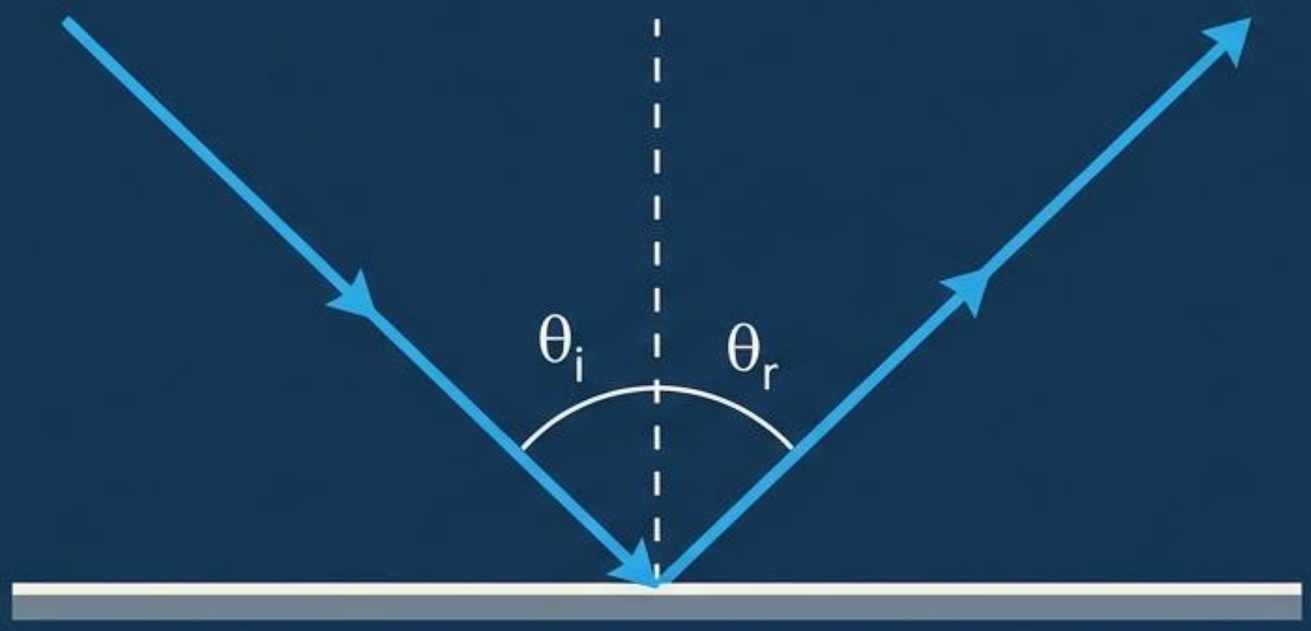
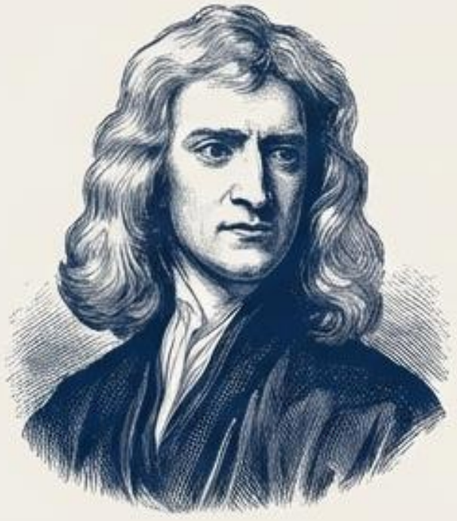
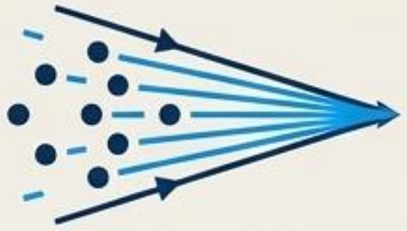
Light, Reflection, and Refraction

Class 10 Physics Revision Notes



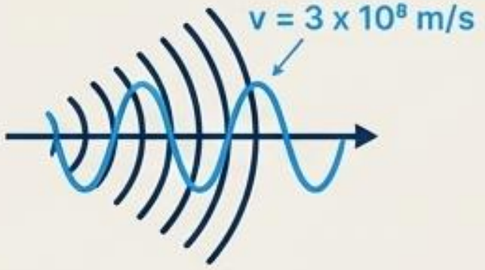
Newton (Corpuscular Theory)





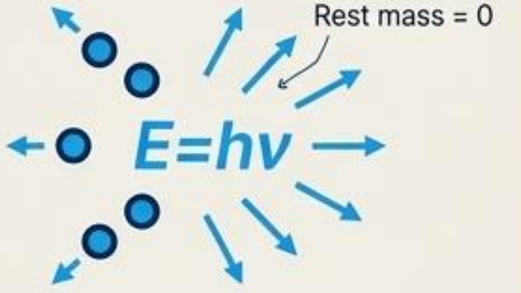
Light travels in space with great speed as a stream of very small particles. Expiains reflection and refraction.

Huygens (Wave Theory)



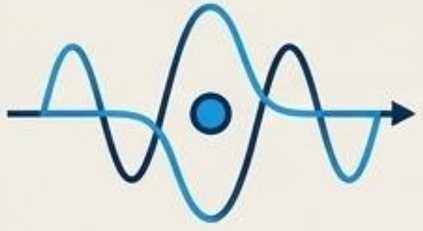
Light propagates as electromagnetic waves. Needs no medium; travels in a vacuum at 3 x 10^8 m/s.

Planck (Quantum Theory)



Light travels in energy packets called photons (Rest mass = 0). Energy of each quanta: E=hv.

De Broglie (Dual Nature)



Unifies the theories. Light acts as both a transverse electromagnetic wave and a particle (photon).

LIGHT

Ray Optics

Large-scale optics. Reflection and refraction at a normal scale (>10^-2 m).

