

Subject: Physics

Summary

Chapter-4

CHAPTER FOUR: REFLECTION OF LIGHT (Continue)

IMAGE:

Definition: When the rays of light diverging from an object, after reflection, either actually meet at some other point or appear to meet at some other point.

kinds of images

1) Virtual image

2) Real image.

1) Virtual Image: When the rays of light diverging from an object, after reflection appear to diverge from another point.

2) Real Image: When the rays of light diverging from a point, after reflection actually converge at some other point.

Differences between Virtual and Real Image

Virtual Image	Real Image
1. The rays of light after reflection or refraction appear to meet at some other point or appear to diverge from some other point.	• The rays of light after reflection or refraction actually meet at some other point.
2. It cannot be taken on a screen.	• It can always be taken on a screen.
3. It is always erect, but laterally inverted.	• It is always inverted.

CHARACTERISTICS OF AN IMAGE FORMED IN A PLANE MIRROR

1. Image is virtual, i.e., it cannot be taken on screen.
2. Image is erect.
3. Image is of same size as the size of object. Thus, there is magnification of image is.
4. **Plane mirrors** produce **images** that have a magnification of **1**.
5. Image is laterally inverted, i.e, the left side of object appears as right side of the image.
6. Image is formed as far behind the plane mirror as the object is in front of it.

NOTE: To see his full height, a person requires a plane mirror which is half of his own height; i.e; $h_m = \frac{1}{2} h_o$

Images formed by two plane mirrors

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When two plane mirrors placed at an angle multiple images are formed due to reflections from the two mirrors. Two mirrors are fixed facing each other in show case, when multiple images are formed. **They are used as in providing false dimension in show case.**

Reflecting Periscope

Periscope: is an optical instrument that uses system of prism, lenses or mirrors to reflect images through a tube.

Light from distant object strikes the top of mirror and is then reflected at an angle of 90 degrees down the periscope.

It consists of card board or wooden tube. The bend twice at right angles and it provided with two opening as shown in the figure on the **page-131**.

Uses of Reflecting Periscope

- 1) It is used to see above the head of crowds.
- 2) It is used by soldiers in trench warfare.

Disadvantages of Reflecting Periscope

- 1) The final image is not brightly illuminated.
- 2) Any deposition of moisture or dust on the mirror reduces reflection.

Uses of Plane mirror

- 1) They are used as **looking glass**.
- 2) They are used as in providing **false dimensions** in show cases.
- 3) They are used by **opticians** to provide false dimensions.
- 4) They are used in contraction of a **reflecting periscope**.
- 5) They are used for **signaling purposes**.
- 6) They are used in **solar cookers** for reflecting rays of sun in the cooker.
- 7) They are used by **barbers** to show the customer the back of his head.

Lesson Exercises (Hint Page-132)

Reflection of light at curved surface

Spherical Mirror: Is that mirror whose reflecting surface is the part of a hollow sphere.

Kinds Of Spherical Mirror

- 1) **Concave mirror:** Is that spherical mirror in which the reflection of light takes place at the concave surface (bent-in surface).
- 2) **Convex Mirror:** Is that spherical mirror in which the reflection of light takes place at the convex surface (bulging-out surface).

General Terms Associated With Spherical Mirrors

- 1) **Spherical Mirror:** A mirror which is made from a part of a hollow sphere.
- 2) **Concave mirror:** A mirror which is polished from the outer side of a hollow sphere.

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3) Convex Mirror: A mirror which is polished on the hollow side of the sphere.

4) Pole: The midpoint of a spherical mirror is called its pole. It is denoted by the letter **P**.

5) Centre of curvature: The centre of the hollow sphere, of which the spherical mirror is a part, it is denoted by the letter **C**.

6) Principal axis: An imaginary line passing through the pole and the centre of curvature of a spherical mirror.

7) Linear aperture: The diameter of a spherical

8) Principal focus: It is a point on the principal axis, where a parallel beam of light after reflection, either **actually meets or appears to meet**. It is denoted by the letter **F**.

9) Focal length: The distance between the pole and the principal focus. It is denoted by the letter **f**.

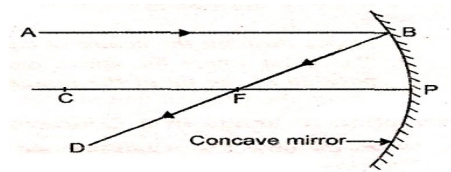
10) Radius of curvature: The distance between the pole and the centre of curvature. It is denoted by the letter **R**. $f = \frac{R}{2}$ or $R = 2f$

11) Focal Plane: An imaginary plane passing through principal focus, such that it is at right angles to principal axis is called **focal plane**

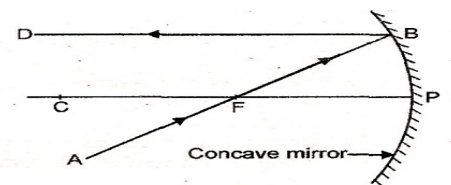
Representation of Images Formed in Concave Mirror by Ray Diagrams

Before, we proceed to draw images by ray diagrams in concave mirror, let us learn the rules for drawing images.

