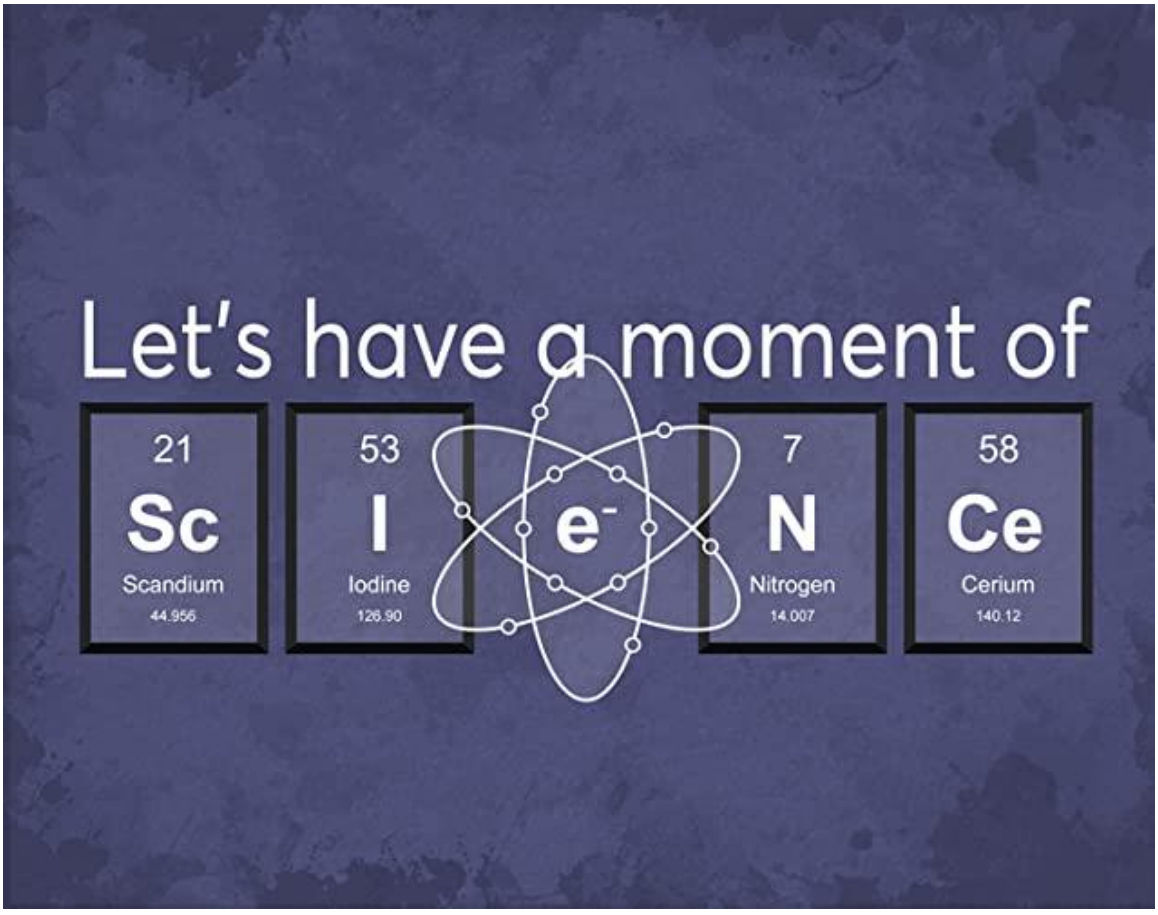
MBC – Mridul Bhaiya Classes

CLASS X

SCIENCE NOTES

LIGHT REFLECTION AND REFRACTION

- ✓ Detailed notes
- ✓ PYQs with answers
- ✓ Graphics included



LIGHT REFLECTION AND REFRACTION

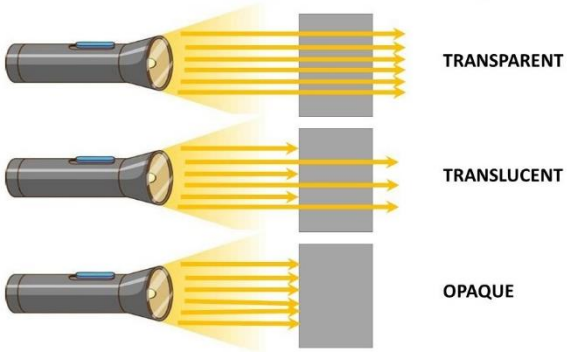
Definition of Light : Light Is a form of invisible energy which produces the sensation of sight.

Q. How we see objects?

We can see the objects in the presence of light, When light falls on an object some of the incident light is reflected back which enters in our eyes and the image of that object is created in our brain. Hence we see the objects.

Types of Medium or Object

1. **Transparent :** Allows light to pass through clearly.
2. **Translucent :** Allows some light but scatters it.
3. **Opaque:** Blocks light, making objects behind it invisible.



Q. How we know Light Travel in Straight line ?

When light falls on a solid object (opaque in nature) a shadow is formed behind the solid object. This shows that light travels in straight line.

Ray of light : A ray of light is a path followed by light energy in a transparent medium which is represented by a staight line having a aroww sign in the direction of propagation of light.