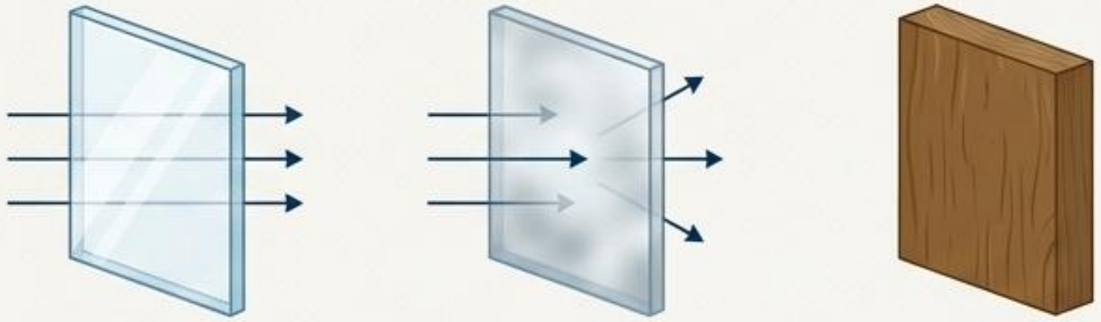
Wave Optics

Micro-scale. Order of the wavelength of light. Covers diffraction (bending of light) and interference.

Quantum Optics

Photon theory. Covers the photoelectric effect and Compton effect.

FUNDAMENTAL PROPERTIES OF LIGHT



TRANSPARENT TRANSLUCENT OPAQUE

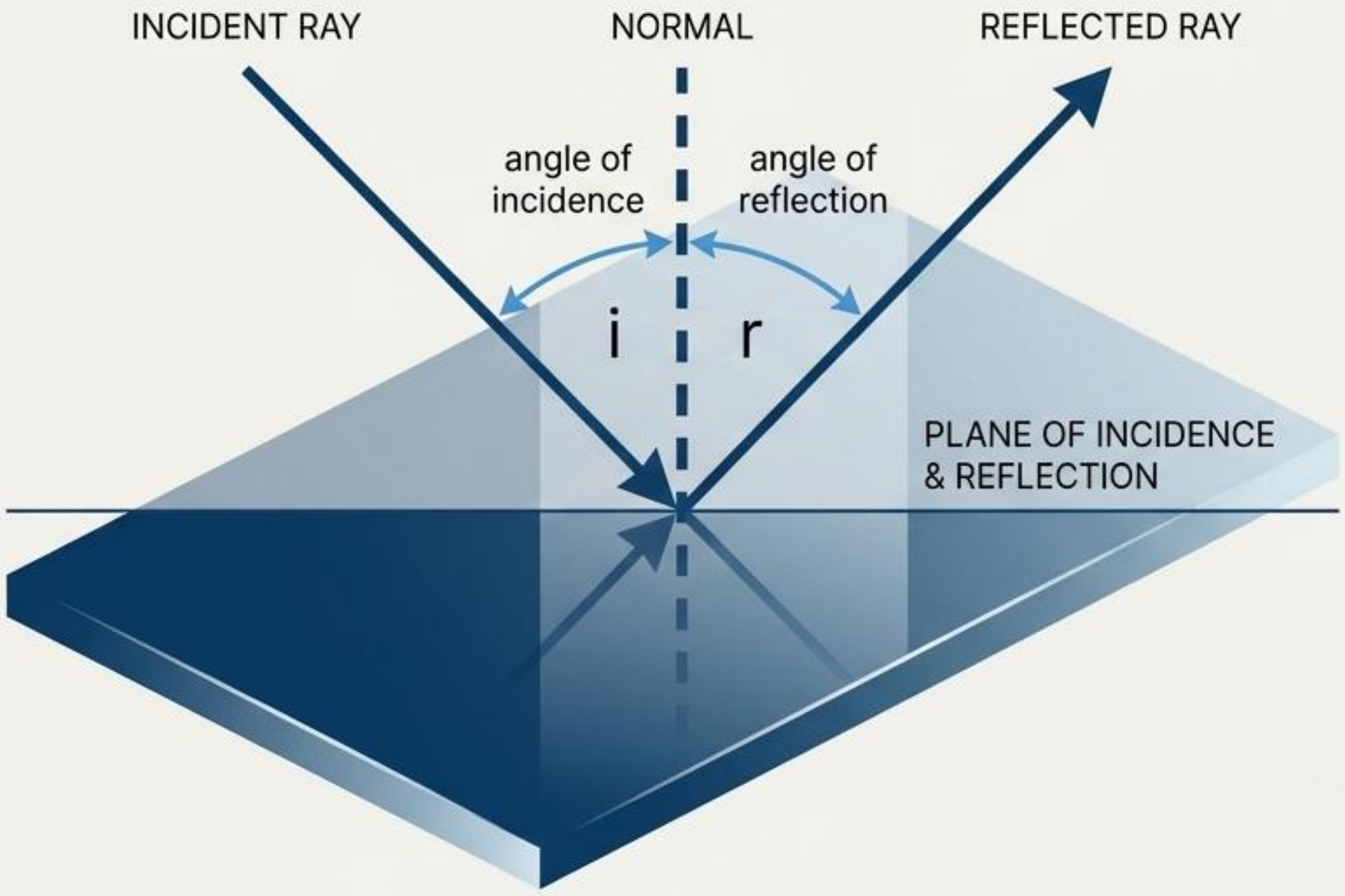
- **PROPAGATION:** Light travels in straight lines (rectilinear propagation) at a maximum velocity of 3 x 10^8 m/s in a vacuum.
- **VISIBILITY:** Luminous objects (Sun, stars) emit light. Non-luminous objects (book, moon) only scatter or reflect it.

RAY AND BEAM CONCEPT

RAY OF LIGHT DIVERGENT BEAM CONVERGENT BEAM

- **RAY VS. BEAM:** A ray is a straight line showing the direction of light. A beam is a bundle of these rays converging or diverging.

