# 🟦 Chapter 9: Light – Reflection and Refraction

### 🔆 What is Light?

Light enables us to see objects. We see an object when light reflected from it enters our eyes.

Light travels in a straight line. This property explains how shadows form and why light casts a sharp shadow through a small aperture.

### 🔎 Reflection of Light

📋 Reflection is the bouncing back of light when it hits a smooth surface like a mirror.

## 🌟 Laws of Reflection:

1. **Angle of incidence =** Angle of reflection
2. Incident ray, reflected ray and normal all lie in the same plane

### 📌 Image by Plane Mirror:

- Always virtual and erect
- Same size as the object
- Laterally inverted
- Distance of image = Distance of object from the mirror

🧪 **Activity 9.1:** Take a shining spoon and observe your image in the curved surface. Try both sides:

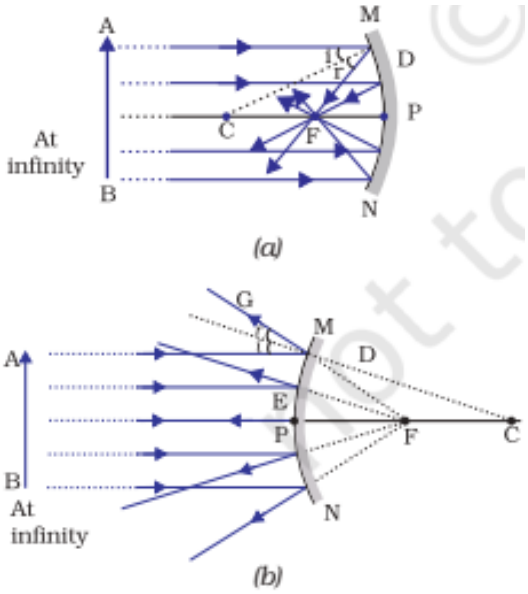
- Inner side (concave): Image appears large and inverted.
- Outer side (convex): Image appears small and erect.

This shows that curved surfaces behave like mirrors—either concave or convex.

### 🔮 Types of Spherical Mirrors

1. **Concave Mirror:** Reflecting surface is curved inward (like a cave).
2. **Convex Mirror:** Reflecting surface is bulged outward**.**

### 📌 Important Terms (Fig. 9.1, 9.2):




- **Pole (P)**: Center of the mirror surface
- **Centre of Curvature (C):** Center of the sphere the mirror is part of
- **Radius of Curvature (R):** Distance between P and C
- **Principal Axis:** Line joining P and C
- **Focus (F):** Point where rays converge (concave) or appear to diverge (convex)
- **Focal Length (f):** Distance between P and F; R = 2f

🧪 **Activity 9.2:** Focus sunlight using a concave mirror on paper. A bright spot (the Sun's image) appears and may burn the paper. This is because the mirror concentrates light to a point—the focus.

## 📔 Image Formation by Concave Mirror

🧪 **Activity 9.3:** Place a burning candle at different distances from a concave mirror and observe image size, position, and nature on a screen.

## 📋 Summary (Table 9.1):

| Object Position | Image Position | Size | Nature |
|---|---|---|---|
| At infinity | At F | Point-size | Real, Inverted |
| Beyond C | Between F and C | Diminished | Real, Inverted |
| At C | At C | Same size | Real, Inverted |
| Between C and F | Beyond C | Enlarged | Real, Inverted |
| At F | At Infinity | Enlarged | Real, Inverted |
| Between F and P | Behind mirror | Enlarged | Virtual, Erect |

🎯 **Ray Diagrams:** (Fig. 9.3 to 9.7)

