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PHYSICS HUMAN EYE
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HUMAN EYE
REVISION MODULE

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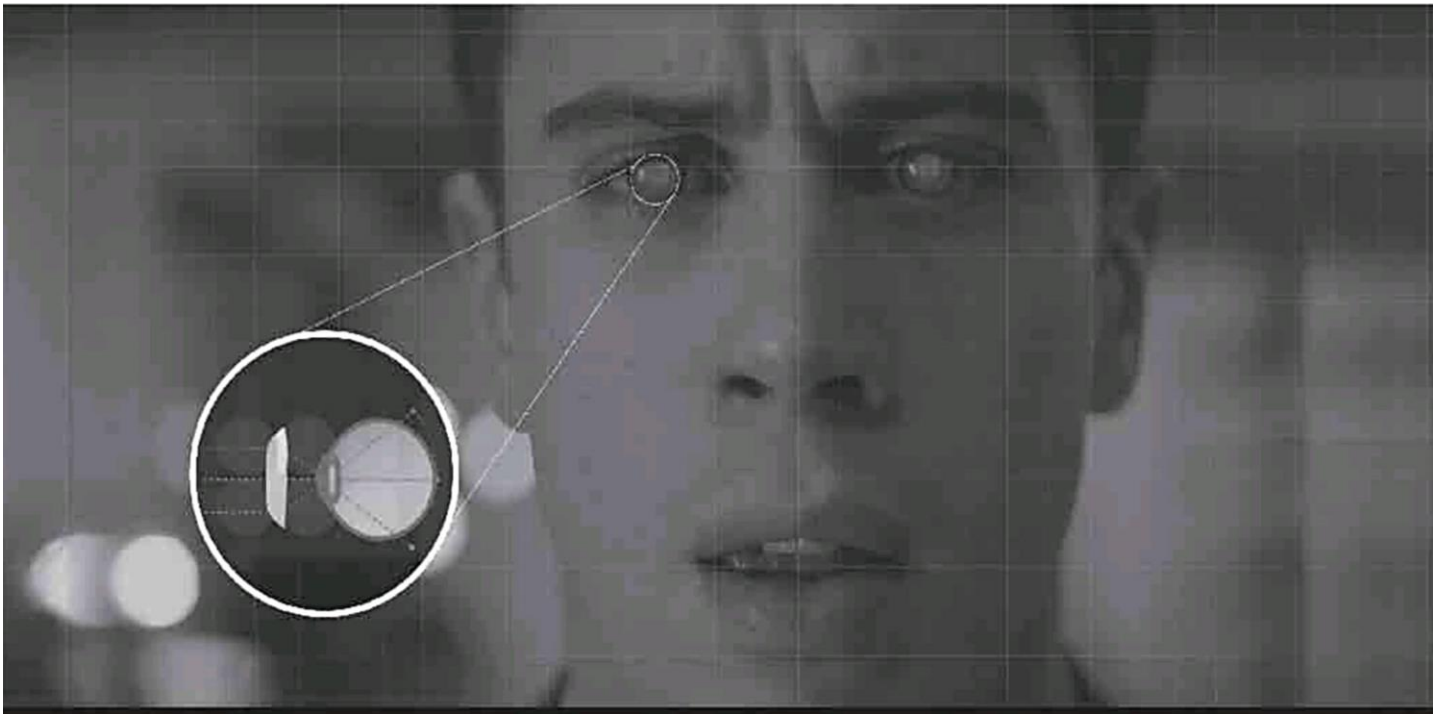
HUMAN EYE
COLOURFUL WORLD



The human eye uses light and enables us to see objects around us. The concept shown above is fixing the problem of far-sightedness by wearing contact lens (the ones we buy at Lenskart or even glasses we wear daily). Contact lenses work like a convex lens in this case to converge the light rays to your eye lens correctly.

Topic Notes

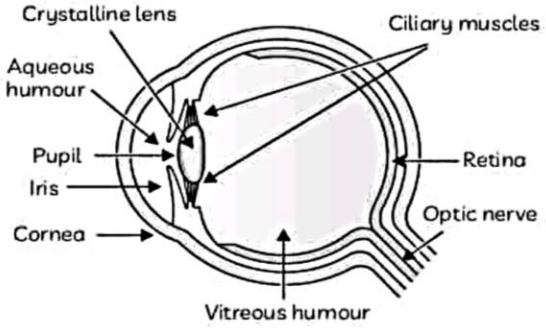
- *The Human Eye*
- *Defects of Vision*
- *Refraction of Light Through a Prism*
- *Dispersion of White Light by a Glass Prism*
- *Atmospheric Refraction*
- *Scattering of Light*

TOPIC 1

THE HUMAN EYE

Optical instruments, including our eyes, extend the range of our vision and enable us to see objects varying in size from very tiny, nearby objects to very large, distant objects. In this chapter we shall study about the human eye and optical phenomena in nature, such as rainbow formation, splitting of white light and blue colour of the sky, *etc.*

The human eye is one of the most wonderful sense organs as it enables us to see various things and colours around us. It is like a camera.



The Human Eye

Parts of the Human Eye

Retina

This is a light sensitive screen inside the eye on which an inverted and real image of an object is formed by the eye lens. It contains light sensitive cells called rods and cones.

Cornea

Cornea is a thin membrane covering the transparent bulge on the surface of the eyeball and through which light enters the eyes.

Aqueous Humour

Aqueous humour acts as a lens along with the cornea, and provides most of the refraction of light rays entering the eyes.

Crystalline Lens

Crystalline lens provides the finer adjustment of focal length required to focus objects lying at various distances on the retina. It is composed of a fibrous jelly like substance.

Iris

Iris is a dark muscular assembly which lies behind the cornea and controls the size of the pupil.

Pupil

Pupil is a variable aperture which regulates the amount of light entering the eyes. When the light is very bright, the pupil becomes very small (as the iris muscles contract) and in dim light, it opens up (as the iris muscles relax).

Ciliary Muscles

The ciliary muscles change the shape or curvature of the eye lens so that nearby as well as distant objects can be focused. The ciliary muscles contract when we are looking at nearby objects so that the eye lens becomes more round in shape thus reducing the focal length of the lens. When looking at distant objects, the eye lens relaxes, so that these objects can be seen clearly. The focal length of the eye lens is about 2.5 cm when the muscles are relaxed.

Visual Impairment

If due to a damage or malfunction of any part of the visual system, there is a significant loss of visual functioning, it is called visual impairment. It can be due to damage to any of the structures involved in the transmission of light such as cornea, pupil, eye lens, etc or those responsible for the conversion of light to electrical impulses, like the retina or optic nerve.

Power of Accommodation

Power of Accommodation is the ability of the eye lens to focus at nearby as well as distant objects by adjusting its focal length. For viewing nearby objects, the eye lens becomes thick and for viewing distant objects, the eye lens becomes thin.

Least distance of distinct vision or near point: It is the minimum distance at which objects can be seen most distinctly without strain and is 25 cm for a normal eye.

Far point: It is the farthest point upto which the eye can see objects clearly and is infinity for a normal eye.

Power of accommodation: It is the maximum variation of the power of the eye for focusing on near and distant objects and is about 4 dioptres for a young adult with normal vision.

Cataract: It occurs when the crystalline lens of our eyes becomes hazy or even opaque due to the development of a membrane over it. It usually occurs at old age and leads to the decrease or loss of vision, but can be corrected by surgery.

Reason for having two eyes: Having two eyes gives us a wider field of view of about 180° with two eyes as compared to 150° with one eye. It also enables us to detect faint objects. Our eyes are positioned on the front of our heads which reduces the field of view in favour of stereopsis.

Example 1. Why is a normal eye not able to see clearly the objects placed closer than 25 cm? **[NCERT]**

Ans. A normal eye is not able to see clearly the

objects placed closer than 25 cm as there is a limit to which the ciliary muscles can change the curvature of the eye lens. If object is held closer than 25 cm, there is a lot of strain on the eyes.

TOPIC 2

DEFECTS OF VISION

Sometimes, the eye may gradually lose its power of accommodation due to which the person cannot see the objects distinctly and comfortably. The defects of vision are described below:

Myopia

Myopia is also known as near-sightedness. A person can see nearby objects clearly but cannot see distant objects clearly as the image of the object is formed in front of the retina.

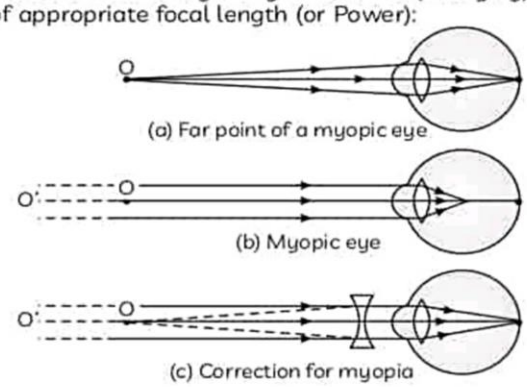
Causes of Myopia

(1) Excessive curvature of the cornea

(2) Elongation of the eyeball

Correction of Myopia

Myopia be corrected by using a concave (diverging) lens of appropriate focal length (or Power):



(a) Far point of a myopic eye

(b) Myopic eye

(c) Correction for myopia

Example 2. 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? **[NCERT]**

Ans. To find the nature and power of lens, we will use $u = -\infty$, $v = -80$ cm.

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = -\frac{1}{80} \Rightarrow f = -80cm = -0.8m$$

It is a concave lens of focal length 0.8 m. Power of lens = –1.25 D.

Hypermetropia

Also known as far-sightedness. A person can see distant objects clearly but cannot see nearby objects so clearly.

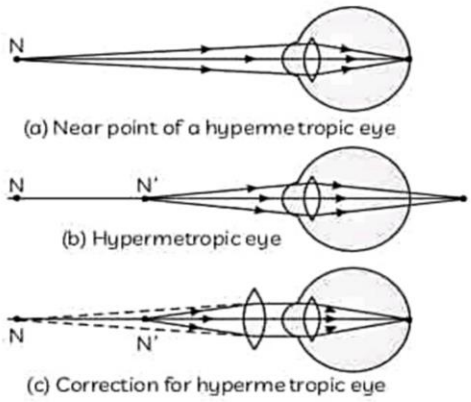
Causes of Hypermetropia

(1) Large focal length of the eye lens

(2) Shortening of the eye ball.

Correction of Hypermetropia

Hypermetropia can be corrected by using a convex (converging) lens of appropriate focal length (or Power).



(a) Near point of a hypermetropic eye

(b) Hypermetropic eye

(c) Correction for hypermetropic eye

Example 3. A person needs a lens of power –5.5 dioptres for correcting his distant vision. For correcting his near vision he needs a lens of power +1.5 dioptre. What is the focal length of the lens required for correcting (A) distant vision, and (B) near vision? **[NCERT]**

Ans. The relation between power (P) and focal length (f in metres) is given by $P = \frac{1}{f(\text{in } m)}$

(A) To find the focal length of the lens required for correcting distant vision, it is given that P = –5.5 D.

Therefore, using the relation

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

$$\Rightarrow \quad f(\text{in } m) = \frac{1}{P} = -\frac{1}{5.5}$$

$$= -0.18 \text{ m} = -18 \text{ cm}$$

It is a concave lens of focal length 18 cm.

(B) To find the focal length of the lens required for correcting near vision, it is given that P = + 1.5 D.

Therefore, using the relation

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

$$\Rightarrow f\,(\text{in } m) = \frac{1}{P} = +\frac{1}{5.5}$$

$$= +0.67 \text{ m} = +66.67 \text{ cm}$$

It is a convex lens of focal length 66.67 cm.

Presbyopia

With ageing, the near point of most people gradually recedes due to which they are unable to see nearby objects distinctly. A person may suffer from both myopia and hypermetropia

Causes of Presbyopia

(1) Gradual weakening of the ciliary muscles with age

(2) Decreasing flexibility of the crystalline lens.

Correction of Presbyopia

For a person suffering from both myopia and hypermetropia, bi-focal lenses are required in which the upper part is a concave lens and lower part is a convex lens.

Example 4. 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. **[NCERT]**

Ans. *(b) accommodation.*

Explanation: The ability of the human eye to focus on nearby and distant objects by changing the curvature and hence focal length of the eye lens is called accommodation of the eye.