LAWS OF REFLECTION



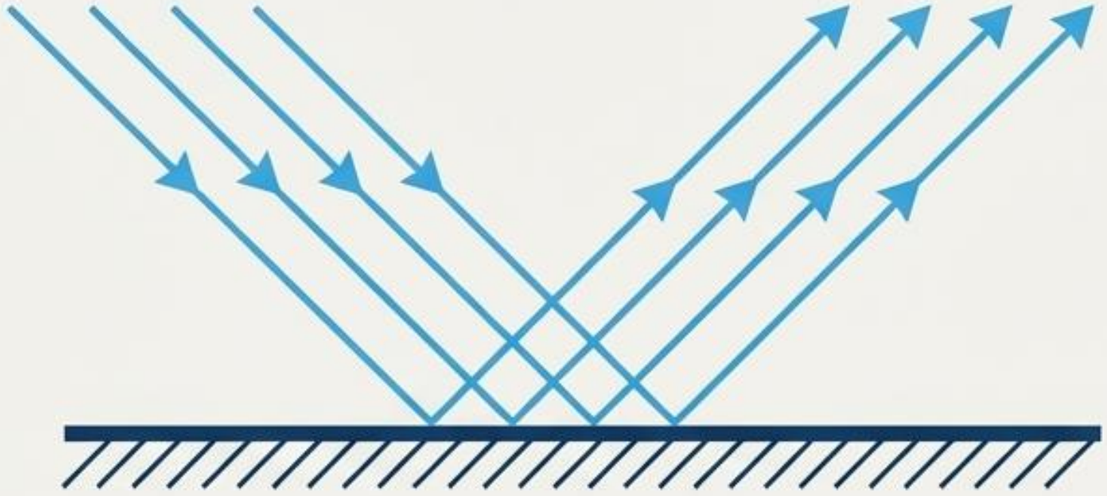
The First Law: The incident ray, the reflected ray, and the normal to the surface at the point of incidence all lie in the same plane.

The Second Law: The angle of incidence (i) is always exactly equal to the angle of reflection (r). i = r.

Callout: If a ray falls completely normally (at a right angle) to the mirror, it gets reflected back along the exact same path.

TYPES OF REFLECTION

Regular (Specular) Reflection

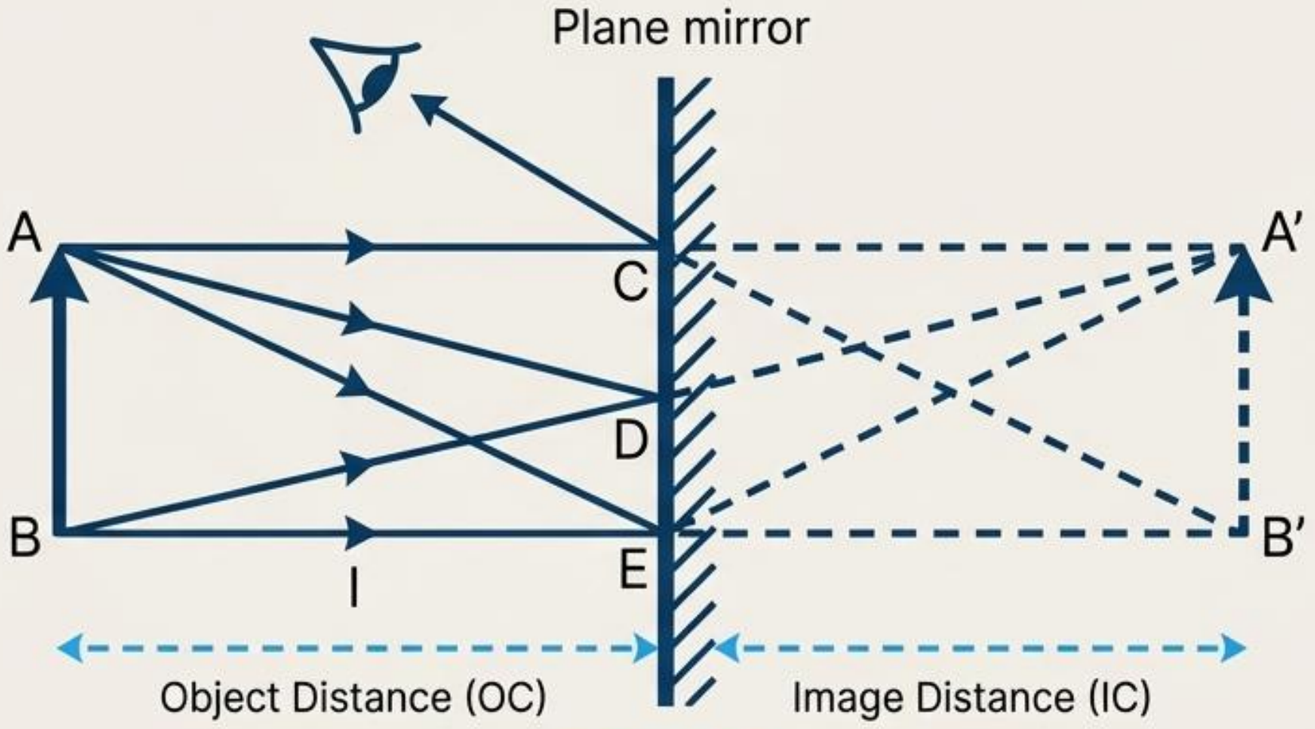


Regular (Specular) Reflection: Parallel light rays fall on a smooth plane surface (like a mirror) and reflect parallelly along a definite direction.

Irregular (Diffused) Reflection

Irregular (Diffused) Reflection: Parallel light rays fall on a rough surface and are reflected in all possible directions.

