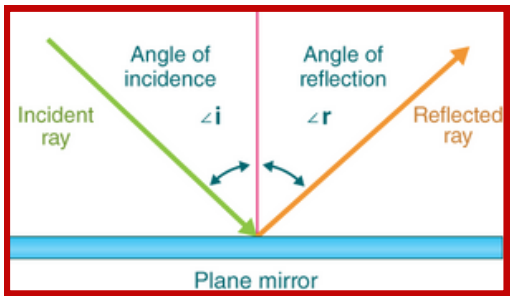
Light

PRASHANT KIRAD

- Rectilinear propagation of light - light travels in a straight line.
- Speed of Light = c = 3 x 10^8 m/s

Reflection: The bouncing back of light from any shiny surface e.g. mirror or water.



The Laws of reflection states that:
1. The **Incident ray**, the **Reflected ray** and **Normal** all lie in the **same plane**.
2. Angle of incidence (∠i) = The angle of reflection (∠r).

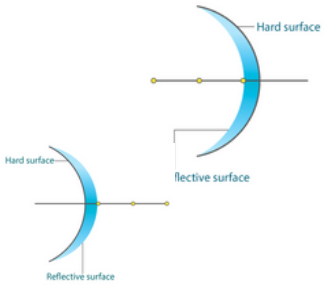
Plane mirror: A smooth and polished surface that reflects light uniformly.

The image formed by a plane mirror is :
- always virtual and erect.
- size of the image is equal to that of the object.
- image formed is as far behind the mirror as the object is in front of it.
- image is **laterally inverted.**

Spherical mirror: a mirror whose reflecting surface is part of a hollow sphere of glass.

CONCAVE MIRROR
reflecting surface is curved inwards, towards the center of the sphere

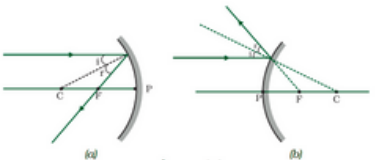
CONVEX MIRROR
reflecting surface is curved outwards.



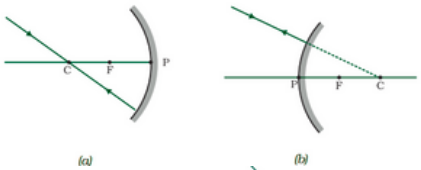
- **Pole (P):** The center point of the reflecting surface of a spherical mirror.
- **Centre of Curvature (C)**: The center of the sphere of which the mirror's reflecting surface forms a part.
- **Radius of Curvature (R)**: The radius of the sphere of which the mirror's reflecting surface forms a part. **R=2f**
- **Principal Axis:** The straight line passing through the pole and the center of curvature of the mirror.
- **Principal Focus (F)**: The point where parallel rays of light either converge or appear to diverge after reflecting from the mirror.
- **Focal Length (f)**: The distance between the pole and the principal focus.
- **Aperture:** The diameter of the reflecting surface of the spherical mirror.

Ray Diagrams

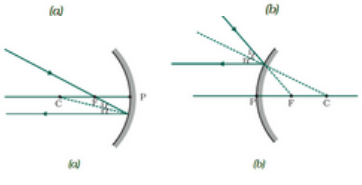
(i) A ray parallel to principal axis will pass through focus after reflection.



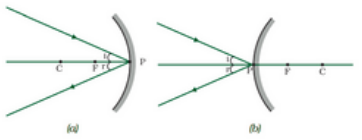
(iii) A ray passing through center of curvature will follow the same path back after reflection.



