Column 1	Column 2	Column 3
Farsightedness	Nearby object can be seen clearly	Bifocal lens
Presbyopia	Faraway object can be seen clearly	Concave lens
Nearsightedness	Problem of old age	Convex lens

Farsightedness is the defect of vision in which a human eye can see distant objects clearly but is unable to see nearby objects clearly. Farsightedness is corrected using a suitable convex lens.

Presbyopia is the defect of vision in which aged people find it difficult to see nearby objects comfortably and clearly without spectacles. Presbyopia is correctd using a suitable bifocal lens.

Nearsightedness is the defect of vision in which a human eye can see nearby objects distinctly but is unable to see distant objects clearly as they appear indistinct. Nearsightedness is corrected using a suitable concave lens.

2. Draw a figure explaining various terms related to a lens.

(1) Centre of curvature (C)

The centres of the spheres whose parts from the surfaces of the lens are called the centres of curvature of the lens. A lens has two centres of curvature C_1 and C_2 for its two spherical surfaces.

(2) Radii of curvature (R)

The radii of the spheres whose parts from surfaces of a lens are called the radii of curvature of the lens.

(3) Principal axis

The imaginary straight line passing through the two centres of curvature of a lens is called the principal axis of the lens.

(4) Optical centre (O)

The point inside a lens on the principle axis, through which light rays pass without changing their path is called the optical centre of the lens.

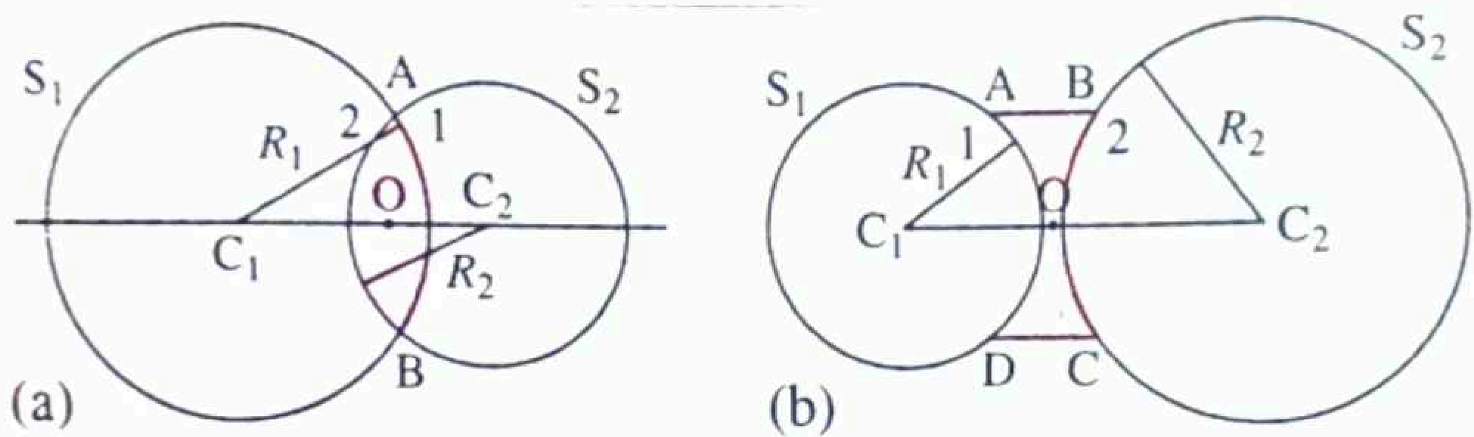
(5) Principal focus (F)

When light rays parallel to the principal axis are incident on a convex lens, they converge at a point on the principal axis. This point is called the principal focus (F) of the convex lens. Light rays travelling parallel to the principal axis of a concave lens diverge after refraction in such a way that they appear to be coming out of a point on the principal axis. This point is called the principal focus of the concave lens. A lens has two principal foci F_1 and F_2.

