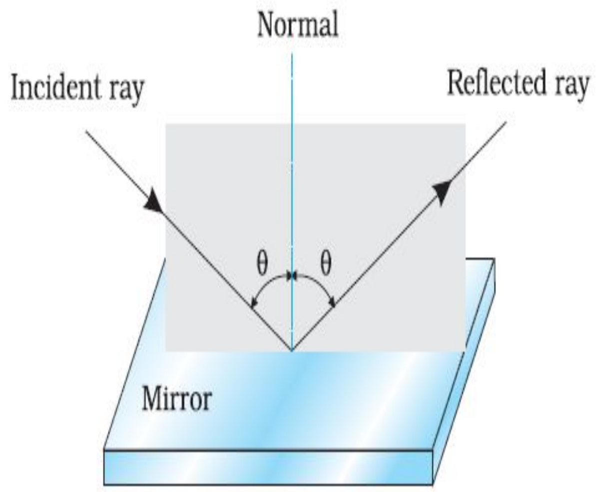
In this chapter, we consider the phenomena of reflection, refraction and dispersion of light, using the ray picture of light. Using the basic laws of reflection and refraction, we shall study the image formation by plane and spherical reflecting and refracting surfaces. We then go on to describe the construction and working of some important optical instruments, including the human eye.

Laws of Reflection

The **angle of reflection** (i.e., the angle between reflected ray and the normal to the reflecting surface or the mirror) equals the **angle of incidence** (angle between incident ray and the normal). Also that the incident ray, reflected ray and the normal to the reflecting surface at the point of incidence **lie in the same plane**



Sign convention

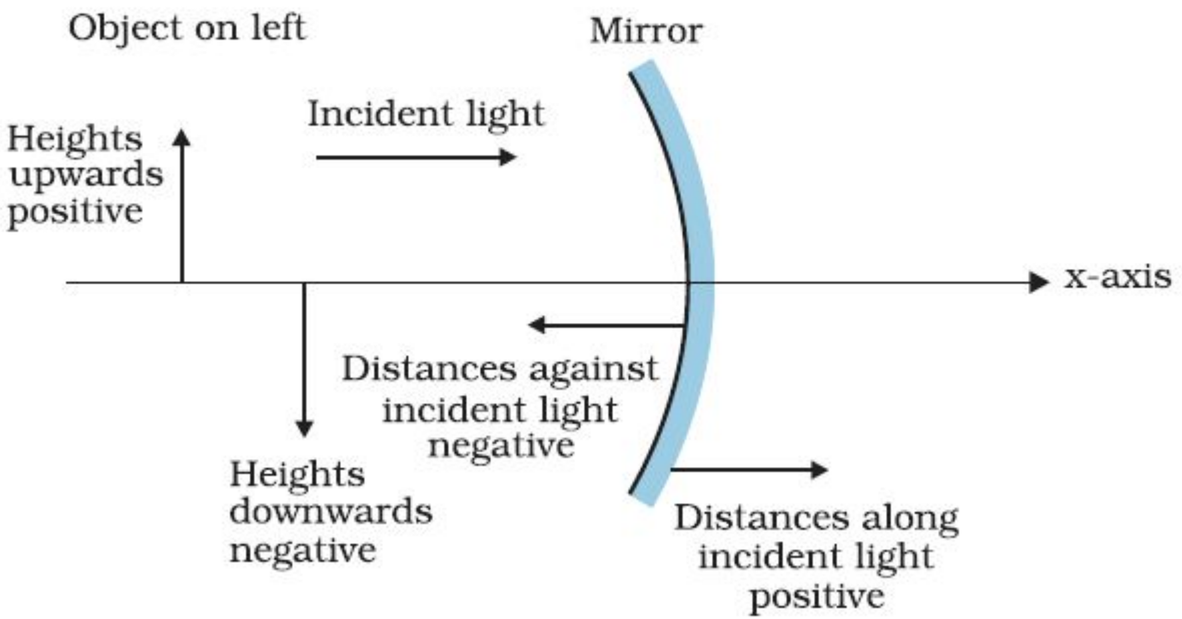


FIGURE 9.2 The Cartesian Sign Convention.

