LIGHT

REFRACTION OF LIGHT

REFRACTION

The phenomenon of bending of light at the surface separating the two media of different optical densities.

1. When a ray of light goes from a rarer medium to a denser medium, it bends towards the normal.

2. When a ray of light goes from a denser medium to a rarer medium it bends away from the normal.

- The refraction of light takes place on going from one medium to another because the speed of light is different in the two media.
- The greater is the difference in speeds of light in the two media, the greater will be the refraction or bending of light.

Optically rarer medium and optically denser medium

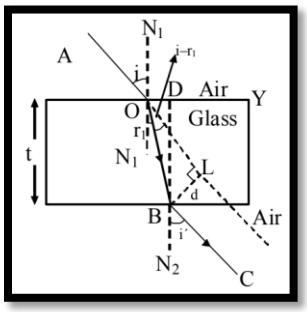
Speed of light is different in two media.

A medium in which the speed of light isomerism known as optically rarer medium (or less denser medium)

A medium in which the speed of light is less, is known as optically denser medium.

- The optical density of a substance should not be confused with its density. 5.9.2

Refraction through a Glass Slab

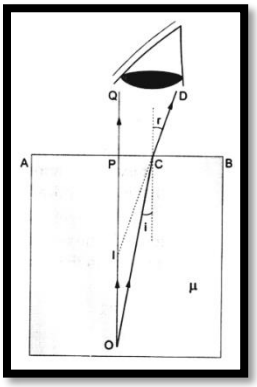


Angle i = Angle i'

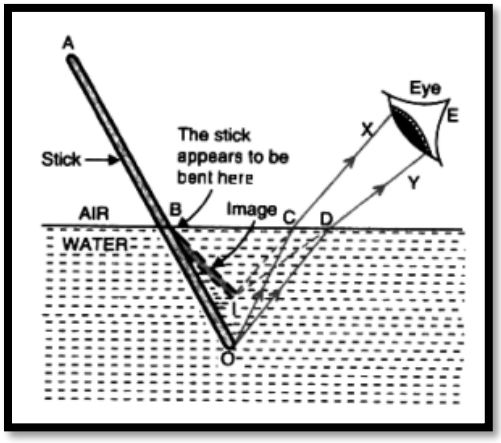
i.e. incident ray and Emergent ray are parallel. Lateral shift(d) : It is the perpendicular distance between the incident ray and emergent ray

Phenomena based on refraction

(A) Apparent Depth: Consider an object O placed in a medium Since the object is actually at O, PO is the real depth of the object below the surface. And because the object appear to be at I, PI is its apparent depth. This is because the coin appears slightly above its real position due to refraction of light



(B) A straight object like a pencil kept partly immersed in water in a glass tumbler. Then the part of the pencil inside water appears to be bent relative to the part that is above water. The part of the pencil inside water also appears to be thicker if viewed from the side

