CHAPTER

11 HUMAN EYE AND COLOURFUL WORLD

Syllabus

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

Quick Review

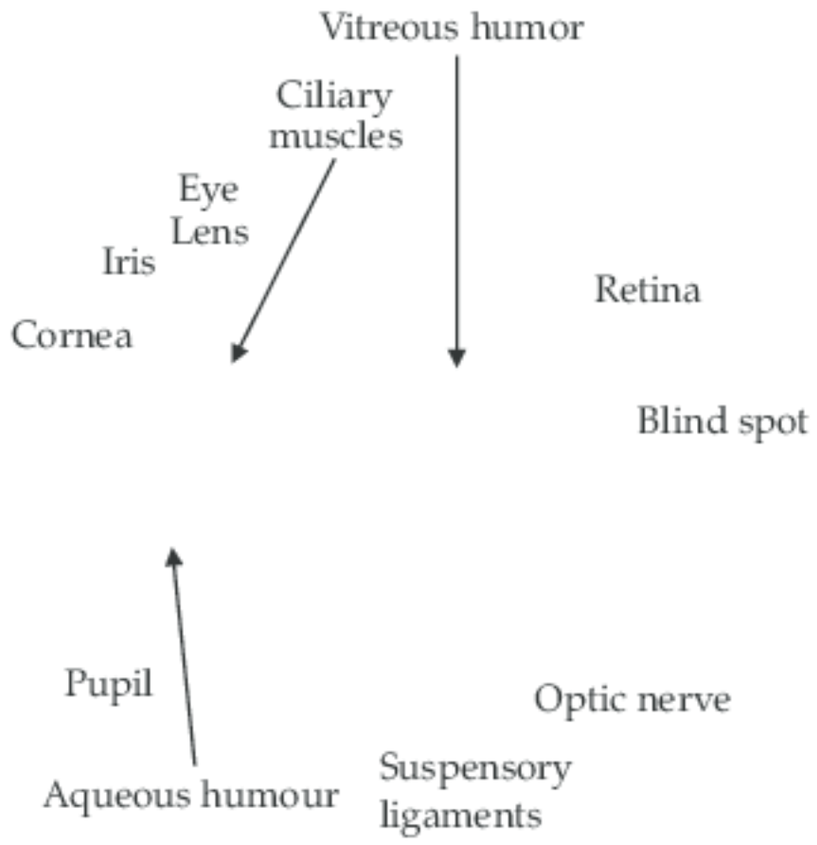
- Eye is a natural optical device using which man could see objects around him. It forms an inverted, real image on a light sensitive surface called retina.
- Rods and cones are the cells in retina, which are light sensitive. Rods respond to the intensity of light. Cones respond to the illumination colours. There are around 125 million cells-rods and cones. The cells generate signals which are transmitted to the brain through optical nerve.

Parts of Human Eye

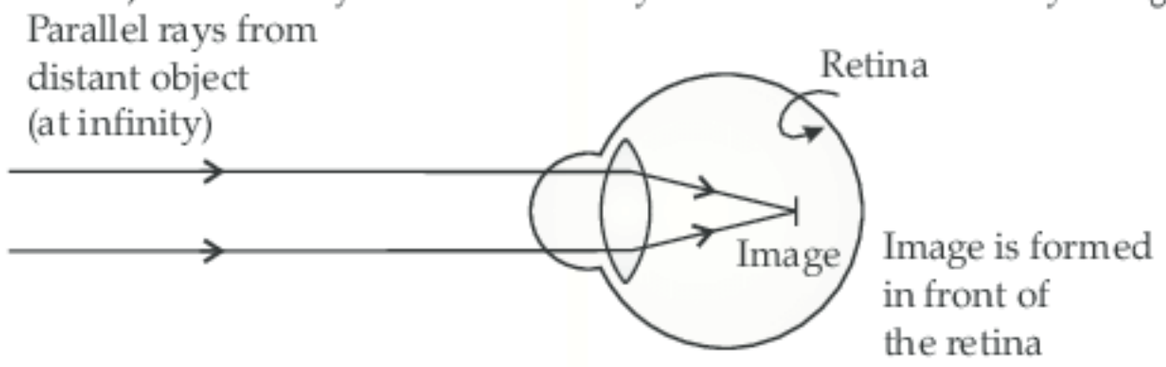
- **Cornea :** It is the outermost, transparent part. It provides most of the refraction of light.
- **Lens :** It is composed of a fibrous, jelly like material. Provides the focused real and inverted image of the object on the retina. This convex lens that converges light at retina.
- **Iris :** It is a dark muscular diaphragm that controls the size of the pupil.
- **Pupil :** It is the window of the eye. It is the central aperture in iris. It regulates and controls the amount of light entering the eye.
- **Retina :** It is a delicate membrane having enormous number of light sensitive cells.
- **Far point :** The maximum distance at which object can be seen clearly is far point of the eye. For a normal adult eye, its value is infinity.

Near point or Least distance of distinct vision

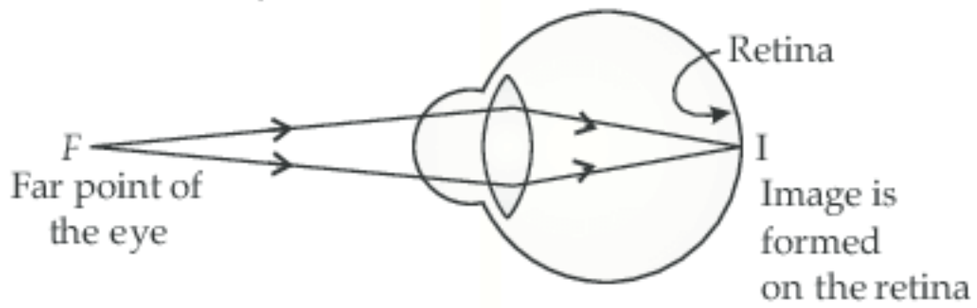
- The minimum distance at which objects can be seen most distinctively without strain.
  - For a normal adult eye, its value is 25 cm.
  - Range of human vision – 25 cm to infinity.
- **Accommodation :** The ability of the eye lens to adjust its focal length is called accommodation. Focal length can be changed with help of ciliary muscles.



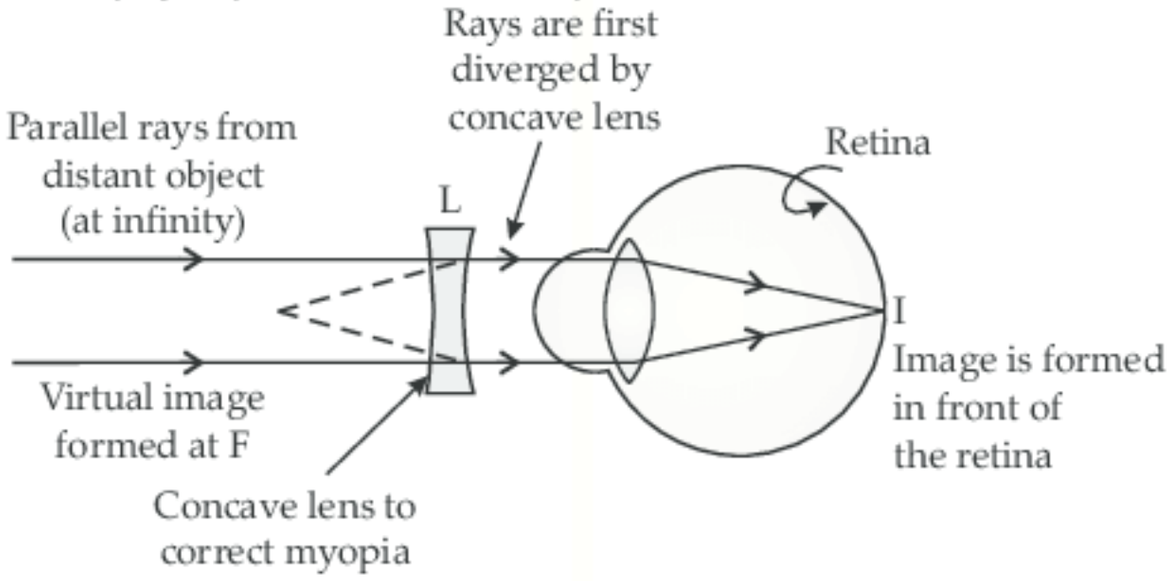
➢ **Myopia (Near Sightedness) :** Distant objects are not clearly visible. It is corrected by using concave lens.



(a) In a myopic eye, image of distance object is formed in front of the retina (and not on the retina)



(b) The far point (F) of a myopic eye is less than infinity.



(c) Correction of myopia. The concave lens placed in front of the eye forms a virtual image of distant object at far point (F) of myopic eye.

Hypermetropia (Far sightedness)

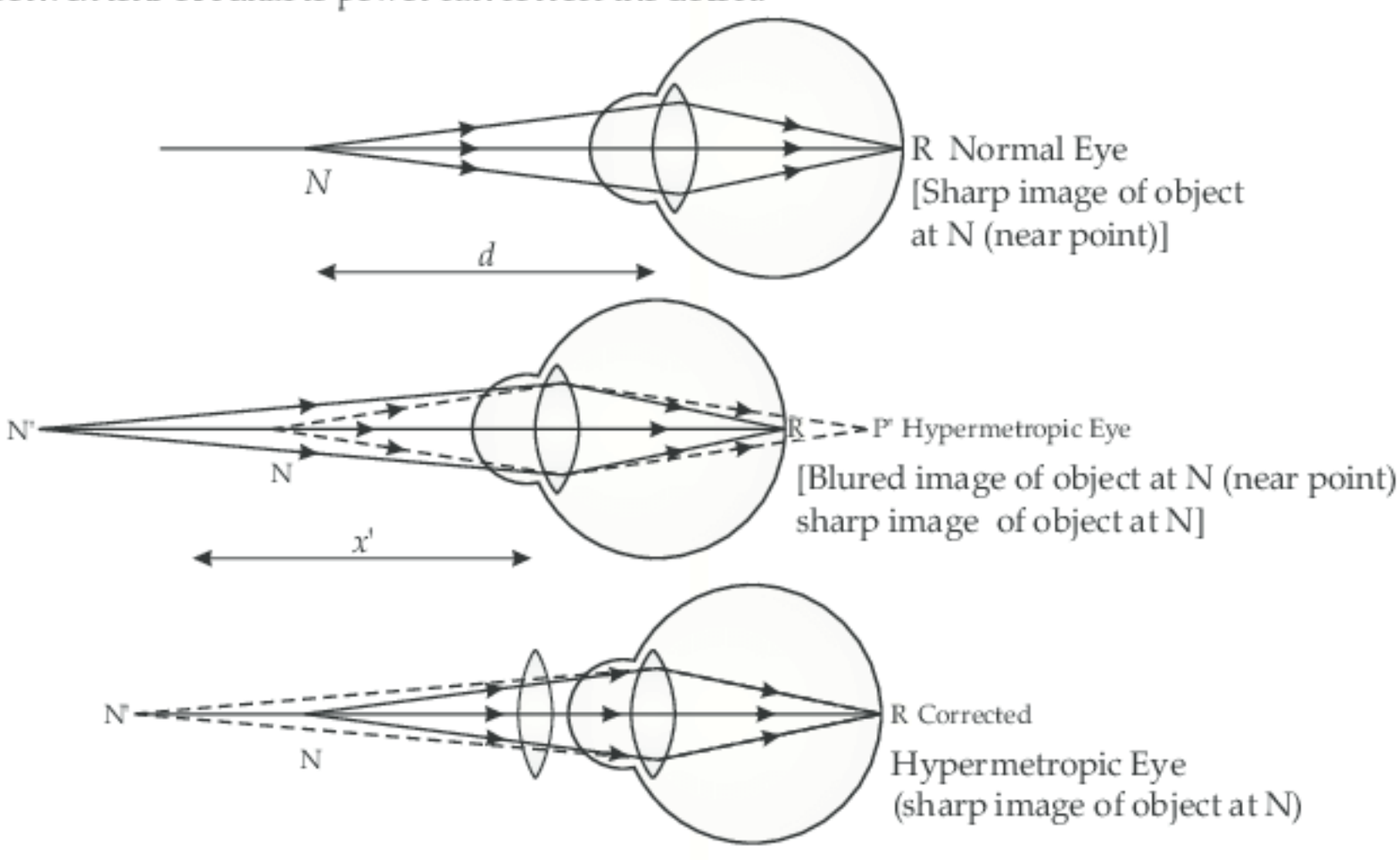
➢ Affected person can see far objects clearly but cannot see nearby objects clearly.

➢ The near point of the eye moves away.

➢ Image is formed behind the retina.

Correction

➢ Use of convex lens of suitable power can correct the defect.



Presbyopia (Old age Hypermetropia)

- It is the defect of vision due to which an old person cannot see the nearby objects clearly due to less power of accommodation of the eye.
  - The near-point of old person having presbyopia gradually recedes and becomes much more than 25 cm away.
- The phenomenon of splitting of white light into its constituent seven colours on passing through a glass prism is called **dispersion of light**.
- Different colours undergo different deviations on passing through 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.
- **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.
- Light travelling from rarer to denser layers always bends towards the normal.
- Stars twinkle on account of atmospheric refraction.
- Sun appears to rise 2 minutes earlier and set 2 minutes later due to atmospheric refraction.
- The phenomenon in which a part of the light incident on a particle is redirected in different directions is called **scattering of light.**
- Very small particles scatter light of shorter wavelengths better than longer wavelengths.
- The scattering of longer wavelengths of light increases as the size of the particle increases.
- Larger particles scatter light of all wavelengths equally well.

Know the Terms

- **Range of Vision :** The distance between far point and near point of the eye is called the range of vision.
- **Accommodation :** The ability of an eye lens to adjust its focal length by the action of ciliary muscles to get a clear and sharp image of the distant object as well as nearby object is called accommodation. For a person having normal vision, it is about 4 dioptres.
- **Power of Accommodation :** The maximum variation in the converging power (focal length) of eye lens so that the far–off and nearby objects are viewed clearly is called power of accommodation.
- **Persistence of vision :** The time for which the impression or sensation of an object continues in the eye is called the persistence of vision. It is about $1/16^{th}$ of a second.
- **Prism :** Prism is a homogenous, transparent, refracting material, such as glass, enclosed by two inclined plane refracting surfaces, at some fixed angle, called refracting angle or angle of prism. It has two triangular bases and three rectangular lateral surfaces which are inclined to each other.
- **Angle of Refraction :** The angle between the refracted ray and the normal is called angle of refraction ($\angle r$).
- **Angle of Emergence :** The angle between the emergent ray and normal at the second refracting face of the prism is called angle of emergence ($\angle e$).
- **Angle of Deviation :** The angle formed between the incident ray produced in the forward direction and emergent ray produced in the backward direction in the refraction through the prism is called angle of deviation ($\angle \delta$).
- **Dispersion :** The splitting up of white light into its constituent colours is called dispersion. It occurs because refraction or bending differs with the colour.
- **Atmospheric Refraction :** Change in the direction of propagation of light rays travelling through the atmosphere due to change in density of the different layers of air is called atmospheric refraction.
- **Scattering of Light :** The phenomenon of change in the direction of propagation of light caused by the large number of molecules, such as smoke, tiny water droplets, suspended particles of dust and molecules of air present in the earth's atmosphere is called scattering of light.
- **Tyndall effect :** The phenomenon of scattering of light by the colloidal particles is known as tyndall effect.

TOPIC-1
Human eye, Defects of vision and correction

Very Short Answer Type Questions (1 mark each)

R Q. 1. Define power of accommodation.

OR

What is meant by power of accommodation of the eye ?

Ans. The ability or the property of the eye lens to its focal length in order to focus both near and distance objects is known as the power of accommodation. **1**

U **Q. 2. What is the purpose of human eye ?**

Ans. It enables us to see and perceive the object in our vicinity. **1**

R **Q. 3. State one function of iris in human eye.**

[Board Term II, Set AI, 2012]

Ans. Function of Iris : It controls the size of the pupil. **1**

R **Q. 4. Name the part of the human eye that helps in changing the focal length of the eye lens.**

[Board Term II, Set A1, 2011]

Ans. Ciliary muscles. **1**

R **Q. 5. What is the range of vision of a normal human eye ?** **[Board Term II, Set A1, 2011]**

Ans. 25 cm to infinity. **1**

R **Q. 6. What is the function of pupil in human eye ?**

[Board Term II, Set AI, 2011]

Ans. The pupil helps to control the amount of light entering the eye. **1**

R **Q. 7. Name the part of the eye ?**

(i) that controls the amount of light entering into the eye.

