The Human Eye and the Colourful World

TOPICS COVERED

The Human Eye and Power of Accommodation

Multiple Choice Questions **1 Mark**

1. **The muscular diaphragm that controls the size of the pupil is**
   (*a*) cornea (*b*) ciliary muscles
   (*c*) iris (*d*) retina
2. **The black opening between the aqueous humour and the lens is called**
   (*a*) retina (*b*) iris
   (*c*) cornea (*d*) pupil
3. **Near and far points of a young person normal eye respectively are:**
   (*a*) 0 and infinity (*b*) 0 and 25 cm
   (*c*) 25 cm and infinity
   (*d*) 25 cm and 150 cm.
4. **The ability of eye lens to adjust its focal length to form a sharp image of the object at varying distances on the retina is called**
   (*a*) power of observation of the eye
   (*b*) power of adjustment of the eye
   (*c*) power of accommodation of the eye
   (*d*) power of enabling of the eye
5. **The image formed on the retina of the human eye is**
   (*a*) virtual and inverted (*b*) real and inverted
   (*c*) real and erect (*d*) virtual and erect
6. **The near point and the far point are determined with regards to the function of which part of the eye?** [CFPQ, CBSE]
   (*a*) Pupil (*b*) Retina
   (*c*) Eye-ball (*d*) Ciliary muscles

7. **Which of the following can be directly affected if the iris does not function properly?** [CFPQ, CBSE]
   (*a*) Identification of colours
   (*b*) The amount of light entering the eye
   (*c*) Transmission of visual information to the brain
   (*d*) Finer adjustments for focussing the objects

8. **When the eye is looking at a distant objects, the ciliary muscles are in a**
   (*a*) contract position
   (*b*) relaxed position
   (*c*) neutral position
   (*d*) stretched position

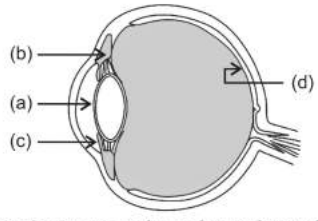
9. **Which of the following correctly gives the sequence of events that take place when human eye changes its focus from a distant object to an object closer to the eye?** [CFPQ, CBSE]
   (*a*) Ciliary muscles relax → Curvature of eye lens increases → Focal length of eye lens increases
   (*b*) Ciliary muscles contract → Curvature of eye lens decreases → Focal length of eye lens increases
   (*c*) Ciliary muscles relax → Curvature of eye lens decreases → Focal length of eye lens decreases
   (*d*) Ciliary muscles contract → Curvature of eye lens increases → Focal length of eye lens decreases

Answers

1. (*c*) Iris controls the size of pupil.
2. (*d*) The black opening between the aqueous humour and the eye lens is called pupil.
3. (*c*) Near point = 25 cm while far point = infinity.
4. (*c*) It is called power of accommodation of the eye.
5. (*b*) Eye lens is convex in nature. So, image formed by it on the retina is real and inverted.
6. (*d*) 7. (*b*) 8. (*b*) 9. (*d*)

VSA Very Short Answer Type Questions 2 Marks

10. **Name the four parts labelled as *a*, *b*, *c* and *d* in given diagram and write their functions.** [DoE]



Ans. (*a*) **Pupil:** It controls and regulates the amount of light entering the eye.
(*b*) **Ciliary muscles:** These muscles help to modify the curvature and there by the focal length of eye lens to focus the image of the object on the retina.
(*c*) **Iris:** It controls the size of the pupil.
(*d*) **Retina:** A real, inverted and diminished image of the object is formed on it.

11. **What is meant by least distance of distinct vision? How does this vary between the very young and old people ?**

Ans. The minimum distance at which an object can be seen most distinctly without strain by the eye, is termed as least distance of distinct vision.
For an infant, it is about 5 to 8 cm.
For a young adult with normal vision, it is about 25 cm.
For an old person, the power of accommodation of the eye decreases due to gradual weakening of ciliary muscles and the diminishing flexibility of the eye lens. Hence the least distance of distinct vision for him generally increases.

12. **The limitation of an eye is that the distance from the eye lens to where the image formed is always the same. How is then it possible for the eye to form focussed images from the objects that are located at varying distances from the eye?**

Ans. The ability of eye lens to adjust its focal length with the help of ciliary muscles, it is possible for the eye to form focussed images from the objects that are located at varying distances from the eye. This mechanism is called accommodation.

13. **Why does it take sometime to see the objects in dim light when you enter the room from bright sunlight outside?**

Ans. In bright sunlight, the iris contracts the pupil to allow less light to enter the eye and in dim light, the iris expands the pupil to admit more light to see the object clearly. Therefore, it takes sometime to increase the size of pupil in dim light.

14. **Why are we not able to see the things clearly when we come out of a darkroom?**

Ans. In dim light, the iris expands the pupil to allow more light to enter the eye. So, when we come out of a darkroom into the bright sunlight, a large amount of light enters into our eyes and due to glare feeling, we are not able to see the things clearly. Gradually, the iris contracts the pupil to allow less light to enter the eye to see the objects clearly. It take some time for the pupil. For that time interval, person is unable to see the things.

15. **In which of the following two cases the focal length of the eye lens will be more–**
   (*i*) When ciliary muscles of a normal eye is most relaxed.
   (*ii*) When ciliary muscles of a normal eye is in most contracted state.
   Explain with reason.

