Ch:10 Light - Reflection and Refraction

Reflection of Light

The laws of reflection are:

(i) Angle of incidence = Angle of reflection.

(ii) The incident ray, reflected ray and the normal, all lie on the same place.

Spherical Mirrors

A spherical mirror whose reflecting surface is curved inward is called a concave mirror.
A spherical mirror whose reflecting surface is curved outward is called a convex mirror.

Terms commonly used in spherical mirror

1. Pole: The center of the reflecting surface of a spherical mirror is a point. which is called the Pole. Pole is represented as 'P'.

2. Center of curvature: The reflecting surface of a spherical mirror forms a part of a ~~surface~~ sphere this sphere has a center, which is called the center of curvature. Center of curvature is not a part of a spherical mirror. It is represented as 'C'.

3. Radius of curvature: The radius of the sphere of which the reflecting surface of a spherical region forms apart, is called the radius of curvature. It is represented as 'R'.

4. Principal axis: Its an imaginary straight line passing through the pole and the center of curvature of a spherical mirror. Principal axis is normal to the mirror at the pole.

5. Focus: The reflected rays from a spherical mirror meet at a point or it appears to come from a point on the principal axis. This point is called Focus. It is represented as 'F.'

6. Focal Length: The distance between the pole and the principal focus of a spherical mirror is called Focal length. It is represented as 'f'.

7. Aperture: The diameter of the reflecting surface of a spherical mirror is called ~~Ap~~ Aperture.

For a spherical mirror, the radius of curvature is found to be twice the Focal length. $2f = R$

