Light

Spherical Mirrors

(a) Concave mirror (b) Convex mirror

1. The centre of the reflecting surface of a spherical mirror is a point called the **pole**.
2. The reflecting surface of a spherical mirror forms a part of a sphere. It's center is called **center of curvature.**
3. The centre of curvature of a concave mirror lies in front of it. It lies behind the mirror in case of a convex mirror.

Laws of reflection:

(i) The angle of incidence is equal to the angle of reflection.

(ii) The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane.

Image Formation by Spherical Mirrors

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

1. In torches, search-lights and vehicles headlights to get powerful parallel beams of light.
2. In shaving mirrors
3. The dentists use concave mirrors to see large images of the teeth of patients.
4. Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

Uses of convex mirrors

Rear-view (wing) mirrors in vehicles. These mirrors are fitted on the sides of the vehicle, enabling the driver to see traffic behind him/her to facilitate safe driving. Convex mirrors are preferred because they always give an erect, though diminished, image.

Light

Ray diagrams for the image formation by a concave mirror

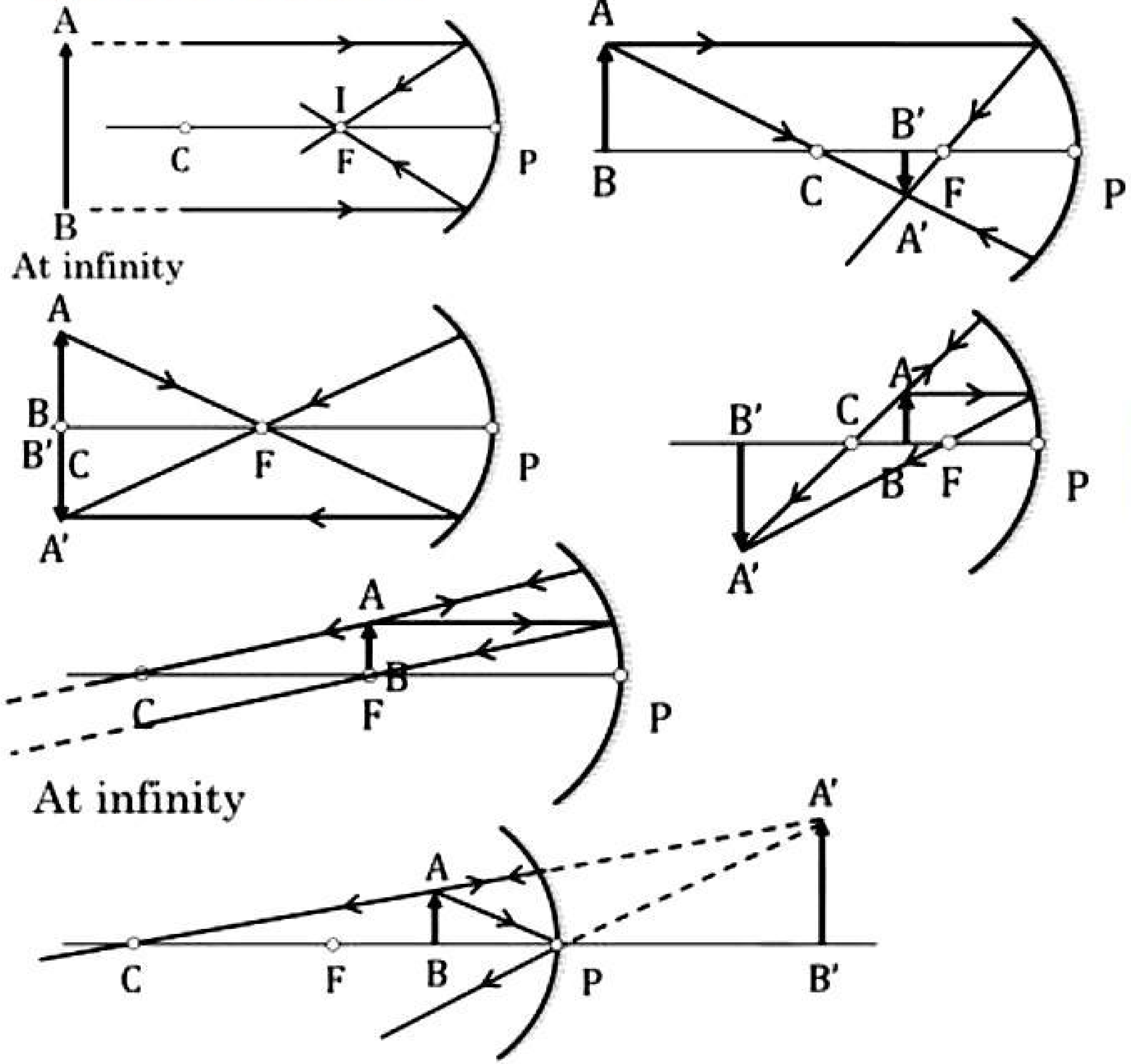


Image formation by a concave mirror

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

Ray diagrams for the image formation by a convex mirror

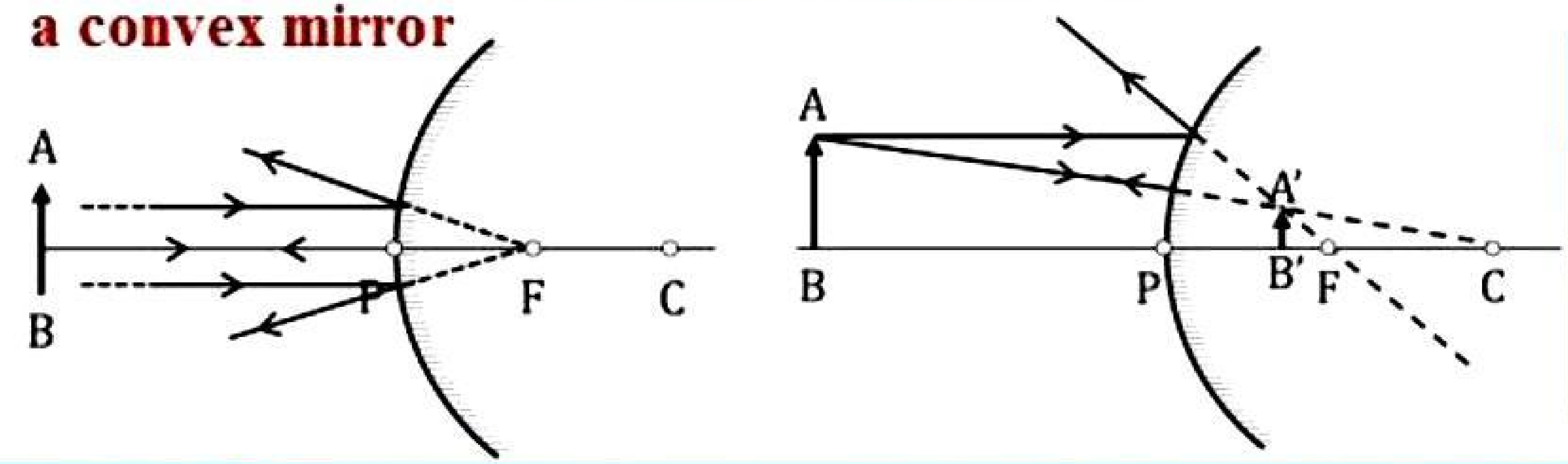
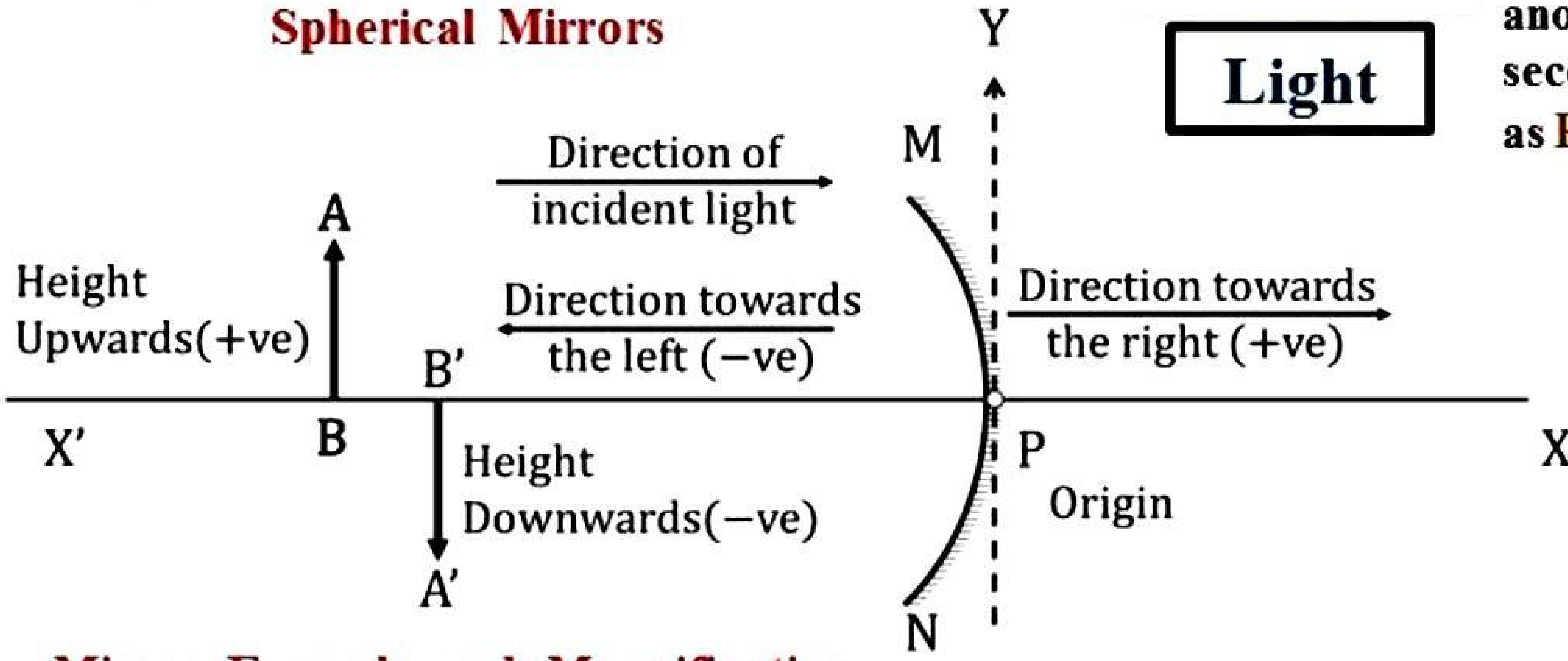