Ans. The focal length of the eye lens will be more in case
(*i*) i.e. when ciliary muscles of a normal eye is most relaxed.
Reason: When ciliary muscles are relaxed, the eye lens becomes thin. Thus, its focal length increases.
(*ii*) When ciliary muscles is in most contracted state, curvature of eye lens increases. Lens becomes thicker. This decreases the focal length of eye lens.

16. What happens to the image distance in the normal human eye when we decrease the distance of an object, say 10 m to 1 m? Justify your answer. [Delhi 2019]

Ans. There is no change in the image distance in the eye. The eye lens has the ability to adjust its focal length called accommodation. When object distance decreases, ciliary muscles contract and lens becomes thick and its focal length decreases. It facilitate the near vision.

Short Answer Type Questions 3 Marks

17. (*a*) Which part of the eye has delicate membrane and containing large number of light sensitive cells?
(*b*) What happens to the size of pupil of our eye in (*i*) dim light, (*ii*) bright light?
(*c*) State the structure of eye lens and its function.

Ans. (*a*) Retina contains large number of light sensitive cells known as rods and cones.
(*b*) (*i*) Increases (*ii*) Decreases.
(*c*) The eye lens of human eye is in the form of convex lens which as thicker in the middle and thinner at the edge. It converge the rays incident on it and form the real, inverted and diminished image on the retina.

18. 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?

Or

What is power of accommodation? How ciliary muscles help in accommodation? [DoE]

Ans. The ability of eye lens to adjust its focal length to form a sharp image of the object at varying distances on the retina, is called its power of accommodation.
Help by the ciliary muscles in accommodation:
When we are looking at nearby object, the ciliary muscles contract or strained. This increases the curvature of eye lens but its radius of curvature decreases. The eye lens then becomes thicker. As a result, the focal length of the eye lens decreases in such a way that a clear sharp image of nearby object is formed on the retina. Thus, the object is seen clearly to us.
When we are looking at distant object, these muscles are in relaxed position. This decreases the curvature of eye lens but its radius of curvature increases. The eye lens becomes thinner. As a result, the focal length of the eye lens increases. Therefore, the parallel rays coming from the distant object are focussed on the retina and the 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.

PRACTICE QUESTIONS

1. Most of the refraction for the light rays occurs
(*a*) at the outer surface of the cornea
(*b*) at the inner surface of the cornea
(*c*) at the eye lens
(*d*) by the iris behind the cornea

2. The amount of light entering the human eye is regulated and controlled by
(*a*) cornea
(*b*) iris
(*c*) pupil
(*d*) crystalline lens

3. In human eye, the pupil opens completely through the
(*a*) relaxation of eye lens
(*b*) contraction of ciliary muscles
(*c*) relaxation of ciliary muscles
(*d*) relaxation of iris

4. State the function of pupil and ciliary muscles.

5. (*a*) State one function each of iris and cornea.
(*b*) Calculate maximum power of accommodation of a person having normal vision.

TOPICS COVERED

Defects of Vision and their Correction

Multiple Choice Questions 1 Mark

1. **Which of these is a reason why a far-sighted person needs a convex lens to correct his vision?** [CFPQ, CBSE]
   (*a*) The image forms in front of his retina.
   (*b*) The image forms behind the retina.
   (*c*) The image forms below the retina.
   (*d*) The image forms on the retina.

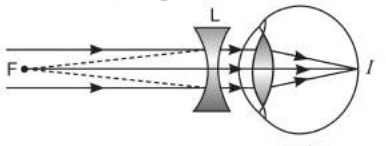
2. **Under which of these can myopia and hypermetropia be classified?** [CFPQ, CBSE]
   (*a*) Breakdown of tissues.
   (*b*) Incorrect bending of light in the eye.
   (*c*) Incorrect reflection of light by surfaces around us.
   (*d*) Incorrect coordination with brain for colour.

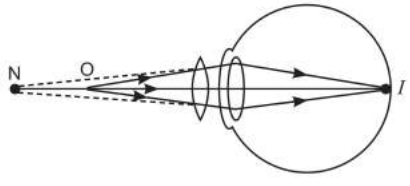
3. **Myopia and hypermetropia can be corrected by**
   (*a*) concave and plano-convex lens
   (*b*) concave and convex lens
   (*c*) convex and concave lens
   (*d*) plano-concave lens for both defects.

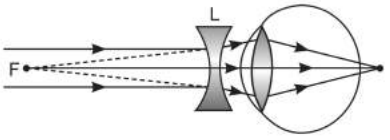
4. **Bi-focal lens are required to correct**
   (*a*) cataract
   (*b*) hypermetropia
   (*c*) myopia
   (*d*) presbyopia

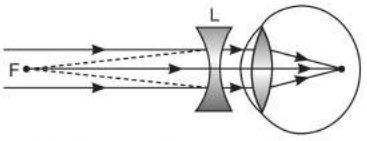
5. **The basic cause of refractive error that makes far-away objects look blurry is**
   (*a*) decrease in the focal length of eye-lens.
   (*b*) increase in the focal length of eye-lens.
   (*c*) decreasing curvature of eye-lens.
   (*d*) weakening of ciliary muscles.

6. **The diagram showing the correctness of refractive error in which images focus in front of retina is**

(*a*)


(*b*)


(*c*)


(*d*)


7. **Corrective lens used to correct the myopic defect of eye forms a virtual image of distant object at**
   (*a*) near point of myopic eye
   (*b*) far point of myopic eye
   (*c*) least distance of distinct vision
   (*d*) any where between near point and far point of the eye.

