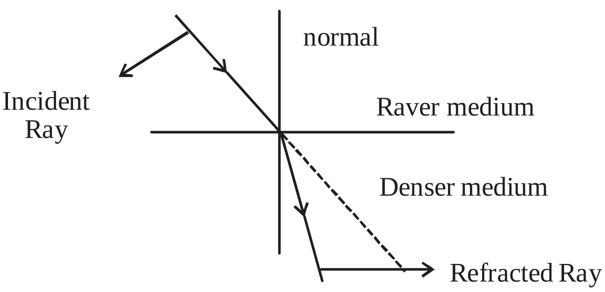
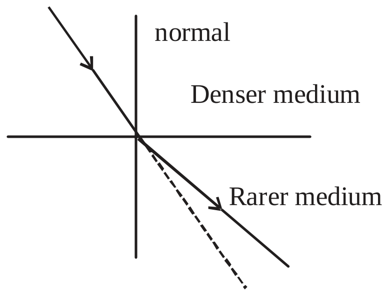
Refraction is due to **change in the speed of light** as it enters from one transparent medium toanother.

Speed of light decreases as the beamof light travel fromrarer mediumto the denser medium.



When ray travel from Rarer to Denser it bends towards normal after refraction

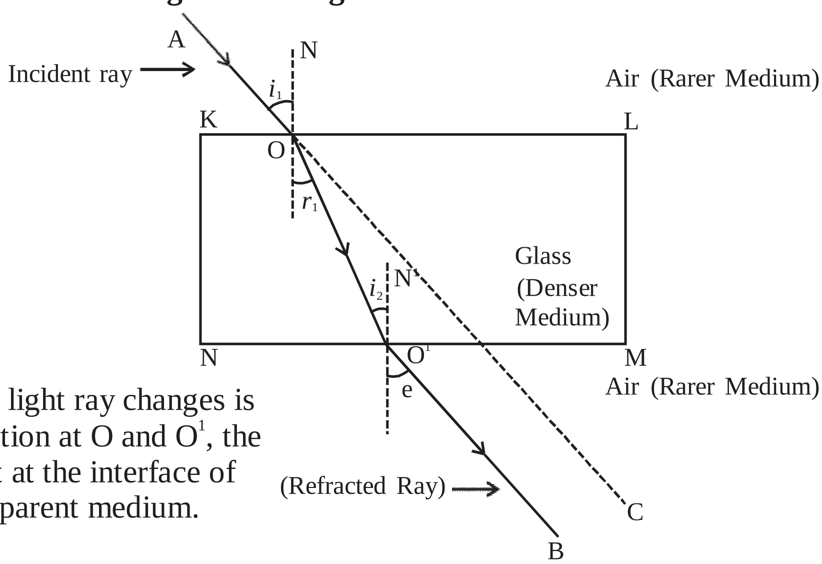


When ray travel from denser to rarer medium it bends away fromnormal

Some Commonly observed phenomenon due to Refraction

1. The stone at the bottom of watertub appear to be raised.
2. Afish kept in aquarium appear to be bigger than its actual size.
3. Apencil partially immersed in water appears to be displaced at the interface of air andwater.

Refraction through a Rectangular Glass Slab



Here light ray changes is direction at O and O^1, the point at the interface of transparent medium.

When a incident ray of light AO passes from a rarer medium (air) to a denser medium (glass) at point. O on interface AB, it will bends towards the normal. At pt O^1, on interface DC the light ray entered from denser medium (glass) to rarer medium (air) here the light ray will bend away from normal $OO^1$is a refracted ray OB is an emergent ray. If the incident ray is extended to C, we will observe that emergent ray O^1B is parallel to incident ray. The ray will slightly displaced laterally after refraction.

Note : When a ray of light is incident normally to the interface of two media it will go straight, without any deviation.

Laws of refraction of light-

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 is a constant ie.

$$\frac{\sin i}{\sin r} = \text{constant } (r)$$

for given colour and pair of media, this law is also known as <u>Snells Law</u>

<u>Constant</u> <u>n</u> is the refractive index for a <u>given pair of medium</u>. It is the refractive index of the second medium with respect to first medium.

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1} = n_{21}$$

Where 2 is for second medium and 1 is for first medium

Refractive Index

The refractive index of glass with respect is air is given by ratio of speed of light in air to the speed of light inglass.

$$n_{ga} = \frac{n_g}{n_a} = \frac{\text{Speed of light in air}}{\text{Speed of light in glass}} = \frac{c}{v}$$

C Speed of light in vacuum = $3 \bullet 10^8$ m/s
speed of light in air is marginally less, compared to that in vacuum.