Beam of light : A group of parallel rays of light emitted by source of light.

Figure 1 : Ray of light

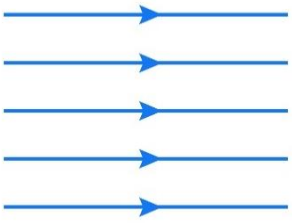


Figure 2 : Beam of light

Use of Ray picture of light

Using the ray picture of light, we can explain phenomena like reflection of light, refraction of light, and formation of images by Plane mirror, spherical mirror and lenses.

When light is treated in terms of rays of light, then it is known as **Ray Optics**.

Condition for Ray optics : Ray optics is valid only if the size of the opaque object in the path of light is much bigger than the wavelength of light.

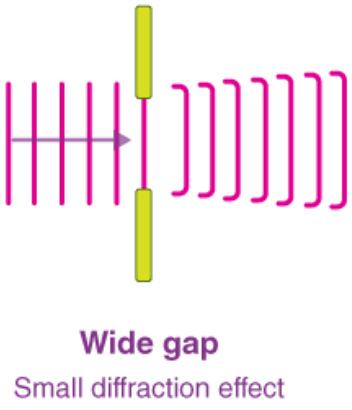
DUAL NATURE OF LIGHT

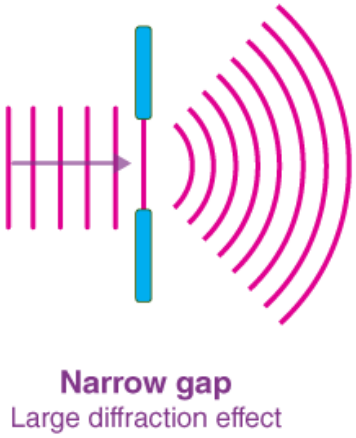
Light has **Dual nature** i.e it behaves as a wave as well as a stream of particles.

When the size of the opaque object in the path of light is much smaller than the wavelength of light, the light bends around the corners of the opaque object.

This phenomenon is known as ***Diffraction of light***. It is explained by considering light as a wave.

