LIGHT

Light :- It is a form of Energy that gives us a sensation of vision.
- It is a form of Electromagnetic radiation.
- It is a transverse wave. (disturbance produced in a wave is in 1st direction to the direc^{n} of propogation of wave).

Sources of Light

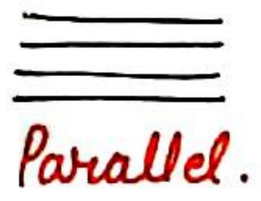
Self Luminous
These sources emit light of their own.
e.g. Sun, Stars, Candles etc.

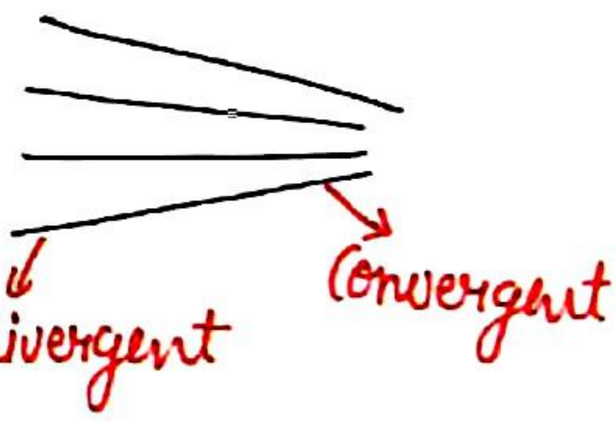
Non-Luminous
These sources does not emit light of their own.
e.g:- The moon, book, table etc.

Ray of Light :- The linear path joining the one point from where light wave propogate to another. is called Ray of Light.

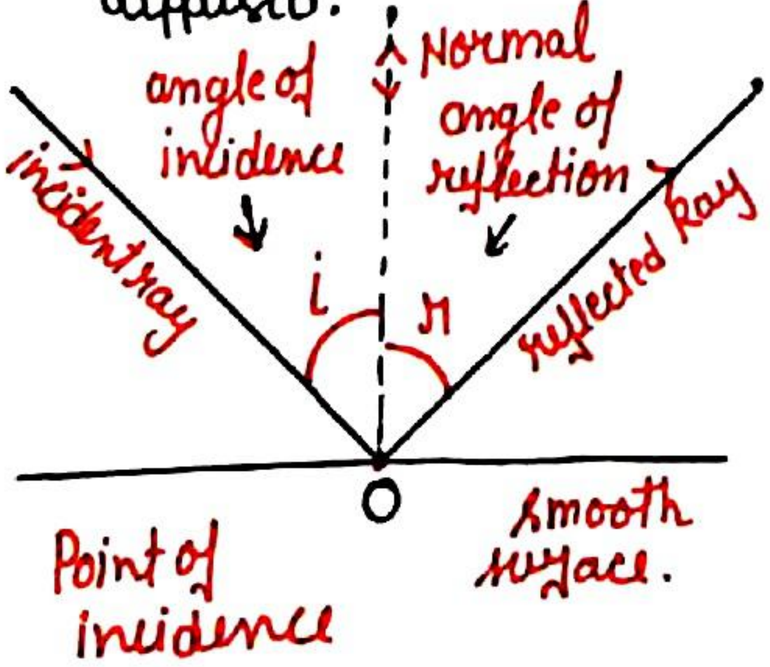
Medium of Light The substance through which light propogate or tries to do so is called medium.
- → **Transparent** Medium through which light propogates completely. Air,
- → **Translucent** through which light propogates partially. frosted glass.
- → **Opaque** through which light does not propogates. Metals, wood.

Beam of Light :- A Bundle of rays of light is called beam of light.
- → Parallel beam of light.
- → Convergent beam of light
- → divergent beam of light.


Parallel.



Reflection of Light :- The phenomenon of bouncing back of light after falling on a polished smooth surfaces into the same medium. is called Reflection of Light.
- → Regular Reflection. or specular
- → Irregular Reflection. or diffused.



Laws of Reflection There are two laws.

1. The angle of incidence (i) is equal to the angle of reflection. (r). i.e. $\boxed{\angle i = \angle r}$

2. The incident ray. the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane.

Images The point at which the reflected ray converge or appear to diverge is known as image.

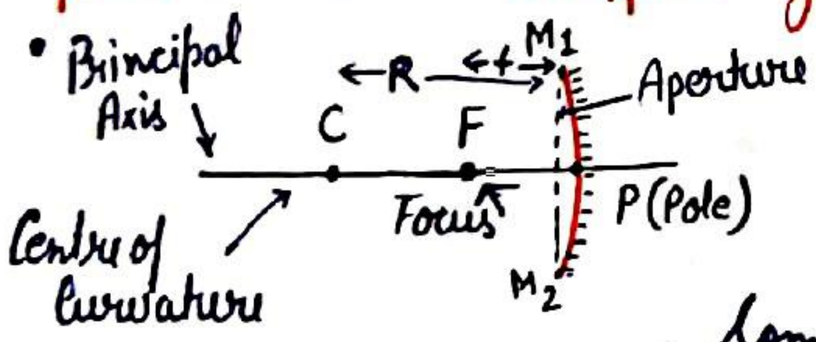
→ **Real** - If the light rays after reflection/refraction actually passes through the point where the image is located, it is called Real image.
- It can be obtained on a screen. • Always Inverted.

→ **Virtual** - If the light appears to come from the point where the image is located. it is called Virtual Image.
- Can not be obtained on a screen. • Always erect.

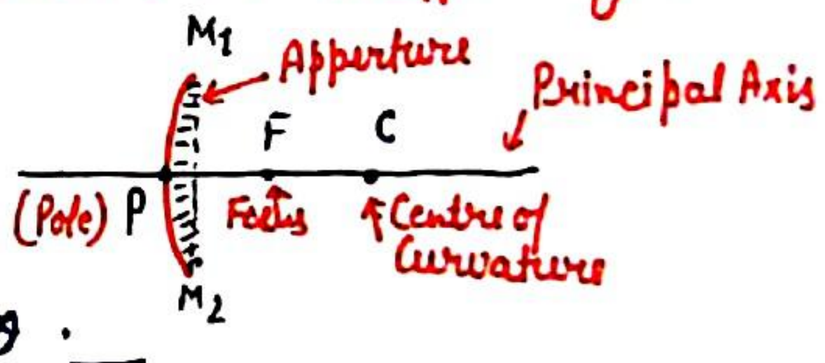
Mirrors → **Plane Mirrors** - It is flat and reflects the light in order they are recieved.
- Image is laterally inverted (reversed left to right.)
- Object's size and distance remains the same in plane mirror reflection.

Spherical Mirrors - Mirrors which have the shape of the piece cutout of a spherical surface. It's one side is silver polished.

Concave (Converging)
- A Spherical mirror whose outer side is polished & inner is reflecting one.



Convex (Diverging)
- A Spherical mirror whose inner side is polished & outer is reflecting one.



Some terms Related to Spherical Mirrors

Pole (P) - It is the geometrical centre of spherical mirror's reflecting surface.

Centre of Curvature (C) - It is the centre of the imaginary sphere of which, mirror is a part.

Radius of Curvature (R) - It is the radius of the imaginary sphere of which mirror is a part.

Aperture - Diameter of the reflecting surface of spherical mirror is called its aperture.

Principal Axis - The imaginary line joining the centre of curvature & the pole.

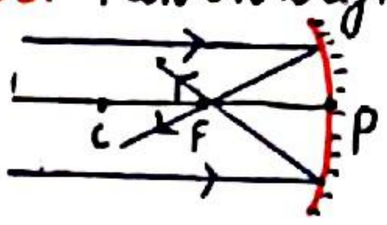
Focal length (f) - It is the distance between the principal focus and the pole.
If the apperture is small $f = R/2$

Principal Focus (F) - It is the point on the principal axis of which all the parallel rays coming from infinity actually converge (in case of concave) or appear to converge (in case of convex) after reflection from respective mirror.

