Al-Mustaqbal University

Department of Optics Techniques

Medical and optical physics 1

First stage

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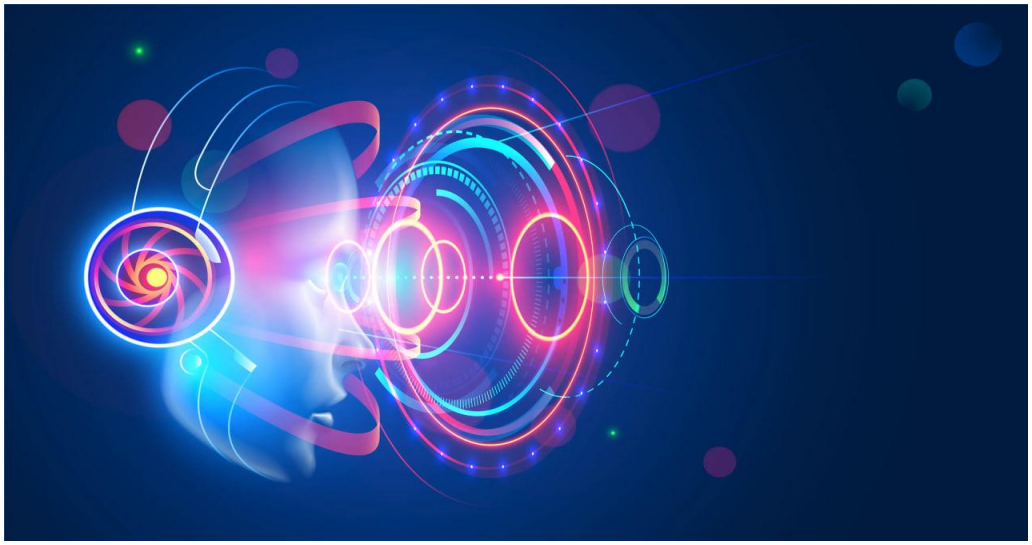


➢Lecture 8 Lenses

Introduction: Lenses in physics are fundamental optical tools that manipulate light, allowing for the focusing, magnification, and reshaping of images. The behavior of lenses is governed by the laws of geometric optics, The introduction of lenses in physics marked a significant advancement in our understanding and utilization of light.

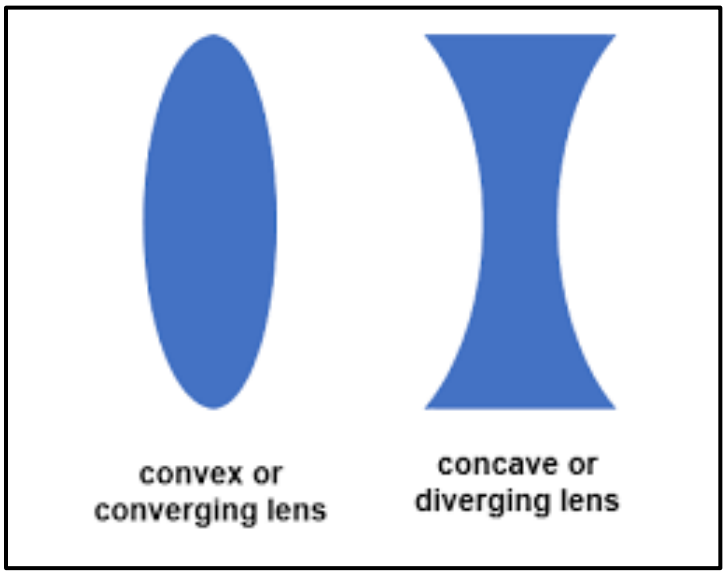
Lenses are not only essential for understanding the behavior of light but also have practical applications in various fields such as photography, microscopy, astronomy, and vision correction. The study of lenses in physics has led to significant technological advancements and has deepened our understanding of the nature of light and vision.

Lenses: A lens is a transmissive tool device that focuses or disperses light beams using refraction. A simple lens consists of a single piece of transparent material, while compound lenses consist of several simple lenses arranged along with a common axis. A lens can focus light to form an image, unlike a prism, which refracts light without focusing.