8. **The defective eye of a person has near point 0.5 m and far point is at 3 m. The power for corrective lens required for (*i*) reading purpose and (*ii*) seeing distant objects, respectively are:**
   (*a*) 0.5 D and +3D (*b*) +2D and $-\frac{1}{3}$D
   (*c*) – 2D and $+\frac{1}{3}$D (*d*) 0.5 D and – 3.0 D

9. **The defect of vision in which image of nearby objects is formed behind the retina is** [CBSE 2000]
   (*a*) short-sightedness (*b*) far-sightedness
   (*c*) presbyopia (*d*) all of these

10. **If curvature of eye lens causes decrease in its focal length, then the refractive defect of vision will be**
    (*a*) myopia (*b*) hypermetropia
    (*c*) presbyopia (*d*) cataract

11. **A person's near point is at 45 cm and far point is at 2 m. What kind of corrective lens is BEST suited for his vision defect?** [CFPQ, CBSE]
    (*a*) Convex (*b*) Concave
    (*c*) Bifocal (*d*) Plano-convex

12. **The defect of vision in which the person is able to see distant object distinctly but cannot see nearby objects clearly is called**
    (*a*) Long sightedness (*b*) Far-sightedness
    (*c*) Hypermetropia (*d*) All of these

Answers

1. (*b*)
2. (*b*)

3. (*b*) Myopia is corrected by using of suitable power of concave lens while hypermetropia is corrected by convex lens.
4. (*d*) Bifocal lens are required to correct the presbyopia. Upper point of bifocal lens consists of concave lens used for distant vision while lower point consists of convex lens facilitates near vision.
5. (*a*)
6. (*a*)
7. (*b*)
8. (*b*) For reading purpose

$u = -25$ cm, $v = 0.5$ m $= -50$ cm, $f = ?$ P $= ?$

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

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

For distant objects

$u = \infty$, $v = -3$ m, $f = ?$ P $= ?$

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

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

9. (*b*) **10.** (*a*) **11.** (*c*)
12. (*d*) Hypermetropia is also called long-sightedness or far-sightedness.

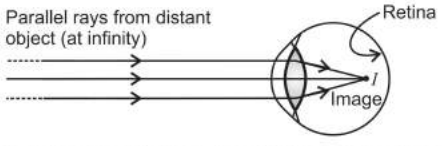
VSA Very Short Answer Type Questions 2 Marks

13. **Name the defect of vision due to**
    (*i*) Power of the eye is too long.
    (*ii*) Focal length of the eye lens is too long.

Ans. (*i*) Short-sightedness
(*ii*) Long-sightedness.

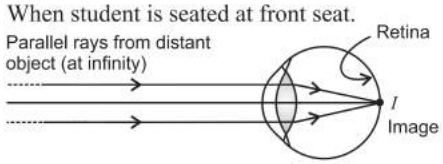
14. **A student sitting at the back bench in a class, is not able to see what is written on the blackboard. He, however, sees it clearly when sitting on the front seat at an approximate distance of 1.5 m from the blackboard. Draw ray diagrams to illustrate the image formation of the blackboard when he is seated at the (*a*) back seat (*b*) front seat.** [HOTS]

Ans. (*a*) When student is seated at the back seat.



In this case student is suffering from myopia and have short focal length of eye lens.

(*b*) When student is seated at front seat.



15. **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 even 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.

16. **The near point of a hypermetropic eye is 50 cm. What is the nature and power of the lens required to enable him to read a book placed at 25 cm from the eye?**

Ans. Given: Object distance, $u = -25$, Image distance, $v = -50$ cm, Power of lens, $P = ?$

Using lens formula,

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

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

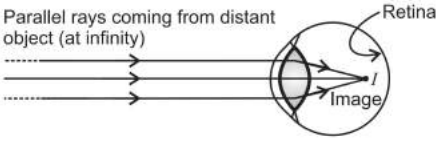
or $f = +50$ cm $= +0.5$ m

The nature of lens is convex.

and power, $P = \frac{1}{f(\text{m})} = \frac{1}{0.5} = +2.0$ D

17. **A student has difficulty in reading the blackboard while sitting in the last row. What could be his defect of vision? Draw a ray diagram to illustrate this defect of vision.**

Ans. **Short-sightedness or myopia:** The image in this case forms in front of the retina.



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

Ans. The defect of vision is hypermetropia.

Focal length of lenses, $f = \frac{1}{P} = \frac{1}{+0.5\text{ D}} = +2$ m

SA Short Answer Type Questions 3 Marks

19. **(*a*) Name the defects of vision when a person cannot see clearly:**
    (*i*) the nearby objects
    (*ii*) the distant objects

(b) Ritu needs a lens of power -2D for correct of her vision.

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

(ii) What are the possible cause of this defect?

(iii) What is the nature of corrective lens? [KVS]

Ans. (a) (i) Hypermetropia

(ii) Myopia

(b) (i) Ritu is suffering from myopia or short sightedness.

(ii) **Causes:** • Increase in size of eye ball.
• Decrease in focal length of eye lens.

(iii) **Nature of corrective lens:** Concave/ diverging lens.

20. You are given three lenses namely, bifocal lens, convex lens and concave lens. Which lens would you prefer to correct the myopia, hypermetropia, and presbyopia respectively?

Ans.