Refractive index of air with respect to glass is given by

$$\begin{pmatrix} a & \text{air} \\ g & \text{glass} \end{pmatrix} \quad n_{ag} = \frac{n_a}{n_g} = \frac{\text{Speed of light in glass}}{\text{Speed of light in air}} = \frac{v}{c}$$

The absolute refractive index of a medium is simply called refractive index

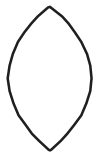
$$n_m = \frac{\text{Speed of light in air}}{\text{Speed of light in the medium}} = \frac{c}{v}$$

Refractive index of water (n_w) = 1.33
Refractive index of glass (n_g) = 1.52

Spherical Lens

A transparent material bound by two surface, of which one or both surfaces are spherical, forms a lens.

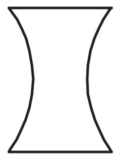
CONVEX LENS



A lens may have two spherical surfaces, bulging outwards, is called double convex lens (or simply convex lens.

It is also known as converging lens because it converges the light.

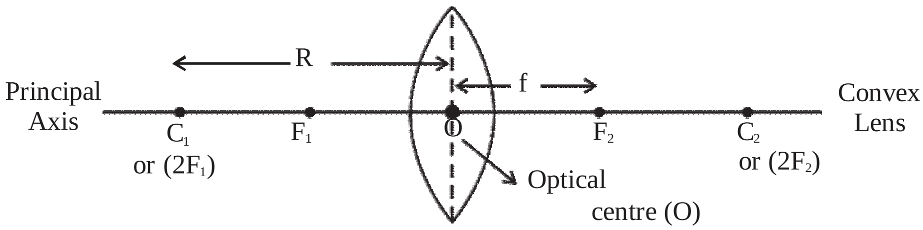
CONCAVE LENS

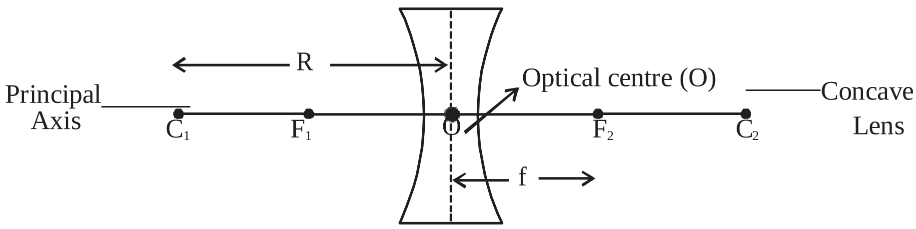


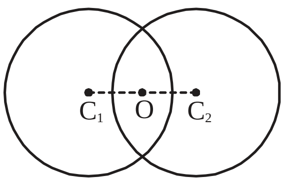
A lens bounded by two spherical surfaces, curved inwards is known as double concave lens (or simply concave lens)

It is also known as diverging lens because it diverges the light.

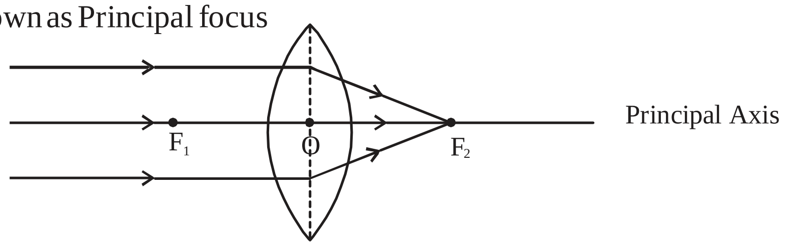
Few Basic Terms related to spherical lens.



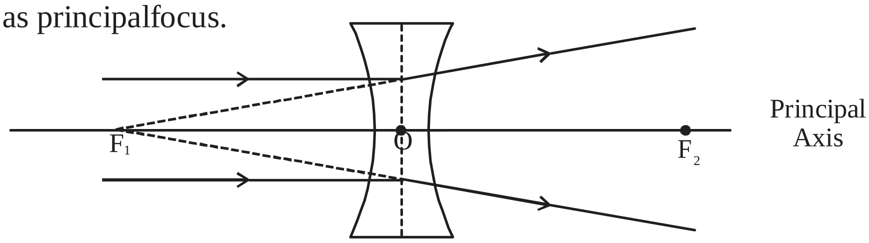




1. **Centre of curvature -** A lens, either a convex lens or a concave lens has two spherical surfaces. Each of these surfaces form a part of sphere. The centre of these two spheres are called centreof curvature represented by C_1 and C_2.
2. **Principal axis -** Imaginary straight line passing through the two centres of curvature
3. **Optical Centre -** The central point of lens is its optical centre (O). A ray of light, when passes through 'O' it remains undeviated i.e. it goes straight.
4. **Aperture -** The effective diameter of the circular outline of a spherical lens.
5. Focus of lens - Beamof light parallel is principal axis, after refraction from
   1) **Convex lens,** converge to the point on principal axis, denoted by F, known as Principal focus



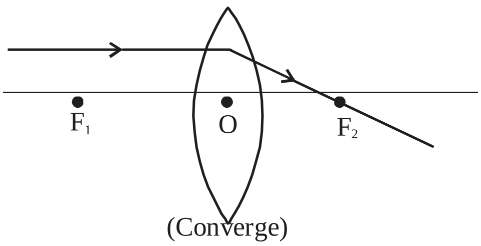
   2) Concave lens, appear to diverge from a point on the principal axis, known as principalfocus.



