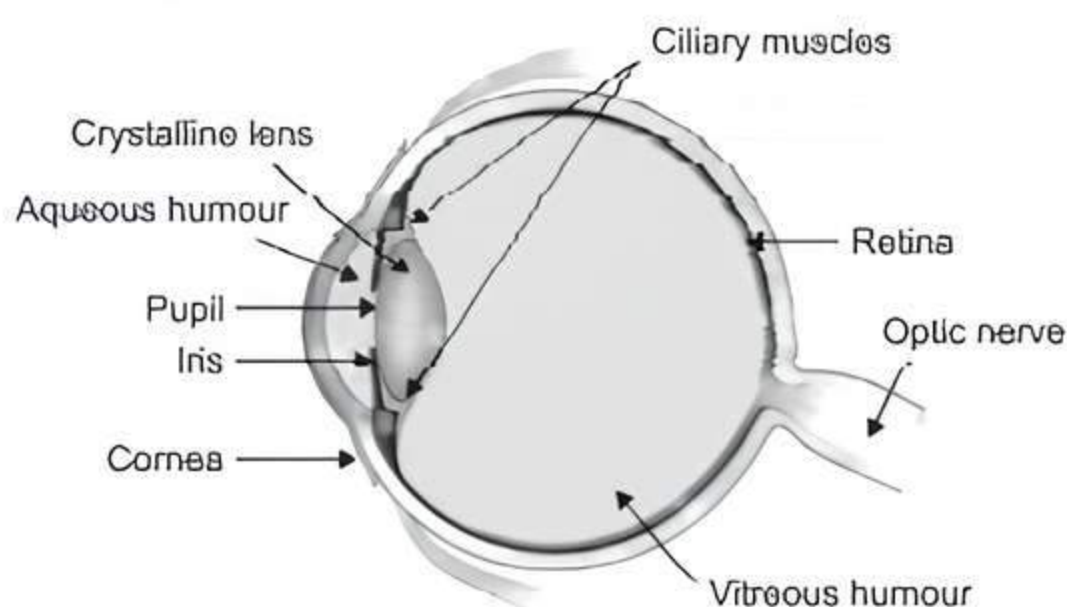


10 The Human Eye and the Colourful World

Fastrack« Revision

- **Human Eye:** It is one of the most valuable and sensitive sense organs. It is an optical device that serves as our organ of sight. Human eye is like a camera and is based on the lens system. It enables us to see the wonderful and colourful world by forming an image on a light-sensitive screen called the retina.



The Human Eye

It consists of the following parts:

- (i) **Cornea:** It is a thin membrane through which light enters the eye.
- (ii) **Iris:** It is a dark muscular diaphragm that controls the size of the pupil.
- (iii) **Pupil:** It regulates and controls the amount of light entering the eye.
- (iv) **Eye Lens:** It is a convex lens made of transparent and fibrous jelly-like material. Its curvature can be adjusted through ciliary muscles. It forms an inverted real image of the object on the retina.
- (v) **Retina:** It works as a screen having enormous number of light-sensitive cells. The light-sensitive cells convert light into electrical signals and transmit these signals to the brain through optic nerve for visual recognition.

MNEMONICS

Concept : Parts of the human eye

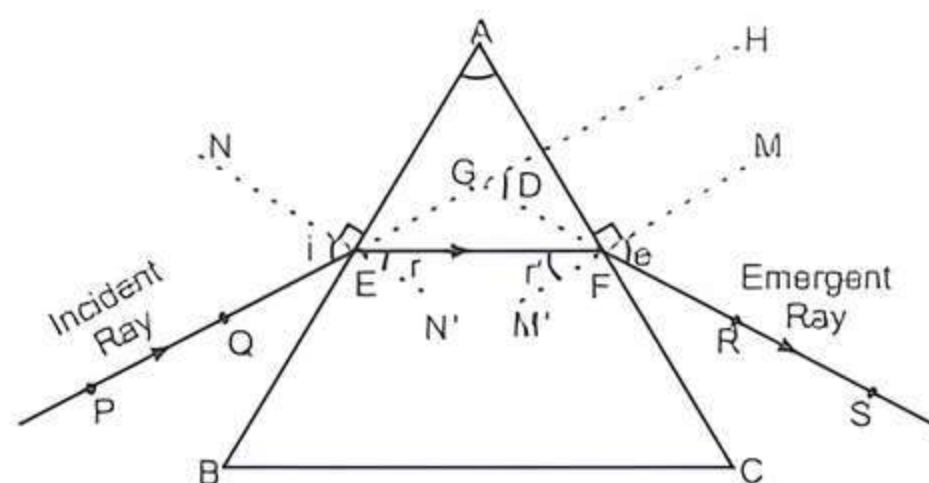
Mnemonics: Innocent Circus People Love Raisin Oats

Interpretation: Iris, Cornea, Pupil, Lens, Retina, Optic Nerve.

- **Power of Accommodation:** The ability of eye lens to focus the distant objects as well as nearby objects on the retina by changing the focal length of the eye lens is known as power of accommodation of the eye.
- **Far Point of the Eye:** It is the farthest point up to which the eye can see clearly. It is infinity for a normal eye.
- **Near Point of the Eye:** The minimum distance from eye from which an object can be seen most distinctly without any strain is called near point of

the eye. For a healthy normal eye of an adult, it is 25 cm.

- **Myopia:** In this defect, a person can see nearby objects clearly, but is unable to see distant objects clearly, since the image of a distant object (at infinity) is formed in front of the retina. Myopia is caused due to excessive curvature of eye lens or elongation of eyeball. This defect can be corrected by using concave lens of suitable focal length.
- **Hypermetropia:** In this defect, a person can see distant objects clearly but unable to see nearby objects distinctly, since the image of normal near point is formed behind the retina. This type of defect is known as hypermetropia or far-sightedness. Hypermetropia is caused due to decrease in power of eye lens (increase in focal length of eye lens) or shortening of eye ball. The defect can be corrected by using convex lens of suitable focal length.
- **Presbyopia:** Due to old age or excessive reading or careless practices of a person, the power of accommodation of the eye decreases. In such a situation, a person cannot see the nearby objects as well as distant objects clearly. Such type of defect is known as presbyopia. Presbyopia is caused due to decrease in flexibility of eye lens and gradual weakening of ciliary muscles. This defect can be corrected by using bi-focal lenses. A bi-focal lens consists of both convex lens (to facilitate near vision) and concave lens (to facilitate distant vision).
- **Prism:** A prism is a transparent material bounded by five plane surfaces (two triangular bases and three rectangular lateral surfaces) inclined at some angles. When a ray of light passes through a glass prism, refraction (or bending) of light occurs twice, once when it enters the prism and then when it leaves the prism. The diagram shows refraction of a ray of light through a prism.

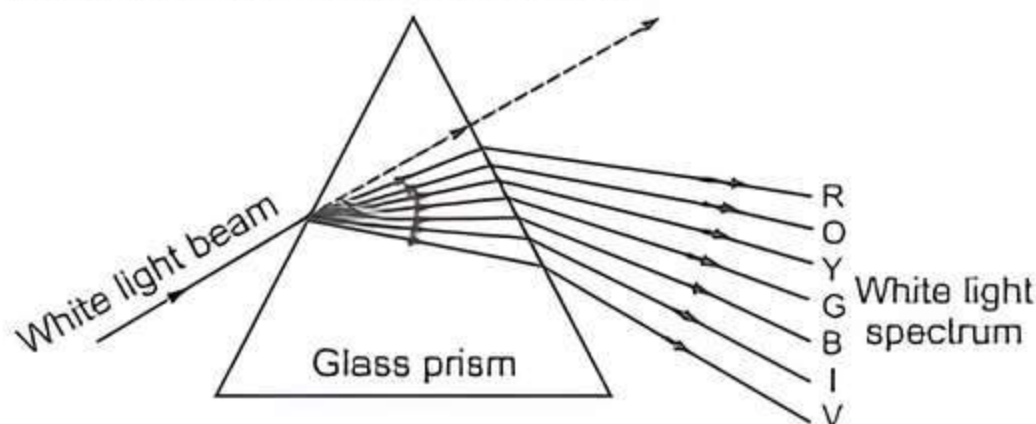


Here, PE = Incident ray, FS = Emergent ray, $\angle i$ = Angle of incidence, $\angle e$ = Angle of emergence, EF = Refracted ray, $\angle A$ = Angle of prism, $\angle r$ = Angle of refraction, $\angle D$ = Angle of deviation.

- (i) The angle between incident ray and emergent ray is called angle of deviation.

- (ii) In refraction through a glass slab, the emergent ray is parallel to the incident ray, but in refraction through a glass prism, the emergent ray is not parallel to the incident ray.

- **Dispersion:** The splitting of white light into its components due to different bending abilities of colours when it passes through a prism is called dispersion.



Dispersion of White Light by the Glass Prism

- **Recombination of White Light:** Isaac Newton was the first to use a glass prism to obtain the spectrum of sunlight. He found that when an inverted prism is placed in the path of dispersed light then after passing through prism, they recombine to form white light. He observed that the red colour bends the least while the violet colour bends the most.
- **Spectrum:** The rainbow is an arc of seven colours (Violet, Indigo, Blue, Green, Yellow, Orange and Red), visible in the

sky due to dispersion of Sun's light by raindrops present in the atmosphere. This arc (called VIBGYOR) is known as spectrum. It is formed due to dispersion, refraction and total internal reflection of light.

