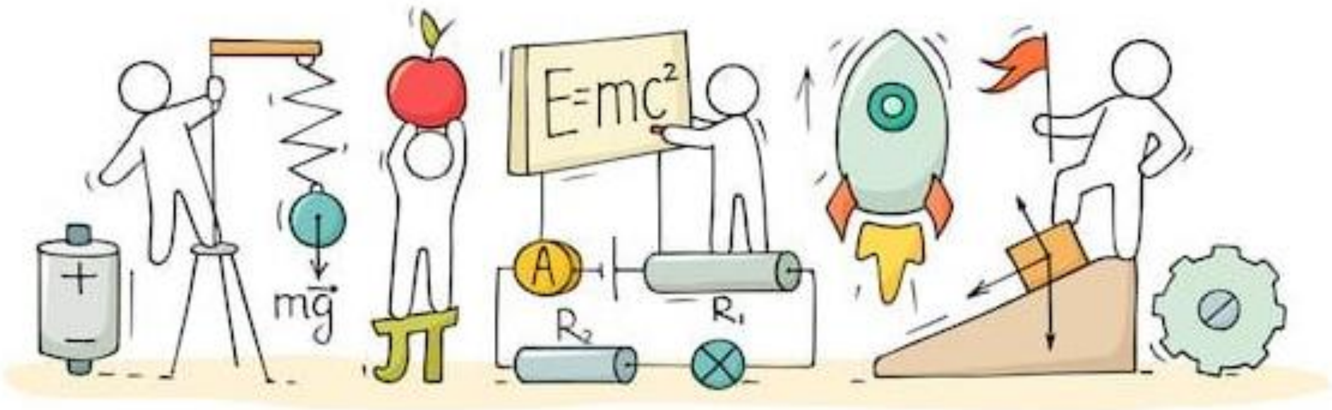
SCIENCE

(Physics)

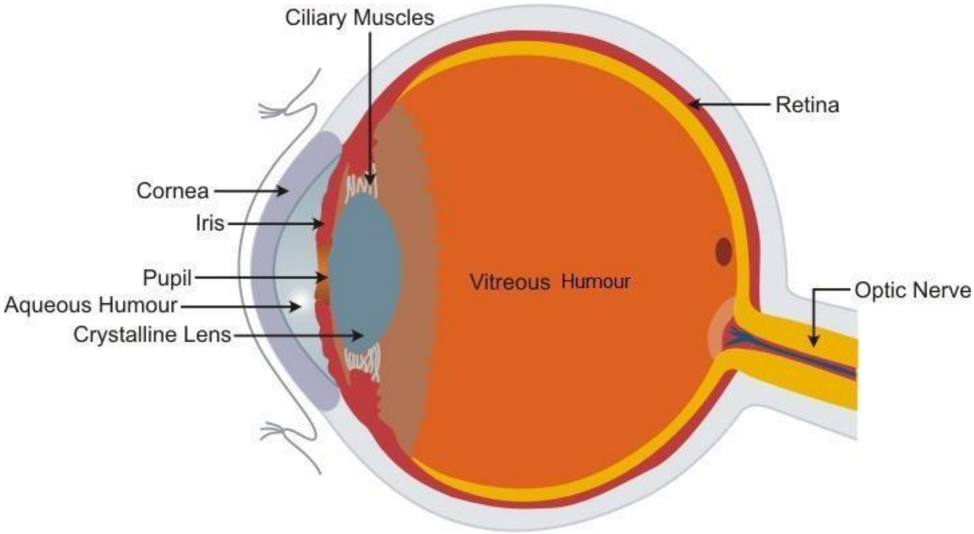
Chapter 11: Human Eye and the Colourful World



Human Eye and the Colourful World

Human Eye

- The human eye is an important and valuable sense organ which uses light and enables us to see the colourful world around us.



- The various parts of the human eye and their respective functions include

Part	Function
Cornea	Protective layer of the eye Refraction of light rays entering the eye
Eye lens	Adjust the focal length and form an inverted image of the object on the retina
Pupil	Regulates the amount of light entering the eye
Iris	Controls the size of the pupil
Retina	Acts as a screen for forming the image
Ciliary muscles	Adjust the thickness of the lens
Optic nerves	Send signals to the brain

- The image of any object seen persists on the retina for $\frac{1^{th}}{16}$ of a second, even after the removal of the object. This continuance of sensation on the eye for some time is called **persistence of vision**.
- The numerous light-sensitive cells contained in the retina of the eye are of two types:
  - **Rod-shaped cells** which respond to the **brightness or intensity** of light.
  - **Cone-shaped cells** which respond to the **colour** of light.

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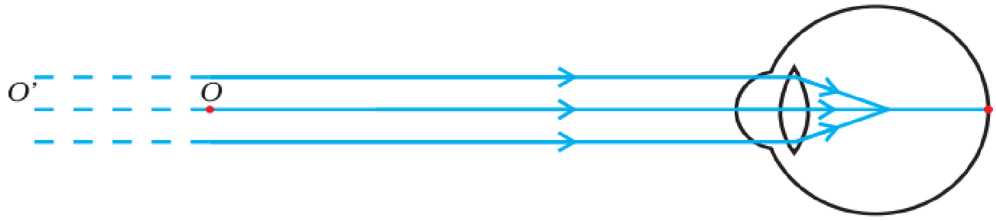
Power of Accommodation of the Human Eye

- Power of accommodation of the eye is the ability of the eye to observe distinctly the objects, situated at widely different distances from the eye, on account of change in the focal length of the eye lens by the action of the ciliary muscles holding the lens.
- The farthest point up to which the eye can see objects clearly is called the **far point (F)** of the eye. It is ideally **infinity** for a normal eye.
- The point of closest distance at which an object can be seen clearly by the eye is called the **near point (N)** of the eye. For a normal eye, the near point is 25 cm, which is called the **least distance of distinct vision (d)** of a normal eye.
- The distance between the far point (F) and near point (N) is called the **range of vision** of the eye.