(ii) that had real, inverted image of the object formed on it. **[Board Term II, Set A1, 2011]**

Ans. (i) Pupil, (ii) Retina. ½+½

R **Q. 8. What is the nature of the image formed on the retina ?**

Ans. Real, inverted and same-sized. **1**

R **Q. 9. What is the principle of the working of the human eye ?**

Ans. It is like a camera having a lens system forming an inverted, real image on the light sensitive screen, retina inside the eye. **1**

U **Q. 10. A person is advised to wear spectacles with convex lenses. State the defect of vision he is suffering from.** **[Board Term II, Set B1, 2011]**

Ans. The person is suffering from hypermetropia.

Short Answer Type Questions-I

(2 marks each)

R **Q. 1. What are Rods and Cones ?**

Ans. Rods and cones are light sensitive cells present in the retina. Rods control the intensity of light, while cones control the colour perception . **2**

R **Q. 2. State the structure of iris and its function in human eye.** **[Board Term II, Set-8XSVHLC, Set-QNA4XWT, 2014]**

Ans. Just behind the cornea is a dark coloured muscular diaphragm which has a small circular opening in the middle. Iris is made of muscles. They control the size of opening of pupil. **1+1**

[CBSE Marking Scheme, 2014]

R **Q. 3. What is meant by near point and far point of an eye ? State their values for the normal human eye.** **[Board Term II, Set (67001), 2012]**

OR

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

Ans. The nearest point to the eye at which an object is visible distinctly is called the near point. (25 cm).**1**

The maximum distance up to which the normal eye can see things is called the far point (infinity). **[CBSE Marking Scheme, 2012] 1**

R **Q. 4. (i) Define distance of distinct vision and give its range.**

(ii) What is the role of iris in a human eye ?

[Board Term-II, Set (2040), 2012]

Ans. (i) The distance up to which normal eye can see clearly without putting any strain on muscles of eye. **1**

(ii) Controls the size of the pupil. **1**

[CBSE Marking Scheme, 2012]

A **Q. 5. Name the type of defect of vision a person is suffering from, if he uses convex lenses in his spectacles for the correction of this vision. If the power of the lenses is +0.5 D, find the focal length of lenses.** **[OD Comptt. 31/1 2017]**

Ans. Hypermetropia or Long sightedness

$$f = \frac{1}{P} \times 100$$

$$f = \frac{1}{0.5} \times 100 = 200 \qquad \textbf{1+1}$$

U **Q. 6. How is a normal eye able to see distinctly distant as well as nearer objects ? What is the distance of distinct vision ?**

[Board Term II, Foreign Set-II, 2014]

[Board Term II, Set (2008), 2012]

Ans. Eye lens is made up of fibrous material. Its curvature can be changed by ciliary muscles which changes its focal length. When muscles are relaxed, the lens becomes thin and focal length increases and the eye is able to see distant objects. Similarly when ciliary muscles contract, focal length decreases and eye is able to see nearer objects. **1**

The minimum distance at which objects can be seen distinctly is called distance of distinct vision. It is 25 cm. **[CBSE Marking Scheme, 2012] 1**

A **Q. 7. An old person is unable to see clearly nearby object as well as distant objects :**

(i) What defect of vision is he suffering from ?

(ii) What kind of lens will be required to see clearly the nearby as well as distant objects ? Give reason. **[Board Term II, Set (2007), 2012]**

Ans. (i) Presbyopia. **1**

(ii) He shall have to use both kinds of lenses. Convex lens for long sightedness and concave lens for short-sightedness. **1**

[CBSE Marking Scheme, 2012]

U **Q. 8. When a person is said to have developed cataract? How is the vision of such a person restored ?**

Ans. When the crystalline lens of eye becomes hazy (or ever opaque) due to the formation of thin membrane over it, this causes partial or complete loss of vision. This defect of eye is called cataract. The vision of the defected eye can be restored by the cataract surgery. **2**

A **Q. 9. Why does it take some time to see the objects in a dim room when we enter the room from bright sunlight outside ?**

[Board Term II, Set A1, 2011]

Ans. In bright light, the size of the pupil is small to control the amount of light entering the eye. **1**

When we enter a dim room, it takes some time so that the pupil expands and allows more light to enter and helps to see things clearly. **1**

A **Q. 10. Why does it takes some time to see objects in a cinema hall when we just enter the hall from bright sunlight ? Explain in brief.**

[Board Term II, Set B1, 2011]

Ans. (i) The pupil regulates and controls the amount of light entering the eye. **1**

(ii) In bright sunlight, the size of the pupil is small and when we enter the cinema hall it takes some time for the pupil to expand in size due to dim light. **1**

U **Q. 11. (i) What is meant by least distance of distinct vision ?**

(ii) How does the thickness of the eye lens change when we shift looking from a distant tree to reading a book ? **[Board Term II, Set A1, 2011]**

Ans. (i) It is the minimum distance to which, normal eye can see two similar object distinctly. **1**

(ii) Eye lens is comparatively thicker, while reading a book. **1**

Short Answer Type Questions-II

(3 marks each)

U **Q. 1. State one main function each of iris, pupil and cornea.** **[Board Term II, Set-GFUTB86, 2015]**

Ans. (i) Iris : Gives colour to eyes, controls size of pupil.

(ii) Pupil : Regulate amount of light.

(iii) Cornea : Refracts most of the light into eyes.

[CBSE Marking Scheme, 2015] 1+1+1

U **Q. 2. What is meant by the term 'power of accommodation' of human eye ? How does it help a person to see nearby as well as distant objects clearly ?** **[Board Term II Foreign 2012]**

OR

How are we able to see nearby and also the distant objects clearly ? **(NCERT Exemplar)**

Ans. Power of accommodation of human eye : The ability of eye lens to adjust its focal length to form the sharp image of the object at varying distance on the retina is called its power of accommodation.

The curvature of eye lens can be changed (*i.e.* change in its focal length) to some extent by the ciliary muscles.

When we are looking at the nearby objects, the ciliary muscles contract, it increases the thickness of eye lens. The eye lens then becomes thicker. As a result, the focal length of eye lens decreases in such a way that the clear sharp image of nearby object is formed on the retina. Thus, the object is seen clearly to us. When we are looking at the distance objects, these muscles are in relaxed position, the eye lens becomes thinner, focal length of the lens increases. Therefore, the parallel rays coming from the distant object are focussed on the retina and object is seen clearly to us. Thus, the accommodation power of an eye helps a person to see nearby as well as distant objects clearly. **3**

U **Q. 3. (i) What is meant by 'least distance of distinct vision' ?**

(ii) How does iris controls the size of the pupil in bright light and dim light ?

Ans. (i) The minimum distance at which objects can be seen most distinctly without strain is called the least distance of distinct vision. **1**

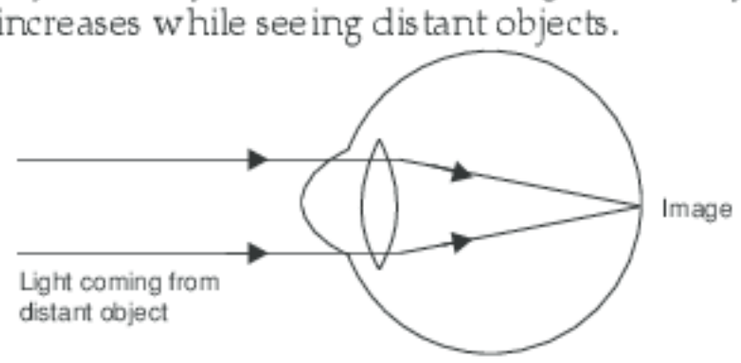
(ii) In bright light, the iris contracts the pupil to allow less light to enter the eye. In dim light, the iris expands the pupil to allow more light to enter the eye. **2**

U **Q. 4. 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 (a) a distance object, (b) nearby objects.**

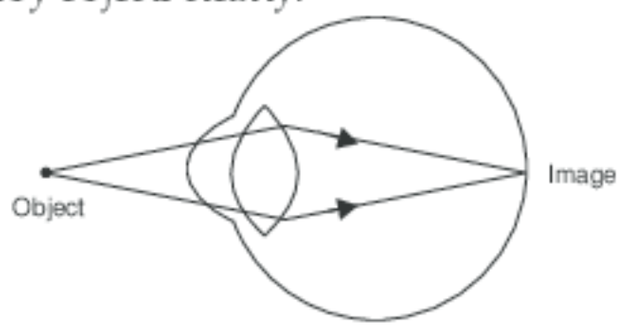
Explain, why a normal eye is not able to see distinctly the object placed closer than 25 cm, without putting any strain on the eye.

[Delhi 31/1/2 2017]

Ans. (i) When we see distant objects, the ciliary muscles relax/expand to decrease the curvature and thereby increase the focal length of the lens. Hence, the lens becomes thin. This enables us to see the distant object clearly. Thus, the focal length of the eye lens increases while seeing distant objects.



(ii) To see the nearby objects clearly, the focal length of the lens should be shorter. For this, the ciliary muscles contract to increase the curvature and thereby decrease the focal length of the lens Hence, the lens becomes thick. This enables you to see the nearby objects clearly.



A normal eye is not able to see distinctly the objects placed closer than 25 cm, without putting any strain on the eye. This is because the ciliary muscles of eyes are unable to contract beyond a certain limit. If the objects are placed at a distance less than 25 cm from the eye, then the objects appear blurred because light rays coming from the object meet beyond the retina. **1+1+1**

A **Q. 5. (i) What are the values of (a) near point and (b) far point of vision of a normal adult person ?**

(ii) A person with a myopic eye cannot see objects beyond 1.2 m directly. What should be the type of the corrective lens used ? What would be its power? **[Board Term II, 2011, Set AI]**

Ans. (i) (a) 25 cm, **(b)** Infinity (∞).

(ii) To correct, an objects at ∞ has to be brought at an image to 120 cm.

$$\frac{1}{f} = \frac{1}{-120} - \frac{1}{(-\infty)} = \frac{1}{-120}$$

$$f = -120 \text{ cm}$$

$$P = \frac{100}{-120} = \frac{-5}{6} D = -0.83 D$$

A concave lens of focal length 120 cm and power –0.83 D is to be used. **1+2**

U **Q. 6. 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.** **(Delhi 31/1/1 2017)**

Ans. ● Presbyopia
● Bifocal lens
● Upper portion/part — Concave/ Diverging lens
— To view far off objects
Lower part — Convex/converging lens
— To facilitate/ view nearby objects
[CBSE Marking Scheme]3

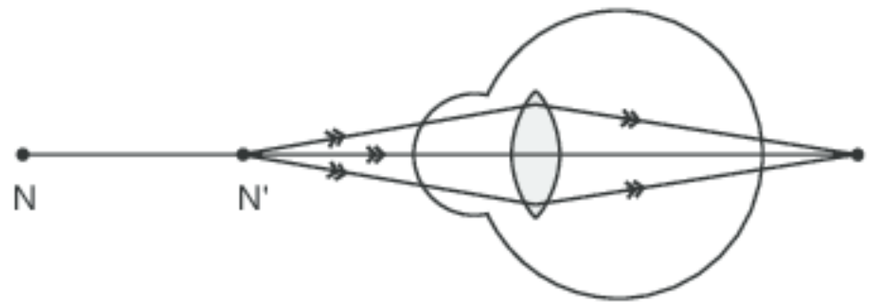
Detailed Answer :

The defect caused due to gradual weakening of ciliary muscles and diminishing flexibility of the eye lens is presbyopia.

The type of lens required by such person to improve the vision is bifocal lens.

A bifocal lens consists of both convex lens and concave lenses. The convex lens used in bifocal lens is used to correct hypermetropia (far-sightedness) and concave lens is used to correct myopia (short-sightedness). **3**

A **Q. 7. Study the diagram given below and answer the following questions :**



(i) Name the defect of vision depicted in the diagram.

(ii) List two causes of the defect.

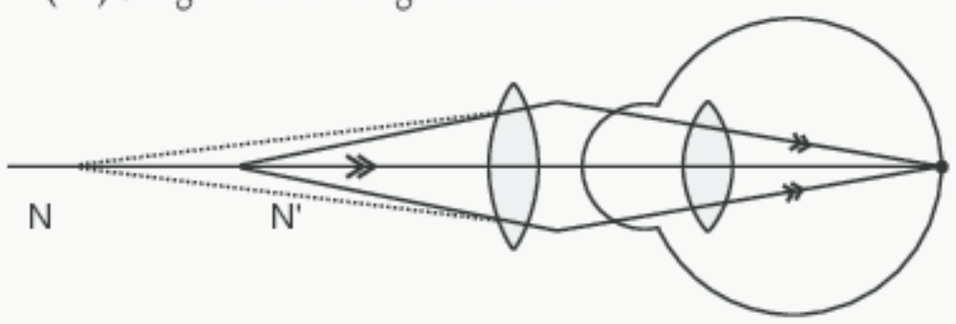
(iii) Draw a ray diagram for the correction of the above defect using an appropriate lens.

[Board Term-II, Set-GFUTB86, 2015]

Ans. (i) Hypermetropia. **1**

(ii) A focal length of the eye lens is too long. The eyeball becomes too small. **1**

(iii) Diagram showing correction.



[CBSE Marking Scheme, 2015] 1

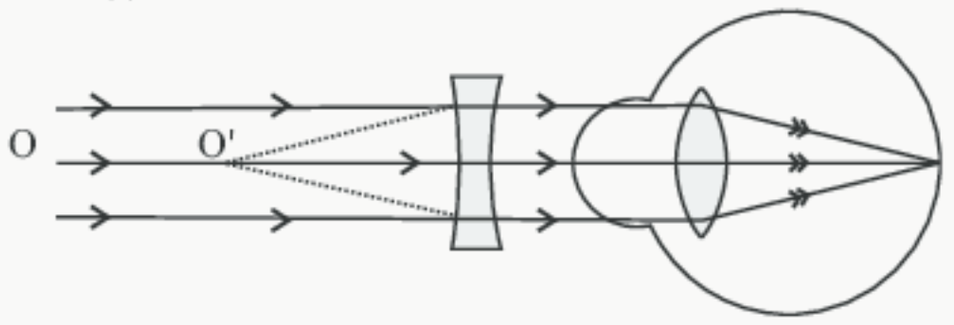
A **Q. 8. (i) Make a ray diagram to show how the eye defect-myopia is corrected by using a suitable lens.**

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

(iii) A person with myopic eye cannot see objects beyond a distance of 1.5 m. What is the power of the lens required to correct the problem ?

[Board Term II, Set (67002), 2012]

Ans. (i) **1**



(ii) (a) Elongation of the eye ball ½

(b) Decrease in focal length of eye lens. ½

(iii) $u = \infty$, $v = -1{\cdot}5$ m

$$P = \frac{1}{f} = \frac{1}{u} - \frac{1}{v} \quad ½$$

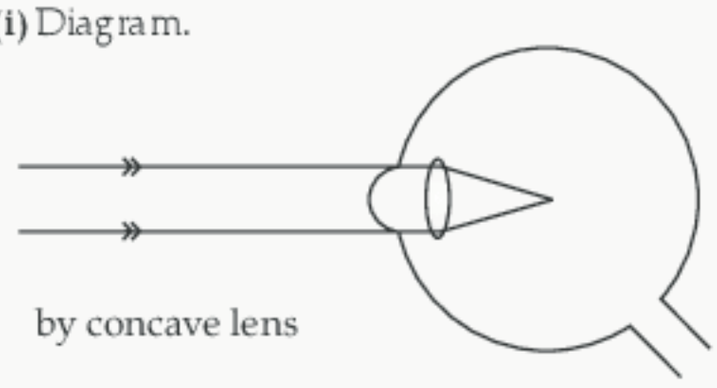
$$= \frac{1}{-15} = -0{\cdot}66 D \quad ½$$

[CBSE Marking Scheme, 2012]

A **Q. 9. (i) Draw a diagram to show the formation of image of a distant object by a myopic eye. How can such an eye-defect be rectified ?**

(ii) State two reasons due to which this eye defect may be caused. [Board Term II, Set (2018), 2012]

Ans. (i) Diagram. **1**



by concave lens

It can be rectified. **1**

(ii) Due to excessive curvature of lens or elongation of eye ball. **1**

[CBSE Marking Scheme, 2012]

U **Q. 10. Write about power of accommodation of human eye. Explain why the image distance in the eye does not change when we change the distance of an object from the eye ? [Delhi 31/1/3 2017]**

Ans. The ability of the eye lens to adjust its focal length is called power of accommodation.