- **Atmospheric Refraction:** The refraction of light caused by the Earth's atmosphere (having air layers of varying optical densities) is atmospheric refraction. Twinkling of Stars, the Stars seem higher than they actually are and advanced sunrise and delayed sunset are some phenomenon based on atmospheric refraction.
- **Scattering of Light:** When a ray of light passes through a path of suspended particles, it splits up in various random directions. Such a phenomenon is known as scattering of light. In this situation, scattering depends upon the size of the particles as in the case of a true solution and a colloidal solution. According to Rayleigh's law of scattering, the amount of scattered light is $1/(\text{wavelength})^4$.
- **Tyndall Effect:** The phenomenon of scattering of light by the colloidal particles is known as Tyndall effect.
- The scattering of blue component of the white sunlight by air molecules present in the atmosphere causes the blue colour of the sky.
 - In outer space, the sky looks black instead of blue because there is no atmosphere to scatter sunlight.



Practice Exercise



Multiple Choice Questions

- Q 1. The phenomenon of light responsible for the working of the human eye is:
- refraction
 - reflection
 - power of accommodation
 - persistence of vision

- Q 2. Match the parts of eye given in Column (A) with their appropriate function given in Column (B):

Column (A)	Column (B)
A. Pupil	1. It converts images formed by lens into electrical impulses.
B. Retina	2. It controls the size of the pupil.
C. Cornea	3. It controls the amount of light entering the eye.
D. Iris	4. Light enters the eye through it.

A B C D

a. 2 1 4 3

c. 3 4 1 2

A B C D

b. 3 1 4 2

d. 2 4 1 3

- Q 3. When we enter a dark room coming from outside, the things inside the room do not appear clear to our eyes immediately. This is because:
- pupils do not open at all in the dark
 - pupils take time to adjust
 - light travels slower in a dark room
 - pupils open very quickly in the dark

- Q 4. When light rays enter the eye, most of the refraction occurs at the:

- crystalline lens
- outer surface of the cornea
- iris
- pupil

- Q 5. The image distance from the eye lens in the normal eye when we increase the distance of an object from the eye:

(CBSE 2020)

- increases
- decreases
- remains unchanged
- depends on the size of the eyeball

- Q 6. A person cannot see objects distinctly kept beyond 2 m. This defect can be corrected by using which type of lens and of what power?

- Convex lens, + 0.5 D
- Concave lens, + 0.5 D
- Convex lens, - 0.2 D
- Concave lens, - 0.5 D

- Q 7. Which of the following is considered as a reason for hypermetropia?

- The eye lens is not able to contract
- The eye lens becomes thick
- The eye lens becomes thin
- Both a. and b.

- Q 8. What is the cause of presbyopia?

- Weakening of ciliary muscles
- Thin eye lens
- Both a. and b.
- Thickness of eye lens

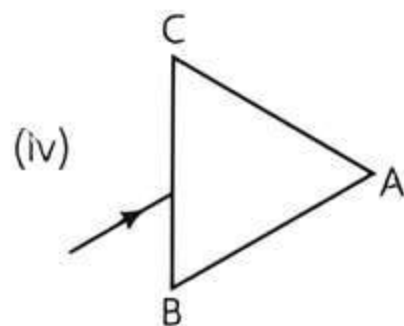
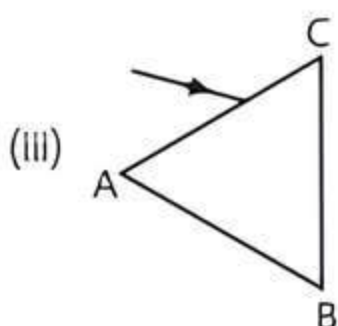
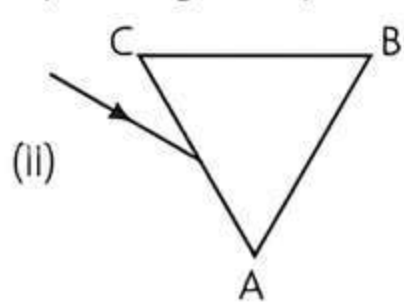
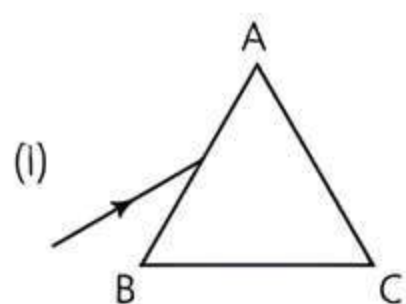
- Q 9. Person suffering from cataract has:** (CBSE 2020)
- elongated eyeball
 - excessive curvature of eye lens
 - weakened ciliary muscles
 - opaque eye lens

- Q 10. When a ray passes through a prism:**
- it goes undeviated
 - it remains parallel to the base
 - it bends towards the base
 - None of the above

- Q 11. A transparent refracting material which is bounded by two plane refracting surfaces is:**
- prism
 - convex lens
 - glass slab
 - None of these

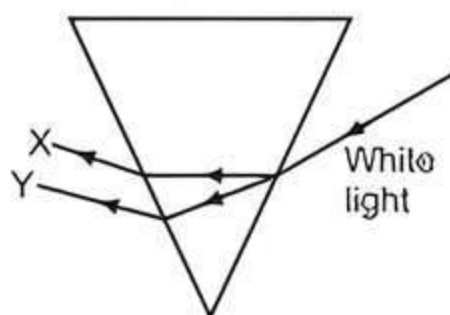
- Q 12. A prism ABC (with BC as base) is placed in different orientations. A narrow beam of white light is incident on the prism as shown in below figure. In which of the following diagrams, after dispersion, the third colour from the top of the spectrum corresponds to the colour of the sky?**

(CBSE SQP 2021, Term-1)



- (I)
 - (II)
 - (III)
 - (IV)
- Q 13. If a beam of red light and a beam of violet light are incident at the same angle on the inclined surface of a prism from air medium and produce angles of refraction r and v respectively, which of the following is correct?** (CBSE SQP 2021, Term-1)
- $r = v$
 - $r > v$
 - $r = 1/v$
 - $r < v$

- Q 14. In the diagram given below, X and Y are the end colours of the spectrum of white light. The colour of 'Y' represents the:**



- Colour of sky as seen from Earth during the day
- Colour of the sky as seen from the Moon
- Colour used to paint the danger signals
- Colour of Sun at the time of noon

- Q 15. Which of the following phenomenon of light are involved in the formation of a rainbow?**

(NCERT EXEMPLAR)

- Reflection, refraction and dispersion
- Refraction, dispersion and total internal reflection
- Refraction, dispersion and internal reflection
- Dispersion, scattering and total internal reflection

- Q 16. The sky appears dark to passengers flying at very high altitudes mainly because:** (CBSE 2020)

- scattering of light is not enough at such heights
- there is no atmosphere at great heights
- the size of molecules is smaller than the wavelength of visible light
- the light gets scattered towards the Earth

- Q 17. Twinkling of stars is due to atmospheric:**

(NCERT EXEMPLAR)

- dispersion of light by water droplets
- refraction of light by different layers of varying refractive indices
- scattering of light by dust particles
- internal reflection of light by clouds

- Q 18. When light enters the atmosphere, it strikes on extremely fine particles, which deflect the rays of light in all possible directions. This is due to:**

(CBSE SQP 2023-24)

- reflection of light
- atmospheric refraction
- scattering of light
- dispersion of light

- Q 19. Which of the following is not the cause of atmospheric refraction?**

- Apparent image of Sun is formed closer to the Earth
- Dawn or dusk are formed
- Sun can be seen 2 minutes before actual sunrise and 2 minutes after actual sunset
- Clouds look white

- Q 20. Refraction of light by the Earth's atmosphere due to variation in air density is called:**

- atmospheric reflection
- atmospheric dispersion
- atmospheric scattering
- atmospheric refraction



Assertion & Reason Type Questions

Directions (Q. Nos. 21-28): Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Give answer:

- Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
- Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
- Assertion (A) is true but Reason (R) is false.
- Assertion (A) is false but Reason (R) is true.

- Q 21. **Assertion (A):** Ciliary muscles help in changing the focal length of the eye lens.
Reason (R): Ciliary muscles help to focus near and distant objects in quick succession.
- Q 22. **Assertion (A):** A person suffering from myopia cannot see the distant objects clearly.
Reason (R): A converging lens is used for the correction of myopic eye as it can form real as well as virtual images of the objects placed in front of it. (CBSE 2023)
- Q 23. **Assertion (A):** The white light is dispersed into seven constituent colours when passed through the prism.
Reason (R): Different colours of light bend through different angles as they pass through a prism.
- Q 24. **Assertion (A):** The planets twinkle while the Stars do not.
Reason (R): The planets are much closer to the Earth than the Stars.
- Q 25. **Assertion (A):** The rainbow is seen when the Sun is behind the observer.

Answers

- (a) refraction
- (b) A-3, B-1, C-4, D-2
- (b) pupils take time to adjust
- (b) outer surface of the cornea
- (c) remains unchanged
- (d) The person mentioned here is suffering from myopia and needs a concave lens to correct the defect.