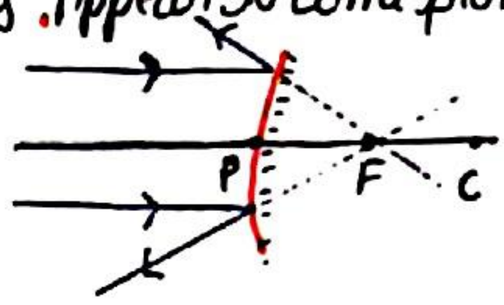
Image Formation Rules

1. The ray coming parallel to the principal Axis.

Concave — Pass through the focus

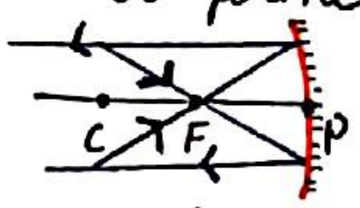


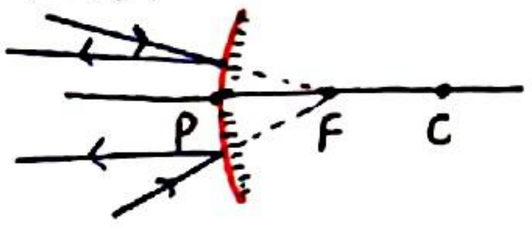
Convex — Appear to come from focus



2. The ray coming through the focus of concave mirror. or coming towards focus of convex mirror.

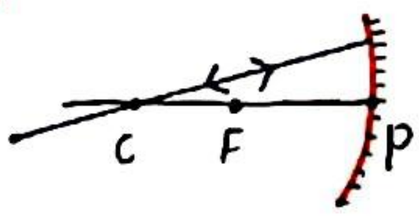
In both mirror it will become parallel to principal Axis.

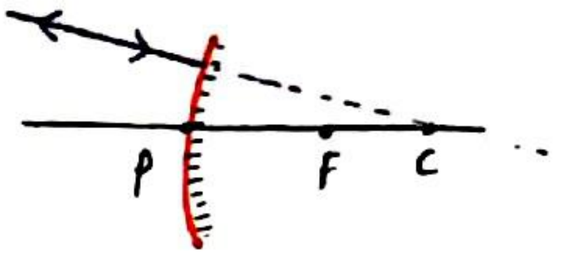




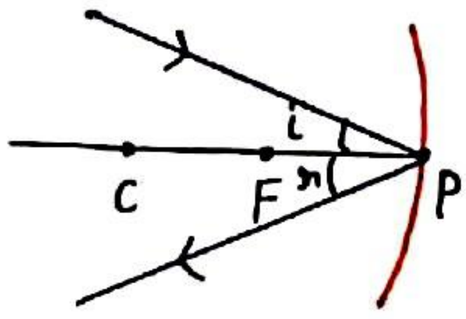
3. A ray coming through centre of Curvature of concave mirror or towards the direction of centre of curvature of a convex mirror.

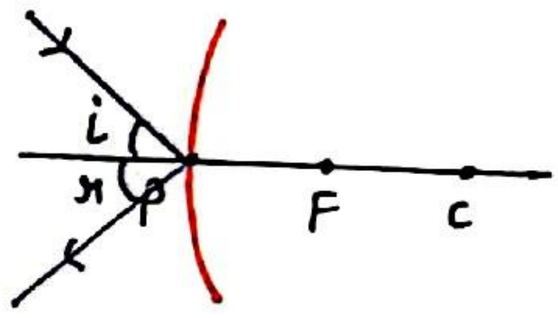
In both mirrors it reflects back along same path.





4. A ray incident obliquely to Principal axis, towards a pole P of a mirror is reflected obliquely following $\angle i = \angle r$ (Law of reflection).



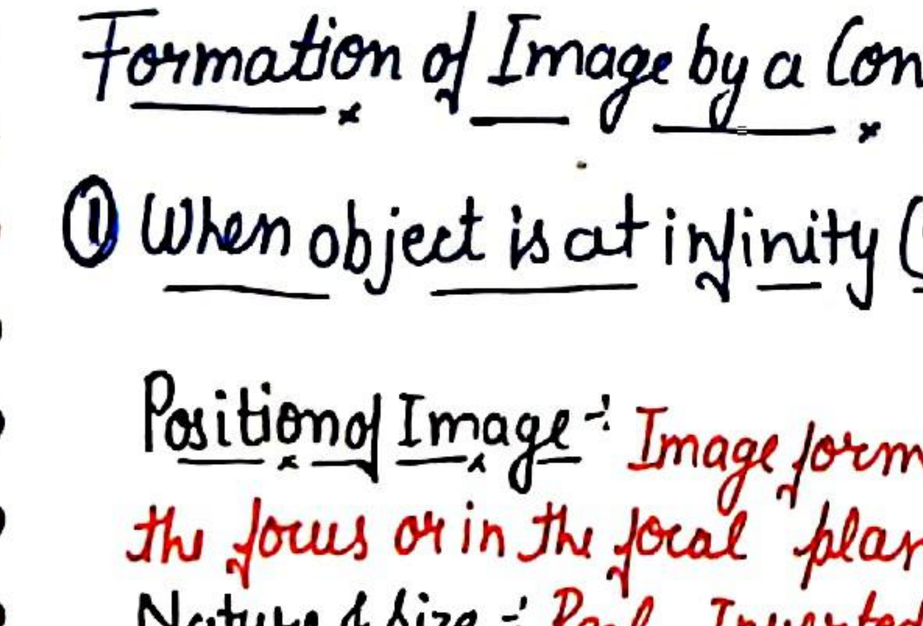


Formation of Image by a Concave Mirror

① When object is at infinity (∞) :-

Position of Image :- Image formed at the focus or in the focal plane.

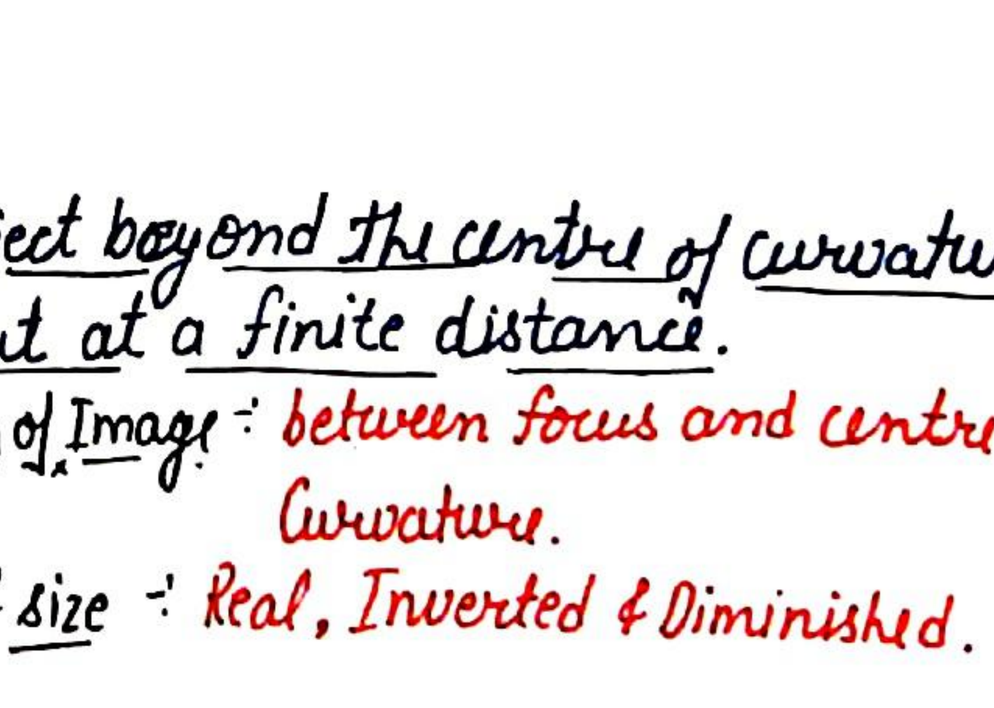
Nature & Size :- Real, Inverted, extremely diminished.