Image formation by a convex mirror

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

Light

Sign Convention for Reflection by Spherical Mirrors



Mirror Formula and Magnification

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

The distance of the image from the pole of the mirror is called the image distance (v).

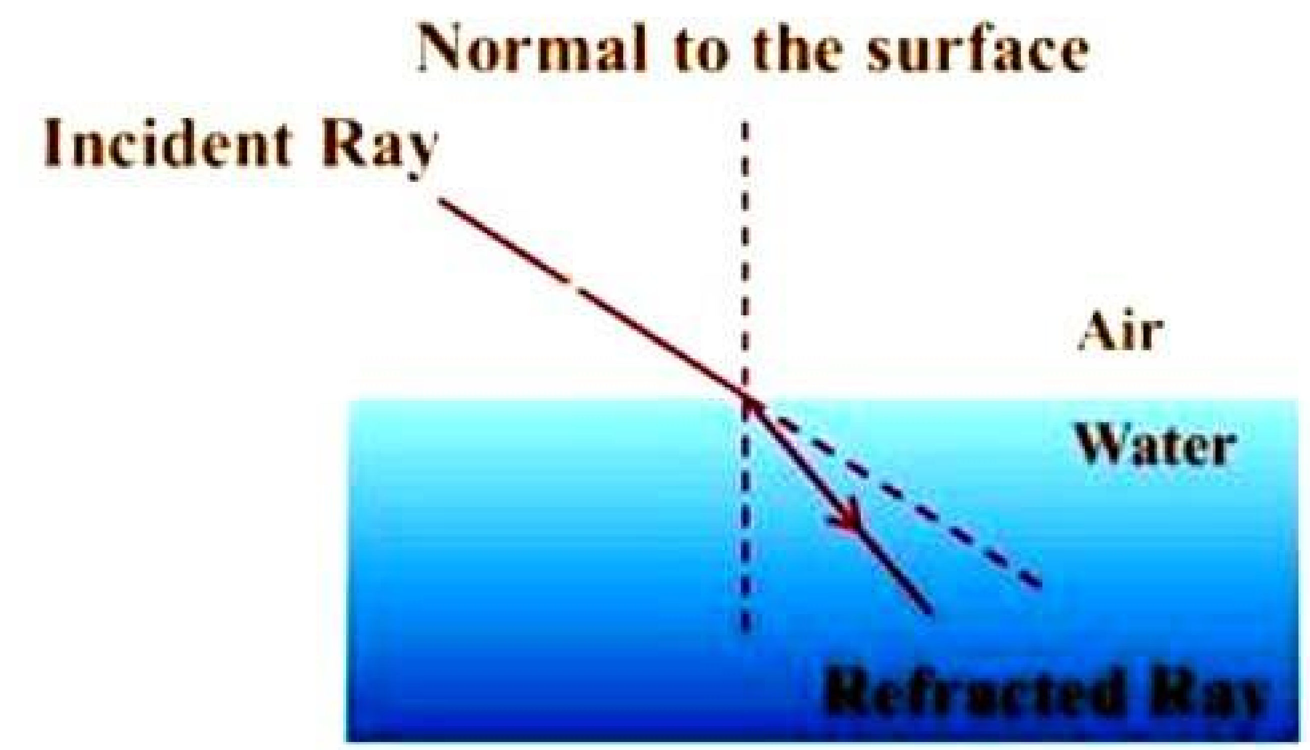
In a spherical mirror, the distance of the object from its pole is called the object distance (u).

