

## CHAPTER

## 11

## HUMAN EYE AND THE COLOURFUL WORLD

## Syllabus

- *Functioning of a lens in human eye, defects of vision and their corrections, applications of spherical mirrors and lenses.*
- *Refraction of light through a prism, dispersion of light, scattering of light, applications in daily life.*



## STAND ALONE MCQs

(1 Mark each)

- Q. 1. When we enter a dark room coming from outside, immediately the things inside the room do not appear clear to our eyes. This is because
- (A) pupils do not open at all in the dark.  
 (B) pupils take time to adjust.  
 (C) light travels slower in a dark room.  
 (D) pupils open very quickly in the dark. U

[CBSE SQP, 2019]

Ans. Option (B) is correct.

**Explanation:** When we enter a dark room coming from outside, immediately the things inside the room do not appear clear to our eyes. This is because pupils take time to adjust.

- Q. 2. The phenomena of light responsible for the working of the human eye is
- (A) reflection  
 (B) refraction  
 (C) power of accommodation  
 (D) persistence of vision [CBSE SQP, 2019]

Ans. Option (B) is correct.

**Explanation:** Refraction is responsible for image formation at retina.

- Q. 3. When light rays enter the eye, most of the refraction occurs at the
- (A) crystalline lens.  
 (B) outer surface of the cornea.  
 (C) iris.  
 (D) pupil. R

Ans. Option (B) is correct.

**Explanation:** Light rays reflecting from distant objects are focussed on the retina after they passed through the cornea, aqueous humour, the lens, and finally the vitreous humour. Most of the refraction of light occurs when the difference in the refractive indices of abutting media is the greatest.

- AI** Q. 4. Which of the following statement is correct?
- (A) A person with myopia can see distant objects clearly.  
 (B) A person with hypermetropia can see nearby objects clearly.  
 (C) A person with myopia can see nearby objects clearly.  
 (D) A person with hypermetropia cannot see distant objects clearly. U

Ans. Option (C) is correct.

**Explanation:** This is the reason; myopia is also known as near sightedness.

Near-sightedness, or myopia, as it is medically termed, is a vision condition in which people can see close objects clearly, but objects farther away appear blurred.

- Q. 5. 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. Option (C) is correct.



**Explanation:** The least distance of distinct vision is the minimum distance of an object to see clear and distinct image. It is 25 cm for a young adult with normal visions.

Q. 6. The focal length of the eye lens increases when eye muscles

- (A) are relaxed and lens becomes thinner.
- (B) contract and lens become thicker.
- (C) are relaxed and lens becomes thicker.
- (D) contract and lens become thinner. U

Ans. Option (A) is correct.

**Explanation:** The contraction and relaxation of ciliary muscles helps to alter the curvature of the lens. The ability of the eye to change the focus between objects at different distances by altering the curvature of the lens is called power of accommodation.

Q. 7. 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. R

Ans. Option (C) is correct.

**Explanation:** The relaxation or contraction of ciliary muscles changes the curvature of the eye lens. The change in curvature of the eye lens changes the focal length of the eyes. Hence, the change in focal length of an eye lens is caused by the action of ciliary muscles.

