray are taken to be +ve.

**(iv)** Distances measured in a direction opposite to the incident ray are taken to be -ve.

**(v)** Distances measured upwards and perpendicular to principal axis are taken +ve.

**(vi)** Distance measured downwards and perpendicular to principal axis are taken -ve.




$\therefore \left.\begin{matrix}\text{Focal length concave mirrro is} - \text{ve} \\ \text{Focal length of convex mirror is} + \text{ve}\end{matrix}\right\}$

**IMPORTANT :**

These sign are according to the rectilinear co-ordinate system.

**NOTE :**

Always draw a rough ray diagram while solving a numerical problem. Otherwise we will be confuse as to which distance should be taken as +ve & which -ve.

**For virtual image :**

M is +ve [as virtual image is erect $\therefore$ $h_2$ is +ve as well as $h_2$ is +ve

**For real image :**

m is -ve [as real image is always inverted $\therefore$ is -ve while $h_1$ is +ve]

**MIRROR FORMULA :**

The mirror formula is relation relating the object distance (u), the image distance (v) and the focal length (*f*) of a mirror.

The mirror formula is : $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$

**POWER OF MIRROR :**

A spherical mirror has infinite number of focus. Optical power of a mirror (in Dioptres) = $\frac{1}{f(\text{in meters})}$

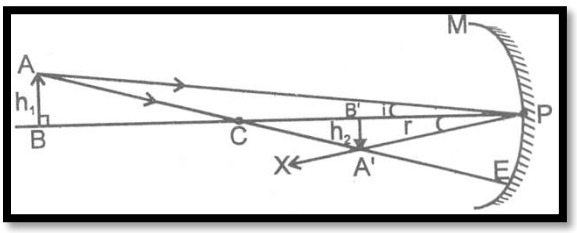
**RELATION BETWEEN FOCAL LENGTH (f) AND RADIUS OF CURBATURE (R) :**

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

A curbed or spherical mirror is reflecting surface, which is formed by a part of a hollow sphere. The spherical mirrors are of two types concave mirror and convex mirror.

**MAGNIFICATION FOR CONCAVE MIRROR :**

For magnification consider an object AB of height $h_1$, placed beyond C, such that its one ray is incident at pole P & another passes through C. After reflection ray from pole comes in the direction PX and the one which passed through C after reflection meets PX at A'. So A'B' is the image of height $h_2$.



Now $\Delta$ ABP & $\Delta$ A'B'P are similar (By AAA)

$$\therefore \quad \frac{A'B'}{AB} = \frac{B'P}{BP}$$

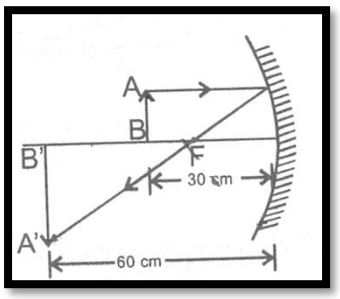
$$\frac{-h_2}{h_1} = \frac{-v}{-u} \Rightarrow \frac{h_2}{h_1} = -\frac{v}{u}$$

As $m = \frac{h_2}{h_1}$

$$\therefore \quad m = -\frac{v}{u}$$

**ILLUSTRATION :**

(i) A 2.0 cm long object is placed perpendicular to the principal axis of a concave mirror. The distance of the object from the mirror is 30 cm and its image is formed 60 cm from the mirror on the same side of the mirror as the object. Find the height of the image formed.




**Sol.** u = - 30 cm, v = - 60 cm

$$\therefore \quad m = \frac{h_2}{h_1} = -\frac{v}{u} = -\frac{-60}{-30} = -2$$

$$\Rightarrow \quad H_2 = -2h_1 = -2 \times 2 = -4 \text{ cm.}$$

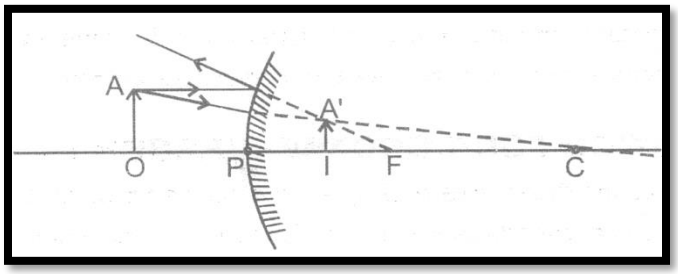
$\therefore$ Height of the image is 4 cm. It is inverted.

(iii) A 1.2 cm long pin is placed perpendicular to the principal axis of a convex mirror of Focal length 12 cm, at a distance of 8 cm from it.

(a) Find the location of the image

(b) Find the height of the image.

(c) Is the image erect or inverted ?




**Sol.** Here ƒ is +ve so ƒ = 12 cm.

Also u = -8 cm.

$\therefore \quad \frac{1}{v}+\frac{1}{u}=\frac{1}{f}$

Or $\frac{1}{v}=\frac{1}{f}-\frac{1}{u}=\frac{1}{12}+\frac{1}{8}=\frac{5}{24}$ $\therefore \quad v=\frac{24}{5}cm=4.8cm$

Given, $h_1 = 1.2$ cm

We know $\frac{h_2}{h_1}=-\frac{v}{u}$ $\Rightarrow$ $h_2=-\frac{v}{u}\times h_1=0.72cm$

Image formed is erect.