TOPIC 3

REFRACTION OF LIGHT THROUGH A PRISM

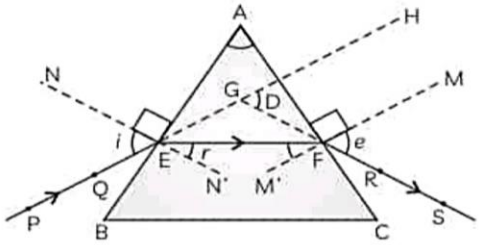
A prism has two triangular bases and three rectangular lateral surfaces which are inclined to each other. The angle between its two lateral faces is called the angle of the prism. In the figure,

PE - Incident ray ∠ i - Angle of incidence

EF - Refracted ray ∠ r - Angle of refraction

FS - Emergent ray ∠ e - Angle of emergence

∠A - Angle of the prism ∠ D - Angle of deviation



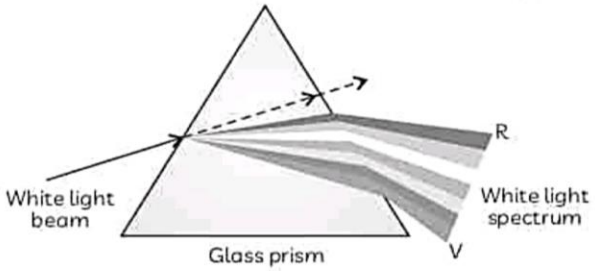
TOPIC 4

DISPERSION OF WHITE LIGHT BY A GLASS PRISM

When white light is incident on a glass prism, it splits into a band of colours as the refracting surfaces of the glass prism are inclined at an angle.

Example 8. Case Based:

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 the light from the slit to fall on one of its faces as shown in figure.



Turn the prism slowly until the light that comes out of it appears on a nearby screen.

[NCERT Activity 11.2]

(A) When the prism is turned slowly in the above activity, it is observed that:

(I) White light comes out of the prism on a nearby screen

(II) A band of seven colours is observed on a nearby screen with red and Indigo colours at the two ends.

(III) A band of seven colours is observed on a nearby screen with Yellow and Violet colours at the two ends.

(IV) A band of seven colours is observed on a nearby screen with red and Violet colours at the two ends.

Select the incorrect observations from the above:

(a) Both (I) and (II)

(b) Both (II) and (III)

(c) (I), (II) and (III)

(d) (I), (III) and (IV)

(B) The colour of light that has the minimum velocity in the glass prism is:

(a) Red **(b) Green**

(c) Blue **(d) Violet**

(C) Which colour of light deviates the most on passing white light through a prism?

(D) When white light enters a glass prism from air, for which colour is the angle of deviation the least?

(E) Assertion (A) : The rays of different colours emerge along different paths from a glass prism.

Reason (R) : Light rays undergo refraction and bend away from the normal when they travel from glass prism to air.

(a) Both (A) and (R) are true and (R) is the correct explanation of the assertion.

(b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion.

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.

Ans. **(A)** *(c) (I), (II) and (III)*

Explanation: When the prism is turned slowly, a band of seven colours is observed on a nearby screen, with red and violet colours at the two ends of the band. The various colours seen are Violet, Indigo, Blue, Green, Yellow, Orange and Red, as shown in figure. The band of the coloured components of a light beam is called its spectrum.

(B) *(d) Violet*

Explanation: Violet colour has the minimum wavelength among the visible colours of the spectrum and deviates the maximum. This is because it has the minimum velocity in the glass prism since refractive index of glass is maximum for violet.

(C) Violet colour deviates the most when white light is passed through a glass prism. This is because violet has the least wavelength among the seven visible colours of spectrum and refractive index of glass for violet light is the maximum.

(D) The angle of deviation will be least for red colour as red colour has the longest wavelength among the visible colours of the spectrum and therefore refractive index of glass for red colour will be minimum. So, red will suffer the minimum deviation.

(E) *(b) Both (A) and (R) are true, but (R) is not the correct explanation of the (A).*

Explanation: The rays of different colours emerge along different paths from a glass slab as the refractive index of glass is different for different colours due to which different colours bend by different amounts on passing through the glass prism. The reason given, though correct, does not explain the splitting of light into its constituent colours.

Dispersion of White Light

The splitting of light into its component colours is called dispersion of light.

Spectrum

The band of the coloured components of a light beam is known as its spectrum.The sequence of colours is Violet, Indigo, Blue, Green, Yellow, Orange and Red and is given by the famous acronym – **VIBGYOR**.

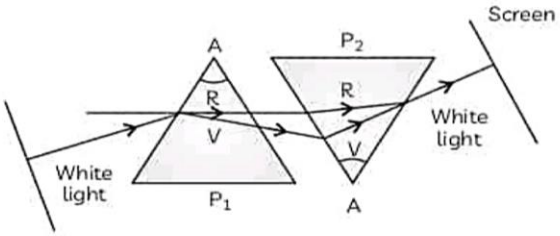
Cause of Dispersion

Dispersion occurs because light rays of different colours travel with different speeds in a refractive medium. The refractive index of glass is largest for violet colour and least for red colour due to which violet colour is dispersed the maximum and red colour the least.

Recombination of Spectrum Colours

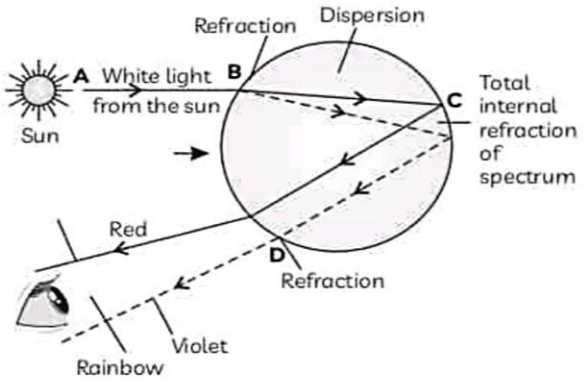
If a second identical prism is placed in an inverted position with respect to the first prism such that all colours of the spectrum pass through the second prism, then a beam of white light emerges from the other side of the second prism.

This observation gave Newton the idea that the sunlight is made up of seven colours.



Formation of Rainbow

A rainbow is formed in the sky after a rain shower due to the dispersion of sunlight by the tiny droplets of water present in the atmosphere. It is always formed in a direction opposite to that of the Sun. The tiny droplets of water act like small prisms which refract and disperse the incident sunlight, then reflect the light internally and finally refract it again when it comes out of the raindrop. Different colours reach the observers eyes due to the dispersion of light and internal reflection.



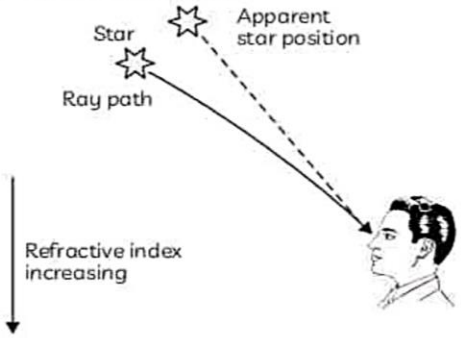
TOPIC 4

ATMOSPHERIC REFRACTION

Atmospheric refraction is the refraction of light by the earth's atmosphere due to the decrease of refractive index with decreasing density or increasing temperature of air.

Apparent Position of Stars

The stars appear slightly higher than its actual position when viewed near the horizon due to the phenomenon of atmospheric refraction. When the star light enters the earth's atmosphere, where its refractive index is increasing gradually, the star light is bent towards the normal.

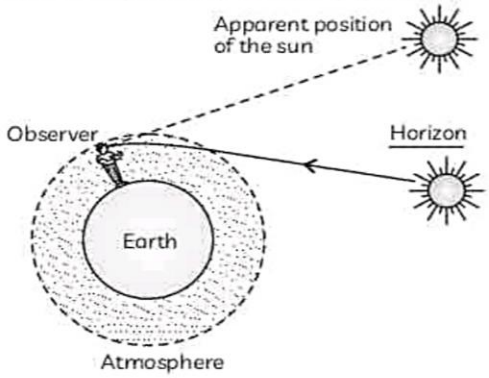


Twinkling of Stars

The apparent position of the star is not stationary, but keeps on changing slightly, since the physical conditions of the earth's atmosphere are not stationary. Since the stars are very distant, they approximate point-sized sources of light. As the path of rays of light coming from the star goes on varying slightly, the apparent position of the star fluctuates and the amount of star light entering the eye flickers – the star sometimes appears brighter, and at some other time, fainter, which is the twinkling effect.

Planets do not Twinkle

Planets are much closer to the earth and therefore act as extended sources. A planet can therefore be considered as a collection of large number of point-sized objects such that the total variation in the amount of light entering our eye from all the individual point-sized sources will average to zero, and hence the twinkling effect is nullified.



Advance sunrise and delayed sunset: The sun is visible to us 2 minutes before actual sunrise and 2 minutes after actual sunset due to atmospheric refraction.

The time difference between actual sunset and the apparent sunset is about 2 minutes. The apparent flattening of the Sun's disc at sunrise and sunset is also due to the same phenomenon.

TOPIC 5

SCATTERING OF LIGHT

The phenomenon of change in the direction of light on striking an obstacle like an atom, a molecule, dust particle, water droplet etc is known as scattering of light. It involves bouncing off electromagnetic

radiation by atoms/molecules of the medium through which they are travelling.

Tyndall Effect

Tyndall effect deals with the phenomenon of scattering of light by colloidal particles.

(1) When a fine beam of sunlight enters a room, the particles present in the room become visible due to scattering of light by these particles.

(2) When sunlight passes through a canopy of a dense forest, tiny water droplets in the mist scatter light.

The colour of the scattered light depends on the size of the scattering particle. Very fine particles scatter mainly blue light while particles of larger size scatter light of longer wavelength. If the size of the scattering particle is large enough, then the scattered light may even appear white.

Blue Colour of Sky

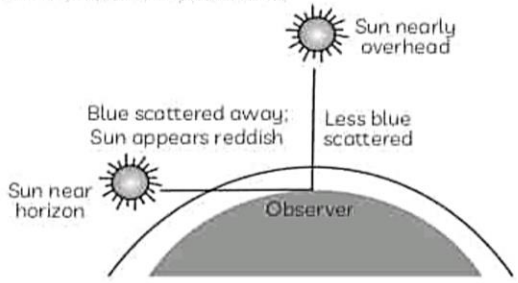
The blue colour of sky is due to the scattering of light by the large numbers of molecules present in the earth's atmosphere. As the size of the scatterer is much smaller than the wavelength of light, light of smaller wavelength is scattered the most. If the earth had no atmosphere, the sky would appear black in the day time as no colour of sunlight would be scattered then.

White Colour of Clouds

Clouds are visible to us due to scattering of light from lower parts of earth's atmosphere which contains dust particles, water droplets, ice particles etc. As the size of the scatterer is much larger than the wavelength, all wavelengths are scattered nearly equally, due to which clouds appear generally white.

Sun Looks Reddish at Sunrise and Sunset

At the time of sunrise and sunset, the sun is near the horizon due to which sunrays have to travel much larger part of the atmosphere. Most of the blue light is thus scattered away. The red colour having the longest wavelength is scattered the least and hence enters our eyes. When the sun is nearly overhead, the sunlight has to pass through much smaller portion of earth's atmosphere due to which scattering is much less and the sun looks white.



Reddening of the sun at sunrise and sunset

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. A student traces the path of a ray of light through a glass prism for different angles of incidence. He analyses each diagram and draws the following conclusion:

(I) On entering prism, the light ray bends towards its base.

(II) Light ray suffers refraction at the point of incidence and point of emergence while passing through the prism.

(III) Emergent ray bends at certain angle to the direction of the incident ray.

(IV) While emerging from the prism, the light ray bends towards the vertex of the prism.

Out of the above inferences, the correct ones are:

(a) (I), (II) and (III) (b) (I), (III) and (IV)

(c) (II), (III) and (IV) (d) (I) and (IV)

[CBSE 2017]

Ans. *(a) (I), (II) and (III)*

Related Theory

- *In a prism, the ray of light from air into glass bends towards the normal. The ray of light from glass to air bends away from the normal. In both cases, when a ray of light passes through a prism, it bends towards the base of the prism.*

2. A 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 the lights of all other colours by the atmosphere

(d) lights of all other colours is scattered more than the violet and blue colour lights by the atmosphere

[CBSE 2012, 11]

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

(a) Red light moves the fastest.

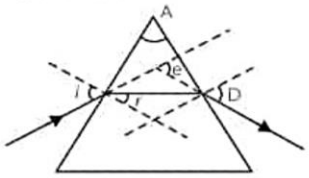
(b) Blue light moves faster than green light.