(6) Focal length (f)

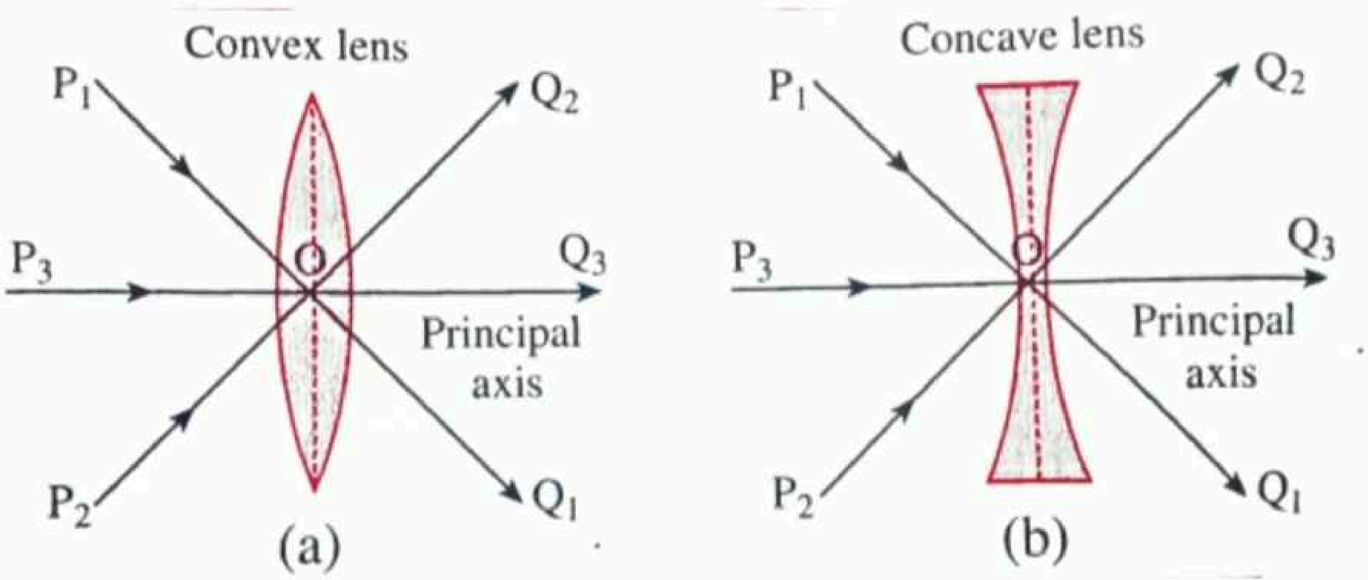
The distance between the optical centre and the principal focus of a lens is called the focal length (f) of the lens.

