Human Eye and Colourful World

SYLLABUS

Functioning of a lens in human eye, defects of vision and their corrections, applications of lenses. Refraction of light through a prism, Dispersion of light, Scattering of light, Applications in daily life.

Facts that Matter

Human eye resembles a camera. It has a lens screen, ciliary muscles, cornea etc. Their functions are as follows:

Cornea: Thin membrane of eye through which light enters the eye first and gets refracted.

Iris: It is a dark muscular diaphragm that controls the size of the pupil.

Pupil: Small hole in the iris, appears black because no light is reflected from it. Pupil regulates and controls the amount of light entering the eye.

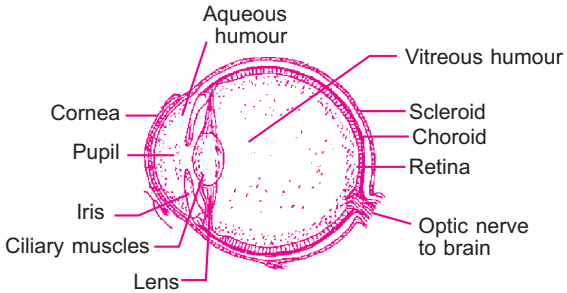
Eye lens: Transparent crystalline lens, made up of fibres, jelly like material, convex in nature.

Ciliary muscles: It holds the lens and can modify the lens curvature.

Retina: It is a screen in the eye, delicate membrane with lot of light sensitive cells called rods and cones. These cells get activated on illumination and produce electrical signals.

Optic nerve: It is a nerve connecting eye and brain. It sends the electrical signals to brain.

Diameter of human eye is approx. 2.3 cm.



The human eye

Power of Accommodation: The ability of the eye lens to see far and near objects by adjusting its focal length. It occurs through following mechanism:

(*a*) Relaxation of ciliary muscles: Lens becomes thin, focal length of eye '*f*' increases. One can see distant objects.

(*b*) Contraction of ciliary muscles: Lens becomes thick, focal length of eye '*f*' decreases. One can see near objects.

Least distance of distinct vision (near point D): The minimum distance at which objects can be seen most distinctly without strain.

For normal vision in young adult D = 25 cm.

Far Point: The farthest point (for normal vision it is at infinity) upto which the eye can see objects clearly.

Persistence of vision: The image formed on retina remains for about 1/10th of a second and is called persistence of vision.

Used in cinematography: Sequence of showing 24 images or more per second, appears to be in motion.

Light sensitive cells

Rods	***Cones***
1. Respond to intensity of light. 2. Enables to see in dim light. 3. Cannot distinguish various colours.	1. Respond to colour. 2. Become active in bright light. 3. It can distinguish between various colours.

Colour blindness: It is a genetic disorder caused due to absence of cone cells in the retina.

Vision is normal but eye cannot distinguish between colours.

[People with colour blindness are not issued driving license.]

Retina of chicks (birds) have mostly cones and few rods. So the chick wakes up with sunrise and sleeps by sunset.

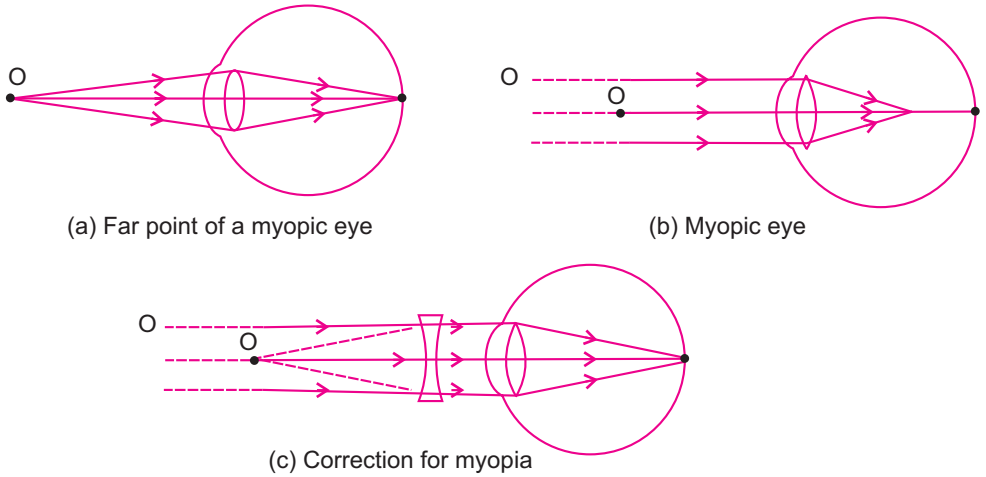
Cataract: The crystalline lens of some old people becomes hazy or even opaque due to the development of a membrane over it, which leads to the loss of vision of eye. It can be corrected by surgery.

Defects of vision, cause and remedy:

I. Myopia, II. Hypermetropia III. Presbyopia.

	Myopia	***Hypermetropia***	***Presbyopia***
Symptoms:	Cannot see distant object clearly. Image is formed in front of retina.	Cannot see nearby objects clearly. Image is formed behind retina.	Power of accommodation decreases with ageing. Nearby objects are not visible clearly.
Correction:	Use of concave lens with appropriate focal length.	Use of Convex lens with appropriate focal length.	Can be corrected by using bifocal lenses.
Cause:	(*i*) Due to thickening of lens. (*ii*) Eye ball may be elongated.	Eye lens may be thinner. Eye ball may be oval.	Due to the gradual weakening of the ciliary muscles.

Myopic eye, correction for myopia with concave lens.

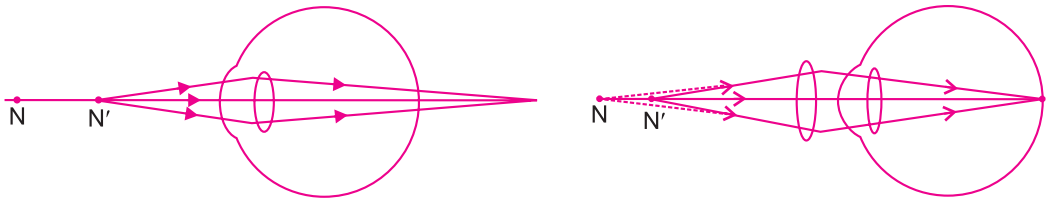


(a) Far point of a myopic eye (b) Myopic eye

(c) Correction for myopia

(a), (b) The myopic eye, and (c) correction for myopia with a concave lens

Hypermetropic eye, correction with convex lens.

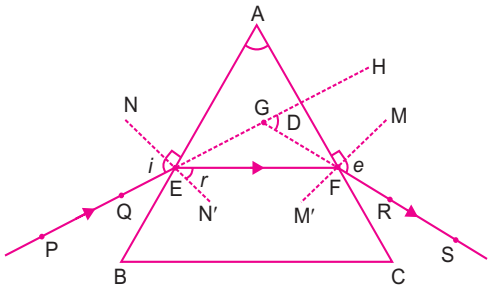


(a) (b)

(a) The hypermetropic eye, and (b) correction for hypermetropia with a convex lens

Refraction of light through a prism. Prism has two triangular bases and three rectangular lateral surfaces. The surfaces are inclined to each other.

The angle between two lateral faces is called the angle of prism.