② Object beyond the centre of curvature but at a finite distance.

Position of Image :- between focus and centre of Curvature.

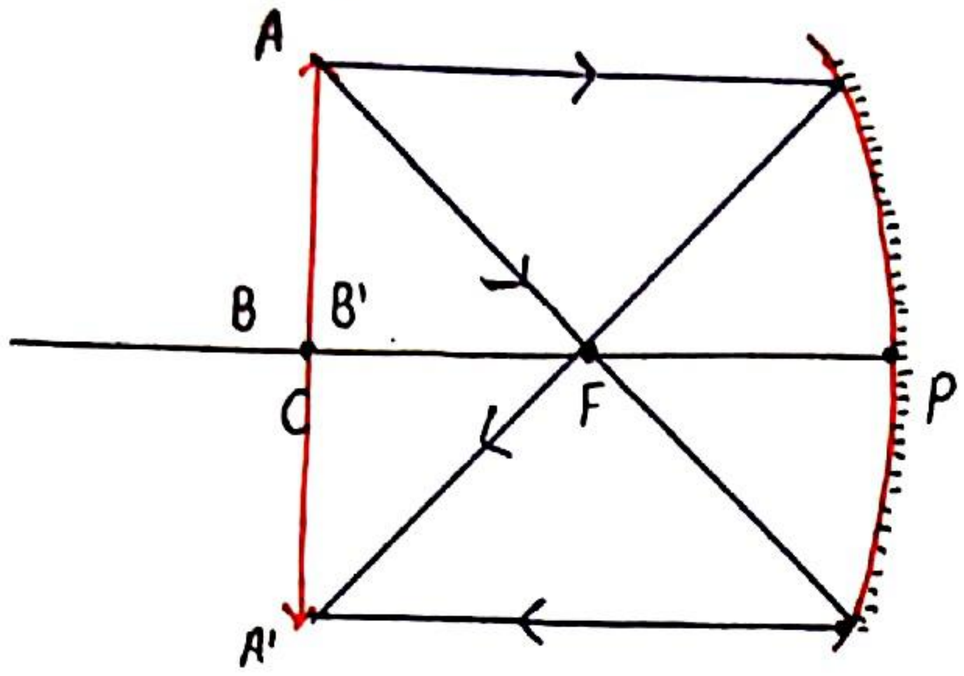
Nature & size :- Real, Inverted & Diminished.



③ Object at the centre of Curvature

Position of Image - At centre of Curvature.

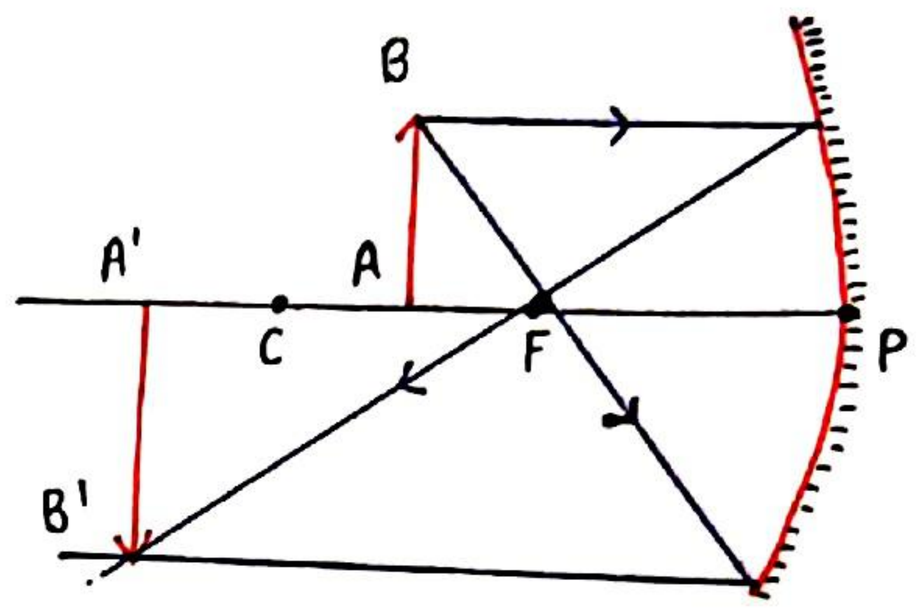
Nature & Size - Real, Inverted & equal to the same size.



④ Object between the Focus & Centre of Curvature

Position of Image - Beyond the Centre of Curvature

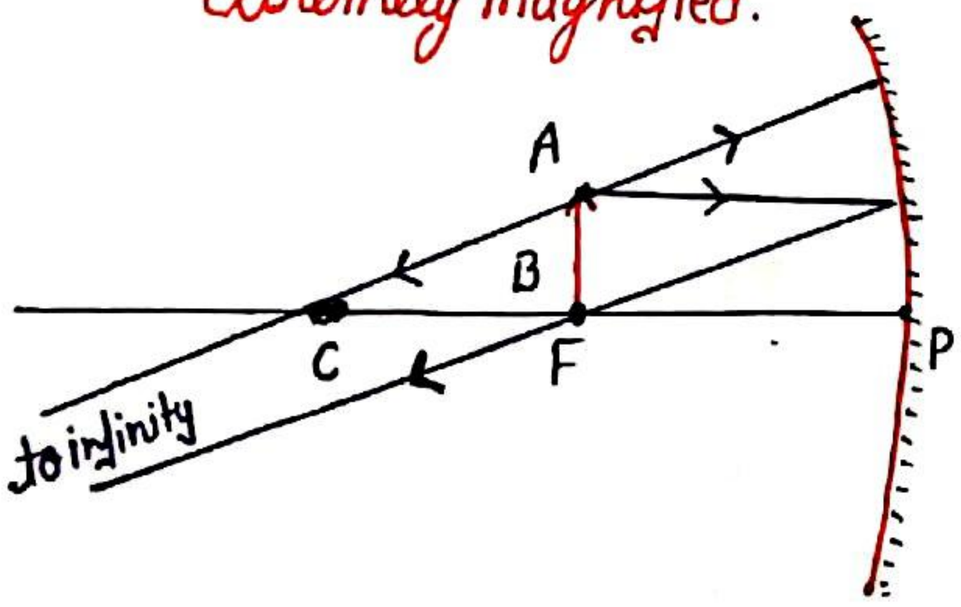
Nature & Size - Real, Inverted & bigger than object.



⑤ Object at the focus

Position of Image - Image forms at ∞.