Eye defects	Corrective lenses
Myopia	Concave lens
Hypermetropia	Convex lens
Presbyopia	Bifocal lens

21. Explain why?

(a) A myopic person prefer to remove his spectacles while reading a book.

(b) A hypermetropic person prefer to remove his spectacles while looking at the sky. [HOTS]

Ans. (a) A 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 a 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 appears to him is also smaller then actual size. Therefore, the person prefer to remove his spectacles while reading a book.

(b) A 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 the retina due to increase in converging power and hence the person cannot see distant objects distinctly. Therefore, such person prefers to remove his spectacles while looking at the sky.

22. A person can see clearly objects only when the object is lies between 40 cm and 350 cm. In order to increase the distances of distinct vision to infinity, find the power of corrective lens and type of lens used by the person to see the objects clearly.

Ans. Here, $v = -350$ cm $= -3.5$ cm.

$u = -\infty, f = ?$

Using lens formula,

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

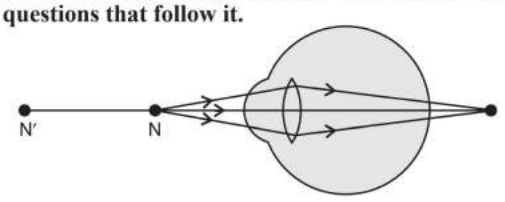
$$= \frac{1}{-3.5} - \frac{1}{-\infty} = -\frac{1}{3.5}$$

$\Rightarrow \quad f = -3.5$ m

Negative sign shows that corrective lens is concave lens and its power is

$$P = \frac{1}{f(\text{m})} = -\frac{1}{3.5} = -0.28 \text{ D}$$

23. Study the diagram given below and answer the questions that follow it.



(a) Identify the defect of vision. Give reason for your answer.

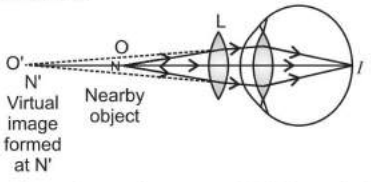
(b) State two possible causes of this defect.

(c) How can we rectify this defect? Explain with a diagram. [DoE]

Ans. (a) This defect of vision is hypermetropia, as the image is formed behind the retina.

(b) (i) Due to greater focal length of the eye lens and
(ii) Eyeball becomes smaller.

(c) It can be corrected by using a convex lens as shown below.



24. The far point of myopic person is 150 cm in front of the eye. Calculate the focal length and power of the lens required to enable him to see distant objects clearly. [CBSE 2014]

Ans. For myopic person, $u = \infty, v = -150$ cm, $f = ?$

From less formula, $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$$= \frac{1}{-150} - \frac{1}{\infty} = -\frac{1}{150}$$

$\Rightarrow \quad f = -150$ cm $= -1.5$ m

Power of corrective lens,

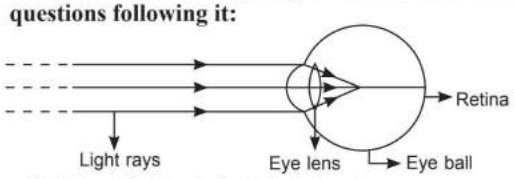
$$P = \frac{1}{f(\text{m})}$$

$$= \frac{-1}{1.5} = \frac{-2}{3}$$

$\Rightarrow$ $P = -0.66$ D

So, concave lens of power, 0.66 D enable him to see distant objects clearly.

25. Observe the following diagram and answer the questions following it:



(*i*) Identify the defect of vision shown.

(*ii*) List its two causes.

(*iii*) Name the type of lens used for the correction of this defect. **[CBSE 2023]**

Ans. (*i*) The defect of vision shown is myopia.

(*ii*) – Excessive curvature of the eye lens.
– Elongation of eyeball.

(*iii*) Myopia can be corrected by using a concave lens of suitable power placed in front of eye.

Long Answer Type Questions 5 Marks

26. What is myopia? List two causes for the development of this defect. How can this defect be corrected using a lens? Draw ray diagrams to show the image formation in case of (*i*) defective eye and (*ii*) corrected eye. **[Foreign 2014]**

Or

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. **[Delhi 2015]**

Or

What is myopia? State the two causes of myopia. With the help of a labelled ray diagram show (*a*) eye defect (*b*) correction of myopia. **[DoE]**

Ans. Myopia or Short-sightedness or Nearsightedness:

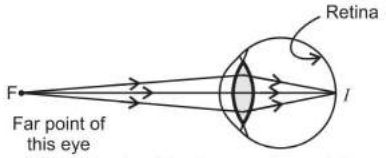
The defect of vision is due to which an eye cannot see distant object distinctly but can see nearby objects clearly. This defect of the eye is called myopia.

Short-sightedness is caused due to

(*i*) excessive curvature of the eye lens or

(*ii*) elongation of eyeball.

The image in this case, forms in front of the retina, so the distant object looks blurred. For every myopic eye, there exists a far point beyond which a clear image cannot be seen. When the object lies at the far point, the image formed is focussed on the retina by the eye lens and therefore the object is clearly visible to us.



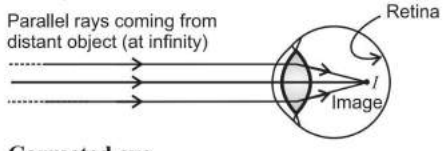
The far point (F) of a myopic eye is less than infinity: Image is formed on the retina

The short-sightedness is corrected by using a concave lens of suitable power placed in front of eye. It diverges the rays and forms a virtual image of distant object at far point of the myopic eye. These diverged rays enter into the eye and form the image on the retina. Thus, the concave lens shifts the image back onto the retina instead of in front of it and the defect is corrected.