(c) All the colours of the white light travel with the same speed.

(d) Yellow light moves with the mean speed as that of red and the violet light.

[CBSE 2015, 12]

4. In the following diagram, the correctly marked angles are:



(a) All

(b) Only $\angle i$ and $\angle A$

(c) $\angle i$, $\angle r$ and $\angle A$

(d) $\angle i$, $\angle A$ and $\angle D$ [CBSE 2017]

5. The bluish colour of water in deep sea is due to:

(a) the presence of algae and other plants found in water

(b) reflection of the sky in water

(c) scattering of light

(d) absorption of light by the sea

[CBSE 2015, 11]

Ans. *(c) scattering of light*

Explanation: The bluish colour of water in deep sea is due to scattering of light. The fine particles in water scatter mainly blue light having shortest wavelength.

Related Theory

- *Water appears blue because when white light from the Sun falls on the water molecules, only blue light is reflected and scattered and reaches our eyes.*
- *The absorption of light by a molecule depends on the wavelength and the size of the molecule. A molecule absorbs light of a wavelength either equal to or greater than the order of the size of the object.*
- *Since red, orange and yellow have longer wavelengths, they are absorbed by the water molecules, whereas blue, having a shorter wavelength, is scattered.*

6. During the experiment, to trace the path of ray of light through the glass prism, students reported the following observations:

(I) The ray of light from air to glass at the first refracting surface bends away from the normal after refraction.

(II) At the second refracting surface, light rays entered from air to glass.

(III) Light ray suffers two refractions on passing through a prism and in each refraction it bends towards the base of the prism.

(IV) Light ray suffers two refractions on passing through a prism. In first refraction it bends away from the normal while in the second refraction it bends towards the normal.

The correct observation(s) is/are:

(a) (I) and (II) only (b) (III) only

(c) (II) and (IV) only (d) (I) and (IV) only

[CBSE 2016]

7. 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.

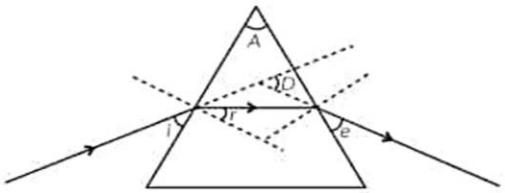
(b) is along the same direction of incident ray.

(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 2016]

8. In the following ray diagram the correctly marked angle are:



(a) $\angle i$ and $\angle e$ (b) $\angle A$ and $\angle D$
(c) $\angle i$, $\angle e$ and $\angle D$ (d) $\angle r$, $\angle A$ and $\angle D$

Ans. *(d) $\angle r$, $\angle A$ and $\angle D$*

9. A person cannot see distinctly the objects kept beyond 2 m. This defect can be corrected by using a lens of power:
(a) + 0.5 D (b) – 0.5 D
(c) + 0.2 D (d) – 0.2 D
[CBSE 2020, 17, 14, 15, 11, NCERT Exemplar]

10. 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 statements 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.
[CBSE 2018, 15, 12, NCERT Exemplar]

Ans. *(a) The near point of his eyes has receded away.*

Explanation: The student can see the object which is far from him but can't see nearby objects. It means that the near point of his eyes has receded away. This condition is known as hypermetropia or far sightedness.

11. 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 [CBSE 2015, 14, NCERT Exemplar]

Ans. *(b) outer surface of the cornea*

Explanation: Light enters the eye through a thin membrane called the cornea. It causes most of the bending of incident light rays, i.e. refraction, to make them converge which in turn causes image formation on retina.

12. The focal length of the eye lens increases when eye muscles:
(a) are relaxed and the lens becomes thinner
(b) contract and the lens becomes thicker
(c) are relaxed and the lens becomes thicker
(d) contract and the lens becomes thinner
[CBSE 2012, NCERT Exemplar]

13. Which of the following statements 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.
[CBSE 2017, 15, 14, 11, NCERT Exemplar]

Ans. *(c) A person with myopia can see nearby objects clearly.*

Explanation: Myopia is also termed as short-sightedness. A person suffering from myopia can see nearby objects clearly but not the distant objects. Whereas hypermetropia is termed as long-sightedness. A person suffering from hypermetropia can see distant objects clearly but not the nearby objects.

14. Person suffering from cataract has:
(a) elongated eyeball
(b) excessive curvature of eye lens
(c) weakened ciliary muscles
(d) opaque eye lens [CBSE 2020]

15. 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.

16. 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

17. The sky appears dark to passengers flying at very high altitudes mainly because :
(a) Scattering of light is not enough at such heights.

(b) There is no atmosphere at great heights.

(c) The size of molecules is smaller than the wavelength of visible light.

(d) The light gets scattered towards the earth. [CBSE 2020]

Ans. *(a) Scattering of light is not enough at such heights.*

Explanation: At higher altihide either the atmospheric medium is very rare or there are no particles present/ no atmosphere, thus the scattering of light taking place is not enough at such heights or no scattering of sunlight takes place. Hence, the sky appears dark to the passengers flying at very high altitude.

18. **Given below are some common observations related to optics. Select the row containing incorrect observations and its reason.**

	Observation	Reason
(a)	Colour of water in deep sea	Scattering of light
(b)	Apparent position of stars	Atmospheric refraction
(c)	Fishes appear higher than their actual depth	Diffraction of light
(d)	Spectrum seen on soap bubbles	Dispersion of light

Ans. *(c) Observation: Fishes appear higher than their actual depth, Reason: Diffraction of light*

Explanation: Fishes appear higher than their actual depth due to the refraction of light as light travels from water, an optically denser medium, to air, a rarer medium. Diffraction of light refers to the phenomena of bending of light around corners.

19. **The defective eye of a person has near point 0.5 m and far point 75 cm. The table below lists the type of corrective lens and its power required for reading purpose and for seeing distant objects.**

Select the row containing the correct information:

	For reading purpose	For seeing distant objects
(a)	Concave lens of power - 0.5 D	Convex lens of power + 0.75 D
(b)	Convex lens of power +0.5 D	Concave lens of power - 0.75 D
(c)	Convex lens of power + 0.5 D	Concave lens of power – 1.33 D
(d)	Convex lens of power + 2.0 D	Concave lens of power – 1.33 D

20. **A 55 year old near-sightedness person wears spectacles with a power of - 2.5 D for distance viewing. His doctor prescribes a correction of + 2.0 D in the near-vision section of his bi-focals. This is measured relative to the main part of the lens.**

Select the correct statements:

(I) The focal length of distance-viewing part of the lens is – 40 cm.

(II) The focal length of the near-vision part of the lens is + 50 cm.

(III) The focal length of distance-viewing part of the lens is + 50 cm.

(IV) The focal length of near-vision part of the lens is – 40 cm.

(a) Both (I) and (II)

(b) Both (I) and (IV)

(c) Both (II) and (III)

(d) Both (III) and (IV)

21. **A beam of white light falling on a glass prism gets split up into seven colours marked 1 to 7 as shown in the diagram**

Select the incorrect statements regarding the colours marked from 1 to 7:

(I) The colour at position marked 7 and 5 are similar to the colour of the blood and colour of gold metal respectively.

(II) The colour at position marked 1 and 3 are similar to the colour of the blood and colour of gold metal respectively.

(III) The colour at position marked 3 and 4 are similar to the colour of the sky and colour of leaves in plants respectively.

(IV) The colour at position marked 5 and 4 are similar to the colour of the sky and colour of leaves in plants respectively.

(a) Both (I) and (II)

(b) Both (I) and (III)

(c) Both (II) and (III)

(d) Both (II) and (IV)

22. **The defects of vision hypermetropia and myopia can be corrected by:**

(a) Concave and plano-convex lens

(b) Concave and convex lens

(c) Convex and concave lens

(d) Plano-concave lens for both defects.

Ans. *(c) Convex and concave lens*

Explanation: Hypermetropia or far sightedness can be corrected by using convex lens of appropriate power and myopia by concave lens of appropriate power.

23. The layer of atmosphere whose temperature is less than that of hotter layer behaves as an optically

(a) denser medium

(b) rarer medium

(c) inactive medium

(d) either denser or rarer medium

Ans. *(a) denser medium*

Explanation: The layer of atmosphere whose temperature is less than that of hotter layer is more denser as compared to the hotter layer of atmosphere. So, when light travels from a cooler layer of atmosphere to a hotter layer, it will bend away from the normal.

24. The sun appears white at noon as:

(a) Blue colour is scattered the most

(b) Red colour is scattered the most

(c) Light is least scattered

(d) All the colours of the white light are scattered away

Assertion-Reason Questions

For the following questions, two statements are given-one labled Assertion (A) and the other labeled Reason (R) select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below:

(a) Both (A) and (R) are true and (R) is correct explanation of the (A).

(b) Both (A) and (R) are true but (R) is not correct explanation of the (A).

(c) (A) is true but (R) is false.

(d) (A) is false but (R) is true.

25. Assertion (A) : Sky appears in blue colour.

Reason (R) : Blue colour in sunlight travelling through atmosphere undergoes maximum scattering.

Ans. *(a) Both (A) and (R) are true and (R) is correct explanation of the (A).*

Explanation: Blue colour of the sky is due to scattering of blue colour to the maximum extent by dust particles. Blue colour appears to be coming from the sky. Blue colour has the least wavelength. Hence, the correct option is (a).

26. Assertion (A) : When white light passes through a glass prism, red colour is deviated the least.

Reason (R) : Red colour has the minimum speed in the glass prism.

Ans. *(c) (A) is true but (R) is false.*

Explanation: When white light passes through a glass prism, red colour is deviated the least because red colour has maximum speed in the prism.

27. Assertion (A) : When objects are observed through hot air, they appear to be moving slightly.

Reason (R) : Hotter air is optically denser and the cooler air is optically rarer.

28. Assertion (A) : A rainbow is always formed in the sky after a rain shower and in the same direction as sun.

Reason (R) : Water droplets act like tiny prisms.

Ans. *(d) (A) is false but (R) is true.*

Explanation: A rainbow is always formed in the sky in a direction opposite to that of the sun. The water droplets present in the sky act as tiny prisms, which refract and disperse sunlight, then reflect it internally and finally refract it again when it comes out of the raindrop.

29. Assertion (A) : The sun's disc appears to be flattened at sunrise and sunset.

Reason (R) : The sun is near the horizon at sunrise and sunset and sunlight suffers atmospheric refraction.

Very Short Answer Type Questions

30. What would have been the colour of sky if the earth had no atmosphere?

31. Why do stars appear higher than their actual position?

Ans. Stars appear higher than their actual position as starlight undergoes refraction continuously on entering earth's atmosphere and bends towards the normal.

32. On the basis of which observation did Newton conclude that sunlight is made up of seven colours?

33. How does the refractive index of earth's atmosphere vary with height?

34. Why is a small amount of sodium thiosulphate added to water in tank in the activity to understand reddish appearance of sun at sunrise and sunset?

Ans. Sodium thiosulphate is added to water in the tank for precipitating minute colloidal sulphur particles which scatter short wavelengths of light.

35. State one effect produced by the scattering of light by the atmosphere? [Diksha]

Ans. There are two effects produced due to scattering of light in the atmosphere: Tyndall effect and appearance of the blue colour of the sky.

Related Theory

- *When light moves from one medium to another, the light scatters in different directions due to change in the medium. This is called scattering of light. When tiny particles of dust come in front of light and leads to its scattering, this is called Tyndall effect. We can see these tiny dust particles in the scattered light.*
- *When the light from stars enters the atmosphere, the light with smaller wavelengths gets easily scattered, while lights with longer wavelength do not scatter much and hence travels straight. This gives red colour to the sky during sunrise and sunset.*

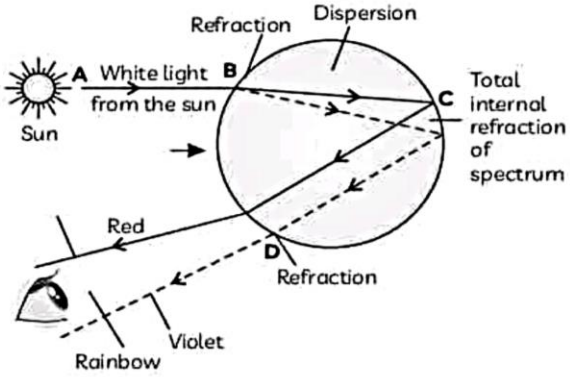
On the other hand, the shorter wavelengths scatter in the sky and give the sky its usual blue colour.

