CHAPTER

11

HUMAN EYE AND THE COLOURFUL WORLD

Syllabus

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

Trend Analysis

List of Concepts	2018	2019		2020	
	OD/D	OD	D	OD	D
Human eye: Structure and Functions	1 Q (5 M)	1 Q (2 M)	1 Q (3 M)		
Eye defects and their correction	1 Q (5 M)	1 Q (5 M)			
Refraction of Light through glass prism, Dispersion of white light, Atmospheric refraction, Scattering of light		1 Q (3 M)		1 Q (3 M) OR 1 Q (3 M)	1 Q (3 M)

TOPIC - 1

Human eye, Defects of vision and corrections

Revision Notes

Human Eye

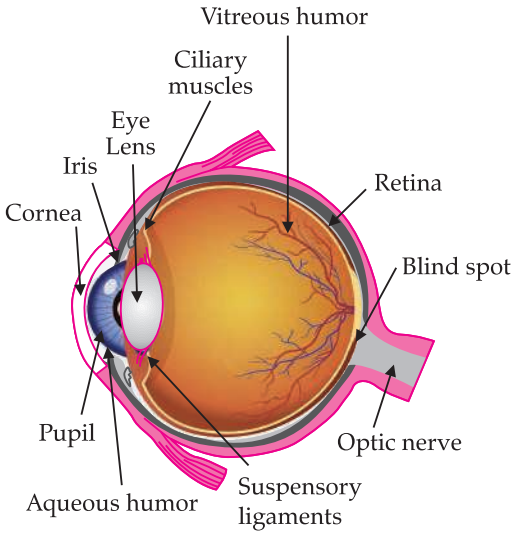
- Eye is a natural optical device using which human could see objects around him. It forms an inverted, real image on a light sensitive surface called retina.
- Rods and cones are the cells in retina, which are light sensitive. Rods respond to the intensity of light. Cones respond to the illumination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

Parts of Human Eye

- **Cornea:** It is the outermost, transparent part. It is responsible for most of the refraction of light.

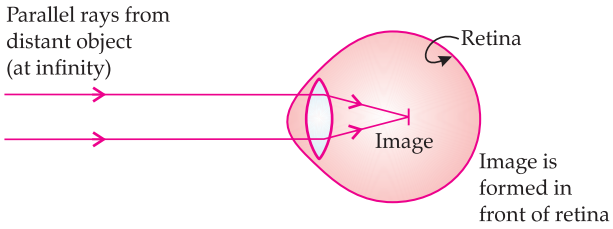
- **Lens:** It is composed of a fibrous, jelly like material. It provides the focused, real and inverted image of the object on the retina. This convex lens converges light at retina.
- **Iris:** It is a dark muscular diaphragm that controls the size of the pupil.
- **Pupil:** It is the window of the 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.
- **Ciliary muscles:** These muscles change the shape and size of the eye lens for focussing.
- **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.
- **Optic Nerve:** The optic nerve sends the electrical impulses from the retina, at the back of the eyes to the brain.
- **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 is 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 the help of ciliary muscles.

Structure of an Human Eye:

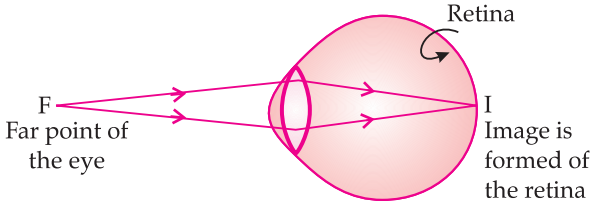


Myopia (Near-sightedness):

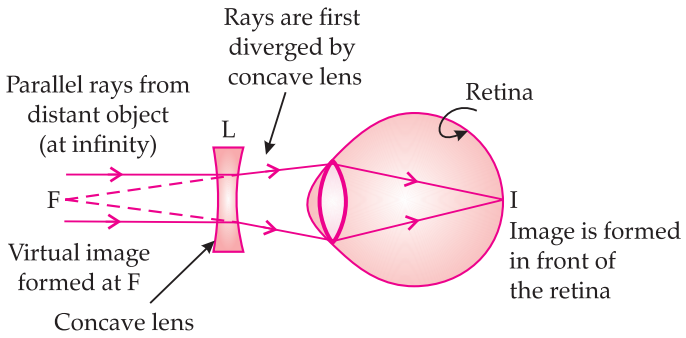
- Distant objects are not clearly visible.



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



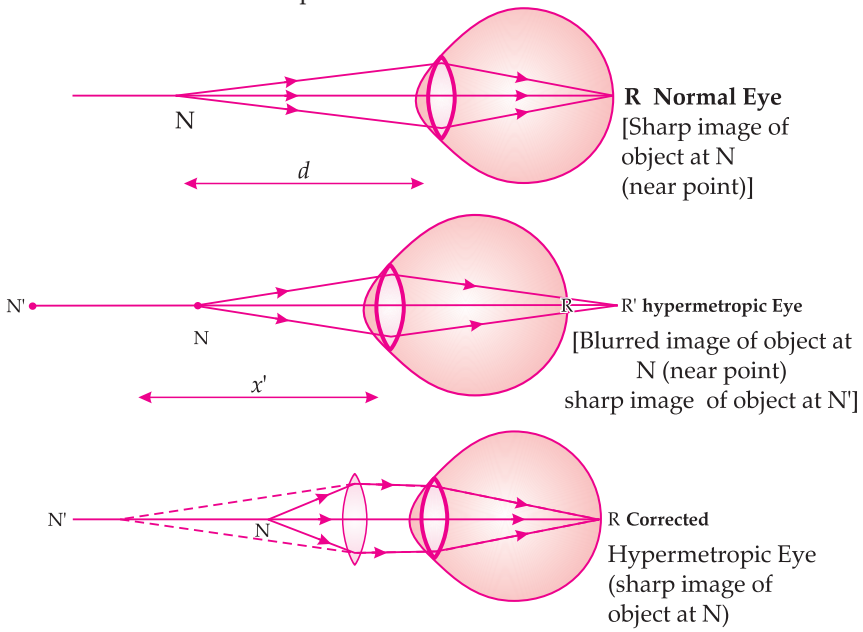
- The far point (F) of a myopic eye is less than infinity.



- **Correction:** 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 from 25 cm.
- Image is formed behind the retina.
- **Correction:** Use of convex lens of suitable power can correct this 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.

Objective Type Questions — 1 mark each

A Multiple Choice Questions

Q. 1. When we enter a dark room coming from outside, immediately the things inside the room do not appear clear to our eyes. This is because

(a) pupils do not open at all in the dark.
(b) pupils take time to adjust.
(c) light travels slower in a dark room.
(d) pupils open very quickly in the dark.

[CBSE SQP, 2019]

Ans. Correct option: (b)

Explanation: When we enter a dark room coming from outside, immediately the things inside the room do not appear clear to our eyes. This is because pupils take time to adjust. **1**

Q. 2. The phenomena of light responsible for the working of the human eye is

(a) reflection
(b) refraction
(c) power of accommodation
(d) persistence of vision **[CBSE SQP, 2019]**

Ans. Correct Option: (b)

Explanation: Refraction is responsible for image formation at retina.

Q. 3. When light rays enter the eye, most of the refraction occurs at the
(a) crystalline lens.
(b) outer surface of the cornea.
(c) iris.
(d) pupil. [NCERT Exemp.]

Ans. Correct option : (b)
Explanation: Light rays reflecting from distant objects are focussed on the retina after they passed through the cornea, aqueous humour, the lens, and finally the vitreous humour. Most of the refraction of light occurs when the difference in the refractive indices of abutting media is the greatest.
A list of Refractive Indices of various components of the human eye:

S. No.	Medium	Refractive Index
(i)	Air	1.000
(ii)	Cornea	1.376
(iii)	Aqueous humour	1.336
(iv)	Lens	1.42
(v)	Vitreous humour	1.336

B Assertions and Reasons Type Questions

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Q. 1. Assertion (A): Eye lens has the ability to focus clearly on the retina by adjusting its focal length.
Reason (R): This phenomenon is known as power of accommodation.

Ans. Correct option : (b)
Explanation: The ability of the eye lens to focus clearly on the retina by adjusting its focal length is known as the power of accommodation. **1**

Q. 2. Assertion (A): A hypermetropic person prefers to remove his spectacles, while driving.
Reason (R): 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 thus appears blurred.

Ans. Correct option : (a)
Explanation: 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. **1**

Q. 3. Assertion (A): Concave lens is used to correct myopia or short- sightedness.
Reason (R): A concave lens of suitable focal length diverges the parallel rays from the distant objects as if they are coming from the far point of the myopic eye. This helps the eye lens to form a clear image at the retina.

Ans. Correct option : (a)
Explanation: A concave lens of suitable focal length diverges the parallel rays from the distant objects as if they are coming from the far point of the myopic eye. This helps the eye lens to form a clear image at the retina. So, a concave lens used to correct myopia or short- sightedness. **1**

Q. 4. Assertion (A): Light from a distant object arriving at the eye lens may get converged at a point in front of the retina.
Reason (R): The eye is producing too much divergence in the incident beam.

