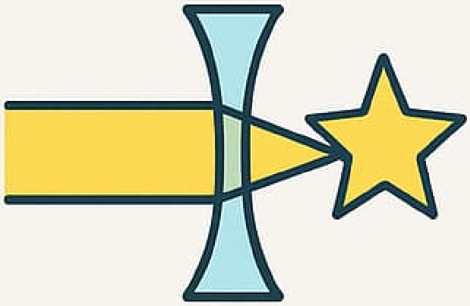
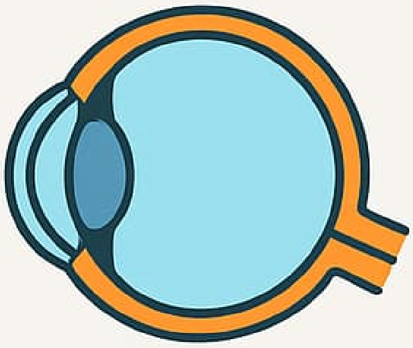
PHYSICS

CLASS 10 NOTES

Based on NCERT 2025-26

- Comprehensive notes
- Easy to understand language



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CONTENTS

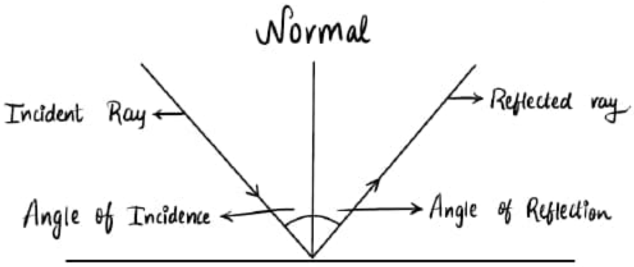
Ch 09 – LIGHT - REFLECTION AND REFRACTION

⇒ **Light**: Light is a form of energy which produces the sensation of sight of view. Light detected by our eyes.

⇒ **Luminous Objects**: The objects which emit their own light is called luminous objects. Ex – Sun, stars, bulb etc.

⇒ **Non-Luminous objects**: The object which does not emit their own light is called non-luminous object. Ex – Moon, pen etc.

⇒ **Laws of Reflection of Light**:
- The angle of incidence is equal to the angle of reflection ($i = r$).
- The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane.

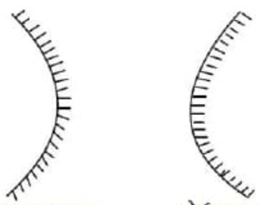


⇒ **Properties of Image in a Plane Mirror**:
- Image size = object size
- Image distance = object distance
- Image is always erect
- Image is always virtual
- Image is always laterally invented

⇒ **Spherical Mirrors**: A mirror whose reflecting surface is a part of a sphere is called spherical mirror. Spherical mirrors are of two types:

⇒ **Concave Mirror**: A spherical mirror, whose reflecting surface is curved inwards, that is, faces towards the centre of the sphere, is called a concave mirror.

⇒ **Convex Mirror**: A spherical mirror whose reflecting surface is curved outwards, is called a convex mirror.



a) Concave mirror b) Convex mirror

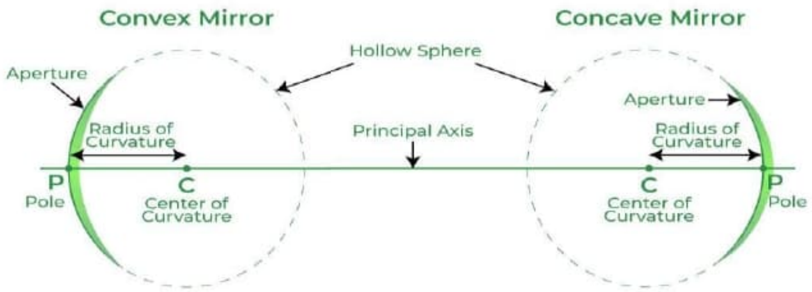
⇒ **Terms Related to Spherical Mirrors**:
- **Pole** (P): The center of the mirror's surface is called pole.
- **Center of Curvature** (C): The center of the sphere from which the mirror is a part. It lies in front of the mirror in concave and behind the mirror in convex mirrors.
- **Radius of Curvature** (R): The distance between the pole (P) and the center of curvature (C).
- **Principal Axis**: The straight line passing through the pole and the center of curvature.
- **Aperture**: The diameter of the reflecting surface of spherical mirror is called aperture.