2. Draw a figure explaining various terms related to a lens.

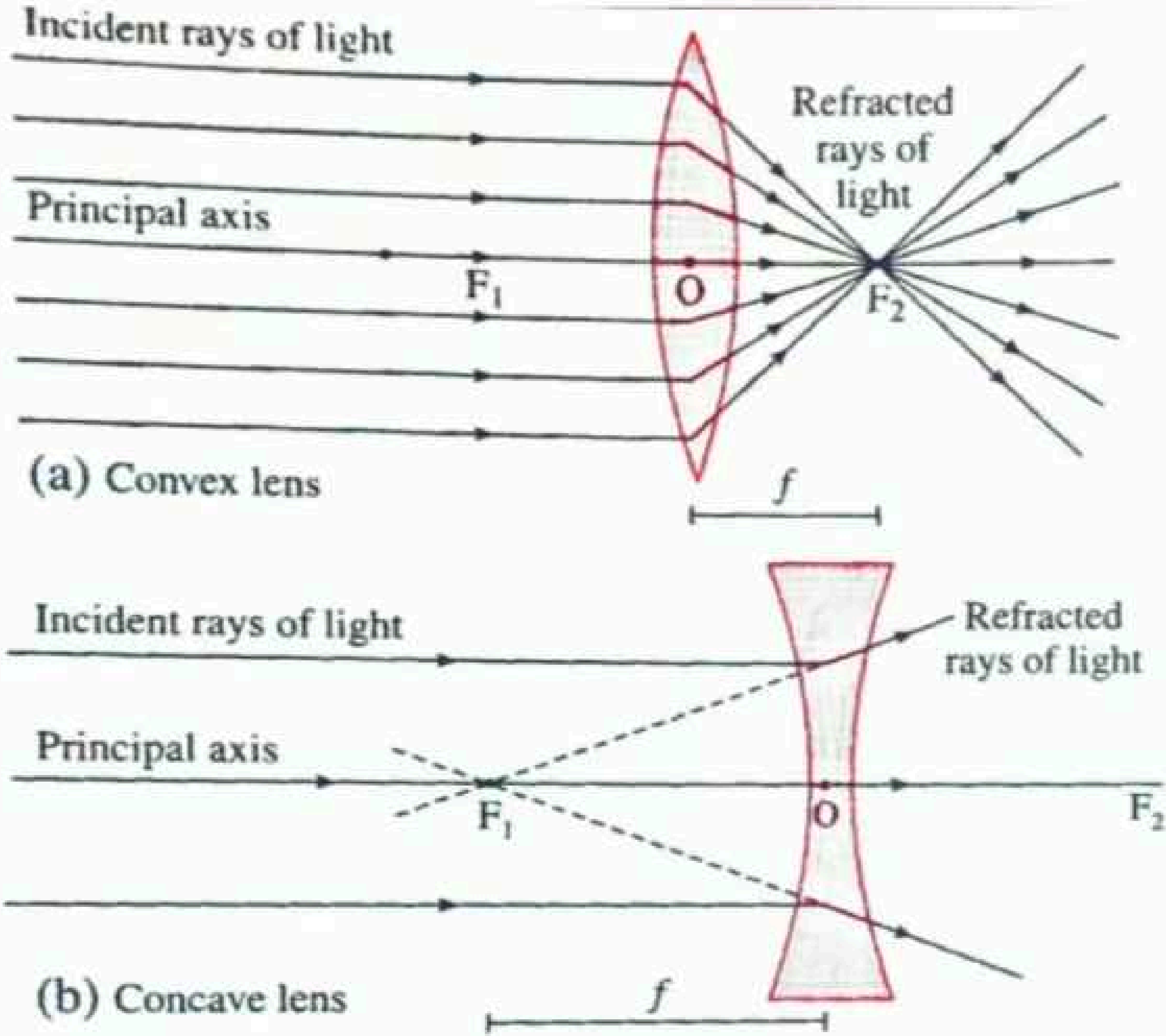


C_1, C_2 : Centres of curvature ;
R_1, R_2 : Radii of curvature ;
O : Optical centre

The cross sections of convex and concave lenses are shown in parts (a) and (b) of fig. The surface marked as 1 is part of sphere S_1 while the surface marked as 2 is part of sphere S_2.