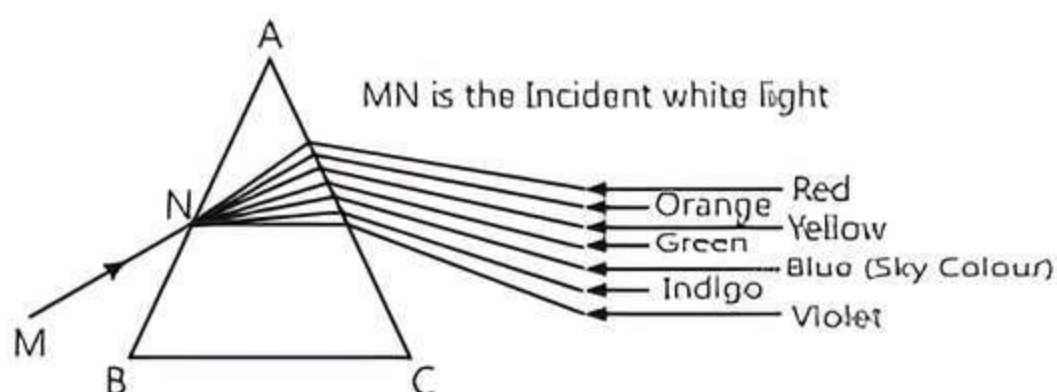
According to the question,

$$f = 2 \text{ m}$$

$$P = -\frac{1}{2} = -0.5 \text{ D}$$

Thus, the power of -0.5 D is required to correct this defect.

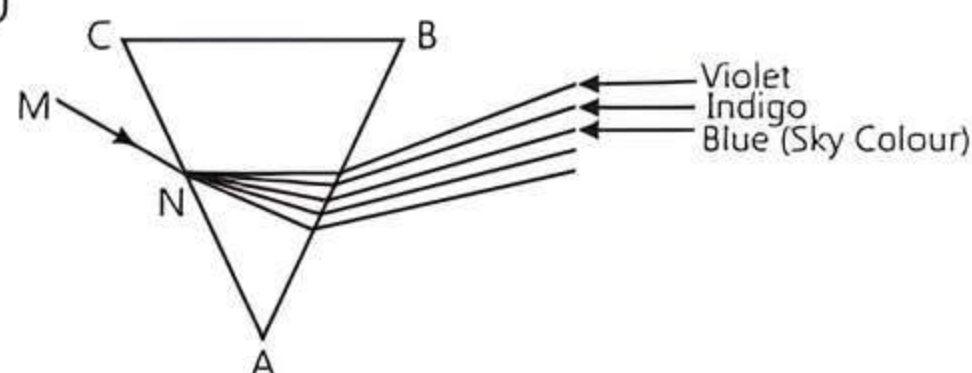
- (d) Both a. and b.
- (a) Weakening of ciliary muscles.
- (d) opaque eye lens
- (c) It bends towards the base
- (a) prism
- (b) Generally, in case of a prism (i), the formation of spectrum is shown below.



In the above figure, from top the third colour is yellow. But we can see that from bottom the third colour is blue (colour of sky). So, we can obtain the correct situation by inverting the prism. Thus, the required orientation can be found in case (ii).

Reason (R): Rainbow is produced due to dispersion of white light by small rain drops hanging in the air after the rain.

- Q 26. **Assertion (A):** The Sun is visible to us about 2 minutes before the actual sunrise and about 2 minutes after the actual sunset because of atmospheric refraction.
Reason (R): The time difference between actual sunset and the apparent sunset is about 4 minutes.
- Q 27. **Assertion (A):** The scattering of longer wavelengths of light increases as the size of the particles increases.
Reason (R): Large particles scatter lights of all wavelengths equally well.
- Q 28. **Assertion (A):** The scattered light makes path of light visible.
Reason (R): Scattering of light is the result of Tyndall effect.



- (d) While passing through the prism, red light bends the least and violet light the most.
- (c) Colour used to paint the danger signals
- (c) Refraction, dispersion and internal reflection
- (a) scattering of light is not enough at such heights
- (b) refraction of light by different layers of varying refractive indices
- (c) scattering of light
- (d) Clouds look white because water droplets present in the atmosphere scatters all wavelengths due to their large size.
- (d) atmospheric refraction
- (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
- (c) Reason (R) is false because a diverging lens or concave lens is used for the correction of myopic eye.
- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
- (d) Assertion (A) is false because planets do not twinkle while stars twinkle.
- (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
Just after the rain, a large number of small droplets of water remain suspended in the air. Each drop acts like a small prism. When sunlight fall on these drops the white light splits into seven colours. The dispersed light from a large number of drops forms a continuous band of seven colours.

26. (c) Reason (R) is false because the time difference between actual sunset and apparent sunset is 2 minutes
27. (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
28. (b) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

Case Study Based Questions

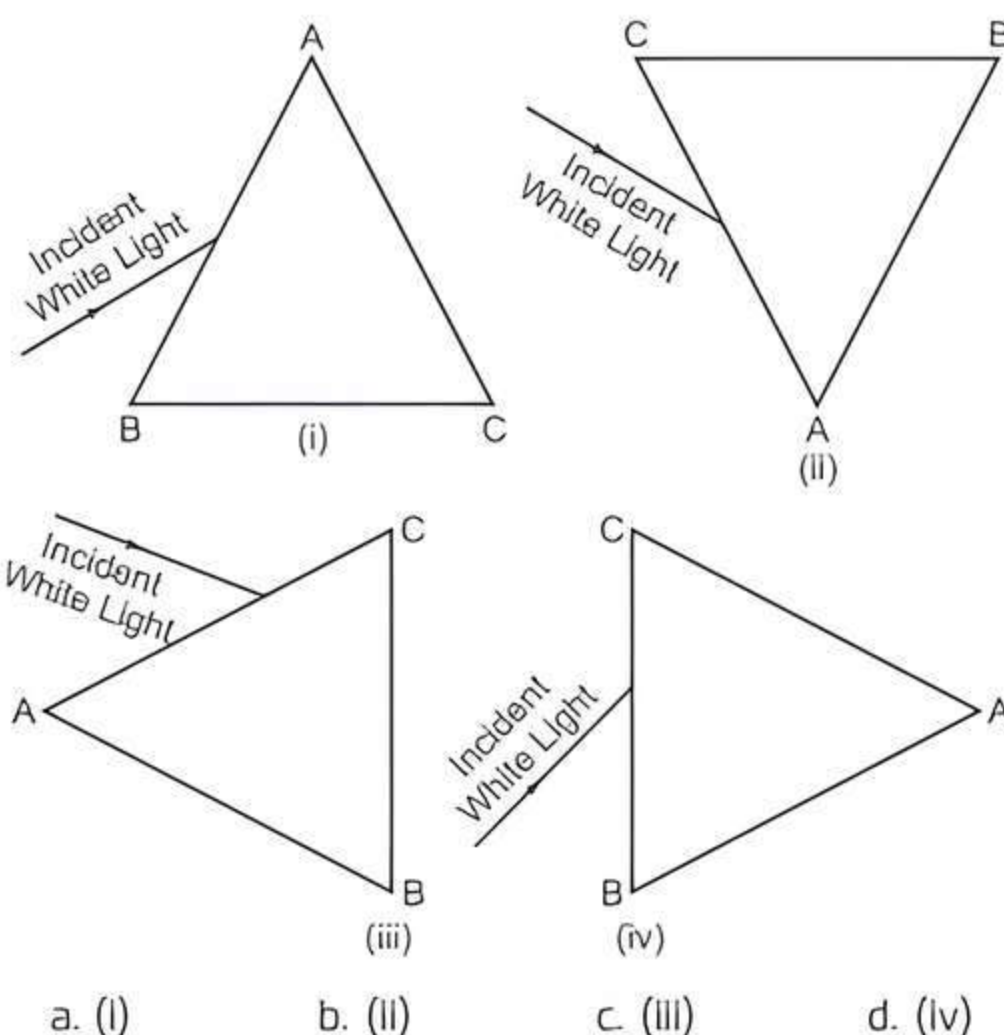
Case Study 1

The triangular glass prism is a transparent object made of glass having two triangular ends and three rectangular sides. The opposite faces of a triangular glass prism are not parallel to one another.

When a ray of light passes through a prism, it bends towards the base of prism. But when white light consisting of seven colours falls on a glass prism, each colour in it is refracted by a different angle, with the result that seven colours are spread out to form a spectrum. The red colour is deviated the least and the violet colour is deviated the maximum.

Read the above passage carefully and give the answer of the following questions:

- Q 1. Angle of deviation in a prism is the angle between:**
- incident and reflected ray
 - reflected and emergent ray
 - incident and emergent ray
 - incident and refracted ray
- Q 2. Which of the following phenomenon of light are involved in the formation of a rainbow?**
- Reflection, refraction and dispersion
 - Refraction, dispersion and total internal reflection
 - Refraction, dispersion and internal reflection
 - Dispersion, scattering and total internal reflection
- Q 3. Which of the following coloured light has the least speed in glass prism?**
- Violet
 - Yellow
 - Red
 - Green
- Q 4. The colour of light which undergoes least bending on passing through the glass prism is:**
- green
 - violet
 - red
 - blue
- Q 5. Based on the different orientations of a prism ABC given below, in which of the following cases, after dispersion, the third colour from the top corresponds to the colour of the sky?**



Answers

- (c) Incident and emergent ray
- (c) Refraction, dispersion and internal reflection
- (a) Violet
- (c) red
- (b) (ii)

Case Study 2

We know that when light goes from one medium to another medium having different optical densities, then refraction of light rays (or bending of light rays) takes place. Now, in the atmosphere, we have air everywhere. But all the air in the atmosphere is not at the same temperature. Some of the air layers of the atmosphere are cold whereas other air layers of the atmosphere are comparatively warm (or hotter). Now the cooler air layers of the atmosphere behave as optically denser medium for light rays whereas the warmer air layers (or hotter air layers) of the atmosphere behave as optically rarer medium for the light rays. So, in the same atmosphere we have air layers having different optical densities. And when light rays pass through the atmosphere having air layers of different optical densities, then refraction of light takes place. The refraction of light caused by the Earth's atmosphere (having air layers of varying optical densities) is called atmospheric refraction.