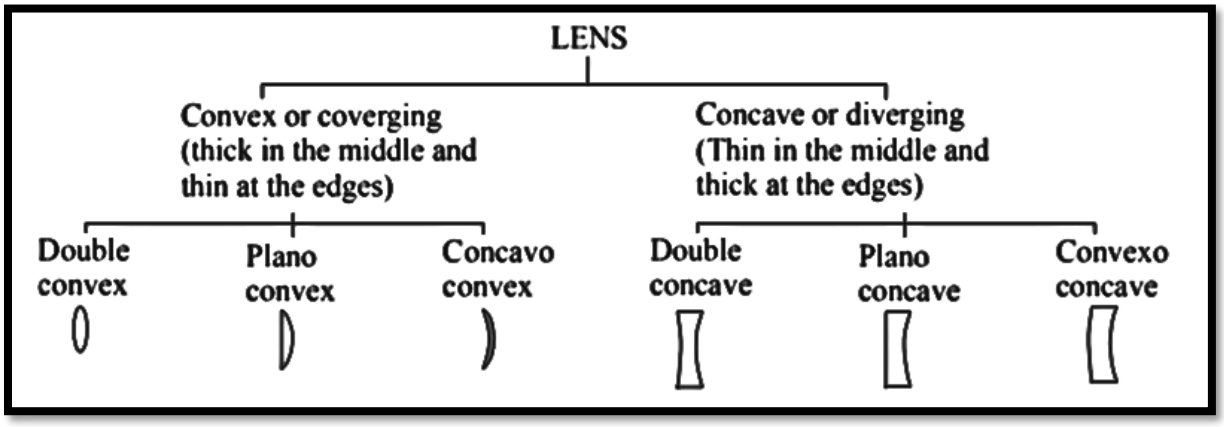


(C) Twinkling of stars

We have seen that the density of the air decrease with height above the earth's surface. This cause light from stars and other heavenly bodies to bend as it passes through the atmosphere. As a result, we see the star at a position that is slightly shifted from its actual position. But when we look at starts, while often they do not appear steady. They disappear for a fraction of a second before reappearing (the intensity of light from them fluctuates) or their positions seem to shift slightly in random direction. We call this the twinkling of starts. It is due to phenomenon of Atmospheric refraction.

Refraction by spherical lenses

Lens A piece of a transparent medium bounded by at least one spherical surface is called lens. Types of Len



2 Terms associated with Spherical Lenses

(i) Principal axis:

Line passing through the optical center and joining the centers of curvature of the two curved surface.

(ii) Optical center (O):

Itis a point lyingwithina lens through which thoreaulite pass undedicated.

(iii) Principal focus (F):

It is a point on the principal axis of the lens where all the rays of light coming parallel to the principal axis either converge actually (convex lens) or appear to diverge (concave).

(iv) Focal length (f):

The distance between the optical center and the principal focus.

For a convex lens: f = +ve. For a concave lens: f = –ve

Sign convention for spherical Lenses

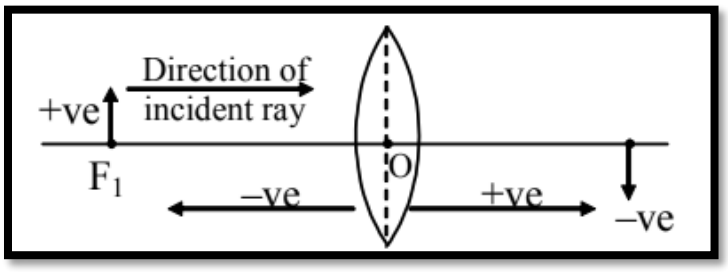
(i) All the distances are measured from the optical centre of the lens.

(ii) The distance measured in the same direction as that of incident light are taken as positive.

(iii) The distance measured against the direction of incident light are taken as negative.

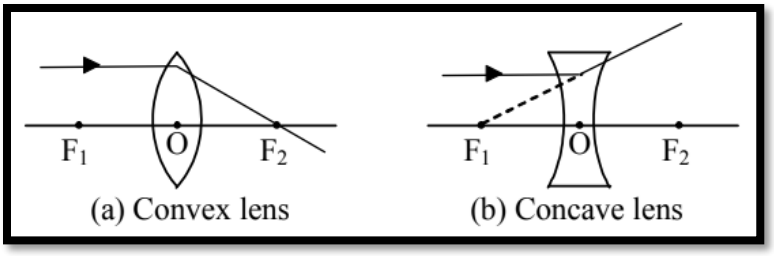
(iv) The distances measured upward and perpendicular to the principal axis are taken as positive.

(v) The distances measured downward and perpendicular to the principal axis are taken as negative.

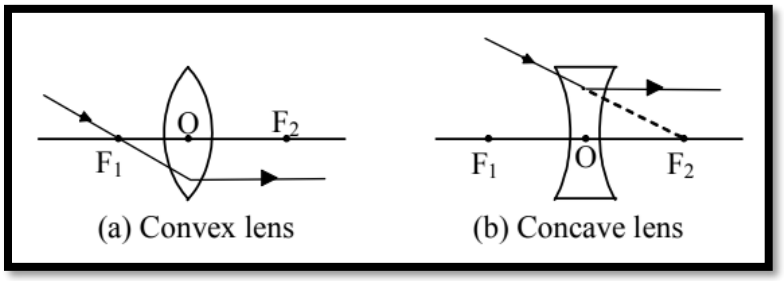


Rules for image formation by a Lens

(i) A ray of light travellingparallelto the principal axis, after refraction passes through (convex lens) or appears to come from (concave lens) its second principal fox



(ii) A ray of light initiallytravellingthrough (convex lens)or along the direction of first principal focus after refraction, travels parallel to the principal axis



(iii) A ray of light which passes through the optical center, does not suffer any refraction.