36. An astronaut in space finds sky to be dark. Explain reason for this observation. [Diksha]

37. What is a rainbow? Draw a labelled diagram to show the formation of a rainbow.

[CBSE 2019, 17]

Ans. Rainbow: A rainbow is the natural spectrum formed in the sky after a rain shower due to the dispersion of sunlight by the tiny droplets of water present in the atmosphere. The tiny droplets of water act like small prisms which refract and disperse the incident sunlight, then reflect the light internally and finally refract it again when it comes out of the raindrop. Different colours reach the observers eyes due to the dispersion of light and internal reflection.



38. Why does the sun appear white at noon?

COMPETENCY BASED Questions (CBQs)

[1, 4 & 5 marks]

39. *Ankit remarked that he has seen wavering of objects when seen through a stream of hot air rising above a tandoor or a fire. He said that the air just above the fire becomes hotter than the air further higher up. He further said that this wavering can also be seen in the earth's atmosphere as the earth's atmosphere is not evenly distributed and several observations can be explained on the basis of this phenomenon.*

(A) Name the phenomenon about which Ankit remarked.

(B) Name two observations which can be explained by the above phenomenon.

(C) What is the total time difference on duration of day on earth?

(D) Why don't planets twinkle?

Ans. (B) The two observations are: twinkling of stars, advance sunrise, delayed sunset and apparent position of stars. (Any two).

(D) Planets are much closer to the earth and can be considered as extended sources or a collection of several point sources. The

total variation in intensity of light entering our eyes from each of these point sources average out to zero, thereby nullifying the twinkling effect.

40. *Renu was returning home after purchasing some medicines for her mother. It was noon and really very hot on that particular day. She tried to look at the sun but the sun was shining so brightly that she could hardly see it directly. She somehow managed to see its reflection on a window and noticed that the colour of sun was white.*

At noon, the Sun appears white as:

(a) light is least scattered

(b) all the colours of the white light are scattered away

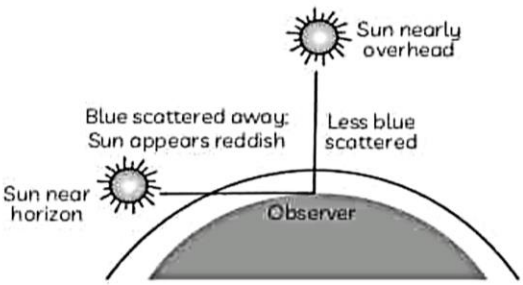
(c) blue colour is scattered the most

(d) red colour is scattered the most

[CBSE 2016, 15, 12, 11]

Ans. *(a) light is least scattered*

Explanation: At noon, the sun is directly over head and has lesser air to travel through and thus will be reduced if the distance to be traveled in air is reduced. Less scattering leads to the Sun appearing white as only a little of the blue and violet colour is scattered.



41. *Raman is a keen observer and loved the spectacular colours in a rainbow. He also observed the same pattern when he allowed sunlight to pass through a glass prism. He guessed that it is due to the inclined refracting surfaces of a glass prism which is responsible for showing such exciting phenomenon. Whereas, no such phenomenon was observed when light passes through a glass slab.*

(A) Name the phenomenon which could explain the formation of rainbow.

(B) What is the band of colours known as?

(C) What is the cause of formation of band of colours?

(D) Why don't we observe similar band of colours when light passes through a glass slab?

Ans. (A) The phenomenon which could explain the formation of rainbow is dispersion or splitting of light into its component colours.

(C) The cause for formation of spectrum of light is that different colours of light bend through different angles with respect to the incident ray as light passes through a prism.

(D) We don't observe splitting of white light into its component colours when light passes through a glass slab because the refracting surfaces in a glass slab are parallel to each other whereas they are inclined at an angle in a glass prism

42. *Sunny and his friends went to the terrace of their apartment building to watch the night sky. They noticed that all apartment buildings had red light installed at the terrace. Sunny had also seen red lights on top of tall towers such as the Pitampura TV tower and even on top of the GSM towers.*

The danger signals installed at the top of tall buildings are red in colour. These can be easily seen from a distance because among all other colours, the red light:

(a) is scattered the most by smoke or fog

(b) is scattered the least by smoke or fog

(c) is absorbed the most by smoke or fog

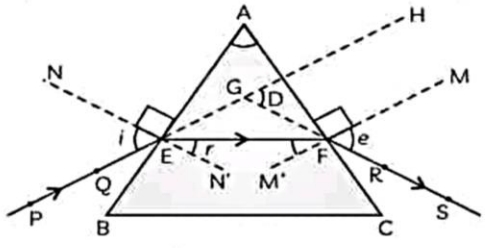
(d) moves the fastest in air [CBSE 2011]

Ans. *(b) is scattered the least by smoke or fog*

Explanation: Among all the colours, red is scattered the least by smoke or fog. This is because the wavelength of red colour is the largest. Thus, it can be easily seen from a distance. Since the wavelength of red light is maximum in the spectrum, it's penetration power in the air is maximum and so we can see red colour from farther distances. thus, danger signal uses red colour.

43. *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 Fig. 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 (i), the angle of refraction (r) and the angle of emergence (e) as shown in Fig. **[NCERT Activity 11.1]**



(A) Given below are four statements regarding incident ray, refracted ray and emergent ray in the above figure.

Select the incorrect statements:

(I) PE is the incident ray.

(II) EF is the emergent ray.

(III) EF is the refracted ray and FS is the emergent ray.

(IV) PE is the incident ray and FS is the refracted ray.

(a) Both (I) and (II)

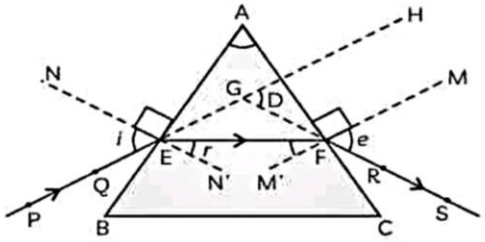
(b) Both (I) and (III)

(c) Both (II) and (IV)

(d) Both (III) and (IV)

(B) The angles of incidence (i), refraction (r) and emergence (e) are mentioned in the table below. Select the row containing the correct marking of angles:

	Angle of incidence (i)	Angle of refraction (r)	Angle of emergence (e)
(a)	PEN	FEN'	SFM
(b)	PEN'	FEN	SFM'
(c)	PEN	GEF	SFM
(d)	PEN	GEF	SFM'



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

(C) The angle of deviation is the angle between:

(a) Refracted ray and incident ray

(b) Refracted ray and emergent ray

(c) Emergent ray and face AC of the prism

(d) Emergent ray and incident ray

(D) In a glass prism, the emergent ray is not parallel to the incident ray as:

(a) The laws of refraction do not hold in the case of glass prism.

(b) The refracting surfaces are inclined at an angle.

(c) The angle of refraction in glass is greater than the angle of incidence.

(d) The angle of refraction in glass is greater than the angle of emergence.

(E) If n is the refractive index of glass of which the prism is made, which of the following relations is correct ?

(a) $n = \frac{\sin \angle i}{\sin \angle r}$ (b) $n = \frac{\sin \angle r}{\sin \angle i}$

(c) $n = \frac{\sin 90°}{\sin \angle e}$ (d) $n = \frac{\sin \angle r}{\sin \angle e}$

Ans. (A) *(c) Both (II) and (IV)*

Explanation: Here PE is the incident ray, EF is the refracted ray and FS is the emergent ray. PE is the incident ray as light is incident on the prism face AB. Light undergoes refraction in the glass prism and bends away from the normal and hence EF is the refracted ray. The ray FS is the emergent ray as light emerges out of the face AC of the prism along this direction.

(E) *(a)* $n = \frac{\sin \angle i}{\sin \angle r}$

44. *While walking along the beach in Mumbai, Madhuri and her friends were amazed at the beauty of the setting sun and its reflection on the sea against the backdrop of buildings. They observed that the sun appeared reddish at sunset and even at sunrise.*

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 Earth

[CBSE 2015, 11]

Ans. *(b) Scattering of light*

Explanation: Scattering of light contributes to the reddish appearance of the Sun at sunrise or sunset. Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles. Therefore, the light that reaches our eyes is of longer wavelengths. The red light has the maximum wavelength. This gives rise to the reddish appearance of the Sun.

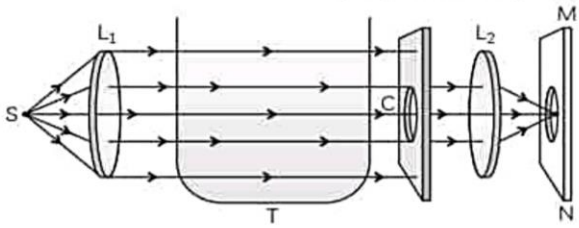
Related Theory

Light from the Sun, near the horizon, passes through thicker layers of air and a large distance in Earth's atmosphere before reaching our eyes. Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles. Therefore, the light that reaches our eyes is of longer wavelengths. The red light has the maximum wavelength. This gives rise to the reddish appearance of the Sun.

45. *Place a strong source (S) of white light at the focus of a converging lens (L_1). 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 Fig. 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.

[NCERT Activity 11.3]



(A) What is the role of lenses L_1 and L_2 in the activity?

	Role of Lens L_1	Role of Lens L_2
(a)	Converges a beam of light placed at S	Converges a parallel beam of light
(b)	Provides a parallel beam of light	Converges a parallel beam of light
(c)	Provides a parallel beam of light	Provides a parallel beam of light
(d)	Converges a beam of light placed at S	Provides a parallel beam of light

(B) When about 200 g of sodium thiosulphate (hypo) is dissolved in about 2 L of clean water taken in the tank and about 1 to

2 mL of concentrated sulphuric acid is added to the water, it is observed that:

(a) A true solution is formed after 2 to 3 minutes.

(b) A suspension of sodium is formed in the tank

(c) Sulphur particles start precipitating in about 2 to 3 minutes.

(d) No change is observed.

(C) The observations regarding change in colour of light in the tank about 2 to 3 minutes after adding sulphuric acid to hypo is:

(I) Blue light can be seen from the side of the tank facing the circular hole.

(II) Blue light can be seen from the three sides of the glass tank.

(III) At first orange red light and then red light can be seen from the side of the tank facing the circular hole.

(IV) At first orange red light and then red light can be seen from the three sides of the glass tank.

Select the incorrect observations:

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(D) The observations can be explained by the phenomenon of:

(a) Scattering of light

(b) Reflection of light

(c) Refraction of light

(d) Dispersion of light

(E) The activity above helps us in understanding:

(a) Twinkling of stars

(b) Formation of rainbow

(c) Advance sunrise and delayed sunset

(d) Reddish appearance of the Sun at the sunrise

Ans. (B) *(c) Sulphur particles start precipitating in about 2 to 3 minutes.*

Explanation: We will find fine microscopic sulphur particles precipitating in about 2 to 3 minutes due to the reaction between sulphuric acid and sodium thiosulphate.

(E) *(d) Reddish appearance of the Sun at the sunrise*

Explanation: This activity demonstrates the scattering of light that helps us to understand the bluish colour of the sky and the reddish appearance of the Sun at the sunrise or the sunset. Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles. Therefore, the light that reaches our eyes is of longer wavelengths. This gives rise to the reddish appearance of the Sun.

46. *Parth noticed that his father had two sets of spectacles. So he asked him the reason for the same. His father explained that one spectacle is for viewing distant objects while the other is for reading books. It means that his father had both the defects of vision- farsightedness as well as near sightedness.*

The defect of vision in which the image of nearby objects is formed behind the retina is

(a) Near sightedness

(b) Cataract

(c) Far sightedness

(d) Presbyopia

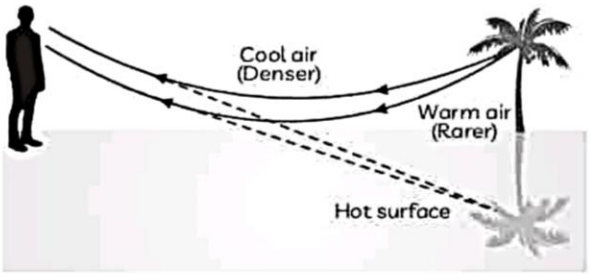
Ans. *(c) Far sightedness*

Explanation: Far sightedness or hypermetropia is the defect of vision in which the image of a nearby object is formed behind the retina due to either long focal length of the eye lens or shortening of the eye ball.