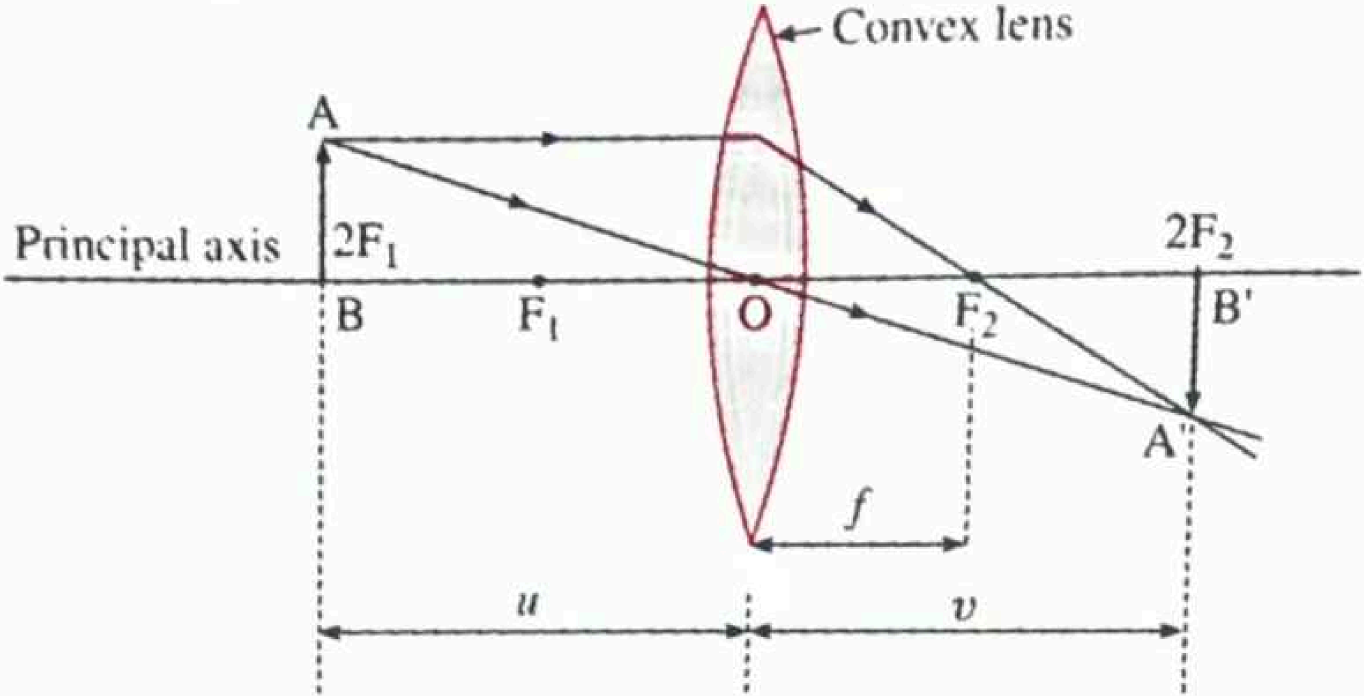


P_1, P_2, P_3 : Incident rays of light, Q_1, Q_2, Q_3 : Refracted rays of light, O : Optical centre



Principal focus of a lens

3. At which position will you keep an object in front of a convex lens so as to get a real image of the same size as the object ? Draw a figure.



O : Optical centre, F_1, F_2 : Principal foci,

f : Focal length,

AB : Object, A′B′ : Image, *u* : Object distance,

v : Image distance

In this case, the image is formed at $2F_2$. It is real, inverted and of the same size as that of the object.

4. Give scientific reasons :

a. Simple microscope is used for watch repairs.

(1) When an object is placed within the focal length of a magnifying glass or simple microscope (convex lens), its larger and erect image is obtained on the same side of the lens as that of the object.

(2) By adjusting the distance between the object and the lens, the image can be obtained at the minimum distance of distinct vision. Thus, a watch repairer can see the minute parts of a watch more clearly with the aid of a magnifying glass. (a simple microscope) that with the naked eye, Without any stress on the eye. Hence, watch repairers use a magnifying glass (a simple microscope) while repairing the watches.

b. One can sense colours only in bright light.

(1) The retina in the eye is made of many light sensitive cells. The rod-shaped cells respond to the intensity of light while the cone-shaped cells respond to various colours.

(2) The cone-shaped cells do not respond to faint light. They function only in bright light. Hence, one can sense colours only in bright light.

c. We cannot clearly see an object kept at a distance less than 25 cm from the eye.

(1) When we try to see a nearby object, the eye lens becomes more rounded and its focal length decreases. Then a clear image of the object is formed on the retina of the eye.