Read the above passage carefully and give the answer of the following questions:

- Q 1. With respect to atmospheric refraction which of the following point distinguish between cold air and hot air?**
- Cold air is denser than hot air
 - Hot air is lighter than cold air
 - Cold air has higher refractive index than hot air.
 - All of the above

Q 2. What is the reason behind twinkling of Stars?

- Dispersion of star light
- Reflection of star light
- Refraction of star light
- All of the above

Q 3. Why Sun appears flattened during sunrise and sunset?

- Because Sun is closer to Earth
- Because Earth is rotating
- Because Earth is revolving
- Because of atmospheric refraction

Q 4. How much time from sunrise to sunset is lengthened because of atmospheric refraction?

- a. 4 hours b. 2 minutes
c. 4 minutes d. 2 hours

Q 5. When light rays from Stars enter into Earth's atmosphere, it travels from:

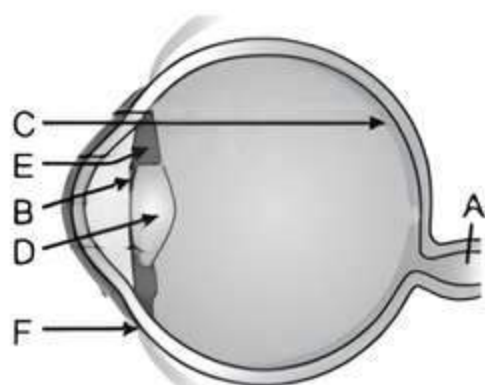
- denser to rarer medium
- rarer to denser medium
- rarer medium to vacuum
- denser medium to vacuum

Answers

1. (d) All of the above
Cold air is denser and heavier than hot air. Also, cold air has higher refractive index than hot air. Hence, all are true.
2. (c) refraction of star light
3. (d) The Sun appears flattened because of atmospheric refraction.
4. (c) The time from sunrise to sunset is lengthened by 4 minutes.
5. (b) When light rays from Stars enter into Earth's atmosphere, it travel from rarer to denser medium.

Case Study 3

Different organs of human eye are labelled as A to E.



The Structure of Human Eye

Study the diagram and answer the following questions:

- Q 1. Name the parts A, B, C, D and E.
- Q 2. What is the nature of image formed on the retina of the eye?
- Q 3. When light rays enter the eye, most of the refraction occurs at the:
- (i) part D (ii) part B
- (iii) outer surface of part F (iv) part E
- Q 4. Define power of accommodation.
- Q 5. What is aqueous humour and vitreous humour?

Answers

1. A—Optic nerve: B—Iris: C—Retina: D—Crystalline lens:
E—Ciliary muscles
2. Real and inverted
3. (iii) outer surface of part F
4. The ability of eye lens to adjust its focal length is called power of accommodation.
5. The space between cornea and eye lens is filled with a watery liquid called aqueous humour, whereas vitreous humour is a transparent jelly-like substance filled between eye lens and retina.

Case Study 4

When light goes from one medium to another medium having different optical densities, then refraction of light rays takes place. All the air in the atmosphere is not at the same temperature. Some of the air layers of the atmosphere are cold (optically denser) whereas other layers of the atmosphere are comparatively warm (optically rarer). So, in the atmosphere we have air layers having different optical densities.

Atmospheric refraction is the deviation of light from a straight line as it passes through the atmosphere due to the variation in air density. Such refraction can raise or lower, or stretch or shorten the images of distant objects and can also make distant objects appear to twinkle or shimmer.

Read the above passage carefully and give the answer of the following questions:

- Q 1. What is atmospheric refraction?
- Q 2. What causes atmospheric refraction?
- Q 3. Name the effects produced by atmospheric refraction.
- Q 4. Which has more refractive index-hot air or cold air?
- Q 5. How much time from sunrise to sunset is lengthened because of atmospheric refraction?

Answers

1. The refraction of light caused by the Earth's atmosphere (having air layers of varying optical densities) is atmospheric refraction.
2. It is caused due to the varying optical densities of different layers of Earth's atmosphere.
3. Twinkling of Stars, the Stars seem higher than they actually are and advanced sunrise and delayed sunset are some phenomenon produced by atmospheric refraction.
4. The refractive index of hot air is less than cold air because cold air is denser than hot air.
5. The sunrise appears 2 minutes early and sunset appears 2 minutes later due to atmospheric refraction. So, total time lengthened is 4 minutes.

Very Short Answer Type Questions

Q 1. State one function of crystalline lens in human eye.

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

Q 2. How is the sense of vision carried from the eye to the brain?

Ans. The sense of vision is carried from the eye to the brain through optic nerve.

Q 3. What is the range of vision for a normal human eye?

Ans. For a normal human eye, the range of vision is from 25 cm to infinity.

Q 4. What is meant by far point of the eye?

Ans. The farthest point up to which the eye can see objects clearly is called the far point of the eye. It is infinity for a normal eye.

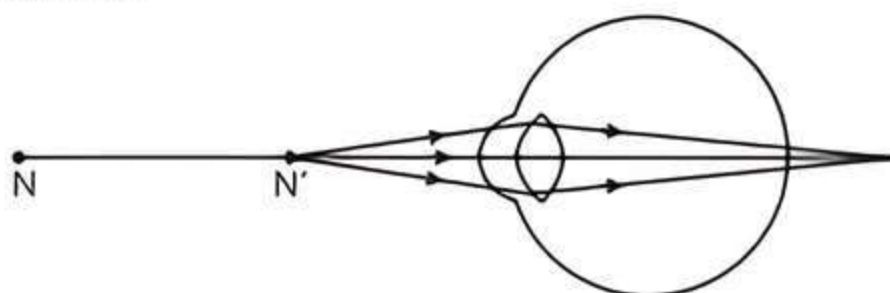
Q 5. Why is a normal eye not able to see clearly the objects placed closer than 25 cm? (NCERT EXERCISE)

Ans. A normal eye is unable to see the objects placed closer than 25 cm because the focal length of the eye lens cannot be decreased below a certain minimum limit.

Q 6. An old person is unable to see clearly nearby objects as well as distant objects. What kind of lens will be required to see clearly nearby objects as well as distant objects?

Ans. Such people require bi-focal lenses, which consists of both concave and convex lenses to facilitate distant and near vision respectively.

Q 7. Study the diagram and answer the questions that follows:



Identify the defect of vision represented by this diagram.

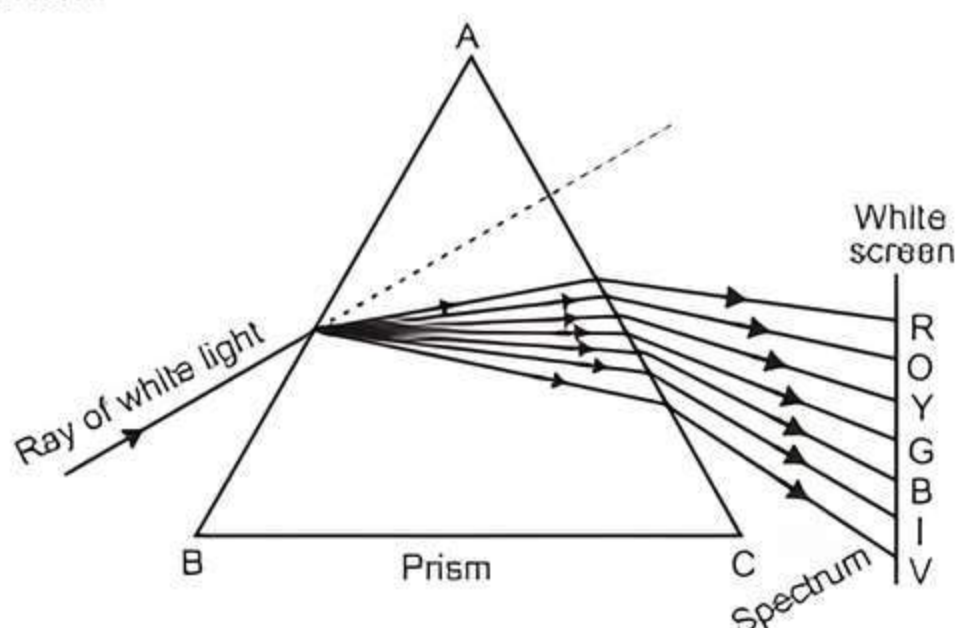
Ans. The defect of vision is hypermetropia.

Q 8. Define dispersion of white light.

Ans. The splitting of white light into its constituent colours is called dispersion.

Q 9. Draw a diagram to show the dispersion of white light by a glass prism.

Ans. Diagram showing dispersion of white light by a glass prism.



Q 10. Name the type of particles which act as prisms in the formation of rainbow in the sky.

Ans. The tiny water droplets present in the atmosphere act like small prisms.

