11

Human Eye and the Colourful World

In the Chapter

- The ability of the eye to focus both near and distant objects, by adjusting its focal length, is known as the accommodation of the eye.
- The smallest distance, at which the eye can see objects clearly without strain, is known as the near point of the eye or the least distance of distinct vision. For a young adult with normal vision, the near point is about 25 cm.
- The common refractive defects of vision are myopia, hypermetropia and presbyopia. Myopia (short-sightedness – the image of distant objects is focussed before the retina) is removed by using a concave lens of suitable power. Hypermetropia (far-sightedness – the image of nearby objects is focussed beyond the retina) is removed by using a convex lens of suitable power. The eye loses its power of accommodation at old age.
- The splitting of white light into its component colours is known as dispersion.
- Scattering of light causes the blue colour of sky and the reddening of the Sun at sunrise and sunset.

Intext Exercises

1. What is meant by power of accommodation of the eye?

Ans. A healthy human eye can see the distant objects as well as nearby objects (not less than 25 cm from eye) distinctly by decreasing or increasing the focal length. This ability of human eye is known as 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 the corrective lens used to restore proper vision?

Ans. The person who cannot see object beyond 1.2 m from eye is suffering from myopia. This defect of vision is corrected by using a concave length of suitable power.

Power of lens = 1 / Far point (in metre)

$P = 1/1.2 = -10/12$

$= -5/6 = -0.83$ dioptre.

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

Ans. A healthy human eye can see the objects at infinity distinctly. So far point is infinity. The eye

can also see the nearby objects beyond 25 cm from eye. So near point is 25 cm.

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. The student is suffering from myopia. This eye defect can be corrected by using a concave lens of suitable focal length.

Exercise

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. (b) accommodation.

2. The human eye forms the image of an object at its
(a) cornea (b) iris (c) pupil (d) retina

Ans. (d) retina.

3. The least distance of distinct vision for a young adult with normal vision is about
(a) 25 m (b) 2.5 cm (c) 25 cm (d) 2.5 m

Ans. (c) 25 cm.

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) 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 (i) distant vision, and (ii) near vision?

Ans. (i) For distant vision :

$$P = -\frac{1}{f}(f \text{ in metre})$$

$$f = -\frac{1}{p} = -\frac{1}{5.5} = -\frac{10}{55} = -\frac{2}{11}\,m$$

$$f = -\frac{2}{11} \times 100\,cm = -\frac{200}{11}\,cm$$

$$f = -18.2\,cm = -0.18\,cm$$

(ii) For near vision :

$$f = \frac{1}{P} = \frac{1}{1.5}$$

$$= \frac{10}{15} \times 100\,cm$$

$$f = \frac{200}{3}\,cm$$

$$f = 66.67\,cm = +0.67\,m$$

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 lens used for correcting this disease is concave lens.

$$\text{Power} = -\frac{1}{\text{far point}} \text{ (in metre)}$$

$$P = -\frac{1}{\frac{80}{100}} = -\frac{100}{80}$$

$$P = -1.25\,D.$$

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

Ans. For the convex lens used for correction.

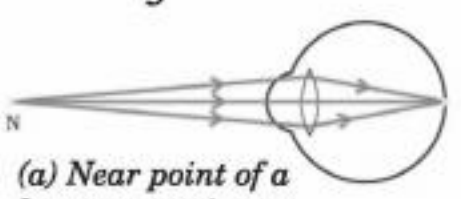
$v = 1$ metre $= -100$ cm, $u = -25$ cm

We know lens formula :

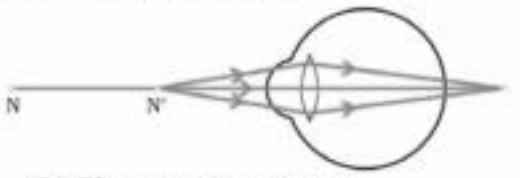
$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

$$= \frac{1}{-100} - \frac{1}{-25} = \frac{1}{f} = \frac{-1+4}{100} = \frac{1}{f}$$

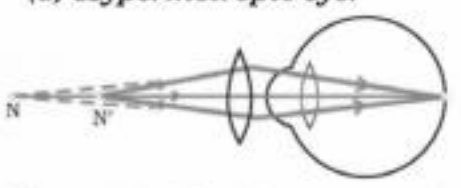
$$f = \frac{100}{3} \text{ cm}$$



(a) Near point of a hypermetropic eye.



(b) Hypermetropic eye.