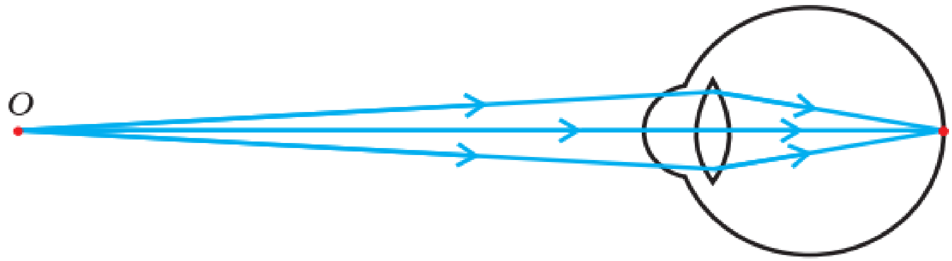
Defects of Vision

(a) Myopia or Short-Sightedness

A person with myopia can see nearby objects clearly but cannot see distant objects distinctly, as if the far point of the eye has shifted from infinity to some particular distance from the eye.



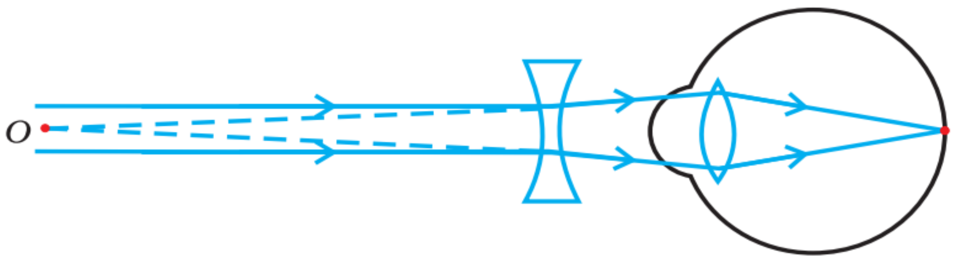
(a) Myopic Eye



(b) Far Point of a Myopic Eye

This defect may arise due to (i) excessive curvature of the eye lens or (ii) elongation of the eyeball.

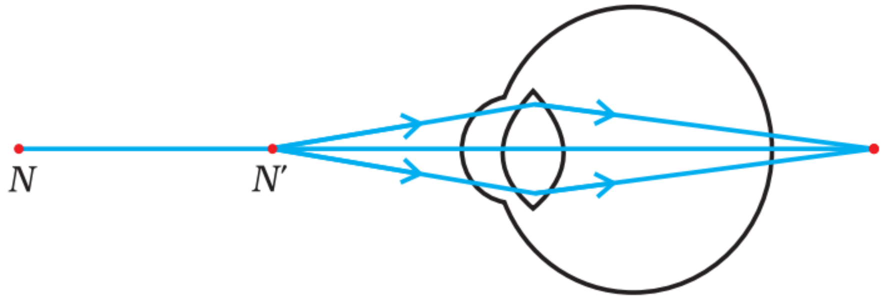
To correct myopia, the person has to wear spectacles with a **concave lens** of focal length equal to the distance of far point of the myopic eye.



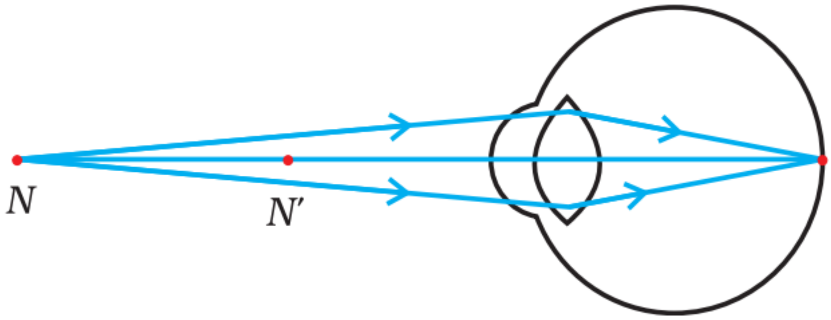
(c) Correction for Myopia

(b) Hypermetropia or Long-Sightedness

A person with hypermetropia can see objects lying at large distances clearly but cannot see nearby objects clearly, as if the near point of the eye has shifted away from the eye.



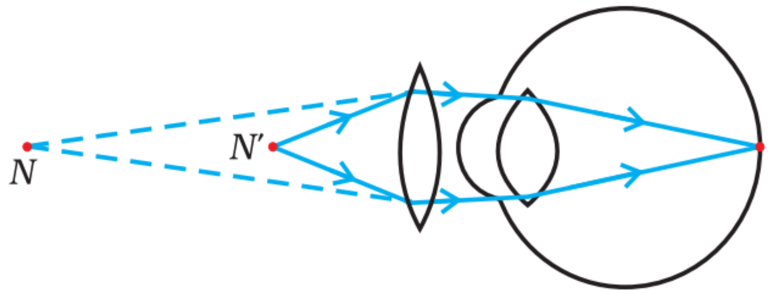
(a) Hypermetropic Eye



(b) Near Point of a Hypermetropic Eye

This defect may arise because (i) focal length of the eye lens is too long or (ii) the eyeball has become too small.

To correct hypermetropia, the person has to wear spectacles with a **convex lens** of focal length f, given by $f \frac{x' d}{x' - d}$, where d is the least distance of distinct vision and x′ is the distance of near point N of the hypermetropic eye.



(c) Correction for Hypermetropia eye

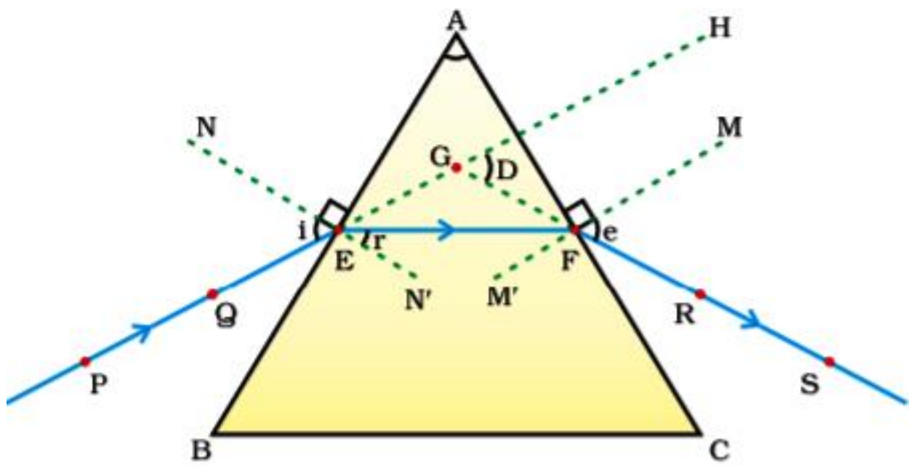
(c) Presbyopia

- Presbyopia is a human eye defect because of which an old person cannot read and write comfortably.
- It occurs in old age when the ciliary muscles holding the eye lens weaken and the eye lens loses some of its flexibility.
- To correct presbyopia, an old person has to wear spectacles with a **convex lens** of suitable focal length (as in hypermetropia).