Ans. Correct option : (c)
Explanation: The light from a distant object arriving at the eye lens may get converged at a point in front of the retina. This type of defect is called near-sightedness or myopia. This means that the eye is producing too much convergence in the incident beam. **1**

C Very Short Answer Type Questions

Q. 1. State one function of iris in human eye. R [CBSE Set AI, 2012]

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

Q. 2. Name the part of the human eye that helps in changing the focal length of the eye lens. R [CBSE Set A1, 2011]

Ans. Ciliary muscles. **1**

AI **Q. 3. What is the range of vision of a normal human eye ?** R [CBSE Set A1, 2011]

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

Q. 4. What is the function of pupil in human eye ? R [CBSE Set AI, 2011]

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

Q. 5. Name the part of the eye:
(i) Controls the amount of light entering into the eye.
(ii) Forms real, inverted image of the object formed on it. R [CBSE Set A1, 2011]

Ans. (i) Pupil, (ii) Retina. ½+½

AI **Q. 6. What is the nature of the image formed on the retina ?** R

Ans. Real, inverted and diminished in size. **1**

Q. 7. A person is advised to wear spectacles with convex lenses. State the defect of vision he is suffering from. U [CBSE Set B1, 2011]

Ans. The person is suffering from hypermetropia. **1**

COMMONLY MADE ERROR

➲ Students usually get confused between myopia and hypermetropia. They write incorrect answer.

ANSWERING TIP

➲ Understand the concept of myopia and hypermetropia with proper ray diagram.

Short Answer Type Questions-I — 2 marks each

Q. 1. Define the term power of accommodation. Write the modification in the curvature of the eye lens which enables us to see the nearby objects clearly ?
R [CBSE Delhi SET I, 2019]

Ans. • Power of accommodation – Ability of eye lens to adjust its focal length. **1**
• Curvature increases/lens becomes thick. **1**
[CBSE Marking Scheme, 2019]

Q. 2. Write the structure of eye lens and state the role of ciliary muscles in the human eye.
R [CBSE Delhi SET II, 2019]

Ans. Structure: Fibrous, jelly like structure **1**
Role: To change the curvature of eye lens / to change the focal length of eye lens.
[CBSE Marking Scheme, 2019] **1**

Q. 3. The power of a lens is +5 diopters. What is the nature and focal length of this lens? At what distance from this lens should an object be placed so as to get its inverted image of the same size ?
R [Outside Delhi SET II, 2019]

Ans. $P = +5$ D
$f = \frac{1}{P} = \frac{100}{5} = 20$ cm **1**
Nature of lens = convex (converging) ½
Distance is 40 cm (at C)
[CBSE Marking Scheme, 2019] ½

Q. 4. What is meant by power of a lens ? What does its sign (+ve or –ve) indicate ? State its S.I. unit. How is this unit related to focal length of a lens ? [CBSE Delhi Set III, 2016]

Ans. • Ability of lens to converge or diverge the light rays. ½
• +ve sign ⟶ converging lens/ convex lens
−ve sign ⟶ diverging lens/ concave lens ½
• S.I. unit – dioptre ½
1 dioptre = 1/ focal length (m) ½

Short Answer Type Questions-II — 3 marks each

Q. 1. The near point of the eye of a person is 50 cm. Find the nature and power of the corrective lens required by the person to enable him to see clearly the objects placed at 25 cm. from the eye.
A [CBSE Delhi Set – III, 2020]

Ans. Given,
Object distance, $u = -25$ cm
Image distance, $v = -50$ cm
Focal length, $f = ?$
Using lens formula,

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

$$= \frac{1}{-50} - \frac{1}{-25}$$

$$= -\frac{1}{50} + \frac{1}{25}$$

$$= \frac{-1+2}{50} = \frac{1}{50}$$

$\therefore \quad f = 50$ cm.

Power of the lens, $P = \frac{1}{f(\text{in m})} = \frac{100}{f(\text{in cm})}$

$\Rightarrow \quad P = \frac{100}{50} = +2\,D$

Hence, the corrective lens is convex, because power of lens is positive. **3**

Q. 2. (a) A person is suffering from both myopia and hypermetropia
(i) What kind of lenses can correct this defect ?
(ii) How are these lenses prepared ?
(b) A person needs a lens of power + 3D for correcting his near vision and –3D for correcting his distant vision. Calculate the focal lengths of the lenses required to correct these defects.
A [CBSE Outside Delhi Set –I, 2020]

Ans. **(a) (i)** The type of lens required by such person to improve the vision is bifocal lens.
(ii) 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).

(b) $P = \frac{1}{f}$

$P_1 = +3D = \frac{1}{f_1}$

$F_1 = \frac{1}{3}\text{m} = +0.33$ m (Convex lens)

$P_2 = -3D = \frac{1}{f_2}$

$F_2 = -\frac{1}{3} = -0.33$ m (Concave lens)

[1+2=3]

Q. 3. A student needs spectacles of power – 0.5 D for the correction of his vision.
(i) Name the defect in vision the student is suffering from.

(ii) Find the nature and focal length of the corrective lens.

(iii) List two causes of this defect.

A [CBSE Outside Delhi, Set- III, 2019]

Ans. (i) Myopia **1**

(ii) Concave / diverging lens and focal ½

Length = 200 cm ½

(iii) (a) Excessive curvature of the eye lens ½

(b) Elongation of eye ball

[CBSE Marking Scheme, 2019] ½

Detailed Answer:

(i) Negative power shows that lens is concave, so the student is suffering from myopia/near- sightedness.

(ii) The nature of lens used to correct this defect is concave lens.

$$\text{Focal length, } f = \frac{1}{p} = \frac{1}{(-0.5)} = -2 \text{ m}$$

(iii) Causes of defect are:

(a) Excessive curvature of the eye lens.

(b) Elongation of the eyeball.

Q. 4. What is meant by power of a lens ? Write the SI unit. A student uses a lens of focal length 40 cm and another of – 20 cm. Write the nature and power of each lens. A [CBSE Delhi Set I, 2018]

Ans. Power of lens = Ability to converge / diverge light rays passing through it/ reciprocal of the focal length in metres $/\frac{1}{f}$ (in metres).

SI unit of power is Dioptre.

Power of 1st lens $P_1 = \frac{100}{f_1} = \frac{100}{40\,\text{cm}} = +2.5D$ **1**

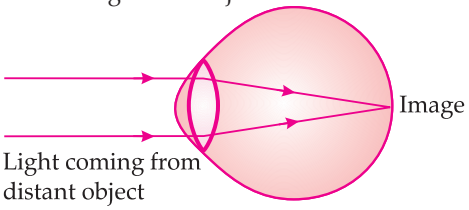
Nature: Converging lens / Convex lens

Power of 2nd lens $P_2 = \frac{100}{f_2} = \frac{100}{-20\,\text{cm}} = -5\,\text{D}$ **1**

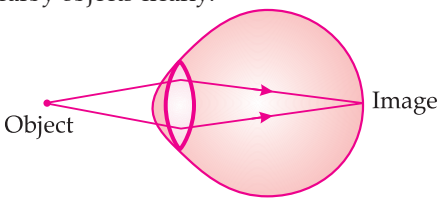
Nature: Diverging lens / Concave lens **1**

Q. 5. 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 distant 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. U [Delhi 31/1/2 2017]

Ans. (a) 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.



(b) 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**

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 lens. R, U [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, 2017] **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).

Q. 7. 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 ? U [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 can not change. Thus, the image distance is equal to distance from the centre of the eye lens to the retina. **1+2**

Long Answer Type Questions — 5 marks each

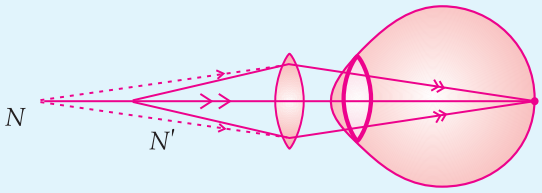
Q. 1. When do we consider a person to be myopic or hypermetropic ? List two causes of hypermetropia. Explain using ray diagrams how the defect associated with hypermetropic eye can be corrected.

R [CBSE Outside Delhi, Set-I, 2019]

Ans. Myopia: Difficult to see the objects placed far away.

Hypermetropia: Difficult to see very close or nearby objects. **1**

Causes of hypermetropia: (i) The focal length of the eye lens is too long (ii) eyeball has become too small. **[½ + ½]**



Note: Diagram with brief description –03 ; only correct diagram with labelling –2 or only explanation 01. [CBSE Marking Scheme, 2019] **3**

Q. 2. (a) Write the function of each of the following parts of human eye: Cornea, iris, crystalline lens, ciliary muscles. R

(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 organized 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 organizing such campaigns.

(ii) List two arguments which you would give to motivate 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. U [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

(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]

Q. 3. (a) A student is unable to see clearly the words written on the black board placed at a distance of approximately 3 m from him. Name the defect of vision the boy is suffering from. State the possible causes of this defect and explain the method of correcting it. R

(b) Why do stars twinkle ? Explain.