(c) Correction for Hypermetropic eye.

$$f = \frac{100}{\frac{3}{100}}$$

$$f = \frac{1}{3} \text{m}$$

$$P = \frac{1}{f} = \frac{1}{\frac{1}{3}} \text{ dioptre}$$

$$P = 3 \text{ dioptres} = +3.0D$$

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

Ans. The rays coming from the objects which are at a distant less than 25cm are not properly focused at retina and the image of object appears blank. Thus, the image cannot be seen clearly.

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

Ans. The image distance remains unchanged. It is because as distance of object increases the focal length of eye lens is adjusted by ciliary muscle such that the image is always formed at retina.

10. Why do stars twinkle?

Ans. The refractive index of atmosphere is changing continuously. As starlight enters in to atmosphere, it undergoes several times refraction. Hence, the apparent position of stars are changing continuously. As the path of rays of light coming from star goes on varying slighting, starlight entering to the eyes flickers. Hence, stars twinkle.

11. Explain why the planets do not twinkle.

Ans. Planets are much closer to the earth and are extended source of light. As planets are large number of point sized sources of light, the total variation in the amount of light entering our eyes will average out to zero. Hence, planets do not twinkle.

12. Why does the Sun appear reddish early in the morning?

Ans. In the morning, the sun is near the horizon. Most of blue light and shorter wave lengths are scattered away by particles. So, the light which reaches our eyes is of longer wave length. This gives rise to the reddish appearance of the sun in the morning.

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

Ans. There is nearly no atmosphere for the astronauts as they are flying high in sky. Therefore, there is no scattering of light. This is why the sky appears dark to the astronauts.

Additional Questions

1. What is astigmatism ? How is it corrected ?

Ans. The surface of the cornea is nearly spherical. Sometimes, its curvature gets distorted and becomes more in one plane than in the other, so that the focal length of the eye in the two planes at right angles to each other becomes different. This defect generally causes indistinct vision and headache and is called astigmatism. This defect is corrected by the use of suitable cylindrical lens.

2. What are rods and cones ? Give their action.

Ans. Sensitive portion of retina has large number of cells; one rod shaped and other cone shaped. Rod shaped cells are sensitive to the intensity or brightness of the light whereas cone shaped cells are sensitive to colours. Different animals have different type of cells.

Bees have certain cone shaped cells which are sensitive to light beyond violet. This part of spectrum beyond violet called ultraviolet region can be seen by bee whereas human being cannot see ultra violet region.

Chickens have very few rod shaped cells and hence their eyes are not able to see less bright (faint) light. Hence they stroll only in bright light. They come out late in the morning and go back earlier in the evening.

3. What is colour blindness?

Ans. It is a defect of the eye in which a person is unable to distinguish between certain colours due to insufficient or no cone shaped cell on retina.

4. What is presbyopia ? Write two causes of this defect. How can it is be corrected?

Ans. This is an age related defect. It occurs almost in all human beings after the age of 35 to 40 years. Elasticity of the eye lens decreases in old age. The ciliary muscles are unable to change effectively the focal length of eye lens. Hence near point of eye shifts away from the

eye and far point shifts towards the eyes.
The eye is not able to see nearer as well as distant objects. The defect can be corrected by using two spectacles, one for near vision and the other for distant vision.

5. What happens when elasticity of the lens is reduced to zero?

Ans. Accomodation of normal eye is very large. As the person grows older, the power of accommodation gradually decreases. A stage may even reach when ciliary muscles lose their power and crystalline lens become almost inelastic so that the power of accommodation is almost zero.

6. Why are we not able to see the objects clearly for some time when we enter bright light to a room with dim light?

Ans. The pupil of the eye acts as a variable aperture whose size can be varied with the help of the iris. When the light is very bright, the iris contracts the pupil to allow less light to enter the eye. However in dim light the iris expands the pupil to allow more light to enter the eye.
When we enter from a bright light area to a dim light area, the pupil is not able to expand quickly to allow more light into the eye We are therefore not able to see the objects in dimlight room momentarily.

7. We are able to see everything with one eye, then why do we have two eyes?

Ans. A human being has a horizontal field of view of about 1500 with one eye and of about 1800 with two eyes. Hence two eyes give us a wider field of view. With one eye the world will appear to us to be a flat one but two eyes open, the world takes on third dimension of depth. With two eyes, we are able to judge the distance of the object.

8. Why do we observe random wavering or flickering of the objects near a fire or on very hot day?

Ans. This is due to refraction. Air above fire becomes hotter than the air further up. Hotter air is lighter than cold air above it. Refractive index of the hotter air is slightly less than that of cooler air. Since the density of air does not remain the same, the apparent position of the object as seen through hot air fluctuates. Wavering is therefore the effect of atmospheric refraction.