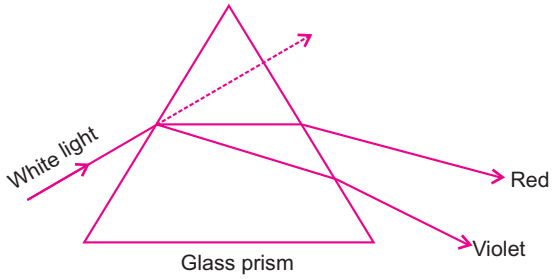
PE – Incident ray
EF – Refracted ray
FS – Emergent ray
∠A – Angle of the prism
∠*i* – Angle of incidence
∠*r* – Angle of refraction
∠*e* – Angle of emergence
∠D – Angle of deviation

Refraction of light through a triangular glass prism

Incident ray enters the prism, gets refracted, it bends towards the normal and when it moves out of the prism, it now bends away from the normal and forms emergent ray. The peculiar shape of the prism makes, the emergent ray bend at an angle to the direction of the incident ray. This angle formed is called angle of deviation.

Dispersion : The splitting of white light into its components due to different bending ability for colours when it pass through prism is called dispersion.

Dispersion of white light.



Spectrum : The band of seven colours obtained due to splitting of light is called spectrum. The red colour light bends the least and the violet colour light bends the maximum.

Rainbows : Rainbow is a natural spectrum that appears in the sky after rain shower. The water droplet present in the atmosphere splits light.

Atmospheric Refraction : Refraction of light by the Earth's atmosphere.

Twinkling of Stars : The light of star when enters Earth's atmosphere undergoes refraction, the light bends towards the normal as light travels from rarer to denser medium so the position of star spotted in sky is different from its actual position.

Star is a point sized source of light and the amount of light entering air changes. Sometimes it appears brighter and at some time hazier as the light travels from far distant and the atmosphere is not same always.

Sun is visible 2 minutes before actual sunrise and about 2 minutes after the actual sunset because of atmospheric refraction.

Sky appears blue: The small sized particles of air scatter blue light (shorter wavelength) that enter our eyes.

Sky appears black: When there is no atmosphere (space) or no light (night), the scattering does not take place.

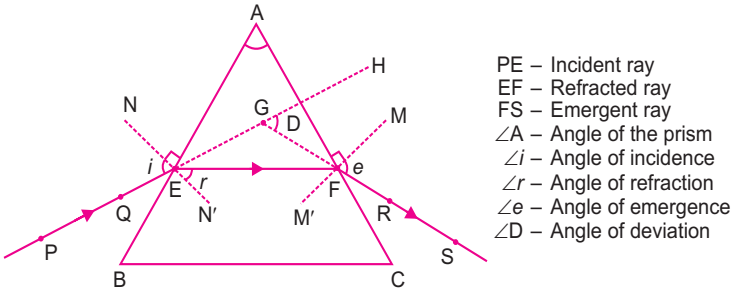
Sky appears red: During sunrise/sunset the sun is near the horizon, light passes through larger distance in the earth's atmosphere. Most of the blue light is scattered away. The red light does not get scattered and reaches our eyes.

NCERT IN-TEXT ACTIVITIES SOLVED

ACTIVITY 11.1

- Fix a sheet of white paper on a drawing board using drawing pins.
- Place a glass prism on it in such a way that it rests on its triangular base. Trace the outline of the prism using a pencil.
- Draw a straight line PE inclined to one of the refracting surfaces, say AB, of the prism.

- Fix two pins, say at points P and Q, on the line PE as shown in figure below:
- Look for the images of the pins, fixed at P and Q, through the other face AC.
- Fix two more pins, at points R and S, such that the pins at R and S and the images of the pins at P and Q lie on the same straight line.
- Remove the pins and the glass prism.
- The line PE meets the boundary of the prism at point E. Similarly, join and produce the points R and S. Let these lines meet the boundary of the prism at E and F, respectively. Join E and F.
- Draw perpendiculars to the refracting surfaces AB and AC of the prism at points E and F, respectively.
- Mark the angle of incidence ($\angle i$), the angle of refraction ($\angle r$) and the angle of emergence ($\angle e$) as shown in figure below.



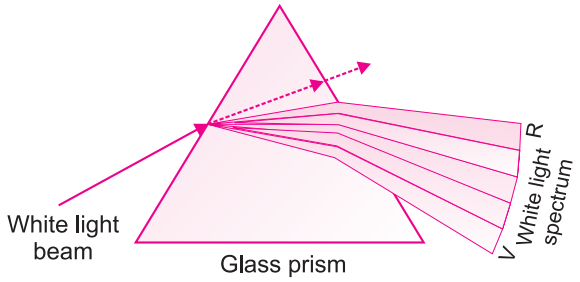
Refraction of light through a triangular glass prism

ACTIVITY 11.2

- Take a thick sheet of cardboard and make a small hole or narrow slit in its middle.
- Allow sunlight to fall on the narrow slit. This gives a narrow beam of white light.
- Now take a glass prism and allow that light from the slit to fall on one of its faces as shown in figure below.
- Turn the prism slowly until the light that comes out of it appears on a nearby screen.
- You will find a beautiful band of colours. This happens because prism split the white light that is incident on it and a band of colours is obtained.

  The blue light bends the most and red light bends the least.

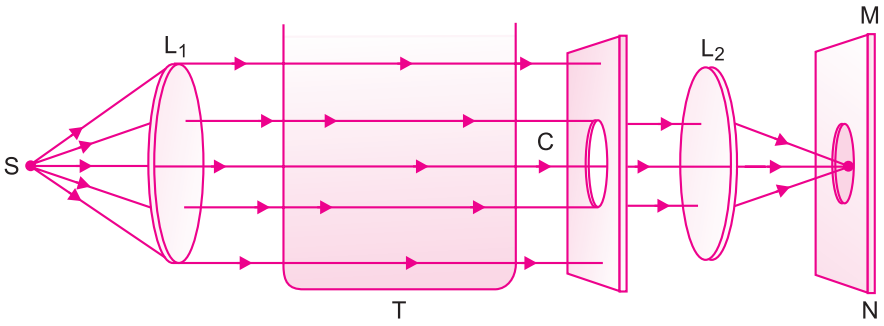
Observation:



Dispersion of white light by the glass prism

ACTIVITY 11.3

- Place a strong source (S) of white light at the focus of a converging lens (L_1). This lens provides a parallel beam of light.
- Allow the light beam to pass through a transparent glass tank (T) containing clear water.
- Allow the beam of light to pass through a circular hole (c) made in a cardboard. Obtain a sharp image of the circular hole on a screen (MN) using a second converging lens (L_2), as shown in figure below.
- Dissolve about 200 g of sodium thiosulphate (hypo) in about 2 L of clean water taken in the tank. Add about 1 to 2 mL of concentrated sulphuric acid to the water. What do you observe?



An arrangement for observing scattering of light in colloidal solution.

Observation: Sulphur particles precipitate in water from sodium thiosulphate. The beaker appears to give blue light on its sides as the scattering of light takes place. While the light obtained on the screen is red in colour because all blue light has scattered and red light travels through the beaker, will not get scattered due to small particles in beaker and passes straight and gets collected on the screen.

NCERT IN-TEXT ACTIVITIES SOLVED

Q1. *What is meant by power of accommodation of the eye?*

Ans. The ability of the eye to focus the distant objects as well as the nearby objects on the retina by changing the focal length of the eye lens is called power of accommodation.

Q2. *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. A person with a myopic eye can use concave lens to restore proper vision.

Q3. *What is the far point and near point of the human eye with normal vision?*

Ans. The far point is infinity and the near point is 25 cm of the human eye with normal vision.

Q4. *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 is suffering with the eye defect named myopia, in this defect person can see nearby objects clearly but cannot see far off objects distinctly. It can be corrected by using concave lens.

QUESTION FROM NCERT TEXTBOOK

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*

Ans. (*b*) accommodation

Q2. *The human eye forms the image of an object at its*

(*a*) *cornea.* (*b*) *iris.*

(*c*) *pupil.* (*d*) *retina.*

Ans. (*d*) retina.

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.*

Ans. (*a*) 25 cm

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.*

Ans. (*c*) ciliary muscles.