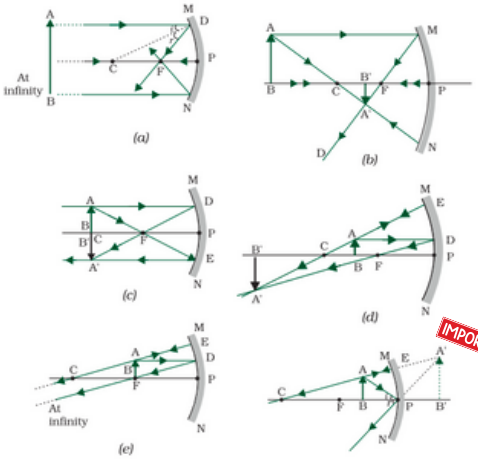
(ii) A ray passing through the principal focus will become parallel to principal axis after reflection



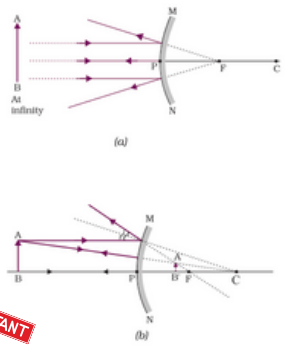
(iv) Ray incident at pole is reflected back making same angle with principal axis.



CONCAVE MIRROR



CONVEX MIRROR



IMPORTANT

Position of the object	Position of the image	Size of the image	Nature of the image
At infinity	At the focus F, behind the mirror	Highly diminished, point-sized	Virtual and erect
Between infinity and the pole P of the mirror	Between P and F, behind the mirror	Diminished	Virtual and erect

Position of the object	Position of the image	Size of the image	Nature of the image
At infinity	At the focus F	Highly diminished, point-sized	Real and inverted
Beyond C	Between F and C	Diminished	Real and inverted
At C	At C	Same size	Real and inverted
Between C and F	Beyond C	Enlarged	Real and inverted
At F	At infinity	Highly enlarged	Real and inverted
Between P and F	Behind the mirror	Enlarged	Virtual and erect

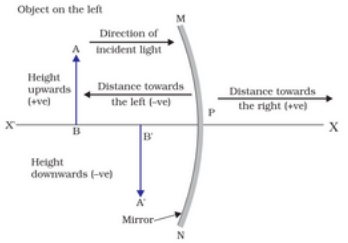
Uses of Concave Mirrors:
- Torches, Search-lights, and Vehicle Headlights:
- Shaving Mirrors
- Dentist's Mirrors
- Solar Furnaces

Uses of Convex Mirrors:
- Rear-view Mirrors in Vehicles:

Preferred in Vehicles:
- Provide erect, though diminished, images.
- Have a wider field of view due to their outward curve.
- Allow drivers to view a larger area compared to plane mirrors.

Sign Conventions for Spherical Mirrors:

- The object is always placed to the left of the mirror.
- Distances are measured from the pole of the mirror.
- Distances along the incident ray (+X-axis) are positive, and those against it (-X-axis) are negative.
- Distances above the principal axis are positive.
- Distances below the principal axis are negative.



Object distance = always +ve
Focal length of concave mirror = -ve
Focal length of convex mirror = +ve

Important Formulas:

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

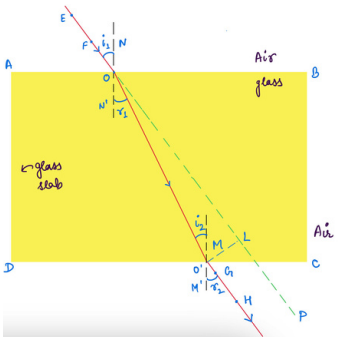
$$m=\frac{Height\ of\ image(h')}{Height\ of\ object(h)}=-\frac{v}{u}$$

h' = positive (virtual images)
h' = negative (real images)
m = negative (real)
m = positive (virtual)

Magnification refers to the ratio of the height of an image to the height of an object

Refraction of Light

Phenomenon of change in the direction of light when it passes from one transparent medium to another.



Laws of refraction of light.

(i) The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.

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

Snell's law of refraction.

Refractive index:

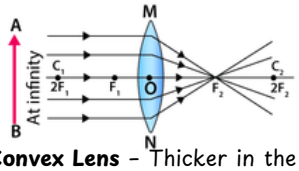
$$n_m=\frac{\text{Speed of light in air}}{\text{Speed of light in medium}}=\frac{c}{v}$$

measurement of how much a light ray bends when it passes from one medium to another.