Focal length of spherical mirrors

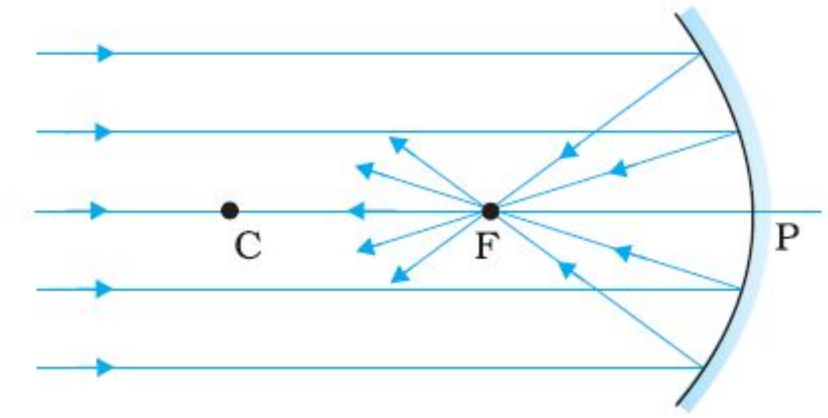
When paraxial rays are incident at

points close to the pole P,

The reflected rays converge

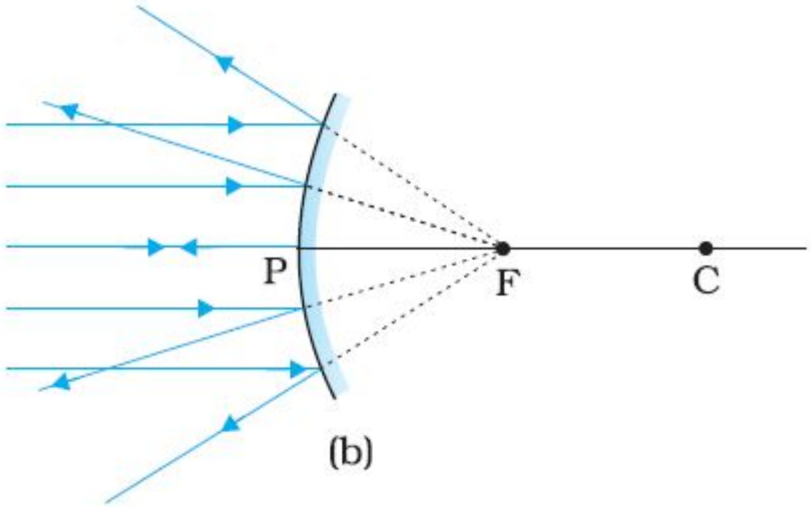
at a point F on the principal axis

of a concave mirror



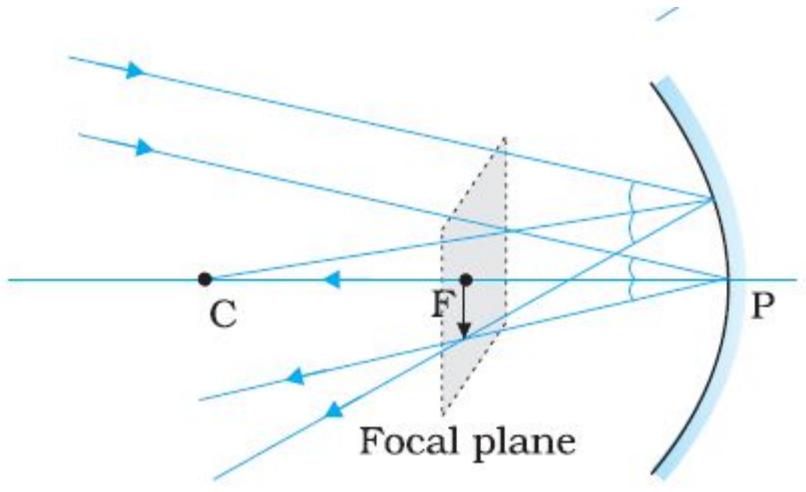
(a)

For a convex mirror, the reflected rays **appear** to diverge from a point F on its principal axis



(b)

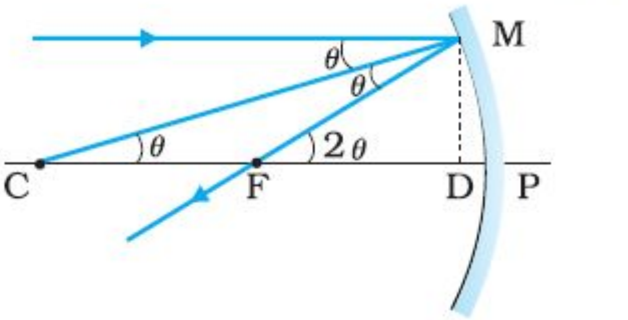
If the parallel paraxial beam of light were incident, making some angle with the principal axis, the reflected rays would converge (or appear to diverge) from a point in a plane through F normal to the principal axis. This is called the **focal plane** of the mirror



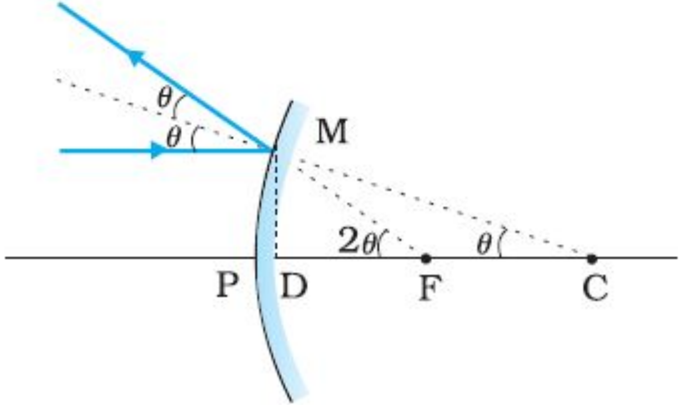
(c)

Relation between f and R

The distance between the focus F and the pole P of the mirror is called the focal length of the mirror, denoted by f. We now show that **f = R/2**



(a)



Let θ be the angle of incidence, and MD be the perpendicular from M on the principal axis.

Then, $\angle MCP = \theta$ and $\angle MFP = 2\theta$

Now,

$$\tan\theta = \frac{MD}{CD} \text{ and } \tan 2\theta = \frac{MD}{FD}$$

For small θ, which is true for paraxial rays,

$$\tan\theta \approx \theta \text{ and } \tan 2\theta \approx 2\theta$$

Therefore
$$\frac{MD}{FD} = 2\,\frac{MD}{CD}$$

$$\text{or, } FD = \frac{CD}{2}$$

Now, for small è, the point D is very close to the point P. Therefore, FD = f and CD = R.

Equation then gives **f = R/2**