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?*

Ans. The focal length of a lens is given by

$$\left(P = \frac{1}{f}\right), \quad f = \frac{1}{P}$$

(*i*) For distant vision

$$f = \frac{1}{-5.5\text{D}} = -0.18$$

(*ii*) For near vision

$$f = \frac{1}{P} \text{ i.e., } f = \frac{1}{1.5D} = 0.67\ m$$

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?*

Ans. For the myopic eye

$$u = -\alpha$$

$$v = -80 \text{ cm}$$

$$f = 1$$

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f} \text{ lens formula}$$

$$\frac{1}{-80\,\text{cm}} = \frac{1}{-\alpha} = \frac{1}{f}$$

$$\therefore \quad f = -80 \text{ cm} = -0.80 \text{ m}$$

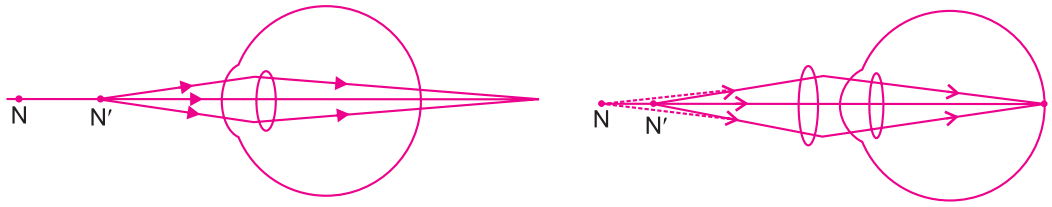
Power of the lens is $P = \frac{1}{f}$

$$\therefore \quad P = \frac{1}{-0.80 \text{ m}} = -1.25\ D$$

A concave lens; $P = -1.25\ D$.

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.*

Ans.



(a) (b)

(a) The hypermetropic eye, and (b) correction for hypermetropia with a convex lens

$$u = -25 \text{ cm}, \ v = -1 \text{ m} = -100 \text{ cm}$$

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

$$= \frac{1}{-100} - \frac{1}{(-25)} = \frac{1}{100} + \frac{1}{25}$$

$$= \frac{-1+4}{100} = \frac{3}{100} \text{ or } f = \frac{1}{3} \text{ m}$$

$$P = \frac{1}{f} = \frac{1}{1/3} = 3\text{D (convex lens)}$$

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

Ans. Ciliary muscles can contract the lens of human eye to a certain limit because of which a person with normal vision can see the nearby objects clearly only if placed at 25 cm but if the object is placed closer to the eye than it cannot see the objects clearly.

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

Ans. The image distance in the eye remains the same. On increasing the distance of an object from the eye, the focal length of the eyes changes due to ciliary muscles which helps an eye to focus the object image on retina.

Q10. *Why do stars twinkle?*

Ans. Stars twinkle due to atmospheric refraction of light from the stars and changing density of air around the earth.

Q11. *Explain why the planets do not twinkle.*

Ans. Planets are much closer to earth and behave like extended source.

Q12. *Why does the sun appear reddish early in the morning?*

Ans. When the sun rises early in the morning (or set in the evening), the light from sun travels through the thicker layer of air and larger distance of the atmosphere surrounding the earth. Hence the blue light scatters the most but red light does not scatters and reaches our eyes.

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

Ans. In space there are no particles, air, gases, water droplets etc., present to scatter the light. So when the astronauts look at the sky in the space, there is no light entering our eyes, hence it appears dark.

MORE QUESTIONS SOLVED

I. MULTIPLE CHOICE QUESTIONS

1. The image formed on the retina of human eye is

(*a*) virtual and erect (*b*) real and inverted

(*c*) virtual an inverted (*d*) real and erect

2. The change in the focal length of human eye is caused due to

(*a*) ciliary muscles (b) pupil

(*c*) cornea (d) iris

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

(*a*) 25 m (*b*) 20 m

(*c*) 25 cm (*d*) 20 cm

4. The persistence of vision for normal eye is

(*a*) $\left(\frac{1}{10}\right)$th of a second (*b*) $\left(\frac{1}{16}\right)$th of a second

(*c*) $\left(\frac{1}{6}\right)$th of a second (*d*) $\left(\frac{1}{18}\right)$th of a second

5. The light sensitive cell present on retina and is sensitive to the intensity of light is:
(*a*) cones (*b*) rods
(*c*) both rods and cones (*d*) none of these

6. The phenomenon of light responsible for the working of the human eye is
(*a*) reflection (*b*) refraction
(*c*) power of accommodation (*d*) persistence of vision.

7. Which of the following colours is least scattered by fog, dust of smoke?
(*a*) Violet (*b*) Blue
(*c*) Red (*d*) Yellow

8. The coloured light that refracts most while passing through a prism is
(*a*) Yellow (*b*) Violet
(*c*) Blue (*d*) Red

9. The amount of light entering the human eye is controlled by
(*a*) Ciliary muscles (*b*) Pupil
(*c*) Cornea (*d*) Iris

10. Which part of the eye refracts light entering the eye from external objects?
(*a*) Lens (*b*) Cornea
(*c*) Iris (*d*) Pupil

11. The component of white light with greatest wavelength is
(*a*) Violet (*b*) Red
(*c*) Green (*d*) Blue

12. The focal length of human eye lens can be changed due to
(*a*) Iris (*b*) Ciliary muscles
(*c*) Contact lens (*d*) Spectacles

13. Colour blindness is caused due to
(*a*) lack of rod cells (*b*) absence of optic nerve
(*c*) lack or cone cells (*d*) none of these

14. Long-sightedness or hypermetropia can be corrected by
(*a*) Contact lens (*b*) Concave lens
(*c*) Convex lens (*d*) Bifocal lens

15. A student of class 10, is not able to see clearly the black board Question when seated at a distance of 5 m from the board, the defect he is suffering from is
(*a*) Myopia (*b*) Hypermetropia
(*c*) Presbyopia (*d*) Astigmatism

16. The part of eye that determines the colour of the eye of a person is
(*a*) Pupil (*b*) Cornea
(*c*) Retina (*d*) Iris

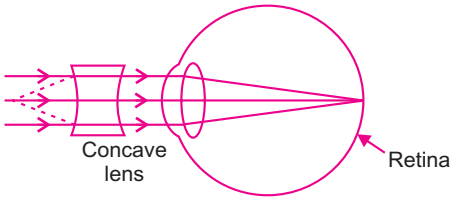
17. The glass has greater refractive index for
(*a*) Violet light (*b*) Green light
(*c*) Blue light (*d*) Red light

18. The colour of sky is blue during day time, red during sunset and black at night. This is due to

(*a*) Scattering of light (*b*) Small particles present in atmosphere

(*c*) Atmospheric refraction (*d*) All of the above.

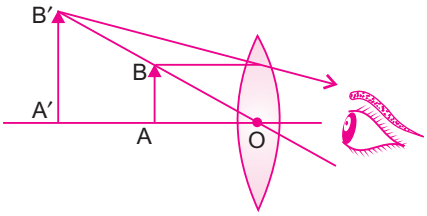
19. The eye defect represented by the figure is



(*a*) Myopia (*b*) Hypermetropia

(*c*) Cataract (*d*) Presbyopia

20. The following illustration represents the



(*a*) Correction of eye defect (*b*) working of a simple microscope

(*c*) both (a) and (b) (*d*) none of the above

Answers

1. (*b*)	**2.** (*a*)	**3.** (*c*)	**4.** (*b*)	**5.** (*b*)
6. (*b*)	**7.** (*c*)	**8.** (*b*)	**9.** (*b*)	**10.** (*b*)
11. (*b*)	**12.** (*b*)	**13.** (*c*)	**14.** (*c*)	**15.** (*a*)
16. (*d*)	**17.** (*a*)	**18.** (*d*)	**19.** (*a*)	**20.** (*b*)

II. VERY SHORT ANSWER TYPE QUESTIONS (*1 Mark*)

Q1. *Name the transparent membrane through which light enters first in the eye.*

Ans. Cornea.