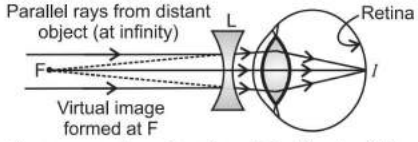
Ray diagrams to show the image formation in case of:

(*i*) **Defective eye**

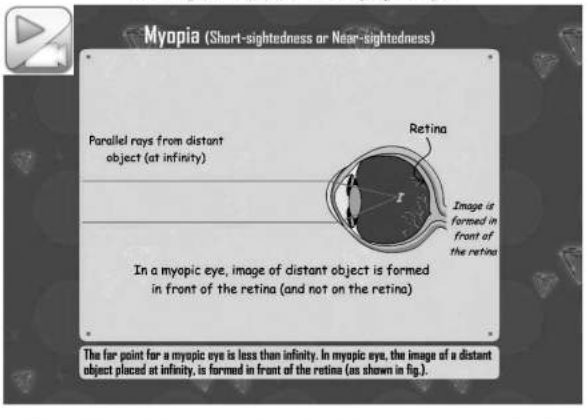
In a myopic eye, the image of distant object is formed in front of the retina (and not on the retina).



(*ii*) **Corrected eye**



A concave lens is placed in front of the eye which forms a virtual image of distant object at far point (F) of the myopic eye.



27. What is hypermetropia? List two causes for the development of this defect. Explain the method

of correcting this defect with the help of ray diagrams.

Or

What is hypermetropia? State two causes. With the help of ray diagram show (*a*) eye defect (*b*) correction of hypermetropia. [DoE]

Or

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 this defect may be corrected using lens of appropriate focal length. [Delhi 2017C]

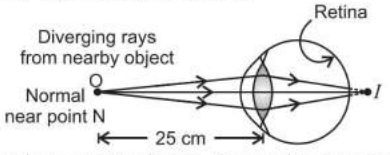
Ans. Hypermetropia or Long-sightedness or Far-sightedness. The defect of vision due to which an eye cannot see nearby objects clearly but can see distant objects distinctly. This defect of the eye is called hypermetropia.

Long-sightedness is caused due to

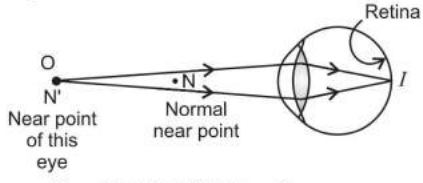
(*i*) greater focal length of the eye lens or

(*ii*) smaller eyeball.

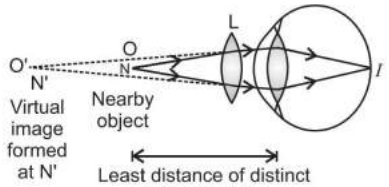
The image in this case, forms behind the retina, so the nearby objects looks blurred.

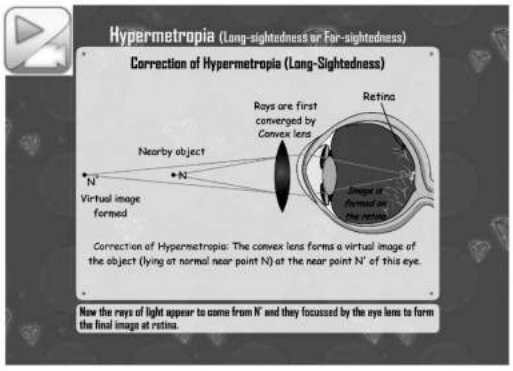


For every hypermetropic eye, there exists a near point N′ which is more than the least distance of distinct vision, i.e. 25 cm. The diverging rays from the object lying at the near point N′ is focussed on the retina by the eye lens and therefore, the object is clearly visible to the eye.



Therefore, long-sightedness is corrected by using a convex lens of suitable power placed in front of the eye. It converges the rays coming from the object lying at normal near point N and forms its virtual image at near point N′ of the hypermetropic eye. The rays appear to come from N′ enter into the eye and get focussed by the eye lens on the retina. Thus, convex lens provides additional focussing power to the eye lens and shifts the image back onto the retina from beyond and therefore the defect is corrected.





28. What is presbyopia? State its cause. How is it corrected?

Or

An old person finds it difficult to see nearby objects comfortably and distinctly without corrective eye glasses.

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

(*ii*) List two causes for the development of this defect.

(*iii*) What kind of lens will be required to see clearly the nearby as well as distant objects? Give reasons.

Ans. (*i*) Presbyopia

- Presbyopia is a condition that occurs as a part of normal ageing.
  Due to loss of power of accommodation of the eye, with age, objects at a normal near working distance will appear blurry. The near point gradually recedes away. This defect of eye is called Presbyopia.
- Sometimes, a person may suffer from both myopia and hypermetropia.

(*ii*) Presbyopia is caused due to

- weakening of ciliary muscles, and
- eye lens becomes less flexible and elastic, i.e. reducing ability of eye lens to change its curvature with the help of ciliary muscles.

(*iii*) **Bifocal lens** will be required to see clearly nearby as well as the distant object. For myopic defect, upper part of bifocal lens consists of a concave lens used for distant vision and to correct hypermetropia, lower part of bifocal lens consists of a convex lens. It facilitates near vision.