The focal length of the eye lens is adjusted so that the image distance does not change. Thus the image distance is equal to distance from the centre of the eye lens to the retina. **1+2**

A **Q. 11. The near point of a person suffering from hypermetropia is 75 cm. Calculate the focal length and power of the lens required to enable him to read the newspaper which is kept at 25 cm from the eye.**

Ans. $u = -25$ cm

$v = -75$ cm

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

$$\frac{1}{-75} - \frac{1}{-25} = \frac{1}{f} \Rightarrow \frac{1}{-75} + \frac{1}{25} = \frac{1}{f}$$

$$\frac{2}{75} = \frac{1}{f}$$

$$\Rightarrow \quad f = \frac{75}{2} = 37{\cdot}5 \text{ cm}$$

So, $$P = \frac{100}{37.5} \text{ cm}$$

$$= 2{\cdot}6 \text{ D} \quad \textbf{3}$$

U **Q. 12. Discuss how the brain perceives the image formed on the retina.**

Ans. Retina contains light sensitive cells known as rods and cones. These cells get activated upon illumination and generate electrical signals or pulses. **1**

The electrical signals are sent to the brain through optic nerves. **1**

In the brain, the signals are processed, interpreted and the objects in front of the eye are perceived. **1**

A **Q. 13. (i) Ravi kept a book at a distance of 10 cm from the eyes of his friend Hari. Hari is not able to read anything written on the book. Explain why ?**

(ii) A lens of focal length 5.0 cm is being used by a student in the laboratory as a magnifying glass. His least distance of distinct vision is 25 cm. What magnification is the student getting?

[Board Term II, Set B1, 2011]

Ans. (i) Because least distance of distinct vision is 25 cm, and book is kept at a distance of 10 cm. **1**

(ii) $u = ?$, $v = -25$ cm, $f = 5$ cm.

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

$$\frac{1}{5} = \frac{1}{(-25)} - \frac{1}{u}$$

$$\frac{1}{u} = \frac{1}{(-25)} - \frac{1}{5}$$

$$u = \frac{-25}{6}$$

$$m = \frac{v}{u}$$

$$m = (-25) \times \frac{6}{-25}$$

$$m = 6 \quad \textbf{1}$$

Long Answer Type Questions

(5 marks each)

U **Q. 1. (a) Write the function of each of the following parts of human eye : Cornea; iris; crystalline lens; ciliary muscles.**

(b) Millions of people of the developing countries of world are suffering from corneal blindness. These persons can be cured by replacing the defective cornea with the cornea of a donated eye. A charitable society of your city has organised a campaign in your neighbourhood in order to create awareness about this fact. If you are asked to participate in this mission how would you contribute in this noble cause ?

(i) State the objective of organising such campaigns.

(ii) List two arguments which you would give to motivate the people to donate their eyes after death.

(iii) List two values which are developed in the persons who actively participate and contribute in such programmes.

[Delhi Set-I, 2016]

Ans. **(a) (i) Cornea** – Refracts the rays of light falling on the eye. ½

(ii) Iris – Controls the size of the pupil. ½

(iii) Crystalline lens – Focuses the image of the object on the retina. ½

(iv) Ciliary muscles – Holds the eye lens and adjusts its focal length. ½

(b) (i) Objectives – To make people aware and realize their duties towards society. **1**

(ii) One person can give sight to two people. ½

Our eyes can live even after our death. ½

(iii) Concern for others/ Responsible behaviour/ Group work/ or any other. **(Any two)** 2×½

[CBSE Marking Scheme, 2016]

U **Q. 2. State the function of each of the following parts of the human eye :**

(i) Cornea (ii) Iris

(iii) Pupil (iv) Retina

[Board Term II Foreign Set-I, 2015]

Millions of people of the developing countries are suffering from corneal blindness. This disease can be cured by replacing the defective cornea with the cornea of a donated eye. Your school has organised a campaign in the school and its neighbourhood in order to create awareness about this fact and motivate people to donate their eyes after death. How can you along with your classmates contribute in this noble cause ? State the objectives of organising such campaigns in schools.

Ans. **(i) Cornea**—Refraction of the light rays falling on the eye.

(ii) Iris—To control the size of the pupil.

(iii) Pupil—To regulate and control the amount of light entering the eye.

(iv) Retina—To act as a screen to obtain the image of object and generate electrical signals which are sent to the brain via optic nerves. ½ × 4 = 2

- Ways of motivating people for the noble cause of eye donation are street play, Banners, Posters, door to door campaign etc..

Objectives—

(i) To develop the habit of group work.

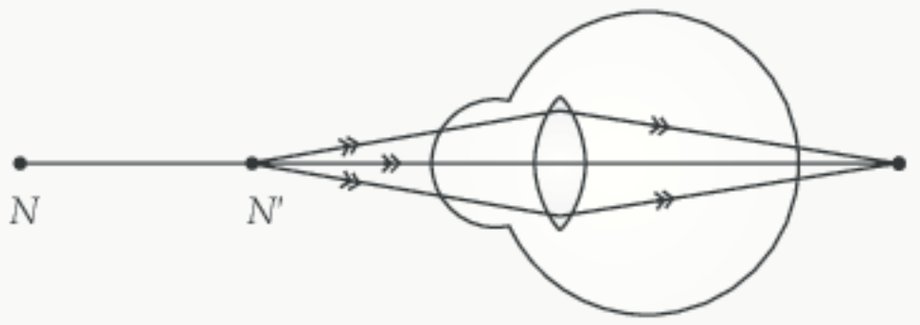
(ii) To work for a common cause.

(iii) To understand social issues and problems. 3

[CBSE Marking Scheme, 2015]

U **Q. 3. A person is unable to see distinctly the words printed on a newspaper. Name the defect of vision he is suffering from. Draw 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.** **[Delhi Comptt. 31/1/3 2017]**

Sol. - Hypermetropia/ Long-sightedness **1**
- Defective eye

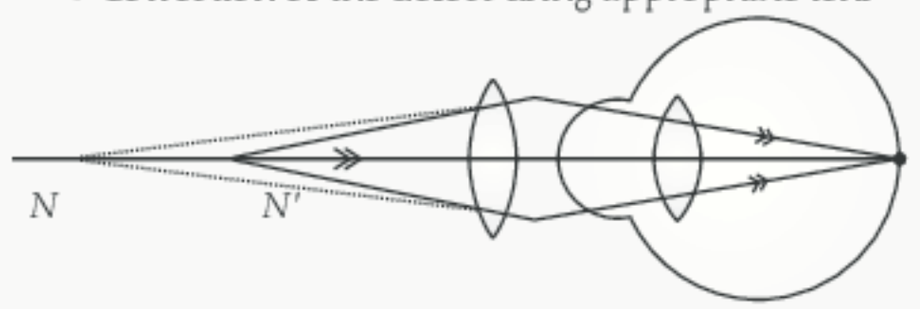


- **Two causes :**

(i) The focal length of the eye lens is too long. **1**

(ii) The eyeball has become too small. **1**

- Correction of the defect using appropriate lens



[CBSE Marking Scheme]

A **Q. 4. Name the eye defect in which eye lens becomes cloudy or milky. Mention the method for its correction. A person uses a lens of power –1.0 D for correcting his distant vision and for correcting his near vision he uses a lens of power + 2.0 D. Calculate the focal length of the lenses required to correct these defects. Explain why a normal eye is not able to see clearly the objects placed closer than the near points.**

[Board Term II, Set-GFUTB 86, 2015]

Ans. **(i)** Sometime, the crystalline lens of people at old age becomes milky and cloudy. This condition is called cataract. This causes partial or complete loss of vision.

It is possible to restore vision through a cataract surgery.

(ii) Focal length for lens for distance vision

$$= -\frac{1}{1} = -1\text{m}$$

Focal length for lens for near vision

$$= +\frac{1}{2} = +0.5\text{ m}$$

(iii) The focal length of eye lens cannot be decreased below a certain minimum limit. If we try to read a printed page by holding it very close to our eyes, we may see the image being blurred or feel strain in the eye. To see an object comfortably and distinctly, we must hold it at about 25 cm from the eyes. **[CBSE Marking Scheme, 2015]** 5

A **Q. 5. A student is unable to see clearly the words written on the blackboard placed at a distance of approximately 4 m from him. Name the defect of vision the boy is suffering from. Explain the method of correcting this defect. Draw ray diagram for the :**

(i) defect of vision and also

(ii) For its correction. [Board Term II Delhi Set-I, 2015]

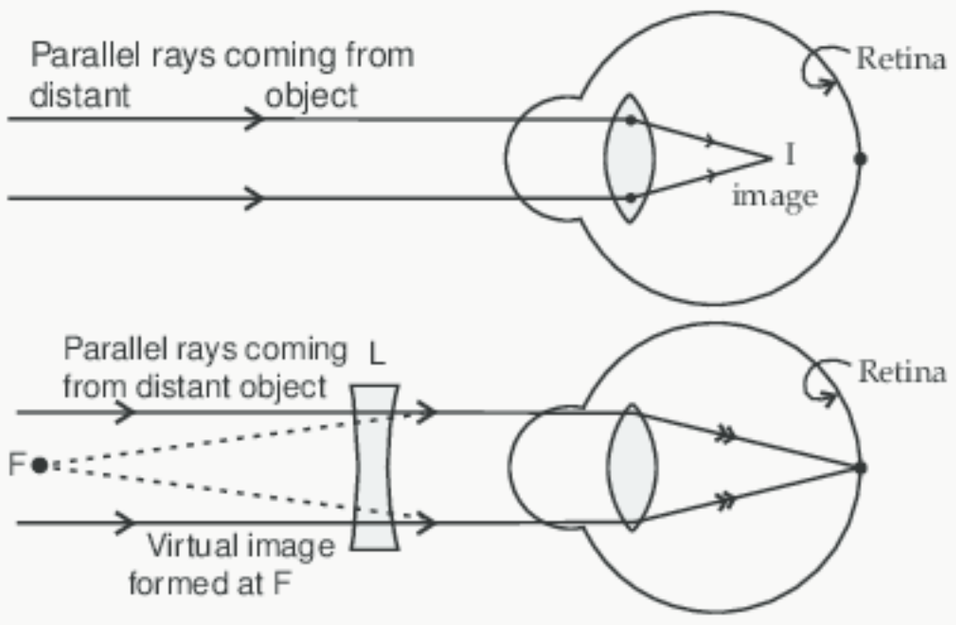
OR

A student has difficulty reading the blackboard while sitting in the last row. What could be the

defect the child suffering from ? How can it be corrected ?

Ans. Myopia on short–sightedness : Inability of an eye in viewing long distance objects. The image in this case falls before the retina. For every myopic eye, there exists a far point beyond which clear image cannot be seen.

The short–sightedness is corrected by using a concave lens which diverges and shifts the image to the retina.



1+2+2

[CBSE Marking Scheme, 2015]

U **Q. 6. (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) 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 ?

[Board Term II, Outside Delhi Set-I, III, 2014]

Ans. (i) The pupil is the perforation in the iris. It is the pupil (or aperture of the eye) through which light enters our eyes. The relaxation and contraction of the muscular fibres of the iris regulate the opening and closing of the pupil. Hence, it is the pupil that controls the amount of light entering our eyes.

(ii) The retina is the "film" of the eye like the film of a camera. 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 of a dead person can be donated to a person having corneal blindness. It will help him/her to see the world. We can also register ourselves to donate our eyes. The organisations that put up eye donation camps preserve our eyes after our death and donate them to the needy. 2+1+2

R **Q. 7. (i) List three common refractive defects of vision. Suggest the way of correcting these defects.**

(ii) About 45 lac people in the developing countries are suffering from corneal blindness. About 30 lac children below the age of 12 years suffering from this defect can be cured by replacing the defective cornea with the cornea of a donated eye. How and why can students of your age involve themselves to create awareness about this fact among people?

[Board Term II, Delhi Set-I, III, 2014]

Ans. (i) The three common refractive defects of vision are as follows :

Myopia (short-sightedness) : It is corrected by using spectacles having concave lenses of appropriate power.

Hypermetropia (far-sightedness) : It is corrected by using spectacles having convex lenses of appropriate power.

Presbyopia : This defect is corrected using bifocal lenses of appropriate power in which the upper part consists of a concave lens (to correct myopia) and the lower part consists of a convex lens (to correct hypermetropia).

(ii) Eyes of a dead person can be donated to the person having corneal blindness. It will help him/her see the world. We can also register ourselves to eye donation camps who can preserve our eyes after our death and donate them to the needy. 3+2

U **Q. 8. (a) State the reasons which lead to hypermetropia. With the help of suitable diagram explain this defect of vision and its correction.**

(b) Draw diagram of an experimental arrangement for observing scattering of light in colloidal solution. Name the two chemicals used in this activity.

[Board Term II, Set 8XSVHLC, 2014]

Ans. (a) This defect arises either because :

(i) the focal length of the eye lens is too long, or

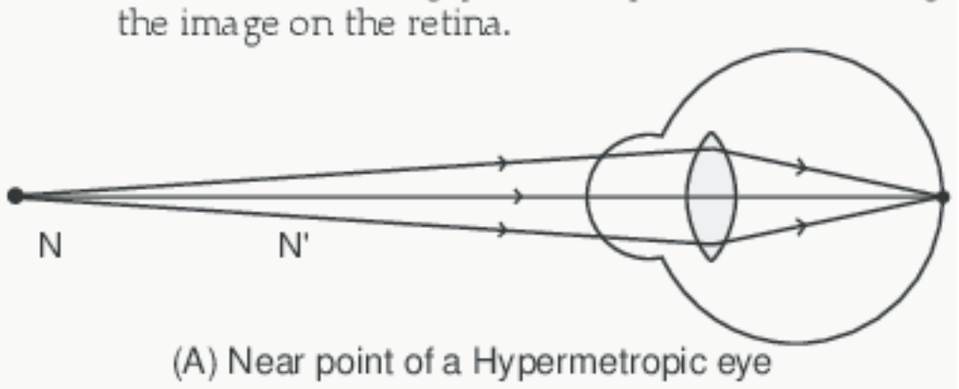
(ii) the eyeball has become too small.

Such a person has to keep a reading material much beyond 25 cm from the eye for comfortable reading. This is because the light rays from a nearby object are focused at a point behind the retina.

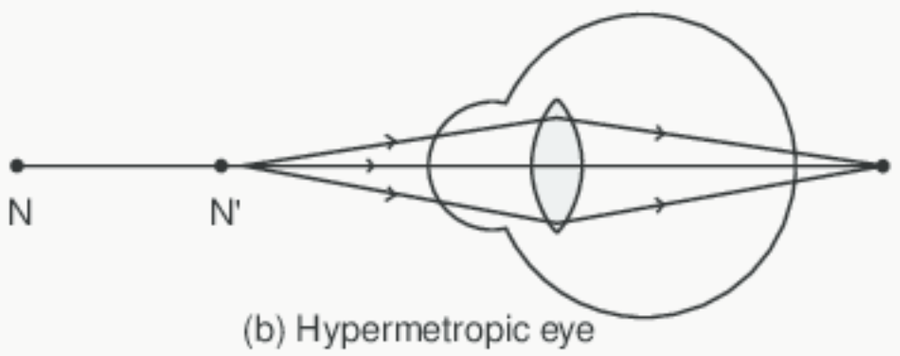
Correction of Hypermetropia :

(i) This defect can be corrected by using a convex lens of appropriate power.

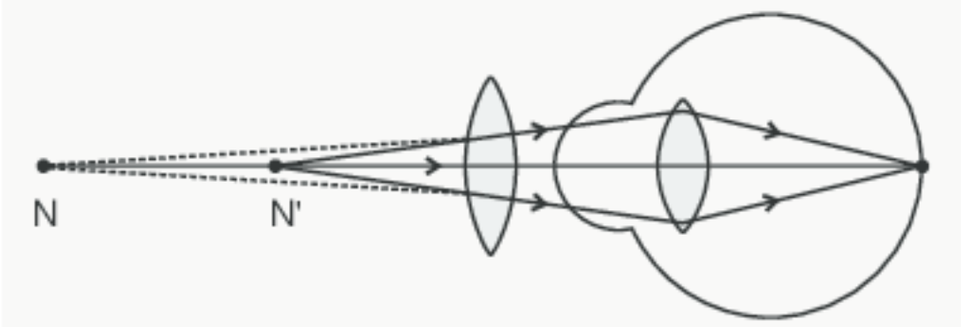
(ii) Eye-glasses with converging lenses provide the additional focusing power required for forming the image on the retina.