The distance of the principal focus from the pole is called the focal length(f).

Magnification

$$m = \frac{\text{height of image}}{\text{height of object}} = -\frac{v}{u}$$

When travelling obliquely from one medium to another, the direction of propagation of light in the second medium changes. This phenomena is known as Refraction of light.



Speed of light in vacuum = 3 x 108 m/s

Speed of light in air is slightly less than 3 x 108 m/s ≈ 3 x 108 m/s

Refractive Index of Medium

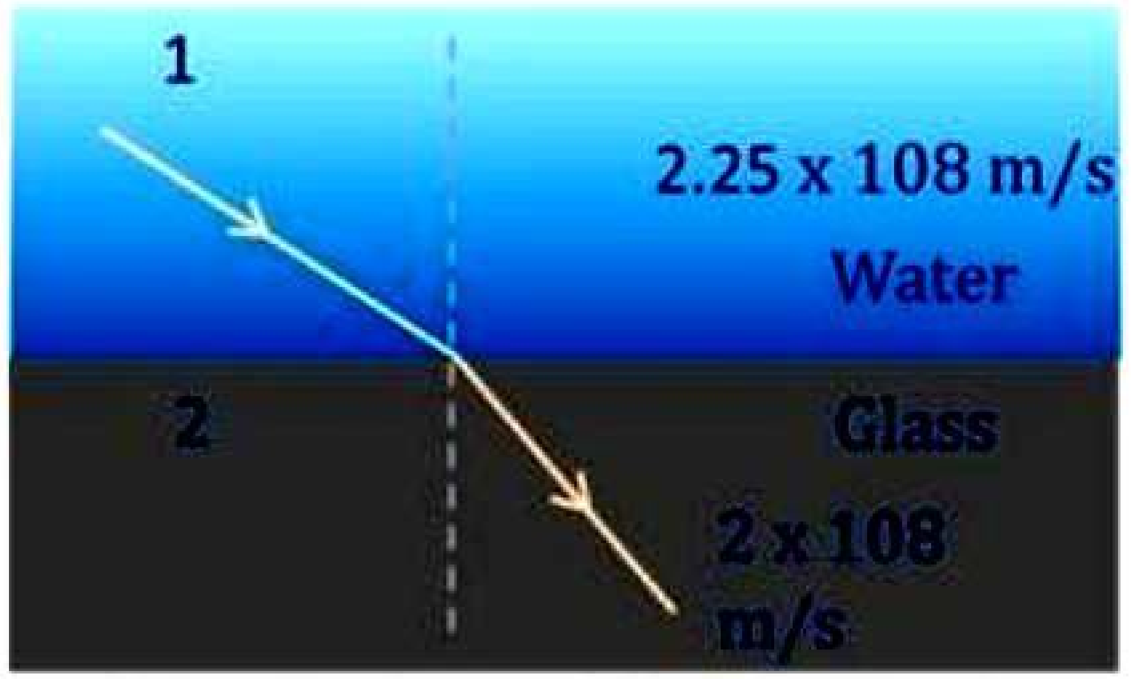
It is ratio of speed of light in vacuum and speed of light in that medium.

$$n_m = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in the medium}} = \frac{c}{v_m}$$

Refractive index has no unit as it is ratio of same quantities.

Light

Relative refractive index of medium 1 with respect to medium 2



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

$$n_{12} = \frac{\text{Speed of light in medium 2}}{\text{Speed of light in the medium 1}} = \frac{v_2}{v_1}$$