Sometimes, a person may suffer from both myopia and hypermetropia. Such a person requires bi-focal lenses. The upper part of a bi-focal lens consists of concave lens facilitating distant vision, and the lower part consists of convex lens facilitating nearby vision.

Refraction through a glass prism

- If you take a glass prism, you can see that it has 2 triangular bases and three rectangular lateral surfaces, inclined at an angle. This angle is called the angle of the prism.
- Let's look at a top view of a triangular prism with a ray of light entering it.



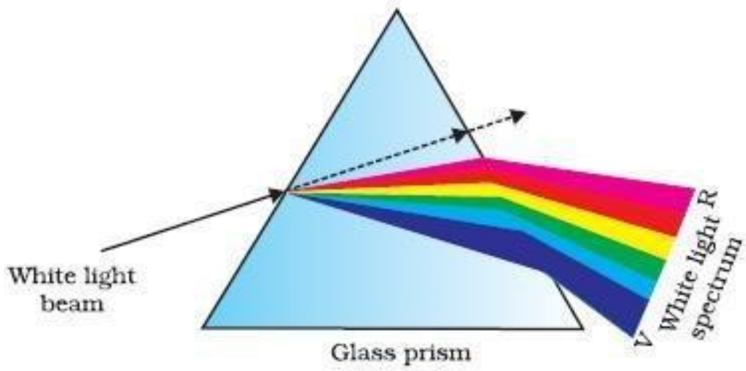
PE – Incident ray
EF – Refracted ray
FS – Emergent ray
∠A – Angle of the prism
∠i – Angle of incidence
∠r – Angle of refraction
∠e – Angle of emergence
∠D – Angle of deviation

In the figure above, A is the angle of the prism.

- As per Snell's law, light travelling from a rarer medium to a denser medium bends towards the normal, and vice versa. Glass is denser than air, and thus, when a ray of light falls on the surface of the prism, it bends towards the normal. According to the diagram, ray PE falls on the surface of the prism and bends towards the normal NE.
- Then, while moving from the glass to air, the emergent ray FS bends away from the normal.
- ∠HDS is the angle of deviation which tells us how much the emergent ray has deviated from the incident ray. When the angle of incidence is equal to the angle of emergence, the angle of deviation is minimum.
- According to the figure, ∠PEN = ∠MES and ∠HDS is thus the angle of minimum deviation. The refracted ray EF is parallel to side BC in this case.

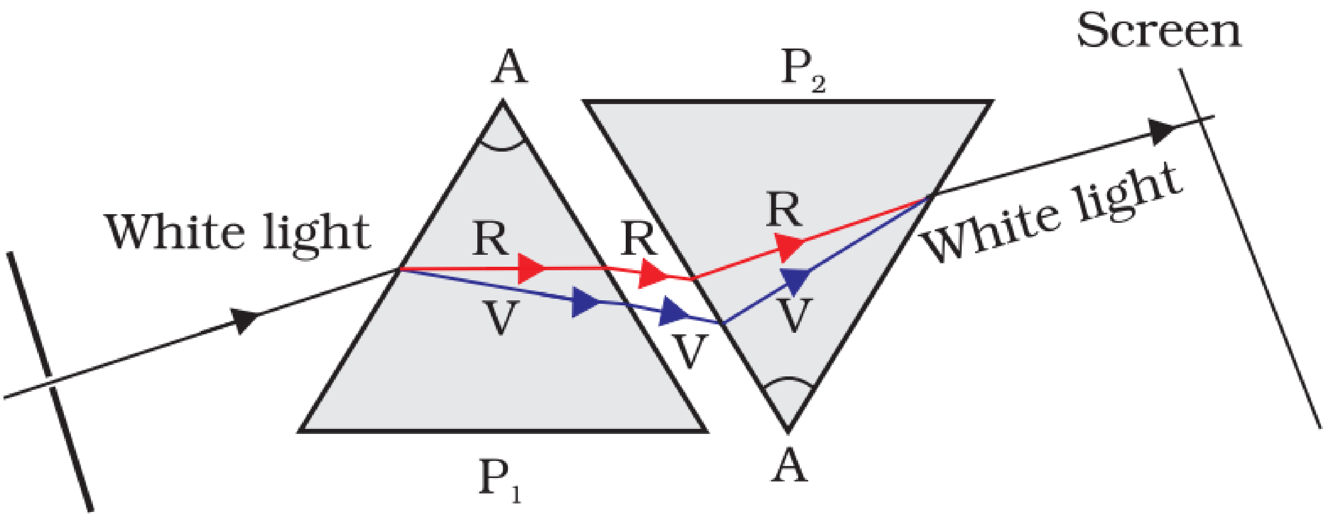
Dispersion of Light

- Dispersion of light is the phenomenon of splitting of a beam of white light into its seven constituent colours on passing through a glass prism.



- The band of coloured components of a light beam is called its **spectrum**.
- The sequence of colours given by the prism is Violet, Indigo, Blue, Green, Yellow, Orange and Red. **VIBGYOR** is the acronym for this sequence.
- The **cause of dispersion** is that different colours of white light with different wavelengths undergo different deviations on passing through a glass prism.
- If a second identical prism is placed in an inverted position with respect to the first prism, all the seven colours **recombine to form white light**.
- The **rainbow** is a beautiful example of dispersion of light in nature. Sunlight gets dispersed on passing through tiny droplets of water suspended in air during or after a shower.

Isaac Newton was the first to use a glass prism to obtain the spectrum of sunlight. Hetried to split the colours of the spectrum of white light further by using another similar prism. However, he could not get any more colours. He then placed a second identical prism in an inverted position with respect to the first prism, allowed all the colours of the spectrum to pass through the second prism. He found a beam of white light emerging from the other side of the second prism. This observation gave Newton the idea that the sunlight is made up of seven colours.



Recombination of the spectrum of white light

Atmospheric Refraction

- Atmospheric refraction is the phenomenon of bending of light on passing through the Earth's atmosphere. This reason for this occurrence is that the upper layers of the Earth's atmosphere are rarer compared to the lower layers.

- On account of atmospheric refraction of light,
  - The stars seem higher than they actually are.
  - The Sun appears to rise 2 minutes before and set 2 minutes later, increasing the apparent length of the day by 4 minutes.
  - The Sun appears oval at sunrise and sunset, but appears circular at noon.
  - The stars twinkle and planets do not.