Q2. *What is the diameter of human eye?*

Ans. 2.3 cm

Q3. *Name the light sensitive part of the eye where image of an object is formed.*

Ans. Retina

Q4. *What is the function of iris?*

Ans. Iris controls the size of the pupil.

Q5. *What are light sensitive cells?*

Ans. Rods and cones.

Q6. *What type of image is formed on the retina?*

Ans. Real, inverted image.

Q7. *Why is inverted image formed on the retina of human eye?*

Ans. The inverted image is formed due to the eye lens which is convex in shape. Through it the light rays enters to form the real, inverted image.

Q8. *What type of signals are generated and sent to the brain by light sensitive cells of retina?*

Ans. Electrical signals.

Q9. *Which part of the human eye controls the amount of light entering the eye?*

Ans. Pupil.

Q10. *What is the function of crystalline lens of human eye?*

Ans. The crystalline lens provides the proper focal length required to focus objects at different distances on the retina.

Q11. *What holds the crystalline lens in the human eye?*

Ans. Ciliary muscles.

Q12. *Which part of the human eye helps in changing the thickness of lens?*

Ans. Ciliary muscles.

Q13. *Name the disease in which crystalline lens of human eye becomes opaque.*

Ans. Cataract.

Q14. *Which is the range of vision of normal eye?*

Ans. 25 cm to infinity.

Q15. *Define least distance of distinct vision.*

Ans. The minimum distance at which the objects can be seen clearly without any strain is called least distance of distinct vision. It is the near point of eye and is equal to 25 cm.

Q16. *What is persistence of vision?*

Ans. When the image is formed on retina it remains there for 1/16th of a second and this property of eye is called persistence of vision.

Q17. *Define the power of accommodation of human eye.*

Ans. The ability of eye to see nearby as well as far off objects at the same time is called power of accommodation.

Q18. *In which type of eye defect far point of the eye gets reduced?*

Ans. Myopia.

Q19. *In which type of eye defect near point of the eye becomes more than 25 cm?*

Ans. Hypermetropia.

Q20. *What is presbyopia?*

Ans. It is the defect of eye in which one cannot see nearby as well as far objects clearly.

Q21. *What type of lens should be used to correct the presbyopia?*

Ans. Bi-focal lens. Concave-convex lens. 

Q22. *What is dispersion of light?*

Ans. The splitting of light into its various components (*i.e.*, 7 colours) is called dispersion of light.

Q23. *Define angle of prism.*

Ans. The angle formed due to two lateral faces of the prism is called the angle of prism.

Q24. *What is spectrum?*

Ans. The band of seven colours obtained due to the dispersion of white light is called spectrum.

Q25. *In visible spectrum which colour has longest wavelength.*

Ans. Red.

Q26. *Give one main difference between the lens of human eye and lens of camera.*

Ans. Lens of human eye has flexible aperture, its focal length can be changed. In camera focal length can not be changed for a lens.

Q27. *What is Tyndall effect?*

Ans. Scattering of light in the nature due to small particles present in the atmosphere is called Tyndall effect.

III. SHORT ANSWER TYPE QUESTIONS (*2 or 3 Marks*)

Q1. *How does eye control the amount of light entering it?*

Ans. The amount of light entering the eye is controlled by the pupil and further the size of the pupil is controlled by iris.

Q2. *The image formed on retina is inverted but we see the object erect. Why?*

Ans. The image formed on retina is inverted, this image is formed on the light sensitive cells called rods and cones of the retina which generates electrical signals. This signal reaches brain via optic nerve. It is the brain that interprets this image and while processing the image it helps in perceiving objects as they are.

Q3. *Why do birds fly back to their nest in the evening?*

Ans. Birds lack light sensitive cells called rods, due to lack of these cells they cannot see the objects clearly in less/dim light.

Q4. *Why danger signals are red?*

Ans. Danger signals are of red colour, as it scatters the least and can be seen from the maximum distance.

Q5. *Why do you take time to see objects when you enter a dim lighted room from outside in the sun?*

Ans. In the sun light the size of pupil, is small but when one enters the dim light, it takes some time for iris to adjust the size of pupil and the light sensitive cells take some time to get activated.

Q6. *Why are two eyes more helpful for us to see as compared to one?*

Ans. Two eyes are more helpful as one eye gives only a view of 150° angle where as two eyes increase the view by making it wide to 180° angle. Two eyes also helps us to see

the objects in dim light or darkness clearly. Two eyes give stereoscopic vision helping us assess the depth of vision.

Q7. *When white light enters the prism, which colour of light deviates/bends the least and which colour bends the most?*

Ans. The light that bends the least is red colour and the light that bends the maximum is violet colour light.

Q8. *Explain the phenomenon which causes twinkling of stars.*

Ans. The phenomenon is atmospheric refraction. In this case the star are point source illuminated objects which are very far from us when light travels through atmosphere it bends, and due to this the amount of light entering the eye is different each time which gives the twinkling effect.

Q9. *Why does a ray of light splits into different colours on passing through a glass prism?*

Ans. When light rays enter the glass prism the angle at which it bends makes the light split into its seven components because the speed of each component of light is different and due to the bending every component shows its different ability to pass through it.

Q10. *In dispersion of white light through prism, which colour deviates most and which colour the least? Why do they deviate differently?*

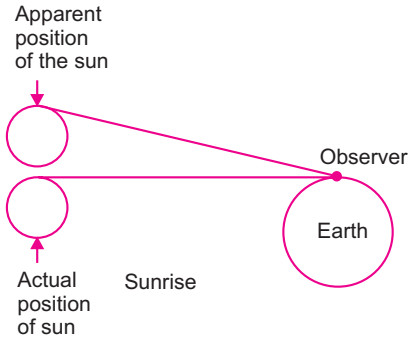
Ans. The colour of light that deviates least is red and violet deviates the maximum. The difference in deviation is due to the difference in wavelength and speed of each colour of light, also due to different bending ability when it passes through the prism.

Q11. *The sun appears to be red at the time of sunset and sunrise. Give the reason.*

Ans. Sun appears red during sunset or sunrise because at this time the sun is far from the earth and the light that reaches the earth from the sun scatters the most and all other colours of light gets scattered. The least scattered light is red and it enters our eye.

Q12. *Give reason for early sunrise and delayed sunset.*

Ans.



Sun being far off the light rays entering our eye gets refracted several times due to the atmosphere and the sunrise and sunset are seen to us due to the bending of light and that light enters our eye to visualise the sun at that particular point.

Q13. *Why doesn't planets appear to be twinkling?*

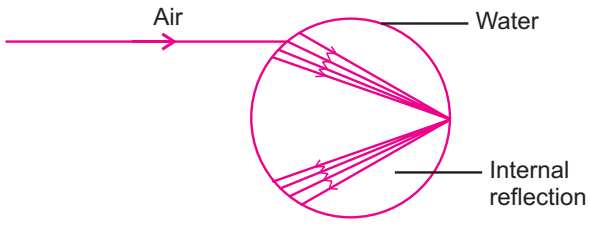
Ans. Planets are big enough and quite closer to the earth, due to these two properties the planets do not appear to be twinkling.

Q14. *What is the direction of rainbow formation? What is the position of red colour in rainbow?*

Ans. Rainbow is always formed in the direction opposite to sun. The position of red colour in the rainbow is at the top.

Q15. *What is internal reflection?*

Ans. When a light rays enters from one medium to another (e.g., rarer to denser *i.e.*, air to water droplet) then a ray of light instead of passing through it reflects in the second medium then it is said to be internal reflection of light.