When light is treated in terms of wave nature, then it is known as **Wave Optics.**



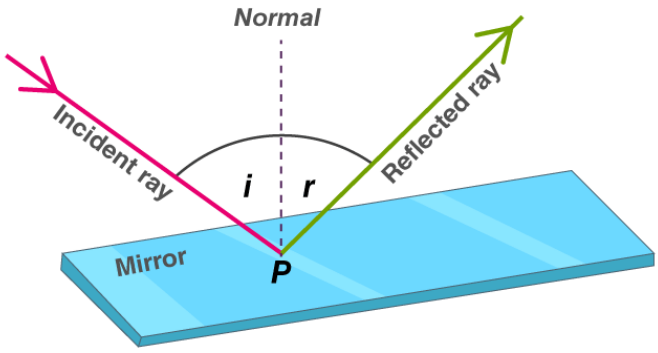


REFLECTION OF LIGHT

Definition : *The process of returning (or bouncing back) the light to the same medium after striking a surface is called reflection of light*

*A surface which reflects the light is known as **reflector**.*

- Silver metal is the best reflector
- Most common reflector used for looking is PLANE MIRROR.
- Polished metal surfaces are good reflectors.



COMMON TERMS :

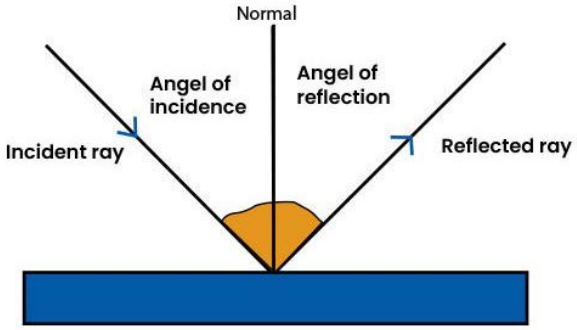
1. **Incident ray of light :** Any ray of light falling on a reflecting surface is known as incident ray of light.
2. **Reflected ray of light :** Any ray of light which is reflected back by a reflecting surface is known as reflected ray of light.
3. **Normal :** A perpendicular drawn on the reflecting surface at point of incidence is known as the normal to the reflecting surface.
4. **Incident angle or Angle of Incidence :** The angle between the incident ray and the normal to the point of incidence on the reflecting surface is known as incident angle or angle of incidence. It is denoted by $\angle i$
5. **Angle of reflection or Reflected angle :** The angle between the reflected ray and the normal to the point of incidence on the reflecting surface is known as reflected angle or angle of reflection. It is denoted by $\angle r$

LAWS OF REFLECTION

The reflection of light from a surface obeys certain laws called laws of reflection

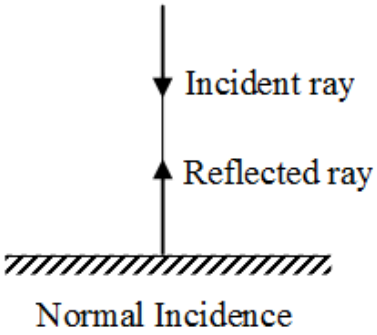
(i) Angle of incidence is equal to the angle of reflection i.e $\angle i = \angle r$

(ii) Incident ray, reflected ray and normal to the reflecting surface at the point of incidence lie in the same plane.



- **A ray of light striking the reflecting surface normally retraces its path**.

Explanation : When a ray of light strikes a reflecting surface normally, then angle of incidence is zero i.e $\angle i = 0$. According to the law of reflection, $\angle i = \angle r$ = 0 i.e the reflected ray is also perpendicular or normal to the reflecting surface. Thus, an incident ray normal to the reflecting surface retraces its path.



- Laws of reflection are also obeyed when light is reflected from the spherical or curved surfaces.
- Laws of reflection is valid for all types of surfaces i.e Rough Surfaces as well as smooth surfaces.

