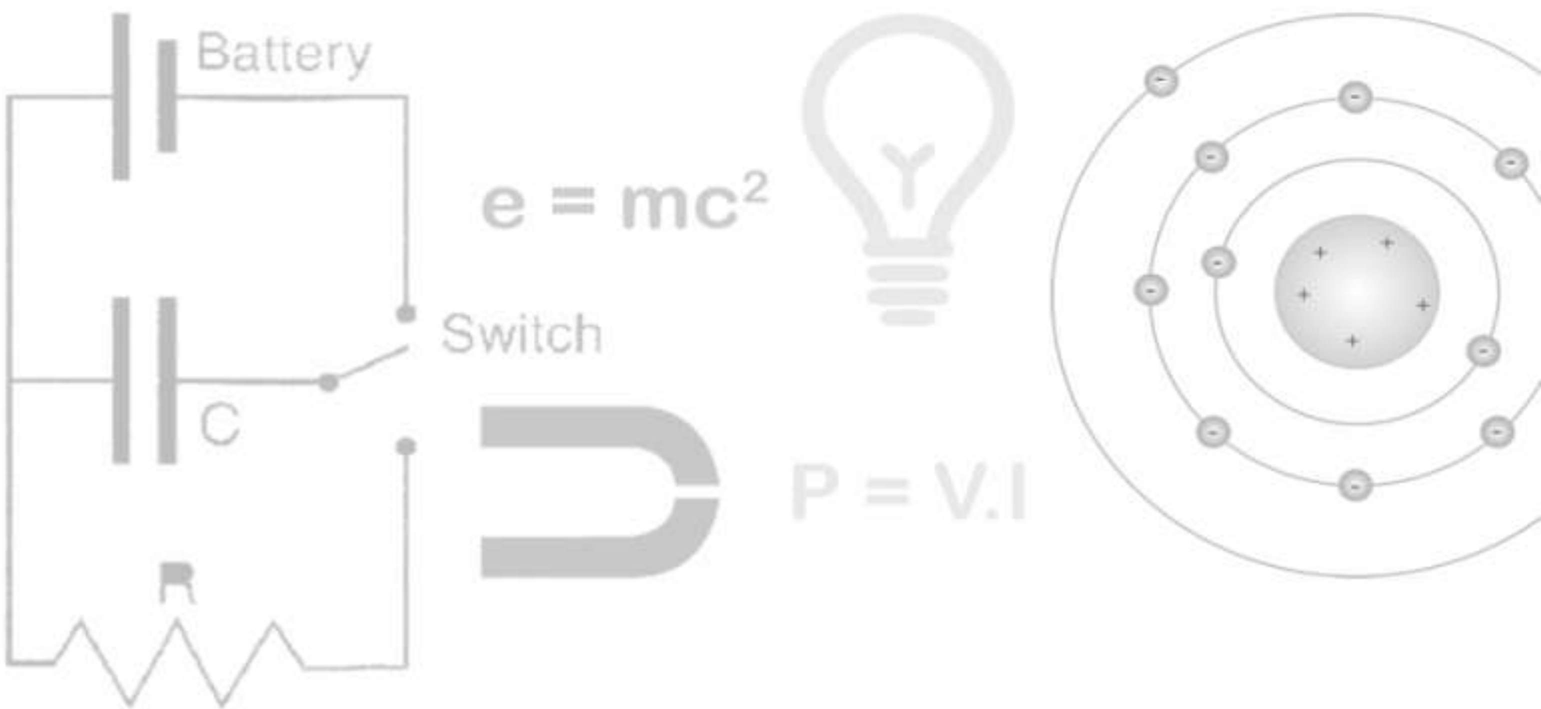
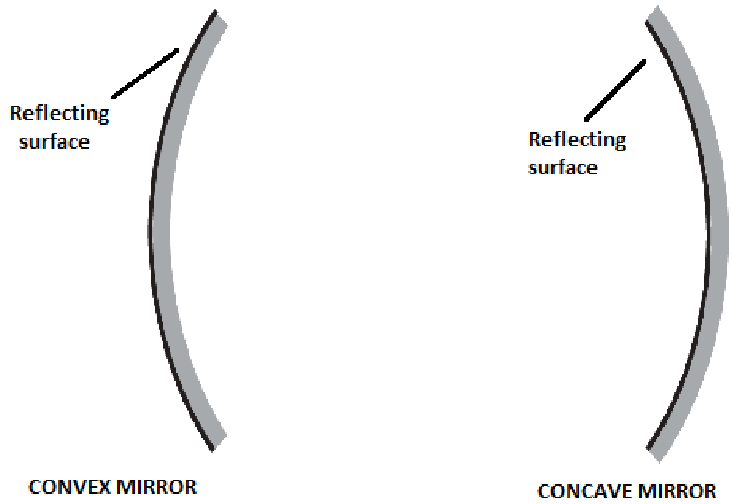
PHYSICS