47. *We've all seen that part in the movie where the weary desert wanderer has been walking for hours and is dying of thirst. Then he happens upon a vast body of water on the horizon. He runs towards the water, it grows closer and closer, until he springs himself into the air only to land back down in the sand and no water in sight. Well, that is due to an optical illusion called Mirage.*

Mirage is an optical phenomenon which creates an illusion of the presence of water and is a result of refraction of light from a non-

uniform medium. Mirage is observed mainly during sunny days when driving on a roadway. Normally, light waves from the sun travel straight through the atmosphere to your eye. But, light travels at different speeds through hot air and cold air. Mirages happen when the ground is very hot and the air is cool and a ray of light gets refracted more and more away from the normal. At a particular angle when a ray of light exceeds critical angle, total internal reflection takes place and ray of light gets reflected in the same medium. When the reflected ray reaches our eye, it appears as coming from tree or sky and hence the inverted image of tree creates an impression from a pond of water.



(A) Mirage is an example of:

(a) Reflection of light and Refraction of light

(b) Dispersion of light

(c) Total Internal Reflection

(d) Refraction of light and Total Internal Reflection of light

(B) Mirages are more common in:

(a) rainforests

(b) dry forests

(c) deserts

(d) highlands

(C) Mirage is formed because:

(I) Air above the ground is very hot and air above is cooler

(II) Air above the ground is cool and air above is warmer.

(III) Light rays from a distant object bend towards the normal when coming towards the ground.

(IV) Light rays from a distant object bend away from the normal when coming towards the ground.

(a) Both (I) and (III)

(b) Both (I) and (IV)

(c) Both (II) and (III)

(d) Both (II) and (IV)

(D) Atmospheric refraction occurs because:

(a) Refractive index in medium is gradually changing

(b) Of presence of dust particles in atmosphere

(c) Large amount of moisture is present in atmosphere on a humid day

(d) Sun's rays travel the most when sun is near the horizon

(E) When starlight enters the earth's atmosphere:

(a) it bends away from the normal

(b) It bends towards the normal

(c) It first bends towards the normal and then away from the normal

(d) It first bends away from the normal and then towards the normal.

Ans. (A) *(d) Refraction of light and Total Internal Reflection of light*

Explanation: As the air just above the ground is hotter than the air above it, light traveling from a distant object travels from a denser medium to a rarer medium and hence bends away from the normal. So, it undergoes refraction. Since light is travelling from a denser medium to a rarer medium, at a certain angle which is greater than the critical angle, the light undergoes total internal reflection.

(B) *(c) deserts*

Explanation: Mirages are formed on hot sunny days in deserts or road surfaces when the air just above the ground is much hotter than the air above it.

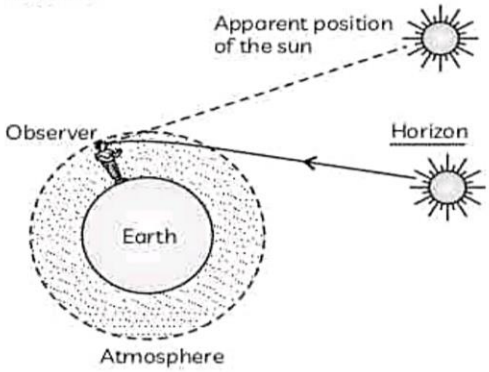
(C) *(b) Both (I) and (IV)*

Explanation: Mirage is formed on a hot day when the air just above the ground is hotter than the air above it. As hotter air is optically rarer than cooler air, light traveling from a distant object travels from a denser medium to a rarer medium and hence bends away from the normal. Since light is travelling from a denser medium to

a rarer medium, at a certain angle which is greater than the critical angle, the light undergoes total internal reflection.

48. *The rising sun looks so beautiful! On a trip to a hill station, Raj was overjoyed to see such a beautiful sight of the sun just rising above the horizon! But his father later told him that the sun had not risen yet and what he is actually seeing is due to an optical phenomenon!*

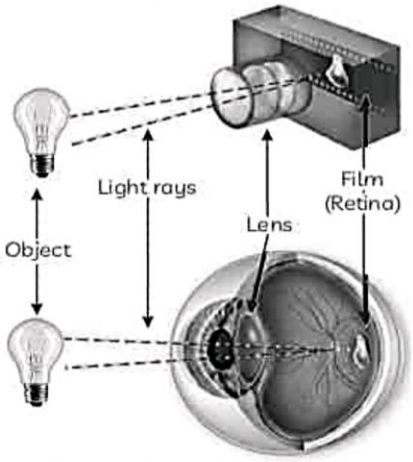
Why is the sun visible to us 2 minutes before actual sunrise and 2 minutes after actual sunset?



Ans. The sun is visible to us 2 minutes before actual sunrise and 2 minutes after actual sunset due to the phenomenon of atmospheric refraction.

During this time when the sun is still below the horizon, the sun's rays enter the earth's atmosphere and undergo continuous refraction and bend towards the normal as the refractive index increases continuously as we reach the earth's surface. So, the sun is visible to us.

49. *The inner workings of the human eye are complex, but at the same time, fascinating. Have you wondered how exactly they do work or what are the major parts of the eye involved in creating vision? It helps us in visualizing objects and also helps us in light perception, color, and depth perception. Besides, these sense organs are pretty much similar to cameras, and they help us see objects when light coming from outside enters into them. The structures and functions of the eyes are complex. Each eye constantly adjusts the amount of light it lets in, focuses on objects near and far, and produces continuous images that are instantly transmitted to the brain.*



(A) The image formed by eye lens is:

(a) Real and erect

(b) Virtual and erect

(c) Real and inverted

(d) Virtual and inverted

(B) Most of the refraction for the light rays entering the eye occurs at:

(a) Outer surface of the cornea.

(b) Eye lens

(c) Pupil

(d) Vitreous humour

(C) Select the correct statements:

(I) The change in the curvature of the eye lens can change its focal length.

(II) When the ciliary muscles are relaxed, the lens becomes thin and its focal length decreases.

(III) When the ciliary muscles contract, the lens becomes thicker and its focal length increases.

(IV) Thin lens enables us to view distant objects clearly whereas thick lens enables us to see nearby objects clearly.

(a) Both (I) and (III)

(b) Both (I) and (IV)

(c) Both (II) and (III)

(d) Both (II) and (IV)

(D) The near point and far point of a young adult with normal vision is:

(a) Near point = 0 cm and Far point = 25cm

(b) Near point = 25 cm and far point = 50 m

(c) Near point = 0 m and far point = infinity

(d) Near point = 25 cm and far point = infinity

(E) Select the row containing incorrect part of human eye and its function

	Part of Human Eye	Function
(a)	Retina	Delicate membrane having large number of light-sensitive cells.
(b)	Iris	Changes the curvature of eye lens
(c)	Cornea	A thin membrane through which light enters the eye
(d)	Pupil	An aperture that regulates and controls the amount of light

Ans. (A) *(c) Real and inverted*

Explanation: The eye lens forms an inverted and real image of the object on the retina as eye lens is a convex lens.

(B) *(a) Outer surface of the cornea.*

Explanation: Most of the refraction for the light rays entering the eye occurs at the outer surface of the cornea. The crystalline lens merely provides the finer adjustment of focal length required to focus objects at different distances on the retina.

(E) *(b) Part of Human Eye: Iris; Function: Change the curvature of eye lens.*

Explanation: Iris is a dark muscular assembly that controls the size of the pupil. The muscle that changes the curvature of eye lens is ciliary muscles.

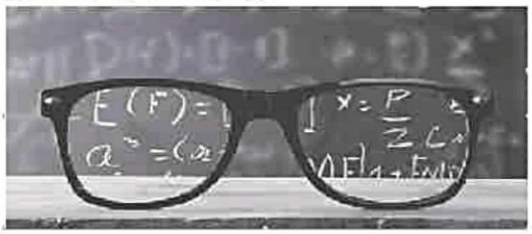
50. *Shradhas parents took her grandfather to the eye specialist as he was complaining of difficulty in seeing things. The doctor diagnosed it as cataract and said that it is quite common in old age.*

What is cataract? How is it caused? How can it be corrected?

Ans. The condition when there is partial or complete loss of vision in the eye of people at old age is known as cataract. It is caused when the crystalline lens of eye becomes milky andcloudy.
It can be corrected through a cataract surgery.

51. *Piyush, who was a back bencher in class, started complaining of frequent headaches. His parents took him to the nearest clinic and the doctor referred him to the eye specialist. The eye specialist tested his vision and asked Piyush whether he was able to read whatever the teacher wrote on the black board clearly or not. He replied in the negative. The doctor told his parents about the defect of vision that Piyush was suffering from and advised corrective glasses.*

After wearing the glasses, Piyush was now able to read the black board clearly and also got rid of his headaches.



(A) Piyush was suffering from:

(a) Cataract

(b) Myopia

(c) Hypermetropia

(d) Presbyopia

(B) Select the correct statements regarding the defect of vision Piyush was suffering from:

(I) A person with this defect has the far point nearer than infinity.

(II) A person with this defect has the near point greater than the least distance of distinct vision.

(III) A person suffering from this defect may see clearly upto a distance of a few metres.

(IV) A person suffering from this defect may not see clearly beyond the near point.

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(C) **Which of the following is not true about the defect of vision Piyush is suffering from ?**

(a) It is caused due to excessive curvature of the eye lens

(b) It may be caused due to elongation of the eyeball.

(c) The image of a distant object is formed behind the retina.

(d) It is corrected by using a concave lens of appropriate power.

(D) The far point of a myopic person is 50 cm in front of the eyes. The nature and power of the lens required for correct the problem is:

	Nature of Lens	Power of Lens
(a)	Concave	- 0.5 D
(b)	Concave	- 2.0 D
(c)	Convex	+ 0.5 D
(d)	Convex	+ 2.0 D

(E) A person needs a lens of power – 4.5 D for correction of her vision. The nature of lens and its focal length is:

	Nature of lens	Focal length
(a)	Concave	- 45 cm
(b)	Convex	+ 45 cm
(c)	Convex	+ 22.22 cm
(d)	Concave	- 22.22 cm

Ans. (B) *(a) Both (I) and (III)*

Explanation: As Piyush is suffering from myopia, a person with this defect has the far point nearer than infinity. A person suffering from this defect may see clearly upto a distance of a few metres. That is why myopia is also known as short sightedness.

(D) *(b) Nature of lens – Concave : Power of lens - 2.0 D*

Explanation: To find the focal length, we use the lens formula

$$\frac{1}{f}=\frac{1}{v}-\frac{1}{u}\Rightarrow\frac{1}{f}=-\frac{1}{50}\Rightarrow f=-0{\cdot}5\ \text{m}$$

$$\text{Power of the lens} = -\frac{1}{0.5}=-2.0\ \text{D}$$

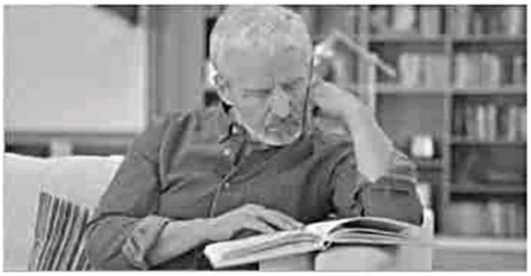
As focal length of the corrective lens is negative, the type of lens used is a concave lens.

(E) *(d) Nature of lens – Concave :Focal length – 22.22 cm*

Explanation: It is given that the power of the corrective lens = - 4.5 D. We know that

As the focal length is negative, the lens is a concave lens.

52. *Pankaj noticed that while reading books or newspaper, most people keep the book neither too far nor too close to their eyes. So, he himself tried to find out what happens when he tried to read the book by keeping the book quite far. He immediately said that he could not read all letters clearly. When he tried to read a book by keeping it very close to his eyes, the letters had become blurred and his eyes started paining!*



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

Ans. The normal eye has the remarkable property to see objects when placed at any distance from the eye due to the ability of the eye lens to adjust its focal length which is called accommodation. However, the normal eye is not able to see clearly objects placed closer to 25 cmas the focal length of the eye lens cannot bedecreased below a certain minimum limit.

53. *Everyone enjoys the spectacle of a rainbow glimmering against a dark stormy sky. How does sunlight falling on clear drops of rain get broken into the rainbow of colors we see? The same process causes white light to be broken into colors by a clear glass prism or a diamond. Sunlight, considered to be white, actually appears to be a bit yellow because of its mixture of wavelengths, but it does contain all visible wavelengths.*

The sequence of colors in rainbows is the same sequence as the colors plotted versus wavelength in Figure below. What this implies is that white light is spread out according to wavelength in a rainbow.