Q16. *A short-sighted person cannot see clearly beyond 5 cm. Calculate the power of lens required to correct his vision to normal?*

Ans. $f = -5$ cm

$$P = \frac{1}{f} = -\frac{1}{5} = 0.20$$

$\therefore$ Power = 0.2 Dioptre

Q17. *Why can't we see object very close to our eye?*

Ans. The objects are seen only when the image forms on retina when the light rays pass through the lens. The lens has its fixed ability of changing the focal length with the help of ciliary muscles.

Ciliary muscles cannot be contracted beyond a certain limit to change the focal length of eye lens. The objects kept very close to our eye cannot be focused by ciliary muscles.

Q18. *What is night blindness and colour blindness?*

Ans. When a person lacks rod cells in retina he is not able to see the objects clearly in less/dim light, such a defect is called night blindness.

When a person lacks cone cells in retina he is not able to see/distinguish between different colours, such a defect of eye is called as colour blindness.

Q19. *What is myopia? How can it be corrected?*

Ans. Myopia is an eye defect also called short-sightedness. In this type of defect person can see nearby objects clearly but cannot see far off objects clearly. It may be caused due to the increase in the size of eye ball or due to the decrease in the focal length of the eye lens.

Correction–It can be corrected by using concave lens of appropriate focal length.

Q20. *What is hypermetropia? How can it be corrected?*

Ans. Hypermetropia is an eye defect also called as long-sightedness. Person can see a far off objects but cannot see nearby objects. It is because the image is formed beyond retina.

Cause – (*a*) The focal length of the eye lens is too long.

(*b*) The eyeball has become too small.

Correction: It can be corrected by using convex lens of appropriate power.

Q21. *What is presbyopia? How can it be corrected?*

Ans. Presbyopia is caused due to decrease in the power of accommodation of the eyes due to ageing and weakening of ciliary muscles diminishing flexibility of eye lens. A person with this defect cannot see nearby as well as far off objects clearly.

Correction: It can be corrected by using bi-focal lens with both concave and convex lens in it.

Q22. *Why does the sky appears blue during day time, red during sunrise and sunset and black to an astronaut.*

Ans. Sky appears blue during day time because the light of sun gets scattered and the most scattered light is blue, so the sky appears blue.

During evening and early morning when the sun is not over head but it is below the horizon, the only light that reaches our eye is red and hence the sky appear to be reddish in colour.

For an astronaut the sky appears to be black because there is no atmosphere that can refract the light.

Q23. *Give the difference between myopia and hypermetropia.*

Ans.

S.No.	*Myopia*	*Hypermetropia*
1.	Short-sightedness—can see nearby object but cannot see far off objects.	Long-sightedness—can see far off objects but cannot see nearby objects.
2.	Image is formed in front of retina.	Image is formed beyond retina.
3.	The size of eyeball increases.	The size of eyeball decreases.
4.	Focal length of eye lens decreases.	Focal length of eye lens increases.
5.	Corrected by using concave lens.	Corrected by using convex lens.

Q24. *Distinguish between presbyopia and hypermetropia.*

Ans.

S.No.	*Hypermetropia*	*Presbyopia*
1.	Only far-sightedness.	It can be only far-sightedness or both far and short-sightedness.
2.	Eye ball becomes short or the focal length increases.	Ciliary muscles become weak and able to adjust the focal length.
3.	Corrected by using convex lens.	Corrected by using bifocal lens.

Q25. *The near point of hypermetropic eye is 80 cm. What is the nature and power of the lens required to enable him to read a book placed at 25 cm from the eyes?*

Ans. Near point = 80 cm

Object distance u = – 25 cm

$v = -80$ cm (convex lens in case of hypermetropia)

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

$$= \frac{1}{(-80)} - \frac{1}{(-25)}$$

$$\therefore \quad \frac{1}{f} = \frac{-1}{80} + \frac{1}{25} = \frac{-5+16}{400}$$

$$\frac{1}{f} = \frac{+11}{400}$$

$$\therefore \quad f = \frac{400}{11} = 36.36 \text{ cm}$$

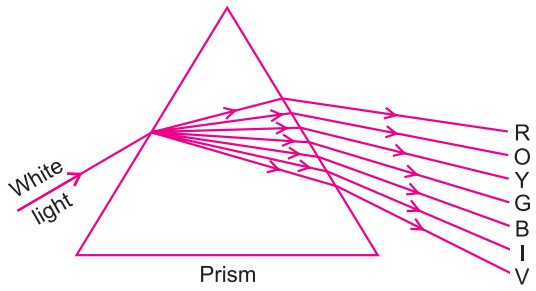
$$f = 0.36 \text{ m}$$

Power of lens $P = \frac{1}{f} = \frac{1}{0.36} = 2.7$ D

Q26. *What is meant by dispersion of white light? Draw a ray diagram to show the dispersion of white light by a glass prism. Give reason why do we get different colours of light?*

Ans. **Dispersion of light:** The splitting of white light into seven colours on passing through a transparent medium like glass prism is called dispersion of light.

Diagram : Dispersion of light



We get different colours because each colour of light has different bending ability when they pass through the glass prism.

Q27. *A student can see objects clearly only when the objects are lying at distances between 60 cm and 320 cm from the eye.*

(a) What kind of eye defect he is suffering from?

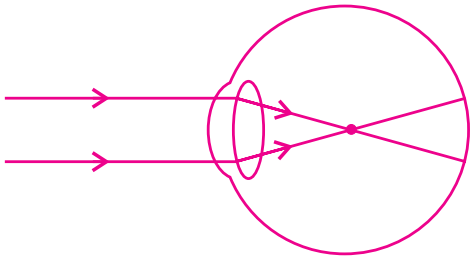
(b) What kind of lens will be required to increase his range from 25 cm to infinity? Explain briefly.

Ans. Student is suffering from myopia. It can be corrected by using concave lens of appropriate focal length and power. The light rays meet before retina and hence concave lens will help the rays to diverge further and help them in meeting on retina.

Q28. *When we see any object through the hot air over the fire, it appears to be wavy, moving slightly. Explain.*

Ans. The objects beyond the hot air appears to be wavy because the medium for light to pass through changes, the light passes from denser to rarer and then again to denser medium thereby causing refraction in the air. Moreover the refractive index of the hot air keeps changing which leads to give the wavy appearance of the object.

Q29. *Study the diagram given below and answer the questions that it follows:*



(*a*) *Name the defect and give reason.*

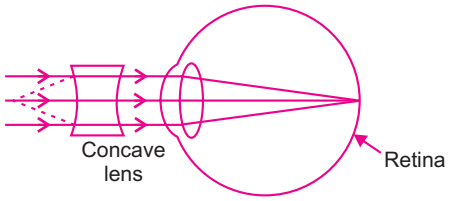
(*b*) *Give 2 causes for this defect.*

(*c*) *Give the correction – draw diagram for the same.*

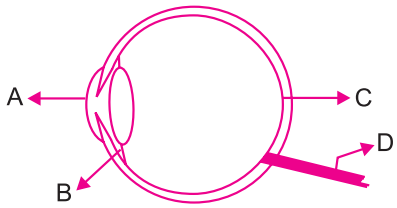
Ans. (*a*) The defect is myopia, short-sightedness

(*b*) It is caused due to the decrease in the focal length of the eye lens and increase in the size of the eye ball.

(*c*) The defect can be corrected by using the concave lens.



Q30. *In the given diagram label A, B, C and D and give the function of B and D.*



Ans. A = Cornea

B = Ciliary muscles

C = Retina

D = Optic nerve

Function of B and D are:

B : Ciliary muscles: It helps in holding the eye lens and changing or adjusting the focal length of the lens.

D : Optic nerve: It sends the electrical signal from retina to the brain.