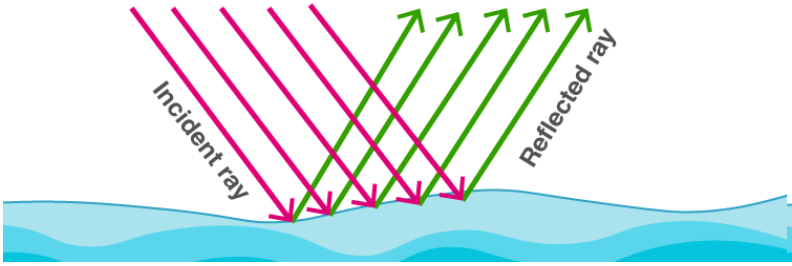


Figure 3 : Regular/Specular Reflection

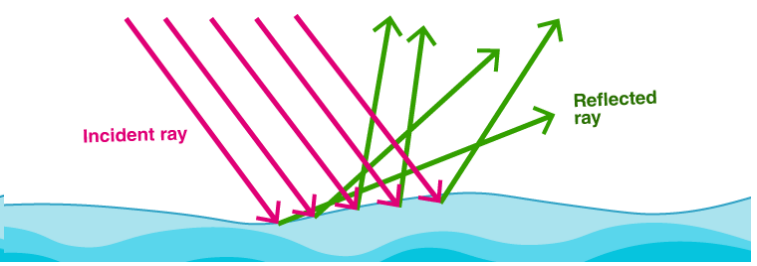
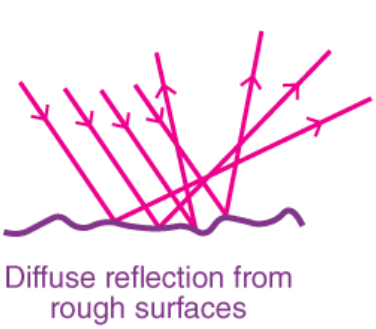
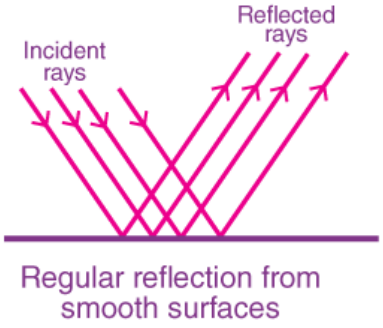


Figure 4 : Diffused Reflection

- Reflection from smooth surfaces is known as Regular Reflection and Reflection from Rough surface is known as Diffused Reflection.





IMAGE

Optical image is the apparent reproduction of an object, formed by a lens or mirror system from reflected, refracted, or diffracted light waves.

The picture of our face in mirror is known as the image of our face.

Images are of two types :

(i) Real image
(ii) Virtual image

Real image : When a beam of light from an object actually meets at a point after reflection, then the image of the object formed at that point I known as real image.

A real image can be obtained on a screen.

Virtual image : When a beam of light from an object does not meet at a point but appears to diverge from it after reflection, then the image of the object formed at that point I known as virtual image.

A virtual image can not be obtained on a screen.