⇒ **Principal Focus of The Concave Mirror**: The principal focus of a concave mirror is the point on the principal axis where light rays that are parallel to the principal axis converge (meet) after reflection from the mirror. It is denoted by the letter F.

⇒ **Principal Focus of The Convex Mirror**: The principal focus of a convex mirror is the point on the principal axis from which light rays parallel to the principal axis appear to diverge after reflection. It is denoted by the letter F.

⇒ **Focal Length** (*f*): The distance between the pole and the principal focus of a spherical mirror is called the focal length. It is represented by the letter *f*.

$$f = \frac{R}{2} \quad \text{or} \quad R = 2f$$



⇒ **Representation of Images Formed by spherical Mirrors Using Ray Diagrams**

⇒ **Types of Rays Used in Image Formation by Spherical Mirrors**

- **Ray Parallel to Principal Axis**: After reflection, it passes through the focus (F) in a concave mirror, or appears to diverge from the focus in a convex mirror.
- **Ray Passing Through the Focus** (F):
  - After reflection, it becomes parallel to the principal axis (for concave mirror).
  - In a convex mirror, the incident ray appears to come from the focus.
- **Ray Passing Through the Centre of Curvature** (C): It reflects back along the same path because it strikes the mirror perpendicularly.
- **Ray Striking the Pole** (P): It reflects symmetrically, following the law of reflection (angle of incidence = angle of reflection).

⇒ **Image Formation by a Concave Mirror**:

Object Position	Image Position	Nature of Image
At infinity	At focus (F)	Point-sized, real, inverted
Beyond center (C)	Between F and C	Real, inverted, smaller
At center (C)	At center (C)	Real, inverted, same size
Between C and F	Beyond C	Real, inverted, larger
At focus (F)	At infinity	Real, inverted, highly enlarged
Between pole and focus	Behind mirror	Virtual, erect, larger

⇒ **Uses of Concave Mirror:**

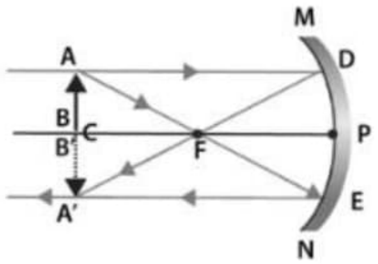
- Concave mirrors are commonly used in torches, search-lights and vehicles headlights to get powerful parallel beam of light.
- They're often used as shaving mirrors to see a larger image of the face.
- The dentists use concave mirrors to see large images of the teeth of patients.
- Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

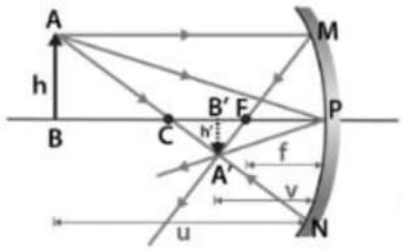
⇒ **Image Formation by a Convex Mirror**:

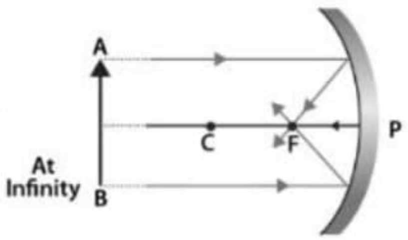
Object Position	Image Position	Nature of Image
At infinity	At focus (F)	Point-sized, virtual, erect
Anywhere in front	Between F and P	Virtual, erect, smaller

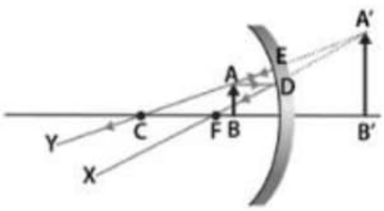
⇒ **Uses of Convex Mirror:**

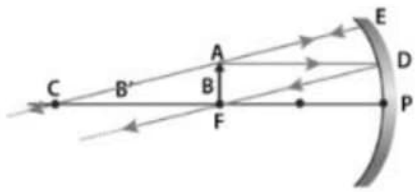
- Convene mirrors are commonly used as rear-view mirrors in vehicles.
- These mirrors are fitted on the sides of the vehicles, enabling the driver to see traffic behind him/her to facilitate safe driving.
- Roadside Curves and Blind Turns – Placed at sharp curves or intersections to help drivers see oncoming traffic and avoid accidents.
- Security and Surveillance – Installed in shops, banks, and buildings to monitor large areas — they let you see around corners.
- Convex mirrors have a wider field of view as they are curved outwards.
- Convex mirrors are preferred because they always give an erect, though diminished, image.