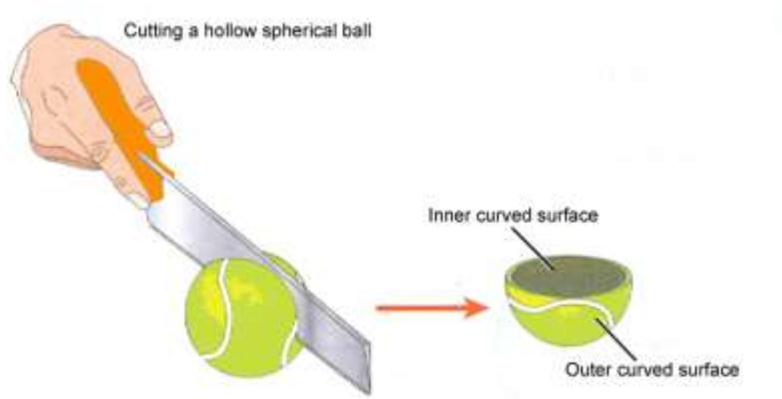
Reflection of Light: Spherical Mirrors

Spherical Mirrors

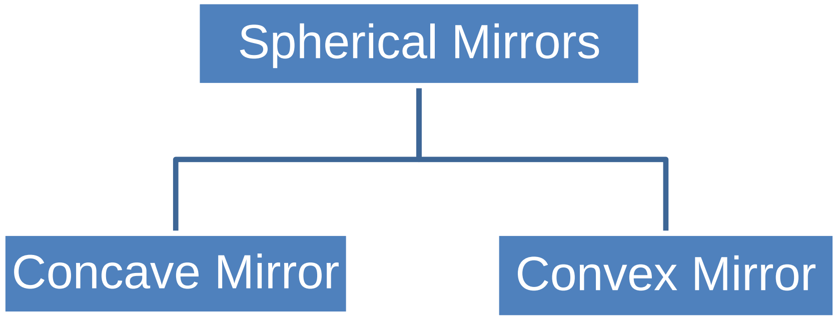
- Mirrors made by silvering the pieces of glass that are a part of a hollow sphere are called as spherical mirrors.



- Spherical mirrors are obtained by slicing a section from a hollow sphere.

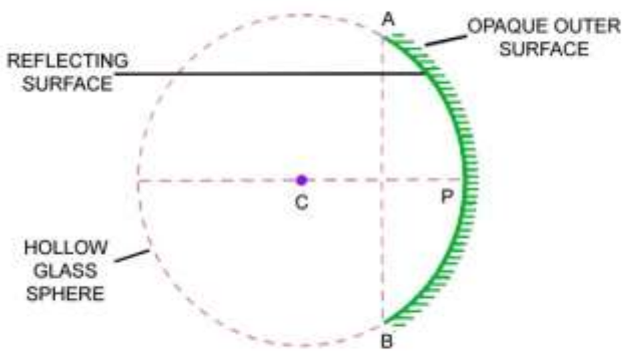


- Spherical mirrors have a convex or concave reflecting surface.
- Types of spherical mirrors:



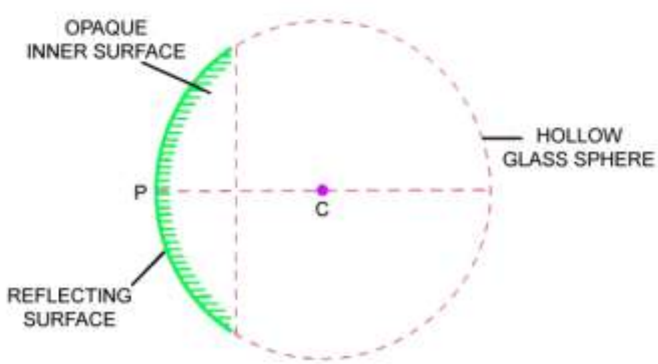
Concave Mirror

A spherical mirror whose reflecting surface is curved inwards is called a **concave mirror**.



Convex Mirror

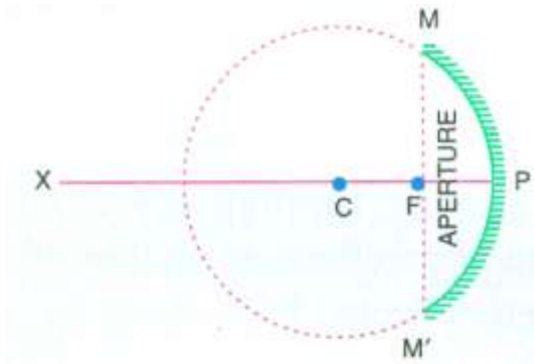
A spherical mirror whose reflecting surface is curved outwards is called a **convex mirror**.



Terms related to Spherical Mirrors

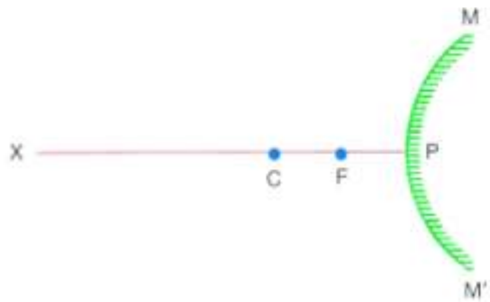
1. Aperture

The largest line joining the extreme ends of a spherical mirror through which the reflection occurs is called its **aperture**.



2. Pole

The geometric centre of the reflecting surface of a spherical mirror is a point called the **pole**.
It is the centre point of the aperture of the mirror. It is represented by P.



3. Centre of curvature

The reflecting surface of a spherical mirror forms a part of a sphere.
The centre of this sphere is called the **centre of curvature** of a spherical mirror. It is represented by C.

4. Radius of curvature

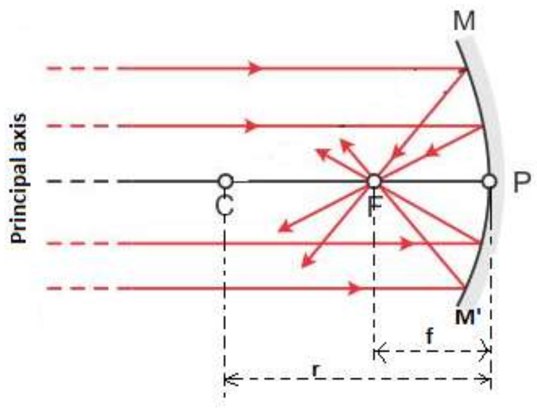
The **radius of curvature** of a spherical mirror is the radius of the sphere of which the reflecting surface of spherical mirror is a part and is represented by r'

5. Principal axis

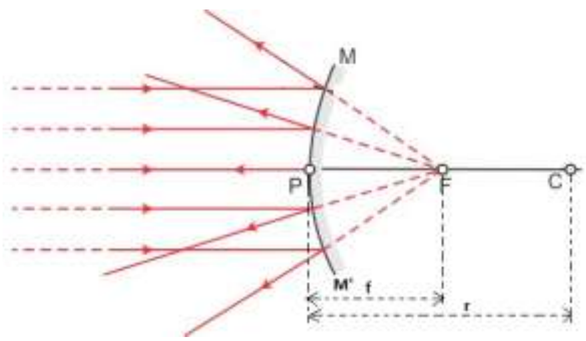
The straight line passing through the centre of curvature and the pole of the spherical mirror is known as the **principal axis** (**PX**).