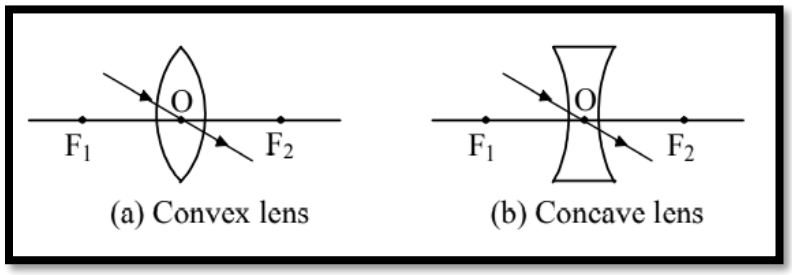
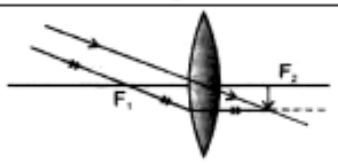
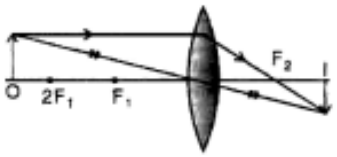
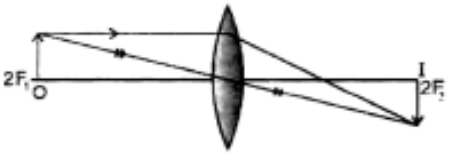
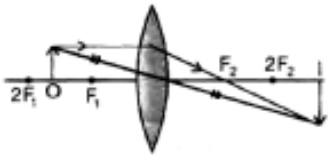
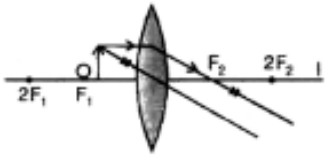
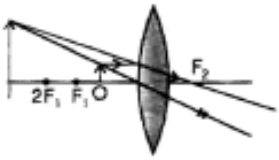


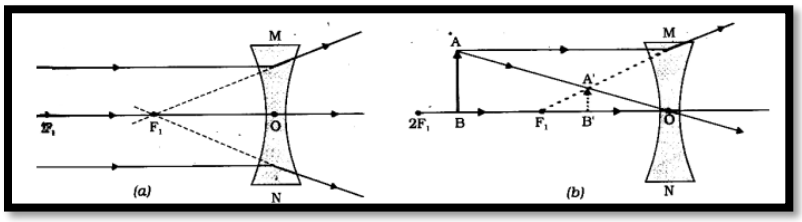
Image formation in lenses using ray diagrams

(A) Image formed by a Convex Lens

Position of object	Details of Image	Figure
At infinity	Real, inverted, diminished ($m << -1$), At F	
Between infinity and 2F	Real, inverted, diminished ($m < -1$), between F and 2F	
At 2F	Real, inverted, equal in size ($m = -1$), At 2F	
Between 2F and F	Real, inverted, enlarged ($m > -1$), Between 2F and ∞	
At F	Real, inverted, enlarged ($m >> -1$), At infinity	
Between Focus and Pole	Virtual, erect, enlarged ($m > +1$), Between ∞ and Object, on same side of object	

(B) Image formed by a Concave Len

	Position of the object	Position of the image	Relative size of the image	Nature of the image
(a)	At infinity	At the focus F_1	Highly diminished, point-sized	Virtual and erect
(b)	Between infinity and optical centre O of the lens	Between focus F_1 and optical centre O	Diminished	Virtual and erect



Power of Lens (P) Reciprocal of focal lengthis called power of lens

$$P = \frac{1}{f(\text{ in meter })} = \frac{100}{f(\text{ in cm})}$$

SI unit of power is dioptre (D).

(i) Power of a convex lens is +ve.

(ii) Power of a concave lens is -ve.

- Poderosa lens is treasure itsdegreeofconvergence or divergenceof light rays falling on it.