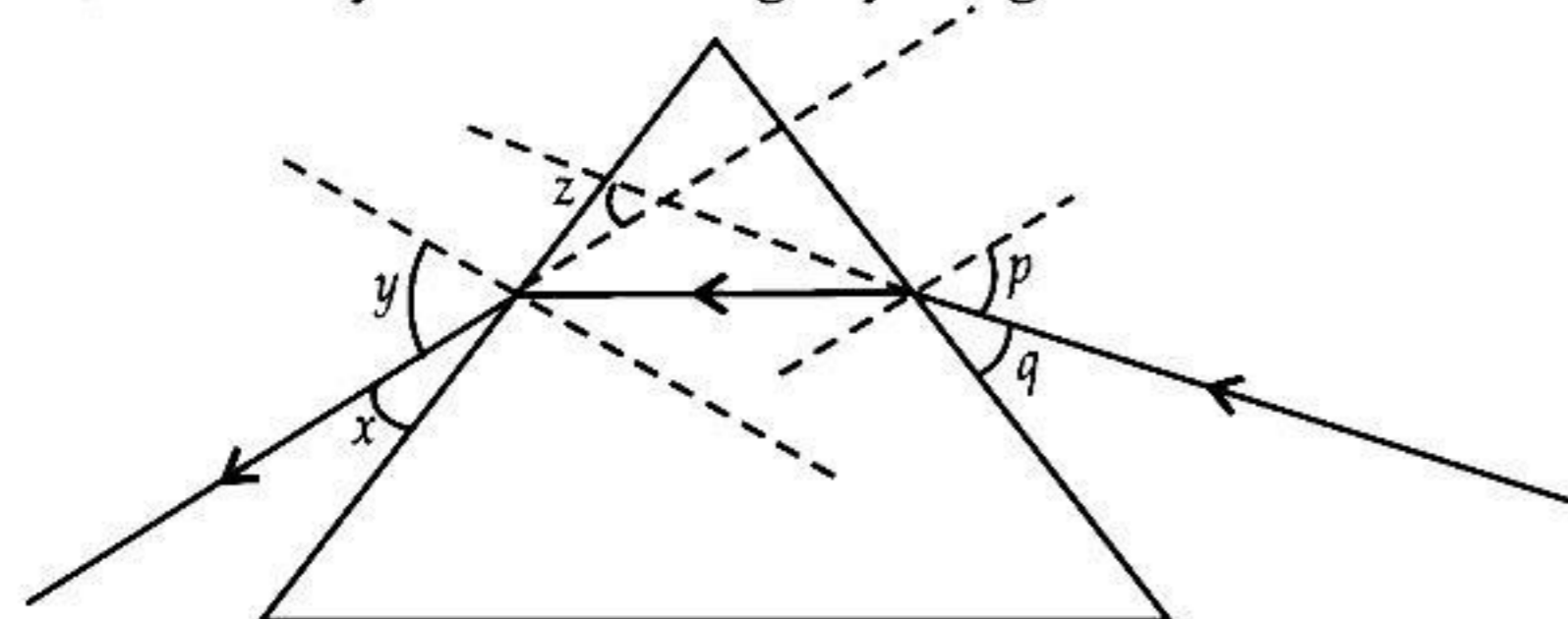
Q. 8. A student sitting on the last bench can read the letters written on the blackboard but is not able to read the letters written in his text book. Which of the following statement is correct?

- (A) The near point of his eyes has receded away.
- (B) The near point of his eyes has come closer to him.
- (C) The far point of his eyes has come closer to him.
- (D) The far point of his eyes has receded away. AE

Ans. Option (A) is correct.

**Explanation:** In hypermetropia, the near point of eye moves away from 25 cm. Due to this, the person needs to keep a book at more than 25 cm to read it properly.

Q. 9. Study the following ray diagram :



In this diagram, the angle of incidence, the angle of emergence and the angle of deviation respectively have been represented by

- (A)  $y$ ,  $p$  and  $z$
- (B)  $x$ ,  $q$  and  $z$
- (C)  $p$ ,  $y$  and  $z$
- (D)  $p$ ,  $z$  and  $y$

[CBSE Board, All India Region, 2017]

Ans. Option (C) is correct.

**Explanation:** The angle between the incident ray and the normal is known as the angle of incidence, and the angle between the emergent ray and the normal is known as the angle of emergence. The emergent ray is bent at an angle with the direction of the incident ray. This angle is called the angle of deviation.

Q. 10. Which of the following phenomena of light are involved in the formation of a rainbow?

- (A) Reflection, refraction and dispersion
- (B) Refraction, dispersion and total internal reflection
- (C) Refraction, dispersion and internal reflection
- (D) Dispersion, scattering and total internal reflection U

Ans. Option (C) is correct.

**Explanation:** Dispersion means white light getting segregated into its component colours. Refraction bends the incident light to an angle that causes internal reflection and finally rainbow is formed.

Q. 11. Twinkling of stars is due to atmospheric

- (A) dispersion of light by water droplets
- (B) refraction of light by different layers of varying refractive indices
- (C) scattering of light by dust particles
- (D) internal reflection of light by clouds

Ans. Option (B) is correct.

**Explanation:** Due to refraction of light by different layers of varying refractive indices, the apparent position of source of light keeps on changing. So stars appear to twinkle.