(A) Near point of a Hypermetropic eye

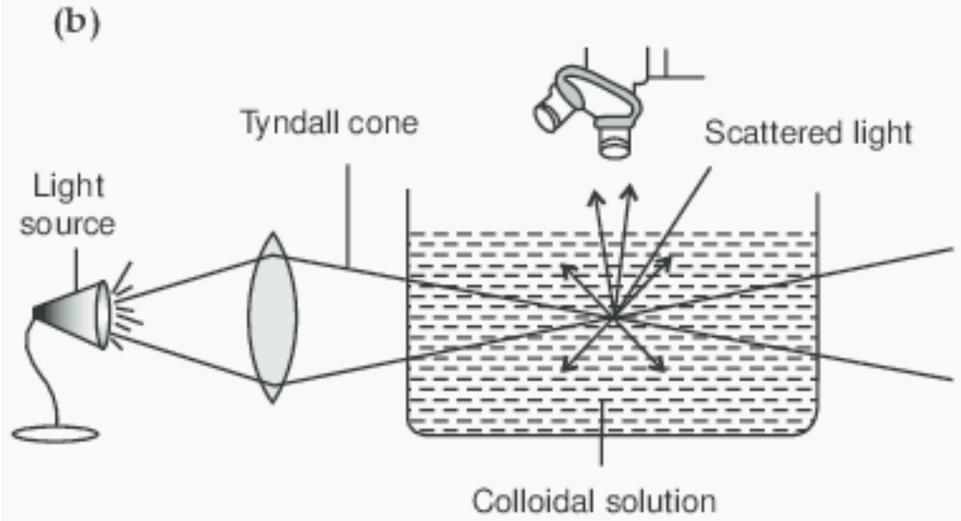


(b) Hypermetropic eye



(c) Correction for Hypermetropic eye

(b)



Colloidal solution

Mixture of milk and water can be used.

[CBSE Marking Scheme, 2014] 3+2

A **Q. 9. (i) What type of spectacles should be worn by a person having the defect of myopia as well as hypermetropia ?**

(ii) The far point of a myopic person is 150 cm. What is the nature and the power of lens required to correct the defect ?

(iii) With the help of ray diagrams, show the formation of image by (i) a myopic eye (ii) correction of myopic eye by using an appropriate lens.

Ans. (i) Spectacle having bifocal lens. **1**

(ii) $u = \infty$, $v = -150$ cm.

Using lens formula,

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

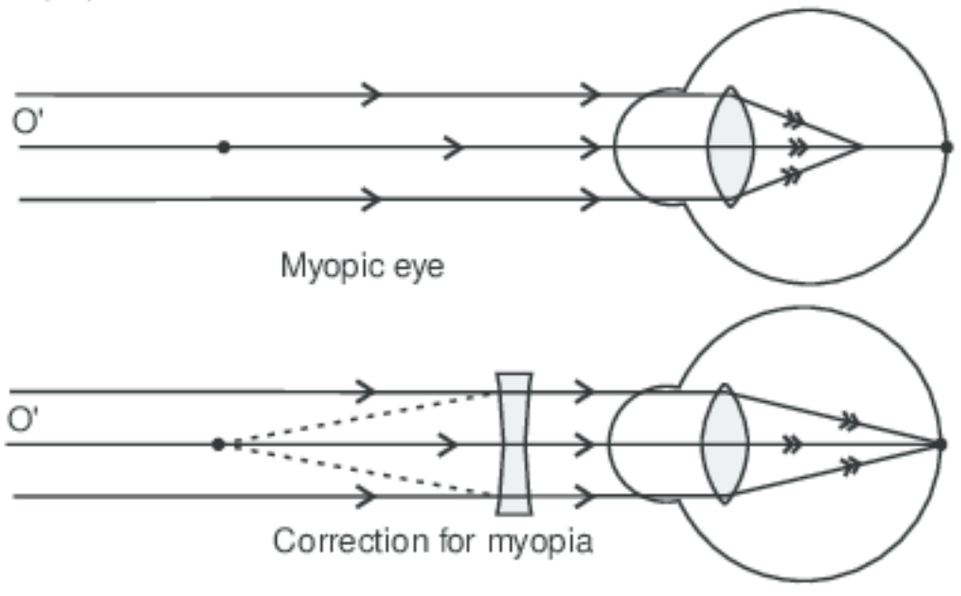
$$\Rightarrow \quad \frac{1}{f} = \frac{1}{-150} - \frac{1}{\infty} \quad \therefore f = -150 \text{ cm.}$$

Power of lens $P = \frac{1}{f} = \frac{-100}{150}$

$= -0{\cdot}67$ D **2**

Nature of lens : Concave.

(iii)



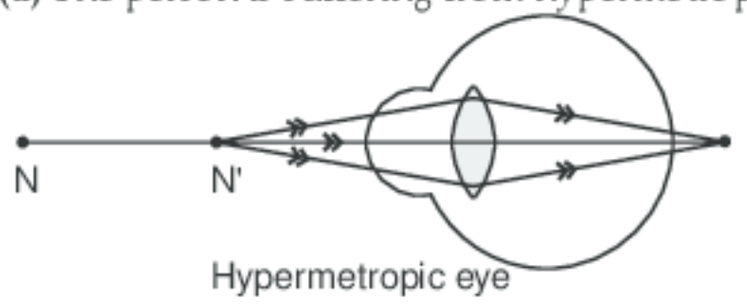
2

A **Q. 10. (a) A person cannot read newspaper placed nearer than 50 cm from his eyes. 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.**

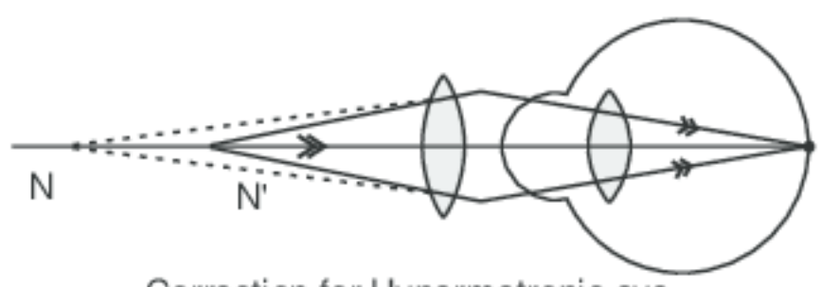
(b) We see advertisements for eye donation on television or in newspaper. Write the importance of such advertisements.

[Board Term II Delhi Set-I, 2013]

Ans. (a) The person is suffering from hypermetropia.



Hypermetropic eye



Correction for Hypermetropic eye **1+1**

Two possible causes :

(i) Greater focal length of the lens. ½

(ii) Eye ball becoming smaller. ½

Use convex lens of focal length

$u = -25$ cm

$v = -50$ cm.

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

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

$$P = \frac{100}{50} = 2 \text{ D is required.} \quad \textbf{1}$$

(b) Eye donation advertisements are important as :

(i) They make the people aware about donation of organs after their death.

(ii) Sympathetic nature towards others. **1**

A **Q. 11. (i) Name the defect of vision in which the eye loses its power of accommodation due to old age.**

(ii) The near point of a person suffering from hypermetropia is at 50 cm from his eye. What is the power of the lens needed to correct this defect/ (near point of normal eye is 25 cm).

(iii) With the help of ray diagrams, show the formation of image by

(a) a hypermetropic eye.

(b) correction of hypermetropia by using an appropriate lens. [Board Term II, Set B1, 2011]

Ans. (i) Presbyopia

(ii) $v = -50$ cm

$u = -25$ cm. **1**

Using lens formula

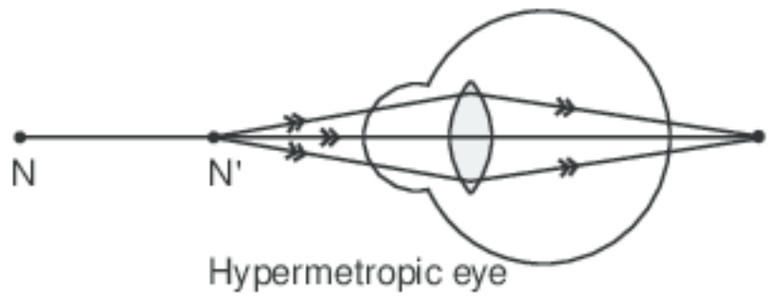
$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{f} = \frac{1}{-50} + \frac{1}{25} = \frac{-1+2}{50}$$

1

$$\frac{1}{f} = \frac{1}{50} \therefore f = 50 \text{ cm}$$

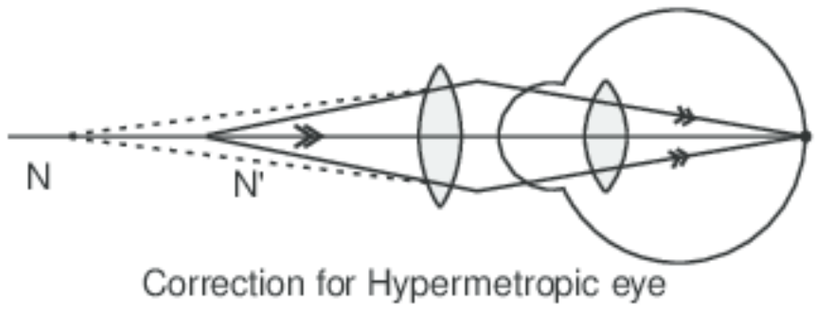
Power of lens, $P = \frac{1}{f(m)} = \frac{100}{50} = +2\,D$ **1**

(a)



Hypermetropic eye **1**

(b)



Correction for Hypermetropic eye **1**

TOPIC-2
Refraction of Light and Dispersion

Very Short Answer Type Questions (1 mark each)

R Q. 1. **What is meant by dispersion of light ?**
[Borad Term II, Foreign Set-I, 2014]

Ans. The splitting of light into its component colours is called dispersion of light. **1**

R Q. 2. **What is tyndall effect ?**
[Board Term II Delhi, 2011]

Ans. The scattering of light by colloidal solution is called tyndall effect. **1**

R Q. 3. **Name the type of particles which acts as a prism in the formation of rainbow in the sky.**

Ans. Water droplets present in the atmosphere. **1**

R Q. 4. **Which coloured component bends the least during the dispersion of white light through prism ?** **[Board Term II, Set A1, 2011]**

Ans. Red. **1**

R Q. 5. **Which colour of white light suffers (i) least deviation and (ii) maximum deviation when a beam of white light passes through a glass prism ?**
[Board Term II, Set A1, 2011]
OR
Name the component of white light that deviates the least and the most while passing through a prism.[Board Term II, Set (2016), 2012]

Ans. (i) Least deviation – Red. ½
(ii) Maximum deviation – Violet. ½
[CBSE Marking Scheme, 2016]

U Q. 6. **On which factor does the colour of the scattered white light depend ?**
[Board Term II, Set (2044), 2012]

Ans. Size of the particles of the medium through which it is passing. **[CBSE Marking Scheme, 2012] 1**

A Q. 7. **The sky appears dark to passengers flying at a very high altitude. Why ?**
[Board Term II, Set (2036), 2012]

Ans. Due to lack of atmosphere, scattering is not prominent. **1**

U Q. 8. **The sky appears dark instead of blue to an astronaut. State its reason.** **[NCERT]**
[Board Term II, Delhi 2012, 2010]

Ans. The sky appears dark to the astronaut as scattering does not take place at very high attitude due to the absence of atmosphere. **1**

R Q. 9. **What is the cause of dispersion of light on passing through a prism ?**
[Board Term II Foreign, 2011]

Ans. The refractive index of the material of a prism is different for different colours of light as different colours have different speed in the material of a prism. Also, prism has non–parallel surfaces. **1**

Short Answer Type Questions-I (2 marks each)

R Q. 1. **(i) Define dispersion of light**
(ii) Name the colour that deviates least and the one which deviates most while passing through a glass prism. **[Board Term II, Set-FF7NBE6, 2015]**

Ans. (i) Dispersion : Breaking up of white light into component colours.
(ii) Red colour deviates the least and violet deviates the most. **[CBSE Marking Scheme, 2015] 1+1**

U **Q. 2. What is dispersion ? What happens when light is passed through a glass prism.**
[Board Term II, Set (67001), 2012]

Ans. The process of splitting up of white light into its constituent colour as it passes through a refracting medium is known as dispersion of light. 1
It bends towards the base of the prism after passing through it. 1
[CBSE Marking Scheme, 2012]

R **Q. 3. (i) A beam of white light splits when it passes through a prism. Name this phenomenon and give its reason.**
(ii) List the colours into which it splits in the decreasing order of their bending on emergence from prism. [Board Term II, Set (2045), 2012]

Ans. (i) Dispersion. White light consists of seven colours of different wavelengths.
These components of light travel with different speeds in glass and get refracted by different angles. Due to this, splitting of white light takes place.
(ii) Violet, Indigo, Blue, Green, Yellow, Orange, Red.
[CBSE Marking Scheme, 2012] 1 + 1

R **Q. 4. Define angle of deviation. Why do different components of white light split up into spectrum when it passes through a triangular glass prism ? [Board Term II, Set (67002), 2012]**

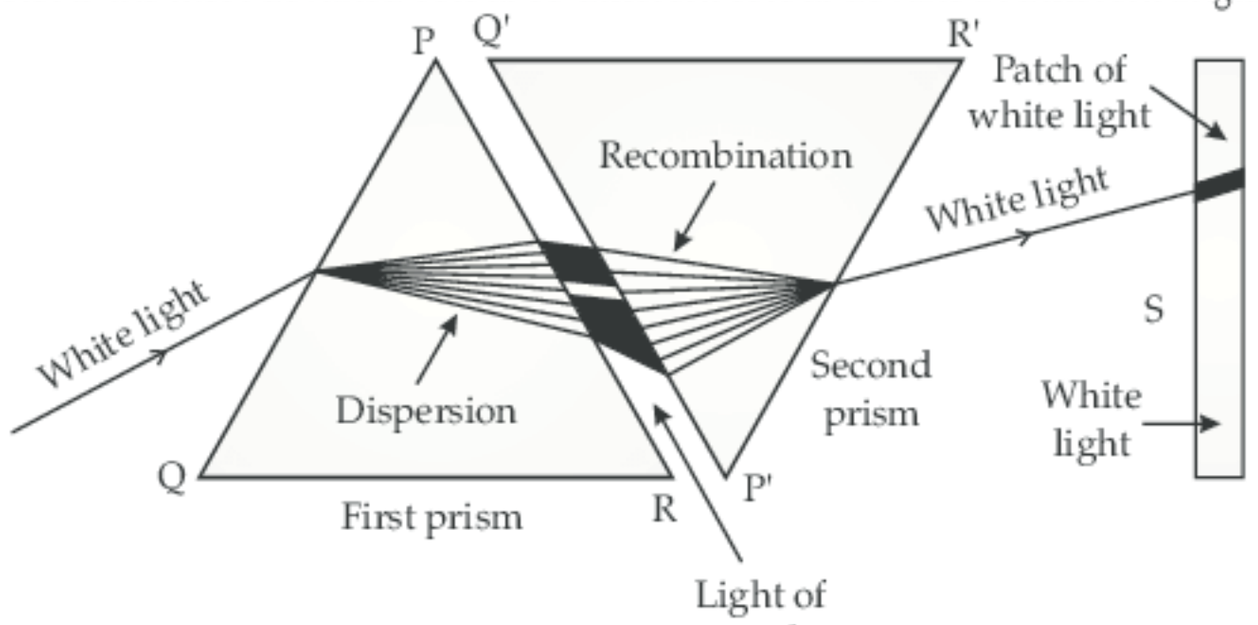
Ans. The angle between the extended incident ray and the emergent ray is called the angle of deviation. 1
This is because the different colours travel through a glass prism at different speeds. 1
[CBSE Marking Scheme, 2012]

R **Q. 5. What is scattering of light ? Explain with the help of an example. [Delhi Comptt. 31/1/ 2017]**

Ans. The phenomenon of change in the direction of propagation of light caused by the large number of particles present in the atmosphere is called scattering of light.
Example : The path of beam of light becomes visible through a colloidal solution due to scattering of light. 2

R **Q. 6. Why Spectrum is formed when white light is passed through a glass prism ? [DDE 2017]**

Ans. Each colour has a definite wavelength and for each wavelength the angle of deviation differs. Red is the least deviated and violet is the most deviated colour so different colour deviate at different angles to form spectrum.