AE [CBSE Delhi/O.D., 2018]

Ans. (a) Defect of vision – Myopia or short sightedness or near sightedness

Causes of myopia: (i) Excessive curvature of eye lens becomes more converging

(ii) Elongation of eyeball

Methods of correction: By the use of concave lens of suitable power or focal length the defect is corrected. It can be represented by a suitable diagrammatic representation.

(b) Due to Atmospheric refraction

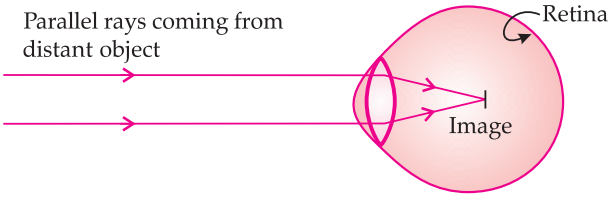
The density of different layers of air keep on changing due to which the apparent images of the stars keep on changing. This changing positions of stars appear as twinkling of stars.

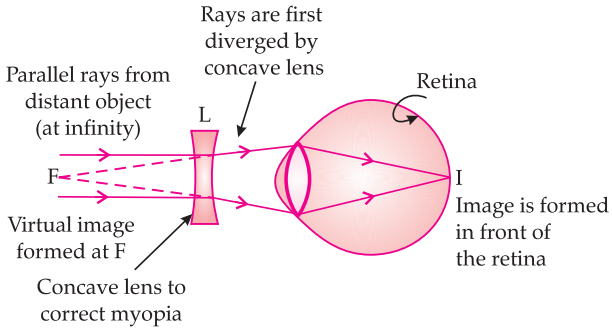
[CBSE Marking Scheme, 2018]

Detailed Answer:

(a) The defect is Myopia or short-sightedness *i.e.*, inability of an eye in viewing long distance objects. This defect is caused by elongation of eyeball and excessive curvature of the lens.

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





(b) Stars are very distant and approximately point-sized sources. Path of star light changes continuously due to gradual change in refractive index of the layers of earth's atmosphere. Thus, the apparent positions

of the stars fluctuate and the amount of star light entering the eye flicker giving the twinkling effect.

3 + 2

COMMONLY MADE ERROR

- Candidates generally get confused while drawing the ray diagram in the defects whether the image has to be drawn before or after retina.

ANSWERING TIP

- Candidates should remember that concave lens is used for correcting Myopia and also draw image before retina when Myopia is the eye defect.

AI **Q. 4. (a) Write the function of each of the following parts of human eye:**
(i) Cornea (ii) Iris
(iii) Crystalline lens (iv) Ciliary muscles

(b) Why does the sun appear reddish early in the morning ? Will this phenomenon be observed by an astronaut on the Moon ? Give reason to justify your answer. U **[CBSE Delhi/O.D., 2018]**

Ans. (a) Function of:

(i) Cornea: focuses light rays / permits the light to enter the eye.

(ii) Iris: Controls amount of light entering the eye and the size of pupil.

(ii) Crystalline Lens: Converges light rays at retina.

(iv) Ciliary Muscles: Adjusts focal length of eye lens by contraction and relaxation so that sharp image can be obtained on the retina. / helps in accommodation

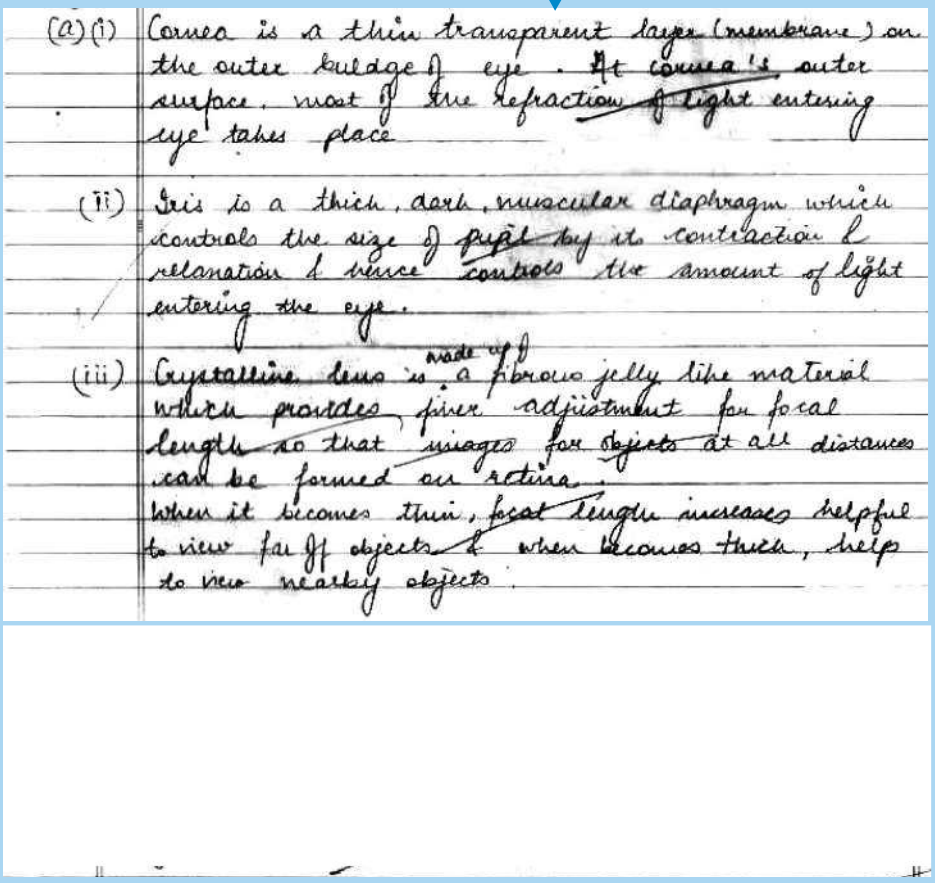
(b) In early morning, sun light has to cover larger distance in the atmosphere. So, the shorter wavelengths scatter out. Only the longer wavelengths like red reach our eye.

On moon – No Cause: Moon has no atmosphere

[CBSE Marking Scheme, 2018] [5]

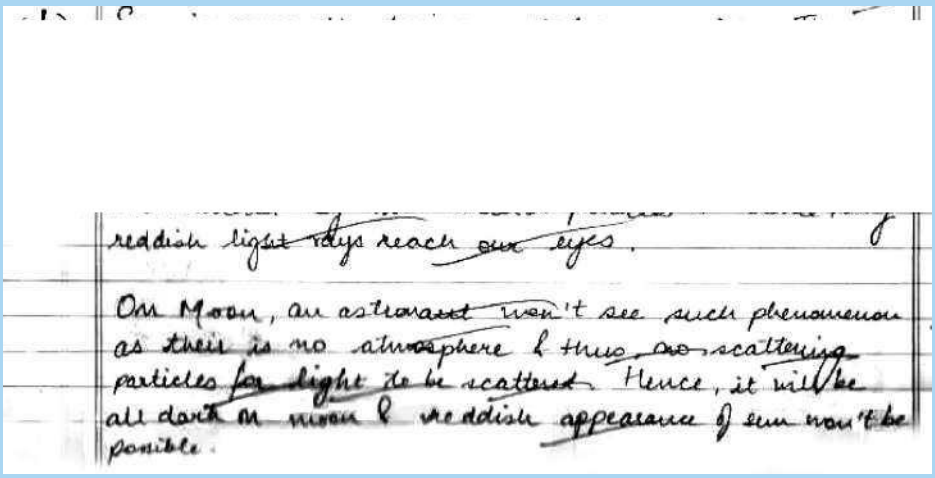
Detailed Answer:

Topper Answer, 2018


(a)(i) Cornea is a thin transparent layer (membrane) on the outer bulge of eye. ~~At cornea's~~ outer surface, most of the refraction ~~of light~~ entering eye takes place

(ii) Iris is a thick, dark, muscular diaphragm which controls the size of ~~pupil~~ by its contraction & relaxation & hence controls the amount of light entering the eye.

(iii) Crystalline lens is made of a fibrous jelly like material which provides finer adjustment for focal length so that images for objects at all distances can be formed on retina.
When it becomes thin, focal length increases helpful to view far off objects & when becomes thick, help to view nearby objects.



Q. 5. (a) What is meant by the term 'power of accommodation' ? Name the component of eye that is responsible for the power of accommodation.

(b) A student sitting at the back bench in a class has difficulty in reading. What could be his defect of vision ? Draw ray diagrams to illustrate the image formation of the blackboard when he sit at the (i) back seat (ii) front seat. State two possible causes of this defect. Explain the method of correcting this defect with the help of a ray diagram. U [SQP- 2018]

Ans. (a) Power of accommodation: It is the ability of the eye lens to adjust its focal length.
Ciliary muscles of eye are responsible for change in its focal length.

(b) Myopia

Causes: (i) Excessive curvature of the eye lens
(ii) Elongation of eyeball

This defect can be corrected by using a concave lens of suitable power.
For ray diagram refer NCERT Page 189 figure 11.2 (a), (b) and (c) [CBSE Marking Scheme, 2018] **[5]**

Detailed Answer:

(a) The ability or the property of the eye lens to adjust its focal length in order to focus both near and distant objects is known as the power of accommodation.