**Use two rays:**

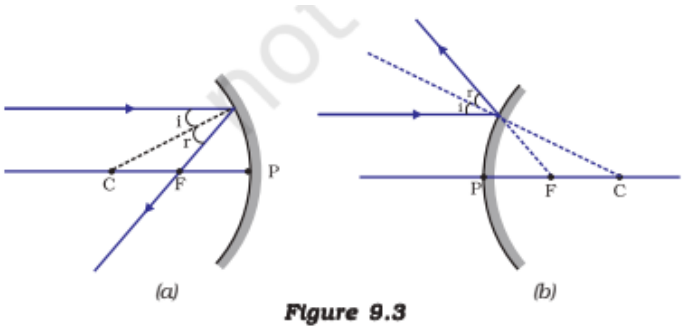



*Figure 9.3*

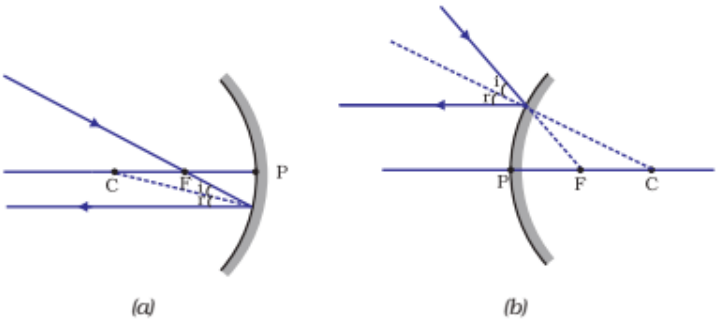



*Figure 9.4*

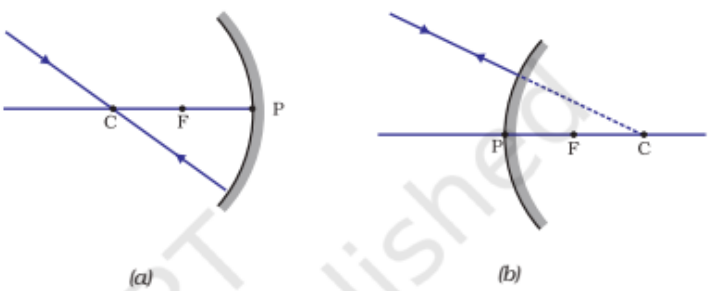



*Figure 9.5*

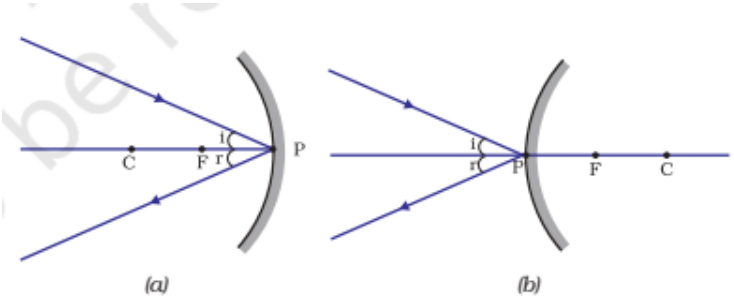



**Figure 9.6**

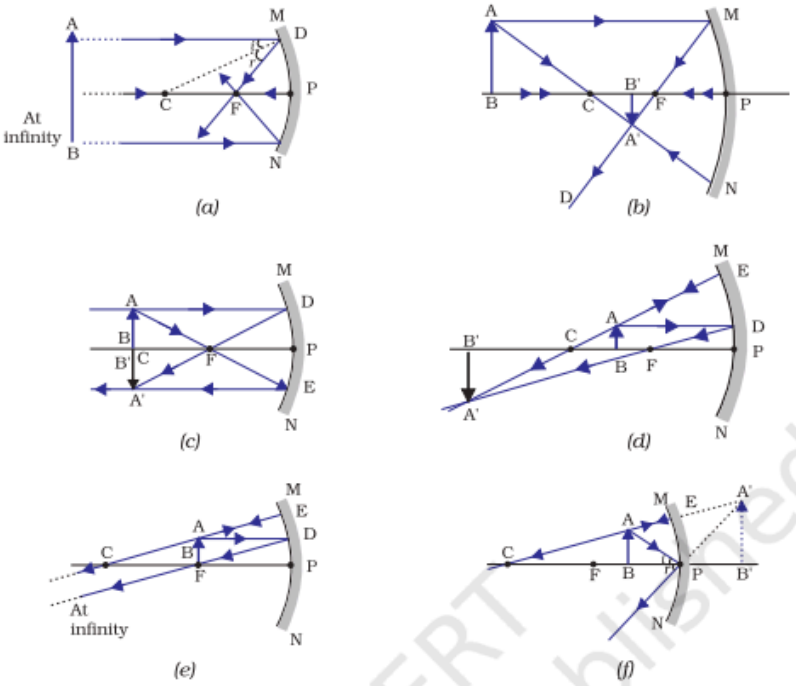



**Figure 9.7** *Ray diagrams for the image formation by a concave mirror*

1. **Parallel to principal axis → passes through F**
2. Through F → reflects parallel
3. Through C → reflects back on itself

## 🪞 Image Formation by Convex Mirror

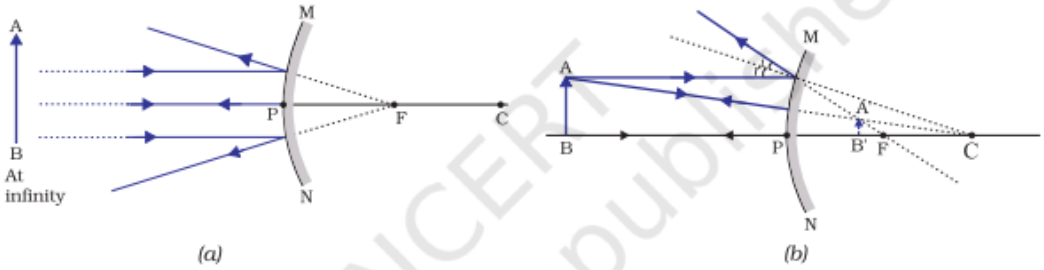



**Figure 9.8** *Formation of image by a convex mirror*

🧪 **Activity 9.5:** Use convex mirror and observe pencil. Image is erect and small. When moved away, image becomes smaller and shifts closer to focus.