6. Focus or focal point

If the beam of light parallel to the principal axis falls on a concave mirror, then the rays meet at one point after reflection. This point is called the focus of the concave mirror.
It is represented by F.



If the beam of light parallel to the principal axis falls on a convex mirror, then the rays diverge after reflection.
The reflected rays are extended backwards and appear to be meeting at a point on the principal axis. It is represented by F.



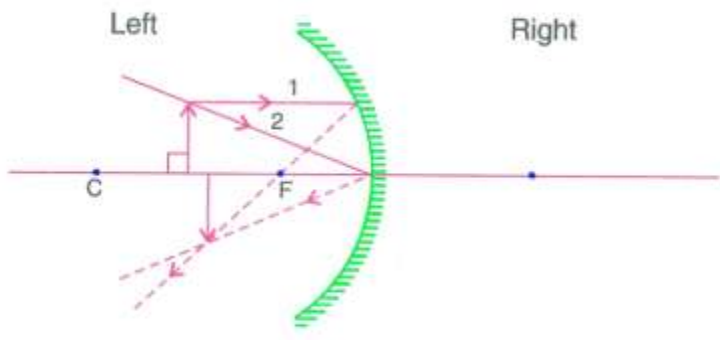
7. **Focal length**
   It is the distance between the pole P and the focus F and is represented by f.
   If f is the focal length and r is the radius of curvature then $\mathbf{f = \frac{r}{2}}$ or $\mathbf{r = 2f}$ and this relation is for concave and convex mirrors.

Formation of Image by Mirrors

Formation of images is done by **ray diagram**.

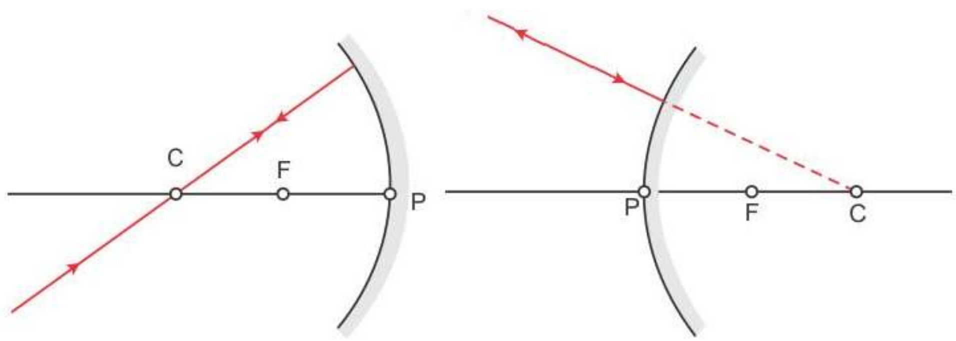
Rules to draw a Ray Diagram

1. To construct a ray diagram, at least two rays whose paths can be traces after reflection are required.
2. An object is kept on the left side of the reflecting surface and not on the right side.
3. An object is always to be kept on the principal axis and its foot should touch the principal axis.