(A) The phenomena that play a role in the formation of rainbow is:

(a) Reflection and refraction of light

(b) Refraction, absorption, dispersion and refraction of light

(c) Dispersion, refraction and reflection of light

(d) Refraction, dispersion, reflection and refraction of light

(B) Select the colours in the correct ascending of wavelength:

(a) Blue, Green, Red

(b) Orange, Green, Red

(c) Blue, Yellow, Green

(d) Orange, Yellow, Green

(C) Select the incorrect statements about rainbow:

(I) Rainbow is caused by scattering of sunlight by tiny water droplets, present in the atmosphere.

(II) A rainbow is always formed in a direction opposite to that of the Sun.

(III) The water droplets refract and scatter the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop.

(IV) Different colours reach the observer's eye due to the scattering of light and internal reflection.

(a) Both (I) and (II)

(b) Both (II) and (III)

(c) (I), (III) and (IV)

(d) (II), (III) and (IV)

(D) A spectrum of light is observed when white light is directed to a prism as:

(a) The different colours in the white light bend away from the normal line at different angles on entering prism.

(b) The different colours in the white light bend towards the normal line at different angles on entering prism.

(c) The different colours in the white light bend away from the normal at same speed to each other on entering prism.

(d) The different colours in the white light bend towards the normal at same speed to each other on entering prism.

(E) The velocity of waves of all colours is same in:

(a) Water (b) Oxygen

(c) Vacuum (d) Glass

Ans. (A) *(d) Refraction, dispersion, reflection and refraction of light*

Explanation: Rainbow is produced after the rain, by refraction, dispersion, total internal reflection and again refraction process in droplets of water

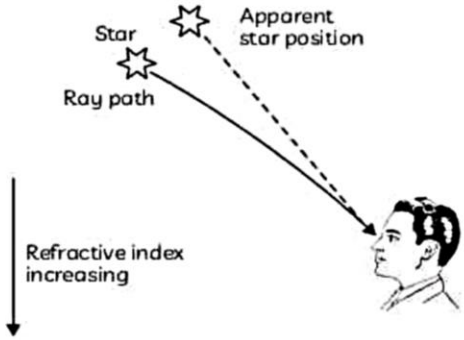
(C) *(c) (I), (III) and (IV)*

Explanation: A rainbow is a natural spectrum appearing in the sky after a rain shower. It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere which act like small prisms. A rainbow is always formed in a direction opposite to that of the Sun. The tiny droplets of water refract and disperse the incident sunlight, then reflect it internally, and finally refract the light again when it comes out of the raindrop. Due to the dispersion of light and internal reflection, different colours reach the observer's eye.

54. *Mike and his friends were enjoying a bonfire in their garden. One of his friends noticed that the air above the fire was wavering. He realized that this is because the physical conditions of air are notstationary because of which the apparent position of the object, as seen through the hotair, changes continuously. This phenomenon can also be used to explain several observations around us.*

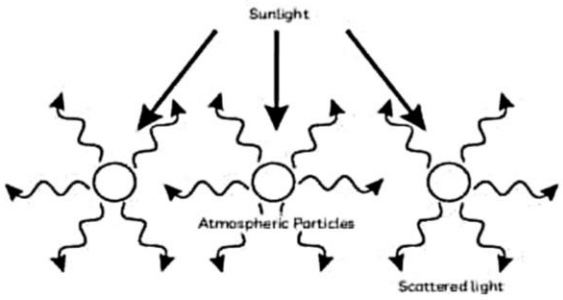
Why do stars appear higher than they actually are?

Ans. Stars appear higher than they actually are due to the phenomenon of atmospheric refraction. When the starlight enters the earth's atmosphere, it undergoes refraction continuously before it reaches the earth as the refractive index of the atmosphere changes continuously. The atmosphere bendsstarlight towards the normal due to which the apparent position of thestar is slightly different from its actual position.



55. *In addition to being absorbed or transmitted, electromagnetic radiation can also be reflected or scattered by particles in the atmosphere. Scattering is the redirection of electromagnetic energy by suspended particles in the atmosphere. The Tyndall effect is light scattering by particles in a colloid or in a very fine suspension.*

The type and amount of scattering that occurs depends on the size of the particles and the wavelength of the energy. Rayleigh scatter occurs when radiation (light) interacts with molecules and particles in the atmosphere that are smaller in diameter than the wavelength of the incoming radiation. Shorter wavelengths are more readily scattered tha longer wavelengths.



(A) Which of the following will not show Tyndall effect?

(a) Milk **(b) Sugar solution**

(c) Smoke **(d) Emulsion**

(B) Tyndall effect is due to

(a) Refraction of light

(b) Dispersion of light

(c) Absorption of light

(d) Scattering of light

(C) Which of the following natural phenomena are not due to scattering of light in nature?

(I) Blue colour of sky

(II) Twinkling of stars

(III) Formation of rainbow

(IV) Colour of water in deep sea

(a) Both (I) and (II)

(b) Both (II) and (III)

(c) Both (II) and (IV)

(d) Both (III) and (IV)

(D) The table below lists the colour of scattered light for different sizes of scattering particles.

Select the row containing the correct information:

	Very fine Particles	Larger Particles	Large Enough particles
(a)	Blue	Red	White
(b)	Blue	White	Red
(c)	Red	Blue	White
(d)	White	Red	Blue

(E) The blue colour of the sky is because:

(a) Red colour is scattered more as compared to other colours

(b) Red colour is absorbed more as compared to other colours

(c) Blue colour is scattered more as compared to other colours

(d) Blue colour is absorbed more as compared to other colours

Ans. (A) *(b) Sugar solution*

Explanation: Tyndall effect is shown by colloids and suspensions but not shown by true solutions. As sugar solution is a true solution, it will not show Tyndall effect.

(B) *(d) Scattering of light*

Explanation: Tyndall effect is due to scattering of light by particles present in the atmosphere, such as smoke, fine dust particles and gas molecules.

(E) *(c) Blue colour is scattered more as compared to other colours*

Explanation: The molecules of air and other fine particles in the atmosphere have sizesmaller than the wavelength of visible light and these are more effective inscattering light of shorter wavelengths at the blue end than light of longerwavelengths at the red end. Thus, when sunlight passes through theatmosphere, the fine particles in air scatter the blue colour (shorter wavelengths) more strongly than red and the sky appears blue to us as the scattered blue light entersour eyes.

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

56. What is the cause of dispersion of white light through a glass prism?

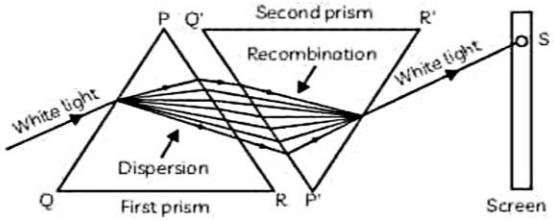
Draw a ray diagram to show the path of light when two identical glass prisms are arranged together in inverted position with respect to each other and a narrow beam of white light is allowed to fall obliquely on one of the faces of the prisms. [CBSE 2019]

Ans. Cause of dispersion of white light by prism:

(1) Light rays of different colours travel with different speeds in glass and as the refractive index of glass is largest for violet colour and least for red colour, violet colour is dispersed the maximum and red colour the least.

(2) The two refracting surfaces are inclined at an angle because of which colours separated by the first surface continue to travel along different paths from the second interface.

Ray diagram to show recombination of white light:



57. Differentiate between a glass slab and a glass prism. What happens when a narrow beam of (i) a monochromatic light, and (ii) white light passes through (A) glass slab and (B) glass prism? [CBSE 2020]

58. When do we consider a student sitting in the class to be myopic? List two causes of this defect. Explain using a ray diagram how this defect of eye can be corrected. [CBSE 2019]

59. Define the term power of accommodation. Write the modification in the curvature of the eye lens which enables us to see the nearby objects clearly? [CBSE 2019]

Ans. Power of accommodation of eye: It is the maximum variation in the power of the eye lens for focusing on nearby and distant objects and is about 4 dioptres for a young adult with normal vision.

The ciliary muscles change the shape or curvature of the eye lens so that nearby as well as distant objects can be focused. For viewing nearby objects, the ciliary muscles contract so that the curvature of the eye lens increases due to which the eye lens becomes more round in shape thus reducing its focal length.

Related Theory

- *The focal length of the eye lens cannot be decreased below a certain limit.*
- *The minimum distance at which an object can be seen distinctly without any eye strain is called near point of the eye and is about 25 cm for a person with normal vision.*

60. List two causes of hypermentropia.

61. Student observes the above phenonmenon in the lab as a white light passes through a prism. Among many other colours, he observed the position of the two colurs Red and Violet.

What is the phenomenon called? What is the reason for the violet light to bend more than the red light?

Ans. The phenomenon is called dispersion. Speed of Violet Light inside the prism is slowest and that of Red is highest. Hence, deviation of Violet Light is maximum and that of red is minimum

Explanation: When a beam of white light is passed through a glass prism, it splits up into seven colours. Different colours of light are characterised by their different wavelengths. All the colours travel in air/vaccum with the same speed, but their speeds in any other refracting medium (like glass or water) are different. As refractive indix of glass $n = \frac{C}{V}$ and V is different for different colours, so 'n' is different for different colours. As $V_{violet} > V_{red}$, therefore $n_{violet} > n_{red}$. It means refractive index of glass for violet colour is more that the refractive index of glass for red colour. Hence, deviation suffered by violet colour is greater than the deviation suffered by the red colour on passing through the prism that is why violet colour is at the lower end of the visible spectrum and red colour is at the upper end of the spectrum.

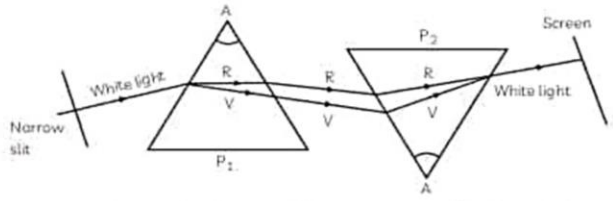
SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

62. How will you use two identical glass prisms so that a narrow beam of white light incident on one prism emerges out of the second prism as white light? Draw and label the ray diagram. [CBSE 2020]

Ans. Two identical prisms can be used to get a narrow beam of white light incident on one prism emerges out of second prism as white light.

A triangular glass prism P, is placed on its base P_1 and another similar prism P_2 is placed alongside it in the inverted position on its vertex, let's say . A with respect to the first prism P_1 so that its refracting surfaces are in opposite direction to the refracting surfaces of first prism.



Recombination of the spectrum of white light

Explanation: When a beam of white light is allowed to fall on first prism P_1, it disperses white light into seven colours. The second prism P_2 receives these seven colours and recombines them into original white light and a patch of ordinary white light is obtained on the screen placed behind the second prism P_2. Newton explained these observations.

The first prism P_1 splits the white light into seven coloured rays.

The second glass prism P_2 recombines all the seven coloured rays from the first one and falls on the screen as white light. This observation gave Newton an idea that the sunlight is made up of seven colours.

This is due to the fact that the refraction (bending) produced by the second prism P_2 is equal and opposite to the refraction (bending) produced by the first prism.

The emergent white light from the second prism P_2 may or may not be in the direction of white light incident on first prism P_1.

63. Why is Tyndall effect shown by colloidal particles? State four instances of observing the Tyndall effect. [CBSE 2020]

64. A person needs a lens of power –5.5 dioptre for correcting his distinct vision. For correcting his near vision, he needs a lens +1.5 dioptre. What is the focal length of the lens required for correcting (A) distinct vision, and (B) near vision? [Diksha]

Ans. Given: P = +1.5 D

To find focal length, f = ?

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

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

$$f = \frac{1}{+1.5} = +0.67 \text{ m}$$

The +ve sign indicates that the lens is convex.

(A) Given:

Power = –5.5 D

To find: focal length, f = ?

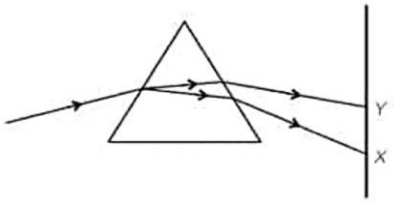
$$P = \frac{1}{f}$$

$$-5.5 = \frac{1}{f}$$

So, $$f = \frac{1}{-5.5} = -0.18 \text{ m}$$

Since the focal length is –ve, it shows that the lens used is concave.