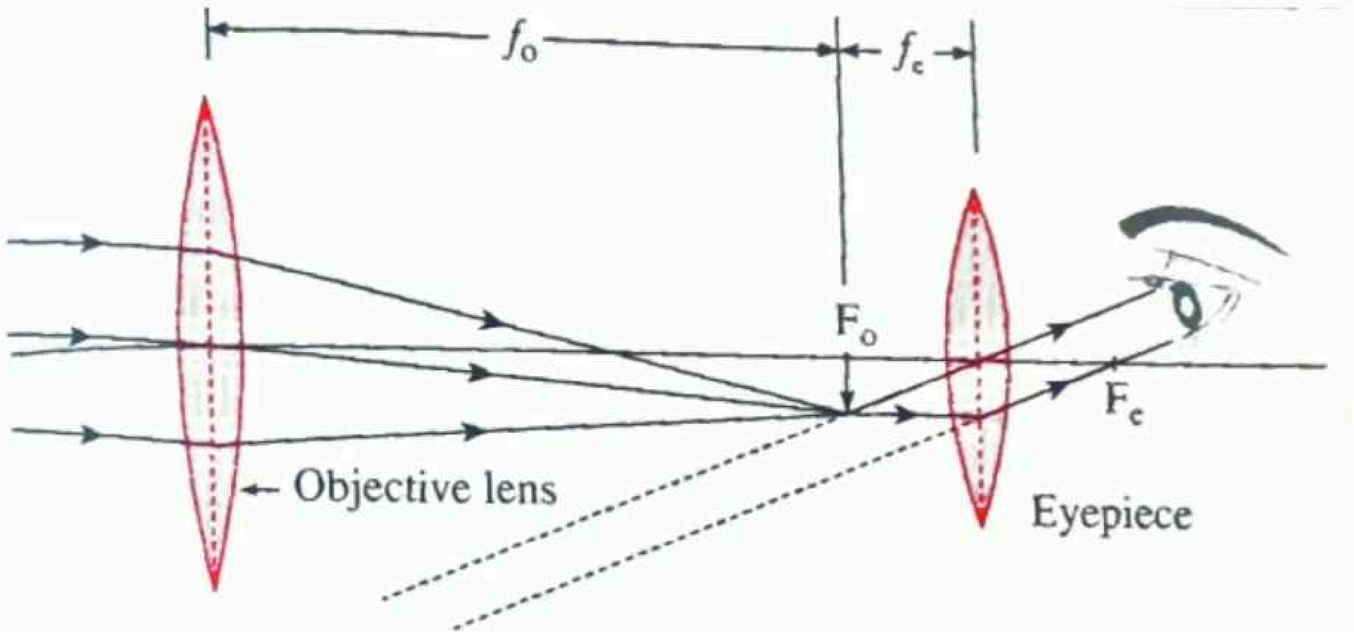
(2) The focal length of the eye lens cannot be decreased beyond some limit. Therefore we cannot clearly see an object kept at a distance less than 25 cm from the eye.

5. Explain the working of an astronomical telescope using refraction of light.

Construction of a refracting telescope

It consists of two convex lenses called the objective lens (directed towards the object) and the eyepiece (directed towards the eye). The focal length and diameter of the objective lens are respectively greater than the focal length and diameter of the eyepiece. The objective lens is fitted at one end of a long metal tube.

A metal tube of smaller diameter is fitted in the metal tube and eyepiece is fitted at the outer end of the smaller tube. With the help of a screw it is is possible to change the distance between the eyepiece and thd objective lens by sliding the tube fitted with the eyepiece. The principal axes of the objective lens and the eyepiece are along the same line. A telescope is usually mounted on a stand.



F_o : Principal focus of the objective lens, F_e : Principal focus of the eyepiece, f_o : Focal length of the objective lens, f_e : Focal length of the eyepiece.

Refracting telescope

Working

When the objective lens is pointed towards the distant object to be observed, the rays of light from the distant object, which are almost parallel to each other, pass through the objective lens. The objective lens collects maximum amount of light as it is large in size. It forms a real, inverted and diminished image in the focal plane of the objective lens.

Working

Now, the position of the eyepiece is adjusted such that this image falls just within the focal length of the eyepiece and serves as the object for the eyepiece which works as a simple microscope.

The final image is highly magnified, virtual, on the same side as that of the object and inverted with respect to the original object. The final image can be observed by keeping the eye close to the eyepiece. If the image formed by the objective lens lies in the focal plane of the eyepiece, the final image is formed at infinity.

Farsightedness	Nearsightedness
In farsightedness, a human eye can see distant objects distinctly but is unable to see nearby objects clearly.	In nearsightedness, human eye can see near objects distinctly, but is unable to see distant objects clearly.
In this case, the image of a nearby object would be formed behind the retina.	In this case, the image of a distant object is formed in front of the retina.
This defect can be corrected using a convex lens of appropriate power.	This defect can be corrected using a concave lens of appropriate power.

