Lenses

Introduction to Lenses

A lens is a transparent, curved surface made of high-quality glass or transparent plastic that helps bend and focus light. Lenses are widely used in everyday objects such as spectacles, cameras, telescopes, and magnifying glasses. The human eye also contains a natural lens that helps form images on the retina.

Types of Lenses

Lenses are primarily of two types:

i. Convex Lens (Converging Lens)

- Thicker in the middle than at the edges.
- Converges (brings together) light rays passing through it.
- Forms real or virtual images depending on the object's position.
- Used in magnifying glasses, microscopes, telescopes, and cameras.

ii. Concave Lens (Diverging Lens)

- Thicker at the edges than in the middle.
- Diverges (spreads out) light rays passing through it.
- Always forms a virtual, diminished, and erect image.
- Used in spectacles for correcting myopia (nearsightedness) and in some telescopes.

Why Do Objects Appear Larger in Water?

Lemons and decorative marbles in a transparent circular container filled with water appear larger due to the magnifying action of water, which behaves like a convex lens. The refraction of light through the curved surface creates a magnified view of the objects.

Image Formation by a Convex Lens

A convex lens can form different types of images depending on the position of the object. The following table summarizes the image characteristics:

Position of Object	Position of Image	Size of Image	Nature of 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 (highly enlarged)	Real and inverted
Between focus F_1 and optical center O	On the same side as the object	Enlarged	Virtual and erect

Diagram Representations

i. **Object at Infinity** → Image at Focus F_2 (highly diminished, real, and inverted)

ii. **Object beyond $2F_1$** → Image between F_2 and $2F_2$ (diminished, real, and inverted)

iii. **Object at $2F_1$** → Image at $2F_2$ (same size, real, and inverted)

iv. **Object between F_1 and $2F_1$** → Image beyond $2F_2$ (enlarged, real, and inverted)

v. **Object at Focus F_1** → Image at infinity (highly enlarged, real, and inverted)

vi. **Object between Focus F_1 and Optical Center O** → Image on the same side as object (enlarged, virtual, and erect)

Uses of Convex Lenses

i. **In Cameras:** Used in all types of cameras except pinhole cameras to focus light.

ii. **In Microscopes & Telescopes:** Used to magnify distant or microscopic objects.

iii. **In Spectacles:** Used for correcting hypermetropia (farsightedness).

Image Formation by a Concave Lens

A concave lens always forms a virtual, diminished, and erect image regardless of the object's position.

Position of Object	Position of Image	Size of Image	Nature of Image
At infinity	At focus F_1	Highly diminished (point-sized)	Virtual and erect
Between infinity and optical center O	Between focus F_1 and optical center O	Diminished	Virtual and erect

Diagram Representations

Object at Infinity → Image at Focus F_1 (highly diminished, virtual, and erect)

Object between Infinity and Optical Center O → Image between F_1 and Optical Center (diminished, virtual, and erect)

Uses of Concave Lenses

In Galileo's Telescope: Helps in viewing distant objects.

In Spectacles: Used for correcting myopia (nearsightedness).

Did You Know?

- The human eye contains a convex lens made of a transparent, jelly-like material that helps focus light onto the retina.
- The principle of lens magnification is used in various optical instruments, including projectors and magnifying glasses.