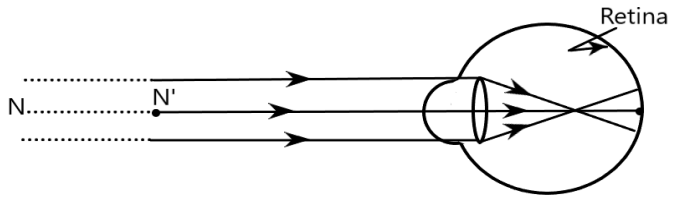
The Human Eye and the Colourful World

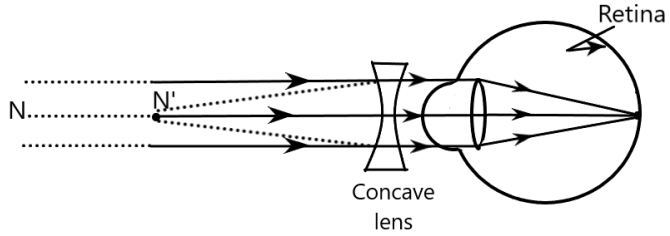
11 Chapter

1. What is meant by the power of accommodation of the eye?
Ans: When the ciliary muscles are relaxed, the eye lens becomes thin. This results in the increase of the focal length, and distant objects are clearly visible to the eyes.
To see the nearby objects clearly, the ciliary muscles contract which makes the eye lens thicker. This results in reduction of focal length of the eye lens, and nearby objects become visible to the eyes.
Therefore, the focal length can be adjusted by the human eye lens to view both distant and nearby objects on the retina. This ability of the eye refers to the power of accommodation of the eye.

2. A person with a myopic eye cannot see objects beyond 1.2 m distinctly. What should be the type of corrective lens used to restore proper vision?
Ans: The person can clearly see the objects which are near, but he cannot see the objects beyond 1.2m . This arises as the image of an object beyond 1.2m is obtained in front of the retina and not at the retina, as displayed in the figure given below.



To correct this defect of vision, a concave lens should be used. The image will be brought back to the retina by the concave lens as shown in the given figure.



3. What is the far point and near point of the human eye with normal vision?

Ans: The near point of the eye refers to the minimum distance of the object from the eye that can be seen clearly without any strain to the eye. This distance is 25 cm, for a normal human eye.

The far point of the eye refers to the maximum distance to which the eye can clearly see the objects, without getting any strain to the eye. The far point of the normal human eye is at an infinite distance.

4. A student has difficulty reading the blackboard while sitting in the last row. What could be the defect the child is suffering from? How can it be corrected?

Ans: A student has difficulty in reading the blackboard while sitting in the last row. It means that he is unable to see the distant objects clearly.

The student is suffering from myopia. This defect can be corrected using a concave lens.

MCQs

1. The human eye can focus objects at different distances by adjusting the focal length of the eye lens. This is due to

a) **Presbyopia**
b) **Accommodation**
c) **Near-sightedness**
d) **Far-sightedness**

Ans: The correct answer is (b) accommodation,

The focal length of the eye lens is changed by the human eye to see objects situated at various distances from the eye. This is possible due to the power of accommodation of the eye lens.

2. The human eye forms the image of an object at its

(a) Cornea
(b) Iris
(c) Pupil
(d) Retina

Ans: (d) The image of an object is formed by the human eye at its retina.

3. The least distance of distinct vision for a young adult with normal vision is about

(a) 25m

(b) 2.5cm
(c) 25cm
(d) 2.5m

Ans: (c) The least distance of distinct vision refers to the minimum distance to see a clear and distinct image. This distance is 25cm for a young adult with normal vision.

4. The change in focal length of an eye lens is caused by the action of the

a) Pupil
b) Retina
c) Ciliary muscles
d) Iris

Ans: (c) The curvature of the eye lens is changed by the relaxation or contraction of ciliary muscles.
The focal length of the eyes is changed due to the change in curvature of the eye lens. Therefore, the change in focal length of an eye lens occurs due to the action of ciliary muscles.

5. A person needs a lens of power -5.5 dioptres for correcting his distant vision. For correcting his near vision, he needs a lens of power $+1.5$ dioptre. What is the focal length of the lens required for correcting

a) distant vision?

Ans: The power P of a lens of focal length f is given by the relation

$$\text{P} = \frac{1}{\text{f}} \quad (\text{f in metres})$$

Power of the lens used for correcting distant vision $= -5.5\text{D}$

Focal length of the required lens, $\text{f} = \frac{1}{\text{P}}$

$$\Rightarrow \text{f} = \frac{1}{-5.5} = -0.181\text{m}$$

The focal length of the lens for correcting distant vision is -0.181m.

b) Near vision?

Ans: Power of the lens used for correcting near vision $= +1.5\text{D}$

Focal length of the required lens, $\text{f} = \frac{1}{\text{P}}$

$$\Rightarrow \text{f} = \frac{1}{1.5} = +0.667$$

The focal length of the lens for correcting near vision is 0.667m.