Scattering of Light

The scattering of light is one of the most important phenomena in daily lives. This phenomenon has been seen by everyone from their childhood like the blue colour of the sky, the colour of the rainbow, etc. The scattering of light is completely different from the reflection and refraction of light. In reflection of light, the light goes in a straight line whereas in the scattering of light the light ray gets scattered in different directions by the medium through which it passes.

The process by which small particles are present in the atmosphere causes the scatter in the light which in turn gives rise to optical phenomena such as the blue colour of the sky in which we term as the scattering of light.

Example: When light strikes the particles in the air, the particles absorb some light and radiate the rest in all directions except the incident direction. This is called "scattering of light". The wavelength of the light and the size of the particle which scattered the light assists in determining the strength of the scattering.

Let p be considered as the probability of scattering and λ is the wavelength of radiation, then it is given as:

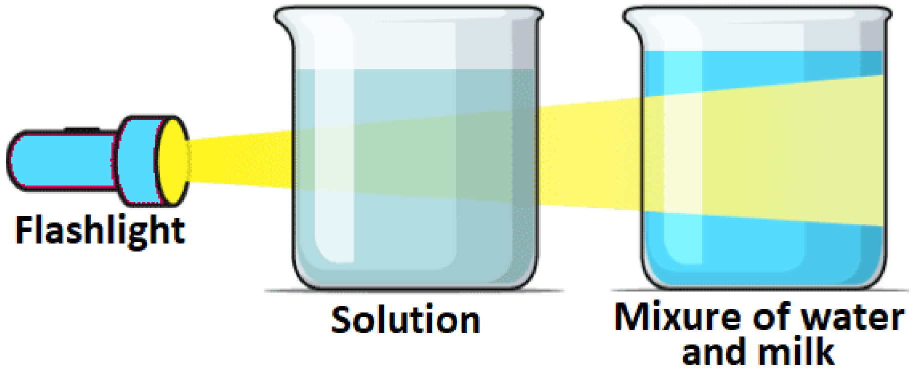
$$P = \frac{1}{\lambda^4}$$

The probability for scattering will give a high rise for shorter wavelength and it is inversely proportional to the fourth power of the wavelength of radiation.

Tyndall Effect

The Tyndall effect is the phenomenon in which the particles in a colloid scatter the beams of light that are directed at them. This effect is exhibited by all colloidal solutions and some very fine suspensions. Therefore, it can be used to verify if a given solution is a colloid. The intensity of scattered light depends on the density of the colloidal particles as well as the frequency of the incident light.

When a beam of light passes through a colloid, the colloidal particles present in the solution do not allow the beam to completely pass through. The light collides with the colloidal particles and is scattered (it deviates from its normal trajectory, which is a straight line). This scattering makes the path of the light beam visible, as illustrated below.



Generally, blue light is scattered to a greater extent when compared to red light. This is because the wavelength of blue light is smaller than that of red light. This is the reason why the smoke released by motorcycles sometimes appears blue.

The Tyndall effect was first discovered by (and is named after) the Irish physicist John Tyndall. The diameters of the particles that cause the Tyndall effect can range from 40 to 900 nanometers (1 nanometer = 10^{-9} meter). In comparison, the wavelength of the visible light spectrum ranges from 400 to 750 nanometers.

Examples of Tyndall Effect

We get to see Tyndall effect in our surroundings very often, some of the examples are

- When a beam of sunlight enters the dark room through small hole or window then its path become visible due to scattering of light by the dust particles present in the room.
- When a beam of light is projected on a screen from a projector in the cinema hall, it becomes visible.
- When sunlight passes through the canopy of a dense forest it get scattered by tiny water droplets.

The colour of the clear Sky Blue

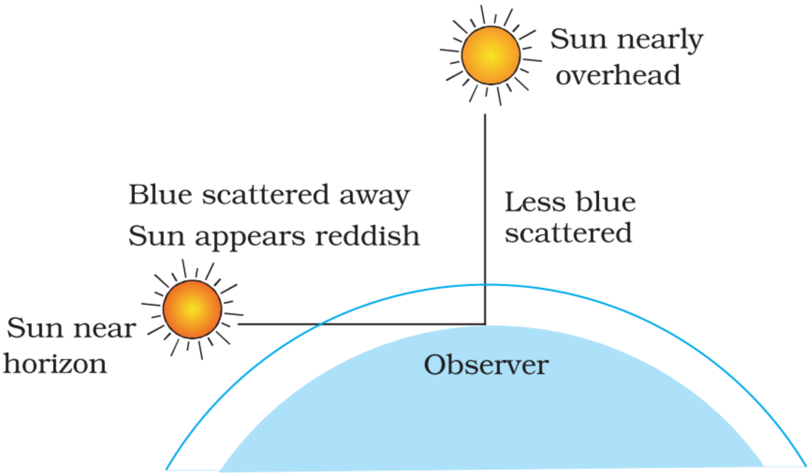
The molecules of air and other fine particles in the atmosphere have smaller size than the wavelength of visible light. These are more effective in scattering light of shorter wavelengths at the blue end than the light of longer wavelength at the red end. Thus, the blue colour is due to the scattering of sunlight through fine particles in air.

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

The sky appears dark instead of blue to an astronaut because there is no atmosphere in the outer space that can scatter the sunlight. As the sunlight is not scattered, no scattered light reach the eyes of the astronauts and the sky appears black to them.

Colour of Sunrise and Sunset

While sunset and sunrise, the colour of the sun and its surrounding appear red. During sunset and sunrise, the sun is near to horizon, and therefore, the sunlight has to travel larger distance in atmosphere. Due to this, most of the blue light (shorter wavelength) is scattered away by the particles. The light of longer wavelength (red colour) reaches our eye. This is why sun appears red in colour.