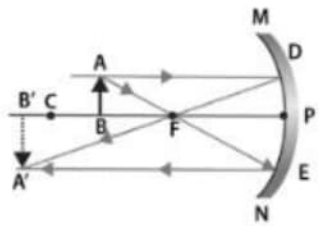


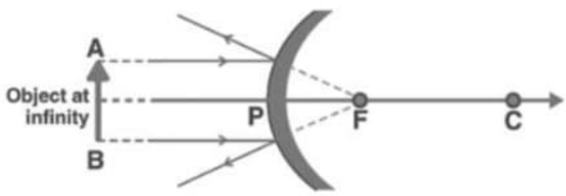


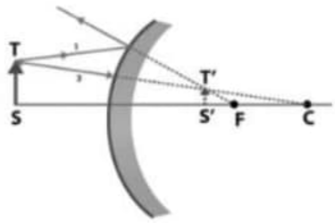






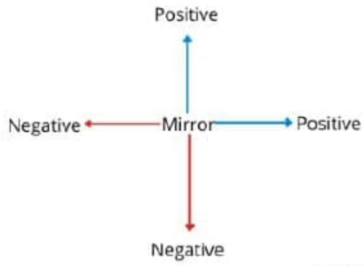


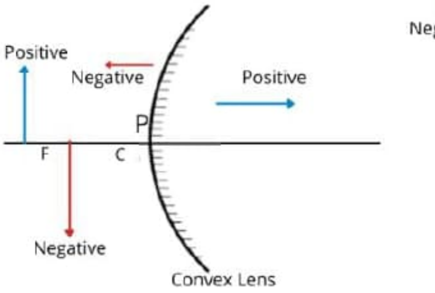




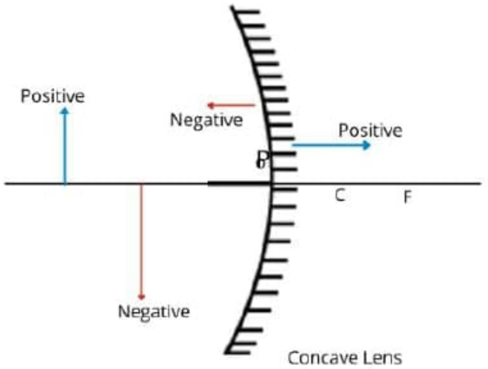
⇒ **Sign Convention for Reflection by Spherical Mirrors**

⇒ The object is always placed to the left of the mirror and all the signs are taken according to the Cartesian Sign Convention.





Focal lenght of convex mirror is always postive



Focal lenght of concave mirror is always negative

⇒ **Mirror Formula**: The mirror formula is a mathematical relationship between the focal length (f), the object distance (u), and the image distance (v) for a spherical mirror.

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

f = focal length of the mirror
v = image distance (from the pole)
u = object distance (from the pole)

Sign Convention:

- All distances are measured from the pole of the mirror.
- Object distance (u) is always taken as negative for real objects.
- Image distance (v) is positive for virtual images (in convex mirrors) and negative for real images (in concave mirrors).
- Focal length (f) is negative for a concave mirror and positive for a convex mirror.

⇒ **Magnification**: Magnification in mirrors tells us how much bigger or smaller the image is compared to the object.

$$Magnification\ (m)=\frac{Height\ of\ the\ image\ (h')}{Height\ of\ the\ object\ (h)}$$

$$m=\frac{h'}{h}$$

The magnification m is also related to the object distance (u) and image distance (v). It can be expressed as:

$$m=-\frac{v}{u}$$

- m > 0: Image is upright (virtual image).
- m < 0: Image is inverted (real image).