29. A person cannot see the objects distinctly, when placed beyond 2 m.
(*a*) Identify the eye defect.
(*b*) Give two reasons for this defect.
(*c*) Calculate the power and nature of the lens he should be using to see the distant objects clearly.
(*d*) Draw the ray diagrams for the defective and the corrected eye.

Ans. (*a*) The eye defect is myopia.

(*b*) Two causes for myopia are
(*i*) excessive curvature of eye lens or
(*ii*) elongation of eye ball

(*c*) Required power of corrective lens is

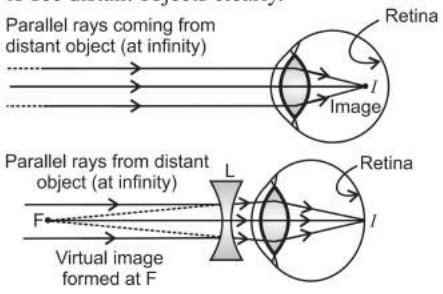
$$P = \frac{1}{f(\text{m})} = \frac{1}{v} - \frac{1}{u}$$

$$= \frac{1}{-2} - \frac{1}{-\infty} \qquad (v = -2 \text{ m}, u = -\infty)$$

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

So, he should use concave lens of power –0.5D to see distant objects clearly.

(*d*)



30. Noopur needs a lens of power –4.5D for correction of her vision.
(*a*) What kind of defect in vision is she suffering from?
(*b*) What is the focal length and nature of the corrective lens?
(*c*) Draw ray diagrams showing the (*i*) defected eye and (*ii*) correction for this defect.
(*d*) What are the causes of this defect?

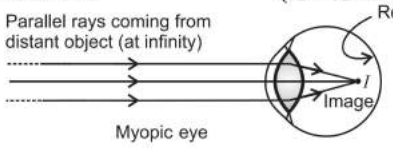
[CBSE Sample Paper 2018]

Ans. (*a*) Myopia **(1 Mark)**

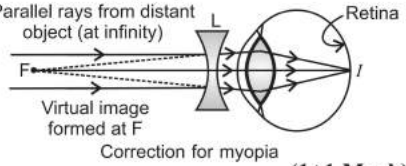
(*b*) $f = \frac{-1}{45} = -0.22$ cm

Concave lens **(½ + ½ Mark)**

(*c*) (*i*)



(*ii*)



(1+1 Mark)

(*d*) Causes:
(*i*) Due to excess curvature of eye lens
(*ii*) Elongation of the eye ball. **(½ + ½ Mark)**

[CBSE Marking Scheme]

PRACTICE QUESTIONS

1. The defect of vision in which eyeball is elongated is
(*a*) myopia (*b*) hypermetropia
(*c*) presbyopia (*d*) cataract
2. Far-sightedness is caused by large focal length of the eye lens. It is corrected by using
(*a*) divergent lens
(*b*) converging lens
(*c*) bifocal lens
(*d*) plano-concave lens
3. When a person is myopic, he/she can clearly see
(*a*) distant object clearly
(*b*) nearby objects clearly
(*c*) both near and distant objects
(*d*) between infinity and 25 cm
4. Name the defect of vision caused by
(*i*) Excessive curvature of cornea
(*ii*) Power of accommodation of eye decreases.
5. When do we consider a student sitting in the class to be (*a*) myopic (*b*) hypermetropic?
6. Why is concave lens used to correct myopia? Why not convex lens?
7. An old man cannot see objects closer than 1 m from the eye clearly. Name the defect of vision he is suffering from. How can it be corrected? Draw ray diagram for the (*i*) defect of vision and also (*ii*) for its correction.
8. Draw a diagram to show why distant objects cannot be seen distinctly by a myopic eye. List two reasons due to which this defect of vision may be caused.
A person with a myopic eye cannot see objects clearly beyond a distance of 2 m. Name the type of corrective lens that would be needed to correct the defect of vision and draw a ray diagram to show how the defect gets corrected.

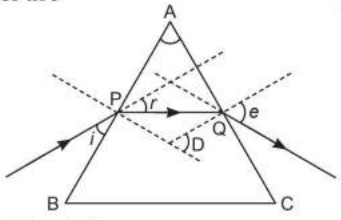
TOPICS COVERED

Refraction and Dispersion of White Light through a Prism

Multiple Choice Questions 1 Mark

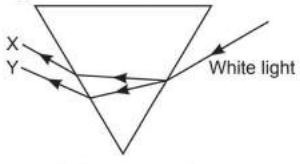
1. **A student traces the path of ray of light through a triangular glass prism for different values of angle of incidence. On analysing the ray diagrams, which one of the following conclusions is he likely to draw?** [CBSE 2015]
   (*a*) The emergent ray is parallel to incident ray.
   (*b*) The emergent ray bends at an angle to the direction of incident ray.
   (*c*) The emergent ray and refracted ray are at right angles to each other.
   (*d*) The emergent ray is perpendicular to the incident ray.

2. **In the following diagram, the correctly marked angles are** [CBSE 2017]



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

3. **In the diagram given below, X and Y are the end colours of the spectrum of white light. The colour of 'Y' represents the** [CBSE 2021]



   (*a*) colour of sky as seen from earth during the day.
   (*b*) colour of the sky as seen from the moon.
   (*c*) colour used to paint the danger signals.
   (*d*) colour of sun at the time of noon.