The component of eye that is responsible for the power of accommodation is ciliary muscles because they are responsible for change in its focal length.

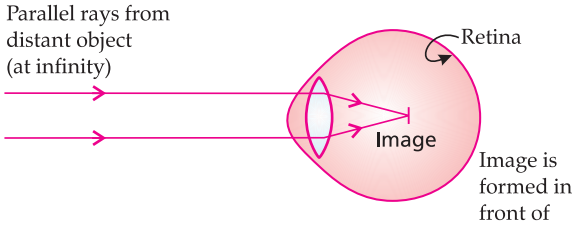
(b) The defect of vision is Myopia:

Causes of Myopia:

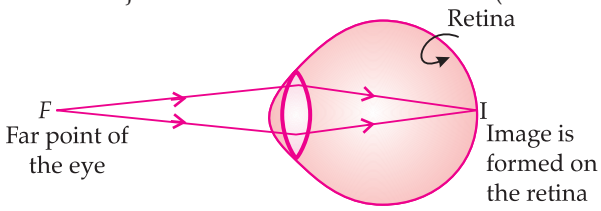
(i) Excessive curvature of the eye lens.

(ii) Elongation of eyeball.

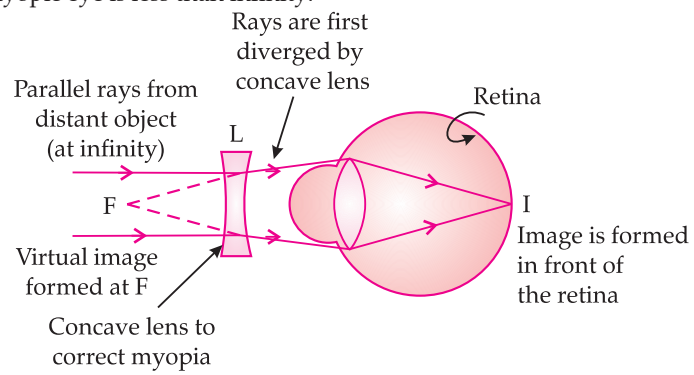
To correct myopia the concave lens placed in front of the eye forms a virtual image of distant object at far point.



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



• The far point of a myopic eye is less than infinity.



Q. 6. (a) A student suffering from myopia is not able to see distinctly the objects placed beyond 5 m. List two possible reasons due to which this defect of vision may have arisen. With the help of ray diagrams, explain;

(i) Why the student is unable to see distinctly the objects placed beyond 5 m from his eyes.

(ii) The type of the corrective lens used to restore proper vision and how this defect is corrected by the use of this lens. U

(b) If, in this case, the numerical value of the focal length of the corrective lens is 5 m, find the power of the lens as per the new Cartesian sign convention. AE [OD 31/1 2017]

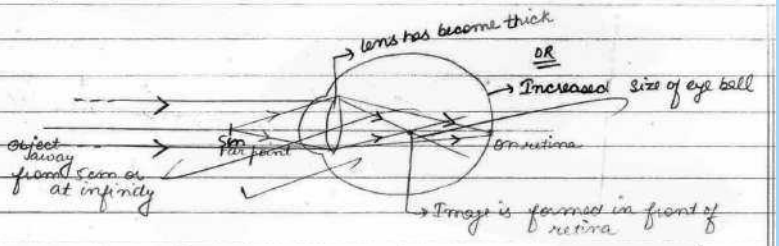
Topper Answer, 2017

Ans.

Ans 24 → (a) causes of myopia →

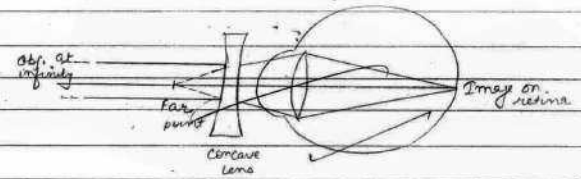
1) Excessive curvature of eye lens.
2) Elongation of eye ball.

(i)



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

(ii)



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

(b) Focal length of concave lens is negative

$\therefore f = -5m$

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

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 where is a person can see nearby 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.

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

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

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

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

$$f = -5 \text{ m}$$

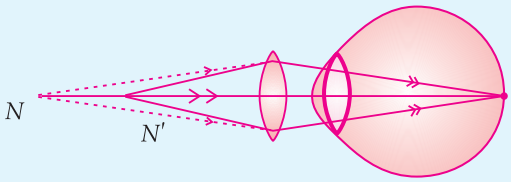
Then, $P = \frac{1}{f} = \frac{1}{-5} = -0.2$ D **5**

Q. 7. 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.

U [Delhi Comptt. 31/1/3 2017]

Sol. • Hypermetropia/ Long-sightedness **1**

• Defective eye

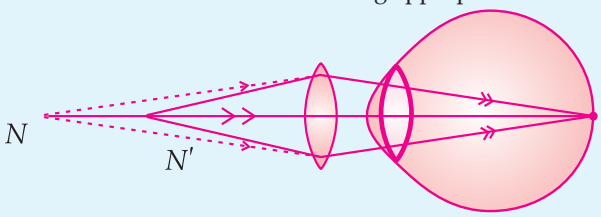


Two causes:

(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, 2017]

Q. 8. (a) What is presbyopia ? State its cause. How is it corrected ?

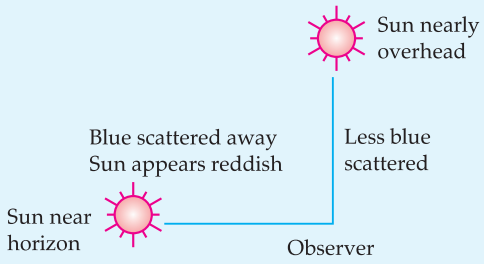
(b) Why does the Sun appear reddish early in the morning ? Explain with the help of a labelled diagram. A [CBSE Delhi Comptt. 31/1, 2018]

Ans. (a) Presbyopia: When a person is unable to see nearby as well as far off objects clearly.

Causes: Gradual weakening of the ciliary muscles/ diminishing flexibility of the eye lens.

Correction: By the use of bi-focal lenses. **1 × 3**

(b) Due to scattering of blue light/light of shorter wavelengths, light of longer wavelengths/ red component of light reaches our eyes. This gives reddish appearance of the sun. **1**



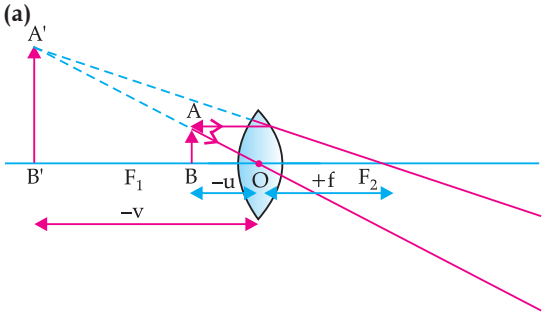
[CBSE Marking Scheme, 2018] **1**

Q. 9. (a) Draw a ray diagram to show the formation of image by a convex lens when an object is placed in front of the lens between its optical centre and principal focus.

(b) In the above ray diagram mark the object-distance (u) and the image-distance (v) with their proper signs (+ve or – ve as per the new Cartesian sign convention) and state how these distances are related to the focal length (f) of the convex lens in this case.

(c) Find the power of a convex lens which forms a real, and inverted image of magnification –1 of an object placed at a distance of 20 cm from its optical centre.

Ans. (a)



1

(b) Relation: $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

(c) $m = -1$; $u = -20$ cm; $v = ?$, $f = ?$

Marking of u & v ½ + ½

$$m = \frac{v}{u} \quad \text{½}$$

$\therefore$ $v = +20$ cm ½

Thus object is at 2F

i.e., $2f = 20$ cm

$\therefore$ $f = 10$ cm $= 0.1$m **1**

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

$$= \frac{1}{0.1} = +10 \text{ D} \quad \textbf{1}$$

TOPIC - 2
Refraction of Light through prism, Dispersion of Light and Scattering of Light

Revision Notes

- The phenomenon of splitting of white light into its constituent colours on passing through a glass prism is called **dispersion of light**.

  Concept Name: Spectrum
- 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 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.

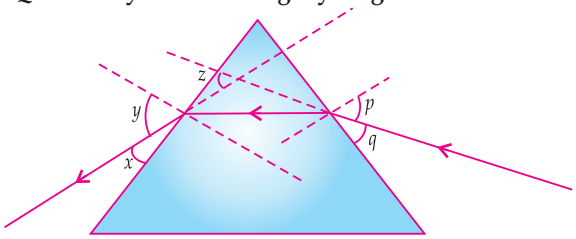
Mnemonics

Concept: Complete Phenomenon of light	
Mnemonics: **VIBGYOR**	
Interpretation: **V - V**iolet **I - I**ndigo **B - B**lue **G - G**reen **Y - Y**ellow **O - O**range **R - R**ed	A prism causes dispersion, Stars twinkle due to refraction, Scattering causes redirection, All have their own attraction.