Q 11. Is the position of a star as seen by us is its true position? Justify your answer. (NCERT EXEMPLAR)

Ans. No, due to atmospheric refraction a star appears to be slightly higher than its actual position.

Q 12. Name the phenomenon responsible for apparent flattening of the Sun's disc at sunrise and sunset.

Ans. The apparent flattening of the Sun's disc at sunrise and sunset is due to atmospheric refraction.

Q 13. Which phenomenon is responsible for making the path of light visible?

Ans. Tyndall effect makes the path of light visible.

Short Answer Type-I Questions

Q 1. 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. The ability of the eye to focus on both near and distant objects, by adjusting its focal length, is called the accommodation of the eye.

While looking at nearby objects, the ciliary muscles contract which increases the curvature of eye lens. The eye lens becomes thicker and focal length of eye lens decreases which enable us to see the nearby objects clearly.

Q 2. Write the structure of eye lens and state the role of ciliary muscles in the human eye. (CBSE 2019)

Ans. The eye lens is a bi-convex lens made of a fibrous, jelly-like material.

The key role of ciliary muscles is to modify the curvature of eye lens and thus change its focal length.

Q 3. What happens to the image distance in the normal human eye when we decrease the distance of an object, say 10 m to 1 m? Justify your answer.

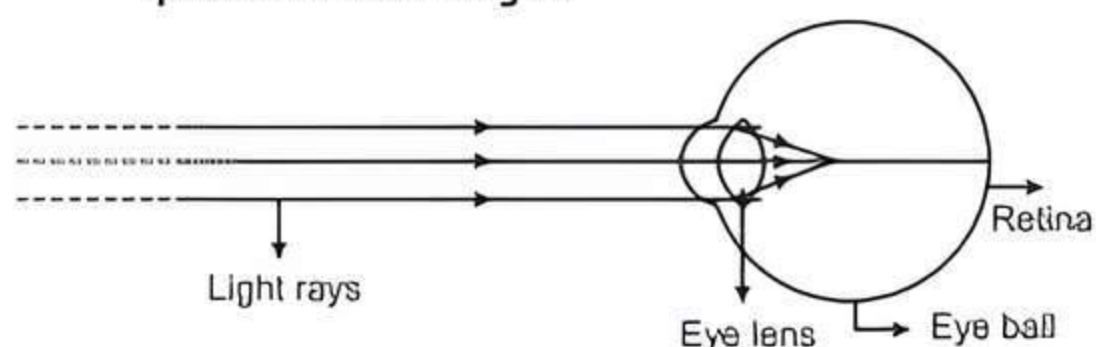
Ans. (CBSE 2019)

TIP For a normal human eye, image distance is independent of object distance as image is always formed on the retina.

When we decrease the object distance from 10 m to 1 m, the focal length of eye lens accommodates itself to obtain a clear image on the retina. This is done by the action of ciliary muscles.

Therefore, the image distance remains the same.

Q 4. Observe the following diagram and answer the questions following it:

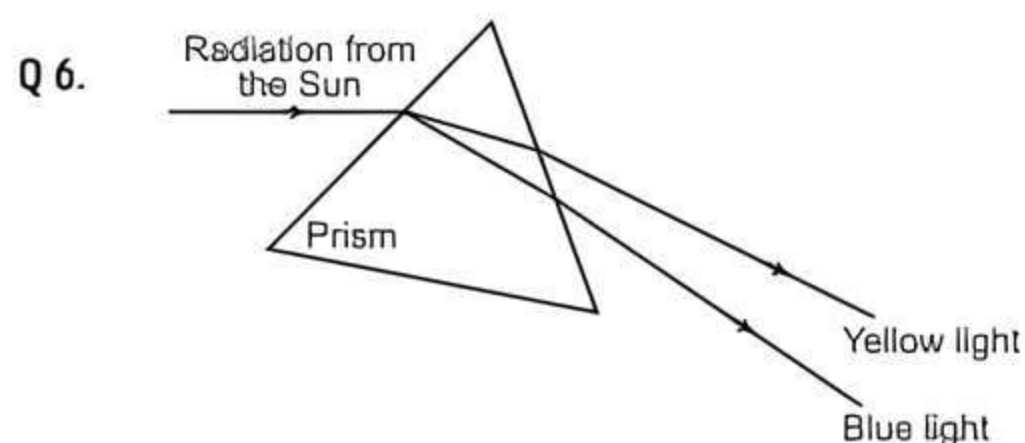
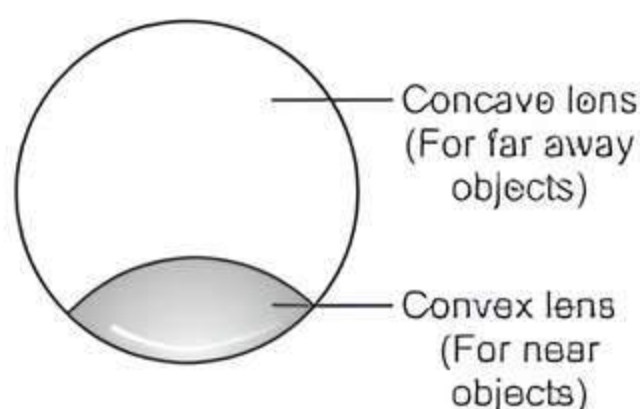


- (i) Identify the defect of vision shown.
 (ii) List its two causes.
 (iii) Name the type of lens used for the correction of this defect. (CBSE 2023)

Ans. (i) Myopia
 (ii) Causes:
 (a) excessive curvature of the eye lens
 (b) elongation of the eye ball
 (iii) A concave lens of suitable power is used for the correction of this defect.

Q 5. List two causes of presbyopia. Draw labelled diagram of a lens used for the correction of this defect of vision. (CBSE 2019)

Ans. Presbyopia arises due to the following reasons:
 (i) gradual weakening of the ciliary muscles and
 (ii) diminishing flexibility of the eye lens.
Bi-focal lens is used for the correction of this defect.

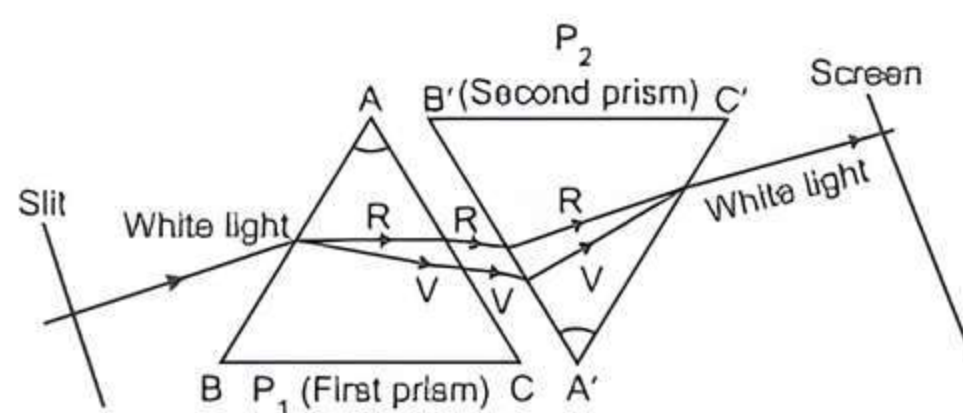


State the phenomena observed in the above diagram. Explain with reference to the diagram, which of the two lights mentioned above will have the higher wavelength? (CBSE SQP 2022-23)

Ans. The splitting of white light into seven colours on passing through a prism is called dispersion.
 For a constant frequency, wavelength is directly proportional to velocity. So, yellow will have greater wavelength than blue as the velocity of yellow light is greater than blue light.

Q 7. How will you use two identical prisms so that a narrow beam of white light incident on one prism emerges out of the second prism as white light? Draw the diagram. (CBSE SQP 2022-23)

Ans. By using two identical prisms, one placed inverted with respect to the other.



Recombination of the spectrum of White light.

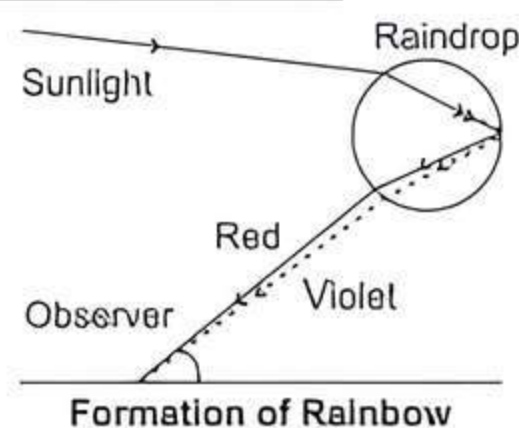
Q 8. A glass prism is able to produce a spectrum when white light passes through it but a rectangular block of same transparent glass does not produce any spectrum. Why? (CBSE 2019)

Ans. In a rectangular block, refraction of light takes place at the two parallel surfaces. In this case, the emergent ray is also a white light because the constituents of white light which are refracted at different angles at the first interface recombine at the second interface and emerge as a single white light.

In a prism, the two interfaces through which the light ray has to pass are not parallel to each other and are inclined at an angle. In this case, the effects of the first interface are not reversed and the colours separated at the first interface continue along different paths upon leaving the glass at the second interface. Hence, we observe a spectrum in a glass prism.