4. **A prism is used to**
   (*a*) change the path of light by reflection and refraction both
   (*b*) rotate the image
   (*c*) disperse the light into its components
   (*d*) all of these

5. **When white light enters a prism, it gets split into its constituent colours. This is due to**
   (*a*) different refractive index for different wavelength of each colour
   (*b*) each colours has same velocity in the prism.
   (*c*) prism material have high density.
   (*d*) scattering of light.

6. **If a beam of red light and a beam of violet light are incident at the same angle on the inclined surface of a prism from air medium and produce angles of refraction '*r*' and '*v*' respectively, which of the following is correct?** [CBSE Sample Paper 2021]
   (*a*) $r = v$ (*b*) $r > v$ (*c*) $r = \frac{1}{v}$ (*d*) $r < v$

7. **The phenomenon of dispersion prove that**
   (*a*) white light passes through a transparent medium.
   (*b*) sunlight is made up of seven colours.
   (*c*) light travels in a straight line path.
   (*d*) different colours travel with the same speed while passing through a glass prism.

8. **When a narrow beam of white light is passed through two identical prisms, one placed inverted with respect to the other, the emerging beam will be**
   (*a*) white beam (*b*) blue light
   (*c*) red light (*d*) all seven colours

9. **When a ray of light passes through a glass prism it suffers two refractions. During these refractions the ray bends:** [CBSE 2022]
   (*a*) Away from the base in both cases
   (*b*) Towards the base in both cases
   (*c*) Towards the base in first case and away from the base in second case
   (*d*) Away from the base in first case and towards the base in second case

10. **In the formation of rainbow, the role of water droplet presents in water fountains is to act as a** [CBSE 2021]
    (*a*) glass slab (*b*) convex lens
    (*c*) concave lens (*d*) prism

11. **When sunlight enters the water droplet suspended in the atmosphere after rainfall, it will get**
    (*a*) refracted only
    (*b*) refracted internally
    (*c*) refracted and dispersed
    (*d*) first refracted and then dispersed while coming out of the water droplet.

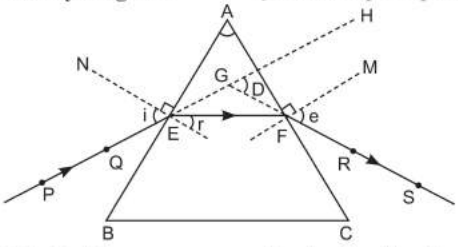
Answers

1. (*b*) 2. (*a*) 3. (*c*) 4. (*c*)
5. (*a*) Dispersion takes place because refractive index of the material of prism is different for different wavelength.
6. (*d*) 7. (*b*) 8. (*a*) 9. (*b*)
10. (*d*) 11. (*c*)

VSA Very Short Answer Type Questions 2 Marks

12. Draw a path of light ray passing through a prism. Label angle of incidence and angle of deviation in the ray diagram. [CBSE Sample Paper 2018]

Ans.

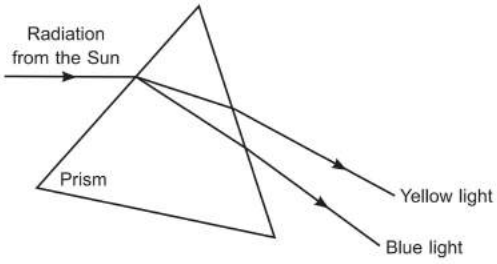


PE – Incident ray ∠*i* – Angle of incidence
EF – Refracted ray ∠*r* – Angle of refraction
FS – Emergent ray ∠*e* – Angle of emergence
∠A – Angle of prism ∠D – Angle of deviation

13. No rainbow could be observed from the surface of the moon by the astronauts. What could be the possible reason?

Ans. The Moon does not have any blanket of air or atmosphere and consequently, in the absence of water droplets no dispersion of sunrays is possible. Therefore, rainbow could not be observed from the surface of the Moon by the astronauts.

14.

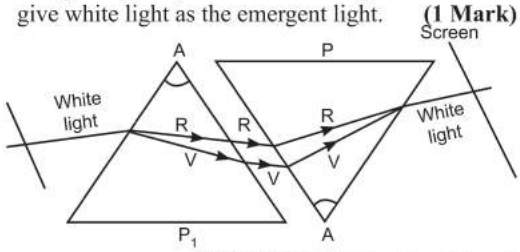


State the phenomena observed in the above diagram. Explain with reference to the diagram, which of the two lights mentioned above will have the higher wavelength? [CBSE Sample Paper 2023]

Ans. **Dispersion:** The splitting of white light into seven colours on passing through a prism. **(1 Mark)**
Velocity is directly proportional to wavelength given constant frequency. So yellow will have greater wavelength than blue as the velocity of yellow light is greater than blue. **(½ + ½ Mark)**
[CBSE Marking Scheme]

15. How will you use two identical prisms so that a narrow beam of white light incident on one prism emerges out of the second prism as white light? Draw the diagram. [CBSE Sample Paper 2023]

Ans. Angle of deflections of the two prisms need to be equal and opposite. While the first prism splits the light in the seven colours due to different angles of deflection, the second prism combines the spectrum along a single ray and the colours again combine to give white light as the emergent light. **(1 Mark)**



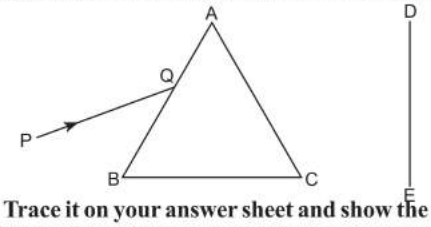
(1 Mark) [CBSE Marking Scheme]

16. What is dispersion of light? Name component of white light that deviate (*i*) the least (*ii*) the most while passing through a glass prism.