Objective Type Questions — 1 mark each

A Multiple Choice Questions

Q. 1. Study the following ray diagram :



In this diagram, the angle of incidence, the angle of emergence and the angle of deviation respectively have been represented by

(A) y, p **and** z **(B)** x, q **and** z
(C) p, y **and** z **(D)** p, z **and** y

[CBSE Board, All India Region, 2017]

Ans. Correct option : (c)

Explanation: The angle between the incident ray and the normal is known as the angle of incidence, and the angle between the emergent ray and the normal is known as the angle of emergence. The emergent ray is bent at an angle with the direction of the incident ray. This angle is called the angle of deviation.

Q. 2. Which of the following phenomena of light are involved in the formation of a rainbow?

(a) Reflection, refraction and dispersion
(b) Refraction, dispersion and total internal reflection
(c) Refraction, dispersion and internal reflection
(d) Dispersion, scattering and total internal reflection

[NCERT Exemp.]

Ans. Correct option : (c)

Explanation: Dispersion means white light getting segregated into its component colours. Refraction bends the incident light to an angle that causes internal reflection and finally rainbow is formed.

Q. 3. Twinkling of stars is due to atmospheric

(a) dispersion of light by water droplets
(b) refraction of light by different layers of varying refractive indices
(c) scattering of light by dust particles
(d) internal reflection of light by clouds

[NCERT Exemp.]

Ans. Correct option : (b)

Explanation: Due to refraction of light by different layers of varying refractive indices, the apparent position of source of light keeps on changing. So stars appear to twinkle.

Q. 4. At noon the sun appears white as

(a) light is least scattered.
(b) all the colours of the white light are scattered away.
(c) blue colour is scattered the most.
(d) red colour is scattered the most.

[NCERT Exemp.]

Ans. Correct option : (a)

Explanation: Sun is directly over the head and sunlight travel relatively shorter distance causing only little of the blue and violet colours to be scattered.

Q. 5. The clear sky appears blue because

(a) blue light gets absorbed in the atmosphere
(b) ultraviolet radiations are absorbed in the atmosphere
(c) violet and blue lights get scattered more than light of all other colours by the atmosphere
(d) light of all other colours is scattered more than the violet and blue colour light by the atmosphere

[NCERT Exemp.]

Ans. Correct option : (c)

Explanation: A clear cloudless day-time sky is blue because molecules in the air scatter blue light from the sun more than they scatter red light. Rayleigh scattering is inversely proportional to the fourth power of wavelength, so that shorter wavelength violet and blue light will scatter more than the longer wavelengths (yellow and especially red light).

B Assertions and Reasons Type Questions

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

Q. 1. Assertion (A): A white light on passing through prism splits into its component colours as such that the red light emerges nearest to the base of the prism.

Reason (R): Wavelength of red light is more than other component colours and hence, red light deviates least.

Ans. Correct option : (d)

Explanation: Dispersion takes place because the refractive index of medium for different wavelengths (colours) is different. The refractive index is inversely proportional to λ

Since λ_{red} is more than other colours wavelength. So, deviation is least for red and it appears farthest from the base of the prism.

Q. 2. Assertion (A): Sunlight reaches us without dispersion in the form of white light and not as its components.

Reason (R): Dispersion takes place due to variation of refractive index for different wavelength but in vacuum the speed of light is independent of wavelength and hence vacuum is a non-dispersive medium.

Ans. Correct option : (a)

Explanation: In vacuum speed of light is independent of wavelength. Hence, no dispersion takes places in vacuum. Thus, vacuum is a non-dispersive medium in which all colours travel with the same speed.

Q. 3. Assertion (A): In case of rainbow, light at the inner surface of the water drop gets internally reflected.

Reason (R): The angle between the refracted ray and normal to the drop surface is greater than the critical angle.

Ans. Correct option : (a)

Explanation: The rainbow is formed when light at the inner surface of the water drop gets internally reflected. If the angle between the refracted ray and normal to the drop surface is greater than the critical angle.

C Very Short Answer Type Questions

Q. 1. Why does the Sun appear white at noon? U
[CBSE Sample Question Paper 2021]

Ans. The light is least scattered at noon. Due to this reason, the Sun appears white at noon. **1**

Q. 2. Why does the sun appear reddish early in the morning? Will this phenomenon be observed by an astronaut on the Moon? Give reason to justify your answer. U

Ans. In early morning, sun light has to cover larger distance in the atmosphere. So, the shorter wavelengths scatter out. Only the longer wavelengths like red reach our eye. No, this phenomenon will not be observed as Moon has no atmosphere. **1**

Q. 3. What is meant by dispersion of light ?
R [Board Term II, Foreign Set-I, 2014]

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

AI **Q. 4. Name the component of white light that deviates the least and the most while passing through a prism.** R [Board Term II, 2012]

Ans. (i) Least deviation – Red. ½
(ii) Maximum deviation – Violet. ½
[CBSE Marking Scheme, 2012]

COMMONLY MADE ERROR

- Candidates get confused with the colours of VIBGYOR and the deviation of beam of light.

ANSWERING TIP

- Understand the concept of dispersion and deviation of light carefully.

AI **Q. 5. Name the type of particles which acts as a prism in the formation of rainbow in the sky.** R

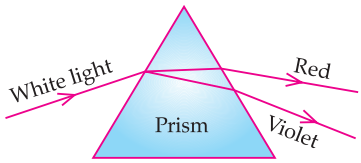
Ans. Water droplets present in the atmosphere. **1**

Q. 6. The sky appears dark to passengers flying at a very high altitude. Why ? C [Board Term II, 2012]

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

Short Answer Type Questions-I — 2 marks each

Q. 1.



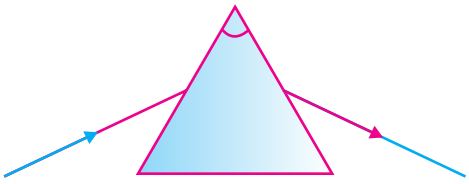
A student observes the above phenomenon in the lab as a white light passes through a prism. Among many other colours, he observed the position of the two colours Red and Violet.

What is the phenomenon called ? What is the reason for the violet light to bend more than the red light ?
R [CBSE Sample Question Paper 2020-21]

Ans. The phenomenon is called dispersion. **1**

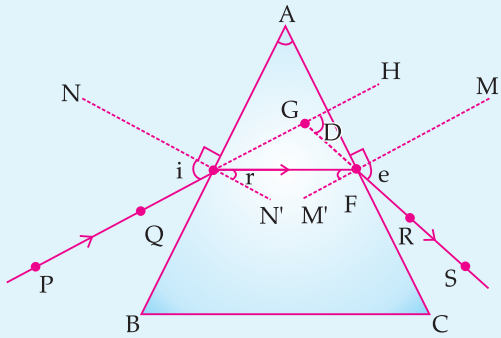
Speed of violet light inside the prism is slowest and that of red is highest. Hence, deviation of violet light is maximum and that of red is minimum. **1**

Q. 2. A student traces the path of a ray of light through a glass prism as shown in the diagram, but leaves it incomplete and unlabelled. Redraw and complete the diagram. Also label on it $\angle i$, $\angle e$, $\angle r$ and $\angle D$.



AE [CBSE Outside Delhi Set-I, 2019]

Ans.

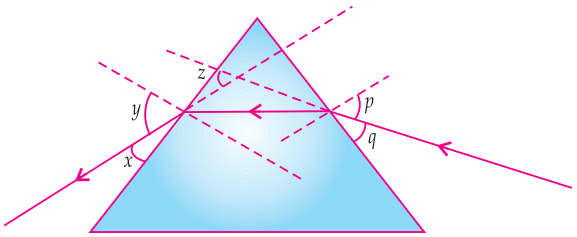


Labelling of $\angle i + \angle e + \angle r$ & $\angle D$
[CBSE Marking Scheme, 2019] ½ × 4

Detailed Answer:

The angle of incident is the angle made by the incident ray with the normal NN′. The angle of emergence is the angle made by the ray coming out of the prism with the normal. The emergent ray shifts from its original path of the incident ray. The angle by which the emergent ray is shifted is known as angle of deviation.

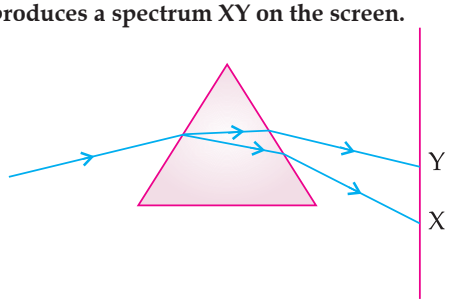
Q. 3. What is the value of angle of incidence, angle of emergence and angle of deviation from the following diagram? U



Ans. The angle between the incident ray and the normal is known as the angle of incidence,and the angle between the emergent ray and the normal is known as the angle of emergence. The emergent ray is bent at an angle with the direction of the incident ray. This angle is called the angle of deviation. Thus, the angle of incidence, angle of emergence and angle of deviation is p, y and z respectively. **1**

Short Answer Type Questions-II — 3 marks each

AI **Q. 1. In the figure given below, a narrow beam of white light is shown to pass through a triangular glass prism. After passing through the prism, it produces a spectrum XY on the screen.**



(i) Name the phenomenon.
(ii) State the colours seen at X and Y.
(iii) Why do different colours of white light bend at different angles through a prism?