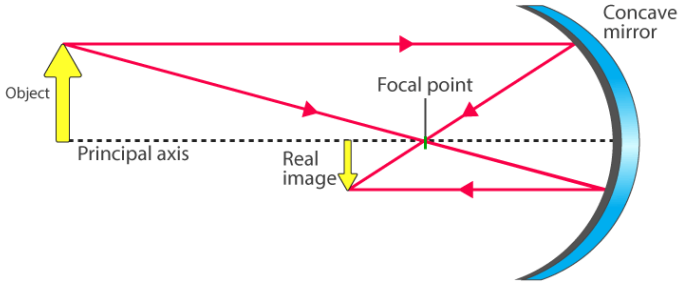


Figure 6 : Real Image

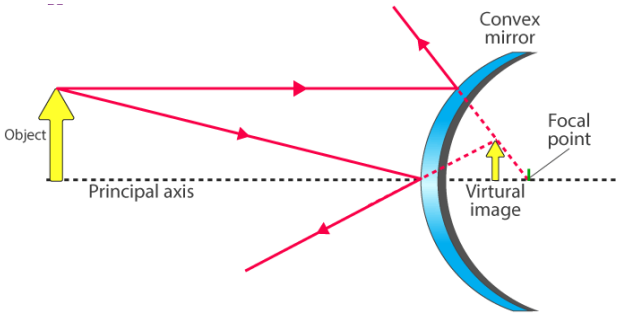
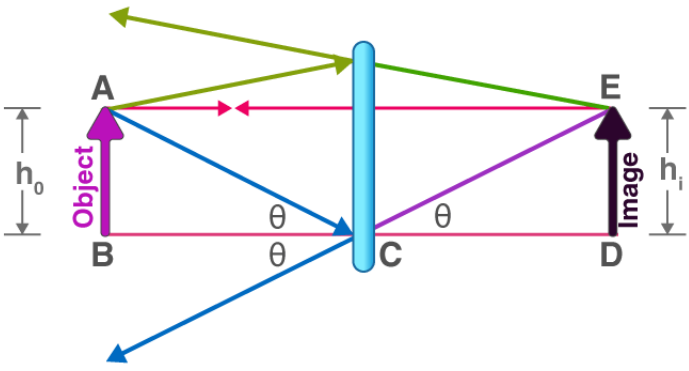


Figure 5 : Virtual Image

Difference Between Real Image and Virtual Image	
Real Image	**Virtual Image**
Real images are inverted	Virtual images are erect
A real image is always formed by a convex lens.	Virtual images can be formed by concave, convex or plane mirrors.
Real images are formed on the screen	Virtual images appear to be on the lens or the mirror itself
Real images are always formed by a concave mirror	Convex mirror forms a virtual image
Real images are formed due to the actual intersection of light rays	Virtual images are formed due to the imaginary intersection of light rays

IMAGE FORMATION BY A PLANE MIRROR



Properties of the image formed by a PLANE MIRROR

(i) Image formed by plane mirror is always virtual and erect
(ii) Size of the image formed by plane mirror is equal to the size of the object.
(iii) The distance of the image of an object behind the plane mirror is equal to the distance of the object in front of the mirror.
(iv) **Lateral Inversion** : The right side of the object appears as the left side of its image and vice-versa.

CURVED OR SPHERICAL MIRRORS

A Curved or a spherical mirror is the reflecting part of a hollow spherical surface.

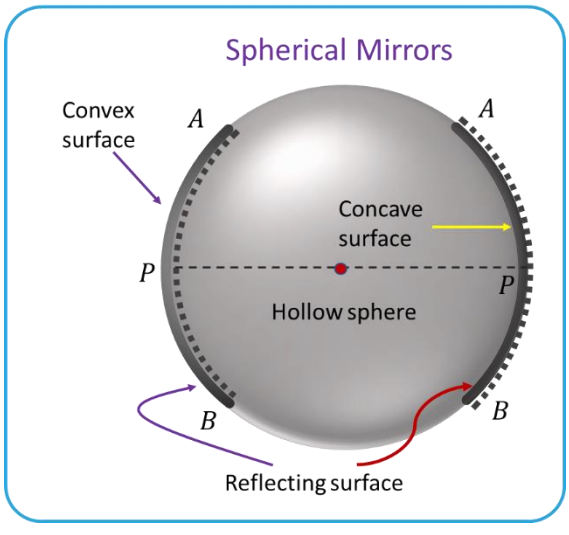
A mirror whose reflecting surface is curved or spherical is called a spherical mirror.

Types of Spherical mirror

1. Concave mirror
2. Convex mirror

Concave mirror : It is the part of a hollow sphere whose outer surface is silvered and the inner surface acts as a reflecting surface.

Convex mirror : It is the part of a hollow sphere whose inner surface is silvered and the outer surface acts as a reflecting surface.



The highly polished surfaces of a spoon behave as spherical mirrors. The inner polished surfaces of a spoon acts as **concave mirror** and outer polished surface of a spoon acts as **convex mirror**.

IMPORTANT TERMS IN RESPECT OF SPHERICAL MIRROR

1. **Centre of Curvature** : *The centre of a hollow sphere of which the curved or spherical mirror forms a part is called centre of curvature*.
   It is denoted by C
   NOTE : It is not the part of the spherical mirror.

