# Al-Mustaqbal University

## Department of Optics Techniques

## Medical and optical physics 1

## First stage

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# Lenses

**Introduction:** Lenses are one of the most important optical tools used in many applications such as eyeglasses, microscopes, telescopes, cameras, vision correctio, etc.

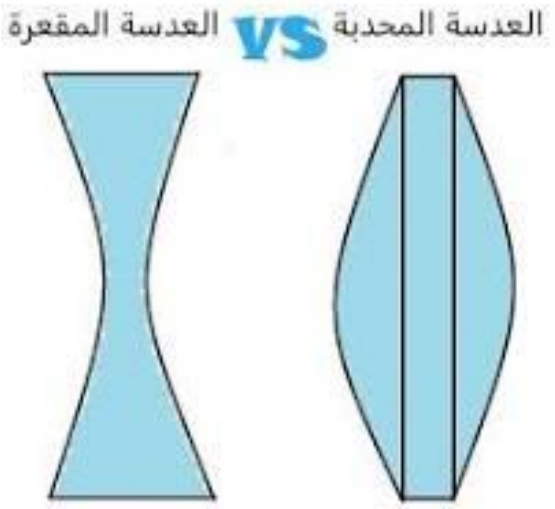
## Types of Lenses:

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 Lenses (Converging lenses):** These lenses are thicker in the middle and thinner at the edges. They focus light to a point and are often used in magnifying glasses, microscopes, and cameras, corrective eyewear for hyperopia.

**Concave Lenses (Diverging lenses):** These lenses are thinner in the middle and thicker at the edges. They spread light rays apart and are used in applications like corrective eyewear for myopia.

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## how lenses work:

Lenses work based on the principle of **refraction**, which is the bending of light when it passes from one medium to another with a different density (like from air to glass or plastic). The lens determines how light is bent, and this bending can focus or spread the light to form images.

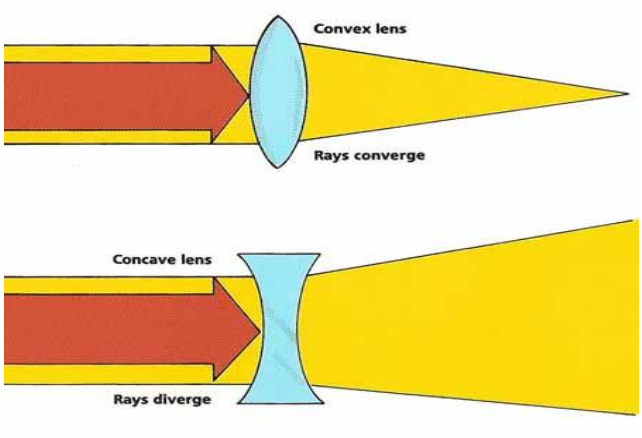
### 1. Refraction of Light

When light travels from air (or another medium) into a lens (usually made of glass or plastic), the change in the light's speed causes it to bend at the surface of the lens. This bending is called **refraction**.

### 2. Focal Point

The bending of light at the lens's surface causes the rays to either converge or diverge, depending on the type of lens. The point where these rays meet (for converging lenses) or appear to meet (for diverging lenses) is called the **focal point**.

**Focal Length**: The distance from the center of the lens to the focal point is known as the focal length. A lens with a shorter focal length will bend light more sharply, creating a stronger focus, while a lens with a longer focal length bends light less sharply.



# Image Formation

When light passes through a lens, it forms an image of the object that the light rays are coming from. The nature of this image depends on:

**1-Type of lens (convex or concave). 2-Distance of the object from the lens.**

## Convex Lenses:

If the object is placed far from the lens (beyond the focal point), the light rays converge and form a **real, inverted** image on the other side of the lens.

If the object is placed closer than the focal point (but still beyond the lens), the light rays don't converge and instead form a **virtual, moderate** image on the same side as the object.

## Concave Lenses:

The image formed by a concave lens is always **virtual , moderate, and smaller** than the object. This is because the light rays diverge and appear to originate from a point behind the lens.

## *Real and Virtual Images*

**Real Image:** This image is formed when light rays converge at a point. Real images are **inverted** (like the image formed on a camera sensor or film).

**Virtual Image:** This image is formed when light rays to diverge from a point, but they don't meet. Virtual images are **moderate**.