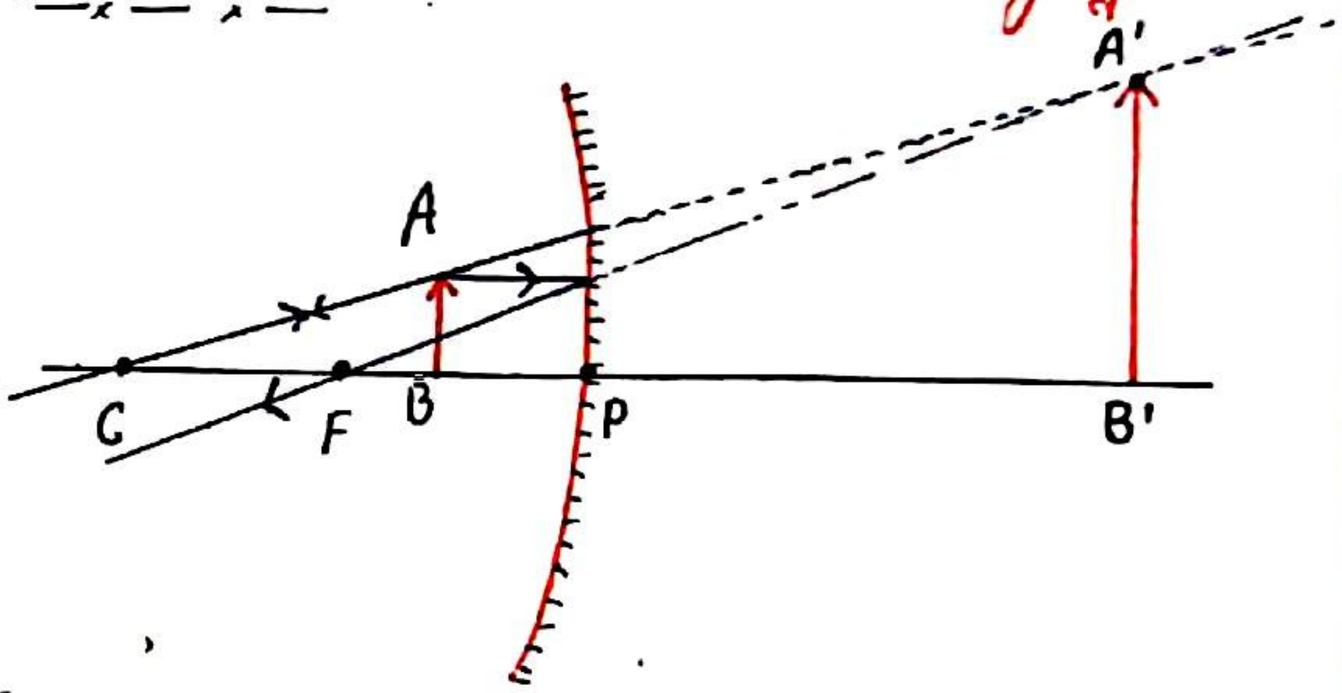
Nature & Size - Real, Inverted & extremely magnified.



⑥ Object bet. the pole & the focus

Position of Image - Behind the mirror.

Nature & Size - Virtual & erect & magnified.

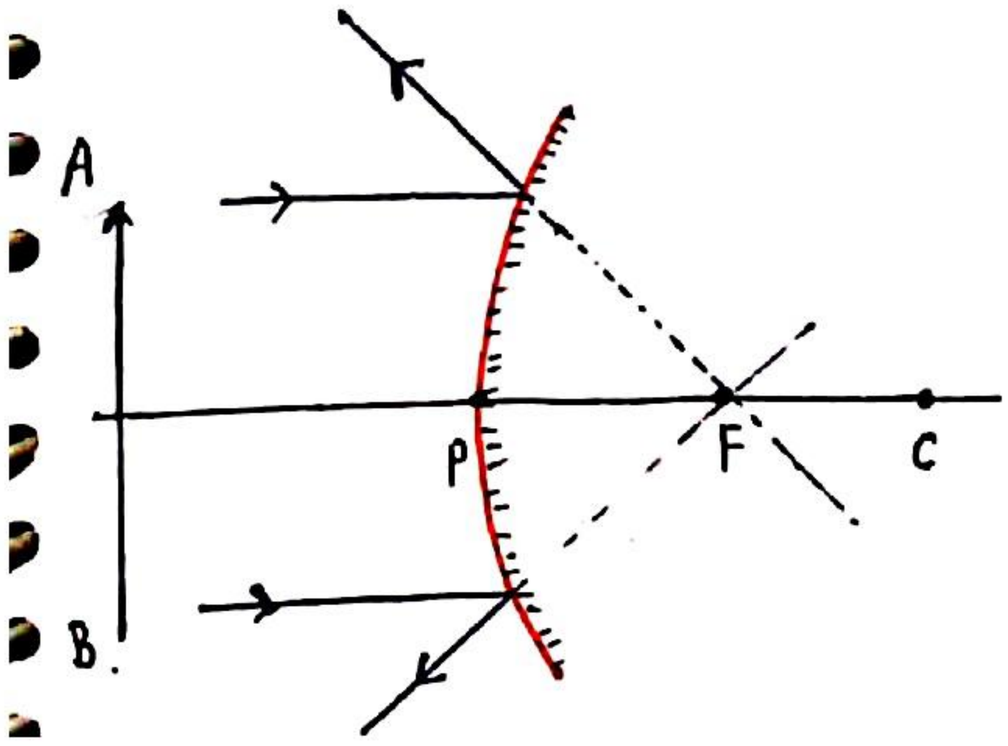


Formation of Image by a Convex Mirror

① Object at ∞.

Position of Image - At F, behind the mirror.

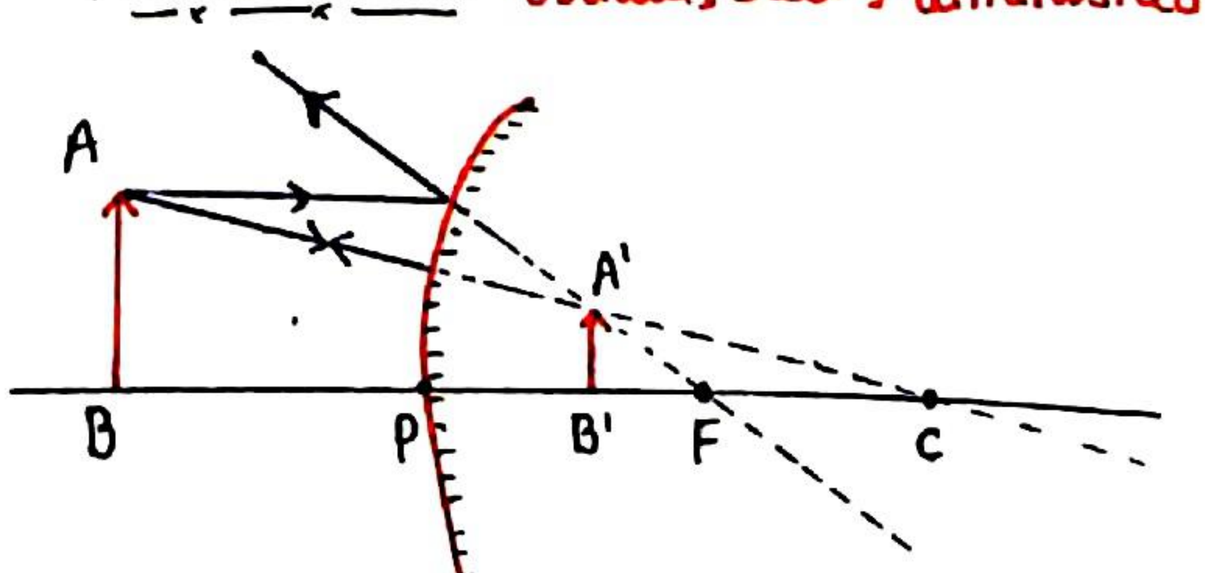
Nature & Size - Virtual, Erect, highly diminished.