2. **Radius of curvature** : *The radius of a hollow sphere of which the spherical mirror forms a part is called radius of curvature*.
   It is denoted by R
   NOTE : It is not the part of the spherical mirror.

3. **Pole** : *The mid point of a spherical mirror is called its pole*.
   It is denoted by P

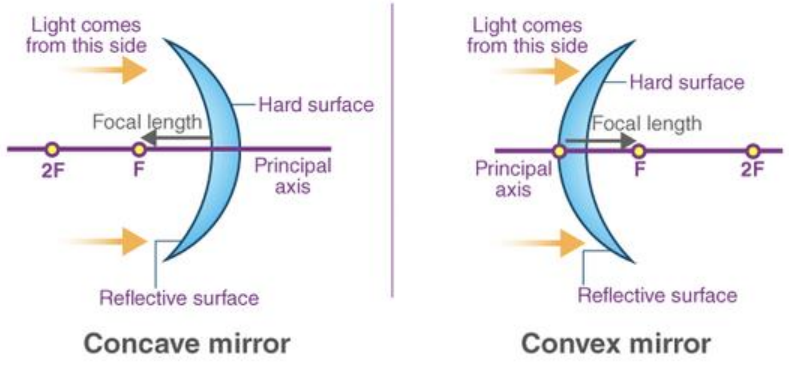
4. **Aperture** : *The diameter of the part of a spherical mirror exposed to the incident light is called the aperture of the spherical mirror*.

5. **Principal axis** : *A line joining the center of curvature (C) and Pole (P) of a spherical mirror and extended on either side is called principal axis*.

6. **Principal Focus** : *A point on the principal axis of a spherical mirror where the rays of light parallel to the principal axis meet or appear to meet after reflection from the spherical mirror is called principal focus.* It is denoted by F.

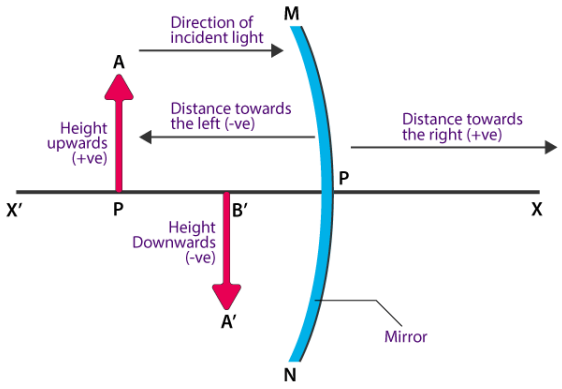
7. **Focal Plane** : *A plane normal or perpendicular to the principal axis and passing through the principal focus of a spherical mirror is called focal plane of spherical mirror*.

8. **Focal Length** : *The distance between the Pole (P) and principal Focus (F) of a spherical mirror is called the focal length of the mirror*. It is denoted by *f*



SIGN CONVENTION FOR REFLECTION BY SPHERICAL MIRROR

1. *The object is assumed to be placed on the left side of a mirror. Thus, light from the object fall on the mirror from left side.*
2. *All distances are* measured from the pole of a *spherical mirror.*
3. *Distance measured* in the direction of Incident light *are taken as positive*, while distances measured in the opposite direction to the direction of Incident light *are taken as negative.*
4. The upward distance *perpendicular to the principal axis are taken as positive*, while the *downward distances perpendicular to the principal axis are taken as negative*.