Q. 12. At noon the sun appears white as

- (A) light is least scattered.
- (B) all the colours of the white light are scattered away.
- (C) blue colour is scattered the most.
- (D) red colour is scattered the most.

Ans. Option (A) is correct.

**Explanation:** Sun is directly over the head and sunlight travel relatively shorter distance causing only little of the blue and violet colours to be scattered.

Q. 13. The clear sky appears blue because

- (A) blue light gets absorbed in the atmosphere
- (B) ultraviolet radiations are absorbed in the atmosphere
- (C) violet and blue lights get scattered more than light of all other colours by the atmosphere



(D) light of all other colours is scattered more than the violet and blue colour light by the atmosphere U

**Ans. Option (C) is correct.**

**Explanation:** A clear cloudless day-time sky is blue because molecules in the air scatter blue light from the sun more than they scatter red light. Rayleigh scattering is inversely proportional to the fourth power of wavelength, so that shorter wavelength violet and blue light will scatter more than the longer wavelengths (yellow and especially red light).

**Q. 14.** Which of the following statements is correct regarding the propagation of light of different colours of white light in air?

- (A) Red light moves fastest
- (B) Blue light moves faster than green light
- (C) All the colours of the white light move with the same speed
- (D) Yellow light moves with the mean speed as that of the red and the violet light

**Ans. Option (C) is correct.**

**Explanation:** Speed of light is a constant value regardless of its colour.

**Q. 15.** Which of the following phenomena contributes significantly to the reddish appearance of the sun at sunrise or sunset?

- (A) Dispersion of light
- (B) Scattering of light
- (C) Total internal reflection of light
- (D) Reflection of light from the earth

**Ans. Option (B) is correct.**

**Explanation:** Red colour scatters the least so that it travels the farthest. During sunset or sunrise, light has to travel a longer distance to reach us. Hence, only red light reaches to us and the sky appears reddish.

**Q. 16.** In an experiment to trace the path of a ray of light through a triangular glass prism, a student would observe that the emergent ray

- (A) is parallel to the incident ray.
- (B) is along the same direction of incident ray.
- (C) gets deviated and bends towards the thinner part of the prism.
- (D) gets deviated and bends towards the thicker part (base) of the prism.

[CBSE Board, Foreign Scheme, 2016]

**Ans. Option (D) is correct.**

**Explanation:** As ray emerges out of the prism, it moves from a denser to a rarer medium, and therefore, bends away from the normal. So, bends towards the thicker part (base) of the prism.



## ASSERTION AND REASON BASED MCQs (1 Mark each)

**Directions :** In the following questions, A statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as.

- (A) Both A and R are true and R is the correct explanation of A.
- (B) Both A and R are true but R is NOT the correct explanation of A.
- (C) A is true but R is false.
- (D) A is false and R is true.

**Q. 1. Assertion (A):** Eye lens has the ability to focus clearly on the retina by adjusting its focal length.

**Reason (R):** This phenomenon is known as power of accommodation.

**Ans. Option (B) is correct.**

**Explanation:** The ability of the eye lens to focus clearly on the retina by adjusting its focal length is known as the power of accommodation.

**Q. 2. Assertion (A):** A hypermetropic person prefers to remove his spectacles, while driving.

**Reason (R):** When a hypermetropic person wearing the spectacles looks at a distant object, the parallel rays from the distant object get converged in front of the retina. The image thus appears blurred.

**Ans. Option (A) is correct.**

**Explanation:** When a hypermetropic person wearing the spectacles looks at a distant object, the parallel rays from the distant object get converged in front of the retina. The image appears blurred, in order to avoid this, the person prefers to remove his spectacles.

**Q. 3. Assertion (A):** Concave lens is used to correct myopia or short-sightedness.

**Reason (R):** A concave lens of suitable focal length diverges the parallel rays from the distant objects as if they are coming from the far point of the myopic eye. This helps the eye lens to form a clear image at the retina.

**Ans. Option (A) is correct.**

**Explanation:** A concave lens of suitable focal length diverges the parallel rays from the distant objects as if they are coming from the far point of the myopic eye. This helps the eye lens to form a clear image at the retina. So, a concave lens used to correct myopia or short-sightedness.



**Q. 4. Assertion (A):** Light from a distant object arriving at the eye lens may get converged at a point in front of the retina.

