كلية المستقبل الجامعة

قسم تقنيات البصريات

الفيزياء الطبية والبصرية

المرحلة الاولى

المحاضرة الرابعة

Department of Optics Techniques

Lecture 4

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lenses

A lens is a transmissive optical device which focuses or disperses a light beam by means of refraction. A simple lens consists of a single piece of transparent material, while a compound lens consists of several simple lenses (elements), usually arranged along a common axis. Lenses are made from materials such as glass or plastic, and are ground and polished or molded to a desired shape. A lens can focus light to form an image, unlike a prism, which refracts light without focusing. Devices that similarly focus or disperse waves and radiation other than visible light are also called lenses, such as microwave lenses, electron lenses, acoustic lenses, or explosive lenses.

Lenses are used in various imaging devices like telescopes, binoculars and cameras. They are also used as visual aids in glasses to correct defects of vision such as myopia and hypermetropia.

types of lenses : -

The two main types of lenses are:

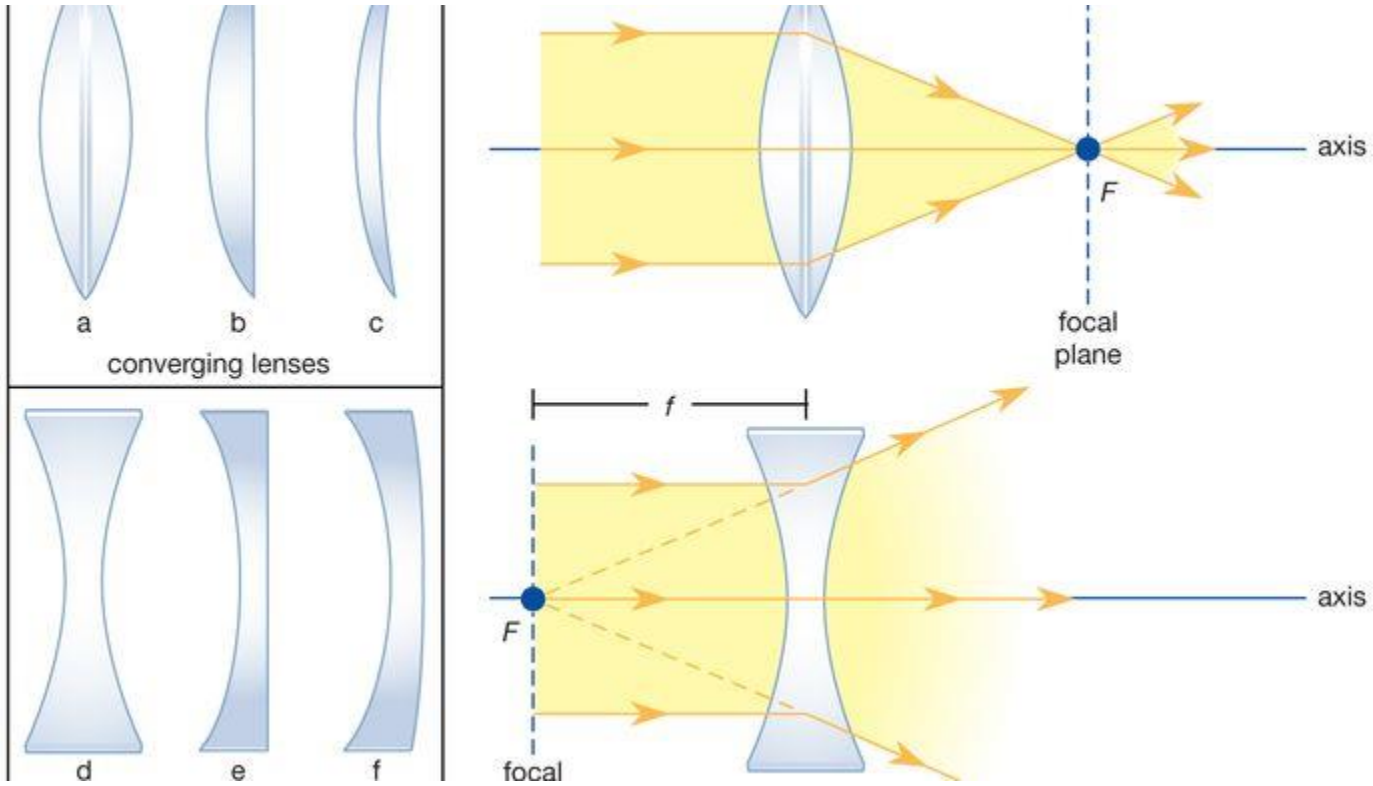
- Convex Lens (Converging)
- Concave Lens (Diverging)

.Convex (Converging) lens -: Convex lenses are thick in the middle and thinner at the edges. A convex lens is also known as the converging lens because it converges parallel light rays inwards to a point known as the focal point.

- **Concave Lens (Diverging)** :- Concave lenses are thinner in the middle and thicker at the edges. concave lens is called a diverging lens because A light ray entering a concave lens diverges making the lens act like a diverging lens.

Optical principles for lenses

A lens produces its focusing effect because light travels more slowly in the lens than in the surrounding air, so that refraction, an abrupt bending, of a light beam occurs both where the beam enters the lens and where it emerges from the lens into the air.



A single lens has two precisely regular opposite surfaces; either both surfaces are curved or one is curved and one is plane. Lenses may be classified according to their two surfaces as biconvex, plano-convex, concavo-convex (converging meniscus), biconcave, plano-concave, and convexo-concave (diverging meniscus). Because of the curvature of the lens surfaces, different rays of an incident light beam are refracted through different angles, so that an entire beam of parallel rays can be caused to converge on, or to appear to diverge from, a single point. This

point is called the focal point, or principal focus, of the lens (often depicted in ray diagrams as F). Refraction of the rays of light reflected from or emitted by an object causes the rays to form a visual image of the object. This image may be either real—photographable or visible on a screen—or virtual—visible only upon looking into the lens, as in a microscope. The image may be much larger or smaller than the object, depending on the focal length of the lens and on the distance between the lens and the object. The focal length of a lens is the distance from the centre of the lens to the point at which the image of a distant object is formed. A long-focus lens forms a larger image of a distant object, while a short-focus lens forms a small image.

Lens Equation

the lens equation expresses the quantitative relationship between the object distance (u), the image distance (v), and the focal length (f). The equation is stated as follows:

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

the magnification equation is stated as follows:

$$M = \frac{h^-}{h} = -\frac{v}{u}$$

These two equations can be combined to yield information about the image distance and image height if the object distance, object height, and focal length are known.

Problem 1

A 4.00-cm tall light bulb is placed a distance of 45.7 cm from a double convex lens having a focal length of 15.2 cm. Determine the image distance and the image size.

Problem 2

A 4.00-cm tall light bulb is placed a distance of 35.5 cm from a diverging lens having a focal length of -12.2 cm. Determine the image distance and the image size.