$$n_{21} = \frac{1}{n_{12}}$$

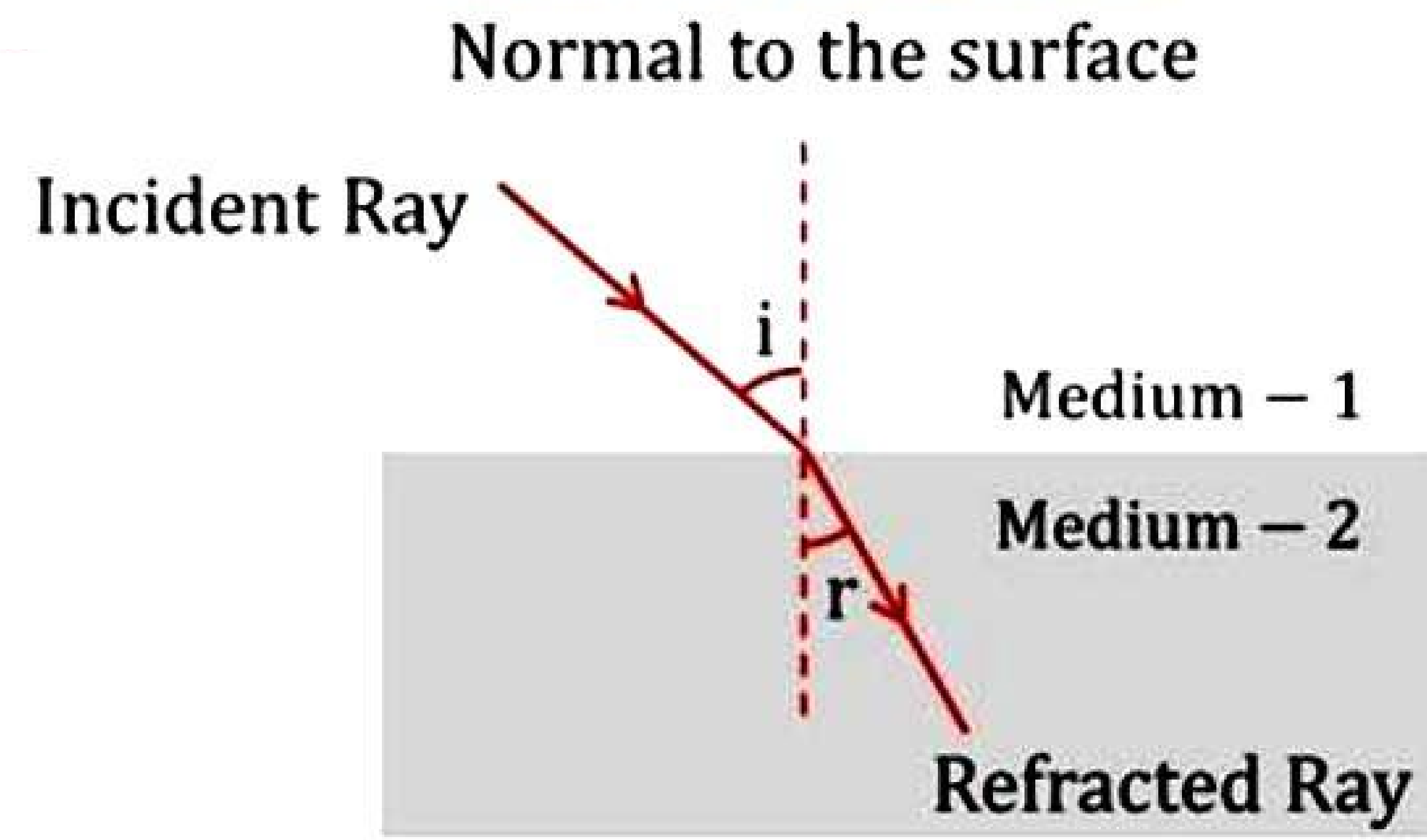
Optical Density

In comparing two media, the one with higher refractive index is said to be Optically Denser than the other.

Speed of light is lesser in optically denser medium than in optically rarer medium