IMAGE FORMATION IN A PLANE MIRROR



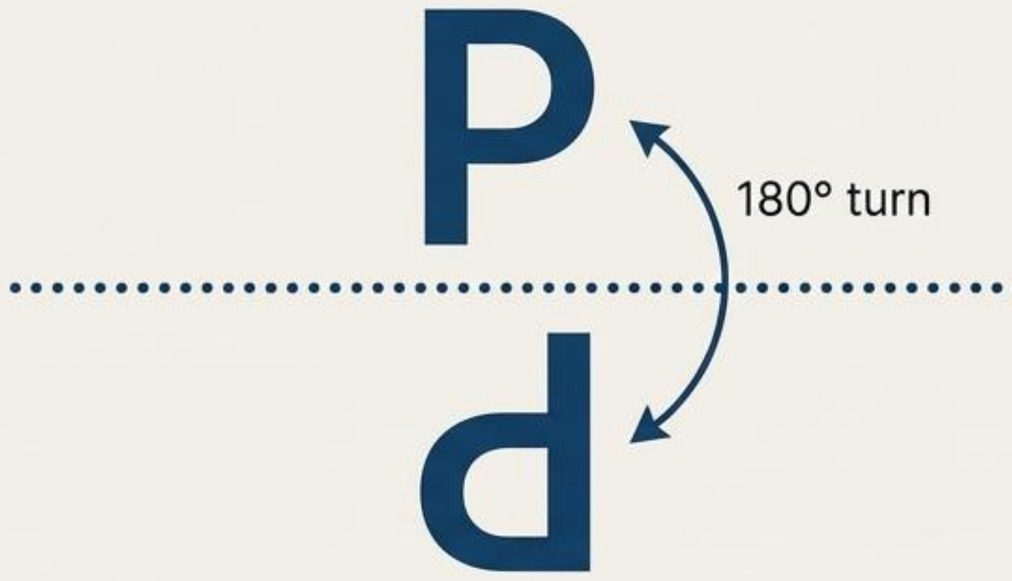
OC = IC

Virtual rays (dashed) intersect to form A'B'

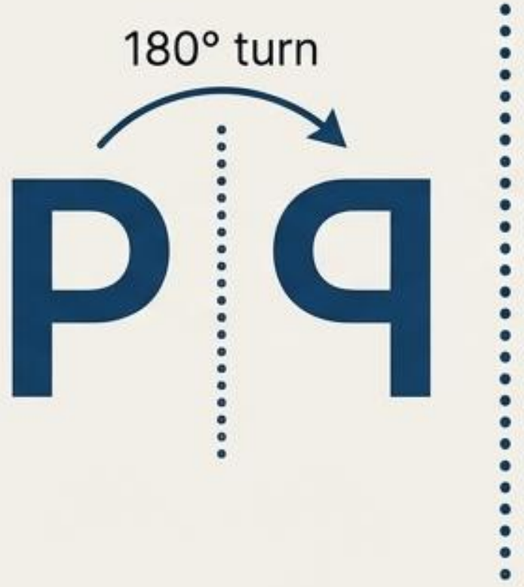
- **Virtual & Erect:** The image is not formed by the actual intersection of light rays, and it does not sit upside down.
- **Equidistant:** The image is formed behind the mirror as far as the object is from the front of the mirror (OC = IC).
- **True Size:** The image is the exact same size as the object.

INVERSION & LATERAL INVERSION

INVERSION



LATERAL INVERSION

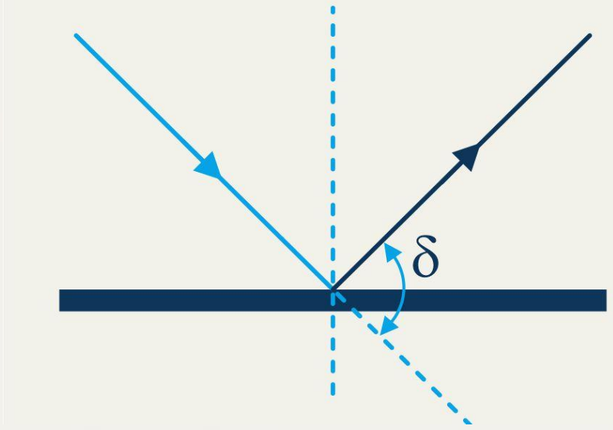


The Phenomenon: The image of an object turns through an angle of 180 degrees through the vertical axis.

The Result: The right side of the object appears as the left side of the image, and vice versa.

OPTICAL PHENOMENA: DEVIATION, ROTATION, AND MULTIPLE REFLECTIONS

Box 1: Deviation

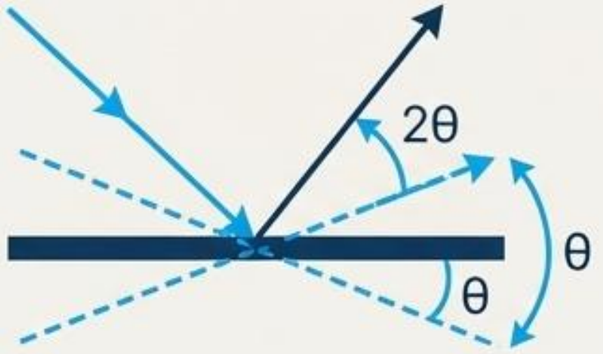


A plane mirror deviates light through an angle.

d = 180 - 2i (in Azure Blue)

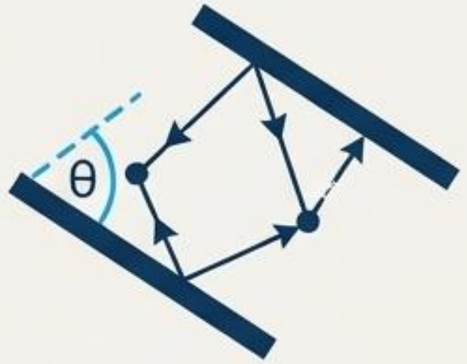
Deviation is maximum (180 degrees) for normal incidence.

Box 2: Rotation Effect



If the mirror rotates by an angle **θ** (theta), the reflected ray rotates by exactly **2*θ**.