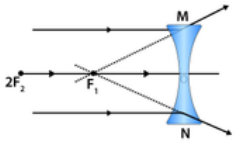
Lenses:

A transparent material bound by two surfaces, of which one or both surfaces are spherical.

CONVEX LENS



CONCAVE LENS

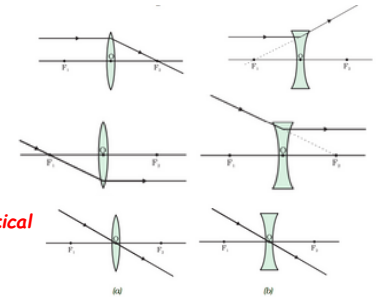


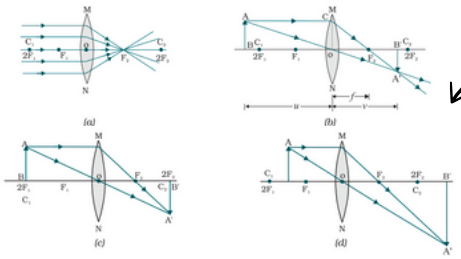
Convex Lens – Thicker in the middle, converges light.
Concave Lens – Thicker at edges, diverges light.
Centre of Curvature (C_1, C_2) – Center of the sphere forming the lens surface.
Principal Axis – Straight line through both curvature centers.
Optical Centre (O) – Central point where light passes undeviated.
Aperture – Effective diameter of the lens.
Principal Focus (F_1, F_2) – Point where parallel rays converge (convex) or diverge (concave).
Focal Length (f) – Distance between the principal focus and optical center.

(i) A ray of light from the object, parallel to the principal axis

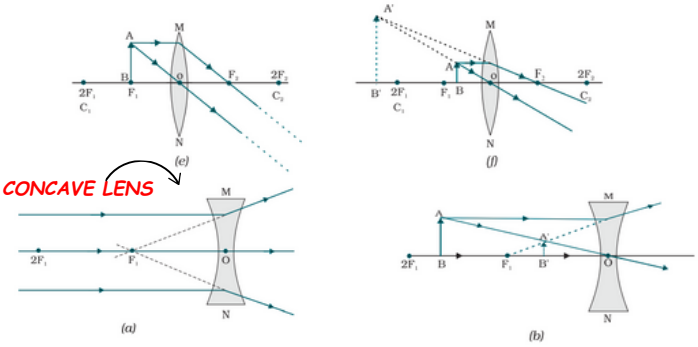
(ii) A ray of light passing through a principal focus

(iii) A ray of light passing through the optical centre of a lens





CONVEX LENS



Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_2	Highly diminished, point-sized	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F_1 and optical centre O	On the same side of the lens as the object	Enlarged	Virtual and erect

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_1	Highly diminished, point-sized	Virtual and erect
Between infinity and optical centre O of the lens	Between focus F_1 and optical centre O	Diminished	Virtual and erect

Uses of Concave Lens:

- spy holes in the doors
- glasses
- some telescopes

Uses of Convex Lens:

- overhead projector
- camera
- focus sunlight
- simple telescope
- projector microscope
- magnifying glasses

Lens formula:

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

$$m = \frac{\text{Height of image}(h')}{\text{Height of object}(h)} = -\frac{v}{u}$$

Power of Lens: The ability of a lens to converge or diverge the ray of light after refraction through it is called the power of the lens. It is defined as the reciprocal of focal length. '
SI unit = Dioptre (D)

1 dioptre is the power of a lens whose focal length is 1 metre.
1D = 1m.

power of a convex lens = positive
power of concave lens = negative.

$$P = \frac{1}{f}$$

Chapter ka KAZAANA:

- **Numerical**
  - **Mirror Formula**
  - **Lens Formula**
  - **Power of Lens**
- **All Ray Diagrams**
- **Snell's Law**