9. Why cannot we see an object clearly if it is placed very close to the eyes?

Ans. Since the distance between eye lens and retina is fixed i.e., v is fixed, eye has to change its focal length f so as to focus object on retina. The focal length of eye lens is changed by action of ciliary muscles. For focusing near objects, the focal length of eye lens is decreased by putting pressure on eye lens. Radius of eye lens cannot be decreased beyond certain limits and hence objects placed very near to eyes cannot be seen clearly.

10. What is the function of sclerotic in the eye ?

Ans. It preserves shape of the eye and protects it against external injury.

11. What is the front transparent portion of sclerotic called ?

Ans. Cornea.

12. Colour of which part represents colour of the eye?

Ans. Colour of iris.

13. What is the function of pupil ?

Ans. It adjusts the amount of light entering the eye.

14. Which muscles hold the lens in its position ?

Ans. Ciliary muscles.

15. What is the most sensitive part of retina ?

Ans. Yellow spot.

16. What acts as shutter to the eyes?

Ans. Eye lid.

17. Which part of the retina is insensitive to light ?
Ans. Blind spot.
18. What is the function of choroid?
Ans. To avoid chances of multiple images due to repeated reflection of light.
19. What is the function of rods on retina?
Ans. Rods are sensitive to intensity of light.
20. What are cones on retina?
Ans. Cones are sensitive to colours.
21. How many types of cones are there?
Ans. Three types, one sensitive to red, second to blue and third to green colour.
22. What is far point ?
Ans. Far point is that distant point to which the eye can see clearly.
23. What is near point?
Ans. It is the nearest point which can be clearly seen by eye.
24. What is near and far point of a normal eye?
Ans. Near point is nearly 25 cm and far point is at infinity.
25. What would have been the colour of the sky, had there been no atmosphere?
Ans. Black.

Multiple Choice Questions

1. Most sensitive part of retina is called :
(a) black spot (b) cornea
(c) yellow spot (d) blue spot.
Ans. (c) yellow spot
2. Power of a lens is 5D, its focal length is :
(a) 20 m (b) 2 cm
(c) 0.2 m (d) none of these.
Ans. (c) 0.2 m
3. Most insensitive part of the eye is called
(a) blind spot (b) yellow spot
(c) cornea (d) blue spot.
Ans. (a) blind spot
4. Focal length of the eye lens can be adjusted by action of :
(a) ciliary muscles (b) choroid
(c) optical nerves (d) retina.
Ans. (a) ciliary muscles
5. Formation of multiple images in the eyes is avoided by action of :
(a) pupil (b) choroid
(c) iris (d) optical nerve.
Ans. (b) choroid
6. Amount of light entering the eye depends upon the size of :
(a) pupil (b) iris
(c) cornea (d) vitreous humour.
Ans. (a) pupil
7. The colour of the eye of a person is alloted on the basis of the colour of his :
(a) pupil (b) retina
(c) iris (d) aqueous humour.

Ans. (c) iris

8. Fovea centralis is a point inside the eye which is :

(a) not sensitive to light
(b) the most sensitive to light
(c) used to convey the message to retina
(d) useless part.

Ans. (b) the most sensitive to light

9. Electric pulses from retina to brain is conveyed via:

(a) ciliary muscles (b) blind spot
(c) optical nerves (d) pupil.

Ans. (c) optical nerves

10. Accommodation of normal eyes is from :

(a) 5 cm to 15 cm (b) 15 cm to 1 m
(c) 1 m to 3 m (d) 20 cm to infinity.

Ans. (d) 20 cm to infinity.

11. Far point of a person is 4 m, the power of lens required to see object at infinity is :

(a) – 0.25D (b) + 0.25D
(c) zero (d) infinity

Ans. (a) – 0.25D

12. Iris controls

(a) size of pupil (b) rods and cones
(c) ciliary muscles (d) curvature of eye lens

Ans. (a) size of pupil

13. A person who cannot distinguish between different colours is a problem related to

(a) cornea (b) eye lens
(c) rods (d) cones

Ans. (d) cones

14. Sun appears red at the time of sunset and sunrise because

(a) red colour is scattered most (b) red colour is scattered least
(c) blue colour is scattered most (d) blue colour is scattered least

Ans. (b) Red colour is scattered least.

15. Focal lengths of eye lens can be alternated by

(a) Iris (b) Ciliary muscles
(c) Rods and cones (d) Vitrous humour

Ans. (b) Ciliary muscles

16. For a healthy human adult, the least distance of distinct vision is

(a) 10 cm (b) 15 cm
(c) 20 cm (d) 25 cm

Ans. (d) 25 cm

17. 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) Far sightedness (d) Near sightedness

Ans. (b) Accommodation