Box 3: Multiple Mirrors



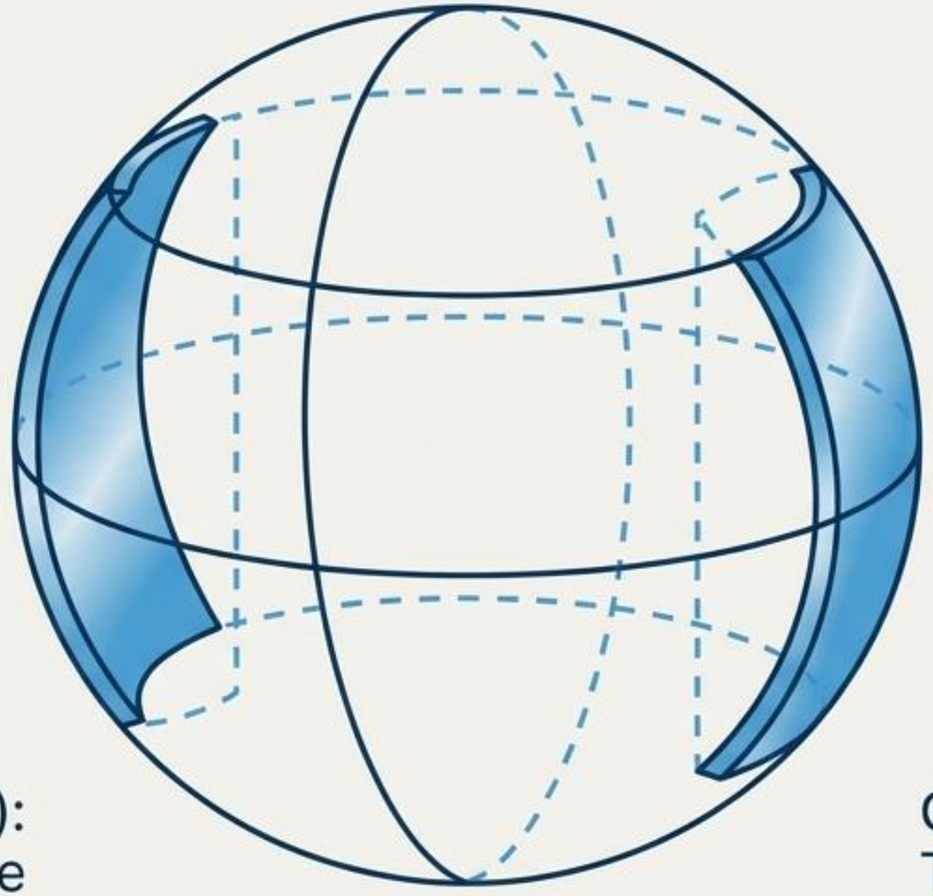
If two mirrors are angled at **θ**, the number of images formed is:

n = (360/θ) - 1 (in Azure Blue)

(if 360/θ is an even integer).

Spherical Mirrors

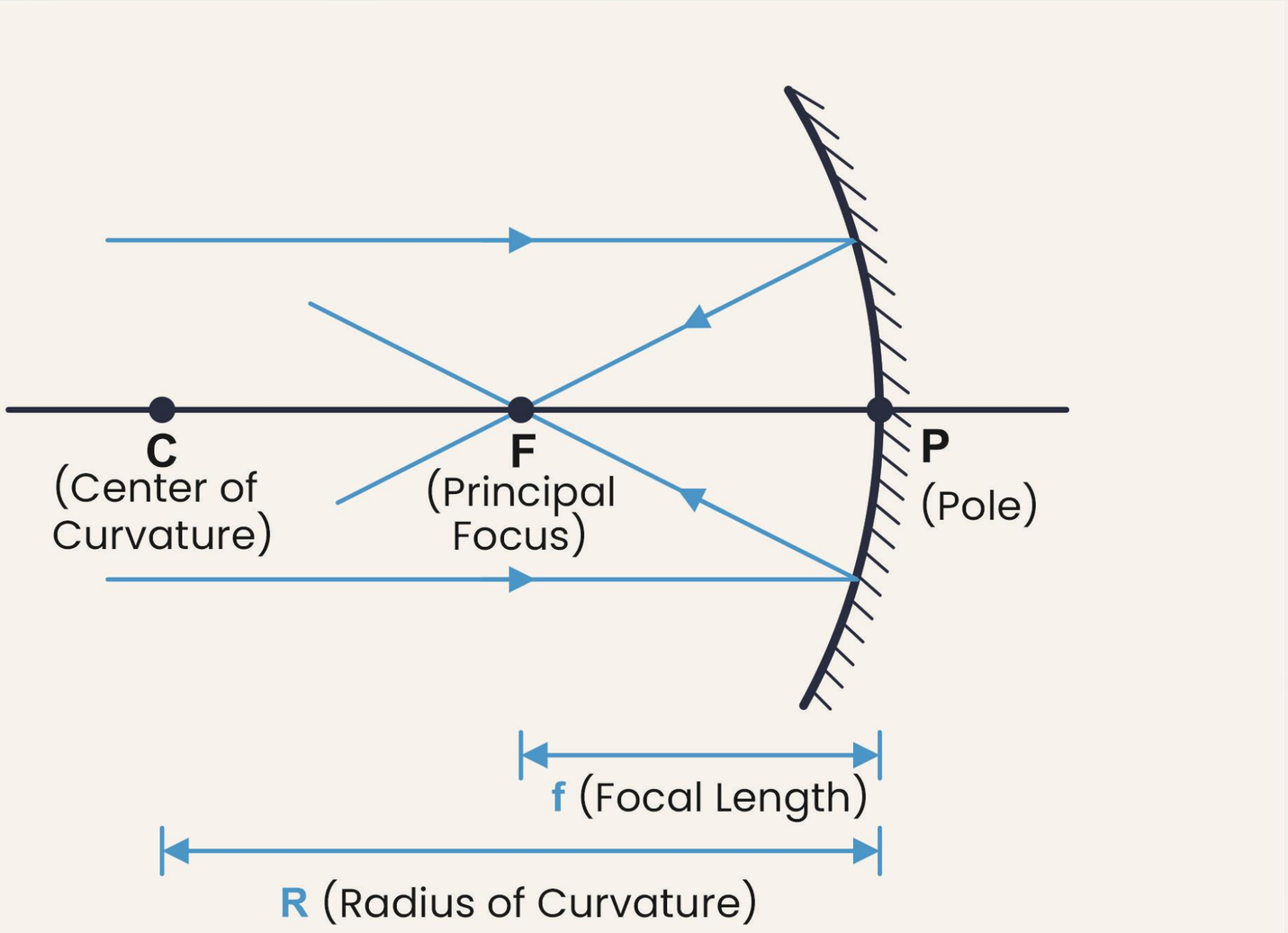
A mirror whose polished reflecting surface is a part of a hollow sphere of glass.