Q31. *Near point of a hypermetropic eye is at 1 m. Find the focal length, power and nature of lens used to correct this defect.*

Ans. Near point of hypermetropic eye is 1 m *i.e.*, 100 cm. The eye cannot see objects between 100 cm and 25 cm.

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

$$v = -1 \text{ m} = -100 \text{ cm}$$

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

$$= \frac{-1}{100} - \frac{1}{(-25)}$$

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

$$\frac{1}{f} = \frac{-1+4}{100} = \frac{3}{100}$$

$$\therefore \quad f = \frac{100}{3} \text{ cm} = \frac{1}{3} \text{ m}$$

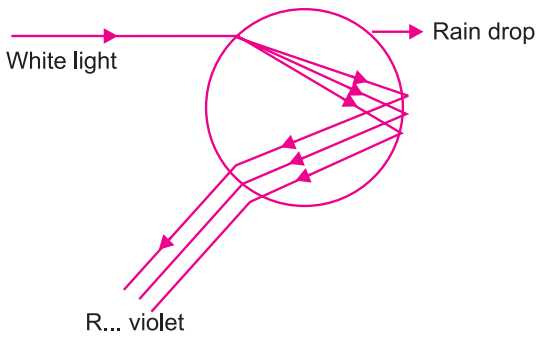
$$P = \frac{1}{f} = \frac{1}{1/3} \text{m}$$

$$\therefore \quad P = +3 \text{ Dioptre}$$

Convex lens of power 3D is used to correct this defect.

Q32. *Draw a labelled diagram of rainbow formation. Also explain the phenomenon of rainbow formation.*

Ans.



When sun light splits due to water drops suspended in air, causing the band of seven colours is called rainbow.

Water droplets acts as tiny prism in the sky. The sunlight when enters these tiny droplets undergo internal reflection and also refract these rays which are dispersed causing a band of seven colours called rainbow.

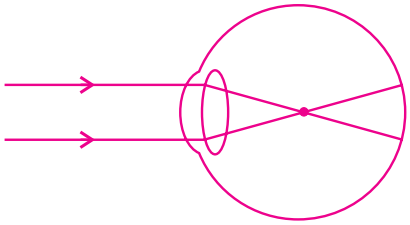
Rainbow is always formed in the direction opposite to the sun.

Q33. (*a*) *Draw a diagram to show the formation of image of a distant object by a myopic eye. How can such an eye defect be remedied?*

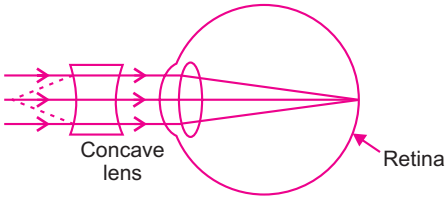
(*b*) *State two reasons due to which this eye defect may be caused.*

(*c*) *A person with a myopic eye cannot see objects beyond a distance of 1.5 m. What would be the power of the corrective lens used to restore proper vision?* (CBSE 2008)

Ans. (*a*) Object at infinity, image is formed in front of retina.



Corrected by concave lens



(*b*) Myopia is caused due to:

(*i*) Elongation of eye ball

(*ii*) Excessive curvature in cornea, focal length decreases.

(*c*) Far point of myopic eye is 1.5 m = u

to change far point to infinity = v

focal length of power $\rightarrow$ P = ?, F = ?

$$\therefore \quad \frac{1}{f} = \frac{1}{v} - \frac{1}{u} \quad \text{(Lens formula)}$$

$$\frac{1}{f} = \frac{1}{-1.5} - \frac{1}{-\infty} = -\frac{1}{1.5\ \text{m}}$$

$$\therefore \quad f = -1.5\ \text{m}$$

$$\text{P} = \frac{1}{f} = \frac{1}{-1.5} = 0.67 \text{ dioptre.}$$

Q34. *Why is red colour selected for danger signal lights?* (CBSE 2008)

Ans. Red colour light has maximum wavelength, it does not scatter due to atmosphere and reaches our eyes, travels fast and hence used for danger signals.

Q35. (*a*) *What is meant by dispersion of white light? Describe the formation of rainbow in the sky with the help of a diagram.*

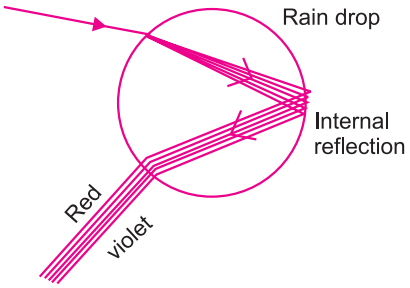
(*b*) *What is hypermetropia? Draw ray diagrams to show the image formation of an objects by*

(*i*) *hypermetropic eye*

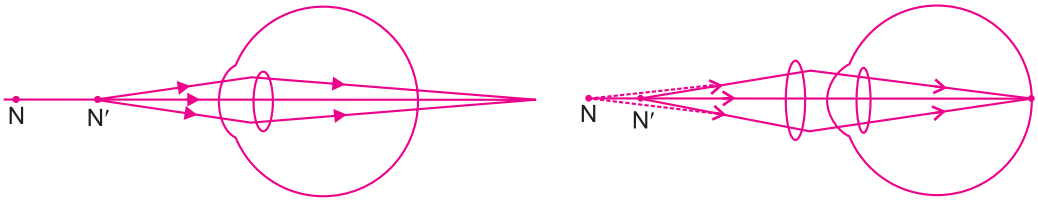
(*ii*) *Correction made with a suitable lens for hypermetropic eye.* (AI CBSE 2008)

Ans. (*a*) The splitting of white light into its constituent seven colours is called dispersion of light.

Rainbow formation in the sky: The water droplets suspended in the atmosphere after rain causes the splitting of sunlight by acting as small prism. The light enters the water droplets, refracts, splits and shows internal reflection. The red colour band is wider than violet or blue colour.



(*b*) **Hypermetropia:** Also called long-sightedness. Person can see long distant objects but cannot see nearby objects distinctly. This is because the eye ball becomes smaller, focal length increases. It can be corrected by using converging lens called convex lens.



(*i*) Hypermetropic eye (*ii*) correction of hypermetropia eye

Q36. (*a*) *Give reasons for the following:*

(*i*) *Colour of the clear sky is blue.*

(*ii*) *The sun can be seen about two minutes before actual sunrise.*

(*iii*) *We cannot see an object clearly if it is placed very close to the eyes.*

(*b*) *What is presbyopia? Write two causes of this defect.* (AI CBSE 2008)

Ans. (*a*) (*i*) Clear sky appears blue because the white light of sun when enters the earth's atmosphere the large number of molecules present in the earth's atmosphere scatter the light. As blue light scatters the maximum it reaches our eyes.

(*ii*) The sun is visible to us 2 minutes before the actual sunrise because of atmospheric refraction. When the sun is below the horizon, the light travelling from rarer to denser medium bends and reaches our eyes creating an impression that it is above the horizon.

(*iii*) A normal human eye has a near point of 25 cm, anything closer to it is not seen clearly.

(*b*) **Presbyopia:** This defect is caused due to ageing. The person suffering from this disease cannot see nearby as well as far off objects. It is caused due to weakening of ciliary muscles. The lens is not able to change the focal length. It can be corrected by using bi-focal lens.

Q37. (*a*) *What is hypermetropia?*

(*b*) *What are the two causes of the defect of vision?*

(*c*) *How can this defect of the eye be corrected? Illustrate your answer by drawing ray diagrams to show the formation of image by*

(*i*) *a hypermetropic eye*

(*ii*) *a hypermetropic eye corrected with a suitable lens.* (CBSE 2008 F)

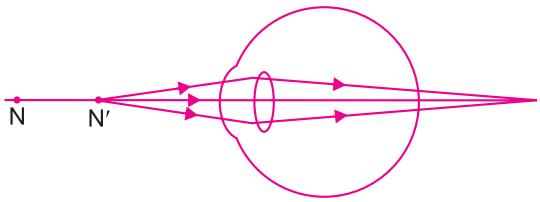
Ans. (*a*) **Hypermetropia:** It is also called long-sightedness. The person with this eye defect can see far off objects but cannot see nearby objects clearly. The image is formed beyond retina.