$$n_m = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in the medium}}$$

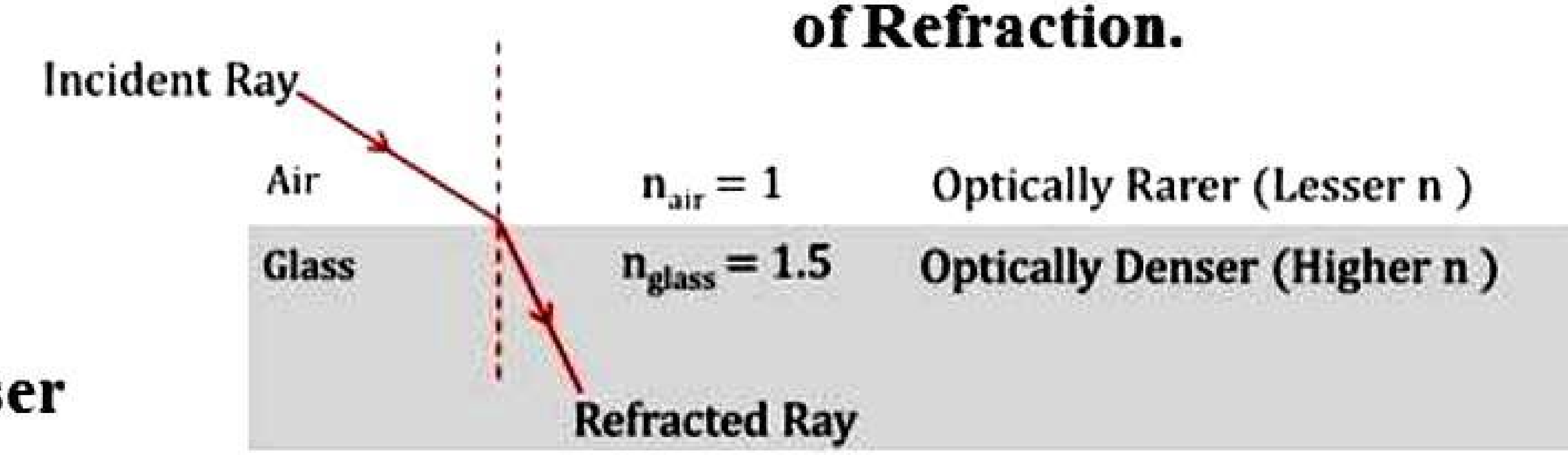
Laws Of Refraction



1. 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.

2. The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given colour and for the given pair of media. This law is also known as Snell's law of Refraction.

$$\frac{\sin i}{\sin r} = \text{constant} = n_{21}$$



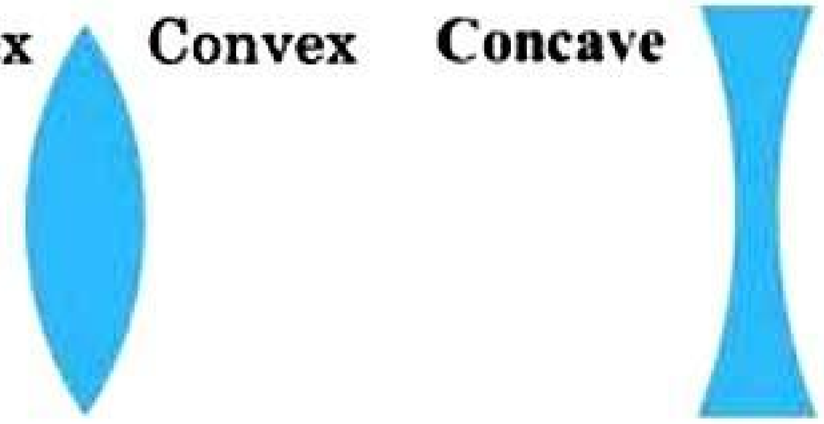
When light travels from optically rarer to denser then it bends towards the normal.

When light travels from optically denser to optically rarer then it bends away from the normal.