Q 9. When and where does a rainbow appear in the sky? Draw a labelled ray diagram to show its formation. (CBSE 2023)

Ans. A rainbow is a natural spectrum appearing in the sky after a rain shower. It is always formed in a direction opposite to that of the Sun.



Q 10. What is atmospheric refraction? List two phenomenon which can be explained on the basis of atmospheric refraction.

Ans. The refraction of light caused by the Earth's atmosphere (having air layers of varying optical densities) is atmospheric refraction.
Twinkling of Stars and advanced sunrise and delayed sunset are the two phenomenon based on atmospheric refraction.



TiP

Understand the concept of atmospheric refraction and the causes of phenomenon caused by atmospheric refraction.

Q 11. Explain why the planets do not twinkle.

Ans. The planets are much closer to the Earth, and are thus considered as a collection of a large number of point-sized sources of light. The total variation in the amount of light entering our eye from all the individual point-sized sources will average out to zero. Hence, the twinkling effects of the planets are nullified and they do not twinkle.

Q 12. What is scattering of light? Why does the clear sky appear blue?

Ans. When a ray of light passes through a path of suspended particles, it splits up in various random directions. Such a phenomenon is known as scattering of light.

When sunlight passes through the atmosphere, the fine particles in air scatter the blue colour (shorter wavelengths) more strongly than red. The scattered blue light enters our eyes and thus the sky appears blue.

Short Answer Type-II Questions

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

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

(iii) What do we have to keep in mind when eyes have to be donated?

Ans. (i) Pupil controls the amount of light entering into it. The relaxation and contraction of the muscular fibres of the iris regulate the opening and closing of the pupil.

(ii) The retina is the light-sensing part of the eye. It converts the incident light into electrical signals and sends them to the brain.

(iii) Eyes must be removed within 4-6 hours after death.

Persons who were infected with or died because of AIDS, Hepatitis B or C, rabies, tetanus, cholera, etc. cannot donate eyes.

Q 2. With the help of ciliary muscles, the human eye can change its curvature and thus alter the focal length of its lens. State the changes that occur in the curvature and focal length of the eye lens while viewing (i) a distance object, (ii) nearby objects. Explain, why a normal eye is not able to see distinctly the objects placed closer than 25 cm, without putting any strain on the eye. (CBSE 2017)

Ans. (i) To see a distant object, the eye lens becomes thin and its focal length increases.

(ii) To see a nearby object, the eye lens becomes thicker and its focal length decreases.

A normal eye is not able to see distinctly the objects placed closer than 25 cm, without putting any strain on the eye because the focal length of the eye lens cannot be decreased below a certain minimum limit.

Q 3. A student uses spectacles of focal length -2.5 m.

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

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

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

(iv) Compute the power of this lens. (CBSE 2020)

Ans. (i) He is suffering from myopia because the focal length required for the lens is negative.

(ii) Myopia is corrected by using a concave lens of suitable power.

(iii) Myopia arises due to: (a) excessive curvature of the eye lens (b) elongation of the eyeball.

COMMON ERROR

Students get confused between the causes and corrective measure of different defects of vision.

(iv) Given, $f = -2.5$ m

We know that, $P = 1/f$

$$= 1/(-2.5)$$

$$= -10/25 = -0.4 \text{ D}$$

Q 4. (i) A person is suffering from both myopia and hypermetropia.

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

(b) How are these lenses prepared?

(ii) A person needs a lens of power $+3\text{D}$ 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)

Ans. (i) (a) Bi-focal lenses can correct this defect.

(b) Upper portion of these lenses consists of a concave lens (to correct myopia) and the lower portion consists of a convex lens (to correct hypermetropia).

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

$$P_1 = +3 \text{ D}$$

$$f_1 = \frac{1}{P} = \frac{1}{3} = +0.33 = 33.3 \text{ cm}$$

$$P_2 = -3 \text{ D}$$

$$f_2 = \frac{1}{-3} = -0.33 = -33.3 \text{ cm}$$

Q 5. 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?

Ans.



TIP

Learn and understand the basic concepts of glass slab and glass prism, refraction of monochromatic light and white light through a glass slab and glass prism.

A glass slab has two parallel refracting surfaces whereas a prism has two inclined refracting surfaces.

(i) When a narrow beam of monochromatic light passes through:

(a) **Glass slab:** It deviates from the actual path, but the incident ray and the emergent ray of light are parallel to each other.

(b) **Glass prism:** It has deviated from the actual path but the incident ray and the emergent ray of light are not parallel to each other.

(ii) When a narrow beam of white light passes through:

(a) **Glass slab:** The splitting of white light into its constituent colours does not occur and the direction of the incident ray and the emergent ray of light are parallel to each other.

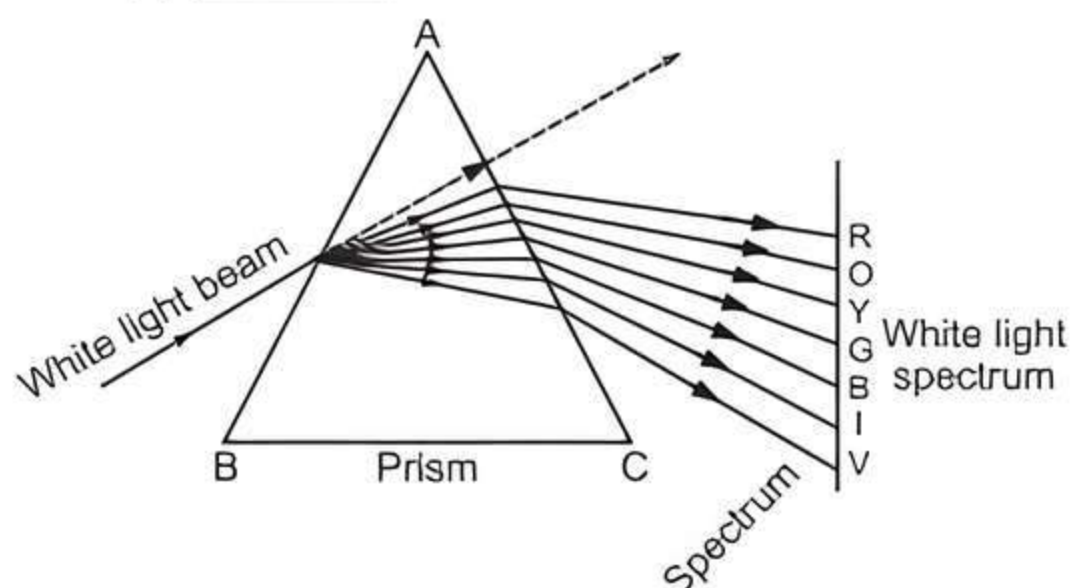
(b) **Glass prism:** The splitting of white light into its constituent seven colours occurs and the direction of the incident ray and the emergent ray of light is not parallel to each other.

Q 6. Define the term dispersion of white light. State the colour which bends (i) the most, (ii) the least while passing through a glass prism. Draw a diagram to show the dispersion of white light. (CBSE 2023)

Ans. The splitting of white light into its components due to different bending abilities of colours when it passes through a prism is called dispersion.

(i) Violet colour bends the most.

(ii) Red colour bends the least.



TiP

Draw correct and labelled diagrams. Deviation of light should be marked properly.

Q 7. (i) What is visible spectrum?

(ii) **Why is red used as the stopping light at traffic signals?**

(iii) **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.**

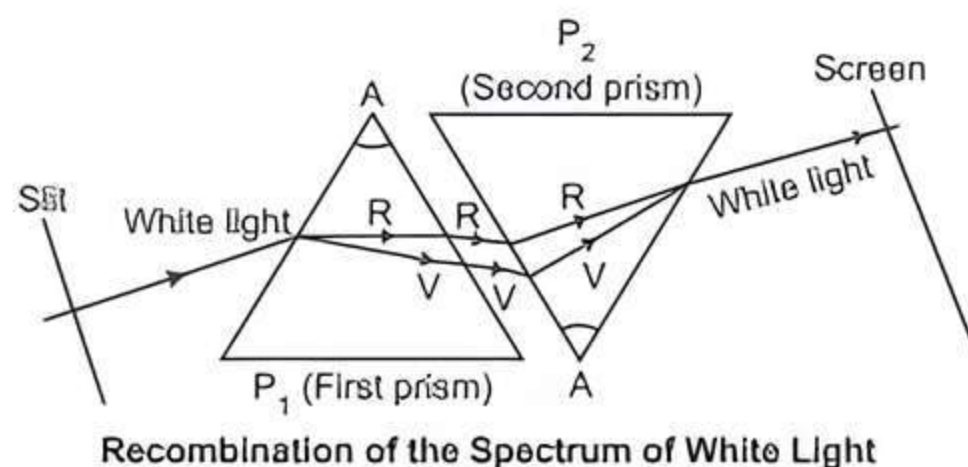
Ans. (i) Visible spectrum is the band of coloured components of a white light beam.

(ii) It is because red is least scattered by air molecules and can easily go through fog or mist or smoke. Therefore, it can be seen in the same colour even from a distant place.

(iii) No, because the given set-up will behave like a glass slab, resulting in recombination of the seven colours to produce white light.

Q 8. State the cause of dispersion of white light by a glass prism. Draw a labelled diagram to illustrate the recombination of the spectrum of white light. Why is it essential that the two prisms used for the purpose should be identical and placed in an inverted position with respect to each other?

Ans. Light rays of different colours travel with the same speed in vacuum and air, but in any other medium, they travel with the different speeds and bend through the different angles, which leads to the dispersion of light.