(*b*) **Two causes**

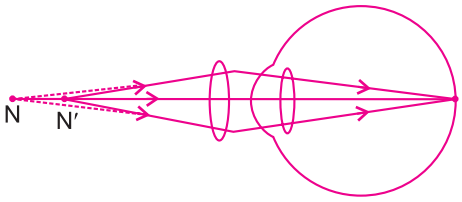
(*i*) Focal length of the lens increases

(*ii*) Eye ball becomes smaller

(*c*) **Correction:** It can be corrected by using a convex lens. It is a converging lens which shifts the image of the object on the retina.



A Hypermetropic eye



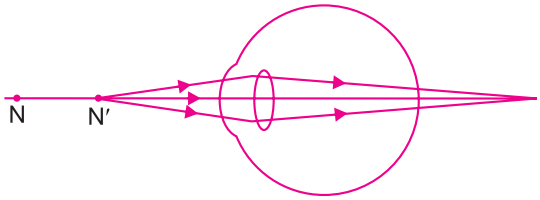
Correction of hypermetropia eye

Q38. *Study the diagram given below and answer the question that it follows:*

(*a*) *Which defect of vision is represented in this case? Give reason for your answer.*

(*b*) *What could be the two causes of this defect?*

(*c*) *With the help of a diagram show how this defect can be corrected by the use of a suitable lens.* (CBSE 2008 C)



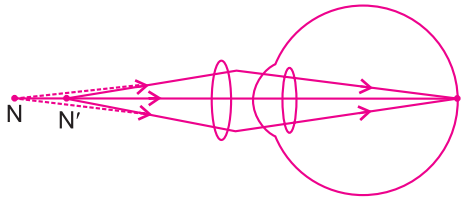
Ans. (*a*) The defect is hypermetropia, as the image of near point is formed beyond retina.

(*b*) Two causes of the defect are:

(*i*) Size of eye ball decreases.

(*ii*) Focal length of the lens increases.

(*c*) This defect can be corrected by using a convex lens of suitable focal length.



Q39. *Why does sky look blue on a clear day?*

Ans. White light scatters due to atmospheric refraction. White light is made up of seven colours out of which, blue light scatters the most hence the sky looks blue.

Q40. *What is hypermetropia? State the two causes of hypermetropia. With the help of ray diagram show:*

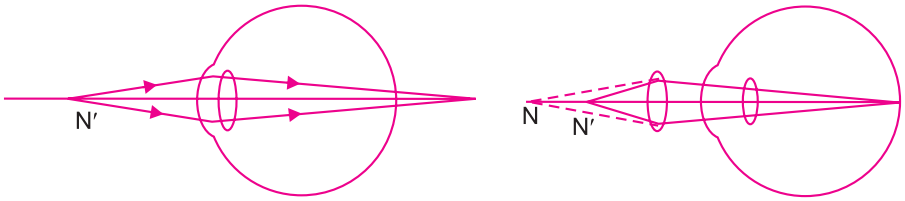
(i) the eye defect hypermetropia.

(ii) correction of hypermetropia by using a lens. (CBSE 2009)

Ans. **Hypermetropia:** Defect of a vision in which a person can see distant objects clearly but cannot see nearby objects clearly.

Causes: (*a*) Focal length of the eye lens is too large.

(*b*) Eye ball has become too small.



(*i*) (*ii*)

Q41. (*a*) *What is myopia? State the two causes of myopia and with the help of a labelled ray diagrams show:*

(i) the eye defect myopia.

(ii) correction of myopia using a lens.

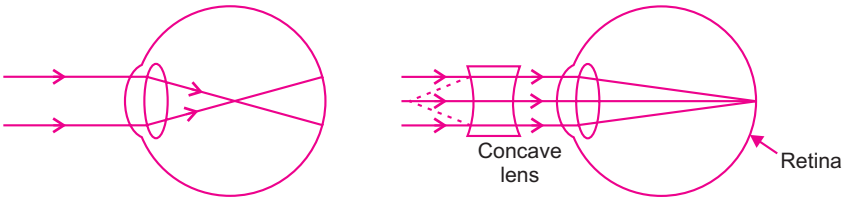
(*b*) *Why is the normal eye unable to focus on an object placed within 10 cm from the eye?* (AI CBSE 2009)

Ans. (*a*) Myopia or short-sightedness—Eye can see objects at short distance. Inability of the eye in viewing long distant objects. The image falls before retina.

Causes: (*i*) Elongation of eye ball.

(*ii*) Excessive curvature in cornea.

Correction: By using concave lens (diverging lens), which shifts the image to the retina by diverging the rays further.



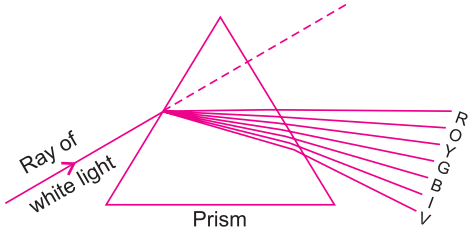
(*b*) The near point of human eye is 25 cm which cannot be changed further hence the objects within 10 cm of the eye cannot be viewed.

Q42. (*a*) *What is dispersion of white light? What is the cause of such dispersion? Draw a diagram to show the dispersion of white light by a glass prism.*

(*b*) *A glass prism is able to produce a spectrum when white light passes through it but a glass slab does not produce any spectrum. Explain why?* (AI CBSE 2009)

Ans. (*a*) Dispersion of white light is splitting of light into its seven constituent colours forming a band of VIBGYOR called spectrum.

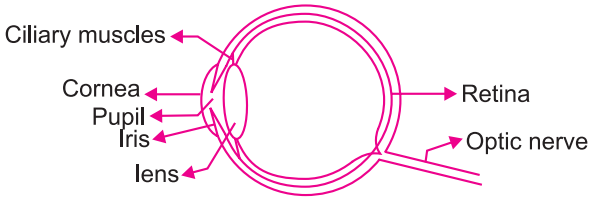
Cause: White light is made up of seven colours, each colour has different speed in different media. Due to different speed, the bending ability varies and the colours split/separate.



(*b*) Dispersion does not take place in glass slab as two refracting surfaces are parallel. The light does not split into its constituent colours.

IV. LONG ANSWER TYPE QUESTIONS (*5 Marks*)

Q1. *Draw a neat labelled diagram of human eye and explain the working of each part of it.*



Ans. **Working of Human eye**

Human eye consists of various parts which helps us in seeing the objects, the function of various parts are:

(*a*) **Cornea:** It is the transparent membrane which refracts the light entering our eye.

(*b*) **Iris:** Iris controls the size of pupil.

(*c*) **Pupil:** It allows the light entering our eye to pass through it.

(*d*) **Lens:** Adjusts the focal length of the eye to see the objects at different places.

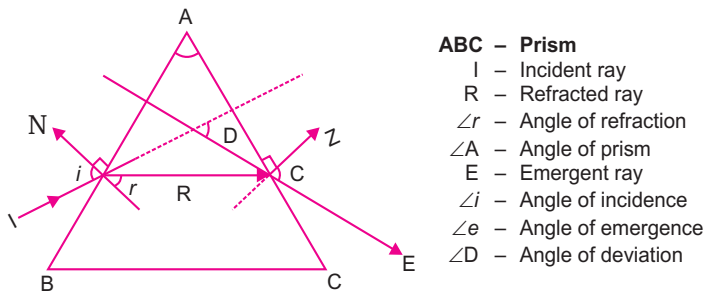
(*e*) **Ciliary muscles:** Helps in changing the focal length of the lens.