Types of lenses

The lens classification depends on how the light rays bend when they pass through the lens. There are two primary types of lenses:

- **Convex Lens (Converging)**
- **Concave Lens (Diverging)**
- **Convex (or converging) lenses:** These lenses are thicker at the center than at the edges. They converge light rays to a focal point after refraction. Convex lenses are commonly used in magnifying glasses, cameras, and telescopes.
- **Concave (or diverging) lenses:** These lenses are thinner at the center than at the edges. They diverge light rays away from a focal point after refraction. Concave lenses are often used in correcting vision problems like nearsightedness (myopia).



Lenses have several fundamental properties and characteristics:

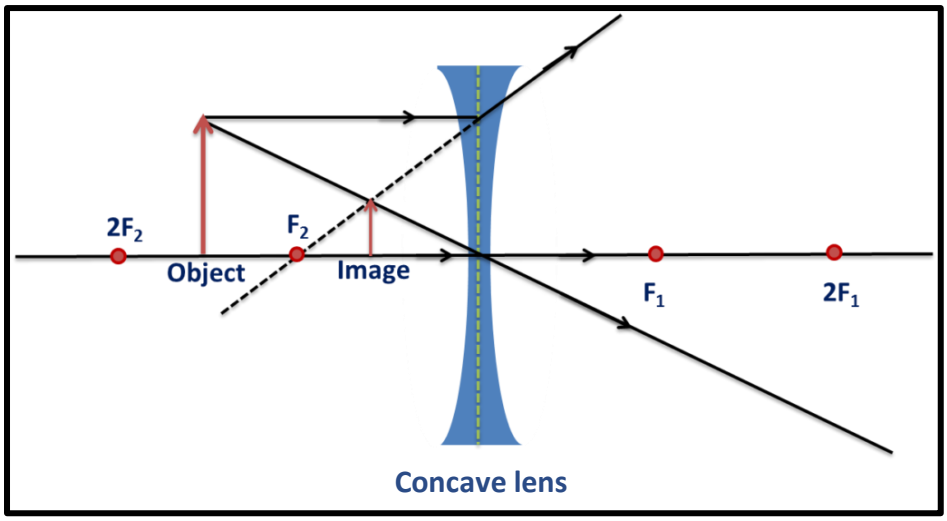
- **Pole (p)**: It is the middle point of the spherical lens or mirror.
- **Centre of curvature (C):** It is the center of the sphere from which the lens is formed.
- **Principal axis:** It is the lines passing through the pole and the center of curvature of the lens.
- **Principal focus (F**): It is the point at which a narrow beam of light converges or diverges.
- **Focal length (f):** It is the distance between the focus and the poles of the mirror.

Image formed by the Lens

The image formed by a lens can be real or virtual, and its characteristics depend on the position of the object relative to the lens and the type of lens used:

➢ Image Formation by Concave Lens:

In case of the concave lens, we always get erect images, diminished images and virtual images.