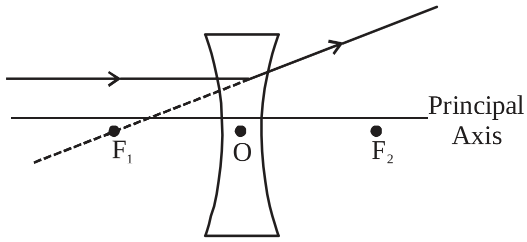
The distance OF_2 and OF_1 is called as focal length

Tips for drawing Ray diagram

a) After refraction, a ray parallel to principal axis willpass through F.

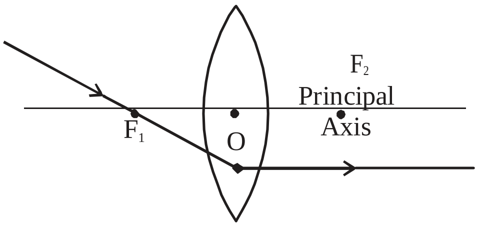


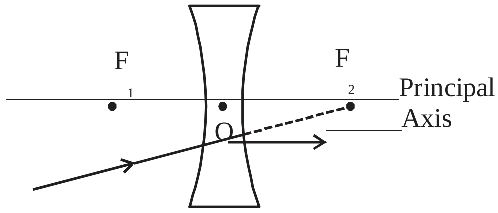
(Converge)



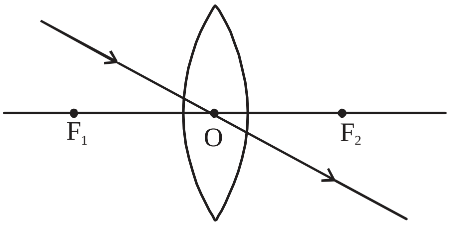
(Diverge)

b) A ray passes through F, after refraction will emerge parallel to principal axis.





c) A ray passes through optical centre 'O', paeses without any deviation.



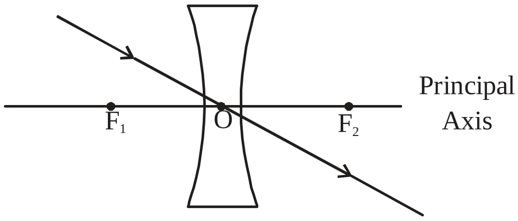
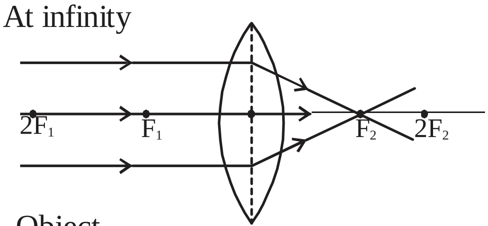


Image formation by a convex lens for various position of object

1. Object
At infinity

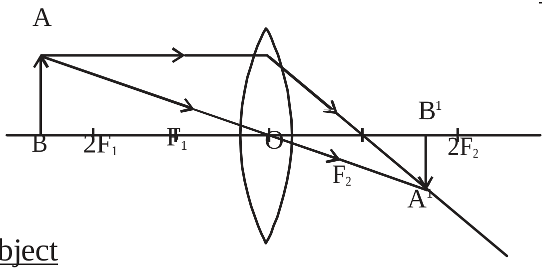


Position of Image
At focus
F_2

Size of Image
Highly diminished (point size)

Nature
Real & inverted

2. Object
Beyond $2F_1$

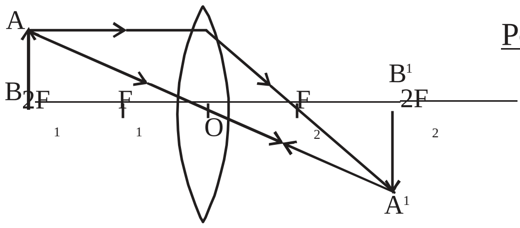


Position of Image
Between F_2 & $2F_2$

Size of Image
Small

Nature
Real & inverted

3. Object
At $2F_1$



Position of Image
At $2F_2$

Size of Image
Same size of object

Nature
Real & inverted