1+1

A **Q. 7. Why do stars appears to twinkle ? Explain.**
[Board Term II, Foreign Set-I, 2015]

Ans. Stars are very distant and approximate point-sized sources. ½
Path of star light changes continuously due to gradual changing of refractive index of the layers of air. 1
Thus, the apparent position of the stars fluctuates and the amount of starlight entering the eye flickers giving the twinkling effect. ½
[CBSE Marking Scheme, 2015]

R **Q. 8. An object placed behind the fire or a hot surface appears to flicker when seen through the air. Give reason why ? [DDE 2017]**

Ans. The air above hot surface becomes hot and rises. The space is occupied by cool air. The refractive index of hot air is less than that of cool air. So, the physical condition of the medium are not constant. Due to changing Refractive Index (RI) of medium, the light appears to come from different directions.
It results in fluctuation in apparent position of object. 2

A **Q. 9. During sunrise and sunset sky appears red while during the day it appears blue. Explain these natural phenomenon.**
[Board Term II, Set (2045), 2012]

Ans. This is because of scattering of light. 1
Light from the sun near the horizon passes through larger distance in the earth's atmosphere before reaching our eyes. So, 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. But during the day shorter wavelength are scattered more by molecules of air and scattered blue light enters our eyes.

[CBSE Marking Scheme, 2012] 1

A **Q. 10. Explain why the planets do not twinkle.**

[Board Term II, Foreign Set-II, 2015] [NCERT]

Ans. Planets, being closer to earth, are seen as extended sources. **1**

If we consider a planet as a collection of large number of point-sized sources of light, the total variation in the amount of light entering our eye due to gradual change of refractive index of the atmosphere from all individual, point-sized sources will average out to zero. This nullifies the twinkling effect. **1**

[CBSE Marking Scheme, 2015]

U **Q. 11. Why do different colours get separated when white light passes through a prism ? How can we recombine the components of white light after a prism has separated them. Explain.**

[Board Term II, Foreign Set-II, 2014]

Ans. A spectrum is the band of distinct colours we obtain when the white light is splitted by a prism. We can recombine the component of white light by passing them through a prism placed upside down near the given prism. When we pass white light through two identical prisms held side by side with their refracting edges in opposite directions; the first prism disperses white light but the second prism recombines them. Thus light emerging from second prism is white. **2**

R **Q. 12. Why danger signs are made in red colour ?**

[DDE 2017]

Sol. Red is the least scattered colour. It is least scattered by fog and smoke and can be seen in the same colour over a long distance. So, danger signs are made in red colour. **2**

A **Q. 13. Why did the clear sky appear blue ?**

[Board Term II, Set (2018), 2012; Set A1, 2011]

[Delhi Comptt. 31/1/1/2017]

OR

Why is the colour of the clear sky blue ?

[NCERT Exemplar]

Ans. The molecules of air and other fine particles in the atmosphere have size smaller than the wavelength of the visible light. **1**

These are more effective in scattering light of shorter wavelength 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. **1**

R **Q. 14. (i) Why do parallel rays of different colours deviate differently while passing through a glass prism ?**

(ii) Name any two phenomenon associated with the formation of a rainbow.

[Board Term II, Foreign Set-III, 2014]

[Board Term II, Set B1, 2013]

Ans. (i) Parallel rays of different colours deviate differently while passing through a glass prism because angle of refraction of different colours are different hence there is difference in refractive index. **1**

(ii) (a) Total Internal reflection, **(b)** Refraction. ½+½

A **Q. 15. Why does the sun look reddish at the time of sunrise and sunset ? Explain.**

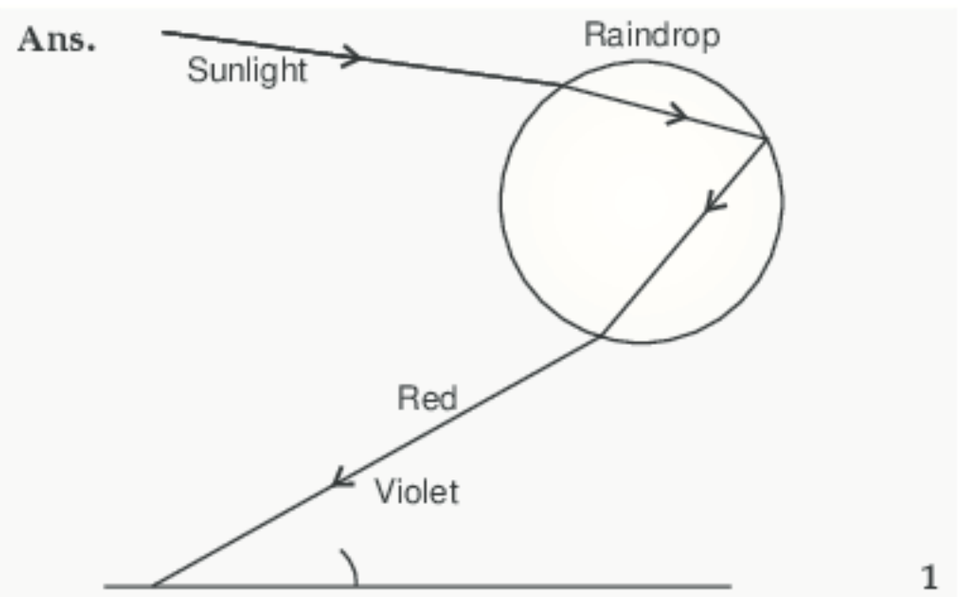
[Board Term II, Set B1, 2011]

Ans. At the time of sunrise or sunset when the sun is near the horizon, the sunlight has to travel the larger distance through the atmosphere to reach us. During this long journey of sunlight, most of the shorter wavelength blue-colour present in it is scattered out and away from our line of sight. So, the light reaching us at the time of sunrise and sunset consists mainly of longer wavelength red colour due to which it appears to be red. **2**

U **Q. 16. Draw a labelled diagram to explain the formation of a rainbow in the sky.**

[Board Term II Foreign Set-III, 2015]

Ans.



1

Labelling **1**

[CBSE Marking Scheme, 2015]

A **Q. 17. Stars twinkle while the planets do not. Why ?**

[Board Term II, Set (2008) 2012, Set B1, 2011]

Ans. Continuously changing atmosphere refract light from the stars by different amounts from one moment to the other. When atmosphere refracts more starlight towards us, the stars appears to be bright and when the atmosphere refracts less starlight, then the stars appear to be dim. **1**

However the planets are nearer to us than the stars, they appears to be comparatively bigger to us so they cannot be considered as a point source, hence no twinkling is seen. **1**

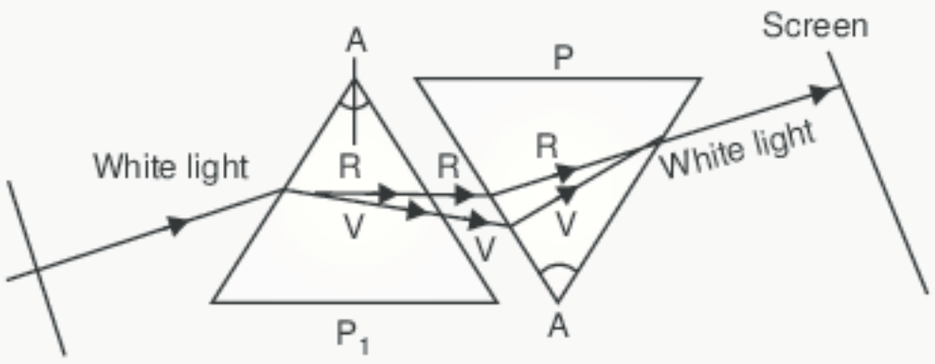
Short Answer Type Questions-II (3 marks each)

A Q. 1. **State the cause of dispersion of white light passing through a glass prism. How did Newton show that white light of sun contains seven colours using two identical glass prisms. 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 focus of the first prism.**

[Board Term II Delhi Set-III, 2016]

[OD 31/1 2017]

Ans. Cause of dispersion of white light : Different colours of light bend through different angles with respect to the incident ray as they pass through a prism. Violet light bends the most and red the least. Thus, the each colour emerges along different paths. 1



[CBSE Marking Scheme, 2016] 2

U Q. 2. **What is meant by scattering of light ? The sky appears blue and the sun appears reddish at sunrise and sunset. Explain these phenomena with reason. [Board Term II Delhi Set-II, 2016]**

OR

What is the difference of colours of the sun observed during sunrise/sunset and noon ? Give explanation of each ? [NCERT Exemplar]

Ans. (i) Scattering of light – Phenomenon of spreading of light (diffused reflection) by minute particles in a medium. 1

(ii) The sky appears blue because the blue colour of sunlight scatters much more strongly than the red colour by particles in atmosphere/ air due to its shorter wavelength. 1

(iii) At sun-rise and sun-set most of the blue light and shorter wavelengths are scattered away by the particles in the atmosphere as the light from the sun near the horizon passes through thick layers of air and larger distance. The light that reaches us is of longer wavelength (red colour) giving a reddish appearance. 1

[CBSE Marking Scheme, 2016]

A Q. 3. **How does refraction of light take place in the atmosphere ? Explain the reason why stars appear to twinkle and the planets do not twinkle. [Delhi Comptt. 31/1/2 2017]**

Ans. ● Since the atmosphere consists of varying densities the apparent position of the object, as seen through the hot air fluctuates. This wavering of light is an effect on atmospheric refraction. 1

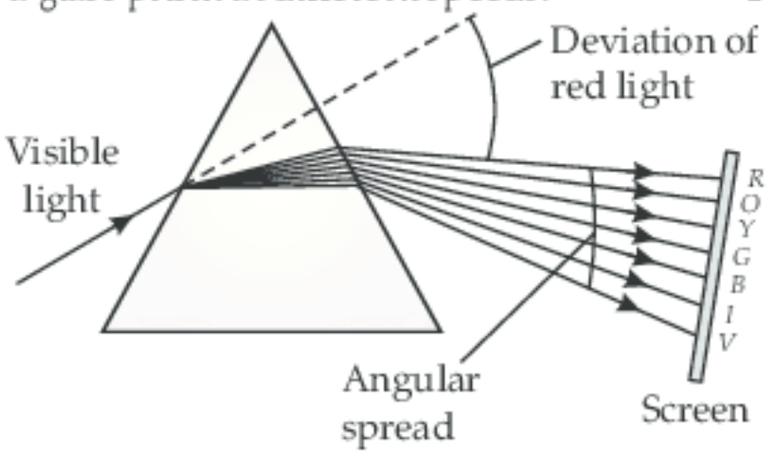
● The twinkling of a star is due to atmosphere refraction of star light. The atmospheric refraction of light occurs in a medium of gradually changing refractive index.

The planets are much closer to the earth and are thus seen as extended sources. A planet is considered as a collection of large number of point sized sources of light, the total variation in the amount of light entering our eye from all individual point sized sources will average out to zero, thereby nullifying the twinkling effect.

A Q. 4. **Define angle of deviation. Why do different components of white light split up into spectrum when it passes through a triangular glass prism ? Show the angle of deviation for red colour when white light passes through a prism. [Board Term II, Set-QNA4XWT 2014]**

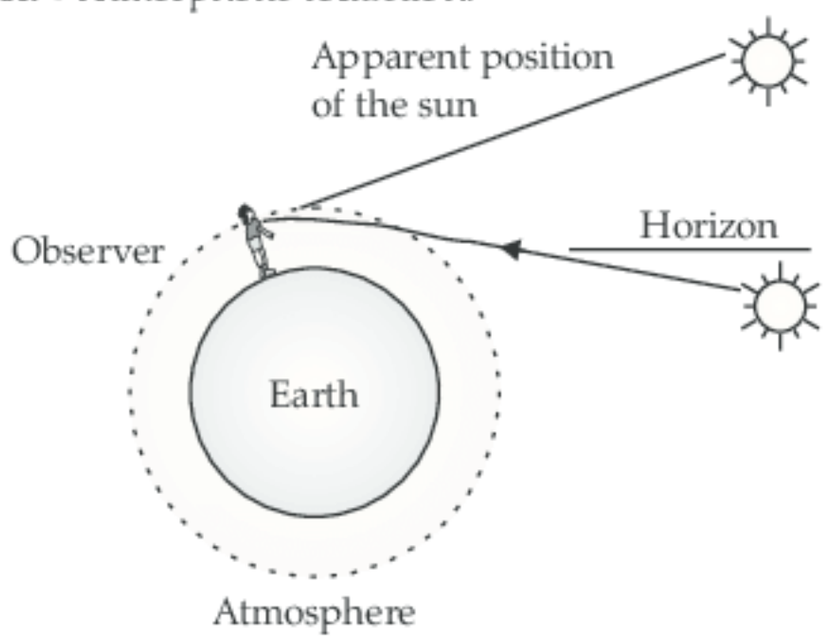
Ans. The angle between the extended incident ray and the emergent ray is called the angle of deviation.

This is because the different colours travel through a glass prism at different speeds. 1+1+1



U Q. 5. **Name the phenomenon responsible for the early sunrise and delayed sunset. Explain with the help of a diagram the reason why the sun is visible to us about 2 minutes before the actual sun-rise and about 2 minutes after the actual sunset. [OD Comptt. 31/2 2017]**

Sol. ● Atmospheric refraction. ½



1½

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. **1**

R **Q. 6. Name the phenomenon associated with the following :**

(i) The sky appear blue.

(ii) Formation of a rainbow in the sky.

(iii) Twinkling of stars. [Board Term II, Set B1, 2011]

Ans. (i) (a) Atmospheric refraction

(b) Scattering of light ½

(ii) (a) Dispersion ½

(b) Refraction ½

(c) Total internal reflection ½

(iii) (a) Atmospheric refraction ½

(b) Change in the density of the atmosphere due to temperature and other conditions. ½

A **Q. 7. (i) Define power of a lens and write its SI unit.**

(ii) A convex lens of power 4D is placed at a distance of 40 cm from a wall. At what distance from the lens should a candle be placed so that its image is formed on the wall ? [Board Term II, Set A1, 2011]

Ans. (i) Reciprocal of focal length expressed in metres is called power. SI unit is dioptre. **1**

(ii) $f = \frac{1}{P} = \frac{1}{4D} = \frac{1}{4}\ \text{m} = 25\ \text{cm}$ **1**

$v = 40\ \text{m}$

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

$\frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{-3}{200}$

$\Rightarrow \quad u = \frac{-200}{3}\ \text{cm}$

So candle should be placed 200/3 cm from the lens. **1**

R **Q. 8. State Snell's law of refraction of light. Express it mathematically. Write the relationship between absolute refraction index of a medium and speed of light in vacuum.**

[OD Comptt. 31/1 2017]

Ans. The ratio of sine of angle of incidence to the sin of angle of refraction is a constant, for the light of a given colour and for the given pair of media. **1**

$\frac{\sin i}{\sin r} = \text{constant}$ **1**

$n_m = \frac{\text{Speed of ligh in air/vacuum}}{\text{Speed of light in the medium}} = \frac{c}{v_m}$ **1**

[CBSE Marking Scheme] 2

A **Q. 9. State the difference in colours of the sun observed during sunrise/sunset and noon. Give explanation for each ?**

[Board Term II Delhi Set-I, 2013]

Ans. The sun rays have to travel through a larger atmospheric distance. As $\lambda_b < \lambda_r$, most of the blue light and shorter wavelengths are removed by scattering. Only red colour, which is least scattered is received by our eye and appears to come from sun. Hence the appearance of sun at sunset or sunrise or full noon near the horizon may look reddish. **3**

A **Q. 10. Why does the sun appear reddish early in the morning ? Will this phenomenon be observed by an observer on the moon ? Justify your answer with a reason. [Board Term II, Delhi Set-I, 2016]**

OR

Why does the sun appear reddish early in the morning ? [NCERT]

Ans. Early in the morning, the sun is near the horizon, sunlight reaches us after travelling a longer distance through thick layers of atmosphere. Thus most of the blue light and shorter wavelengths are scattered away by the particles in the atmosphere. The light that reaches us is of longer wavelengths giving a reddish appearance. **2**

This phenomenon will not be observed by an observer on the moon. ½

Because of the absence of atmosphere on the moon. **[CBSE Marking Scheme, 2016]** ½

R **Q. 11. What is meant by advance sunrise and delayed sunset ? Draw a labelled diagram to explain these phenomena.**

[Board Term II, Foreign Set-I, 2015]

Ans. (i) Due to atmospheric refraction, the sun is visible to us about two minutes before the actual sun-rise and about two minutes after the actual sun-set. **1**

(ii) For Diagram See Topic 2, S.A.T.Q.II (16)

[CBSE Marking Scheme, 2015] 2

A **Q. 12. Enlist at least six phenomena observed in nature subsequent to the scattering of light.**

Ans. The various phenomena observed in nature due to scattering of light are the following :

(i) Sun appears red near the horizons (during sunrise and sunset) and white when seen overhead.