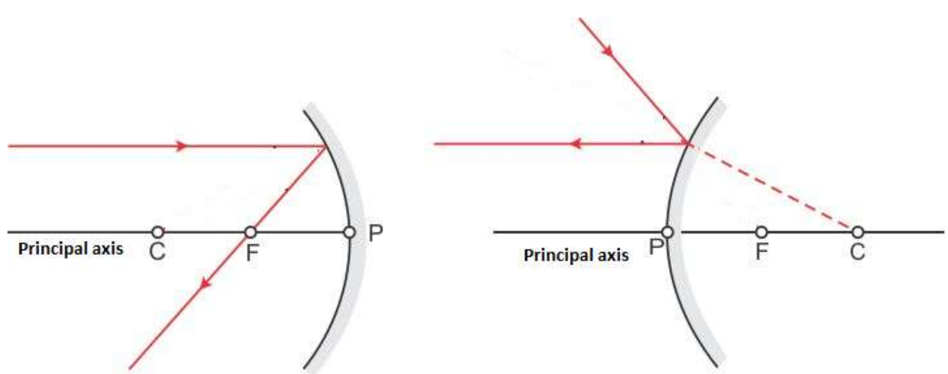


Construction of an Image: Ray Diagram

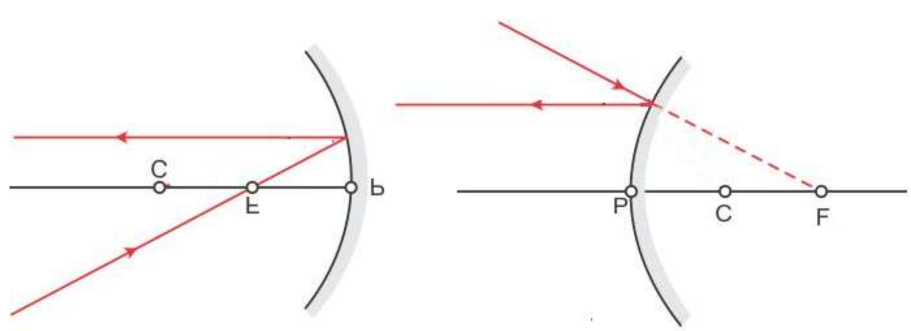
1. A ray of light passing through the centre of curvature is reflected back along the same path.



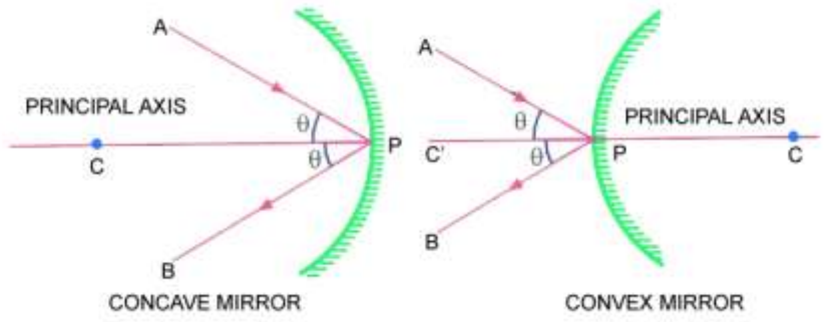
2. A ray of light parallel to the principal axis, after reflection passes through the principal focus in case of a concave mirror or appears to diverge from it in case of a convex mirror.



3. A ray passing through the principal focus of a concave mirror or a ray which is directed towards the principal focus of a convex mirror emerges parallel to the principal axis of the mirror after reflection.



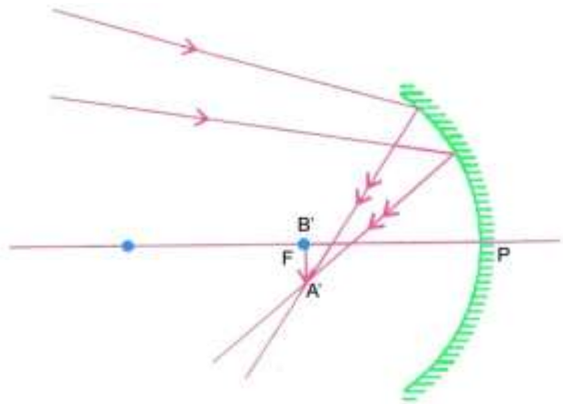
4. A ray of light AP incident obliquely towards the pole P of the mirror is reflected along a path PB obliquely as per the laws of reflection. The angle of incidence is equal to the angle of reflection i.e. $\angle APC$ or $\angle APC' = \angle BPC$ or $\angle BPC'$ and the principal axis is normal at the pole P.