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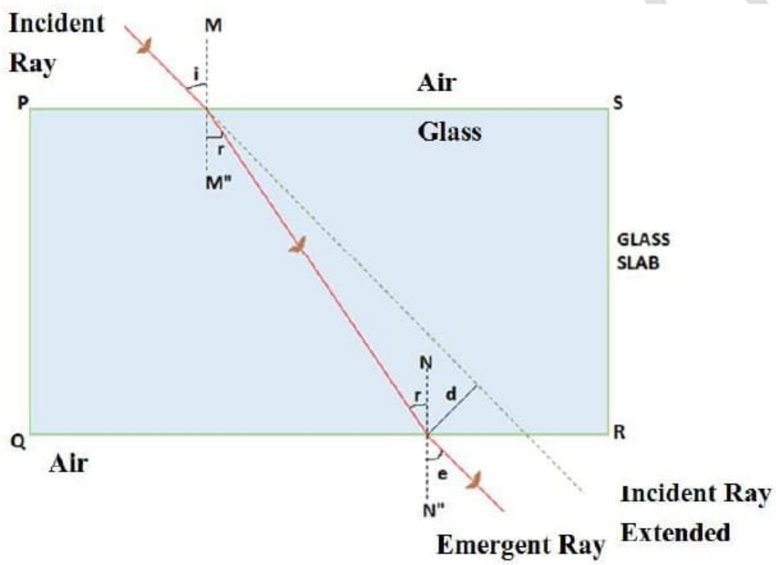
⇒ **Refraction of Light**: Refraction of light is the phenomenon of change in the path of light in going from one medium to another. *(Arises due to variation in speed of light.)*

⇒ **Effects Related to Refraction of Light**:

- The bottom of a tank or a pond containing water appears to be raised.
- When a thick glass slab is placed over some printed matter, the letters appear raised when viewed through the glass slab.
- A pencil partly immersed in water in a glass tumbler appears to be displaced at the interface of air and water.
- A lemon kept in water in a glass tumbler appears to be bigger than its actual size, when viewed from the sides.

The extent of the effect is different for different pair of media.

⇒ **Refraction of Light Through a Glass Slab**:



- When a ray of light travels from air into a glass slab, and then back into air, here's what happens:
  - Incident Ray: The incoming ray in air.
  - Point of Incidence: Where the incident ray hits the glass surface.
  - Normal: A line at 90° to the surface at the point of incidence.
  - Angle of Incidence (i): Angle between the incident ray and the normal.
- At first surface (air to glass):
  - Light bends towards the normal because glass is denser.
  - The ray inside glass is called the Refracted Ray.
  - Angle of Refraction (r_1): Angle between the refracted ray and the normal.
- Inside the glass:
  - The refracted ray travels straight but slower than in air.
- At second surface (glass to air):
  - The ray emerges from glass into air.
  - Emergent Ray: The ray coming out into air.
  - Angle of Emergence (e): Angle between the emergent ray and the normal at the second surface.
  - Light bends away from the normal because air is rarer.

- Important Properties:
  - The emergent ray is parallel to the incident ray.
  - There is a lateral displacement — a sideways shift between incident and emergent rays.
  - Speed of light is less in glass than in air.
  - If the slab is perfectly parallel and uniform, i = e (angle of incidence equals angle of emergence).
- If light moves from a **rarer** to a **denser** medium, it bends towards the normal.
- If light moves from a **denser** to a **rarer** medium, it bends away from the normal.

⇒ **Laws of Refraction of Light**:

1. First Law: The incident ray, the refracted ray, and the normal — all lie in the same plane at the point of incidence.
2. Second Law (Snell's Law): The ratio of the sine of the angle of incidence (i) to the sine of the angle of refraction (r) is constant for a given pair of media.
   That is:

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

where μ is the refractive index of the second medium relative to the first.

⇒ **Relative Refractive Index**: The relative refractive index of medium 2 with respect to medium 1 is the ratio of the speed of light in medium 1 to the speed of light in medium 2.

$$\mu_{21} = \frac{\text{Speed of light in medium 1}}{\text{Speed of light in medium 2}} = \frac{v_1}{v_2}$$

where: μ_{21} = Refractive index of medium 2 with respect to medium 1

Absolute Refractive Index: If medium 1 is vacuum or air, then the refractive index of medium 2 is considered with respect to vacuum. This is called the absolute refractive index of the medium.

If c is the speed of light in air and v is the speed of light in the medium, then, the refractive index of the medium n_m is given by

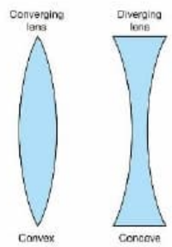
$$n_m = \frac{\text{Speed of light in air}}{\text{Speed of light in the medium}} = \frac{c}{v}$$

The absolute refractive index of a medium is simply called its refractive index.

⇒ **Optical Density**: Optical Density refers to how much a medium slows down the light passing through it.

- A more optically dense medium slows down light more.
- A less optically dense medium slows down light less.
- Optical density is not the same as mass density.
- A medium can have low mass density but still be optically dense (example: water vs glass).

⇒ **Spherical Lenses**: Spherical lenses are transparent optical devices made by joining two spherical surfaces (or one spherical and one flat surface). They are used to converge or diverge light rays.



