CHAPTER- 10

LIGHT – REFLECTION AND REFRACTION

LIGHT

Light is a form of energy, which enable us to see the object. Its speed is \( 3 \times 10^8 \text{ m/s} \) in vacuum. Light always travel in straight line.

Reflection: The bouncing back of rays of light from a polished and shiny surface is called reflection or reflection of light. It is similar to bouncing back of a football after colliding with a wall or any hard surface.

\[
\text{Normal}\quad\quad\quad \text{Incident ray}\quad\quad\quad \text{Reflected ray}
\]

\[\text{Angle of Incidence}\quad\quad\quad \text{Angle of Reflection}\]

Laws of Reflection of light:

1. The angle of incidence is equal to the angle of reflection ie, \( \angle i = \angle r \), and
2. The incident ray, the reflected ray and the normal at the point of incidence, all lie in the same plane.

Note: The angle of incidence is denoted by 'i' and angle of reflection is denoted by 'r'. The law of reflection is applicable to all types of reflecting surface.

Mirror and Reflection of Light:

Mirror is a shiny polished object (glass) which reflects most of the rays of light falling upon it. One side of mirror is polished with suitable material to make the other side reflective.

Types of Image formed by mirrors:

Real Image: Image which is formed in front of the mirror and it can be obtained on a screen is called real image.

Virtual Image: Image which is formed behind the mirror and cannot be obtained on a screen is called virtual image.

Types of Mirror:
1. **Plane Mirror**: A mirror having a flat surface is called plane mirror.

   - A plane mirror always forms virtual and erect image.
   - The distance of image and that of object is equal from the mirror.
   - The image formed by a plane mirror is laterally inverted (The left side of object appear on right side of image).

2. **Spherical Mirror**: Mirrors having curved reflecting surface are called spherical mirrors. A spherical mirror is a part of a sphere.

**Types of Spherical Mirror:**

1. **Concave Mirror**: Spherical mirror with reflecting surface curved inwards is called concave mirror.
2. **Convex Mirror**: Spherical mirror with reflecting surface curved outwards is called convex mirror.

**Important terms in the case of spherical mirror:**

1. **Concave mirror**

   ![Concave mirror diagram]

2. **Convex mirror**

   ![Convex mirror diagram]
1. **Principal axis**: Line joining the pole and centre of curvature of the spherical mirror.

2. **Pole**: The centre of reflecting surface of a spherical mirror is known as Pole. Pole lies on the surface of spherical mirror. Pole is generally represented by ‘P’ denoted by (P).

3. **Aperture**: The width of reflecting spherical surface.

4. **Centre of curvature**: The reflecting surface of a spherical mirror form a part of sphere. It has a centre, which is known as centre of curvature, denoted by (C).

5. **Radius of curvature**: The separation between the pole and the centre of curvature. i.e. \( PC = R \)

6. **Focus point**: The point on the principal axis, where all parallel rays meet after reflection, denoted by (F).

7. **Focal length**: The length between the pole and focus point i.e. \( PF = f \)

8. **Relationship between focal length and Radius of curvature**.

\[
\frac{f}{2} = R \\
\text{or} \\
R = 2f
\]

**REPRESENTATION OF IMAGES FORMED BY SPHERICAL MIRRORS USING RAY DIAGRAMS**

a) A ray of light which is parallel to principle axis always pass through focus (meet at focus) or **vice-versa**

i) **Concave mirror** :-

![Concave Mirror Diagram](image)

ii) **Convex mirror** :-

![Convex Mirror Diagram](image)
b) A ray of light which passes through centre of curvature (it is also known as normal at the point of incidence on spherical mirror) will retrace their path after reflection.

i) Concave mirror:-

![Concave Mirror Diagram]

ii) Convex Mirror :-

![Convex Mirror Diagram]

c) A ray of light falling on pole get reflected at the same angle on the other side of principal axis.

i) Concave mirror:-

![Concave Mirror Diagram]

ii) Convex Mirror:-

![Convex Mirror Diagram]
Note: The image will only form when two or more rays meets at a point.

**IMAGE FORMATION BY A CONCAVE MIRROR FOR DIFFERENT POSITIONS OF THE OBJECT**

**Case 1: Object at infinity**

Position of the image: **At Focus**

Nature of the image: **Real and inverted**

Size of the image: **Highly diminished or Point sized.**

**Case 2: Object Beyond C**

Position of the image: **Between C and F**

Nature of the image: **Real and inverted**

Size of the image: **Diminished.**
**Case 3 : Object at C**

Position of the image: **At C.**

Nature of the image : **Real and inverted**

Size of the image : **Same size.**

**Case 4 : Object between C and F**

Position of the image: **Beyond C.**

Nature of the image : **Real and inverted**

Size of the image : **Enlarged.**

**Case 5 : Object At F**
Position of the image: **At Infinity.**

Nature of the image : **Real and inverted**

Size of the image : **Highly enlarged**

**Case 6 : Object between P and F**

![Diagram of object between P and F]

Position of the image: **Behind the mirror.**

Nature of the image : **Virtual and erect**

Size of the image : **Enlarged**

**IMAGE FORMATION BY A CONVEX MIRROR FOR DIFFERENT POSITIONS OF THE OBJECT**

**Case 1: Object at infinity**

![Diagram of object at infinity]

Position of the image: **At the focus F, behind the mirror**

Nature of the image : **Virtual and erect**

Size of the image : **Highly diminished or point sized.**
Case 1: Between infinity and Pole P of the mirror

Position of the image: Between P and F behind the mirror.

Nature of the image: Virtual and erect

Size of the image: Diminished

Uses of Concave Mirror

1. Used in torches, search light and headlight of vehicle.
2. Used to see large image of face as shaving mirror
3. Used by dentist to see large images of the teeth
4. Large concave mirror used to focus sunlight (heat) in solar furnaces.

Uses of Convex Mirror

1. Used as rear-view mirror in vehicles because it gives erect image. It also helps the driver to view large area.
2. They are used in sunglasses. This is done to help reflect the light of sun away from the eyes of the person wearing the sunglasses.
3. Convex mirrors use also used as street light reflectors because they are able to spread light over a bigger area.
4. They are also used in telescopes.

Sign Convention for Reflection by Spherical Mirror

1. The object is always placed to the left side of mirror.
2. All distance should be measured from pole (P); parallel to principal axis.
3. Take 'P' as origin. Distances measured
   Right of the origin (+ x -Axis) are taken positive
   Left of the origin (– x -Axis) are taken negative
Perpendicular to and above principal axis (+y-Axis) are **taken positive**
Perpendicular to and below principal axis (−y-Axis) are **taken negative**

**Mirror Formula**

\[
\frac{1}{f} = \frac{1}{v} + \frac{1}{u}
\]

Where,

\[
f = \frac{R}{2}
\]

f → focal length of the mirror  
v → Image distance  
u → Object distance  
R → Radius of curvature

**MAGNIFICATION**
It is expressed as the ratio of the height of the image to height of the object

\[
m = \frac{\text{Height of the image} (h')}{\text{Height of the object} (h)} \quad \text{(1)}
\]

It is also related to ′u′ and ′v′

\[
m = \frac{-v}{u} \quad \text{(2)}
\]

Comparing eqn 1 and 2 we can write,

\[
m = \frac{h'}{h} = \frac{-v}{u}
\]
Note:
1. If magnitude $m > 1$, Image is magnified
   $m = 1$, Image is of same size
   $m < 1$, Image is diminished
2. A negative sign in the value of the magnification indicates that the image is real.
3. A positive sign in the value of the magnification indicates that the image is virtual