Reddening of the Sun at sunrise and sunset

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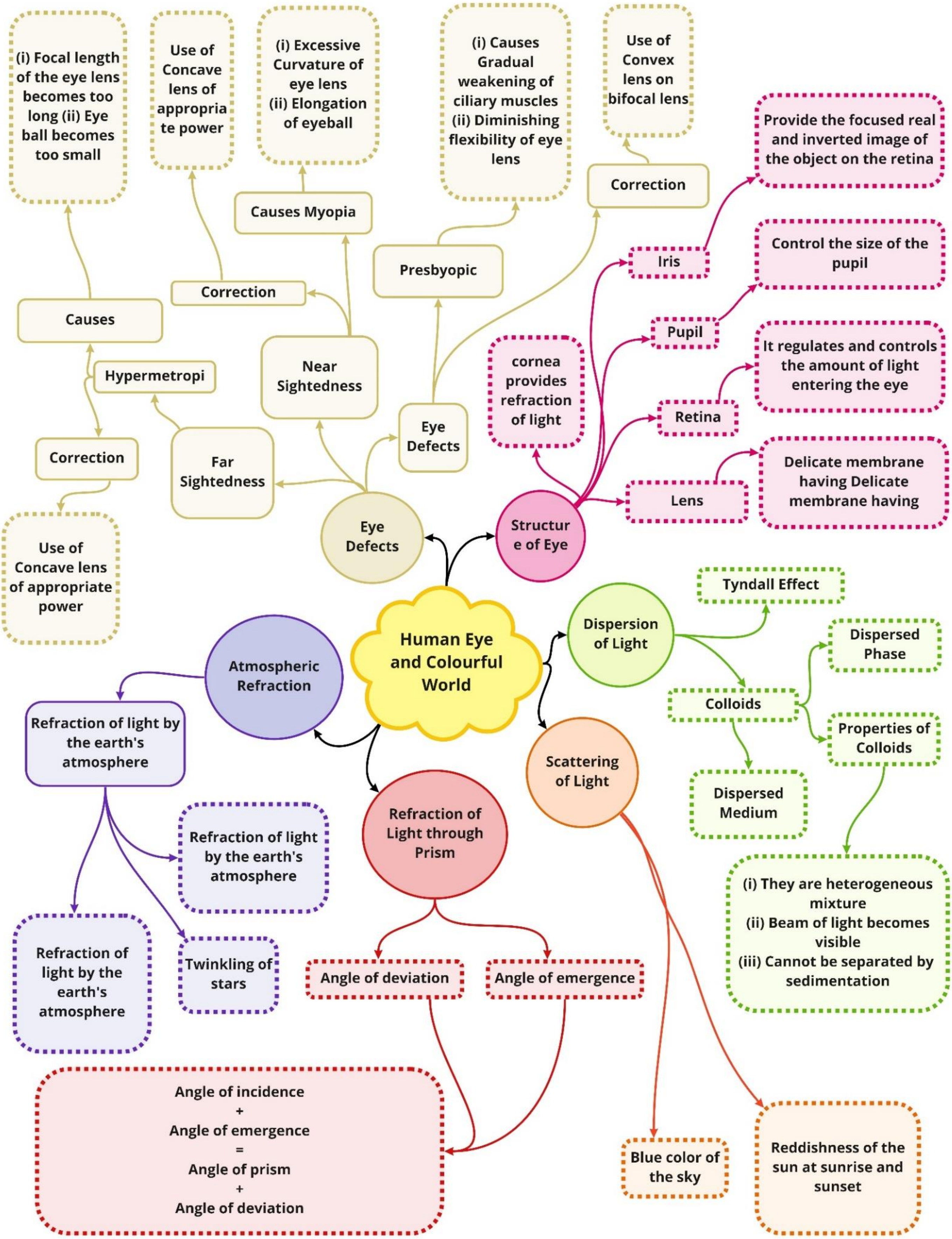


Important Questions

➢ Multiple Choice Questions:

1. A person cannot see distinctly objects kept beyond 2 m. This defect can be corrected by using lens of power

(a) +0.5 D

(b) -0.5 D

(c) +0.2 D

(d) -0.2 D

2. 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 textbook. Which of the following statements is correct?

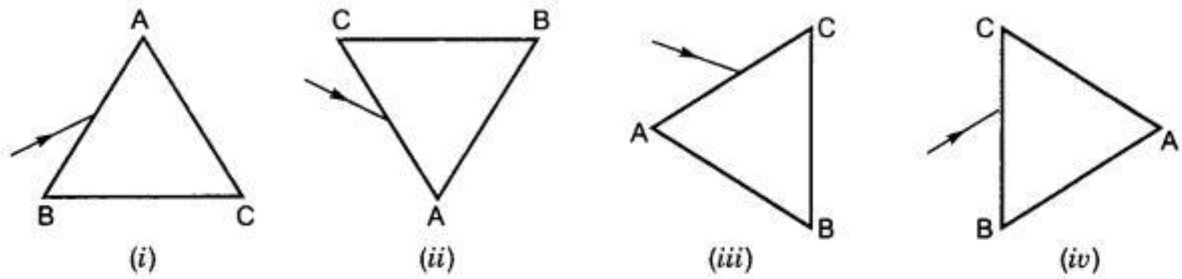
(a) The near point of his eyes has receded away.

(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.

3. 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 the Figures given below. In which of the following cases, after dispersion, the third colour from the top corresponds to the colour of the sky?



(a) (i)

(b) (ii)

(c) (iii)

(d) (iv)

4. 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.

5. Which of the following phenomena of light are involved in the formation of a

rainbow?

(a) Reflection, refraction and dispersion

(b) Refraction, dispersion and total internal reflection

(c) Refraction, dispersion and internal reflection

(d) Dispersion, scattering and total internal reflection

6. Twinkling of stars is due to atmospheric

(a) dispersion of light by water droplets

(b) refraction of light by different layers of varying refractive indices

(c) scattering of light by dust particles

(d) internal reflection of light by clouds

7. The clear sky appears blue because

(a) blue light gets absorbed in the atmosphere.

(b) ultraviolet radiations are absorbed in the atmosphere.

(c) violet and blue lights get scattered more than lights of all other colours by the atmosphere.

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

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

(a) Red light moves fastest.

(b) Blue light moves faster than green light.

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

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

9. 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 fastest in air.

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

(a) Dispersion of light

(b) Scattering of light

(c) Total internal reflection of light

(d) Reflection of light from the earth

➢ Very Short Question:

1. Name the following part of human eye: A thin membrane through which light enters the eye.

2. Write the function of iris in the human eye.

Or

Mention the name of a structure formed in human eye that controls the size of the pupil.

3. What is the function of pupil in human eye?

4. Name the following part of human eye: A dark muscular diaphragm that controls the size of the pupil.

5. Name the type of lens in human eye.

6. Name the part of human eye that helps in changing the focal length of the eye lens.

Or

Name the part responsible for the power of accommodation of the human eye.