R **[CBSE SQP, 2020]**

Ans. (i) The phenomenon is called dispersion.
(ii) X: Violet, Y: Red
(iii) Different colours of white light bend through different angles with respect to the incident beam of light due to difference in speed of light of different wavelengths. **[1+1+1]**

[CBSE Marking Scheme, 2020]

AI **Q. 2. (i) What is visible spectrum?**
(ii) Why is red used as the stopping light at traffic signals?
(iii) Two triangular glass prisms are kept together connected through their rectangular side. A light beam is passed through one side of the combination. Will there be any dispersion? Justify your answer. A, R **[Board SQP, 2020]**

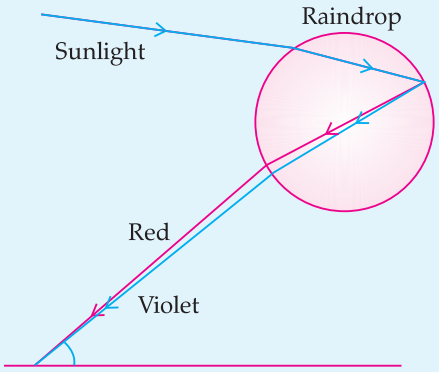
Ans. (i) Visible spectrum is the band of coloured components of a white light beam.
(ii) Red light is scattered the least by air molecules and has longer wavelength. It travels the longest distance.
(iii) The given setup will behave like a glass slab, resulting in recombination of the seven colours to produce white light. **1+1+1**

[CBSE Marking Scheme, 2020]

Q. 3. What is a rainbow ? Draw a labelled diagram to show the formation of a rainbow.

R **[CBSE Delhi, Set- I, 2019]**

Ans. Rainbow – A natural spectrum of sunlight appearing in the sky after a rain shower.



[1 + 2]

[CBSE Marking Scheme, 2019]

Q. 4. What happens to a beam of white light when it gets refracted through a glass prism ? Which colour deviates the most and the least after refraction through a prism ? What is likely to happen if a second identical prism is placed in an inverted position with respect to the first prism? Justify your answer.

U, R **[CBSE Outside Delhi, Set- III, 2019]**

Ans. The white light splits into seven colours when it gets refracted through the glass prism (VIBGYOR) **1**

The colour deviates most – Violet **[½]**

The colour deviates least – Red [½]
Colours disappear and again white light obtained.
[CBSE Marking Scheme, 2019] **1**

Detailed Answer:

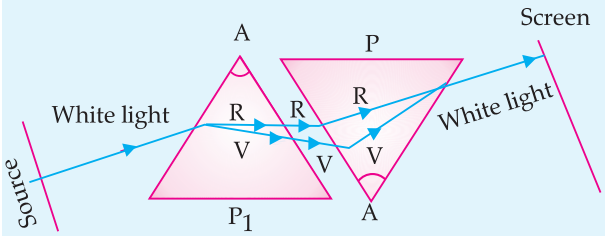
When a beam of white light gets refracted through a glass prism, it refracts through different angles causing a splitting of white light into its seven constituent colours (VIBGYOR). This gives rise to the formation of the colour spectrum.

Violet colour deviates the most and red colour deviates the least after refraction through a prism. When a second identical prism is placed in an inverted position with respect to first prism, a beam of white light emerges from the other side of the second prism. The second prism recombines all the seven colours to give a beam of white light.

Q. 5. 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. U [Board Term II Delhi Set-III, 2016]

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]**

COMMONLY MADE ERRORS

- (i) Correct diagram are not drawn by students.
  (ii) The arrows are not marked.
  (iii) Colours R and V are not marked properly.
  (iv) Both prism are not drawn equally.

ANSWERING TIP

- Practice diagram with proper labels. Carefully read the question and answer all parts of the questions.

AI **Q. 6. 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.** U [CBSE Term II Delhi Set-II, 2016]

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 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]

Q. 7. How does refraction of light take place in the atmosphere ? Explain the reason why stars appear to twinkle and the planets do not twinkle.
U, C [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**

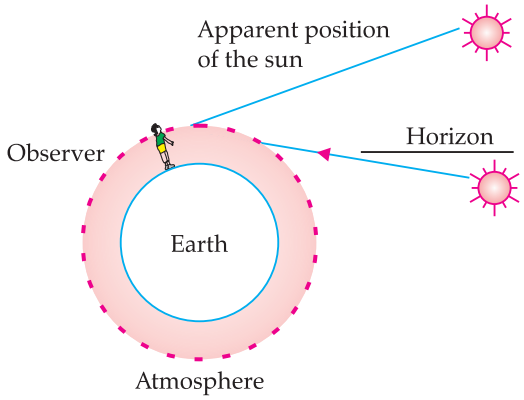
• The twinkling of a star is due to atmosphere refraction of star light. The atmospheric refraction of light occurs in a medium of gradually changing refractive index.

The planets are much closer to the earth and 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. **2**

[CBSE Marking Scheme, 2017]

Q. 8. 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.
U [OD Comptt. 31/2 2017]

Ans. 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**

AI **Q. 9. 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. U **[CBSE 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 wavelength (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) There is no atmosphere in outer space for scattering, so sky appears dark. **1**

[CBSE Marking Scheme, 2016]

AI **Q. 10. 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.** AE **[CBSE 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./ Q. 5. **[CBSE Marking Scheme, 2016]** **1½**

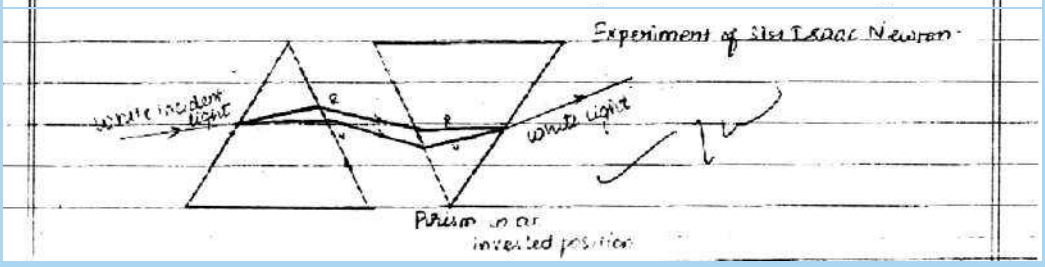
OR

Topper Answer, 2016

Sir Isaac Newton did the experiment of dispersion of white light using prism for the first time.

Things needed: Two prisms, Screen.

Method: Send a white incident light into a glass prism. The incident white light splits into seven colours of the spectrum. Then keep an inverted prism near the first glass prism and allow the seven colours to pass through it. It recombines and comes out as a white light on the other side of the prism. This white light can be observed with or without the screen.



Long Answer Type Questions — 5 marks each

Q. 1. Why is Tyndall effect shown by colloidal particles? State four instances of observing the Tyndall effect. U **[CBSE Delhi, Set- I, 2020]**

Ans. Tyndall effect is shown by colloidal particles because the colloidal particles size are roughly equal to the wavelength of the light.

Four instances of observing tyndall effect are:

(i) In fog.

(ii) When light passes through canopy in forest.

(iii) Blue colour of the sky.

(iv) When light passes through the milk. **1+2**

Q. 2. Differentiate between a glass slab and a glass prism. What happens when a narrow beam of (i) a monochromatic light, and (ii) white light passes through (a) glass slab and (b) glass prism? R **[CBSE Delhi, Set- I, 2020]**

Ans. Difference between glass slab and glass prism:

Glass slab	Glass prism
It is rectangular in shape.	It has two triangular sides, two inclined rectangular sides and one rectangular base.
In this, the direction of incident ray and emergent ray of light are parallel to each other .	In this, the direction of incident ray and emergent ray of light are not parallel to each other.

When a narrow beam of monochromatic light passes through:

(a) Glass slab: It has deviated from the actual path but the direction of the incident ray and the emergent ray are parallel to each other.

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

When a narrow beam of white light passes through:

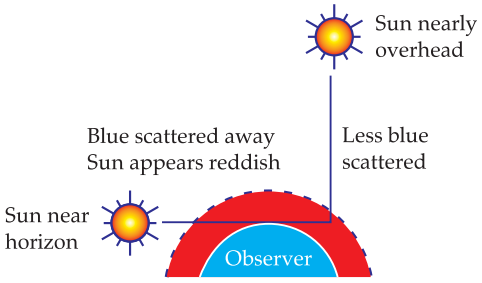
(a) Glass slab, it does not split into its constituent colour. The direction of incident ray and emergent ray of light are parallel to each other.

(b) Glass prism, it splits into its constituent seven colour. The direction of incident ray and emergent ray of light are not parallel to each other. **1+2=3**

Q. 3. Draw a labelled diagram to show (i) reddish appearance of the sun at the sunrise or the sunset and (ii) white appearance of the sun at noon when it is overhead. U **[CBSE Delhi, Set- I, 2020]**

Ans. (i) Reddish appearance of the sun at the sunrise and sunset:

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.