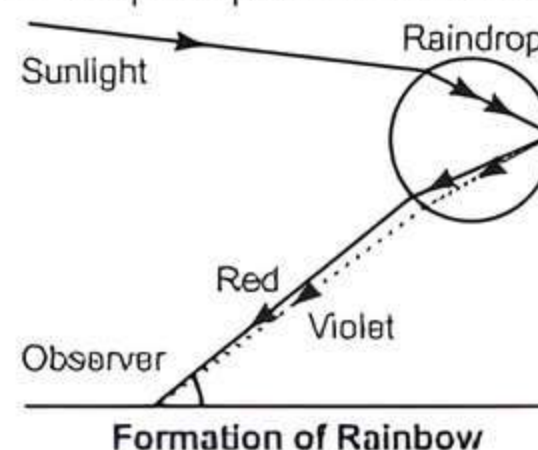
TiP

Practice drawing diagrams and don't memorise the labelling, instead try to understand them.

It is essential to place two identical prisms in an inverted position with respect to each other because the refraction produced by the second prism is equal to the refraction produced by the first prism.

Q 9. What is a rainbow? Draw a labelled diagram to show the formation of a rainbow. (CBSE 2023, 19)

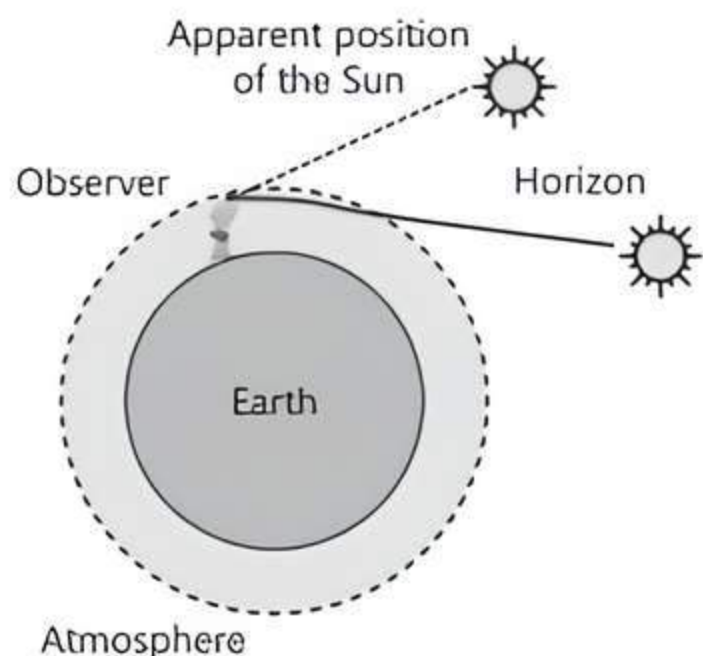
Ans. A rainbow is a natural spectrum appearing in the sky after rainfall. It is caused by dispersion of sunlight by tiny water droplets present in the atmosphere.



Q 10. With the help of a diagram, explain how atmospheric refraction is responsible for the advance sunrise and delayed sunset. How much time difference does it cause on the duration of day on the Earth?

(CBSE 2017)

Ans.



When the Sun is just below the horizon, the light rays bend due to our atmosphere. Due to this, the Sun appears to be at an apparent position and becomes visible to us before actual sunrise. Similarly, at sunset, due to bending of light rays we see the apparent position of the Sun and the Sun is visible for a longer time.

Hence, the Sun is visible to us about 2 minutes before the actual sunrise and about 2 minutes after the actual sunset.

Q 11. Why is Tyndall effect shown by colloidal particles? State four instances of observing the Tyndall effect.

(CBSE 2020)

Ans. Tyndall effect is shown by colloidal particles because of the phenomenon of scattering of light.

Four instances of observing the Tyndall effect:

- It can be observed when a fine beam of light enters a room through a small hole.
- When sunlight passes through the canopy of a dense forest.
- Visible beam of headlights in fog is caused by the Tyndall effect.
- It is the reason for the blue colour of the sky.

Long Answer Type Questions

Q 1 (i) Write the functions of each of the following parts of the human eye:

- Cornea
- Iris
- Crystalline (Eye) lens
- Ciliary muscles
- Retina

(ii) 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 suitable lens.

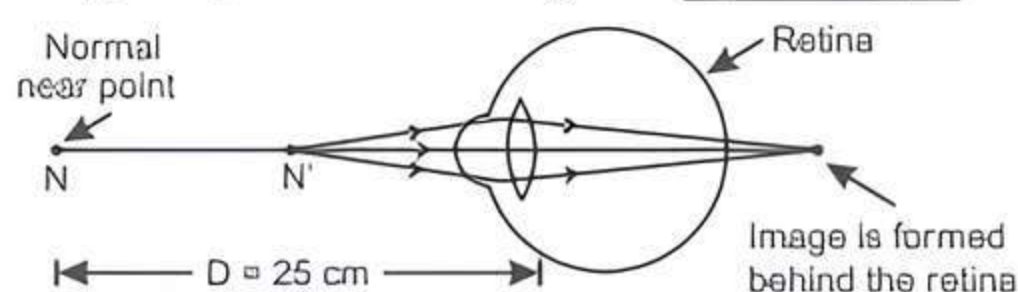
(CBSE 2017)

Ans.

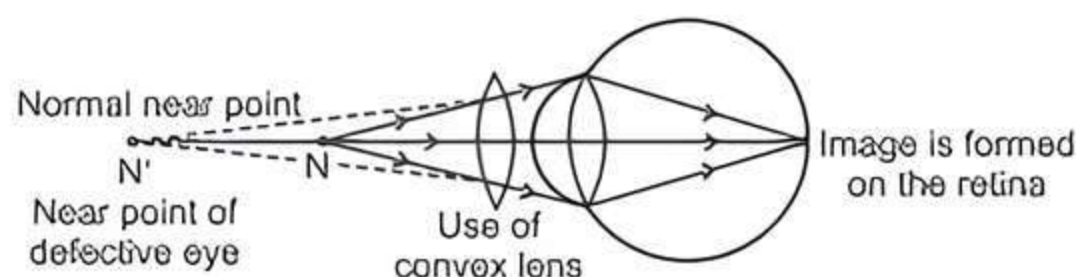
TiP While learning the human eye, lay stress on the function of each part of the human eye.

- Cornea:** It focuses the light that enter the eye by refracting the light towards the lens.
 - Iris:** It regulates and controls the amount of light entering the eye by adjusting the size of the pupil.
 - Crystalline Lens:** It provides adjustment of focal length required to focus objects at different distances on the retina.
 - Ciliary Muscles:** It controls the focal length of the eye lens.
 - Retina:** It acts as a screen on which image is formed in the eye. converts incident light into electrical signals and sends them to the brain.

(ii) The person is suffering from hypermetropia.



Correction:



Q 2. (i) 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:

- why the student is unable to see distinctly the objects placed beyond 5 m from his eyes.
- the type of the corrective lens used to restore proper vision and how this defect is corrected by the use of this lens.

(ii) 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.

(CBSE 2017)

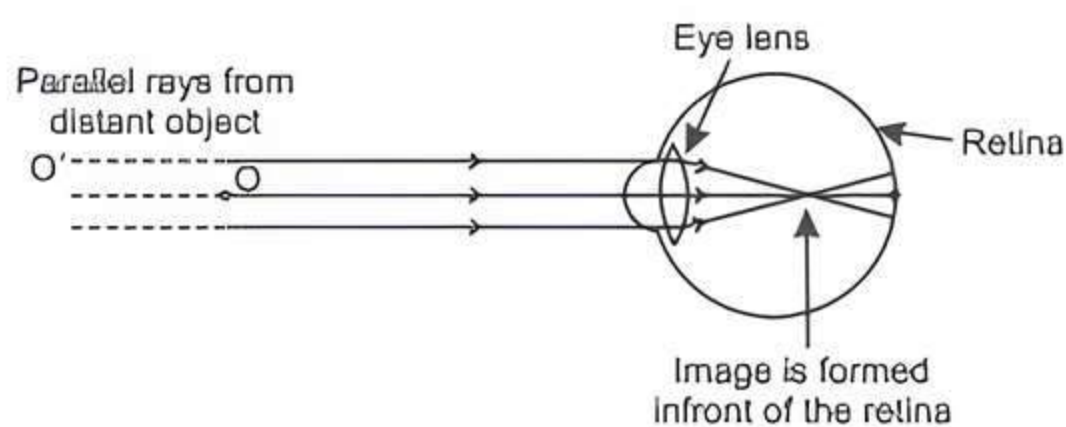
Ans.

TiP Distinctly learn the causes and corrective measures of defects of vision. Practice drawing the ray diagrams with proper labellings.