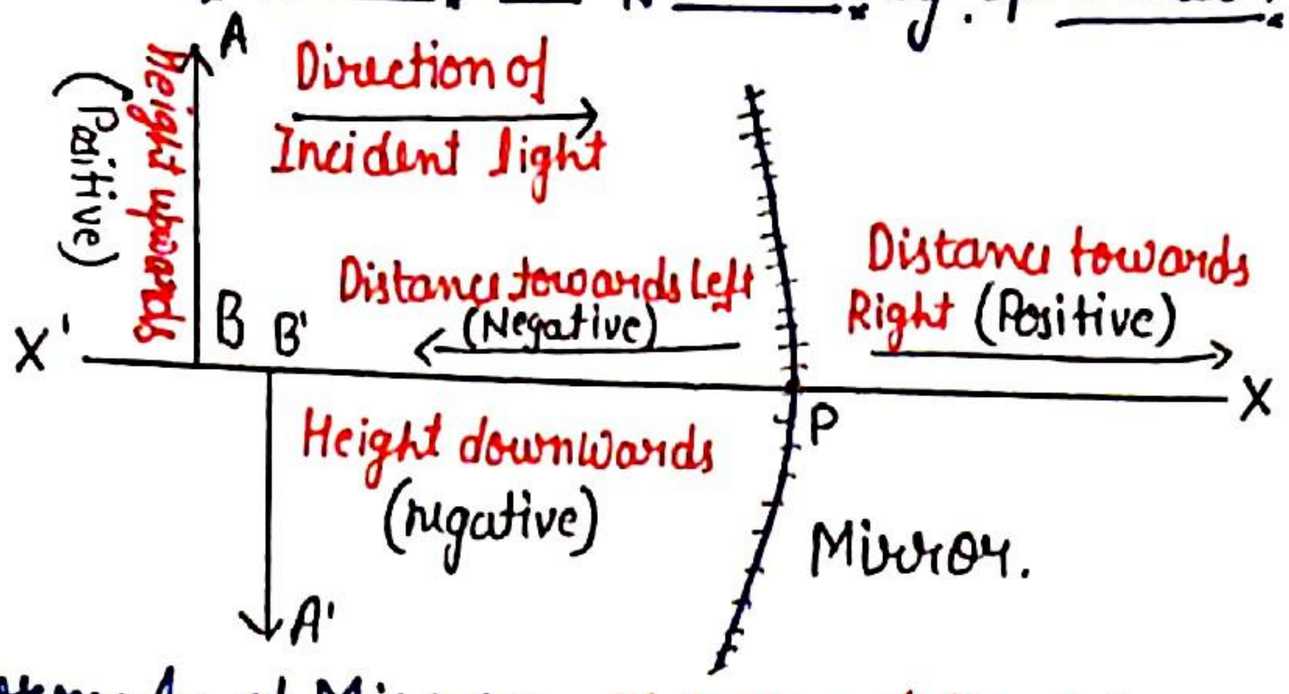
② Object btw. Infinity and Pole.

Position of Image - between focus & Pole behind the mirror.

Nature and Size - Virtual, erect & diminished.



Sign Convention for Reflection by Spherical Mirrors.



- Mirror is considered as origin.
- The object is always placed to the left of the mirror.

Formula of Mirror It is the relation between quantities. u, v and f.

It can be expressed as $\boxed{\frac{1}{v} + \frac{1}{u} = \frac{1}{f}}$

1. Object distance (u) The distance of the object from its pole in case of mirror.
2. Image distance (v) The distance of the image formed from pole of the mirror.
3. focal length (f) The distance of focus from the pole of the mirror.

◆ Values of u, v & f to be used according to Sign convention.

Linear Magnification : It gives the relative extent to which the image of object is magnified with respect to the object size. It expressed as.

$$\text{magnification}(m) = \frac{\text{Height of Object Image } (h_i)}{\text{Height of Image Object } (h_o)}$$

It also related to the u & v.

$$m = \frac{\text{Image distance } (v)}{\text{Object distance}} = \frac{-v}{u}$$

We can say that,

$m = 0 \rightarrow h_i = h_o$

$m < 1 \rightarrow h_i < h_o$

$m > 1 \rightarrow h_i > h_o$

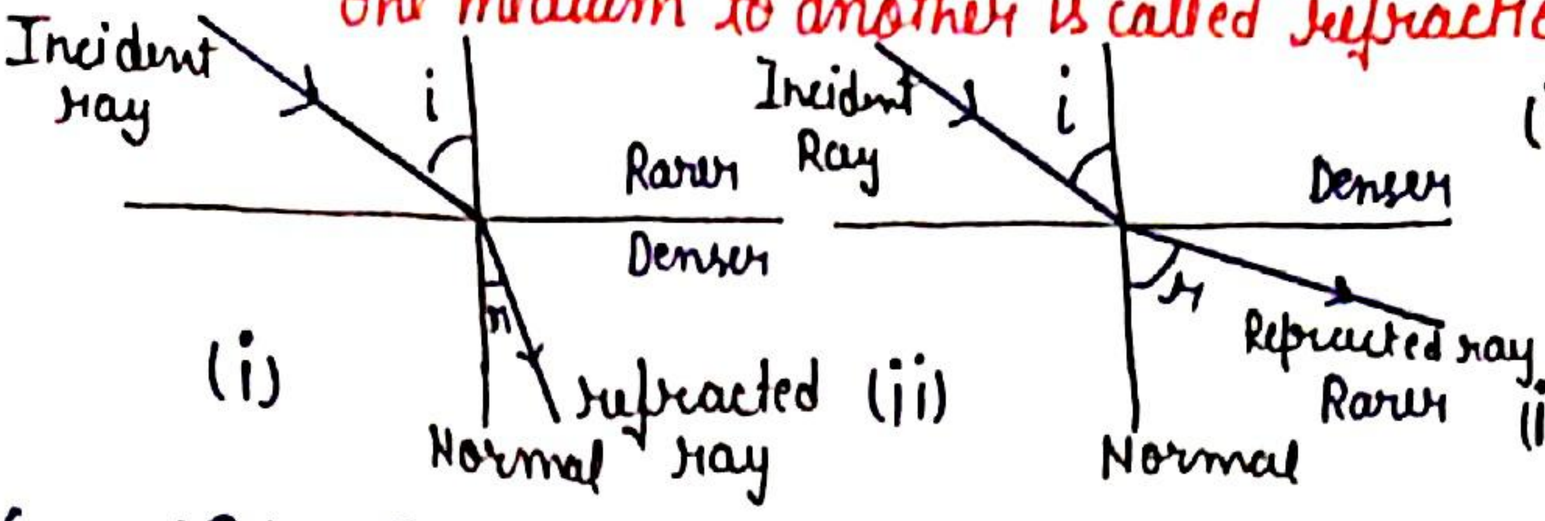
$$\boxed{m = \frac{h_i}{h_o} = \frac{-v}{u}}$$

If m is +ve → Image Virtual & erect.

If m is -ve → Image Real & Inverted.

Refraction

The phenomenon of bending of light ray when passes from one medium to another is called refraction of light.



(i) When light ray passed from Rarer to Denser it bends towards the normal.

(ii) When it passed Denser to Rarer it bends away from the normal.

Cause of Refraction

In every medium, speed of light is different. It may be lesser in denser medium and higher in rarer medium. So, when light enters a denser medium, its speed reduces and it bends towards the normal and when it enters a rarer medium, its speed increases and it bends away from the normal.

Laws of Refraction

1. The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
2. The ratio of Sine of angle of incidence to the sine of angle of refraction for light of a given colour is constant for a given pair of media. (Snell's Law).

$$\frac{\sin i}{\sin r} = \mu = \text{Constant } (\mu \text{ or } n)$$

The constant is known as refractive index (μ).

Refractive Index of Medium and Absolute Refractive index.

→ For a given pair of media ${}_1\mu_2$ represents refractive index of medium 2 with respect to medium 1, when light passes from medium 1 to medium 2.

→ If the refractive index of a medium is taken with respect to vacuum, It is called absolute refractive index of the medium.

For glass/water pair $\quad {}_w\mu_g = \dfrac{{}_a\mu_g}{{}_a\mu_w}$

Min. refractive index is of Air.
Max. refractive index is of Diamond.