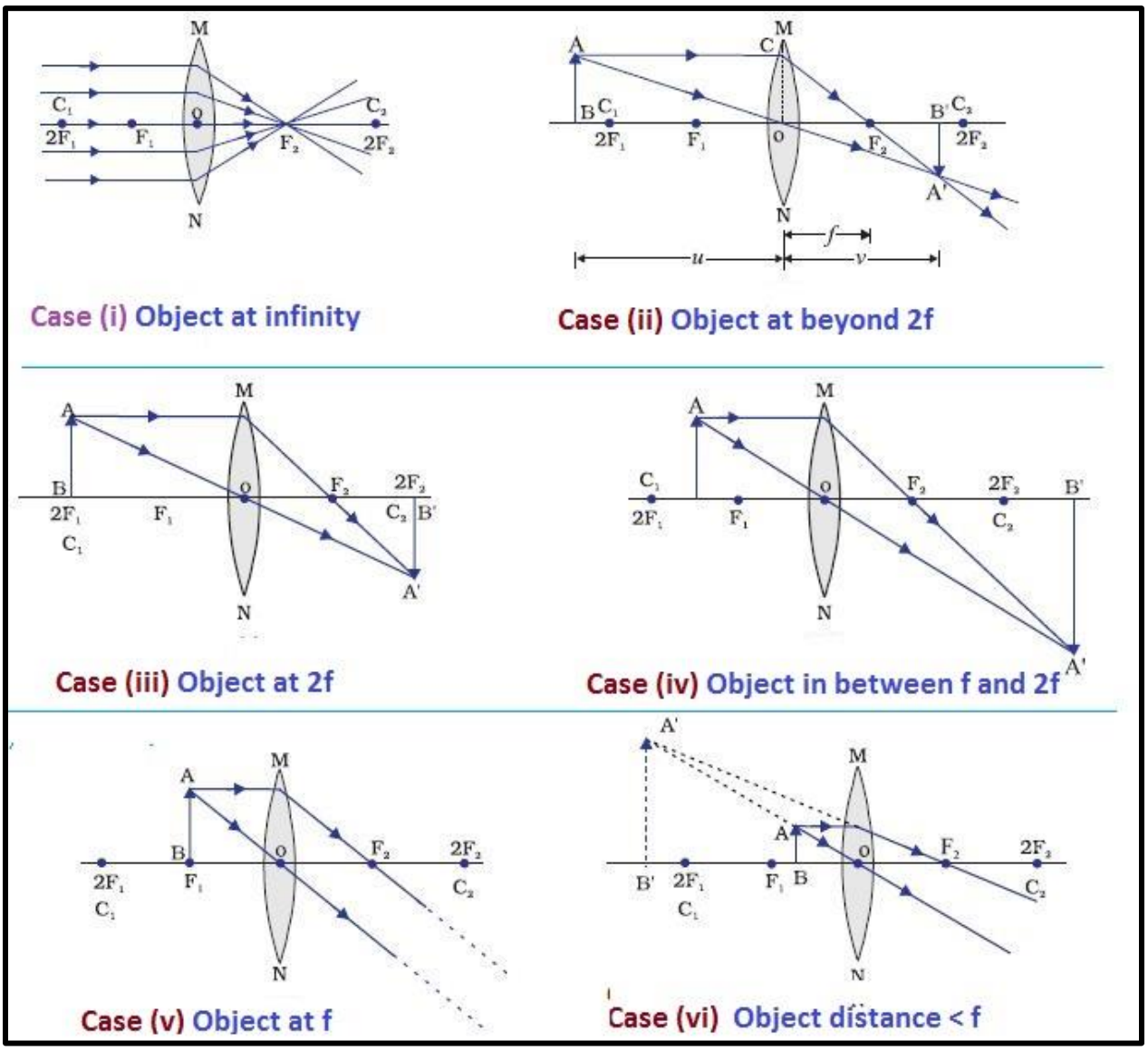
Object location	Image location	Image nature	Image size
Infinity	**At F_2**	**Virtual and Erect**	**Highly Diminished**
Beyond infinity and 0	**Between F_1 and Optical center**	**Virtual and Erect**	**Diminished**

Here if the object is very far away, the images formed by lenses will be all the more diminished.

➢ Image Formation by Convex Lens :

The convex lens, also known as the convex lens. It is a tool that works to collect (focus) the light beam to a specific position at the optical axis of the lens, which is called the focal length of the lens (focal length f). By assembling the light beam, it allows it to create real and imaginary images depending on the position of the object relative to the lens. Here are the different cases:

Object location	Image location	Image nature	Image size
Infinity	At F_2	Real and Inverted	Diminished
Beyond $2F_1$	Between $2F_2$ and F_2	Real and Inverted	Diminished
Between $2F_1$ and F_1	Beyond $2F_2$	Real and Inverted	Enlarged
At F_1	At infinity	Real and Inverted	Enlarged
At 2 F_1	At $2F_2$	Real and Inverted	Same size
Between F_1 and 0	On the same side as object	Virtual and Erect	Enlarged


M
C1
2F1
F1
O
F2
C2
2F2
N
A
C
B
B'
A'
u
f
v
Case (i) Object at infinity
Case (ii) Object at beyond 2f
Case (iii) Object at 2f
Case (iv) Object in between f and 2f
Case (v) Object at f
Case (vi) Object distance < f