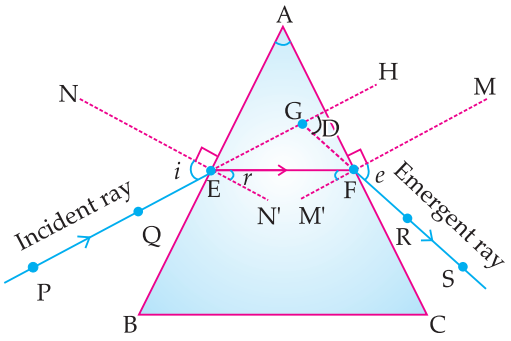
(ii) White appearance of the sun at noon when it is overhead: At noon, the sun is nearly overhead. The sunlight has to pass through much smaller portion of Earth's atmosphere. The scattering is much less and the Sun looks white. **1+1+1=3**

Q. 4. (a) With the help of labelled ray diagram show the path followed by a narrow beam of monochromatic light when it passes through a glass prism.

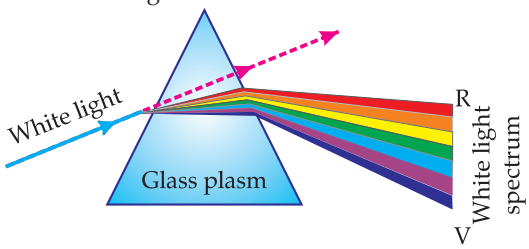
(b) What would happen if this beam is replaced by a narrow beam of white light ?

AE **[CBSE Outside Delhi Set I, 2020]**

Ans. (a) In case of monochromatic light, the ray will bend due to refraction but it will not show dispersion of light.



(b) If narrow beam of monochromatic light is replaced with beam of white light, a combination of narrow beam of seven colour will come out. The phenomenon of splitting of white light into its seven constituent colours when it passes through a glass prism is called dispersion of white light. The various colours seen are Violet, Indigo, Blue, Green, Yellow, Orange and Red. The different component colour of light bends at a different angle w.r.t the incident angle.



[2+1=3]

COMMONLY MADE ERROR

- Candidates get confused with the colours of VIBGYOR and the deviation of beam of light.

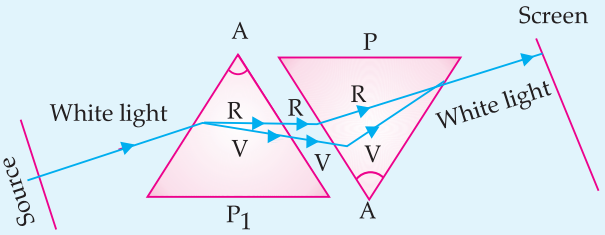
ANSWERING TIP

- Understand the concept of dispersion and deviation of light carefully.

Q. 5. State the cause of dispersion of white light by a glass prism. How did Newton, using two identical glass prisms, show that white light is made of seven colours ? Draw a ray diagram to show the path of a narrow beam of white light, through a combination of two identical prisms arranged together in inverted position with respect to each other, when it is allowed to fall obliquely on one of the faces of the first prism of the combination.

AE **[CBSE Outside Delhi Set I, 2017]**

Ans. Different colours of light bend through different angles with respect to the incident ray / different speed of different colours of light in glass / different values of refractive index of glass for different colours of light.



Direction of ray & labelling.

[CBSE Marking Scheme, 2017] 3

COMMONLY MADE ERROR

- (i) Correct diagram are not drawn by students.
  (ii) The arrows are not marked.
  (iii) Colours R and V are not marked properly.
  (iv) Both prism are not drawn equally.

ANSWERING TIP

- Practice diagram with proper labels. Carefully read the question and answer all parts of the questions.

Q. 6. (a) What is scattering of light ? Explain how the colour of the scattered light depends on the size of the scattering particles.

(b) Explain the reddish appearance of the Sun at sunrise or sunset. Why does it not appear red at noon ? R **[CBSE Outside Delhi, Set- II, 2019]**

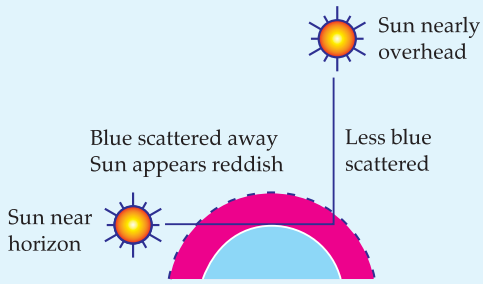
Ans. (a) Scattering: Direction of ray of light changes when it collides with particles of comparable size. **1**

- Fine particle scatter shorter wavelengths like blue light.
- Particles of larger size scatter longer wavelengths like red light.
- If particle size is large enough scattered light may appear white. **[½ × 3]**

(b)

- During sunrise and sunset, sun is near horizon. Sunlight travels longer distance. Most of blue light scatters away by particles. Light of longer wavelength reaches our eye so sun appears reddish.
- At noon, sun is directly overhead so sunlight travels lesser distance. Less amount of blue light is scattered giving white appearance to sun. **[½ × 3]**

Or can be explained with the help of a diagram given below:



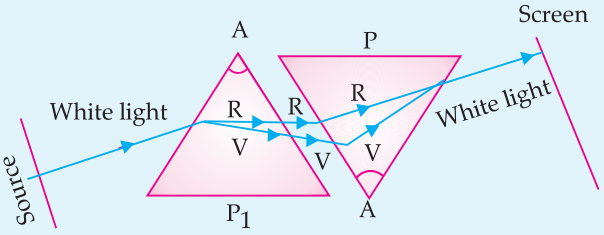
(One Mark with correct labelling) 1

[CBSE Marking Scheme, 2019]

Q. 7. What is "dispersion of white light" ? Draw a labelled diagram to illustrate the recombination of the spectrum of white light. Why is it essential that the two prisms used for the purpose should be identical and placed in an inverted position with respect to each other ? **[CBSE Outside Delhi Set III, 2017]**

Ans. ● Splitting of white light into seven colours. **1**

● Because the refraction / bending produced by second prism is equal to the refraction / bending produced by the first prism. **1**

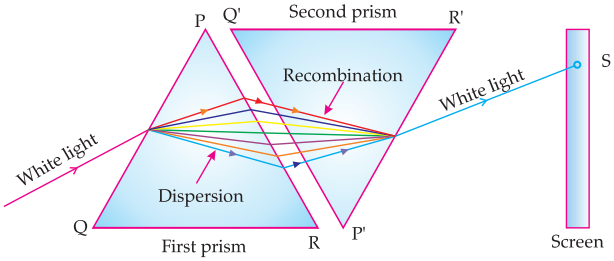


1

[CBSE Marking Scheme, 2017]

Detailed Answer:-

The phenomenon of splitting of white light into its constituent seven colours on passing through a glass prism is called dispersion of light.



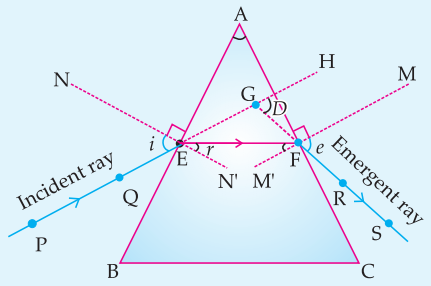
It is essential that the two prisms used should be identical and placed in an inverted position with respect to each other because the extent of refraction produced by second prism is equal to the refraction produced by the first prism. The second prism acts in the opposite sense than that of the first one. **[3]**

AI **Q. 8. (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.

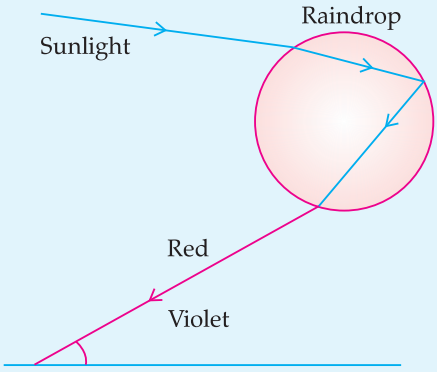
(c) Draw a labelled ray diagram to show the formation of a rainbow. A, AE [Delhi 31/1/1 2017]

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**

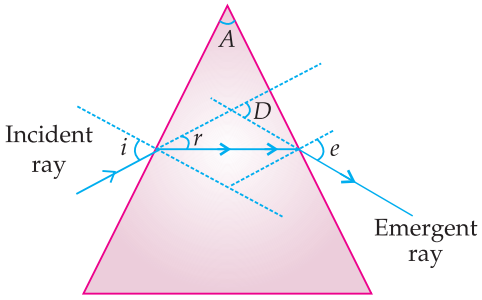
(c)



[CBSE Marking Scheme, 2017]

Detailed Answer:

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



(b) When a beam of light enters a prism, it gets refracted and splits into its 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.

(c) Same as in Marking Scheme Answer.