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# Lens manufacturing stages

The basic stages of lens manufacturing, whether for cameras, glasses or other optical instruments:

**1. Material selection:**

**Glass:** Provides high optical clarity and scratch resistance, but is heavier than plastic.

**Plastic:** Lightweight, common in eyeglasses.

**2. Curvature Formation:** The shape of the lens is controlled so that it is:-

**Convex:** to collect light.

**Concave:** to scatter light.

**Cylindrical:** to correct astigmatism.

**3.Coatings:** After forming the lens, coatings can be added to improve performance such as:-

**Anti-scratch:** to protect the lens.

**Anti-reflective:** to reduce glare and improve vision.

**UV coating:** to protect the eyes from harmful rays.

**4. Cutting and final shaping:**

If the lens is for eyeglasses, it is cut to fit the frame.

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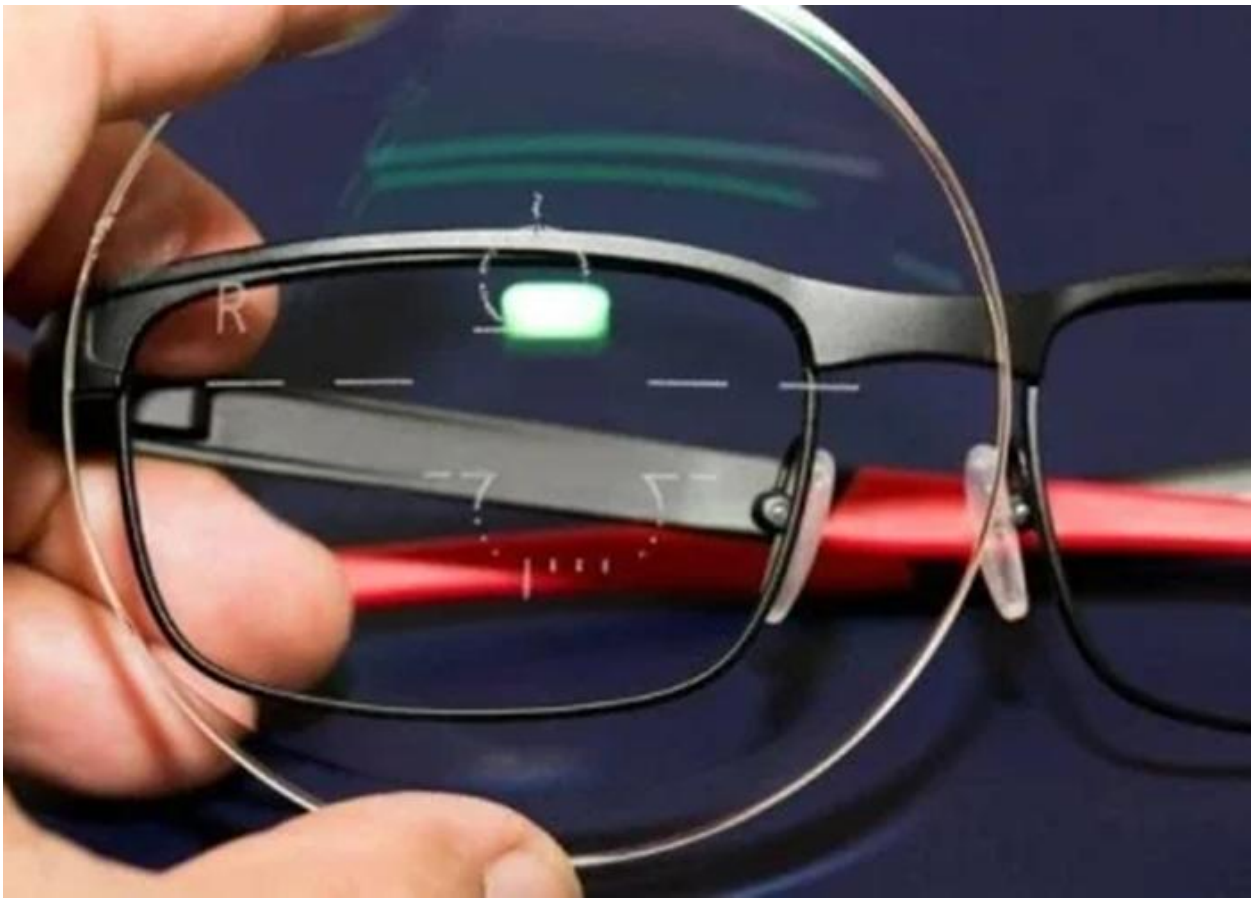
*Most lenses are made from glass or plastic. The material used affects the lens's ability to bend light (its refractive index) and its durability.

Some lenses are coated with special materials to enhance their performance, like anti-reflective coatings or UV protection.

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