**Reason (R):** The eye is producing too much divergence in the incident beam.

**Ans. Option (C) is correct.**

**Explanation:** The light from a distant object arriving at the eye lens may get converged at a point in front of the retina. This type of defect is called near-sightedness or myopia. This means that the eye is producing too much convergence in the incident beam.

**Q. 5. Assertion (A):** A white light on passing through prism splits into its component colours as such that the red light emerges nearest to the base of the prism.

**Reason (R):** Wavelength of red light is more than other component colours and hence, red light deviates least.

**Ans. Option (D) is correct.**

**Explanation:** Dispersion takes place because the refractive index of medium for different wavelengths (colours) is different. The refractive index is inversely proportional to  $\lambda$ . Since  $\lambda_{\text{red}}$  is more than other colours wavelength. So, deviation is least for red and it appears farthest from the base of the prism.

**Q. 6. Assertion (A):** Sunlight reaches us without dispersion in the form of white light and not as its components.

**Reason (R):** Dispersion takes place due to variation of refractive index for different wavelength but in vacuum the speed of light is independent of

wavelength and hence vacuum is a non-dispersive medium.

**Ans. Option (A) is correct.**

**Explanation:** In vacuum speed of light is independent of wavelength. Hence, no dispersion takes place in vacuum. Thus, vacuum is a non-dispersive medium in which all colours travel with the same speed.

**Q. 7. Assertion (A):** In case of rainbow, light at the inner surface of the water drop gets internally reflected.

**Reason (R):** The angle between the refracted ray and normal to the drop surface is greater than the critical angle.

**Ans. Option (A) is correct.**

**Explanation:** The rainbow is formed when light at the inner surface of the water drop gets internally reflected. If the angle between the refracted ray and normal to the drop surface is greater than the critical angle.

**Q. 8. Assertion (A):** Scattering of light is the reflection of light from an object in all directions.

**Reason (R):** The colour of scattered light depends on the size of scattering particles and wavelength of light.

**Ans. Option (B) is correct.**

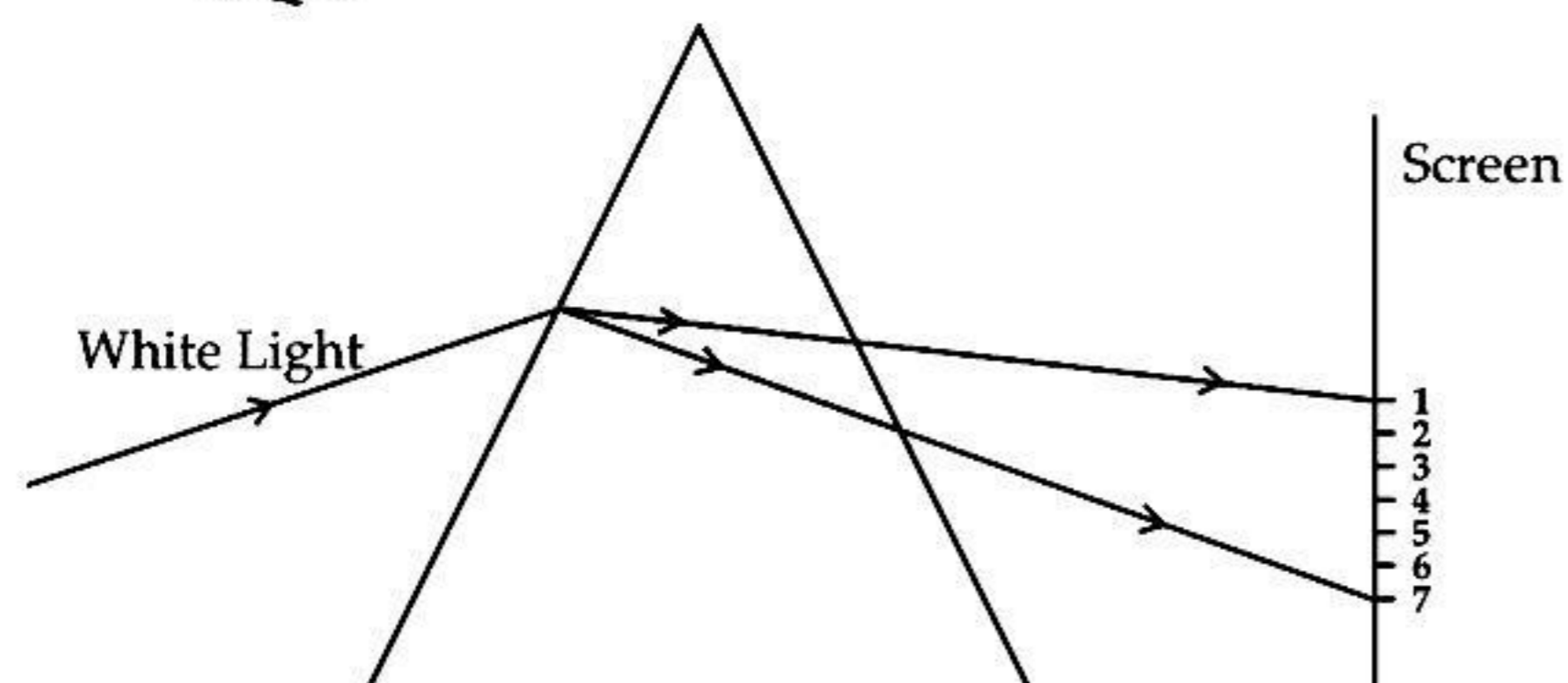
**Explanation:** The reflection of light from an object in all direction is called scattering of light. The colour of scattered light depends on the size of scattering particles and wavelength of light. Very fine particles scatter mainly blue light while particles of larger size scatter light of longer wavelength i.e. red light. If the size of the scattering particles is large enough, then the scattered light may even appear white.