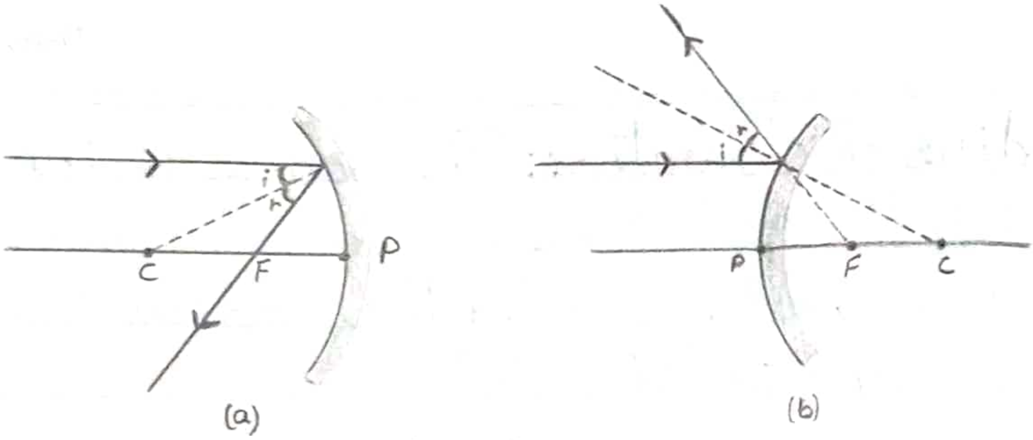


Fig 10.3

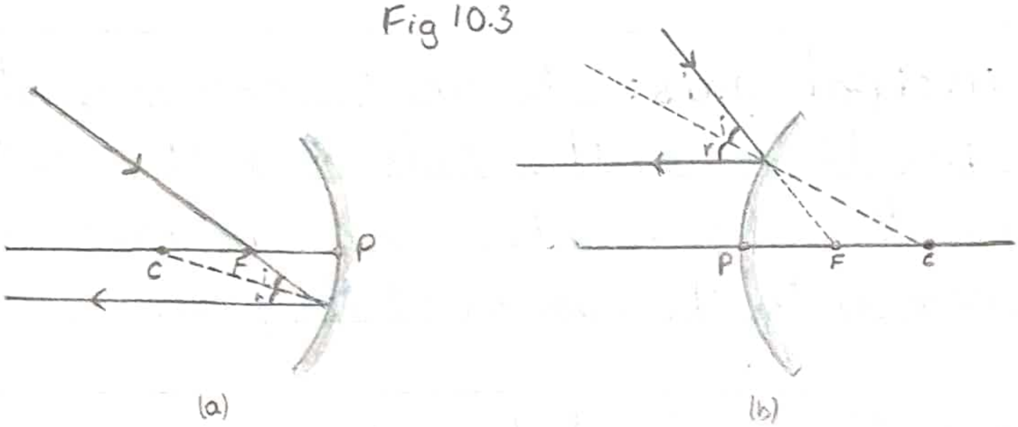


Fig 10.4

Fig 10.5

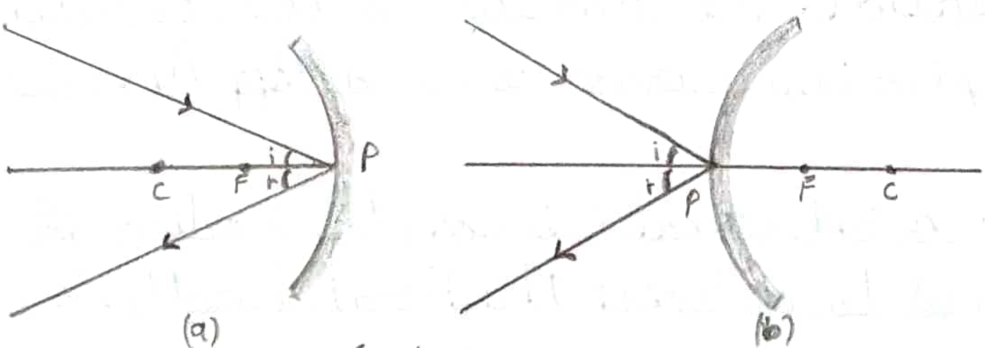


Fig 10.6

Rules for drawing ray diagrams

(i) 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 a convex mirror. ~~This~~ (Fig. 10.3)

(ii) A ray passing through the principal focus of a concave mirror or a ray which is directed towards the principal focus of a convex mirror, after reflection, will emerge parallel to the principal axis. ~~This is~~ (Fig. 10.4)

(iii) 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. This is illustrated in. (Fig. 10.5) (a) and (b). The light rays come back along the same path because the incident rays fall on the mirror along the normal to the reflecting surface.

(iv) A ray incident obliquely to the principal axis, towards a point P (pole of the mirror), on the concave mirror [Fig. 10.6 (a)] or a convex mirror [Fig 10.6 (b)], is reflected obliquely. The incident and reflected rays follow the laws of reflection at the point of incidence (point P), making equal angles with the principal axis.

Exercises

14. An object 5.0 cm in length is placed at a distance of 20 cm in front of a convex mirror of radius of curvature 30 cm. Find the position of the image, its nature and size.

Ans height (h) = 5 cm

distance (u) = -20 cm

radius (R) = 30 cm

$f = \frac{R}{2} = \frac{30}{2}$

$f = 15 cm$

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

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

$\frac{1}{v} = \frac{1}{15} - \frac{1}{(-20)}$

$\frac{1}{v} = \frac{4}{60} + \frac{3}{60} = \frac{7}{60}$

$v = \frac{60}{7} = 8.57 cm$

$\therefore$ Image is formed 8.5 cm behind the mirror

Nature of Image: Virtual and erect

Size of image formed = $\frac{\text{Height of image } (h')}{\text{Height of object } (h)}$

$\frac{h'}{5} = \frac{8.57}{20} = 0.428$

$h' = 0.428 \times 5 = 2.14 cm$

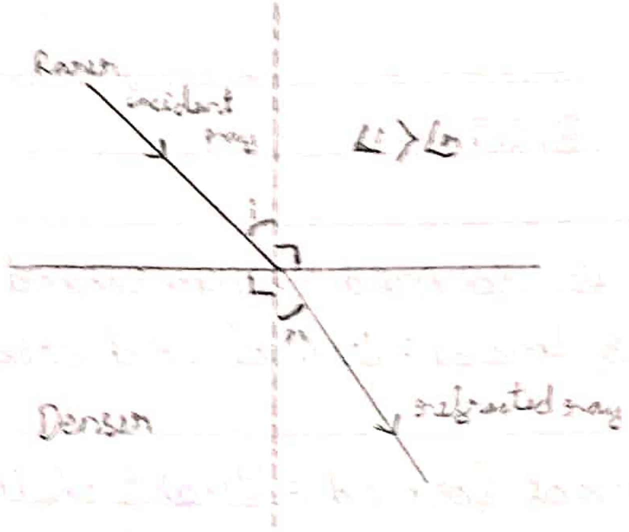
$\therefore$ Height of the image formed = 2.14 cm