65. In the figure given below, a narrow beam of white light is shown to pass through a 3 triangular glass prism. After passing through the prism, it produces a spectrum XY on the screen.



(A) Name the phenomenon.

(B) State the colours seen at X and Y.

(C) Why do different colours of white light bend at different angles through a prism?

66. (A) What is visible spectrum?

(B) Why is red used as the stopping light at traffc signals?

(C) Two triangular glass prisms are kept together connected through their rectangular side. A light beam is passed through one side of the combination. Will there be any dispersion? Justify your answer.

67. What is scattering of light? Why is the colour of the clear sky blue? Explain. [CBSE 2017]

Ans. Scattering of light is the phenomenon of change in the direction of light on striking an obstacle like an atom, a molecule, dust particle, water droplet, *etc.*

The blue colour of the sky is due to the scattering of sunlight by a large number of molecules such as fine dust particles, gases, water vapour, etc. present in Earth's atmosphere. Due to the very small size of the scatterer as compared to the wavelength of light, light of smaller wavelength, such as blue, is scattered the most as compared to light of longer wavelength.

Related Theory

- *The sky appears black to an astronaut as there is no atmosphere in space and no scattering of sunlight takes place.*
- *The sun looks reddish at sunset and sunrise as the sun is near the horizon due to which sunrays have to travel a much larger part of the atmosphere and most of the blue light is scattered away. The red colour, having the longest wavelength, is scattered the least and hence enters our eyes.*

68. Draw ray diagrams, each showing:

(A) Myopic eye and

(B) Hypermetropic eye.

[CBSE 2020, 17, 15, 14, 11, NCERT Exemplar]

69. How are we able to see nearby and also distant objects clearly?

[CBSE 2018, 16, NCERT Exemplar]

Ans. We are able to see nearby and distant objects clearly by altering the focal length of crystalline lens using its power of accommodation.

The eye lens is composed of a fibrous, jelly-like material whose curvature can be modified by the ciliary muscles. The change in the curvature of the eye lens can thus change its focal length. When the muscles are relaxed, the lens becomes thin and its focal length increases. This enables us to see distant objects clearly. When objects are closer to the eye, the ciliary muscles contract, which increases the curvature of the eye lens. The eye lens then becomes thicker. Consequently, the focal length of the eye lens decreases. This enables us to see nearby objects clearly. The ability of the eye lens to adjust its focal length is called power of accommodation.

70. A person needs a lens of power – 4.5 D for correction of her vision.

(A) What kind of vision defect is she suffering from?

(B) What is the focal length of the corrective lens?

(C) What is the nature of the corrective lens?

[CBSE 2012, NCERT Exemplar]

Ans. (A) The negative power of lens suggests that she must be suffering from myopia.

(B) Power, P = – 4.5 D,

focal length, f = ?

Now, $$P = \frac{1}{f}$$

$$\Rightarrow \quad f = \frac{1}{P} = \frac{1}{-4.5}$$

$= -0.222m$

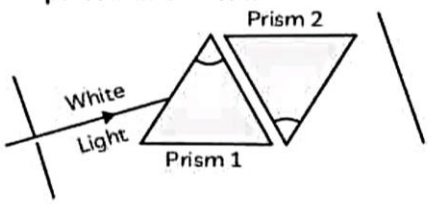
$= -22.2$ cm

(C) Myopia is corrected using a concave or divergent lens.

71. (A) State the relation between colour of scattered light and size of the scattering particle.

(B) The apparent position of an object, when seen through the hot air, fluctuates or wavers. State the basic cause of this observation.

(C) Complete the path of white light when it passes through two identical prisms placed as shown:



72. A student uses spectacles of focal length –2.5 m.

(A) Name the defect of vision he is suffering from.

(B) Which lens is used for the correction of this defect?

(C) List two main causes of developing this defect.

(D) Compute the power of this lens.

Ans. (A) Myopia

(B) Concave lens

Explanation: As focal length is –2.5 m. The corrective lens is concave. In myopia defect a person can see clearly the objects lying at short distances. To cure a myopic eye, the person has to use spectacles with a concave lens to see the far off objects.

(C) The main causes of developing myopia deffect

(1) decrease in focal length of eye

(2) lens increase in length of eye ball.

(D) $P = \frac{1}{f}$ given by $f = -2.5$

$$P = \frac{1}{-2.5} = -0.4 \text{ D}$$

73. Give reasons:

(A) Red colour is selected for danger signals.

(B) The sky appears dark in space.

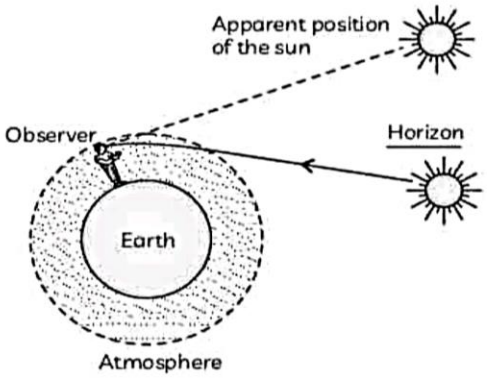
(C) The time difference between actual sunset and apparent sunset is about 2 minutes. [CBSE 2020]

Ans. (A) Red colour is selected for danger signals: This is because red coloured light has longer wavelength and is least scattered by fog or smoke particles. Due to this the red light can be seen in the same colour even from a distance. The phenomenon involved is scattering of light.

(B) The sky appears dark in Space: This is because there is no atmosphere containing air in the other space to scatter sunlight. Since there is no scattered sunlight to reach our eyes in space, the sky appears dark. The phenomenon involved is scattering of light.

(C) The time difference between actual sunset and apparent sunset is about 2 minutes. This is because of atmospheric refraction.

Explanation: The actual sunrise takes place when the sun is just above the horizon. Due to atmospheric refraction, we can see the rising sun about 2 minutes before it is actually above the horizon. This happens because when the sun is slightly below the horizon. Then the sun's light coming from less dense air to more dense air is refracted downwards as it passes through the atmosphere. Because of the atmospheric refraction the sun appears to raised above the horizon when actually it is slightly below the horizon. It is due to the same phenomenon. We can still see the sun for about 2 minutes even after the sun has set below horizon.



Related Theory

- *The time from sunset to sunrise is lengthened by about 2 + 2 = 4 minutes due to atmospheric refraction.*
- *The apparent flattening of sun's disc at sunrise and sunset is also due to atmospheric refraction.*

74. (A) **State Snell's law of refraction of light.**

(B) **When a ray of light travelling in air enters obliquely into a glass slab, it is observed that the light ray emerges parallel to the incident ray but it is shifted sideways slightly. Draw a labelled ray diagram to illustrate it. [CBSE 2020]**

75. (A) **A person is suffering from both myopia and hypermetropia.**

(i) What kind of lenses can correct this defect?

(ii) How are these lenses prepared?

(B) **A person needs a lens of power + 3D for correcting his near vision and – 3D for correcting his distant vision. Calculate the focal lengths of the lenses required to correct these defects. [CBSE 2020]**

76. (A) **Write the importance of ciliary muscles in the human eye.**

(B) Name the defect of vision that arises due to gradual weakening of the ciliary muscles in old age.

(C) What type of lenses are required by the persons suffering from this defect to see the objects clearly?

Ans. (A) Ciliary muscles modify the curvature of the eye lens to enable the eye to focus objects at varying distances/ help in adjusting the focal length of the eye lens.

(B) Presbyopia

(C) Bifocal lens

77. **Name the type of defect of vision a person is suffering from, if he uses convex lenses in his spectacles for the correction of his vision. If the power of the lenses is +0.5 D, find the focal length of the lenses. [CBSE 2017]**

LONG ANSWER Type Questions (LA)

[5 marks]

78. **Describe an activity that demonstrates the scattering of light. [CBSE 2017]**

79. **What is meant by scattering of light? Use this phenomenon to explain why the clear sky appears blue or the sun appears reddish at sunrise.**

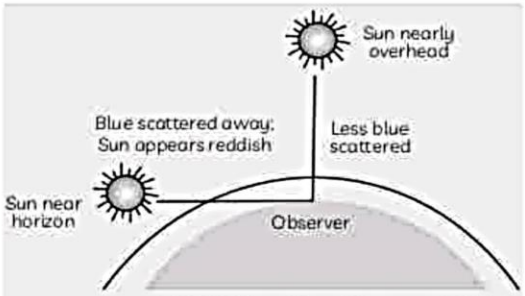
Ans. (A) **Scattering:** Phenomenon of spreading of light (diffused reflected light) caused by minute particles (dust, smoke etc.) in the atmosphere.

(B) Sky appears blue because blue color of sunlight scatters more strongly (due to shorter wavelength) than the red color by the fine particles in the air.

OR

At sunrise the blue color of sunlight get scattered due to smaller wave length while passing through the thicker layers of the atmosphere. The red component (due to longer wavelength) reaches us, giving red appearance, of the Sun.

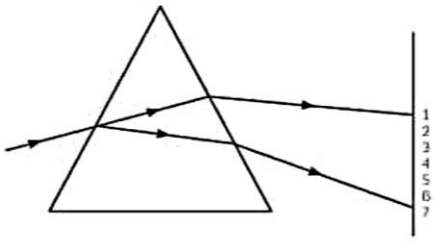
Note: *If explained by following diagram (fully labeled) give full credit.*



[CBSE Marking Scheme 2015]

80. *Answer questions (A)-(B) on the basis of your undersrandling of the following paragraph and related studied concepts.*

A rainbow is formed on a sunny day when we look at the sky through a waterfall of through a water foundation, with the sun behind us. A rainbow is always fomed in a direction opposite to that of the sun. Sometime, a secondary rainbow (double rainbow) is also seen. It is caused by each ray of light reflecting twice on the inside of each droplet before it leaves. The second reflection causes the colours on the secondary rainbow to be reversed.



(A) The colour at position marked 3 and 5 are similar to the colour of the sky and the colour of gold metal respectively. Is the above statement made by the student correct or incorrect? Justify.

(B) Which of the above shown positions corres-ponds approximately to the colour of:

(i) a solution of potassium permanganate?

(ii) danger or stop signal lights?

81. Arjun in his summer holidays went for a boot ride at his grandparent's village. In the midst of the sea he noted water was blue. He liked the view so much that he went home and narrated his experience. His father answered. It is due to a natural physical phenomenon. Answer the following questions based on the situation given above.

(A) What optical phenomenon causes the blue colour of the sea water? Explain in brief.

(B) Give two examples of the same phenomenon.

Ans. (A) Scattering of light causes the blue colour of the seea water.

Light can be examined entirely from its source. When light passes from one medium to any other medium, say air, a glass of water then a part of the light is absorbed by particles of the medium preceded by its subsequent radiation in a particular direction. This phenomenon is termed as a scattering of light. The intensity of scattered light depends on the size of the particles and the wavelength of the light.

Shorter wavelength and high frequency scatter more due to the waviness of the line and its intersection with a particle. The wavier the line, the more are the chances of it interacting with a particle. On the other hand, longer wavelengths have low frequency and they are straighter and chances of colliding with the particle are less.

(B) The blue colour of the sky, reddening of the sun at sunrise and sunset are other examples of scattering of light.

82. Explain the structure and functioning of the human eye. How are we able to see nearby as well as distant objects?

[CBSE 2019, 17, 15, NCERT Exemplar]

83. When do we consider a person to be myopic and hypermetropic? Explain using diagrams how the defects associated with myopic and hypermetropic eye can be corrected?

[CBSE 2020, 18, 15, 12, NCERT Exemplar]

84. (A) List the parts of human eye that controls the amount of light entering into it. Explain how?

(B) Write the function of retina in human eye.

(C) If due to some disease or injury, the cornea of an eye is clouded, the vision is impaired and the person may become blind. This type of blindness may be cured by replacing the defective cornea with the cornea of the donated eye. Suggest some measures for motivating people to donate their eyes after death.

[CBSE 2016]

Ans. (A) The parts are iris and pupil.

Between the cornea and the lens we have a muscular diaphragm called iris, in which a small hole is present which is called pupil.

Iris is the coloured part that we see in the eye. The size of the pupil varies with the help of iris. In dim light, the size of the pupil increases with the help of Iris, so that more light enters the eye. While in bright light, the size of the pupil decreases, so that less light enters the eye.

In other words, when the light is dim, iris expands the pupil and when the light is bright, Iris contracts the pupil.