Images formed by Concave Mirrors

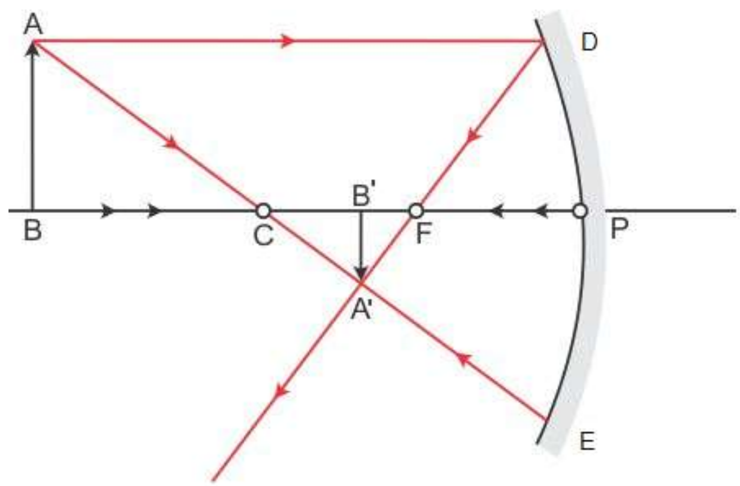
CASE (i)

Position of object	Position of image	Size of image	Nature of image
At infinity	At F	Highly diminished	Real and inverted



CASE (ii)

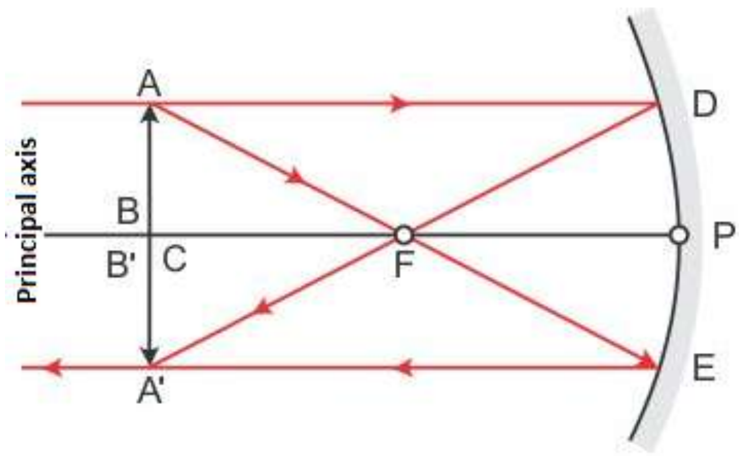
Position of object	Position of image	Size of image	Nature of image
Beyond C	Between F and C	Smaller size	Real and inverted



- Consider two rays, AD and AE coming from the same point of the object. AD is parallel to the principal axis and AE is incident through the centre of curvature.
- AD, after reflection passes through focus F along DA'. Ray AE is reflected back as EA. The two rays DA' and EA intersect at A' to form the image.
- Thus, image A'B' is formed between C and F and is real, inverted and diminished.

CASE (iii)

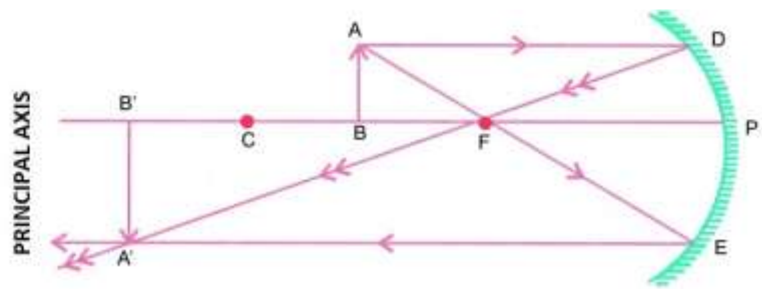
Position of object	Position of image	Size of image	Nature of image
At C	At C	Same size	Real and inverted



- Consider two rays AD and AE coming from the same point of the object. AD is parallel to principal axis and AE is incident through the focus.
- AD, after reflection passes through focus F along DA'. Ray AE is reflected parallel to the principal axis as EA'. The two rays DA' and EA' intersect at A' to form the image.
- Thus, image B'A' is formed at C and is real, inverted and of the same size as the object.