## CASE-BASED MCQs

**Attempt any 4 sub-parts from each question. Each sub-part carries 1 mark.**

**I.** A narrow beam of white light is passing through a glass prism as shown in the diagram. Study the diagram and answer any four questions from Q.1. to Q.5.



**Q. 1.** The phenomenon observed in above set-up is  
(A) scattering of light

- (B) dispersion of light
- (C) reflection of light
- (D) refraction of light

**Ans. Option (B) is correct.**

**Explanation:** The phenomenon of splitting of white light into its constituent colours after passing through a prism is called as dispersion of light. When the light enters the prism, all the colours have different speeds due to which it gets split into bands.

**Q. 2.** In nature, this phenomenon is observed in

- (A) Formation of rainbow
- (B) Twinkling of stars
- (C) Blue colour of sky
- (D) Advance sunrise

**Ans. Option (A) is correct.**



**Explanation:** Rainbow is caused by dispersion of sunlight by tiny water droplets present in the atmosphere which is one of the application of dispersion of light.

Q. 3. Which of the following statement is correct about constituents of white light based on above observations?

- (A) White light consists of seven colours.
- (B) Violet colour suffers minimum deviation.
- (C) Red light suffers maximum deviation.
- (D) All the colours of the white light move with different speed in vacuum.

Ans. Option (A) is correct.

**Explanation:** When the light disperses, various bands of light are clearly visible. It is clear from the figure that the violet light suffers maximum deviation and red light suffers minimum deviation. All the colours of the white light move with the same speed in air or vacuum but with different wavelengths and frequencies.

Q. 4. The cause of dispersion of light is

- (A) All the colors of light travel with the speed more than the speed of light.
- (B) All the colors have different angles of deviation.
- (C) All the colors do not travel with the same speed of light.
- (D) All the colors have the same wavelength .

Ans. Option (C) is correct.

**Explanation:** The various colours of white light have different extent of refraction in a medium. All of colours of light do not travel with same speed in the medium which is the cause of dispersion of light.

Q. 5. Read the following statements carefully

- (i) The prism behaves same as that of rectangular glass slab.
- (ii) All the colours have different angles of deviation in case of dispersion through prism.
- (iii) All the colours travel with the same speed of light in glass.
- (iv) Dispersion of light is observed in case of rectangular glass slab.

Which of the above statement/s is true?

- (A) Only (ii)
- (B) (i) and (ii) only
- (C) (i), (ii) and (iv) only
- (D) All of the above

Ans. Option (A) is correct.