Refraction by Spherical Lenses

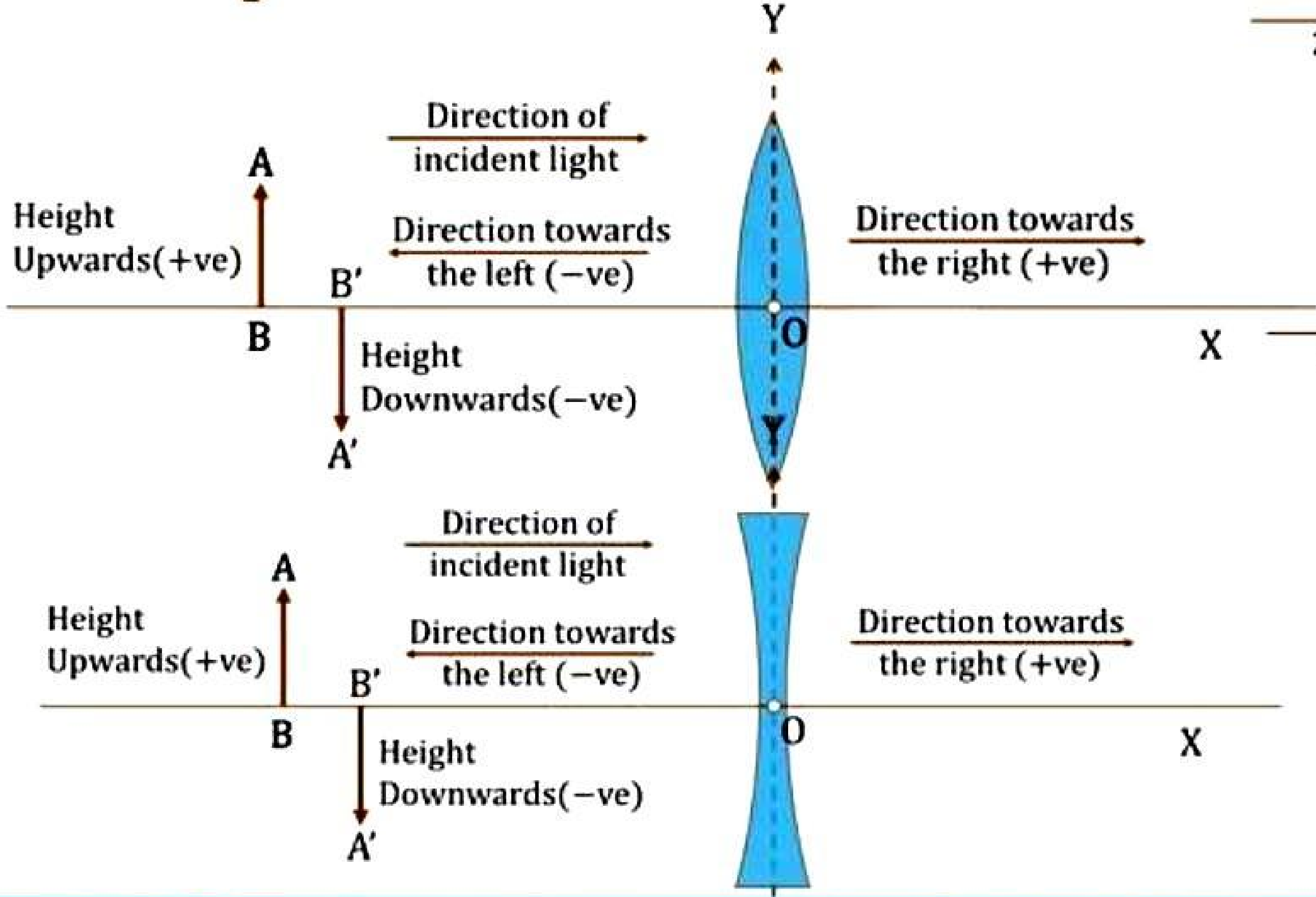
A transparent material bounded by two surfaces, of which one or both surfaces are spherical, forms a lens.

A lens may have two spherical surfaces, bulging outwards. Such a lens is called a double convex lens.



A lens may have two spherical surfaces, curved inwards. Such a lens is called a double concave lens.