7. Name the ability of eye lens to adjust its focal length.

8. What is the nature of the image formed at the retina of human eye?

9. Name the part of human eye which acts as a screen to obtain the image of an object.

10. Mention the value of near point for normal eye.

➢ Short Questions:

1. When we enter a dim-lit room from a bright light, we are not able to see the object in the room for some time.

Explain, why?

Or

Why does it take some time to see objects in a cinema hall when we just enter the hall from bright sun light? Explain.

2. The ciliary muscles of a normal eye are in their (i) most relaxed (ii) most contracted state. In which of the two cases is the focal length of the eye-lens more?

3. Why do we have two eyes instead of one eye?

4. A convex lens made of glass forms a sharp image on the screen for a particular position of an object with respect to the lens. A human eye lens is also a convex lens but it can form sharp images on the retina of eye for different positions of the objects. Explain, why?

5. How is a normal eye able to see distinctly distant as well as nearer objects? What is the distance of distinct vision?

6. What is short-sightedness? How can this defect be corrected?

7. What is long-sightedness? How can this defect be corrected?

8. What is presbyopia? State the cause of Presbyopia. How is presbyopia of a person be corrected?

➢ Long Questions:

1. Write different parts of eye and explain their functions. Also explain, how an image of an object is formed on the retina of eye.

2. What is short-sightedness? List two causes for development of short-sightedness. Describe with a ray diagram, how this defect may be corrected using spectacles.

Or

What is myopia? State the two causes of myopia with a labelled ray diagram show

(i) the eye defect myopia,

(ii) correction of myopia using lens.

3. What is long-sightedness? List two causes for development of long-sightedness. Describe with a ray diagram, how this defect may be corrected using spectacles.

Or

What is hypermetropia? State the two causes of hypermetropia. With the help of a ray diagram, show (i) the eye defect hypermetropia, (ii) correction of hypermetropia by using a lens.

➢ Assertion Reason Questions:

1. For two statements are given-one labelled Assertion (A) and the other labelled 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 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.

Assertion: There is no dispersion of light refracted through a rectangular glass slab.

Reason: Dispersion of light is the phenomenon of splitting of a beam of white light into its constituents' colours.

2. For two statements are given-one labelled Assertion (A) and the other labelled 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 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.

Assertion: A beam of white light gives a spectrum on passing through a hollow prism.

Reason: Speed of light outside the prism is different as the speed of light inside the prism.

➢ Case study Questions:

1. Read the following and answer any four questions from (i) to (v).

Atmospheric refraction is the phenomenon of bending of light on passing through earth's atmosphere. As we move above the surface of earth, density of air goes on decreasing. Local conditions like temperature etc. also affect the optical density of earth's atmosphere. On account of atmospheric refraction, stars seen appear higher than they actual are advanced sunrise; delayed sunset, oval appearance of the sun at sunrise and sunset; stars twinkle, planets do not.

i. Due to atmospheric refraction, apparent length of the day:

a. Increases

b. Decreases

c. Remains the same

d. All of these

ii. Apparent position of the star appears raised due to:

a. Atmospheric refraction.

b. Scattering of light.

c. Both (a) and (b).

d. None of these.

iii. The sun appears oval shaped or flattened due to:

a. Dispersion.

b. Scattering.

c. Atmospheric refraction.

d. Cannot say.

iv. Twinkling of stars and non-twinkling of planets is accounted for by:

a. Scattering of light.

b. Dispersion of light.

c. Atmospheric refraction.

d. None of these

v. In absence of atmosphere, the colour of sky appears:

a. Blue

b. Black

c. Red

d. Yellow

2. Read the following and answer any four questions from (i) to (v).

The spreading of light by the air molecules is called scattering of light. The light having least wavelength scatters more. The sun appears red at sunrise and sunset, appearance of blue sky it is due to the scattering of light. The colour of the scattered light depends on the size of particles. The smaller the molecules in the atmosphere scatter smaller wavelengths of tight. The amount of scattering of light depends on the wavelength of light. When light from sun enters the earth's atmosphere, it gets scattered by the dust particles and air molecules present in the atmosphere. The path of sunlight entering in the dark room through a fine hole is seen because of scattering of the sun light by the dust particles present in its path inside the room.

i. To an astronaut in a spaceship, the colour of earth appears:

a. Red.

b. Blue.

c. White.

d. Black.

ii. At the time of sunrise and sunset, the light from sun has to travel.

a. Longest distance of atmosphere.

b. Shortest distance of atmosphere.

c. Both (a) and (b).

d. Can't say.

iii. The colour of sky appears blue, it is due to the:

a. Refraction of light through the atmosphere.

b. Dispersion of light by air molecules.

c. Scattering of light by air molecules.

d. All of these.

iv. At the time of sunrise and sunset:

a. Blue colour scattered and red colour reaches our eye.

b. Red colour scattered and blue colour reaches our eye.

c. Green and blue scattered and orange reaches our eye.

d. None of these.

v. The danger signs made red in colour, because:

a. The red light can be seen from farthest distance.
b. The scattering of red light is least.
c. Both (a) and (b).
d. None of these.

✓ Answer Key-

➢ Multiple Choice Answers:

1. (b) -0.5 D
2. (a) The near point of his eyes has receded away.
3. (b) (ii)
4. (a) light is least scattered.
5. (c) Refraction, dispersion and internal reflection
6. (b) refraction of light by different layers of varying refractive indices
7. (c) violet and blue lights get scattered more than lights of all other colours by the atmosphere.
8. (c) All the colours of the white light move with the same speed.
9. (b) is scattered the least by smoke or fog.
10. (b) Scattering of light

➢ Very Short Answers:

1. Answer: Cornea.
2. Answer: Iris controls the size of the pupil.
3. Answer: It controls and regulates the light entering the eye.
4. Answer: Iris.
5. Answer: Convex lens.
6. Answer: Ciliary Muscles.
7. Answer: Accommodation.
8. Answer: Real and inverted image.
9. Answer: Retina.
10. Answer: 25 cm.

➢ Short Answers:

1. Answer: In a bright light, the iris contracts the pupil of an eye to allow less light to enter the eye. When, we enter the dim-lit room, iris takes time to expand the pupil of an eye to allow more light to enter the eye so that the visible image of the object lying in the room are formed on the retina of the eye.