(ii) Bluish colour of the sky.

(iii) Visible path of light as it enters a dark room.

(iv) Danger signals or stop signals are usually red.

(v) Blueness of distant mountains.

(vi) Sunlight filtering through clouds. ½ × 6 = 3

A **Q. 13. Explain in brief the reason for each of the following :**

(i) The sun appears reddish during sun-rise.

(ii) At noon the sun appears white.

(iii) To an astronaut the sky appears dark instead of blue. [Board Term II, Foreign Set-III, 2016]

Ans. (i) During morning, sun rays travel large distances in the earth's atmosphere, and in this process the shorter wavelengths scatter away and only large wave length (red light) reaches us. **1**

(ii) At noon, sun is overhead and light rays travel comparatively smaller distance and only little of blue / violet light scatter, so sun appears white. **1**

(iii) No atmosphere in outer space for scattering, so sky appears dark. **1**

[CBSE Marking Scheme, 2016]

A **Q. 14. (i) "Stars seem higher than they actually are"**

(ii) "The sky appears dark to passengers flying at very high altitudes"

Justify these statements with reason.

[Board Term II, Set 8XSVHLC, 2014]

Ans. (i) Light coming from the stars are supposed to travel in a straight line. But the refractive index of air is not same throughout. It changes as hot air is rarer than cold air. So refraction takes place. In this case, starlight continuously travels from a rarer medium to a denser medium. Hence, it continuously bends towards the normal. **1½**
The continuous bending of starlight towards the normal results in a rise of the apparent position of the star.

(ii) Scattering of light take place because of the particles present in atmosphere. At high altitude due to absence of atmosphere scattering of light do not take place and hence sky appears dark to passengers flying at high altitude. **1½**

[CBSE Marking Scheme, 2014]

U **Q. 15. Describe an activity to show that the colours of white light splitted by a glass prism can be recombined to get white light by another identical glass-prism. Also draw ray diagram to show the recombination of the spectrum of white light.** **[Board Term II O.D. Set-I, 2016]**

Ans. Description of activity : When a glass prism is used to obtain a spectrum of sunlight, a second identical prism in an inverted position with respect to the first position will allow all the colours of spectrum to recombine. Thus a beam of white light will emerge from the other side of the second prism. **1½**

For Diagram See Topic 2, S.A.T.Q.II (1). **[CBSE Marking Scheme, 2016]** **1½**

OR

[Topper Answer, 2016]

A **Q. 16. Explain in brief the reason for each of the following : [Board Term II Foreign Set-I, 2016]**

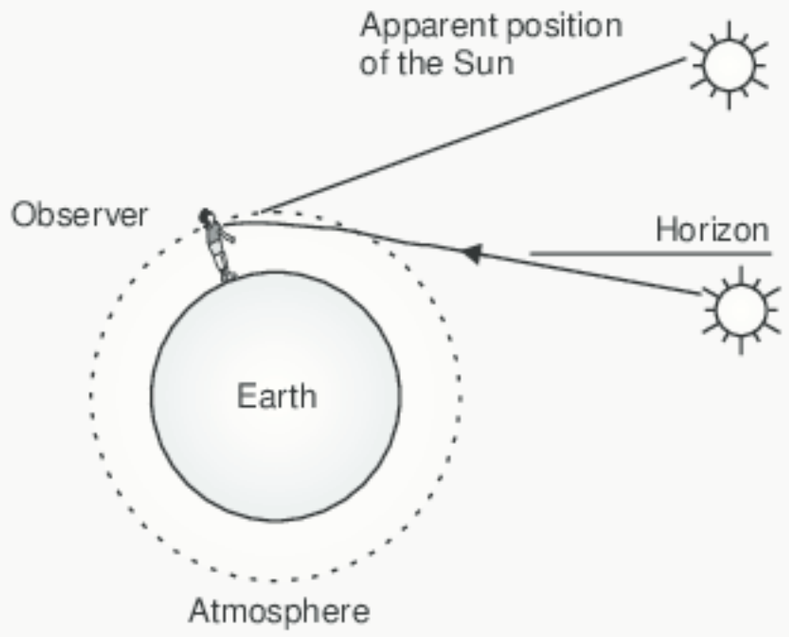
(i) Advanced sun-rise

(ii) Delayed sun-set

(iii) Twinkling of stars

Ans. (i) Advanced sun-rise : When the sun is slightly below the horizon, light rays coming from the sun travel from the rarer to denser medium layers of air because of atmospheric refraction of light, light appears to come from a higher position above the horizon. Thus the sun appear earlier than actual sun rise. **1**

(ii) Delayed sun-set: Same reason as similar refraction occurs at the sunset. **1**



(iii) Twinkling of stars : The light coming from the stars gets refracted several times before reaching the observers eye. Due to change in physical condition of the atmosphere the light sometimes reaches the observer and sometimes it doesn't, hence they appear to twinkle. **1**

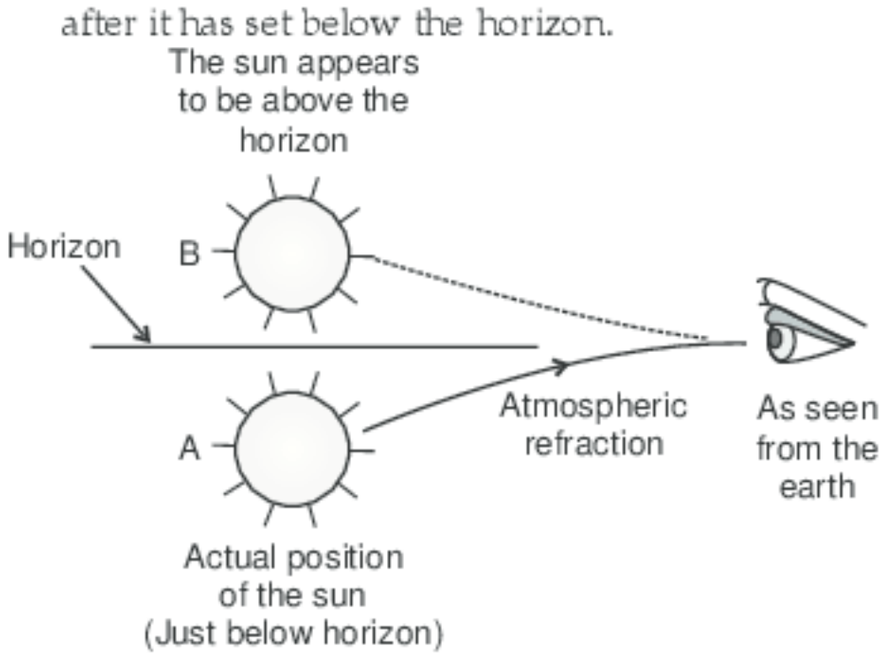
[CBSE Marking Scheme, 2016]

A **Q. 17. Why does the sun seem to rise two minutes before the actual sunrise and set two minutes after the actual sunset ? Explain with the help of labelled diagram.**

[Board Term II, Delhi Set-II, 2014]

Ans. The Sun is visible to us two minutes before the sunrise and two minutes after the sunset because of the bending of the light due to atmospheric refraction. The actual sunrise takes place when the Sun is just above the horizon. But due to atmospheric refraction of light, we see the Sun about two minutes before it is actually above the horizon.

When the Sun is slightly below the horizon, its light moves from less dense air to more dense air and gets refracted towards the normal. Because of this atmospheric refraction, the Sun appears to be above the horizon when it is actually slightly below the horizon. It is also due to atmospheric refraction that we can still see the Sun for about two minutes even after it has set below the horizon. **2**



1

A **Q. 18. Explain giving reason why the sky appears blue to an observer from the surface of the earth ? What will the colour of the sky be for an astronaut staying in the international space station orbiting the earth ? Justify your answer giving reason.**

[Board Term II, Delhi Set-I, 2014]

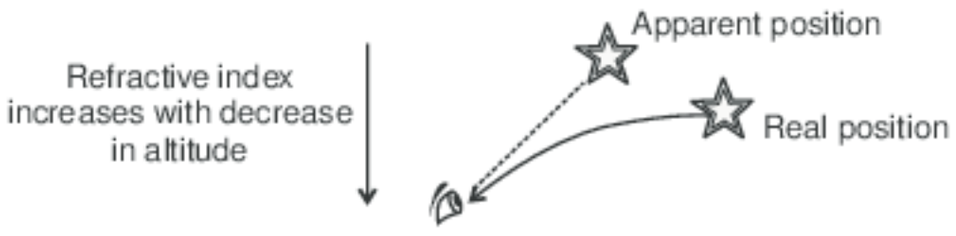
Ans. Sunlight reaches the Earth's atmosphere and is scattered in all directions by the gases and particles in the air. Blue light is scattered more than the other colours because it has the shortest wavelength. This is why the sky appears blue to an observer from the surface of the Earth.

For an astronaut staying in the international space station orbiting the Earth, the colour of the sky will be black because the light reaching it does not scatter. **3**

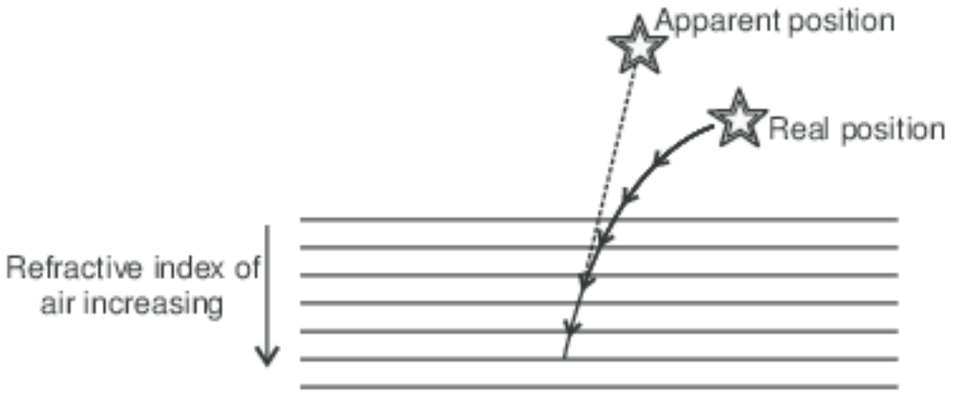
A **Q. 19. Explain with the help of labelled diagram, the cause of twinkling of stars.**

[Board Term II, Delhi Set-II, 2014]

Ans. Light coming from the stars undergoes refraction on entering the Earth's atmosphere. This refraction continues until it reaches the Earth's surface. This happens because of uneven heating of atmospheric air. Hence, the atmospheric air has changing refractive index at various altitudes. In this case, starlight continuously travels from a rarer medium to a denser medium. Hence, it continuously bends towards the normal.



The refractive index of air medium gradually increases with a decrease in altitude. The continuous bending of starlight towards the normal results in a slight rise of the apparent position of the star.



Since the physical conditions of the Earth's atmosphere keeps changing, the apparent position of the star is not stationary. The star changes its position continuously, which makes it twinkle. This happens because starlight travels a very large distance before reaching the observer. However, the path varies continuously because of uneven atmospheric conditions. Hence, the stars seem to be fluctuating, sometimes appearing brighter and sometimes fainter. All this together, gives rise to the twinkling effect of stars. **3**

A **Q. 20. A beam of white light falling on a glass prism gets split up into seven colours. A student makes the statement :**

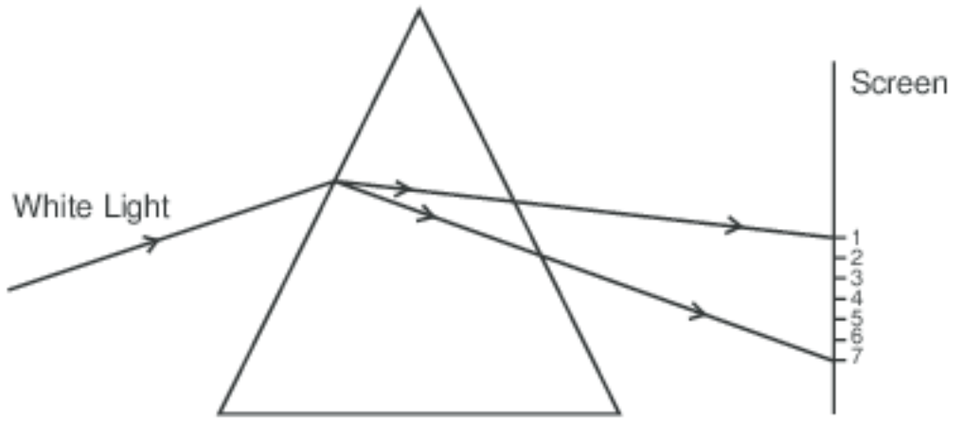
(i) The colour at positions marked 1 and 3 are similar to the colour of 'turmeric' and the colour of 'Chilly powder', respectively. Is the above statement correct or incorrect ? Justify.

(ii) Which two positions correspond to the colour of solution of copper sulphate and signal used to move the vehicles ?

(iii) Light of colour of chilly powder bends the most while the light of colour of brinjal bends the least. Is the statement correct ? Justify.

[Board Term II, Set 8XSVHLC, 2014]

[Board Term II, Set A1, 2011]



Ans. (i) Incorrect

3- turmeric (yellow) ½+½

1- chilli powder (red)

(ii) Copper sulphate—blue colour—position—5

Green—position—4 ½+½

(iii) Incorrect, violet bends the most. ½+½

R **Q. 21. What is Tyndall effect ? Give at least two examples illustrating Tyndall effect.**

Ans. The phenomenon of scattering of white light by colloidal particles is known as Tyndall effect. **1**

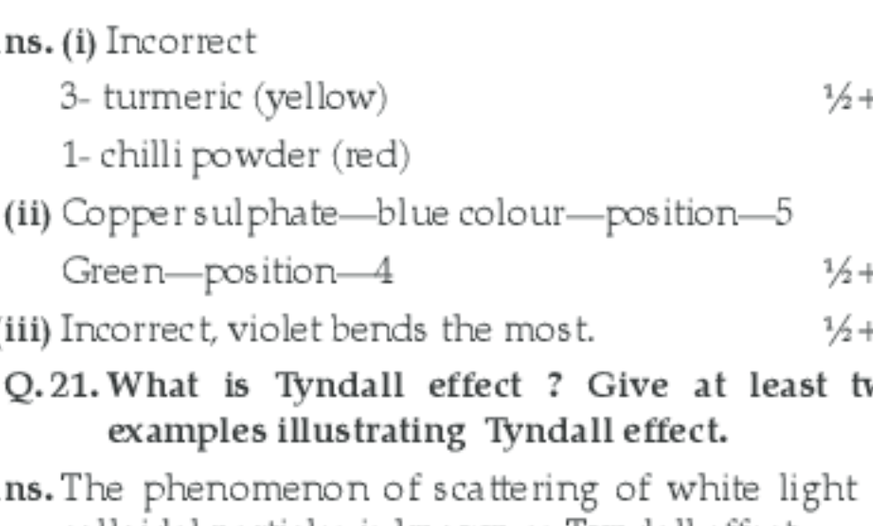
Examples :

(i) A fine beam of sunlight entering a smoke filled room through a hole. Smoke particles scatter the white light and hence the path of light beam becomes visible. **1**

(ii) **(a)** Sunlight passing through the trees of forest.