Rule 1: Any ray of light, travelling parallel to principal axis of a concave mirror, after reflection passes through the principal focus.

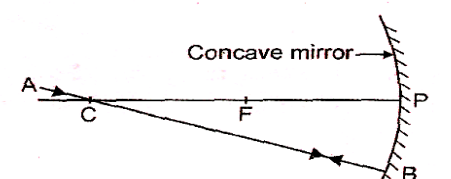


Rule 2: Any ray of light, which first passes through the principal focus of the concave mirror, after reflection travels parallel to the principal axis of the concave mirror.



Rule 3:

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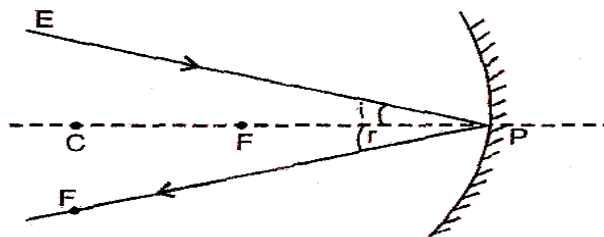
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Any ray of light which first passes through the centre of curvature of a concave mirror, after reflection will retrace its path. It is because; the ray strikes the concave mirror surface at right angles.

Rule 4:

A ray incident obliquely to the principal axis towards the pole P of the concave mirror is reflected obliquely, such that angle of incidence at P is equal to the angle of reflection at P



Formation of Image in A Concave Mirror

Table 1—Nature, Position and Relative Size of Image formed by Concave Mirror

Position of the object	Position of the image	Size of the image	Nature of the image
1. At infinity	At the focus (F)	Highly diminished	Real and inverted
2. Beyond C (Between infinity and C)	Between the C and F	Diminished	Real and inverted
3. At the C	At C	Equal to the object	Real and inverted
4. Between C and F	Beyond C	Enlarged (magnified)	Real and inverted
5. At the Focus	At infinity	Highly enlarged	Real and inverted
6. Between F	Behind the mirror	Enlarged	Virtual and

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and P			erect
7. At mirror	Front mirror	same size as the object	Virtual, upright

Note:

- 1) If the image is formed in **front of the mirror** then the nature will be **real and inverted**.
- 2) If the image is formed **behind the mirror** then the nature will be **virtual and erect**.
- 3) If the object is placed **at the mirror** then the nature will be **virtual and upright**.

Uses of Concave Mirrors

1. Concave mirrors are used as a **shaving mirror**.
2. Concave mirrors are used as a **reflector** in torches, vehicle head lights and search lights to get powerful beams of light.
3. Concave mirrors are used by **doctors** to focus light coming from a lamp on the body parts of patient (such as eye, ear, nose, teeth, etc.) to be examined by the doctor.
4. Concave dishes are used in **TV dish antennas** to receive TV signals from the distant communication satellites.
5. Concave mirrors are used by **dentists** because it gives the dentist a magnified reflection of the mouth. **The image in the mirror is larger, brighter and easier to see the dentist.**
6. Large Concave mirrors are used in the field of **solar energy** to focus sun's rays for heating solar furnaces. **(See figure 4.37 on Page-148).**

Formation of Image In A Convex Mirror

Table 2 —Nature, Position and Relative Size of Image formed by Convex Mirror

Position of the object	Position of the image	Size of the image	Nature of the image
1. At infinity	At F, behind the mirror	Highly diminished Or point size	Virtual and erect
2. Between infinity and pole of the mirror	Between P and F, behind the mirror	Diminished	Virtual and erect

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Note: The nature of images formed by convex mirrors will be **virtual and erect**.

Uses of Convex Mirrors

1. Convex Mirrors are used as **rear-view mirrors** in vehicles (like cars, trucks and buses) to see the traffic at the rear side or back side.
Because it can cover a very wide field behind the driver. (See figure 4.36 on the end Page-148).
2. Big convex mirrors are used as **shop's security mirrors. (See figure 4.39 on Page-149).**

Mirror Formulas and Linear Magnification

$$1) \quad \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \quad \text{and} \quad \frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

$$2) \quad M = \frac{d_i}{d_o} = \frac{h_i}{h_o} = \frac{-v}{u}$$

$$3) \quad R = 2f$$

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

Notes for Linear Magnification

M > 1: image is magnified (means the image is larger than the object), it is **convex mirror**.

M < 1: image is diminished (means the image is smaller than the object), it is **concave mirror**.

M = 1: image is the same size as object (means the image is the same size as height the object), it is **plane mirror**.

Summary Table For Sign Conventions

f		di		do	
Negative	Positive	Negative	Positive	Negative	Positive
Convex mirror	Concave mirror	Virtual image	Real image	Virtual object	Real object