NOTE : Radius of Curvature of a plane mirror = ∞ (infinite)

Focal Length of a plane mirror = ∞

RELATION BETWEEN FOCAL LENGTH AND RADIUS OF CURVATURE:

Focal Length of Spherical mirror is half the length of Centre of Curvature i.e Radius of Curvature

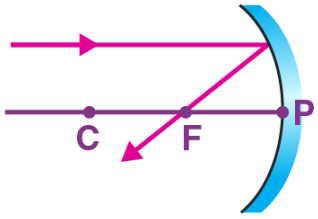
$$f = R/2$$

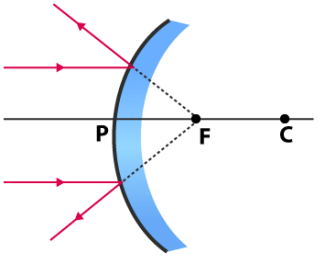
NUMERICALS

1. The radius of curvature of a spherical mirror is 30 cm. Find the focal length of this mirror. (**Ans : 15cm**)
2. Calculate the focal length of a concave mirror whose Radius of Curvature is 32 cm. (**Ans : -16cm**)
3. Find the nature and Focal length of a spherical mirror whose radius of curvature is +24 cm. (**Ans : +12cm**)
4. The focal length of a concave mirror is 15cm. Find its Radius of curvature. (**Ans: 30cm**)

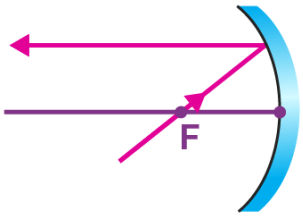
RULES FOR IMAGE FORMATION BY SPHERICAL MIRROR

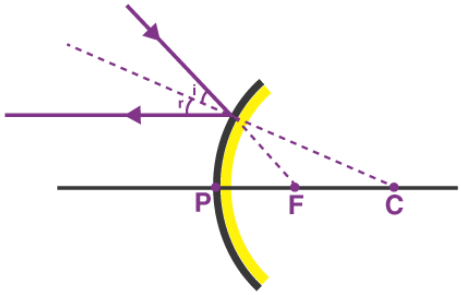
Rule 1 : Any Ray parallel to the principal axis, after Reflection, will pass through the principal focus (F) in case of a Concave Mirror or Appears to Diverge from the Principal Focus in case of a Convex Mirror.



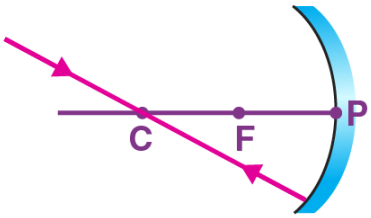


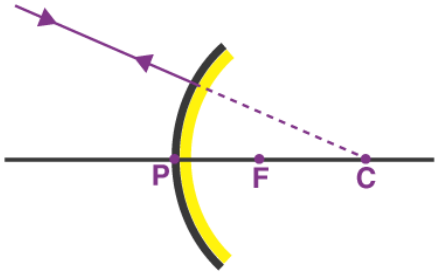
Rule 2 : Any Ray passing through the principal focus of a concave mirror or ray which is directed towards the principal focus of a convex mirror, after Reflection will emerge parallel to the Principal axis.



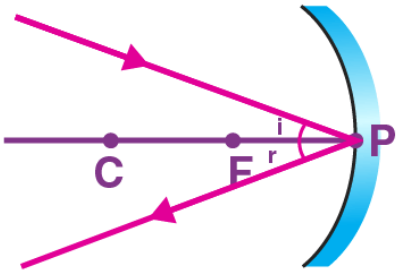


Rule 3 : Any Ray passing through the Centre of Curvature of a Concave mirror or directed in the direction of the centre of curvature of a Convex Mirror, After Reflection, is Reflected back along the same path.





Rule 4 : Incident Ray of light travelling obliquely to the principal axis is reflected obliquely to after striking a spherical mirror at its pole.