(i) Two reasons due to which myopia has arisen are:

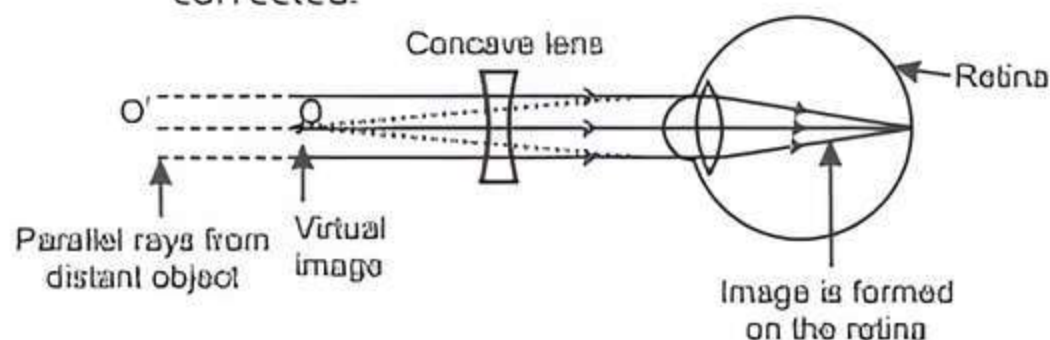
- excessive curvature of eye lens.
- elongation of eyeball.

(a) Student is unable to see distinctly the objects placed beyond 5 m because images of objects placed beyond 5 m are formed in front of the retina and not at the retina itself.



(b) A concave lens of suitable power is used to restore proper vision.

A concave lens of suitable power will bring the image back on to the retina and thus myopia is corrected.



(ii) Given, $f = -5 \text{ m}$ (corrective lens is concave)

$$P = \frac{1}{f(\text{in m})} = \frac{1}{-5}$$

$$P = -0.2\text{D}$$

Q 3. When do we consider a person to be myopic or hypermetropic? List two causes of hypermetropia. Explain using ray diagrams how the defect associated with hypermetropic eye can be corrected. (CBSE 2019)

Ans. When a person is unable to clearly see distant objects, he is suffering from myopia. This happens when image is formed in front of the retina.

When a person is unable to clearly see a nearby

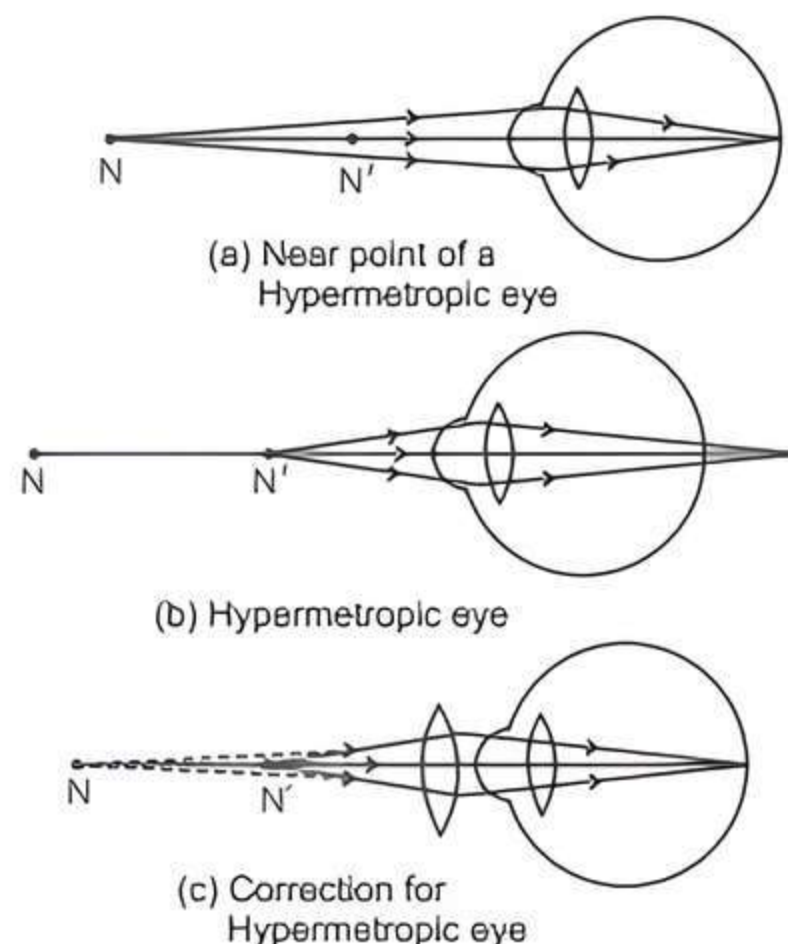
object, he is suffering from hypermetropia. This happens when image is formed behind the retina.

Causes of hypermetropia:

(i) Increase in focal length of eye lens

(ii) Decrease in the length of eyeball

Hypermetropia is corrected by using a convex lens of appropriate power placed in front of eye. It shifts the image back onto the retina instead of behind the retina and the defect is corrected.



COMMON ERROR

Mostly students commit errors in drawing myopic/hypermetropic eye and its correction.



Chapter Test

Multiple Choice Questions

- Q 1.** The angle between the two rectangular surfaces of a prism is called:
- angle of prism
 - refracting angle
 - Both a. and b.
 - None of the above
- Q 2.** The human eye can focus objects at different distances by adjusting focal length of the eye lens. This is due to:
- presbyopia
 - accommodation
 - near-sightedness
 - far-sightedness
- Q 3.** The sky generally appears blue, because the colour which scatters closest to eye is:
- violet
 - indigo
 - blue
 - violet and indigo
- Q 4.** The deflection of light by minute particles and molecules of the atmosphere in all directions is called of light.
- dispersion
 - scattering
 - interference
 - Tyndall effect

Assertion and Reason Type Questions

Directions (Q. Nos. 5-6): Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Give answer:

- Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
 - Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
 - Assertion (A) is true but Reason (R) is false.
 - Assertion (A) is false but Reason (R) is true.
- Q 5.** **Assertion (A):** Higher the refracting index of the prism material lower is the angle of deviation.
Reason (R): The angle of deviation is directly proportional to the angle of prism.
- Q 6.** **Assertion (A):** Rainbow is an example of the dispersion of sunlight by the water droplets.
Reason (R): Light of shorter wavelength is scattered much more than light of larger wavelength.

Case Study Based Question

Q 7. Figures A and B show the ray diagrams related to defects of vision.

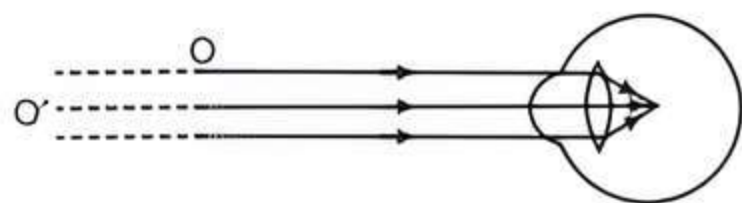


Fig. A: Defect of vision in patient X

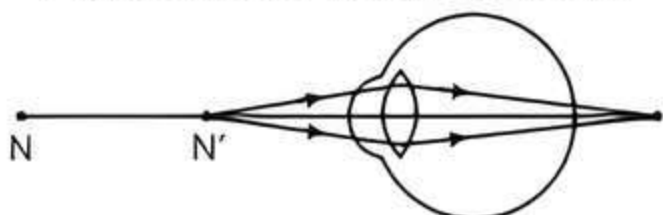
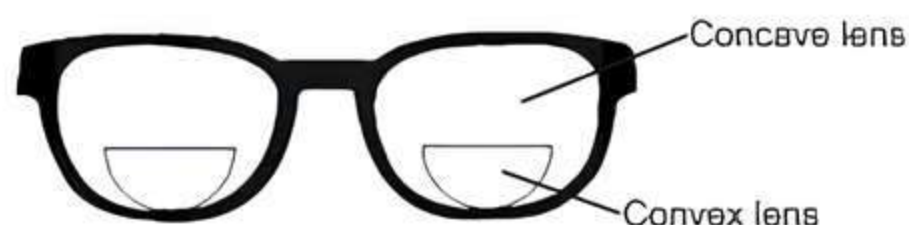


Fig. B: Defect of vision in patient Y

Read the above passage carefully and give the answer of the following questions:

- (i) Refer to fig. B and fig. A, showing the defects of vision in patients Y and X. Infer the defects which can be diagnosed from the given ray diagrams.
- (ii) The patient X needs a lens of power -4.5D for correction of his vision.
 - (a) What is the focal length of the corrective lens?
 - (b) What is the nature of corrective lens?
- (iii) Based on the spectacles given below, infer the eye defect which can be diagnosed from it. Also list two causes of this defect.



- (iv) Identify the eye defect resulting due to the eye lens becoming cloudy.

Very Short Answer Type Questions

- Q 8. What is meant by scattering of light?
- Q 9. When is the thickness of the eye lens minimum?

Short Answer Type-I Questions

- Q 10. Why the eye lens is not perfectly solid?
- Q 11. Calculate maximum power of accommodation of a person having normal vision.
- Q 12. Name the phenomenon associated with the following:
 - (i) The sky appears blue
 - (ii) Formation of a rainbow in the sky.

Short Answer Type-II Questions

- Q 13. The near point of a hypermetropic person is 75 cm from the eye. What is the power of the lens required to enable him to read clearly a book held at 25 cm from the eye?
- Q 14. What is presbyopia? How can it be corrected?
- Q 15.
 - (i) Define angle of deviation.
 - (ii) Show the angle of deviation for red colour when white light passes through a prism.

Long Answer Type Questions

- Q 16.
 - (i) Demonstrate an activity with a well labelled diagram to prove that white light is made up of seven colours.
 - (ii) Which colour of light bends least and which one the most while passing out from the prism? Also state the reason for the same.
- Q 17.
 - (i) List three common refractive defects of vision. Suggest the way of correcting these defects.
 - (ii) Explain the reason why stars appear to twinkle and the planets do not twinkle.