NCERT EXERCISE SOLUTIONS

CHAPTER: THE HUMAN EYE AND THE COLOURFUL WORLD

Q1. 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

Answer: (b) accommodation
Explanation: The process by which the ciliary muscles alter the curvature of the eye-lens to adjust its focal length, enabling it to focus clearly on both near and distant objects, is known as the power of accommodation.

Q2. The human eye forms the image of an object at its:
(a) cornea
(b) iris
(c) pupil
(d) retina

Answer: (d) retina
Explanation: The retina acts as a light-sensitive screen located at the back of the eye where the real and inverted image of an external object is formed.

Q3. 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

Answer: (c) 25 cm
Explanation: For a normal adult eye, the closest distance at which objects can be seen clearly without straining the eyes is approximately 25 cm. This point is known as the near point of the eye.

Q4. 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

Answer: (c) ciliary muscles
Explanation: The contraction and relaxation of the ciliary muscles change the curvature of the crystalline eye-lens, which dynamically modifies its focal length.

Q5. 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?

Answer:
The mathematical relation between focal length (f) and power (P) is given by: f = 1 / P

(i) For Distant Vision:
Given: Power, P1 = -5.5 D
f1 = 1 / -5.5 m = -10 / 55 m = -0.1818 m = -18.2 cm
The negative sign indicates that a concave lens is required.

(ii) For Near Vision:
Given: Power, P2 = +1.5 D
f2 = 1 / +1.5 m = 10 / 15 m = +0.6667 m = +66.7 cm
The positive sign indicates that a convex lens is required.

Q6. 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?

Answer:
To see distant objects clearly, the virtual image of an object located at infinity (infinity symbol) must be formed at the person’s actual far point (80 cm).

Object distance, u = -infinity
Image distance, v = -80 cm = -0.8 m

Using the lens formula: 1/f = 1/v - 1/u
1/f = 1/-0.8 - 1/-infinity

1/f = -1/0.8 + 0
f = -0.8 m

Calculating the Power (P):
P = 1/f = 1/-0.8 m = -1.25 D

Conclusion: The nature of the lens is concave (diverging lens) with a power of -1.25 D.

Q7. 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.

Answer:
(Note for Word document: You can insert a standard ray diagram here showing a convex lens converging incoming light rays from 25 cm so that they appear to originate from 1 m).

Mathematical Calculation:
To read an object kept at the normal near point (25 cm), the corrective lens must form its virtual image at the defective eye's near point (1 m).

Object distance, u = -25 cm = -0.25 m
Image distance, v = -1 m = -100 cm

Using the lens formula: 1/f = 1/v - 1/u
1/f = 1/-1 - 1/-0.25
1/f = -1 + 4 = +3 per meter
f = +1/3 m = +33.3 cm

Calculating the Power (P):
P = 1/f = +3 D

Conclusion: A convex lens (converging lens) with a power of +3 D is required.

Q8. Why is a normal eye not able to see clearly the objects placed closer than 25 cm?

Answer:
The ciliary muscles have a maximum limit to how much they can contract and increase the curvature or thickness of the eye-lens. When an object is placed

closer than 25 cm, the ciliary muscles cannot shorten the focal length of the eye-lens any further to converge the highly diverging rays onto the retina. As a result, the image is formed behind the retina, appearing blurred.

Q9. What happens to the image distance in the eye when we increase the distance of an object from the eye?

Answer:
The image distance inside the human eye remains constant. It corresponds strictly to the fixed distance between the eye-lens and the retina, which is roughly 2.5 cm. When the object distance increases, the ciliary muscles relax, making the eye-lens thinner. This increase in the focal length of the lens ensures that the image continues to form exactly on the retina.

Q10. Why do stars twinkle?

Answer:
Stars twinkle due to the atmospheric refraction of starlight combined with shifting air currents.

1. Point Source of Light: Stars are located incredibly far from Earth, acting as tiny point sources of light.
2. Changing Refractive Index: As starlight travels through the Earth's atmosphere, it passes through layers of air with continuously varying temperatures and densities. This constantly shifts the refractive index of the medium.
3. Fluctuation: Consequently, the apparent position of the star fluctuates rapidly, and the amount of light entering our eye changes every millisecond. This causes the star to appear bright at one moment and dim the next.

Q11. Explain why the planets do not twinkle.

Answer:
Unlike stars, planets are situated much closer to Earth.

1. Extended Sources: Because of their proximity, planets do not act as single point sources, but rather as an extended array or collection of numerous point sources of light.
2. Cancellation Effect: Although the light from individual points within the planet undergoes atmospheric refraction and fluctuates, the variations from different parts average out. The total variations in the amount of light entering our eye from all the point-sized sources neutralize each other, keeping the overall brightness steady.

Q12. Why does the Sun appear reddish early in the morning?

Answer:
During sunrise and sunset, the Sun sits near the horizon.

1. Longer Path Length: The sunlight must travel through a much thicker layer of the Earth's atmosphere and cover a longer distance compared to when it is overhead at noon.
2. Scattering of Blue Light: Most of the shorter wavelengths, such as blue and violet light, are intensely scattered away by the fine particles and molecules present in the atmosphere.
3. Survival of Red Light: The longer wavelengths, primarily red and orange, suffer the least scattering and successfully penetrate the thick atmosphere to reach our eyes, making the Sun appear reddish.

Q13. Why does the sky appear dark instead of blue to an astronaut?

Answer:
The blue color of our sky is the result of Rayleigh scattering of sunlight by gas molecules and fine dust particles in the atmosphere. When an astronaut travels into outer space, there is a total vacuum with no atmosphere or scattering particles. Because there is no medium to scatter the sunlight into their eyes, the sky looks completely dark and black.