**Explanation:** A prism is made up of glass in which the faces are joined at a certain angle but in case of rectangular glass slab, the opposite faces are parallel to each other. As the light enters in the prism, all the colours travel with the different speed of light because glass is a denser medium as compared to air and dispersion of light is not observed in case of a rectangular glass slab. So, both prism and rectangular glass slab behave differently.

**AT II.** Read the passage on human eye and answer any four questions from Q.1. to Q.1.

Eye is a natural optical device by which human could see objects around him. It forms an inverted, real image on a light sensitive surface. It works on the phenomenon of refraction of light through a natural convex lens. However, Meena was unable to see clearly the words written on the black board placed at a distance of approximately 3 m from her. Her mother discussed the same with the doctor. Doctor explained her about this defect of vision and its correction.

Q. 1. The human eye forms the image of the object at its

- (A) Cornea
- (B) Iris
- (C) Pupil
- (D) Retina

Ans. Option (D) is correct.

**Explanation:** The retina in the human eye consists of contains a large number of light-sensitive cells which help in the organization of visual information. Thus, the retina helps in sending information to the brain due to which a person is able to see.

Q. 2. What kind of defect Meena is suffering from?

- (A) Myopia
- (B) Hypermetropia
- (C) Astigmatism
- (D) Malnutrition

Ans. Option (A) is correct.

**Explanation:** Meena was unable to read the words written on the blackboard i.e. she could see the nearby objects clearly but was unable to see the far off objects. Thus, she was suffering from Myopia

Q. 3. The possible cause this defect is

- (A) eye ball is of same size
- (B) eye ball becomes long
- (C) eye ball becomes small
- (D) None of the above

Ans. Option (B) is correct.

**Explanation:** The excessive curvature of eye lens becomes more converging and it results in the elongation of eye ball due to which a person suffers from Myopia.

Q. 4. The closest distance up to which a person can see without any strain in the eyes

- (A) 35 cm
- (B) 15 cm
- (C) 5 cm
- (D) 25 cm

Ans. Option (D) is correct.

**Explanation:** A normal eye is not able to see distinctly the objects placed closer than 25 cm, without putting any strain on the eye. This is because the ciliary muscles of eyes are unable to contract beyond a certain limit. If the objects are placed at a distance less than 25 cm from the eye, then the objects appear blurred because light rays coming from the object meet beyond the retina.



Q. 5. The defective eye of a person has near point 0.5 m and far point as 3 m. The power of both lens required for reading purpose and seeing far off objects is

- (A) 0.75 D and +4 D (B) +2D and -1/3 D  
(C) -2.5D and +1/8D (D) 0.85 D and -2 D

Ans. Option (B) is correct.

**Explanation:** Let the object distance =  $u$   
image distance =  $v$   
 $u = -25$  cm,  $v = 0.5$  cm,  $m = -50$  cm  
Using Lens formula

$$\begin{aligned}\frac{1}{f} &= \frac{1}{v} - \frac{1}{u} \\ &= \frac{1}{-50} - \frac{1}{-25} \\ &= \frac{1}{50}\end{aligned}$$

$$\therefore P = \frac{100}{f(\text{cm})} = 100 \times \frac{1}{50} = +2D$$

If the distance objects are taken into consideration

$$u = \infty, v = -3 \text{ m}$$

Using Lens formula

$$\begin{aligned}\frac{1}{f} &= \frac{1}{v} - \frac{1}{u} \\ &= \frac{1}{-3} - \frac{1}{\infty} \\ &= -\frac{1}{3}\end{aligned}$$

$$\therefore P = \frac{1}{f(\text{m})} = -\frac{1}{3}D$$

III. Read the given passage and answer any of the four questions from 1 to 5.

The human eyes gradually lose their power of accommodation. In such cases, the person cannot see distinctly and comfortably. There are three common eye defects, and they are myopia or near-sightedness, hypermetropia or far-sightedness, and Presbyopia. These defects are corrected by the use of suitable spherical lenses.

Q. 1. A person cannot read newspaper placed nearer than 50 cm from his eyes. The defect of vision he is suffering from is

- (A) Myopia (B) Hypermetropia  
(C) Presbyopia (D) None of these

Ans. Option (B) is correct.

**Explanation:** In hypermetropia, the affected person can see far objects clearly but cannot see nearby objects clearly. The near point of the eye moves away from 25 cm.