6. The far point of a myopic person is 80 cm in front of the eye. What is the nature and power of the lens required to correct the problem?

Ans: The person is suffering from an eye defect called myopia. In this defect, the image of an object is formed in front of the retina. Hence, a concave lens is used to correct this defect of vision.

Object distance, $u = \text{infinity} = \infty$

Image distance, $v = -80\text{cm}$

Focal length $= f$

According to the lens formula,

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

$$\Rightarrow -\frac{1}{80} - \frac{1}{\infty} = \frac{1}{f}$$

$$\Rightarrow \frac{1}{f} = -\frac{1}{80}$$

$$\Rightarrow f = -80\text{cm} \text{ or } -0.8\text{m}$$

Power of the lens and the focus can be given as:

$$P = \frac{1}{f}, (\text{ f is in metres})$$

$$\Rightarrow P = \frac{1}{-0.8} = -1.25\text{D}$$

Thus, a concave lens of power -1.25D is required by the person to correct his defect.

7. Make a diagram to show how hypermetropia is corrected. The near point of a hypermetropic eye is 1m. What is the power of the lens required to correct this defect? Assume that the near point of the normal eye is 25cm.

Ans: A person who suffers from hypermetropia can see distinct objects clearly but faces difficulty in seeing nearby objects clearly. This happens because the eye lens focuses the incoming divergent rays beyond the retina.

This defect of vision can be fixed using a convex lens. A convex lens of a suitable power converges the incoming light in such a manner that the image is formed on the retina, as shown in the given figure.

The person will be able to clearly see the object kept at 25cm (near point of the normal eye), if the image of the object is formed at his near point, which is given as 1m.

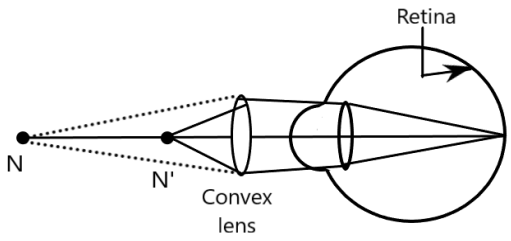


Fig-Correction for Hypermetropia

Object distance, $u = -25\text{cm}$
Image distance, $v = -1\text{m} = -100\text{cm}$
Focal length, f
Using the lens formula,

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

$$\Rightarrow -\frac{1}{100} - \frac{1}{-25} = \frac{1}{f}$$

$$\Rightarrow \frac{1}{f} = \frac{1}{25} - \frac{1}{100}$$

$$\Rightarrow \frac{1}{f} = \frac{4-1}{100}$$

$$\Rightarrow f = \frac{100}{3}\text{cm} = 33.33\text{cm} = 0.33\text{m}$$

Power,

$P = \frac{1}{f}$ **(**f is in meters)

$$\Rightarrow P = \frac{1}{0.33}$$

$$\Rightarrow P = +3\text{D}$$

Thus, a convex lens of power +3.0 D is needed to rectify the defect.

8. Why is a normal eye not able to see clearly the objects placed closer than 25 cm?

Ans: A normal eye is unable to clearly see the objects placed closer than 25 cm because the ciliary muscles of eyes are unable to contract beyond a certain limit.

9. What happens to the image distance in the eye when we increase the distance of an object from the eye?

Ans: The size of eyes cannot increase or decrease because of which the image distance remains constant.

When the object's distance from the eye is increased, the image distance in the eye does not change. The increase in the object distance is balanced by the change in the focal length of the eye lens. The focal length of the eye changes in such a manner that the image is always formed at the retina of the eye.

10. Why do stars twinkle?

Ans: Stars emit their own light and they shine due to the atmospheric refraction of light.

Stars are situated very far away from the earth. Therefore, they are considered as point sources of light. When the light coming from stars enters the earth's atmosphere, it gets refracted at different levels because of the variation in air density present at different levels of the atmosphere.

When the star light refracted by the atmosphere comes more towards the surface of earth, it appears brighter than when it comes less towards the earth. Clearly, it appears as if the stars are twinkling at night.

11. Explain why the planets do not twinkle?

Ans: Planets do not twinkle because they appear larger in size than the stars as they are comparatively closer to earth. Planets are a collection of many point-sized sources of light. The various regions of these planets produce either a brighter or dimmer effect in such a way that the resultant of the brighter and dimmer effect is zero.

Clearly, the twinkling effects of the planets are nullified and that is why they do not twinkle.

12. Why does the sky appear dark instead of blue to an astronaut?

Ans: Since there is no atmosphere in outer space that can scatter the sunlight, the sky appears dark instead of blue to an astronaut.

Since the sunlight is not scattered in space, no scattered light reaches the astronaut's eyes and the sky appears black to them instead of blue.