Sign Convention for Lens



Light

Image formation by convex Lenses

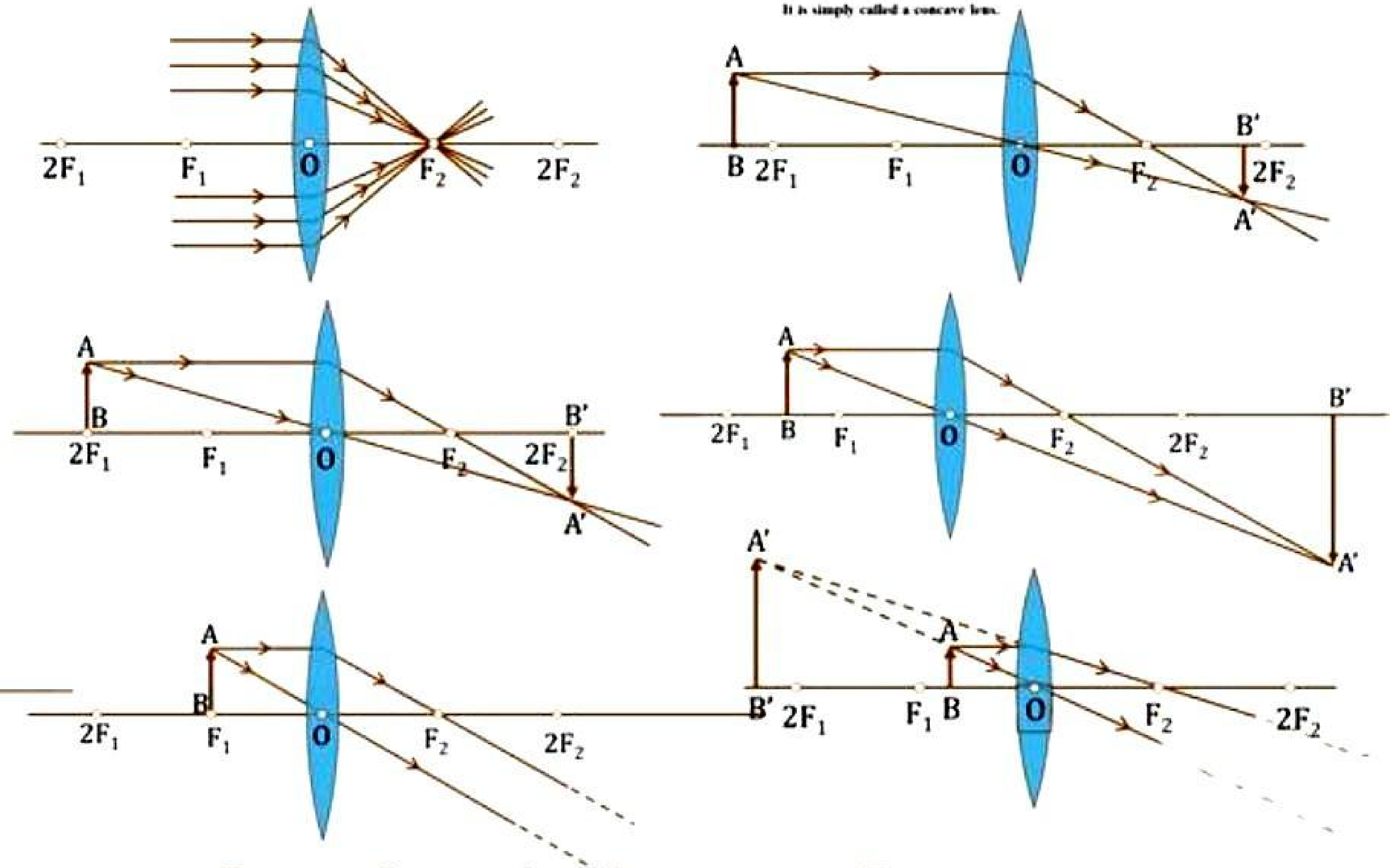
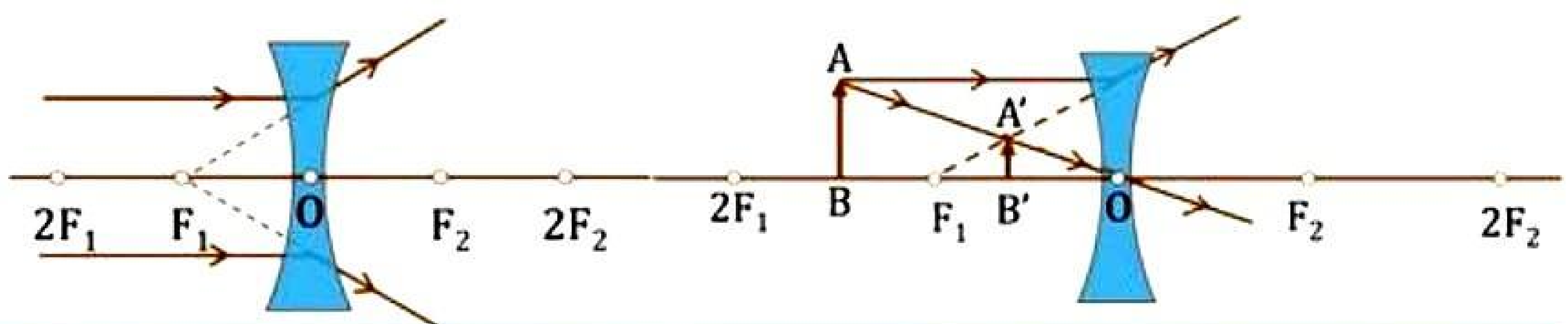


Image formation by concave Lenses



Lens Formula and Magnification

This formula gives the relationship between object- distance (u), image-distance (v) and the focal length (f). The lens formula is expressed as

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

Magnification

defined as the ratio of the height of the image and the height of the object. Magnification is represented by the letter m.

$$m = \frac{\text{Height of the Image}}{\text{Height of the object}} = \frac{h'}{h}$$

Magnification produced by a lens is also related to the object-distance u, and the image-distance v. This relationship is given by

$$\text{Magnification } (m) = h'/h = v/u$$

Light

Power of a Lens

The degree of convergence or divergence of light rays achieved by a lens is expressed in terms of its power.

The power of a lens is defined as the reciprocal of its focal length. It is represented by the letter P.

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

The SI unit of power of a lens is 'dioptre'

It is denoted by the letter D

1 dioptre is the power of a lens whose focal length is 1 metre. $1D = 1m^{-1}$.