CASE (iv)

Position of object	Position of image	Size of image	Nature of image
Between C and F	Beyond C	Magnified	Real and inverted

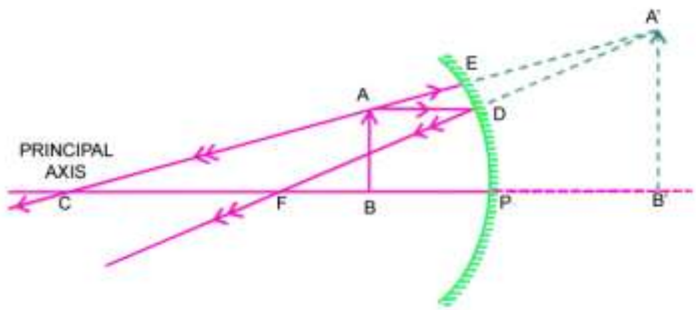


- Consider two rays AD and AE coming from the same point of the object. AD is parallel to the principal axis and AE appears to come from the centre of curvature and falls normally on the mirror.

- AD, after reflection passes through focus F along DA'. Ray AE is reflected back along EA'. The two rays DA' and EA' intersect at A' to form the image.
- Thus, the image B'A' is formed beyond C and is real, inverted and magnified than the object.

CASE (v)

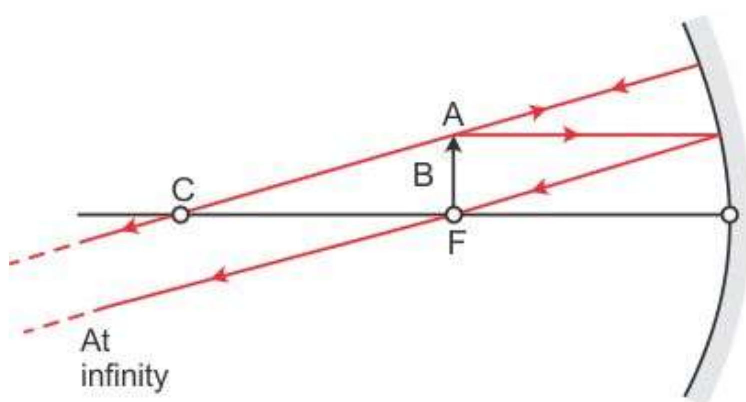
Position of object	Position of image	Size of image	Nature of image
Between P and F	Behind mirror	Magnified	Virtual and erect



- Consider two rays AD and AE coming from the same point of the object. AD is parallel to principal axis and AE appears to come from the centre of curvature and falls normally on the mirror.
- AD, after reflection passes through focus F along DF. Ray AE is reflected back along EA. The two rays DF and EA appear to diverge from point A_1 when produced backwards.
- If one observes from a point between C and F, the rays appear to come from A' which is virtual image of A.
- Thus, the image B'A' is formed behind the mirror and is virtual, erect and magnified than the object.

CASE (vi)

Position of object	Position of image	Size of image	Nature of image
At F	At infinity	Highly magnified	Real and inverted



- When an object is at principal focus, the image is formed at infinity and is real, inverted and highly magnified than the object.

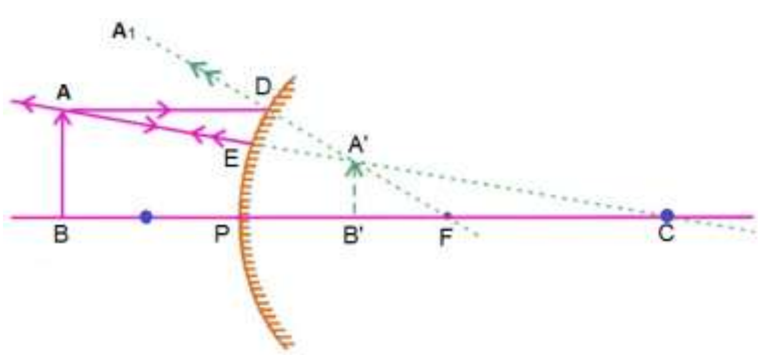
Image formed by a Concave Mirror for different positions of the object