⇒ **Types of Spherical Lenses**:

- Convex Lens (Converging lens) – thicker in the middle.
- Concave Lens (Diverging lens) – thinner in the middle.

⇒ **Terms Related to Spherical Lens**:

Optical Centre (O):

- The central point of the lens.
- A ray passing through it goes undeviated (without bending).

Principal Axis:

- A straight line passing through the optical centre and the centres of curvature.
- It's the main reference line for the lens.

Centre of Curvature (C_1 and C_2):

- The centres of the two imaginary spheres from which the lens surfaces are part.
- Each curved surface has its own centre of curvature.

Radius of Curvature (R_1 and R_2):

- The radius of the spheres of which the lens surfaces are a part.

Focus (F_1 and F_2):

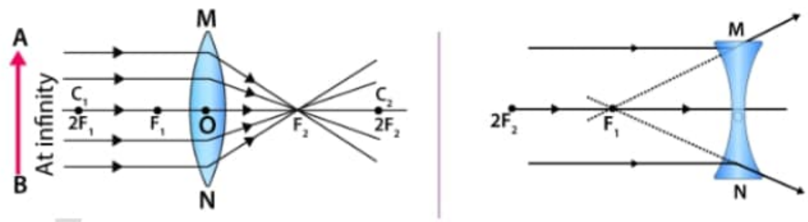
- Points on the principal axis where light rays parallel to the axis either converge (convex lens) or appear to diverge from (concave lens) after refraction.

Focal Length (f):

- The distance between the optical centre and the principal focus.

⇒ **Principal Focus**:

- **Principal Focus of Convex Lens** (Converging Lens): The principal focus is the point on the principal axis where light rays parallel to the principal axis actually meet after refraction.
- **Principal Focus of Concave Lens** (Diverging Lens): The principal focus is the point on the principal axis from which light rays parallel to the principal axis appear to diverge after refraction (the focus is virtual).



⇒ **Types of Rays Used in Image Formation by Spherical Lenses**

- **Parallel Ray**: A ray of light parallel to the principal axis of the lens.
  - Convex Lens: It refracts through the focal point (on the opposite side).
  - Concave Lens: It diverges away from the focal point (on the same side as the object).
- **Central Ray**: A ray of light that passes through the center of the lens (optical center).
  - Both Convex and Concave Lenses: This ray travels in a straight line without bending.
- **Focal Ray**: A ray that passes through the focal point (on the object side of the lens).
  - Convex Lens: It refracts parallel to the principal axis.
  - Concave Lens: It diverges parallel to the principal axis after passing through the focal point.

⇒ **Image Formation by Convex Lenses**:

Object Position	Image Position	Image Nature	Image Size
At infinity	At focus (F_2)	Real, inverted	Highly diminished
Beyond $2F_1$	Between F_2 and $2F_2$	Real, inverted	Diminished
At $2F_1$	At $2F_2$	Real, inverted	Same size
Between F_1 and $2F_1$	Beyond $2F_2$	Real, inverted	Enlarged
At F_1	At infinity	Real, inverted	Highly enlarged
Between lens and F_1	Same side of the lens	Virtual, upright	Enlarged

⇒ **Uses of Convex Lenses:**

- **Magnifying Glass**: A convex lens is used to magnify small objects when held close to them, producing a larger, upright, and virtual image.
- **Corrective Lenses for Hyperopia** (Farsightedness): Convex lenses help people with farsightedness by converging light rays before they reach the retina, allowing for clear near vision.
- **Cameras**: In camera systems, convex lenses are used to focus light and form sharp, real images on film or digital sensors.
- **Microscopes**: Convex lenses are used in both the objective and eyepiece of a microscope to magnify tiny specimens by forming enlarged images.
- **Telescopes**: Convex lenses are used in telescopes to gather and focus light from distant celestial objects, making them appear closer and clearer.
- **Projectors**: A convex lens is used to project an enlarged, real, and inverted image of a small slide or film onto a screen.
- **Human Eye**: The natural lens in the human eye is convex, and it focuses incoming light onto the retina to form clear images.