2. Answer: The focal length of eye-lens is more when the ciliary muscles of a normal eye are in their most relaxed state.
3. Answer: Two eyes are better than one eye because
   - the field of view with two eyes is more than with one eye.
   - two eyes give three dimensional picture of an object (i.e., the length, breadth and depth or height of an object) whereas one eye gives only two dimensional picture of an object.
4. Answer: A convex lens made of glass has a fixed focal length and hence it forms a sharp image on the screen for a particular position of an object. However, the focal length of human eye lens can be changed by the action of ciliary muscles. In other words, human eye lens has the ability to charge its focal length to form sharp images of objects at different positions. The process is known as accommodation of eye.
5. Answer: Eye has the ability known as accommodation of eye to see distant as well as nearer objects clearly. When objects is far away, the focal length of lens is increased due to the relaxed ciliary muscles. Hence sharp image of object is formed on the retina of eye. When object is nearer to the eye, the focal length of lens is decreased due to the contraction of ciliary muscles and hence sharp image of the object is formed on the retina of eye. The distance of distinct vision is 25 cm.
6. Answer: Short-sightedness or near-sightedness or Myopia
   - A human eye is myopic if it can see the near objects clearly but unable to see far off objects or distant objects clearly.

   Causes of Myopia: This defect arises due to either by
   - the elongation of the eye ball or
   - the excessive curvature of the cornea.
7. Answer: A human eye which can see far off objects or distant objects clearly but can not see the near objects clearly is said to be suffered with a defect known as long sightedness or far sightedness or Hypermetropia.

   Causes of Hypermetropia: This defect arises due to either by
   - the increase in the focal length of eye lens or
   - the size of the eye ball becomes too small so that the light rays from the nearby points or objects are not brought to focus on the retina of the eye.
8. Answer: A human eye which cannot see the near objects and distant objects clearly is said to suffer from a defect known as Presbyopia. Eye suffering from Presbyopia cannot read and write comfortably.

   This defect arises due to the aging of a person. The ciliary muscles are weakened and the flexibility of the crystalline lens of the human eye decreases with age of the person. As a result, human eye is unable to focus on close as well as distant objects.

This defect can be corrected by using a bi-focal lens. A bi-focal lens consists of a concave lens which forms the upper surface of the bi-focal lens and a convex lens which forms the lower surface of the bi-focal lens. The upper surface of bi-focal lens (i.e. the concave lens) enables the person to see distant objects clearly and the lower surface of bi-focal lens {i.e. convex lens) enables the person to see the near objects.

➢ Long Answers:

1. Answer:

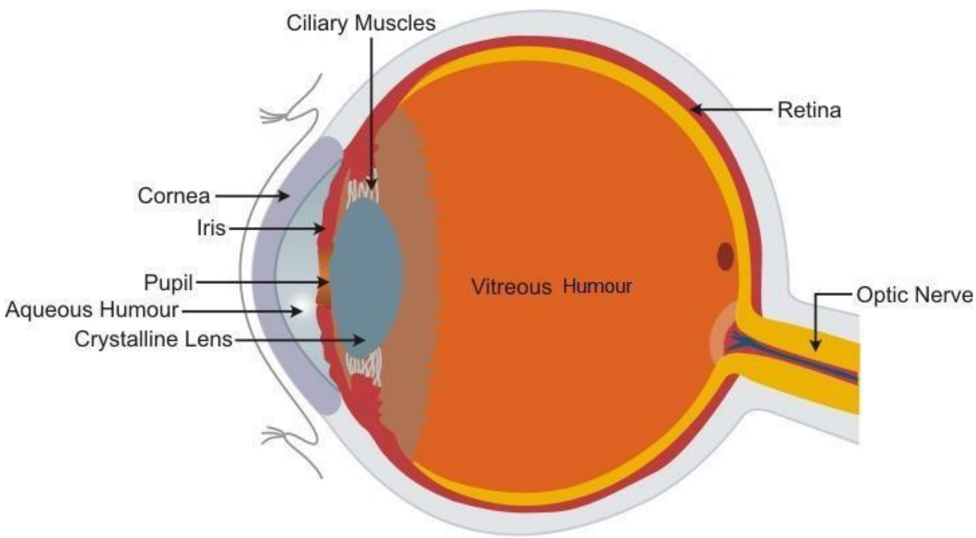
The main parts of an eye and their functions are given below:

Cornea is the outermost part of the eye. It is transparent part of eye and allows the light to enter in the eye.

Iris: It is a circular dark diaphragm having a hole in its centre. This hole is called pupil. The circular dark diaphragm has muscles and coloured pigments. The colour of an eye depends upon the colour of these pigments.

The function of iris is to control the size of the pupil. On the other hand, pupil controls and regulates the light entering the eye. The pupil becomes small when bright light falls on the eye. However, it becomes wide when there is dim light.

Lens: The eye lens is a crystalline double convex lens and made of transparent and flexible tissues. It is behind the pupil and held by the muscles called ciliary muscles. It focuses the images of objects on the retina of the eye.



Ciliary muscles: These muscles hold the eye lens in position. Ciliary muscles controls the focal length of the eye lens. When these muscles contracts, then the lens becomes thick and the focal length of the lens decreases. On the other hand, when ciliary muscles are relaxed, then the lens becomes thin and the focal length of the lens increases.

Retina: It acts as a light-sensitive screen to obtain the image of the object. It contains number of cells in the form of rods and cones which are sensitive to light. These cells convert light energy into electrical impulses or signals.

Optic nerve: Optic nerve is formed by the nerve fibers coming from the retina. It carries nerve or electrical impulses or signals to the brain. The brain finally interprets the signal.

2. Answer:

A human eye is myopic if it can see the near objects clearly but unable to see far off objects or distant objects clearly.

Correction of short sightedness or Myopia

The image of a distant object (i.e., at infinity) is formed in front of the retina of eye suffering from myopia as shown in figure 5(a). As the image of the object lying at infinity is not formed on the retina of the eye, so such object cannot be seen clearly by the Myopic eye. The far point of such an eye is near to the eye as shown in figure 5(b).