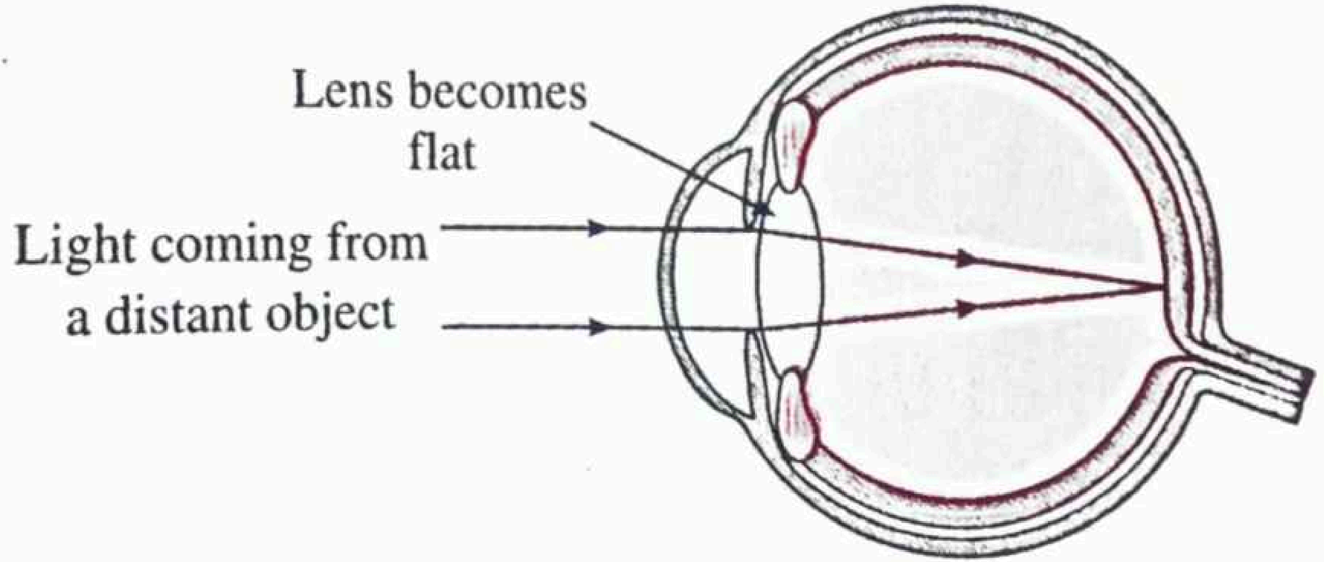
Concave lens	Convex lens
A concave lens has its surfaces curved inwards.	A convex lens has its surfaces puffed up out wards.
It is thicker at thd edges than in the middle.	It is thicker in the middle than at the edges.
It can form only a virtual image.	It can from a real image as well as a virtual image.
It can form only a diminished image.	It can form a magnified, diminished or the same sized image depending on the position of the object.

7. What is the function of iris and the muscles connected to the lens in human eye ?

When the incident light is very bright, the muscles of the iris stretch to reduce the size of the pupil. When the incident light is dim, the muscles of the iris relax to increase the size of the pupil. Thus, the iris controls the size of the pupil and thereby regulates the amount of light entering the eye.