Concave (Converging):
The inner hollow surface is the reflecting surface

Convex (Diverging):
The outer bulging surface is the reflecting surface.

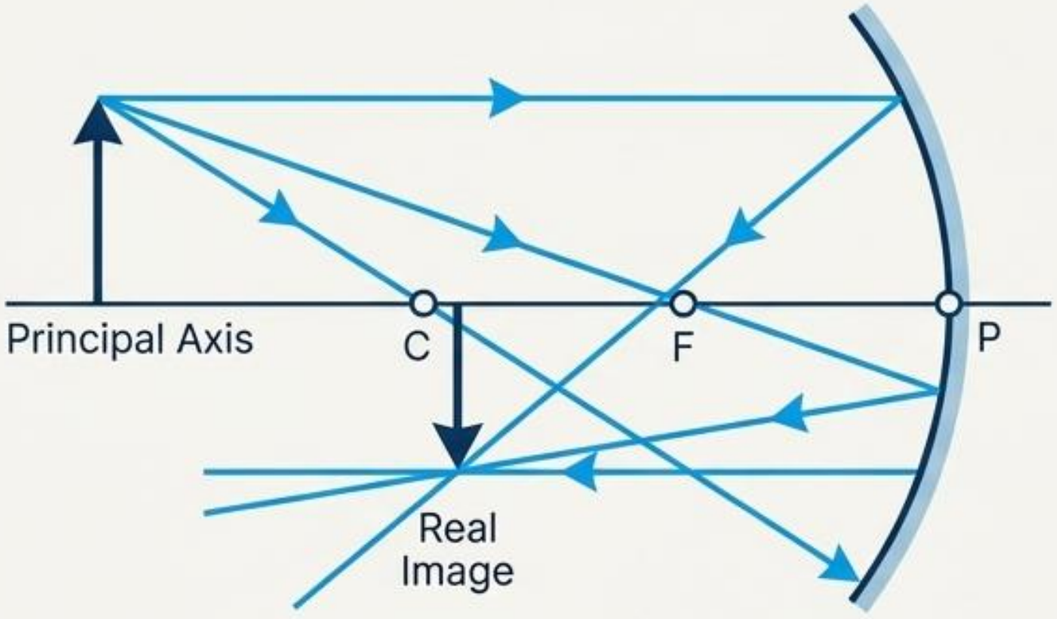
Concave Mirror Terminology



Key Terms and Definitions

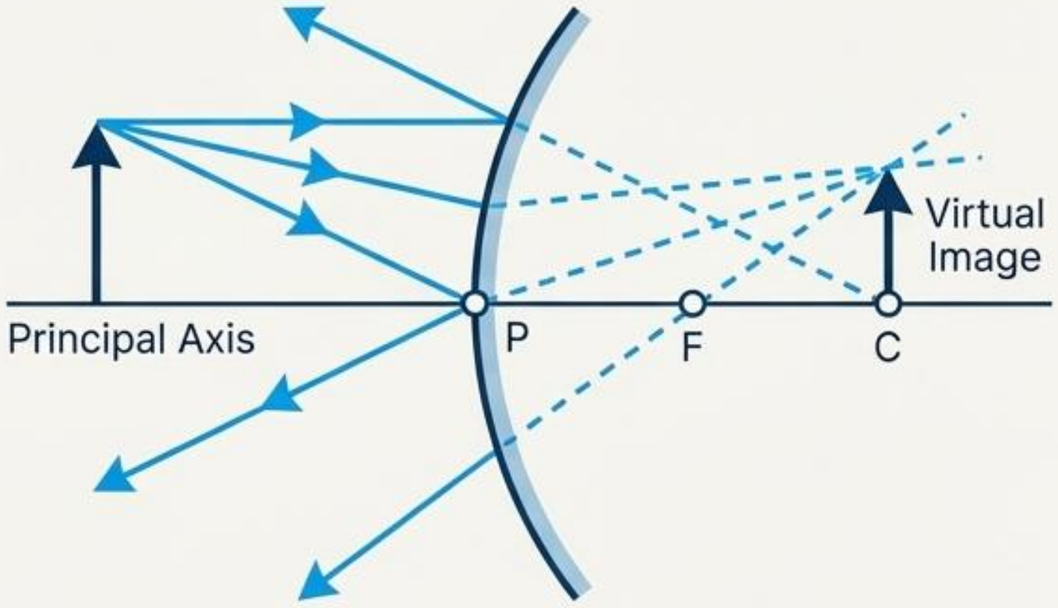
- **Pole (P):** The exact center of the spherical mirror.
- **Center of Curvature (C):** The center of the original hollow sphere.
- **Principal Focus (F):** The point where all parallel rays meet after reflection.
- **Focal Length (f):** The distance between P and F. Formula: f = R/2 (Radius of Curvature divided by 2)

Real Image



Real Image: Rays actually intersect.
Can be obtained on a screen.
Always inverted. Formed in front of the mirror.