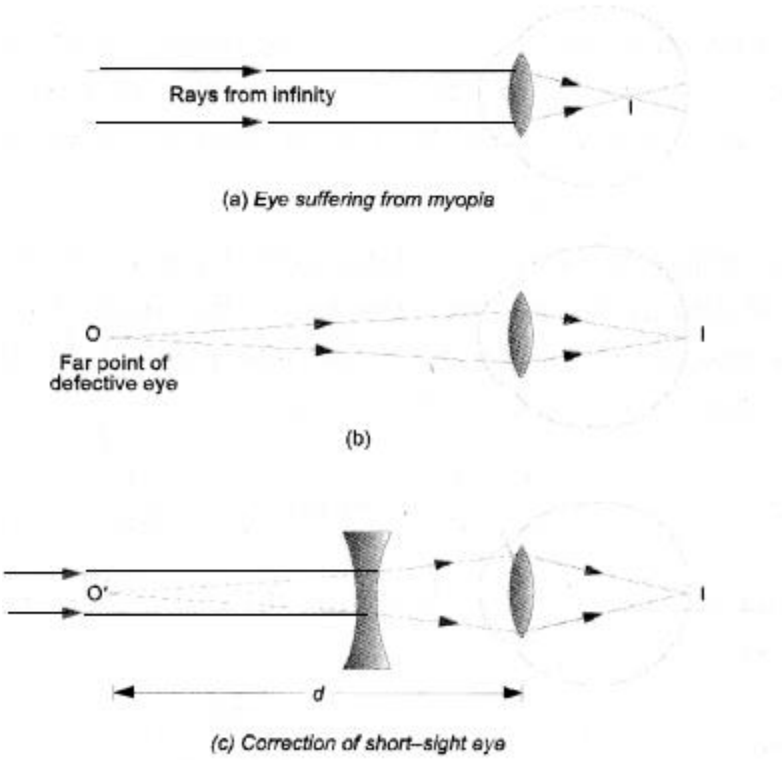


FIGURE 5

This defect can be corrected by using a concave lens of suitable focal length (or power). So, a man suffering from this defect wears spectacles having concave lens of suitable focal length. The concave lens used diverges the rays of light entering the eye from infinity. Hence this lens makes the rays of light appear to come from the far point (O') of the defective eye as shown in figure 5(c).

Causes of Myopia: This defect arises due to either by

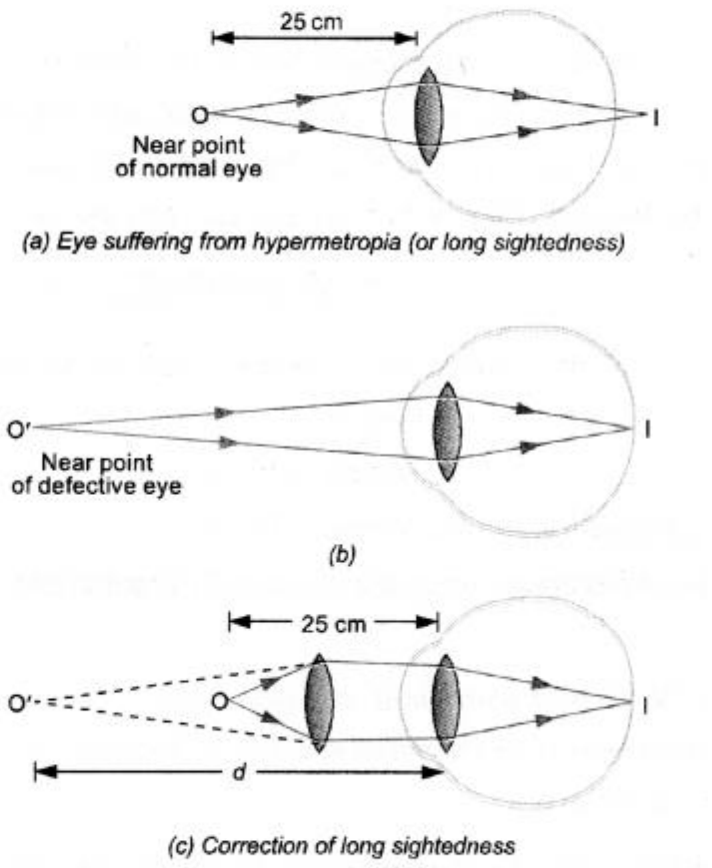
- the elongation of the eye ball or
- the excessive curvature of the cornea.

3. Answer:

A human eye which can see far off objects or distant objects clearly but can not see the near objects clearly is said to be suffered with a defect known as long sightedness or far sightedness or Hypermetropia.

Correction of long-sightedness (or Hypermetropia)

The image of a normal near point (which is 25 cm from the eye lens) is formed behind the retina of eye having long-sight defect as shown in figure 4(a). Hence, the image of the normal near point formed on the retina is blurred. The near point of such eye is little far from the near point of normal eye as shown in figure 4(b).



(a) Eye suffering from hypermetropia (or long sightedness)

(b)

(c) Correction of long sightedness

FIGURE 4

This defect can be corrected by using a convex lens of suitable focal length. So, a man suffering from this defect wears spectacles having convex lens of suitable focal length. The convex lens of spectacles reduces the divergence of rays of light entering the eye. Hence this lens makes the rays of light appear to come from the near point of the defective eye as shown in figure 4(c).

Causes of Hypermetropia: This defect arises due to either by

- the increase in the focal length of eye lens or
- the size of the eye ball becomes too small so that the light rays from the nearby points or objects are not brought to focus on the retina of the eye.

➢ Assertion Reason Answer:

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

Explanation:

After refraction at two parallel faces of a glass slab, a ray of light emerges in a direction parallel to the direction of incidence of white light on the slab. As rays of all colours emerge in same direction, hence there is no dispersion only lateral displacement takes place.

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

Explanation:

Dispersion of light cannot occur on passing through air contained in a hollow prism. Dispersion takes place because the refractive index of medium for different colours is different.

➢ Case Study Answer:

1. i (a)increases

   Explanation:

   Due to atmospheric refraction, apparent length of the day increases by 4 minutes.

   ii. (a) Atmospheric refraction.

   Explanation:

   Apparent position of the star appears raised due to atmospheric refraction.

   iii. Atmospheric refraction.

   iv. Atmospheric refraction.

   Explanation:

   Twinkling of stars and non-twinkling of planets is on account of atmospheric refraction.

   v. (b) Black

   Explanation:

   Due to no scattering of light.

2. i (b) Blue.

   Explanation:

   Light is scattered by the air molecules present in atmosphere.

   ii. (a) Longest distance of atmosphere.

   Explanation:

   As the distance between us and sun is more at the time of sunrise and sunset.

   iii. (c) Scattering of light by air molecules.

   Explanation:

   Due to the more scattering of blue colour by molecules of air.

   iv. (a) Blue colour scattered, and red colour reaches our eye.

   Explanation:

Red light being of largest wavelength blue scatter more, red scattered least.

v. (c) Both (a) and (b).

Explanation:

Scattering is least but velocity of red light is more.