Refractive Index & Speed of light :

$$\mu = \frac{\text{Speed of light in vacuum/Air}}{\text{Speed of light in medium}} = \frac{c}{v}$$

For any two media, the refractive index of second medium w.r.t. first medium is equal to the ratio of the velocities of light in the medium.

$${}_a\mu_g = \frac{c}{v_g} \quad -(1) \qquad {}_a\mu_w = \frac{c}{v_w} \quad -(2)$$

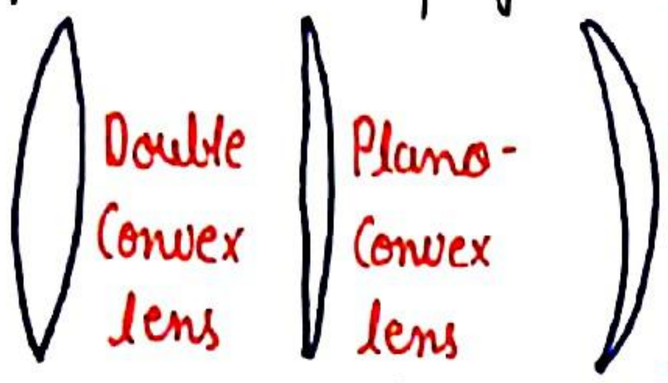
On dividing eqn (2) from eqn (1).

$${}_g\mu_w = \frac{{}_a\mu_w}{{}_a\mu_g} = \frac{v_g}{v_w}$$

Lenses - It is a transparent medium bounded by two surfaces, out of which one or both surfaces are spherical. These are of two Types.

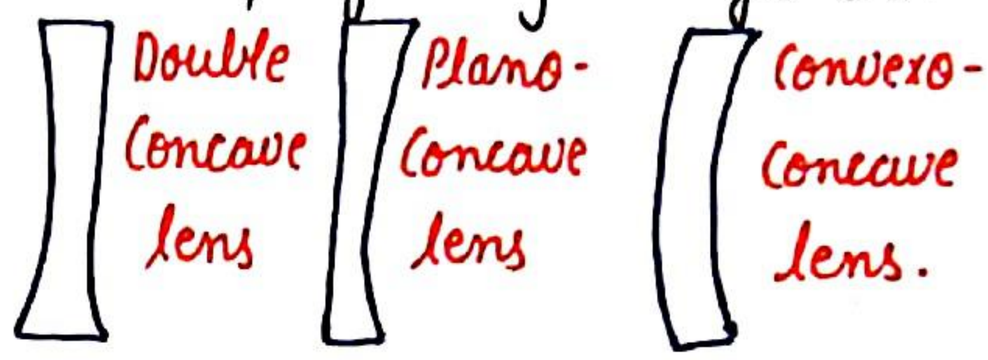
Convex or Converging Lens

A lens which is thicker at the centre & thinner at its ends is a convex lens. Converging lens because it converges a parallel beam of light ray.



Concave or Diverging Lens

A lens which is thinner at the centre and thicker at its ends is a concave lens. Diverging lens because it diverges a parallel beam of light ray through it.



Some Terms related to lenses -

1. **Optical Centre** - The geometrical centre of a lens is called as its optical centre (o).

2. **Centres of Curvature** - The centre of curvature of the two imaginary spheres of which lens is a part are referred to as centres of curvature of lens. because of two curved surfaces a lens has two centres of curvature.

3. **Radii of Curvature** - The radii of the two imaginary spheres of which, the lens is a part are known as radii of curvature of the lens. (c). The two radii of curvature of lens may or may not be equal depends upon spheres.

4. **Principal Axis** - The imaginary line joining the two centres of curvature is called principal axis of a lens. It also passes through optical centre.

5. **Principal Focus** - Lens has two principal focii.
   ① **First principal Focus** - A point located on principal axis of lens, where the rays where the rays run parallel to principal axis after refraction.

   ② **Second principal Focus** - A point located on principal axis at which the rays coming parallel to the principal axis, converge on the other side of lens (Convex) or appear to meet on the same side of lens (Concave), after refraction from the lens.

   Both focii of convex lens are Real while of concave lens are Virtual.

6. Focal length of a lens - The distance between focus & optical centre of lens.

7. Focal Plane - The plane passing through focus & perpedicular to principal axis.

8. Aperture - The effective diameter of a circular outline of a spherical lens.

9. Refractive Axis - Imaginary axis at the optical centre perpendicular to the principal axis which represents the lens.

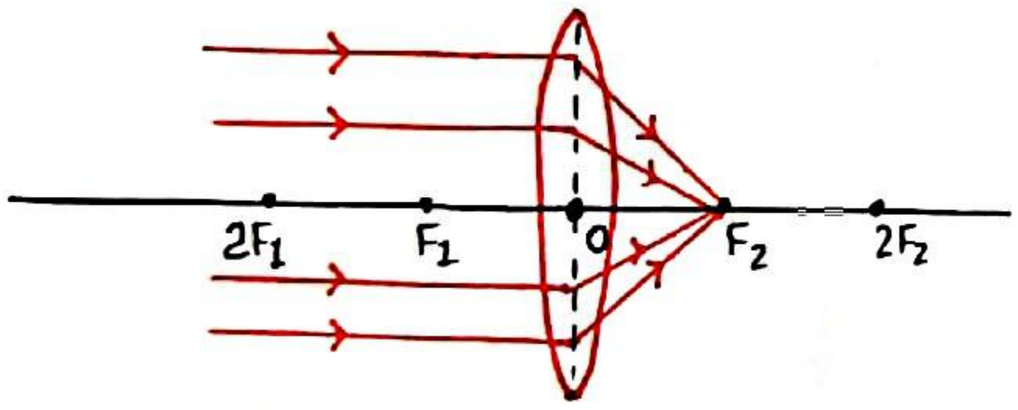
Image formation by Lenses

Rules

1. Rays parallel to the principal axis, will pass through second principal focus after refraction
2. Rays passing through the focus will emerge parallel to the principal axis after refraction.
3. Rays passing through the optical centre, will emerge without any deviation after refraction through the lens.

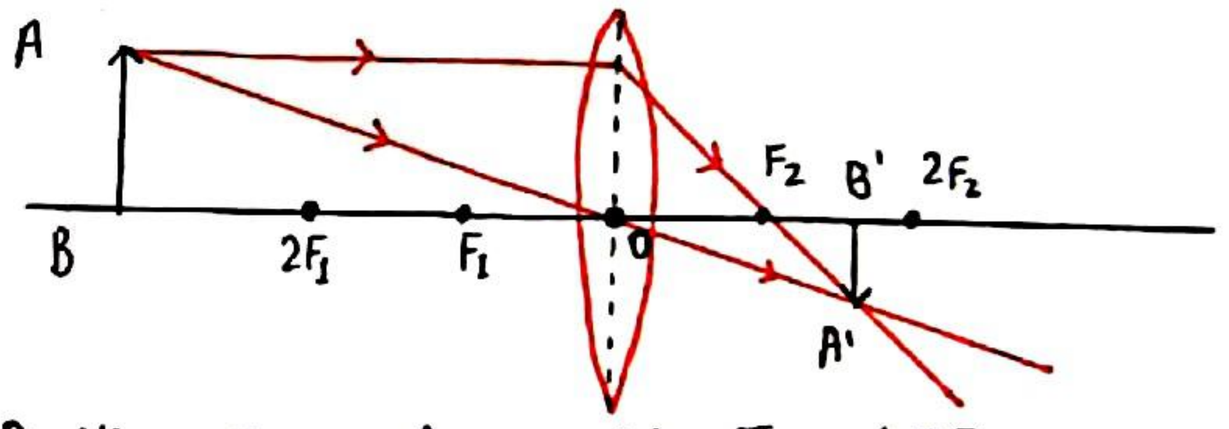
Image formation by a Convex lens

① When object is at infinity.