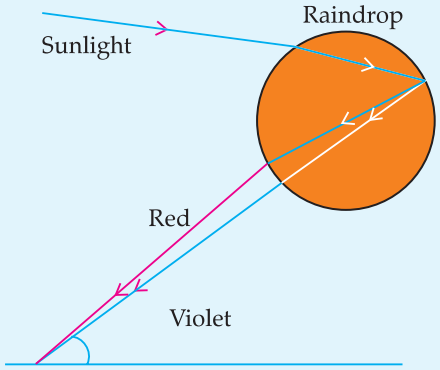
Q. 9. (i) What is dispersion of white light ? State its cause.

(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. R, AE [CBSE 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]

Q. 10. What is atmospheric refraction ? Use this phenomenon to explain the following natural events. U, A [CBSE Term II O.D. Set-I, 2016]

(i) Twinkling of stars.

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

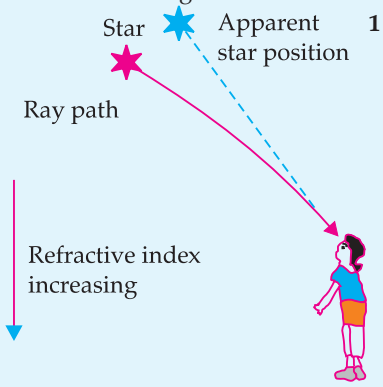
Draw diagrams to illustrate your answers.

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

(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

[CBSE Marking Scheme, 2016] **1**

OR

Topper Answer, 2016

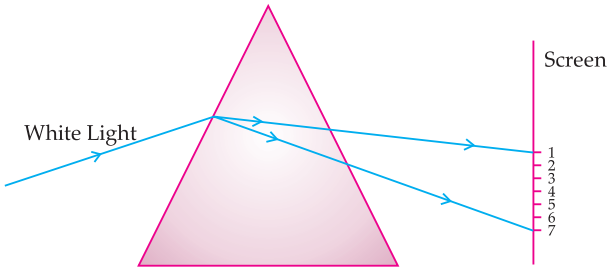
The refraction of light rays when it passes through the atmosphere bend towards the normal and reaches us. This atmosphere is phenomena of refraction in the atmosphere is called atmospheric refraction.

(a) Twinkling of Stars

The starlight on entering the atmosphere undergoes refraction completely and continuously. It bend towards the normal. Since, the atmosphere is not stationary, the apparant position of Star changes. It appears slightly higher up. The amount of starlight that enters the

Visual Case-based Questions — 4 marks each

1. A narrow beam of white light is passing through a glass prism as shown in the diagram. Study the diagram and answer any four questions from (a) to (e).



(a) The phenomenon observed in above set-up is

(i) scattering of light **(ii) dispersion of light**

(iii) reflection of light **(iv) refraction of light**

(b) In nature, this phenomenon is observed in

(i) Formation of rainbow **(ii) Twinkling of stars**

(iii) Blue colour of sky **(iv) Advance sunrise**

(c) Which of the following statement is correct about constituents of white light based on above observations?

(i) White light consists of seven colours.

(ii) Violet colour suffers minimum deviation.

(iii) Red light suffers maximum deviation.

(iv) All the colours of the white light move with different speed in vacuum.

(d) The cause of dispersion of light is

(i) All the colors of light travel with the speed more than the speed of light.

(ii) All the colors have different angles of deviation.

(iii) All the colors do not travel with the same speed of light.

(iv) All the colors have the same wavelength .

(e) Read the following statements carefully

(I) The prism behaves same as that of rectangular glass slab.

(II) All the colours have different angles of deviation in case of dispersion through prism.

(III) All the colours travel with the same speed of light in glass.

(IV) Dispersion of light is observed in case of rectangular glass slab.

Which of the above statement/s is true?

(i) Only II **(ii) I and II only**

(iii) I, II and IV only **(iv) All of the above**

Ans. (a) (ii) Dispersion of light.

Explanation: The phenomenon of splitting of white light into its constituent colours after passing through a prism is called as dispersion of light. When the light enters the prism, all the colours have different speeds due to which its gets split into bands.

(b) (i) Formation of rainbow

Explanation: Rainbow is caused by dispersion of sunlight by tiny water droplets present in the atmosphere which is one of the application of dispersion of light.

(c) (i) White light consists of seven colours.

Explanation: When the light disperses, various bands of light are clearly visible. It is clear from the figure that the violet light suffers maximum deviation and red light suffers minimum deviation. All the colours of the white light move with the same speed in air or vacuum but with different wavelengths and frequencies.

(d) (iii) All the colours do not travel with the same speed of light

Explanation: The various colours of white light have different extent of refraction in a medium. All of colours of light do not travel with same speed in the medium which is the cause of dispersion of light.

(e) (i) Only II

Explanation: A prism is made up of glass in which the faces are joined at a certain angle but in case of rectangular glass slab, the opposite faces are parallel to each other. As the light enters in the prism, all the colours travel with the different speed of light because glass is a denser medium as compared to air and dispersion of light is not observed in case of a rectangular glass slab. So, both prism and rectangular glass slab behave differently.

Q. 2. Read the passage on human eye and answer any four questions from (a) to (e).

Eye is a natural optical device by which human could see objects around him. It forms an inverted, real image on a light sensitive surface. It works on the phenomenon of refraction of light through a natural convex lens. However, Meena was unable to see clearly the words written on the black board placed at a distance of approximately 3 m from her. Her mother discussed the same with the doctor. Doctor explained her about this defect of vision and its correction.

(a) The human eye forms the image of the object at its

(i) Cornea **(ii) Iris**

(iii) Pupil **(iv) Retina**

(b) What kind of defect Meena is suffering from?

(i) Myopia **(ii) Hypermetropia**

(iii) Astigmatism **(iv) Malnutrition**

(c) The possible cause this defect is

(i) eye ball is of same size

(ii) eye ball becomes long

(iii) eye ball becomes small

(iv) None of the above

(d) The closest distance up to which a person can see without any strain in the eyes

(i) 35 cm **(ii) 15 cm**

(iii) 5 cm **(iv) 25 cm**

(e) The defective eye of a person has near point 0.5 m and far point as 3 m. The power of both lens required for reading purpose and seeing far off objects is

(i) 0.75 D and +4 D **(ii) +2D and – 1/3 D**

(iii) – 2.5D and + 1/8D **(iv) 0.85 D and – 2 D**

Ans. (a) (iv) Retina

Explanation: The retina in the human eye consists of contains a large number of light-sensitive cells which help in the organization of visual information. Thus, the retina helps in sending information to the brain due to which a person is able to see.

(b) (i) Myopia

Explanation: Meena was unable to read the words written on the blackboard i.e. she could see the nearby objects clearly but was unable to see the far off objects. Thus, she was suffering from Myopia

(c) (ii) eye ball becomes long

Explanation: The excessive curvature of eye lens becomes more converging and it results in the elongation of eye ball due to which a person suffers from Myopia.

(d) (iv) 25 cm

Explanation: 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.

(e) (ii) +2D and – 1/3 D

Explanation: Let the object distance = u

image distrance = v

$u = -25$ cm, $v = 0.5$ cm, $m = -50$ cm

Using Lens formula

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

$$= \frac{1}{-50} - \frac{1}{-25}$$

$$= \frac{1}{50}$$

$$\therefore P = \frac{100}{f(\text{cm})} = 100 \times \frac{1}{50} = +2\text{D}$$

If the distance objects are taken into consideration

$$u = \infty, v = -3 \text{ m}$$

Using Lens formula

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

$$= \frac{1}{-3} - \frac{1}{\infty}$$

$$= -\frac{1}{3}$$

$$\therefore \quad P = \frac{1}{f(\text{m})} = -\frac{1}{3}\text{D}$$

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 diopter.
- **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 ($\angle \delta$).
- **Tyndall effect:** The phenomenon of scattering of light by the colloidal particles is known as tyndall effect.

❑❑❑

SELF ASSESSMENT TEST - 3

Maximum Time: 1 hour **MM: 25**

Q. 1. What is the reason due to which the planets do not twinkle? **1**

Q. 2. What is tyndall effect? **1**

Q. 3. What is the relationship between wavelength of a particular colour and extent of bending through a prism? **1**

Q. 4. Directions : In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as :

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

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

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

(d) Assertion (A) is false but reason (R) is true. 1

Q. 5. (i) Define dispersion of light

(ii) List the colours into which it splits in the decreasing order of their bending on emergence from the prism. **2**

Q. 6. What is the reason for scattering of light? Explain this phenomenon with an example. **2**

Q. 7. 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. **3**

Q. 8. (a) Name the type of particles which acts as a prism in the formation of rainbow in the sky.

(b) Name the component of white light that deviates the least and the most while passing through a prism.

(c) On which factor does the colour of the scattered white light depend? **1+1+1**

Q. 9. (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. **5**

Q. 10. (a) (i) What should be the range of distance of object if we desire to obtain an erect image of an object using focal length of 20 cm. **1**

(ii) State the size of the image. ½

(iii) Draw a ray diagram to show the image formation in the above case. **1**

(b) Now, if the one half of the convex lens of focal length 20 cm is covered with black paper?

(i) Will a complete image will be formed by lens? ½

(ii) Draw a ray diagram to show the formation of image when object is placed at $2F_1$ using the covered lens as discussed above. **1**

(iii) How will the intensity of image changes on using covered lens? **1**

■■