

7. Lenses

- Differences between a spherical mirror and a lens:

Spherical mirror	Spherical lens
Image is formed by reflection of light.	Image is formed by refraction of light.
A spherical mirror has only one focus.	A spherical lens has two foci.
The centre of the spherical mirror is termed as its pole.	The centre of the spherical lens is termed as its optical centre.

- Centre of curvature = Centre of the sphere of which the lens surfaces is a part of (Same as Spherical mirror)
- Optical centre is a point at the centre of the lens. It always lies inside the lens and not on the surface
- The straight line joining the two centers of curvature and the optical centre is called the principal axis of the lens.
- Focus = Where parallel rays meet after refraction (On principal axis = principal focus)

- **Convex lens and Image**

- Virtual and erect images – when the object is placed between F1 and the optical centre (Magnifying glass)
- Image size = object size when object at 2F (= Centre of curvature)

- **Concave lens and Image**

- Virtual and erect at all object positions

- **Lens Formula**

For concave lens $f = -ve$

convex lens $f = +ve$

- **Magnification**

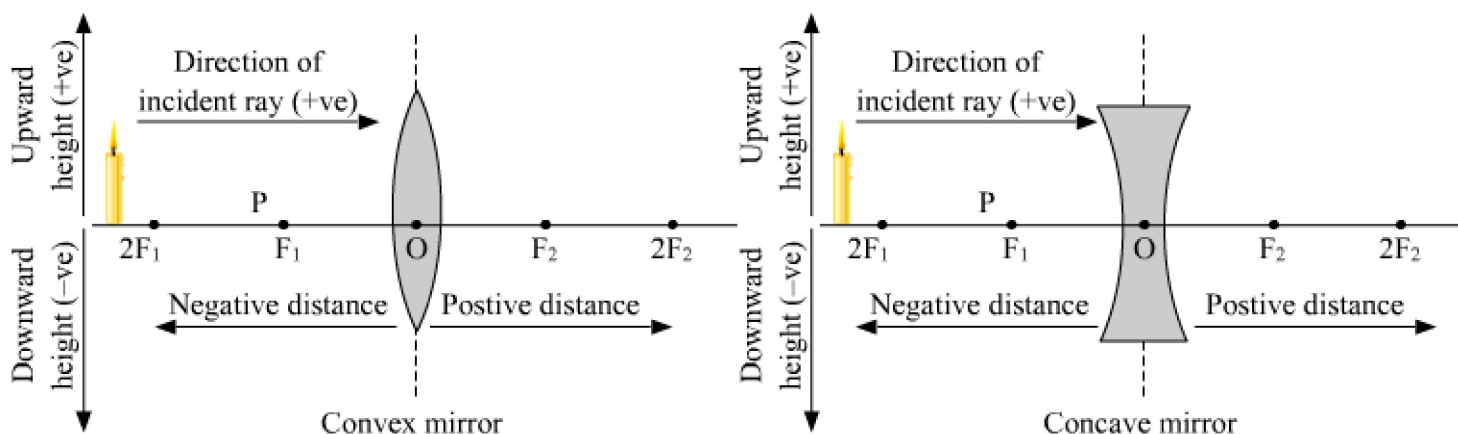
$$m = \frac{\text{Image height}}{\text{Object height}} = \frac{v}{u} \text{ (Same as mirror)}$$

- **Lens power**

$$P \text{ (Unit dioptre)} = \frac{1}{f \text{ (in m)}} \quad f = -ve \text{ for concave}$$

- **Sign Convention for Lenses:**





- **Lens Formula**

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

For concave lens $f = -ve$

convex lens $f = +ve$

- **Magnification**

$$m = \frac{\text{Image height}}{\text{Object height}} = \frac{v}{u} \text{ (Same as mirror)}$$

- **Lens power:** Power of lens is the reciprocal of its focal length.

$$P \text{ (Unit dioptre)} = \frac{1}{f \text{ (in m)}} = -ve \text{ for concave}$$

and + ve for convex lens.

- Vitamin A (raw carrots, broccoli, green vegetables, cod-liver oil, etc.) is necessary for good vision.

- **To protect your eyes, the following points should be remembered:**

- Avoid reading in dim light.
- Wash your eyes at least four times a day with clean and cold water.
- Wash your eyes quickly if dust particles or small insects enter your eye.
- Visit an eye specialist regularly. Improper vision can cause stress, eyestrain, and even headaches.
- While reading, maintain a distance of atleast 25 cm between your eyes and the book.
- Do not rub your eyes. If redness in the eye persists, then consult an eye specialist immediately.
- Avoid direct exposure to sunlight. Exposure to a large amount of light can harm your retina.