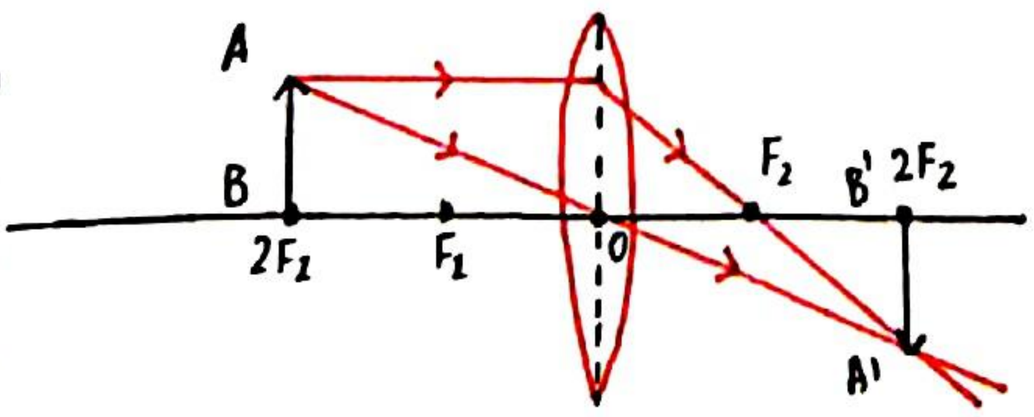
Position - Image forms at F_2.
Size & Nature - Real & Inverted.
Extremely diminished.

② Object beyond $2F_1$ (at Finite distance)



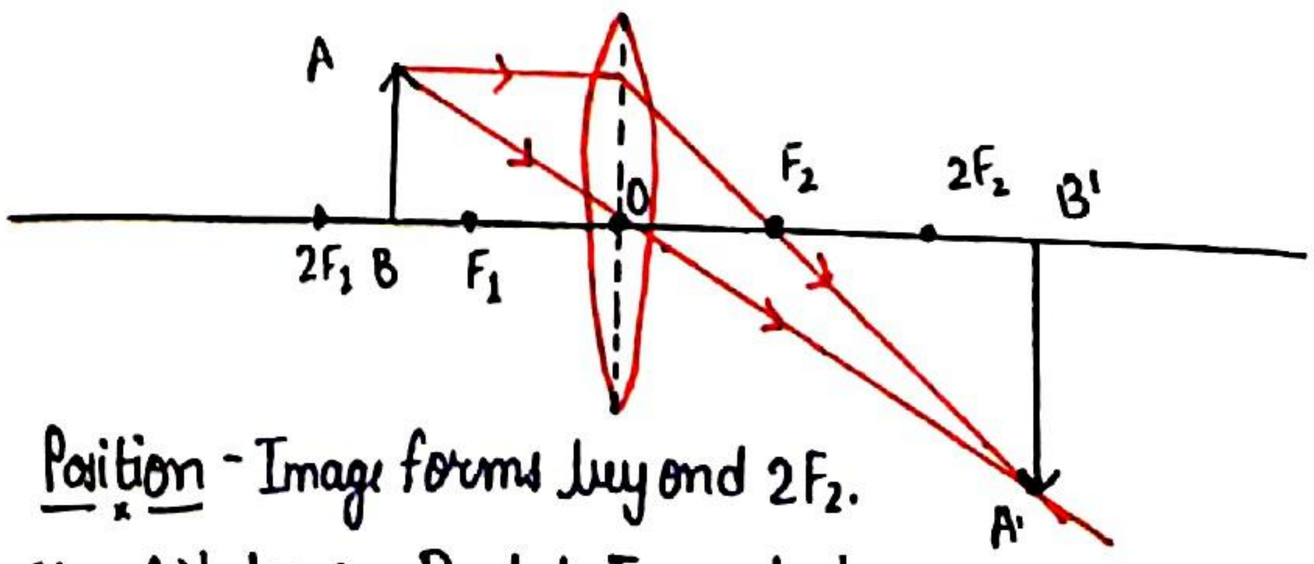
Position - Image forms btw. F_2 and $2F_2$.
Size & Nature - Real & Inverted. Diminished.

③ Object at $2F_1$.



Position - Image forms at $2F_2$.
Size and Nature - Real & Inverted
Same Size

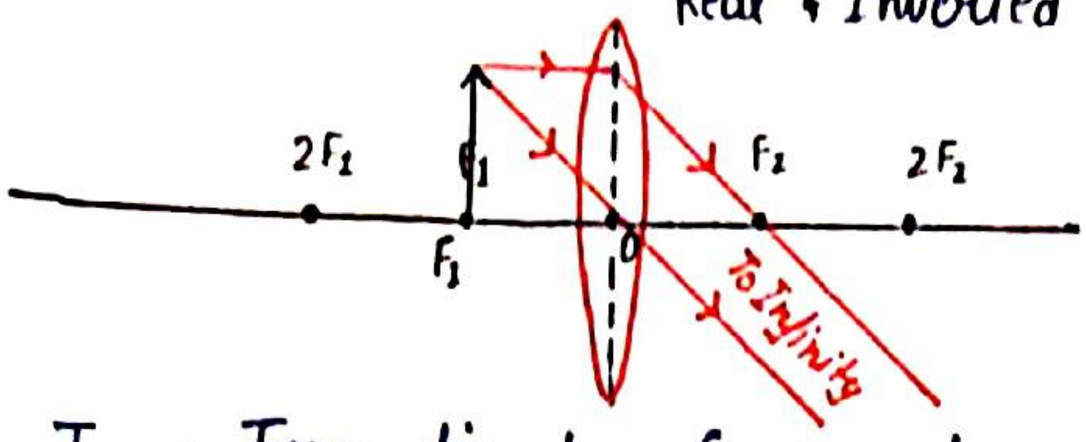
④ Object between F_1 and $2F_1$.



Position - Image forms beyond $2F_2$.
Size & Nature - Real & Inverted
Magnified.