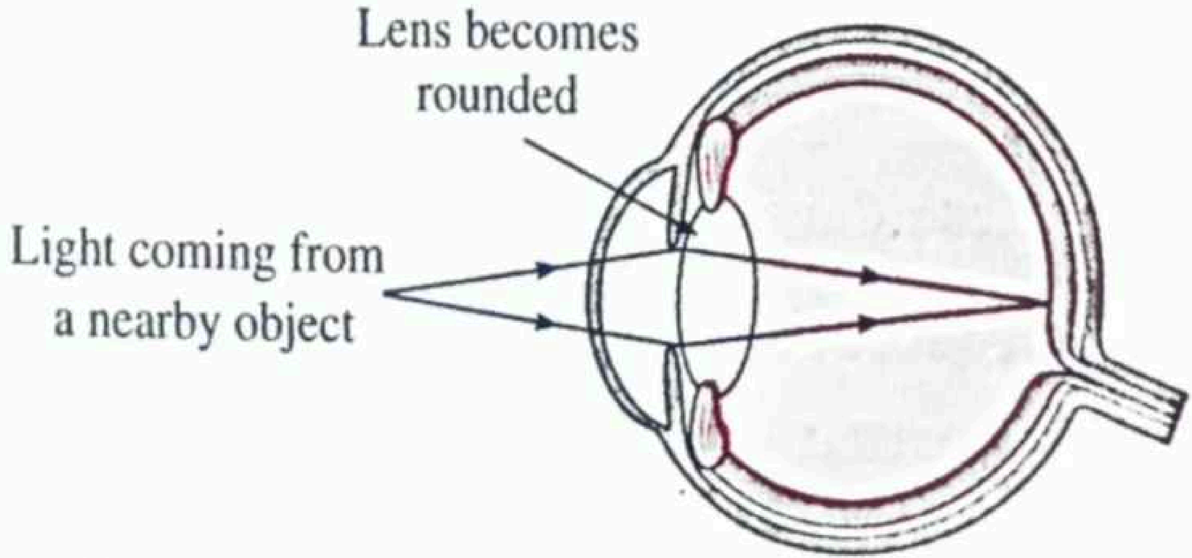
When a distant object is to be observed, the ciliary muscles relax so that the eye lens becomes flat. This increases the focal length of the lens. Therefore, a sharp image of the distant object is formed on the retina.

Thus, we can see a distant object clearly.



Formation of an image of a distant object

When an object closer to the eye is to be observed, the cilliary muscles contract increasing the curvature of the eye lens. The eye lens, therefore, becomes rounded. This decreases the focal length of the lens. Therefore, a sharp image of the nearby object is formed on the retina. Thus, we can see a nearby object clearly.



Formation of an image of a nearby object

8. Solve the following examples.

i. Doctor has prescribed a lens having power +1.5 D. What will be the focal length of the lens ? What is the type of the lens and what must be the defect of vision ?

Given:

Power of lens, P = +1.5 D

Now, focal length of lens,

$$f = \frac{1}{P} = +\frac{1}{1.5} = +0.67m$$

Since, the focal length is positive, the lens prescribed for correction is convex lens. Thus, the defect of vision is farsightedness or hypermetropia.

ii. 5 cm high object is placed at a distance of 25 cm from a converging lens of focal length of 10 cm. Determine the position, size and type of the image

Given:

Height of object, h_o = 5 cm

Object distance, u = -25 cm

Since the lens is converging, thus it is a convex lens.

Focal length of the lens, f = 10 cm

Using lens formula,

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

$$\Rightarrow \frac{1}{v}=\frac{1}{10}+\frac{1}{-25}=\frac{3}{50}$$

$$\Rightarrow v=\frac{50}{3}=16.7cm$$

Thus, the image is formed

16 . 7 cm right of the lens.

Now, we know

$$\frac{v}{u}=\frac{h_i}{h_o}$$

$$\Rightarrow h_i=\frac{50}{3\times -25}\times 5=\frac{10}{3}=-3.3\text{cm}$$

Thus, the size of the image is 3.3 cm. Negative sign shows that the image formed is real and inverted. Hence, the image formed is real and inverted and diminished.

iii. Three lenses having power 2, 2.5 and 1.7 D are kept touching in a row. What is the total power of the lens combination?

Given:

$P_1 = 2D, P_2 = 2.5D, P_3 = 1.7D$

Let the total power of the lens combination be P. Thus,

$$P = P_1 + P_2 + P_3 = 2 + 2.5 + 1.7 = 6.2D$$

iv. An object kept 60 cm from a lens gives a virtual image 20 cm in front of the lens. What is the focal length of the lens ? Is it a converging lens or diverging lens ?

Given:

Object distance, u = - 60 cm

Image distance, v = - 20 cm

Using lens formula,

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

$$\Rightarrow \frac{1}{f} = \frac{1}{-20} - \frac{1}{-60} = -\frac{1}{30}$$

$$\Rightarrow f = -30 \text{ cm}$$

Since, the focal length is negative, the lens is a diverging lens or a concave lens.