- **Power of accommodation**

- Ability of the lens to adjust its focal length
- Thickness of the lens is controlled by ciliary muscles

- Nearest focal distance of lens = 25 cm

- **Defects**

- **Myopia/near-sightedness**

- **Problem:** Distant objects cannot be seen clearly
- Image is formed in front of the retina
- **Correction** –concave lens

- **Hypermetropia/far-sightedness**

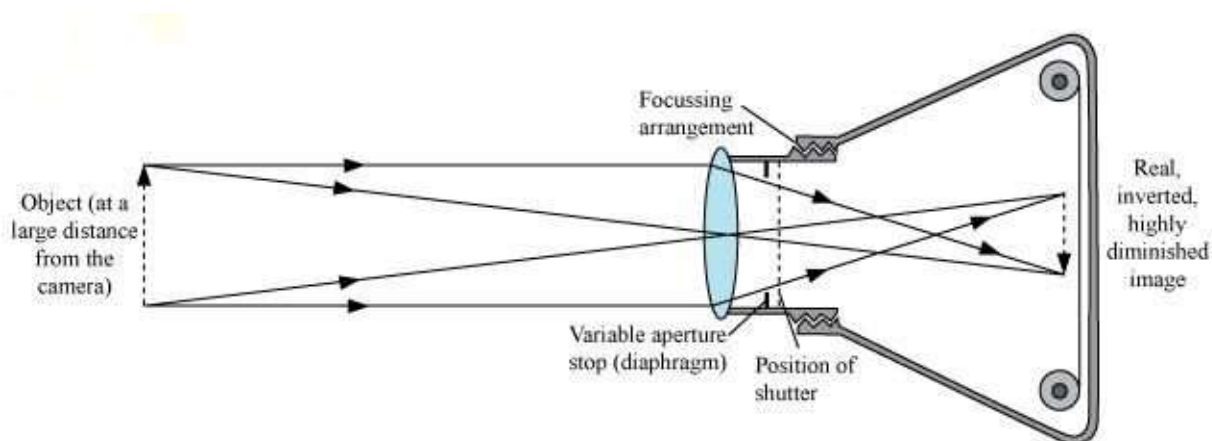
- **Problem:** Near objects are not seen clearly
- Image formed beyond the retina
- **Correction** – convex lens

- **Presbyopia** – Near-focus distance increases with age

- Power of accommodation decreases
- **Correction**– Bi-focal lens and concave lens

Camera

- Used for capturing images
- Comprises a convex lens—which focuses the rays onto the film
- Film is used for storing the image.
- To focus distant objects: Decrease the distance between the lens and the film
- To focus nearby objects: Increase the distance between camera lens and the film
- When the shutter opens, the image of the object is formed on the film.



Microscope

- Magnifies images of very small objects

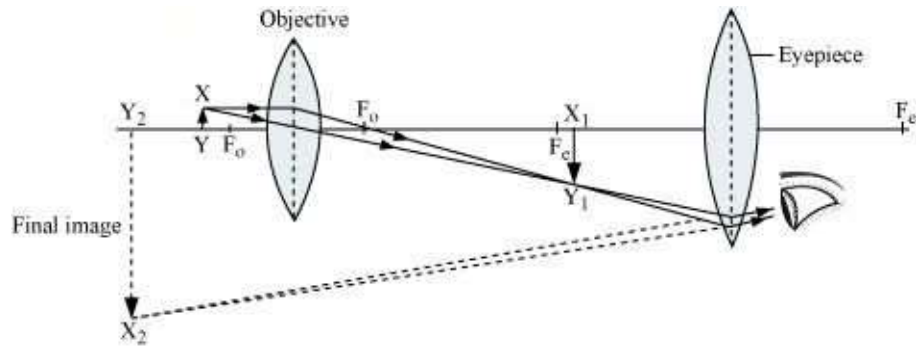
There are two types of microscopes:

Simple Microscope

- Consists of a single convex lens
- Cannot view very small objects like bacteria
- Object is placed between the focus and the lens

Compound microscope

- Consists of two lenses
- One with the lesser focal length is called the objective.
- Other with the greater focal length is called the eyepiece.



Telescope

- Used for getting a magnified image of distant objects
- Astronomical telescope is used for getting a view of heavenly objects.
- Consists of two lenses
- Fixed at the two ends of a long cylindrical tube
- **Objective**—lens with a greater focal length
- **Eyepiece**—lens with the lesser focal length
- Inverted, but magnified image is formed.
- Extra lens is added if an erect image is required.