Sr. No.	Position of the object	Position of the image	Nature of the image
1.	At infinity	At focus (F)	Real, inverted and diminished
2.	Beyond the centre of curvature (C)	Between focus (F) and the centre of curvature (C)	Real, inverted and smaller
3.	At the centre of curvature (C)	At the centre of curvature (C)	Real, inverted and of the same size
4.	Between the centre of curvature (C) and focus (F)	Beyond the centre of curvature (C)	Real, inverted and bigger than the object
5.	At the focus (F)	Infinity	Real and inverted
6.	Between the focus (F) and pole (P)	Behind the mirror	Virtual, erect and enlarged

Images formed by a Convex Mirror

CASE (i)

Position of object	Position of image	Size of image	Nature of image
Between infinity and pole of the mirror	Between P and F behind the mirror	Diminished	Virtual and erect



- A ray AD is incident on the mirror and is parallel to the principal axis which comes from the focus F along DA_1, and ray AE passing through the centre of curvature C gets reflected.

- Rays DA_1 and EA do not meet at point A' behind the mirror.
- Thus A' is the virtual image of point A and A'B' is the image of AB.

Position, Size and Nature of Image formed by a Convex Mirror

No	Position of the object	Position of the image	Size of the image	Nature of the image
1	At infinity	At focus (F)	Diminished to a point	Virtual and upright
2.	At any other point	Between Focus (F) Pole (P)	Diminished	Virtual and upright

Uses of Spherical Mirrors

Uses of Plane Mirrors

- They are used as looking glasses such as dressing table mirrors, wash basin mirrors, mirrors in saloons, etc.
- They are used in making mirrors of periscopes and kaleidoscopes.
- They are also used in stages to create illusion and special effects.

Uses of Concave Mirrors

- They are used as reflectors in projectors, light-house headlights, searchlights, etc.
- Large concave mirrors are used to concentrate the sunlight to produce heat in solar furnaces.
- Concave mirrors of large sizes are used in telescopes.
- They are used as shaving mirrors and make-up mirrors to see an enlarged and erect image of the face (the face must be close to the mirror).
- These mirrors are used by dentists to obtain a magnified image of the teeth.

- Doctors use concave mirrors to examine the ears, nose and throat.

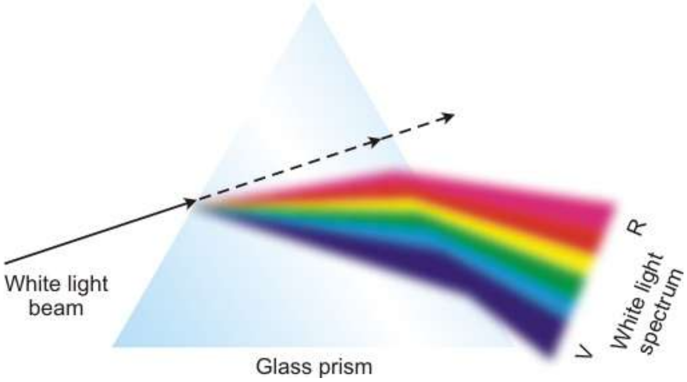
Uses of Convex Mirrors

- These mirrors are used as rear-view mirrors in cars and motorcycles, as they enable the driver/rider to view the road and vehicles behind.

- In street lights, the convex mirrors are used to diverge the light over an extended area.
- They are used as vigilance mirrors in big shops and departmental stores.

Dispersion of Light

- A rainbow is arch-shaped and appears after the rain in the morning or evening when the sun is low in the sky.
- It is formed when white light from the sun passes through tiny prism-like water droplets and splits into different colours.
- The phenomenon of splitting of a beam of white light into its constituent colours on passing through a prism is called **dispersion of light**.
- The order of colours from the lower end is violet, indigo, blue, green, yellow, orange and red, i.e. **VIBGYOR**.



Experiment

- Take a circular disc made of card board with a hole in its centre and then fix a spoke of a bicycle wheel in it so that it is easy to rotate the circular disc.
- Now mark seven lines from the centre of the disc to its periphery, to get seven equal triangles on the circle.
- Colour the triangles violet, indigo, blue, green, yellow, orange and red respectively. Now hold the spoke in the hand and rotate the disc.
- When the motion of the disc is slow, we can see the different colours distinctly, but when the rotating

disc reaches a certain speed it appears to be white.

- Thus, we know that when seven colours are mixed together we get a white colour.