⑤ Object at F_1

Image Formed at ∞
Highly magnified.
Real & Inverted



⑥ Object between lens and F_1. Image formed at the same side of object

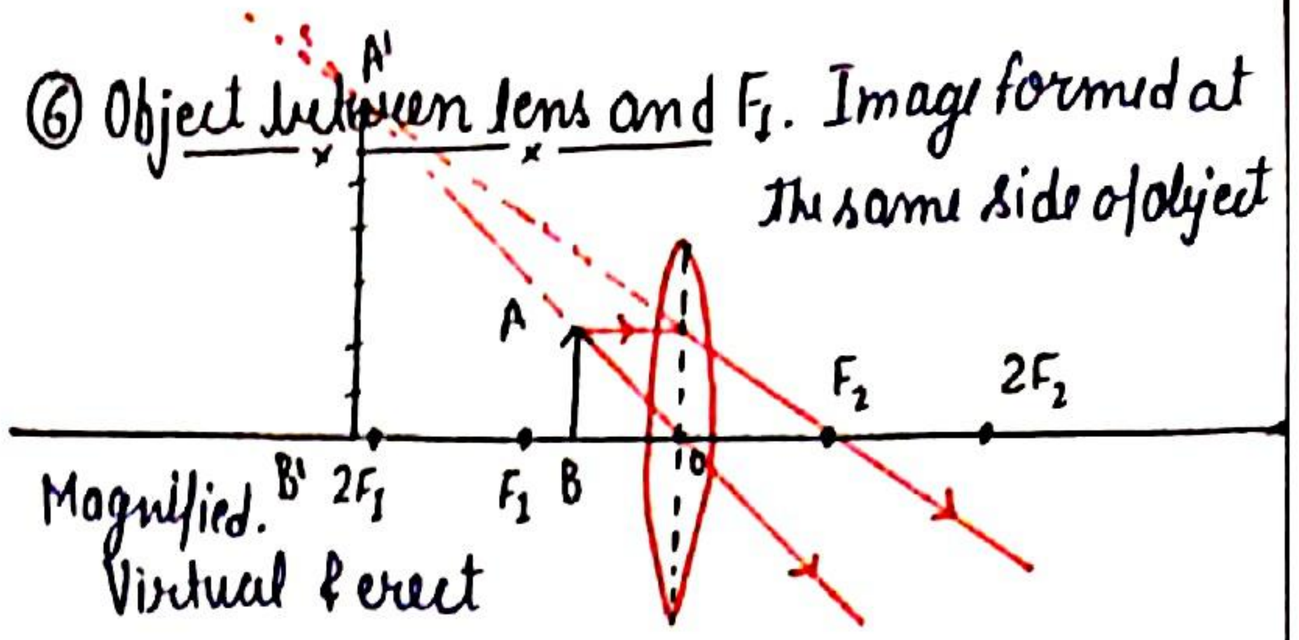
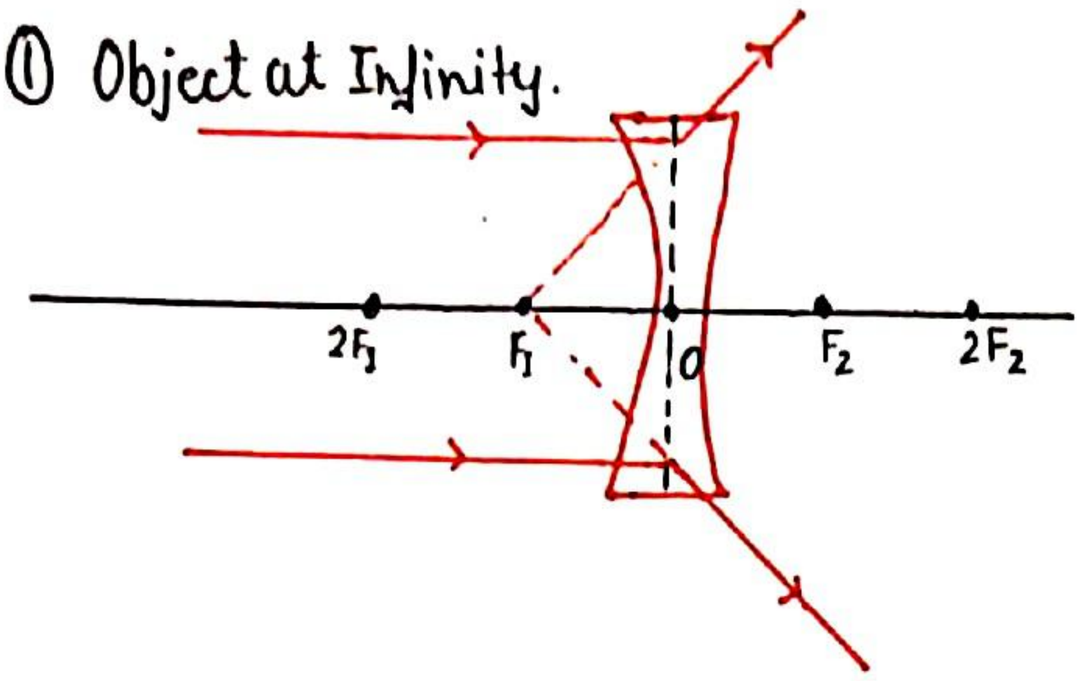


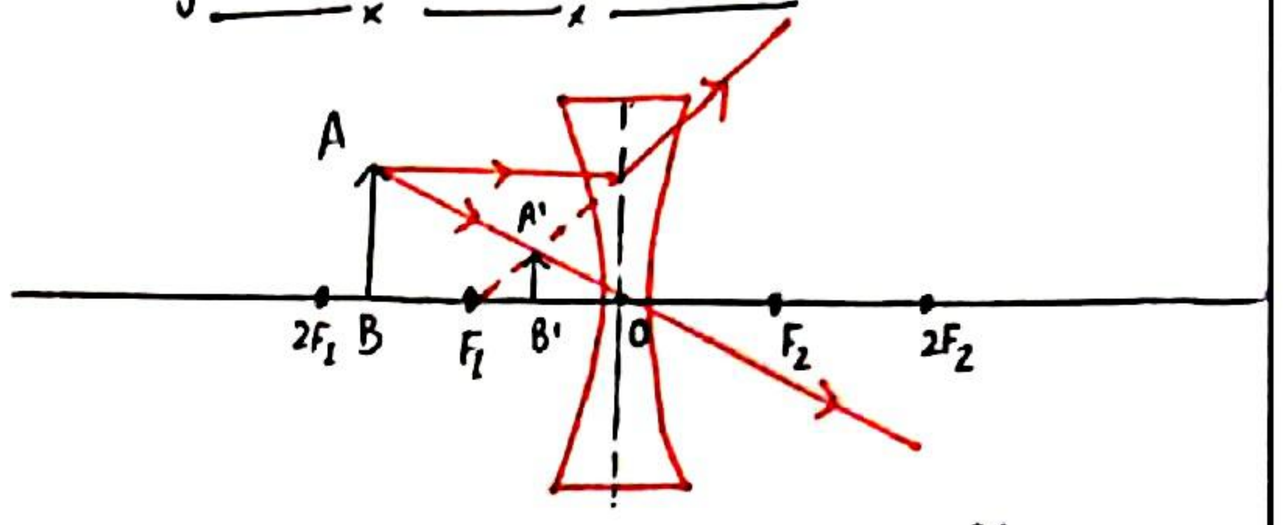
Image Formation by a Concave Lens

① Object at Infinity.



Position :- Forms at Focus same side of object
Size & Nature :- Highly diminished.
Virtual & Erect.

② Object at a finite distance



Position :- Image forms but F_1 & O same side of object.
Size & Nature :- Diminished
Virtual & erect

Sign Convention for Spherical Lenses.

	For Convex Lens	For Concave Lens
1. Distance of the object	Negative	Negative
2. Distance of Real Image	Positive	N.A.
3. Distance of the Virtual Image	Negative	Negative
4. Focal Length	Positive	Negative
5. Height of the Object	Positive	~~Negative~~ Positive
6. Height of Real & Inverted image	Negative	N.A.
7. Height of Virtual erect image	Positive	Positive

Lens Formula Represents relationship between u, v and f.

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

u = object distance v = Image distance
f = focal length.

Linear Magnification The ratio of height of image to the height of object is known as magnification (m).

$$\text{Linear Magnification } (m) = \frac{h_i}{h_o} \text{ or } m = \frac{v}{u}$$

Power of a Lens

The ability of a lens to converge or diverge light rays is known as Power (P) of the lens.

- It is always resiprocal of focal length (in metre).

$$P = \frac{1}{f} \text{ (in metre)}.$$

- It's S.I. Unit is Dioptre (D) $(1D = 1\,m^{-1})$

1 Dioptre is the power of lens whose focal length is 1m.

For Convex lens, power & focal length are positive.
For Concave lens, power & focal length are negative.

Power of Combination of Lenses

When two or more thin lenses are combined the Equivalent focal length (f) and power of combination (P) can be calculated as:

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \text{----} \quad \text{and} \quad P = P_1 + P_2 + \text{---}$$

Magnification of Lens in Combination (m).

$$m = m_1 \times m_2 \text{ - --} \text{ and so on.}$$

Uses :-

Concave Mirror :
- by a dentist.
- In a shaving mirror.
- In search light.
- In head lamps.
- In Ophthalmoscope.

Convex Mirror :
- As a rear-view mirror.
- In shops to check theft.
- At traffic junctions.
- To lighten large area.

Concave Lens :
- Wide-angle spy hole indoors.
- Myopic eye defect correction.

Convex Lens :
- Telescope
- Camera
- Microscope
- Magnifying glass.
- Hypermetropic eye defect correction.