(B) Retina is a thin membrane with large number of sensitive cells. When image is formed at retina, light sensitive cells gets activated and generate electrical signal. These signals are sent to brain via optic nerve. Brain analyse these signals after which we perceive objects as they are.

(C) Following methods may be opt:

(1) By advertising through various sources

(2) Start awareness program.

85. **Due to gradual weakening of ciliary muscles and diminishing flexibility of the eye lens a certain defect of vision arises. Write the name of this defect. Name the type of lens required by such persons to improve the vision. Explain the structure and function of such a lens. [CBSE 2017]**

86. **Varun instead of copying from the black board use to copy regularly from the notebook of his friend, Sudhir with whom he sat on the same desk. Sudhir told the teacher about it. The teacher asked Varun to get his eyes checked by a doctor and explained to whole class the reason why Varun copied from Sudhir's notebook.**

(A) What in your view, is wrong with Varun's eyes and how can it be corrected?

(B) If the doctor prescribes Varun to use lenses of power – 0.5 D, write the type of these lenses.

(C) Write the values displayed by Sudhir and his teacher. [CBSE 2017]

Ans. (A) Varun is suffering from the defect of vision Myopia.

Myopia can be corrected by using concave lens of appropriate power.

(B) Power of lens = – 0.5 D. This means it is a concave lens.

(C) Values displayed by Sudhir: Concerned, helpful, compassionate

Values displayed by teacher: Concerned, Knowledgeable

Related Theory

- *Two causes of myopia are: (i) Excessive curvature of the cornea (ii) Elongation of the eyeball*
- *Myopia is also called short-sightedness as a person is unable to see distant objects clearly but able to see nearby objects distinctly.*
- *To find focal length of the lens, we use the relation* $= \frac{1}{f(\text{in } m)}$ *Using this formula,* $f(\text{in } m) = -\frac{1}{0.5} m$.

$= -2m$.

87. **A person is unable to see distinctly the words printed on a newspaper. Name the defect of vision he is suffering from. Draw a ray diagram to illustrate this defect. List its two possible causes. Draw a ray diagram to show how this defect may be corrected using a lens of appropriate focal length. [CBSE 2017]**

88. **(A) Write the functions of each of the following parts of the human eye:**

(i) Cornea

(ii) Iris

(iii) Crystalline (Eye) lens

(iv) Ciliary muscles

(v) Retina

(B) A person is unable to see distinctly the objects closer than 1 m.

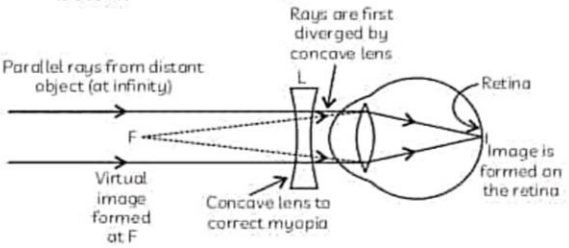
Name the defect of vision he is suffering from. Draw ray diagrams to illustrate the cause of the defect and its correction by suitablelens. [CBSE 2017]

89. **What is myopia? List its two causes. Draw a ray diagram to explain its correction using an appropriate lens. [CBSE 2017]**

Ans. Two causes of myopia are:

(1) Excessive curvature of the cornea
(2) Elongation of the eyeball

Myopia can be corrected by using concave lens of proper power.
Ray diagram for correction of myopia is drawn below:



Here, F is the far point of the defective or myopic eye.

90. **Curvature of eye lens of human eye can be modified by ciliary muscles to some extent so that its focal length is changed as per requirement. How will the curvature and focal length of eye lens change when (A) a distant object is to be seen and (B) a nearby object is to be seen clearly? Write the reason why a normal eye is not able to see clearly, the objects placed closer than 25 cm, without any strain on the eye. [CBSE 2017]**

91. **(A) State the role of ciliary muscles present in our eye.**

(B) Identify the defect of vision in each of the following cases and suggest its corrective measure:

(i) The eye lens has become milky and cloudy.

(ii) The eye lens has excessive curvature.

(iii) The eye lens has large focal length (longer than normal).

(iv) Ciliary muscles have weakened.

Ans. (A) Ciliary muscles relax and contract to adjust/modify the focal length of eye lens.

(B) Eye defects and corrective measures:

Eye Defects	Corrective Measures
(i) Cataract	Operation/Surgery
(ii) Myopia	Suitable concave lens
(iii) Hypermetropia	Suitable convex lens
(iv) Presbyopia	Suitable bifocal lens

[CBSE Marking Scheme 2019]

92. (A) With the help of diagram explain Isaac Newton's experiment that led to the idea that the sunlight is made up of seven colours.

(B) What is atmospheric refraction? List two natural phenomena based on atmospheric refraction.[CBSE 2019]

93. A person is unable to see objects distinctly placed within 50 cm from his eyes.

(A) Name the defect of vision the person is suffering from and list its two possible causes.

(B) Draw a ray diagram to show the defect in the above case.

(C) Mention the type of lens used by him for the correction of the defect and calculate its power. Assume that the near point for the normal eye is 25 cm.

(D) Draw a labelled diagram for the correction of the defect in the above case.

[CBSE 2019]

TOPPER'S CORNER

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

1. (A) List the parts of the human eye that control the amount of light entering into it. Explain how they perform this function.

(B) Write the function of retina in human eye.

(C) Do you know that the corneal-impairment can be cured by replacing the defective cornea with the cornea of the donated eye ? How and why should we organise groups to motivate the community members to donate their eyes after death ?

Ans.

(a) The iris and pupil control the amount of light entering our eye.
The iris is a dark muscular diaphragm behind the cornea with a hole in its centre called the pupil. The iris contracts or relax in order to enlarge or make small the pupil. Accordingly the pupil regulates the amount of light entering our eye.
When pupil is enlarged a large amount of light enters our eye. When it's small, a smaller amount of light enters our eye.
In bright areas, the pupil becomes small and in dim rooms the pupil enlarges.

b. Retina is the light sensitive screen on the back of the eye ball. It is the thin membrane on which the images are formed containing light sensitive cells called rodds and cones which get activated on illumination. These cells convert light energy into electrical impulses which are carried to brain via the optic nerves.

c. There are around 4.5 million corneally blind people, out of which 60% are below 12 years of age. All these people can be cured by a corneal transplantation.
We should organize groups to motivate community members to donate their eyes after death, because of such a situation. A pair of eyes can give sight to two corneally blind people. The community must be made aware of the fact that any person, of any age or sex, who doesn't have any communicable disease, can donate their eyes. Such groups should motivate people to register in eye banks, who will remove the eyes, once the person is dead.
People should be educated about this at a young age, so that they will be motivated to donate not just eyes, but other organs also like kidneys, lives, heart and lungs after death. Such noble acts can better the lives of so many disabled

[CBSE Topper 2014]

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

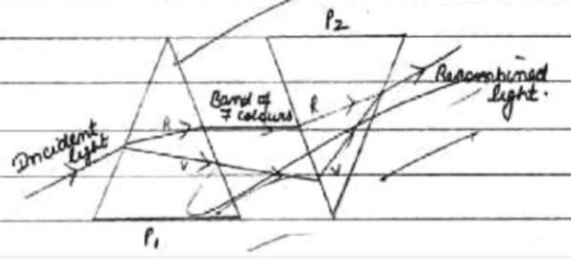
2. State the cause of dispersion of white light by a glass prism. How did Newton, using two identical glass prisms, show that white light is made of seven colours? Draw a ray diagram to show the path of a narrow beam of white light, through a combination of two identical prisms arranged together in inverted position with respect to each other, when it is allowed to fall obliquely on one of the faces of the first prism of the combination.

Ans.

↳ Cause of Dispersion of white light by a glass prism ↳

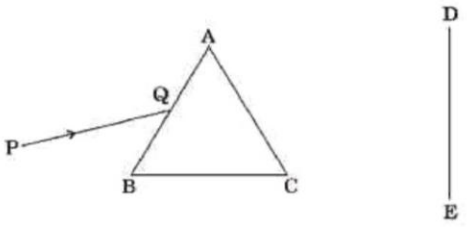
When white light ray passed through a glass prism, its constituents colours having different wavelengths & speeds, bend or deviate at different angles due to which they get separated from each other. This happens due to peculiar shape of prism that different colours go in different directions.

Newton passed a ray of white light through a glass prism. After refraction, the white light splitted into its constituent band of seven colour called spectrum. When he tried to further split it by placing a prism, it didn't occur. But when he placed an inverted prism and passed the band of colours through it, he saw white light ray coming from other side. Thus he concluded that sunlight is made up of seven colours



[CBSE Topper 2017]

3. A narrow beam PQ of white light is passing through a glass prism ABC as shown in the diagram.



LONG ANSWER Type Questions (LA)

[5 marks]

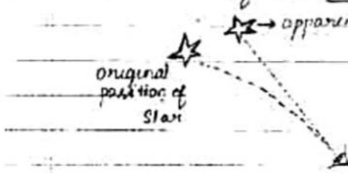
4. What is atmospheric refraction? Use this phenomenon to explain the following natural events:
(a) Twinkling of stars
(b) Advanced sun-rise and delayed sun-set. Draw diagrams to illustrate your answers.

Ans.

The refraction of light rays when it passes through the atmosphere bend towards the normal and reaches us. This atmosphere in phenomena of refraction in the atmosphere is called atmospheric refraction.

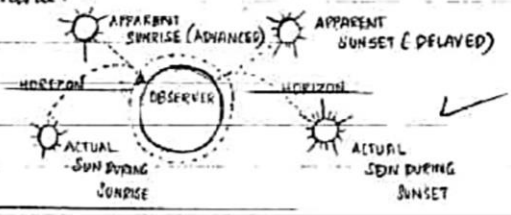
(a) Twinkling of stars:

The starlight on entering the atmosphere undergoes refraction completely and continuously. It bend towards the normal. Since, the atmosphere is not stationary, the apparent position of star changes. It appears slightly higher up. The amount of starlight that enters the eye fluctuates. So, the star flickers and causes the twinkling effect. So, the star appears to be twinkling and this is because of the atmospheric refraction.



b) Advanced sunrise and delayed Sunset.

Sunrise and sunset is actually the crossing of horizon by the sun. The advanced sunrise and delayed sunset is due to atmospheric refraction. The difference between the actual sunrise and apparent sunrise is two minutes. Likewise the difference between the actual sunset and apparent sunset is two minutes. The flattening of sun's disc is also due to this phenomena.



[CBSE Topper 2016]

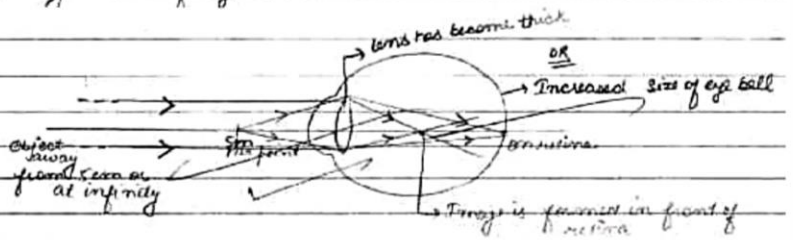
5. (a) A student suffering from myopia is not able to see distinctly the objects placed beyond 5 m. List two possible reasons due to which this defect of vision may have arisen. With the help of ray diagrams, explain:
(i) why the student is unable to see distinctly the objects placed beyond 5 m from his eyes.
(ii) the type of the corrective lens used to restore proper vision and how this defect is corrected by the use of this lens.
(b) If, in this case, the numerical value of the focal length of the corrective lens is 5 m, find the power of the lens as per the new Cartesian sign convention.

Ans.

⟶ (a) causes of Myopia ⟵

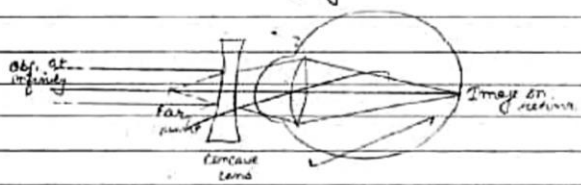
1) Excessive curvature of eye lens.
2) Elongation of eye ball.

(i)



Light rays coming from an object away from 5m like from the infinity are converged much before retina due to increased converging power.

(ii)



Concave lens is used to restore proper vision in case of myopia. Concave lens is diverging and make the image of object placed at infinity on it focus i.e its far point and help us to see objects upto infinity.

(b) Focal length of concave lens is negative

$\therefore f = -5m$

$P = \frac{1}{f} = \frac{-1}{5} = \boxed{-0.2D}$

[CBSE Topper 2017]