Virtual Image



Virtual Image: Rays do not intersect; they appear to diverge from a point.
Cannot be obtained on a screen.
Always erect.
Formed behind the mirror.

Rules of Image Formation from the Concave Mirror

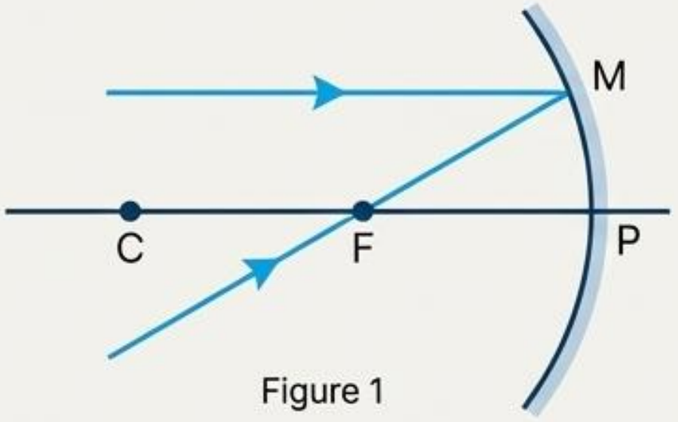


Figure 1

Rule 1: A ray parallel to the principal axis passes exactly through the Focus (F) after reflection.

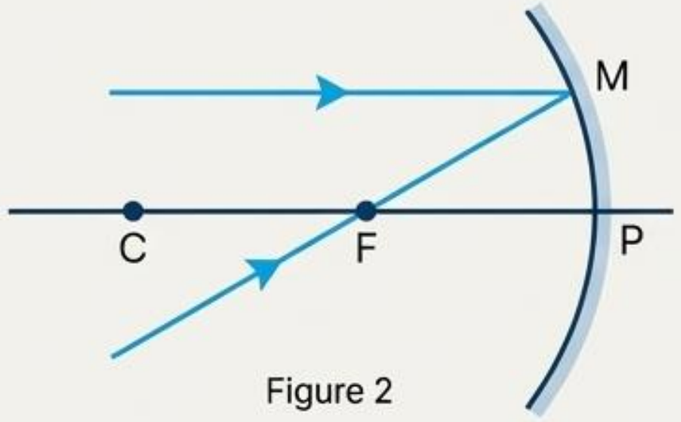


Figure 2

Rule 2: A ray passing through the Focus (F) reflects exactly parallel to the principal axis.

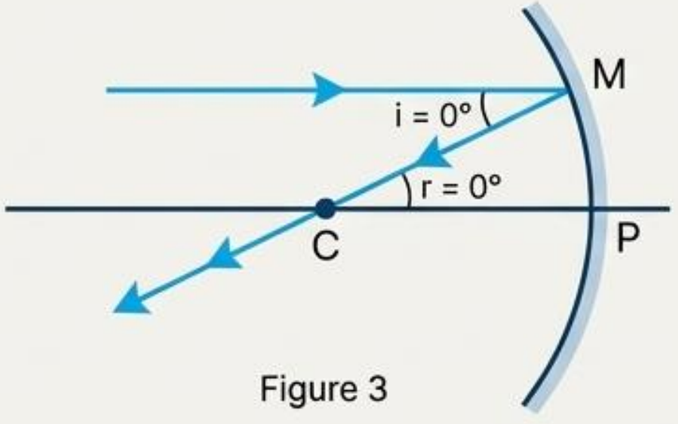


Figure 3

Rule 3: A ray passing through the Center of Curvature (C) retraces its exact path.

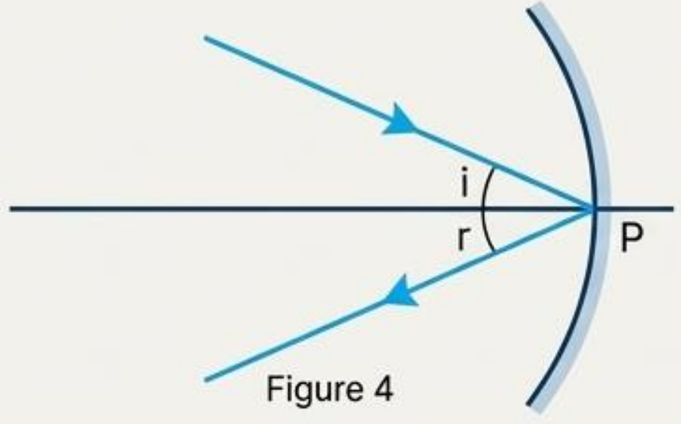
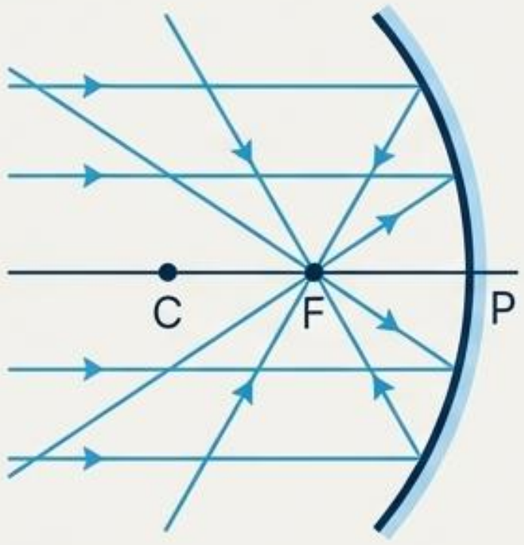


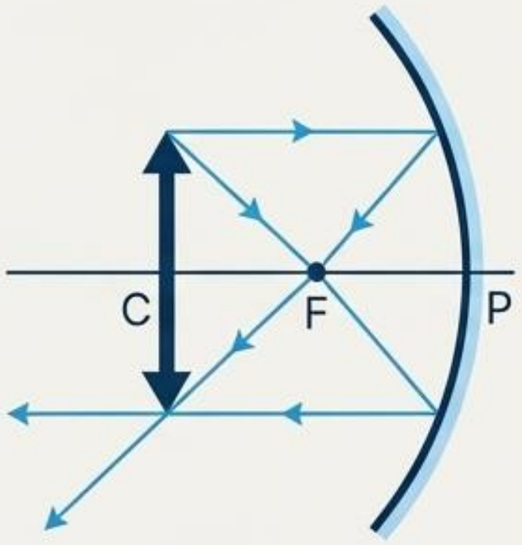
Figure 4

Rule 4: A ray striking the Pole (P) reflects symmetrically (angle i = angle r).