(b) Tiny water droplets in mist scattering white light. **1**

U **Q. 22. A narrow beam PQ of white light is passing through a glass prism ABC as shown in the diagram.**



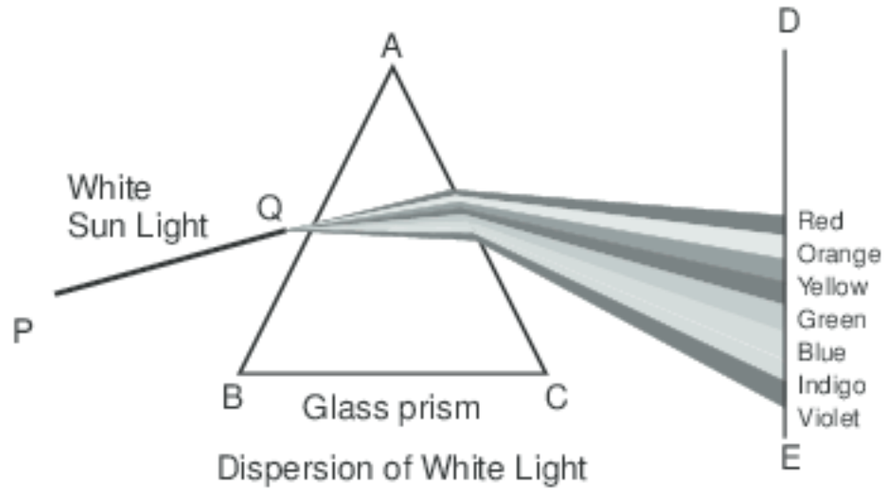
Trace it on your answer sheet and show the path of the emergent beam as observed on the screen DE.

(i) **Write the name and cause of the phenomenon observed.**

(ii) **Where else in nature is this phenomenon observed?**

(iii) **Based on this observation, state the conclusion which can be drawn about the constituents of white light.** [Board Term II, Outside Delhi Set-I, III, Foreign Set-I, 2014]

Ans.



Dispersion of White Light

(i) The phenomenon of the splitting up of the white light into its constituent colours is called dispersion of light.

Dispersion of light is caused because different constituent colours of light offer different refractive indexes to the material of the prism.

(ii) The formation of rainbow is caused by the dispersion of the white sunlight into its constituent colours.

(iii) Based on the dispersion of white light into its constituent colours, we can conclude that–

(a) the white light consists of seven colours.

(b) the violet light suffers maximum deviation and the red light suffers minimum deviation. **1+½+½+1**

A **Q. 23. A person is unable to see objects nearer than 50 cm. He wants to read a book placed at a distance of 25 cm. Find the nature, focal length and power of the lens he requires for his spectacles.**

[Board Term II, Set-8XSVHLC, 2014]

Ans. This person has defect of Hypermetropia which is far sightedness that means the image is formed beyond the retina so it requires a convergent lens to get focused at retina.

Now corrective measure is

$u = -25$ cm

$v = -50$ cm

$1/f = 1/v - 1/u$

$1/f = 1/-50 - 1/-25$

$= -1 + 2/50 = 1/50$

$f = 50$ cm

$p = 1/f$

$p = 100/50 = 2$ D

Focal length = 50 cm,

Power = 2 D **3**

[CBSE Marking Scheme, 2014]

Long Answer Type Questions

(5 marks each)

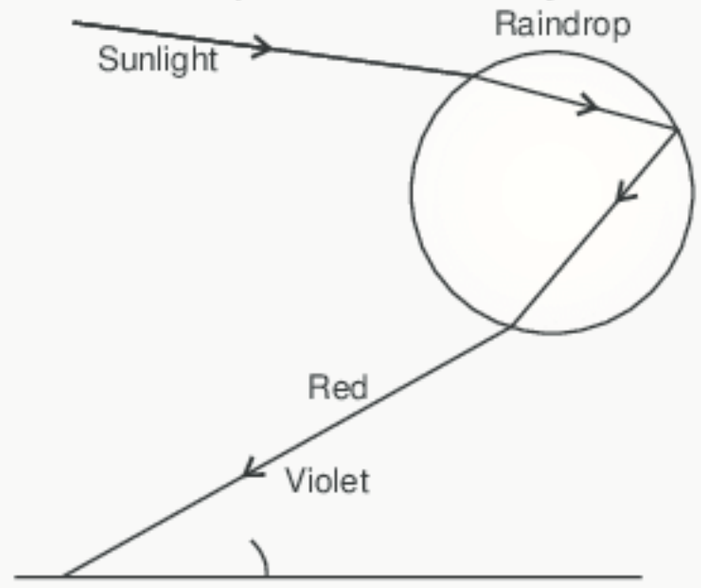
A Q. 1. (i) What is dispersion of white light ? State its cause.

(ii) "Rainbow is an example of dispersion of sunlight." Justify this statement by explaining, with the help of a labelled diagram, the formation of a rainbow in the sky. List two essential conditions for observing a rainbow. [Board Term II Foreign-I, 2016]

Ans. (i) **Definition of Dispersion :** Splitting of white light into seven constituent colours by a prism. 1

Cause of dispersion : When white light passes through a glass prism, different constituent colours bend through different angles with respect to the incident ray and hence are separated. 1

(ii)



2

Conditions for observing a rainbow :

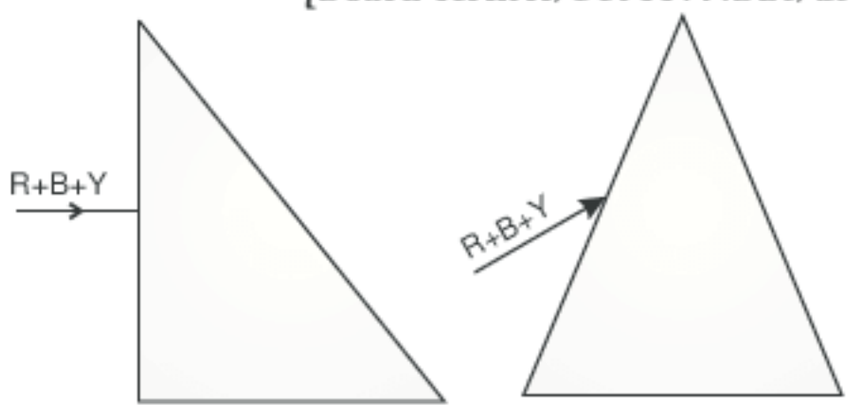
(a) after the rainfall/ at a water fountain.

(b) sun is at the back of the observer. ½ + ½

[CBSE Marking Scheme, 2016]

U Q. 2. (i) Define dispersion of light. How is scattering of light different from dispersion ? Give one example of natural phenomenon based on each of these.

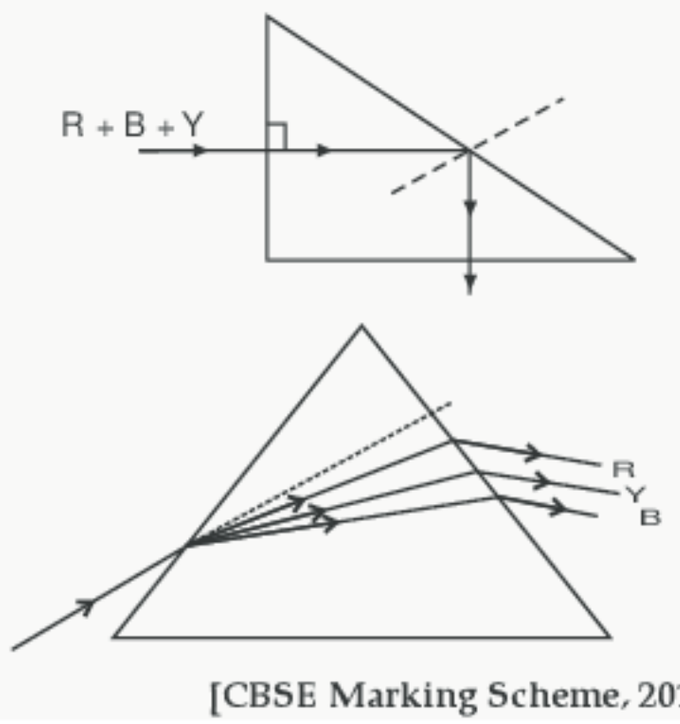
(ii) A beam of light consisting of red, blue and yellow is incident on the prisms as shown below. Complete the diagram to show refracted and emergent ray. [Board Term II, Set-FF7NBE6, 2015]



Ans. (i) Breaking up of the component colours of light is called dispersion. Dispersion is caused due to difference in velocity of each colour through a medium. Scattering of light takes place due to interaction of light and particles suspended in a medium. Rainbow–dispersion.

Blue colour of sky, red colour of sky at sunrise or or sunset–scattering. **(Any one example)** 3

(ii)



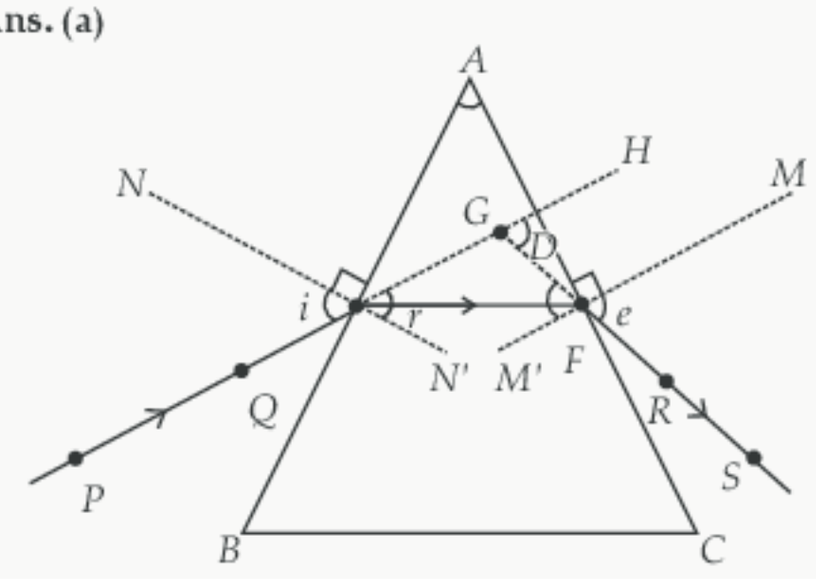
[CBSE Marking Scheme, 2015] 1 + 1

U Q. 3. (a) Draw a ray diagram to explain the term angle of deviation.

(b) Why do the component colour of incident white light split into a spectrum while passing through a glass prism, explain.

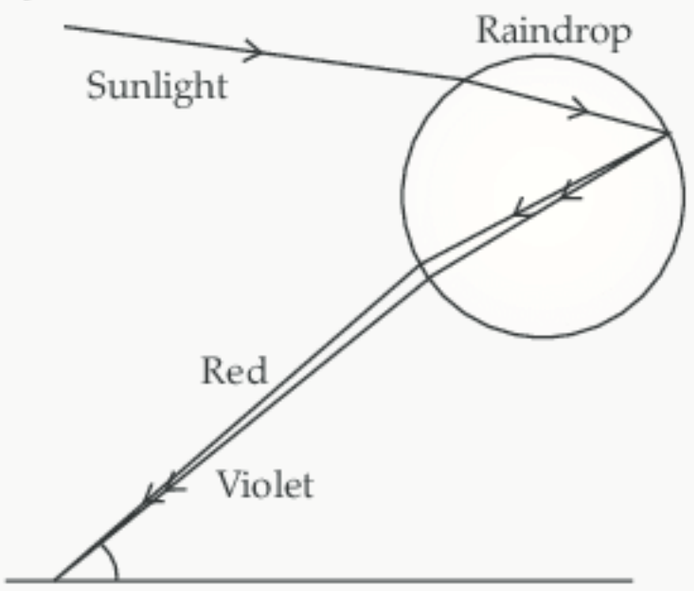
(c) Draw a labelled ray diagram to show the formation of a rainbow. [Delhi 31/1/1 2017]

Ans. (a)



(b) Different colour of white light bend through different angles with respect to the incident light, as they pass through the glass prism. Thus, each colour emerges along a different path, forming a spectrum. 1

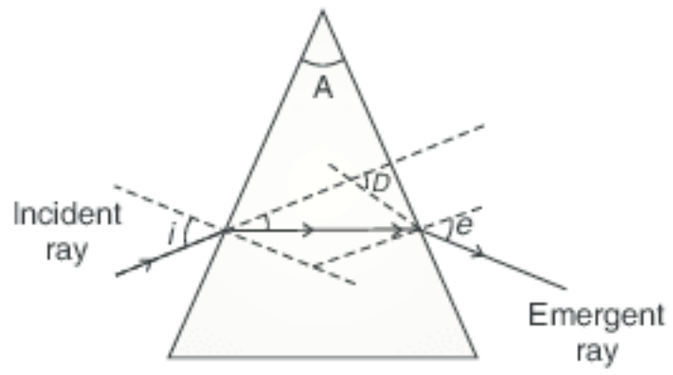
(c)



[CBSE Marking Scheme, 2017]

Detailed Answer :

(i) Emergent ray bends at an angle to the direction of the incident ray and the angle between them is known as angle of deviation.



(ii) When a beam of light enters a prism, it gets refracted and splits into its seven constituent colours. This splitting of the light ray occurs because of the different angles of bending of each colour. Hence, each colour passing through the prism bends at different angles with the respect to the incident beam. This gives rise to the formation of the colour spectrum.

(ii)

Diagram to show the formation of rainbow in the sky.

R Q. 4. (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 corrective lens used to restore proper vision and how hi 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 lens as per the new Cartesian sign convention. [OD 31/1 2017]

Ans.

[Topper Answer, 2016]

Detailed Answer :

(a) (i) The student is unable to see distinctly the objects placed beyond 5 m from his eyes as he is suffering from myopia i.e., near-sightedness wherein a person can see near by objects clearly but cannot see distant objects distinctly.

(ii) Concave lens can be used as the corrective lens to restore proper vision. A concave lens of suitable power will bring the image back on to the retina and thus the defect is corrected. 2

(b) $u = -\infty$, $v = -5m$

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

$$= \frac{1}{-5} - \frac{1}{-\infty}$$

$$= \frac{1}{-5} - 0$$

$$f = -5m$$

$$p = \frac{1}{f} = \frac{1}{-5} = 0{\cdot}2D$$ 3

A Q. 5. **What is atmospheric refraction ? Use this phenomenon to explain the following natural events.**

[Board Term II O.D. Set-I, 2016]

(i) Twinkling of stars.

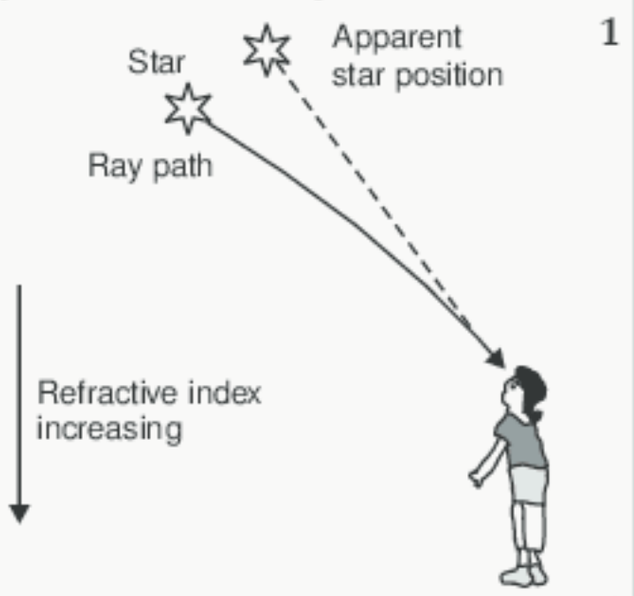
(ii) Advanced sun-rise and delayed sun-set.

Draw diagrams to illustrate your answers.

Ans. Atmospheric refraction : Refraction of light caused by the earth's atmosphere due to change in the refractive indices of different layers. 1

(i) Twinkling of stars : Stars are distant point sized source of light. The path of the rays of light coming from the star goes on varying due to atmospheric refraction slightly. Thus apparent position of the stars fluctuates and the amount of star light entering the eye flickers giving the twinkling effect. 1

(ii) Advanced sun-rise : When the sun is slightly below the horizon, light rays coming from the sun travel from the rarer to denser layers of air. Because of atmospheric refraction of light, light appears to come from a higher position above the horizon. Thus sun appears earlier than actual sunrise. 1



Delayed sunset : Same reason as similar refraction occurs at the sunset. 1

For Diagram See Topic 2, S.A.T.Q.II (5) **[CBSE Marking Scheme, 2016]** 1

OR

[Topper Answer, 2016]

U **Q. 6. (a) Describe an activity along with a labelled diagram the phenomenon of dispersion through a prism.**

(b) Explain in brief the formation of rainbow with the help of figure. [Board Term II, Foreign Set-III, 2014 Set 8XSVHLC, QNA4XWT]

Ans. (a) Place a prism on a white sheet of paper with the triangular face on the sheet and trace its boundary ABC.

