Light : Reflection and Refraction

- Light is the form of energy that provides sensation of vision.

Laws of Reflection

1) Angle of incidence is equal to the angle of reflection.
2) The incident ray, the reflected ray and the normal at the point of incidence, all lie in the same plane.

Characteristics of Image formed by Plane mirror

1) Virtual and erect
2) Size of image is equal to size of object.
3) Distance of object from mirror = Distance of image from mirror.
4) Laterally inverted

Spherical Mirrors

- Mirror whose reflecting surface is curved.
- There are two types of spherical mirrors :

Concave mirror :- Reflecting surface is curved inwards.
Convex mirror :- Reflecting surface is curved outwards.

Concave mirror Convex mirror

Common terms for Spherical mirrors

Principal axis : The line joining the pole and centre of curvature.

Pole : The centre of the spherical mirror.

Apperture : It is the effective diameter of the spherical mirror.

Centre of Curvature : The centre of the hollow glass sphere of which the mirror was a part.

Radius of Curvature : The distance between the pole and the centre of curvature.

Focus : The point on the principal axis where all the parallel light rays actually meet or appear to meet or after reflection.

Relationship between focal length and radius of curvature :

$$f = \frac{R}{2}$$

Rules for making ray diagrams by spherical mirror :

1. A ray parallel to the principal axis, after reflection, will pass through the principal focus in case of a concave mirror or appear to diverge from the principal focus in case of convex mirror.
2. A 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.
3. A 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.

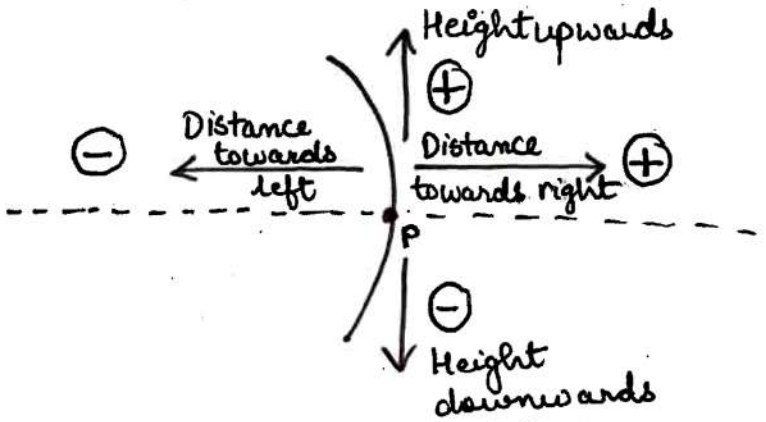
Image formation by concave mirror:

	Object Position	Image Position	Nature & Size of Image
1	At infinity	At 'F'	Real, inverted, point sized
2	Beyond C	Between 'F' & 'C'	Real, Inverted, diminished
3	At C	At 'C'	Real, inverted, same size
4	Between C & F	Beyond 'C'	Real, inverted, enlarged
5	At F	At Infinity	Real, Inverted, highly enlarged
6	Between P & F	Behind the mirror	Virtual, erect and enlarged

Image formation by convex mirror

Object distance	Image distance	Nature & Size of Image
At infinity	At 'F'	Virtual, erect & point sized
Between Pole and infinity	Between 'P' and 'F'	Virtual, erect & diminished

Sign convention for mirrors



Mirror formula and magnification

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$f \rightarrow$ focal length
$v \rightarrow$ image distance
$u \rightarrow$ object distance

$$m = \frac{h_I}{h_O} = -\frac{v}{u}$$

$h_I \rightarrow$ height of image
$h_O \rightarrow$ height of object

Refraction of light

Refraction is bending of light when it enters obliquely from one transparent medium to the other.

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 Snell's law: The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for a light of given colour and for a given pair of media.

Refractive index

The ratio of speed of light in given pair of media.

$$n_{21} = \frac{v_1}{v_2} \quad \text{and} \quad n_{12} = \frac{v_2}{v_1}$$

n_{21}: Refractive index of medium '2' wrt '1'

n_{12}: Refractive index of medium '1' wrt '2'.

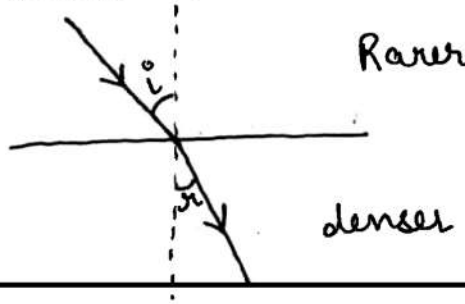
Absolute refractive index

Refractive index of a medium with respect to vacuum or air.

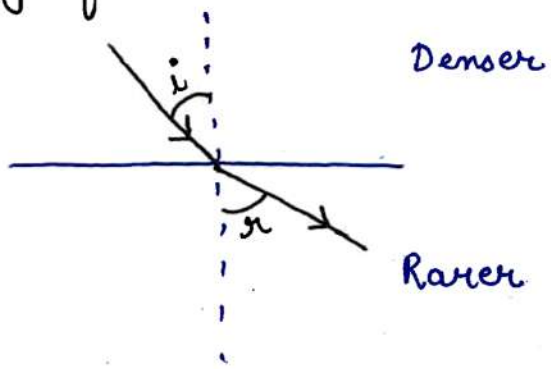
$$\boxed{n = \frac{c}{v}}$$

$c \rightarrow 3 \times 10^8$ m/s

- When light enters obliquely from a rarer to a denser medium, it bends towards the normal.



- When light enters obliquely from denser to rarer medium it bends away from the normal.



Spherical lens

A transparent medium bound by two surfaces, of which one or both surfaces are curved.

convex lens concave lens

Rules for image formation by convex lens

1. A ray of light parallel to the principal axis of a convex lens always pass through the focus on the other side of the lens.
2. A ray of light passing through the principal focus will emerge parallel to the principal axis after refraction
3. A ray of light passing through the optical centre will emerge without any deviation.

Rules for image formation by concave lens

1. A ray of light parallel to the principal axis appear to diverge from the principal focus located on the same side of the lens.
2. A ray of light appearing to meet at the principal focus of a concave lens will emerge parallel to the principal axis.

③ A ray of light passing through the optical centre of a lens will emerge without any deviation.

Image formation by convex lens

Object distance	Image distance	Nature and Size of Image
1) At infinity	at F_2	Real, inverted, point sized
2) Beyond $2F_1$	Between F_2 & $2F_2$	Real, inverted, diminished
3) At $2F_1$	at $2F_2$	Real, inverted, same size
4) Between F_1 & $2F_1$	Beyond $2F_2$	Real, inverted, enlarged
5) At F_1	Infinity	Real, Inverted, highly enlarged
6) Between 'F_1' and Optical centre	On the same side of the lens	Virtual, erect enlarged

Image formation by concave lens

Object position	Image position	Nature and size of image
① At infinity	At 'F_1'	Virtual, erect, point sized
② Between infinity and optical centre	Between 'F' and 'O'	Virtual erect, diminished

Lens formula

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

$$m = \frac{h_I}{h_O} = \frac{v}{u}$$

Power of a lens

It is defined as the reciprocal of focal length in meter.

$$P = \frac{1}{f(m)} \quad \text{or} \quad P = \frac{100}{f(cm)}$$

S.I Unit of Power → Dioptre (D)

Power of concave lens → negative

Power of convex lens → positive