(*f*) **Retina:** It is the screen of the eye on which image is formed. It consists of rods and cones.

(*g*) **Optic nerve:** It carries the electrical signals from retina to brain.

Q2. *Describe with the help of diagram, how the refraction of light takes place through a glass prism.*

Ans.



ABC – Prism
I – Incident ray
R – Refracted ray
$\angle r$ – Angle of refraction
$\angle A$ – Angle of prism
E – Emergent ray
$\angle i$ – Angle of incidence
$\angle e$ – Angle of emergence
$\angle D$ – Angle of deviation

The incident ray I when enters the prism it gets refracted, bends and form $\angle r$ with the normal. Angle of refraction is smaller than the angle of incidence. The incident ray bends towards the normal, as it passes from rarer medium to denser medium. When this refracted ray passes from denser medium to rarer medium it bends away from the normal. This emergent ray has bent out at an angle to the direction of incident ray. This angle is called the angle of deviation $\angle$D.

Q3. *Name three refractive defects of vision with the help of diagram. Explain the reasons and correction of these defects.*

Ans. The three refractive defects of vision are

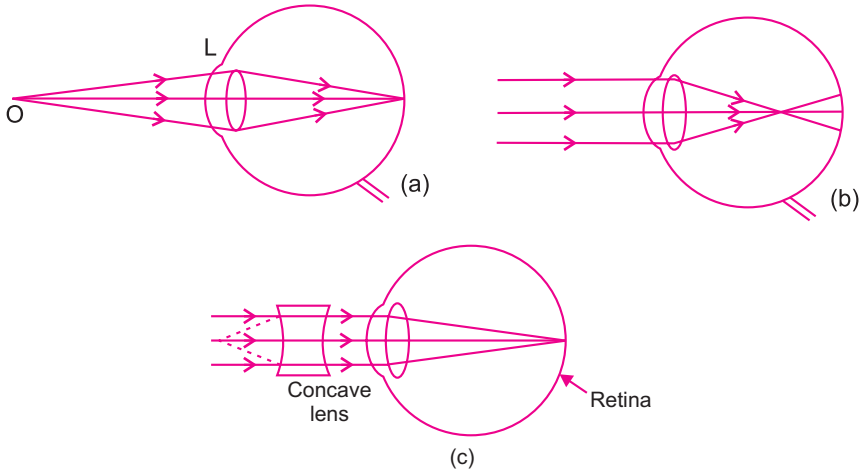
(I) Myopia

(II) Hypermetropia

(III) Presbyopia

(I) Myopia is short-sightedness, the image is formed in front of retina due to the elongation of the eye ball or due to decrease of focal length.

Correction – Using concave lens.



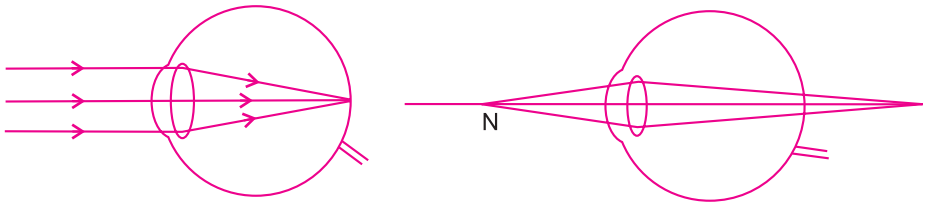
(*a*) Normal eye.

(*b*) Myopic eye, the image is formed in front of retina.

(*c*) Concave lens is used to correct the defect.

(II) Hypermetropia is long-sightedness, the image is formed behind the retina due to shortening of eyeball or due to increase in the focal length of the lens of eye.

Correction: Using convex lens.



Person cannot see nearby objects clearly.

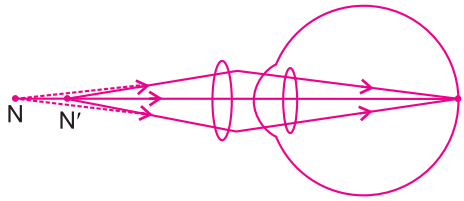


Fig. (*a*) Normal eye, (*b*) Hypermetropia eye, (*c*) Convex lens is used to correct the defect.

(III) Presbyopia: It is the defect of an eye in which the power of accommodation of the eye usually decreases with ageing. Near point changes as well as the far off objects are also not visible clearly. It is caused due to the weakening of ciliary muscles and the reduced flexibility of eye lens.

Such a defect in which a person suffers from both myopia and hypermetropia is called presbyopia. It is corrected by using bifocal lens.

V. QUESTIONS ON HIGH ORDER THINKING SKILLS (HOTS)

Q1. *How does the size of particles present in medium produce different colours of light by its scattering property?*

Ans. The colour of the scattering light in a medium depends on the size of the scattering particles.

(*i*) If the size of particles is very small, it will scatter mainly blue light.

(*ii*) If the size of particles is larger then it will scatter light of longer wavelength i.e., red.

(*iii*) If the size of scattering particles is larger enough, the light appears to be white.

Q2. *Give one use of the following properties of light:*

(*i*) *Scattering of light* (*ii*) *Persistence of vision*

(*iii*) *Power of accommodation* (*iv*) *Refraction of light*

(*v*) *Reflection of light*

Ans. (*i*) Due to scattering of light we can see the different colours of sky and rainbow formation.

(*ii*) Used in cinematography.

(*iii*) Eye can see both nearby and far off objects from same point.

(*iv*) We can see through lenses, eye defects can be corrected, we can see under water.

(*v*) Our eyes can see object only due to reflection of light by the object into our eyes.

Q3. *To correct myopia why we use concave lens and to correct hypermetropia, why do we use convex lens? Why can't we do vice-versa?*

Ans. Myopia is a defect in which the image is formed in front of retina. We need to use diverging lens so that it can further diverge the light rays before it enters our eye and make it possible to meet on the retina.

In case of hypermetropia, the image is formed beyond retina, we need to use convex lens so as to converge the rays and make it possible for the rays to meets on the retina.

Q4. *In presbyopia, we use bi-focal lens with upper portion concave lens and lower portion convex lens. Why is the arrangement so?*

Ans. The upper portion is concave lens so that our eyes can see the distant objects. When the rays come parallel from infinity it will pass through the upper part of spectacles. Whereas for the lower part consists of convex lens which facilitates our eye to see the near objects.

Q5. *Why does light splits into spectrum when it passes through prism only and does not split when it passes through glass slab?*

Ans. Rectangular glass slab has parallel refracting surfaces, the emergent ray is parallel to the incident ray. It slightly gets displaced laterally. While in case of prism the surface is not parallel and the light ray gets deviated at larger angle due to which it splits into its constituent colour.

VI. VALUE-BASED QUESTION

Q1. *Rohan's father is an eye surgeon. He persuaded his father to put a camp in his society for educating people on eye-donation. Rohan made a banner. One donation can give eye-vision to two blind persons.*

(*a*) *Name the part of the eye that is used during eye transplant.*

(*b*) *Name the defect that can be corrected by this transplant.*

(*c*) *What value of Rohan is reflected?*

Ans. (*a*) Cornea is used for eye transplant.

(*b*) Defects caused due to cornea can be corrected by eye donation.

(*c*) Rohan shows sympathy, compassion and empathy in his behaviour.

TEST YOUR SKILLS

Q1. *Draw a neat labelled diagram of human eye.*

Q2. *Define cornea.*

Q3. *Give one main difference between rods and cones.*

Q4. *What is colour blindness?*

Q5. *What is dispersion of white light?*

Q6. *What is myopia? How it can be corrected?*