(i) Fix two pins T and S on one side.

(ii) Place the prism on the boundary ABC.

(iii) Looking through the other side fix two more pins Q and R in such a way that the all four pins appear to be in the same line.

(iv) Remove the pins and mark their positions.

(v) Join TS and RQ and extend them to meet the faces of the prism at P and O respectively.

(vi) Join PO.

(vii) TP represents the incident ray.

(viii) PO represents the refracted ray.

(ix) And OR represents the emergent ray which is bent towards the base.

(x) Let PN and ON be the normal at the points P and O respectively.

(xi) And let i be the angle of incidence and r the angle of refraction.

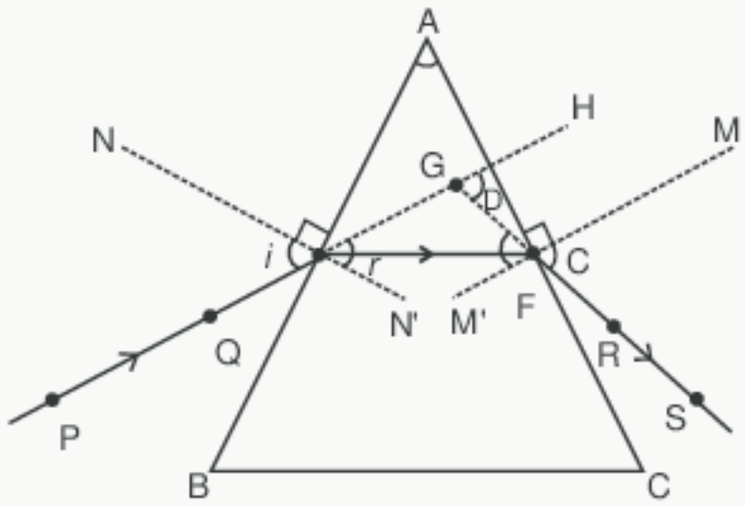
(xii) If the incident ray TP is extended forward and the emergent ray RO backwards, they meet at M, forming the angle OML.

(xiii) Measure the angle OML.

(xiv) This angle is called the angle of deviation.

(xv) Angle of deviation is the angle through which an incident ray deviates.

(xvi) Repeat this for different values of angle of incidence.

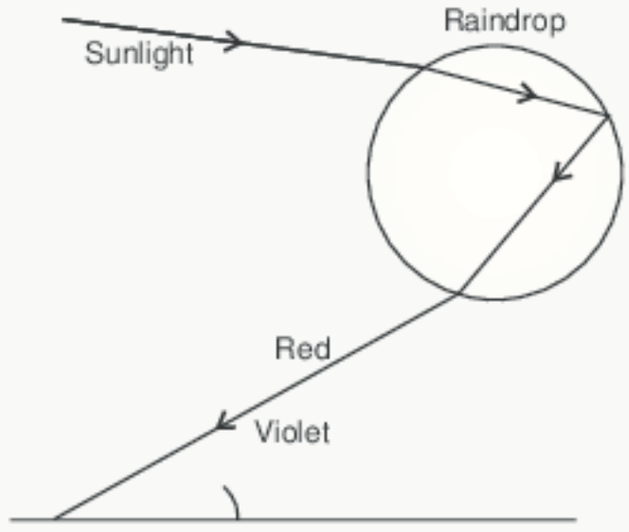


PE – Incident ray ∠ i – Angle of incidence
EF – Refracted ray ∠ r – Angle of refraction
FS – Emergent ray ∠e – Angle of emergence
∠A – Angle of the prism ∠ D – Angle of deviation

3

(b) Rainbow forms when sunlight hits the water droplets suspended in the atmosphere and undergoes total internal reflection. When the sunlight comes out of the drop it disperses, where the drop acts like a small prism.

This dispersion or breaking up of light into several colours forms the Rainbow.



[CBSE Marking Scheme, 2014] 2

R **Q. 7. (i) A person's image when seen through a stream of hot air arising above a fire disperse to waver. Explain.**

(ii) Define dispersion. How does a prism disperse white light ? [Board Term II, Foreign Set-I, 2014]

(iii) Which colour of light bends the most and the least?

Ans. (i) In the region above the fire, the hot air is lighter than the cool air above it. Further the refractive index of hotter region is less than the cooler region and it is not static. **1**

These physical conditions are not steady. Subsequently the image when seen through the hot region is not stationary. The apparent position of the object fluctuates. This gives the wavering effect to the image. **1**

(ii) The phenomenon of obtaining a spectrum of colours by passing white light through the prism is known as dispersion. ½

Dispersion occurs because the refraction of different colours travel with different speeds in a refracting medium. Speed of violet colour is least and that of the red colour is the most. Hence the refractive index of the medium is largest for violet colour and least for the red colour. **1**

(iii) As a result, the refraction or bending of violet colour is the maximum and that of red colour is minimum. This difference in the extent of bending of different colour of light causes dispersion of white light into its constituent colours as they emerge out of prism. Red colour bends the least and violet bends the most. **1½**

U **Q. 8. (a) Write an activity for observing scattering of light in colloidal solution.**

(b) On the basis of this activity explain why sky appears red at sunrise or sunset.

[Board Term II, Set GFUB86, 2015]

Ans. (a) (i) Place a strong source of white light at the focus of converging lens.

(ii) Allow the light beam to pass through a transparent glass tank containing clear water. In that clear water dissolve 200g of sodium thiosulphate in about 2 L of clean water in the tank and add 1 to 2 mL of conc. H_2SO_4 acid.

(iii) Allow the beam of light to pass through a circular hole made in a cardboard. Obtain a sharp image of circular hole on screen by using converging lens. **3**

(b) At sunrise or sunset light travels long distance through thick layers of atmosphere. Blue and other lower wavelength get scattered and only red light reaches earth. **2**

[CBSE Marking Scheme, 2015]

High Order Thinking Skills (HOTS) Questions

Q. 1. A person with myopic eye cannot see object beyond 1.2 m distinctly. What should be the type of the corrective lens used to restore proper vision ? 3

Ans. The far point for myopic eye is 1.2 m

$\therefore$ $u = -\infty, v = -1.2$ m

Using lens formula

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

We get $$P = \frac{1}{-1.2} - \frac{1}{\infty} = 0.83 \text{ D}$$ **3**

Q. 2. Why is a normal eye not able to see clearly the objects placed close than 25 cm ? [NCERT] 3

Ans. Focal length of the eye lens cannot be reduced below a certain limit.

If an object is placed very close to the eye lens less than 25 cm, the ciliary muscles cannot contract further to make eye lens more thick. So, eye lens become unable to form sharp image on the retina. Therefore, we cannot see an object clearly if it is placed very close to the eye *i.e.* less than 25 cm. **3**

Q. 3. Why is a concave lens used to correct myopia or short- sightedness ? **3**

Ans. A concave lens of suitable focal length diverges the parallel rays from the distant objects as if they are coming from the far point F of the myopic eye. This helps the eye lens to form a clear image at the retina. **3**

Q. 4. A hypermetropic person prefers to remove his spectacles, while driving. Give reason. **3**

Ans. When a hypermetropic person wearing the spectacles looks at a distant object, the parallel rays from the distant object get converged in front of the retina. The image appears blurred, in order to avoid this, the person prefers to remove his spectacles. **3**

Q. 5. Explain why ?

(i) Myopic person prefer to remove his spectacles while reading a book. **3**

(ii) A hypermetropic person prefer to remove the spectacles while looking at the sky? **2**

Ans. (i) Myopic person does not need spectacles while reading a book as he has the near point at 25 cm.

If such person reads the book with corrective lens (concave) he will have to keep the book at distance greater than 25 cm so that the image of book will be formed by the concave lens at 25 cm and moreover, the size of the book that appear to him is also smaller. Therefore, the person prefer to remove his spectacles while reading a book. **3**

(ii) Hypermetropic person does not need spectacles to see distant objects as he has the far point at infinity.

If such person uses spectacles (convex lens) to see the distant objects, the image will be formed, before retina due to increase in converging power and hence the person cannot see distant object distinctly. Therefore such persons prefers to remove spectacles while looking at the sky. **1 + 1**

Q. 6. How does the colour of the scattered light depend on the size of the colloidal particles ? **3**

Ans. The colour of the scattered light depends on the size of the scattering particles. Very fine particles having size less than the wavelength of visible light mainly scatter blue light of shorter wavelength of the visible spectrum. The particles of relatively larger size scatter light of longer wavelengths. The large particles such as raindrops, dust and ice particles scatter white light. **3**

Q. 7. Dispersion is caused by refraction not by reflection. Why ? **3**

Ans. The reason is that for a given angle of incidence, the angle of reflection is same for all the wavelengths of white light while the angle of refraction is different for different wavelengths. **3**

Q. 8. What is Tyndall effect ? What is its causes ? Name two phenomena observed in daily life which are based on Tyndall effect. **5**

Ans. Tyndall effect : When a beam of light is passed through a colloidal solution, placed in a dark room, the path of beam becomes illuminated when observed through a microscope placed perpendicular to the path of light. This effect is called Tyndall effect. **1½**

Cause of Tyndall effect : The size of the colloidal particle is relatively larger than the solute particle of a true solution. The colloidal particles first absorb energy from the incident light and then scatter a part of this energy from their surfaces. Thus, Tyndall effect is due to scattering of light by the colloidal particles and the colloidal particles are seen to be moving as points of light moving against a dark background. **1½**

Some daily phenomena based on Tyndall effect are as follows :

(i) When a fine beam of sunlight enters a smoke filled room through a small hole, the smoke particles become visible due to the scattering of light. **1**

(ii) When sunlight passes through a canopy of a dense forest, the tiny water droplets in the mist scatter light and become visible. **1**

Q. 9. What will be the colour of sky in the absence of atmosphere ? **3**

Ans. In the absence of atmosphere, there will be no scattering of sunlight and the sky will appear dark. This is what astronauts actually observe at heights at 20 km above the earth where the atmosphere becomes thin. **3**

Value Based Questions

Q. 1. Varun instead of copying from the black board use to copy regularly from the note book of his friends, Sudhir with whom he sat on the same desk. Sudhir told the teacher about it. The teacher asked Varun to check his eyes by a doctor and explained to whole class the reason why Varun copied from Sudhir's notebook.

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

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

(iii) Write the values displayed by Sudhir and his teacher. **[Delhi Comptt. 31/1/1 2017]**

Ans. (i) Suffering from myopia; using spectacles having concave lenses of appropriate focal length. **½, ½**

(ii) Concave lenses. **1**

(iii) Teacher is concerned and knowledgeable (any one) **½**

Sudhir is helpful as well as concerned (any one) ½
(or any other value)

Q. 2. Sania and Shreya are best friends and study in grade 4, Recently, Sania has been facing difficulty in reading the black-board text from the last desk. Shreya wonders why Sania avoids sitting on the last desk. On observation, she found that Sania often carries junk food in her lunch. Shreya has started sharing her lunch-full of green vegetables and fruits with her. Sania is now better and has also started taking a 'balanced diet'.`

[Board Term II SQP, 2012]

(i) Name the eye defect Sania is suffering from ? 1

(ii) What are the two possible deformities related to her eye defect ? 1

(iii) What values are shown by Shreya and Sania ? 1

Ans.

(i) Myopia, short-sightedness. 1

(ii) Lens defect (increased thinness), Eye ball defect (increased) 1

(iii) Friendship, concern for each other, value and balanced diet. 1

Q. 3. Some persons have difficulty to see the objects in dim light during night. This is due to the lack of vitamin A in the diet and improper functioning of rod-shaped cells. The rod-shaped cells respond to intensify variation in light. These days, it is possible to correct the defect of vision by using contact lenses.

(i) Identify the defect of eye. 1

(ii) 'The people with this defect of eye are treated with care and proper diet.' Suggest two reasons. 2

Ans.

(i) Night blindness. 1

(ii) **(a)** Proper diet provide Vitamin A to reduce this defect. 1

(b) Taking care of eyes for proper functioning of rod-shaped cells. 1

Q. 4. The phenomena of change in the direction of propagation of light caused by the large numbers of molecules such as smoke, tiny water droplets, suspended particles of dust and molecules of air present in the earth's atmosphere is called scattering of light. The most beautiful phenomenon of nature such as 'Blue colour of sky', 'White colour of clouds', 'Red hues of sunrise and sunset', can be explained in terms of scattering of light.

(i) On what factors does the colour of scattered light perceived by us depends ? 1

(ii) "The amount of scattering of shorter wavelength is much more than the light of longer wavelength." Justify the statement by giving two reasons behind. 2

Ans. (i) It depends on the size of the particles. 1

(ii) **(a)** Large-sized particles scatter light of longer wavelengths. 1

(b) The amount of scattering is inversely proportional to the fourth power of wavelength. 1

Q. 5. An eye camp was organised by the doctors in a village. They found that the eyes of aged people in the village has receded the near point and the far point also gets reduced. Often the eye of aged people becomes both myopic and hypermetropic. Doctors (Ophthalmologist) provide these people spectacles of bifocal lens to correct the defect. The people were happy and voted many thanks to the doctors.

(i) Name the eye defect from which the people are suffering. 1

(ii) Give any two cause of this defect. 1

(iii) What were the benefits to organise such camps in rural areas ? Give two suggestions. 1

Ans. (i) Presbyopia. 1

(ii) **(a)** Weakening of ciliary muscles.

(b) Reducing ability of the lens to change the curvature. 1

(iii) **(a)** To make people aware of eye diseases.

(b) To tell people to take proper and balanced diet. 1

Q. 6. Four friends went to a picnic. The weather was pleasant. They played various games and then had snacks. Suddenly, Shyam one of them noticed seven colours in the sky. He said to others, "Wow what a rainbow"? The Ram, one of them, asked him "What is Rainbow"? He then explained to all about its formation. After that everyone in the group thanked him for the knowledge, he had given to them.

(i) If you were in the place of Shyam, how you would have explained such a natural phenomenon. 1

(ii) Which device can be used to obtain such a phenomenon. ½

(iii) If Shyam was facing the rainbow, the where was the sun ? ½

(iv) What is the moral value which is shown by Shyam? 1

Ans. (i) Rainbow is formed by the dispersion of Sunlight by the tiny water droplets present in the atmosphere after the rainfall. These water droplets act like a prism. Rays of Sunlight enter the water droplets. At the points of incidence, they refract and disperse, then gets reflected internally and finally gets refracted again at the point of emergence. Thus, the different colours of this spectrum called rainbow reach the observer's eye. 1

(ii) Prism. ½

(iii) The Sun was behind Shyam. ½

(iv) Knowledge increases by sharing, friendship, love and affection with nature. 1

Q. 7. In a beautiful valley, there was a village. Trains passes from the village, the whistle and the sound of train mixed with the sound of waterfall seemed to be very pleasant to everyone. Children of that village loved to play near the railway track. One very light foggy day, a group children found that a fish plate was missing from the track. Knowing this, all of the villagers became tensed. Aditya, one of the children suddenly put his ear to the line

and tried to know whether a train is coming or not and he knew that a train is coming. He asked his friends to inform the railway cabin crew and he himself put off his red shirt and starting running towards the train, waving his red shirt. Timely, the driver and cabin man got the information and a major accident hadn't taken place.

(a) Name the two physical phenomenon of science used by Aditya. 1

(b) Why did Aditya use a red shirt instead of the other colours ? 1

(c) What moral values were shown by Aditya ? 1

Ans. (a) **(i)** Sound travel through a medium.

(ii) Scattering of light.

(b) The red is least scattered by fog or smoke so it can be seen from a large distance.

(c) **(i)** Proper knowledge and its application

(ii) Concern for each other

(iii) Friendship

(iv) Health Concern **1 + 1 + 1**

Know the Links

- *www.excellup.com*
- *school.aglasem.com*
- *www.jagranjosh.com.articles*
- *cbse-notes.blogspot.com.*

❑❑❑