Q. 2. This defect may be corrected using

- (A) Concave lens of focal length 25 cm.  
(B) Convex lens of focal length 50 cm.  
(C) Concave lens of focal length 50 cm.  
(D) Convex lens of focal length 25 cm

Ans. Option (B) is correct.

**Explanation:** The defect can be corrected by using the convex lens of focal length :

$$u = -25 \text{ cm}$$

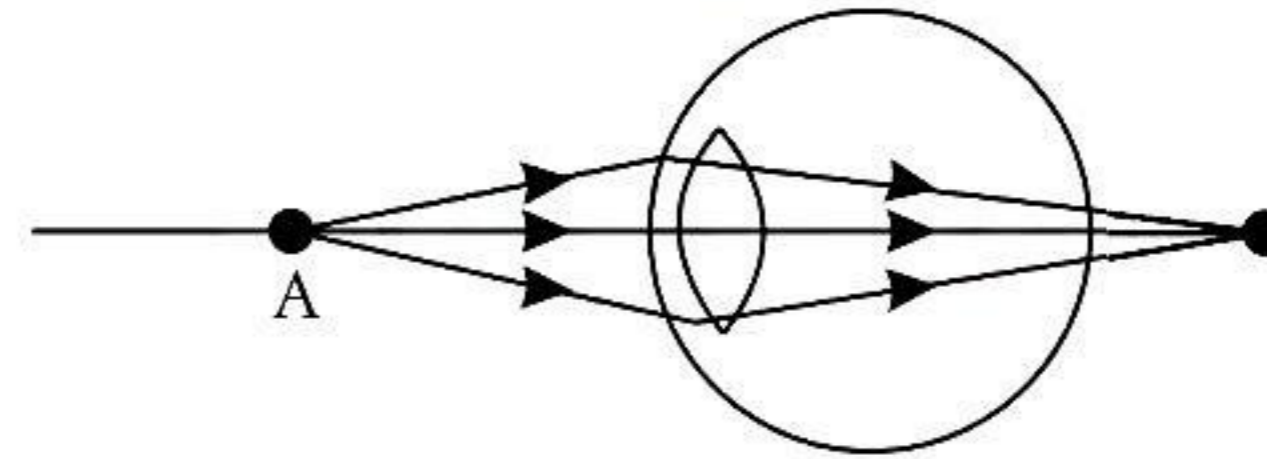
$$v = -50 \text{ cm.}$$

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{-50} - \frac{1}{-25}$$

$$(1/f) = \frac{-1+2}{50} = \frac{1}{50} \Rightarrow f = 50 \text{ cm}$$

$$\text{Now, } P = \frac{100}{50} = 2D$$

Q. 3. Observe the given diagram carefully. What could be the causes of this defect?



- I. The focal length of the eye lens is too long.  
II. The eyeball becomes too small.  
III. The focal length of the eye lens is too small.  
IV. The eyeball becomes too long

- (A) Only (I) and (II) (B) Only (I) and (IV)  
(C) Only (II) and (III) (D) Only (III) and (IV)

Ans. Option (A) is correct.

**Explanation:** The diagram shows defect hypermetropia. This defect arises either because the focal length of the eye lens is too long or the eyeball has become too small.

Q. 4. An old person is unable to see clearly nearby objects as well as distant object. To correct the vision, what kind of lens will he require?

- (A) Concave lens  
(B) Bifocal lens whose upper portion is concave lens and lower portion is convex lens.  
(C) Convex lens  
(D) Bifocal lens whose upper portion is convex lens and lower portion is concave lens.

Ans. Option (B) is correct.

**Explanation:** The upper portion (concave lens) facilitates distant vision and the lower portion (convex lens) facilitates near vision.

Q. 5. An optician while testing the eyes of Mr. X found the vision to be 6/9. What does it mean?

By this he means that Mr. X

- (A) Can read the letters of 6 inches from a distance 9 m.  
(B) Can read the letters of 9 inches from 6 m.  
(C) Can read letters from 6 m which the normal eye can read from 9 m.  
(D) Can read letters from 9 m which the normal eye can read from 6 m

Ans. Option (C) is correct.

**Explanation:** The person can read letters from 6 m which the normal eye can read from 9 m. Dopterometer is used to measure the power of a spectacle.