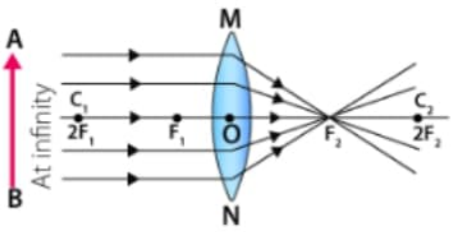
⇒ **Image Formation by Concave Lenses**

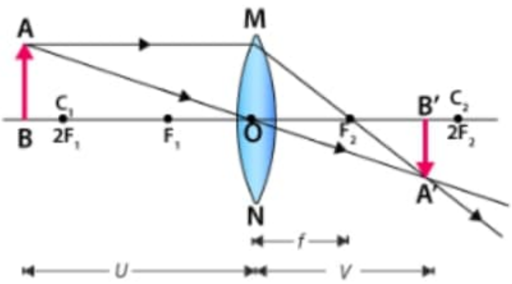
Object Position	Image Position	Image Nature	Image Size
At infinity	At focus (F_1) on same side	Virtual, upright	Highly diminished
At any finite distance	Between optical center (O) and focus (F_1) on same side	Virtual, upright	Diminished

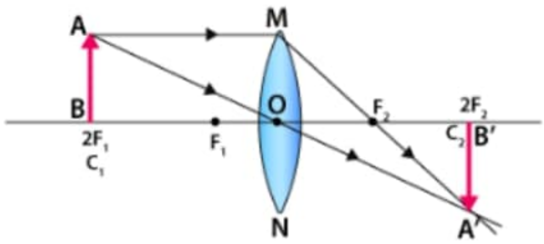
⇒ **Uses of Concave Lenses:**

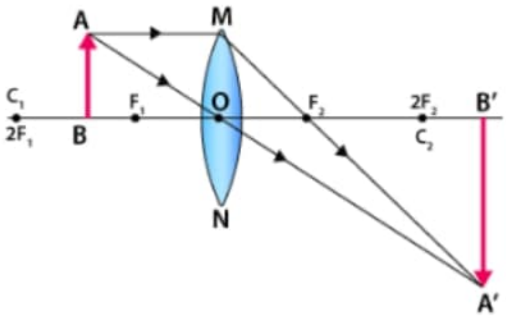
- **Corrective Lenses for Myopia** (Nearsightedness): Concave lenses help people with myopia by diverging incoming light rays so they can be properly focused on the retina.
- **Peepholes** (Door Viewers): Concave lenses are used in peepholes to provide a wider field of view, allowing people to see a broad area outside the door.
- **Laser Devices**: Concave lenses are used to expand laser beams or to make them parallel by diverging the light rays.
- **Flashlights and Torches**: Concave lenses help spread the light over a wider area for broader illumination.

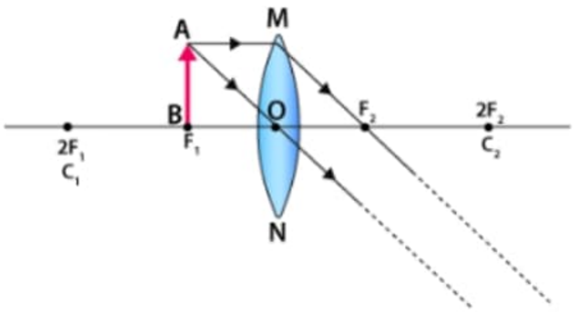
- **Optical Instruments** (like Galilean Telescopes): Concave lenses are used in combination with convex lenses to adjust and correct image formation in compact telescope designs.
- **Camera Viewfinders**: Some viewfinders use concave lenses to adjust the focal length and provide a correct view through the lens system.

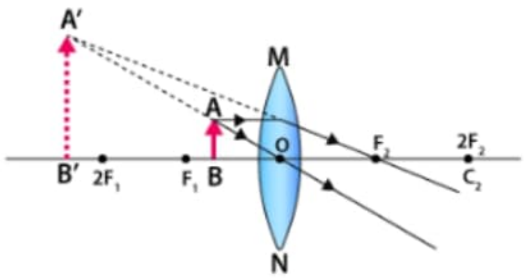


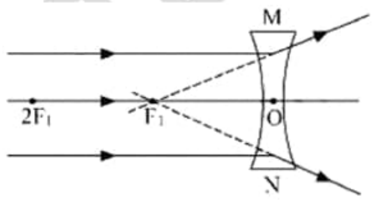


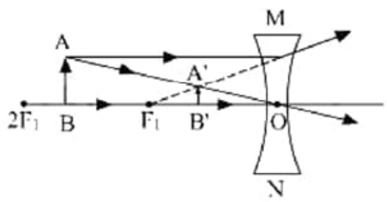












⇒ **Sign Convention for Spherical Lenses:**