📋 Summary (Table 9.2):

| Object Position | Image Position | Size | Nature |
|---|---|---|---|
| At infinity | At F behind mirror | Diminished | Virtual, Erect |
| Between ∞ and P | Between P & F | Diminished | Virtual, Erect |

## 🪞 Uses:

- **Concave mirrors:** torches, shaving mirrors, solar furnaces
- **Convex mirrors:** rear-view mirrors (wide field of view)

## 📌 Sign Convention (Fig. 9.9)

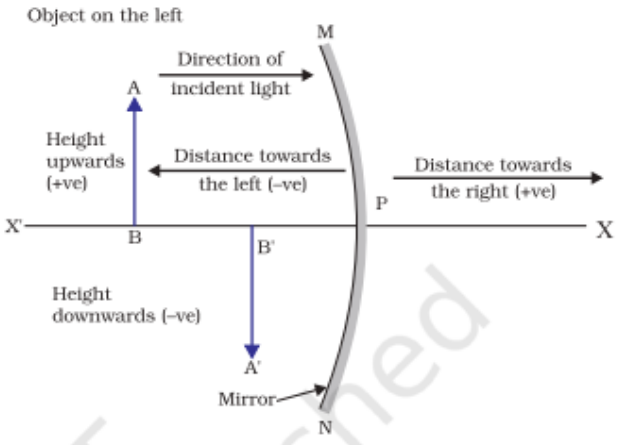



***Figure 9.9***
*The New Cartesian Sign Convention for spherical mirrors*

- Pole (P) is origin.
- All distances are from P:
  - Left side of mirror: negative
  - Right side: positive
  - Above principal axis: positive
  - Below axis: negative

## 🟦 Mirror Formula:

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

Where:

- v = image distance
- u = object distance
- f = focal length

## 🟦 Magnification:

m=h′h=−vum = \frac{h'}{h} = \frac{-v}{u}m=hh′=u−v

➕ m > 0: Image is virtual, erect
➖ m < 0: Image is real, inverted

## 🧪 Refraction of Light

When light passes obliquely from one medium to another, its direction changes. This bending is called refraction.

🧪 **Activity 9.7–9.9:** Coin in water appears shifted. Printed text under glass appears raised. These are results of refraction.

## 🟦 Laws of Refraction (Snell's Law):

1. Incident ray, refracted ray and normal lie in the same plane.
2. sinisinr=constant=n21\frac{\sin i}{\sin r} = \text{constant} = n_{21}sinrsini=constant=n21

## 🟦 Refractive Index:

n21=v1v2ornm=cvn_{21} = \frac{v_1}{v_2} \quad \text{or} \quad n_m = \frac{c}{v}n21=v2v1 ornm=vc

Where:

- n = refractive index
- c = speed of light in air
- v = speed of light in medium

💡 Higher refractive index → optically denser

📊 Table 9.3: Diamond has highest refractive index (2.42)

## 🔍 Refraction through a Lens

- Convex Lens: thicker in middle → converging lens
- Concave Lens: thinner in middle → diverging lens

## 📌 Key Lens Terms:

- **Optical Centre (O)**: central point of the lens
- **Principal Axis**: line through $C_1$ and $C_2$
- **Principal Focus** ($F_1$, $F_2$): point where rays converge/diverge
- **Focal Length** (f): distance between O and F

🧪 **Activity 9.12:** Use convex lens and candle to observe image formation at different positions

## 📋 Image Formation by Convex Lens (Table 9.4):

| Object Position | Image Position | Size | Nature |
|---|---|---|---|
| At infinity | At $F_2$ | Point-size | Real, Inverted |
| Beyond $2F_1$ | Between $F_2$ & $2F_2$ | Diminished | Real, Inverted |
| At $2F_1$ | At $2F_2$ | Same size | Real, Inverted |
| Between $F_1$ & $2F_1$ | Beyond $2F_2$ | Enlarged | Real, Inverted |
| At $F_1$ | At Infinity | Enlarged | Real, Inverted |
| Between $F_1$ and O | Same side | Enlarged | Virtual, Erect |

## 📋 Image Formation by Concave Lens (Table 9.5):

- Always virtual, erect and diminished image between F and optical centre

### 🟦 Lens Formula:

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}v1−u1=f1$$

### 🟦 Magnification for Lenses:

$$m = \frac{h'}{h} = \frac{v}{u}m=hh′=uv$$

### 🟦 Power of a Lens:

$$P = \frac{1}{f\ (\text{in meters})} \quad \text{Unit: Dioptre (D)}P=f(in meters)1Unit: Dioptre (D)$$

➕ **Convex lens:** positive power
➖ **Concave lens**: negative power

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