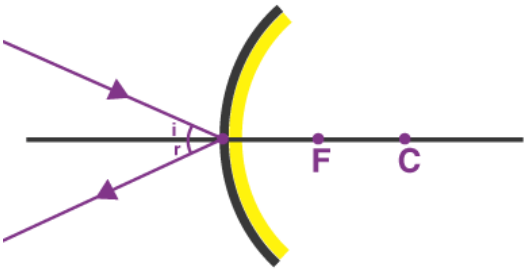


IMAGE FORMATION BY CONCAVE MIRROR

1. When object is at infinity :

Ray Diagram :

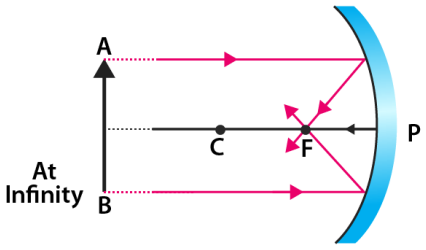


Image Position : At principal focus (F)

Characteristics : 1. Real and Inverted

2. Highly diminished, point size

2. When object is beyond the centre of Curvature (C) :

Ray Diagram :

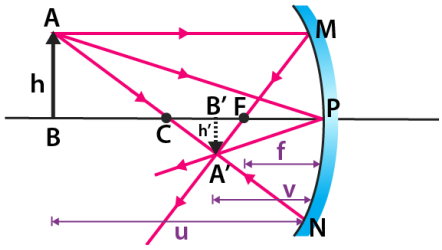


Image Position : At principal focus (F)

Characteristics : 1. Real and Inverted

2. Highly diminished, point size

3. When object is at the centre of Curvature (C) :

Ray Diagram :

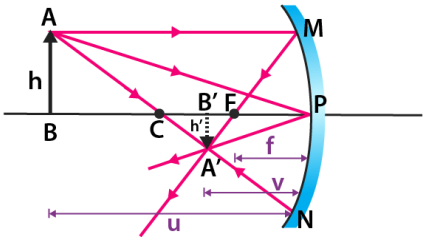


Image Position : At principal focus (F)

Characteristics : 1. Real and Inverted

2. Highly diminished, point size

4. When object is between Centre of Curvature (C) and Principal Focus (F) :

Ray Diagram :

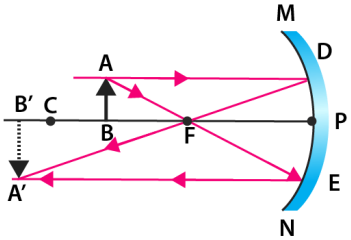


Image Position : At principal focus (F)

Characteristics : 1. Real and Inverted

2. Highly diminished, point size

5. When object is at Focus :

Ray Diagram :

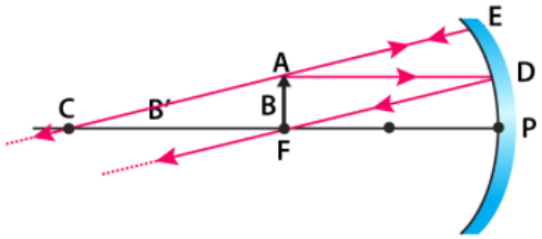


Image Position : At principal focus (F)

Characteristics : 1. Real and Inverted

2. Highly diminished, point size

6. When object is between Principal Focus (F) and Pole (P) :

Ray Diagram :

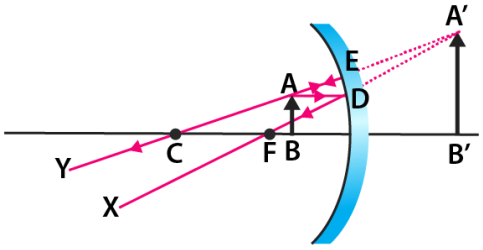


Image Position : At principal focus (F)

Characteristics : 1. Real and Inverted

2. Highly diminished, point size

Position of the Object	Position of the Image	Size of the Image	Nature of the Image
At infinity	At focus, F	Highly diminished and pointed in size	Inverted and real
Beyond C	Between F and C	Diminished	Inverted and real
At C	At C	Same size	Inverted and real
Between C and F	Beyond C	Enlarged	Inverted and real
At F	At infinity	Highly enlarged	Inverted and real
Between F and P	Behind the mirror	Enlarged	Erect and virtual