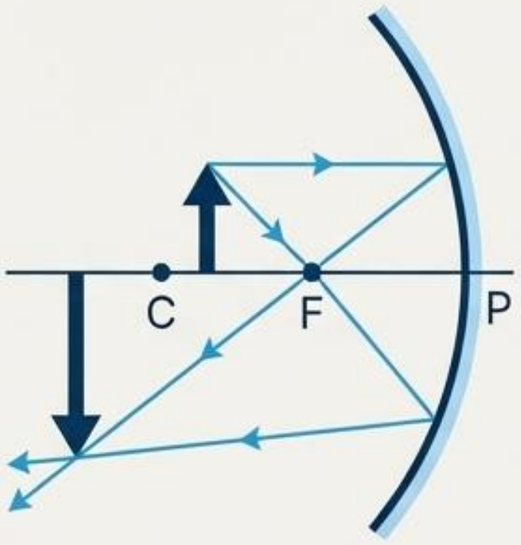
Sequential Image Formation by a Concave Mirror



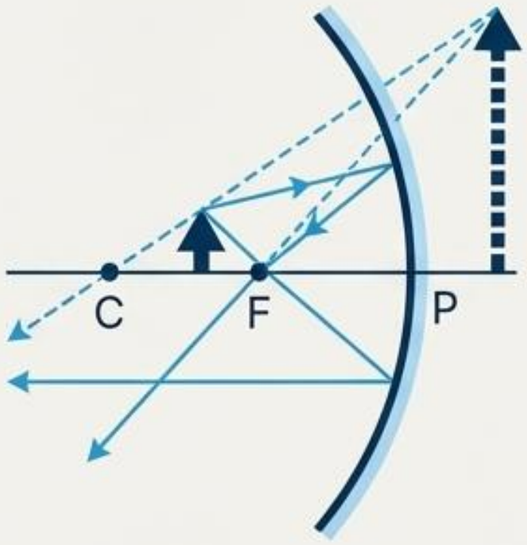
At Infinity:
Image is Real, Inverted, Point-sized (At F).



At C:
Image is Real, Inverted, Same Size (At C).



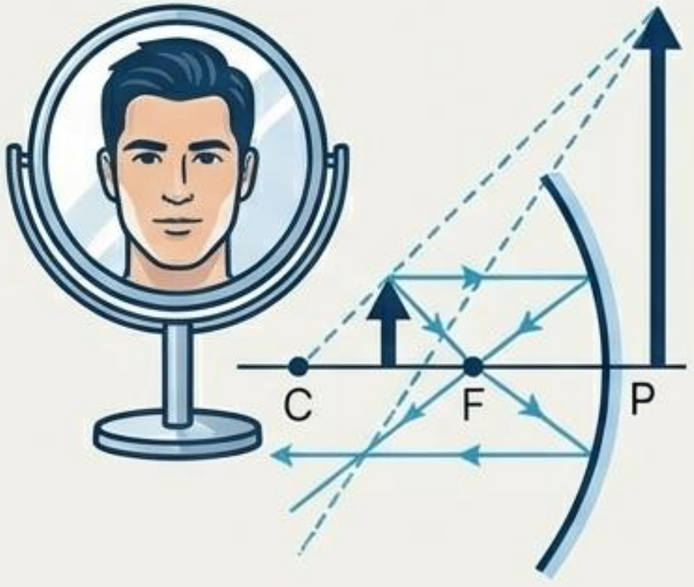
Between C & F:
Image is Real, Inverted, Enlarged (Beyond C).



Between F & P:
Image is Virtual, Erect, Enlarged (Behind Mirror).

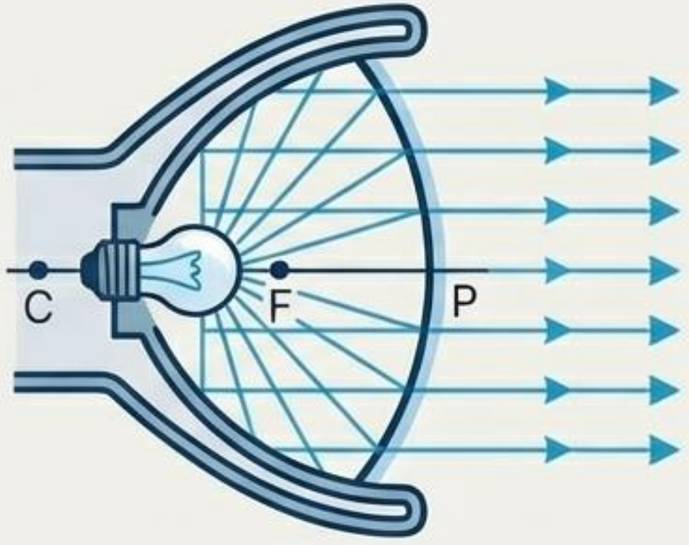
Practical Applications of Concave Mirrors

Shaving Mirrors



Shaving Mirrors: Uses the object position between F and P to create an enlarged, virtual, erect image of the face.

Vehicle Headlights



Vehicle Headlights: Places the lightbulb exactly at the Focus (F), causing all reflected light to beam out perfectly parallel for maximum distance.

Doctor's Head Mirrors

Doctor's Head Mirrors: Uses the curve to focus a parallel beam of ambient light down onto a tiny, specific area for examination.