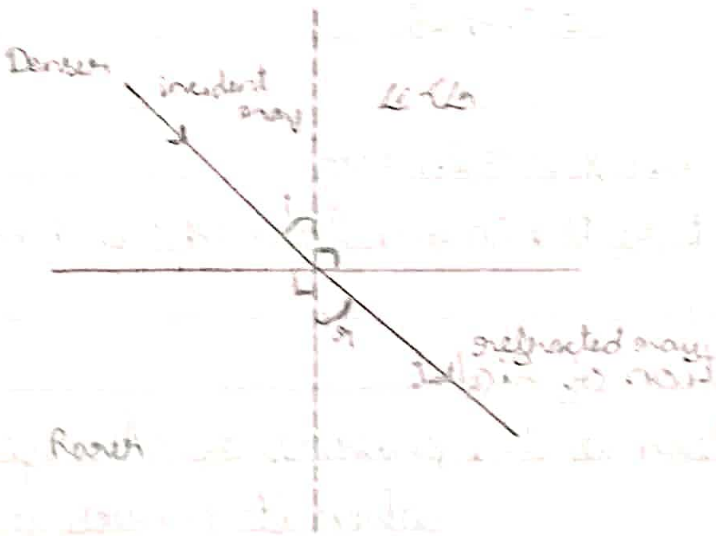
Refraction of Light

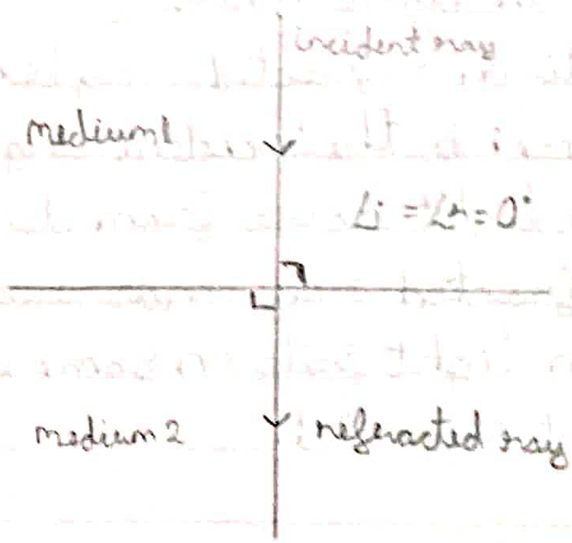
Refraction is the process of changing the direction of the path of light when it moves from one medium to another. When light moves from ~~a~~ rarer medium to denser medium, refracted ray bends towards normal, i.e. $\angle i > \angle r$. Where i is the incident angle and r is refracted angle. When light moves from denser medium to rarer medium, refracted ray bends away from the normal, i.e. $\angle i < \angle r$. When light falls on same direction of normal, it does not get refracted.

Refraction through rectangular glass slab

When the light falls through rectangular glass


Rarer
incident ray
∠i > ∠r
i
r
Denser
refracted ray


Denser
incident ray
∠i < ∠r
i
r
refracted ray
Rarer


incident ray
medium 1
∠i = ∠r = 0°
medium 2
refracted ray

slab, it will undergo 2 refraction processes:

(i) Light which is coming from air to glass slab (incident ray)

(ii) Light going out of glass slab (emergent ray)

Emergent ray will be parallel to the incident ray.

Laws of refraction.

(i) Incident ray, refracted ray and normal to the interface of two transparent media all lie in the sameplane.

(ii) The ratio of sin of $\angle i$ and sin of $\angle r$ is constant for the light of a given colour and pair of media. This law is also known as Snell's law of refraction.

(True if $0^\circ < i < 90^\circ$)

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

this constant value is the refraction index.

Refractive index

When light moves from one medium to another, the extent of the change in direction which takes place in a given pair of media can be expressed in terms of refractive index. The refractive index for a given pair of media depends on the speed of light in the two media.

Example: When light moves from medium 1 to medium 2, let v_1 be speed of light in medium, and v_2 be speed of light in medium 2. Then, refractive index of medium 2 to medium 1 = v_{21} = $\frac{\text{Speed of light in medium 1}}{\text{Speed of light in medium 2}} = \frac{v_1}{v_2}$

Then, refractive index of medium 1 to medium 2 = v_{12}

$= \frac{\text{Speed of light in medium 2}}{\text{Speed of light in medium 1}} = \frac{v_2}{v_1}$

If medium 1 is vaccum or air, refractive index of medium 2 is considered with respect to vacuum. It is called absolute refractive index represented by n.

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

Page: 176

1. A ray of light travelling in air enters obliquely into water. Does the light ray bend towards the normal or away from the normal? Why?

Ans Light ray bends towards normal because the density of water is more than air.

2. Light enters from air to glass having refractive index 1.5. What is speed of light in glass? Speed of light in vacuum is $3 \times 10^8 ms^{-1}$.

Ans $c = 3 \times 10^8 ms^{-1}$ (given)

$n = 1.5$ (given)

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

$\Rightarrow 1.5 = \frac{10^8 ms^{-1}}{v}$

$\Rightarrow 1.5v = 3 \times 10^8 ms^{-1}$

$\Rightarrow v = \frac{3 \times 10^8 ms^{-1}}{1.5} = 2 \times 10^8 ms^{-1}$

3. Find out from table 10.3 medium with highest and lowest optical density.

Ans Highest : Diamond

Lowest : Air