Ans. **Dispersion:** Splitting of white light into its component colours is called dispersion. The component of white light that deviate
(*i*) the most – violet
(*ii*) the least – red
while passing through the glass prism.

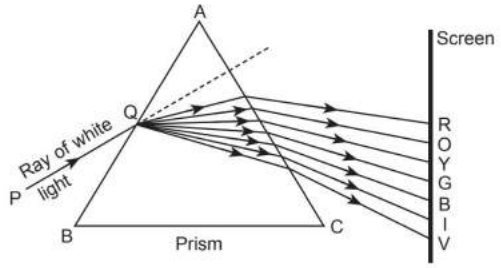
SA Short Answer Type Questions 3 Marks

17. 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.
(*a*) Write the name and cause of the phenomenon observed.
(*b*) Where else in nature is this phenomenon observed?
(*c*) Based on this observation, state the conclusion which can be drawn about the constituents of white light.

Ans.



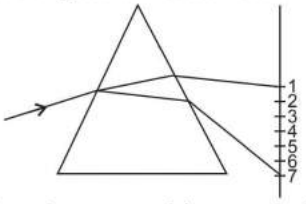
(*a*) The splitting of light into its constituent colours is called dispersion. The dispersion of light is caused as the varying speeds of different constituent colours of white light offer different refractive indices to the material of the prism. Due to this refracted colours emerges through a prism at different angles which form a spectrum on the screen.

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

(*c*) (*i*) A beam of white light consists of seven colours.

(*ii*) The violet colour suffers maximum deviation and the red colour suffers minimum deviation.

18. A beam of white light falling on a glass prism gets split up into seven colours marked 1 to 7 as shown in the diagram. A student makes the following statements about the spectrum observed on the screen.



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

(*b*) Which two positions correspond closely to the colour of

(*i*) a brinjal

(*ii*) 'danger' or stop signal lights?

Ans. (*a*) Incorrect as the student is stating the nature of colours in reverse order, i.e. 3 represents the colour of gold metal and 5 represents the colour of the sky.

(*b*) (*i*) Colour marked 7 is violet.

(*ii*) Colour marked 1 is red.

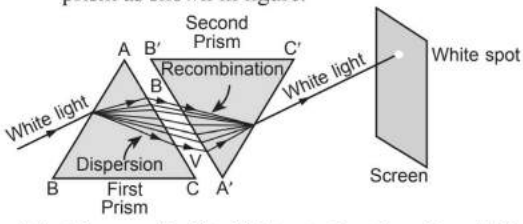
19. Describe an activity to show that the colours of white light splitted by a glass prism can be recombined to get white light by another identical glass prism. Also draw ray diagram to show the recombination of the spectrum of white light.

[AI 2016]

Ans. Recombination of Colours: The colours of white light splitted by a glass prism can be recombined to get white light by another identical glass prism. Newton demonstrated this phenomenon of recombination of the coloured rays of a spectrum to get back white light.

(*a*) A triangular prism ABC is placed on its base BC.

(*b*) A similar prism A′B′C′ is placed alongside with its refracting surface in the opposite direction, i.e. in an inverted position with respect to first prism as shown in figure.



(*c*) A beam of white light entering the prism ABC undergoes refraction and is dispersed into its constituent seven colours.

(*d*) These constituent seven coloured rays are incident on the second inverted prism A′B′C′ and get further refracted.

(*e*) The second prism recombines them into a beam of white light and emerges from the other side of the second prism and falls on the screen.

(*f*) This is due to the fact that the refraction or bending produced by the second inverted prism is equal and opposite to the refraction or bending produced by the first prism. This causes the seven colours to recombine.

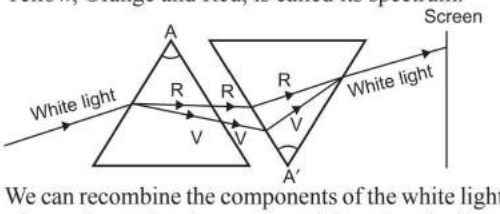
(*g*) A white patch of light is formed on the screen placed beyond the second prism. This proves the phenomenon of recombination of spectrum of white light.

20. What is a spectrum? How can we recombine the components of white light after a glass prism has separated them? Illustrate it by drawing a diagram. **[Foreign 2014]**

Or

When we place a glass prism in the path of a narrow beam of white light, a spectrum is obtained. What happens when a second identical prism is placed in an inverted position with respect to the first prism? Draw a labelled ray diagram to illustrate it.

Ans. **Spectrum:** The band of the coloured components of a white light beam such as Violet, Indigo, Blue, Green, Yellow, Orange and Red, is called its spectrum.



We can recombine the components of the white light after a glass prism has separated them by placing a second identical prism in an inverted position with respect to the first prism.

These constituent seven coloured rays refracted by the first prism are incident on the second inverted prism and get further refracted. These coloured rays again recombine by the second prism into a beam of white light, which emerges out from the other side of the second prism.

Long Answer Type Questions 5 Marks

21. (*a*) What is dispersion of white light? State its cause.

(*b*) "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. **[Foreign 2016]**

Or

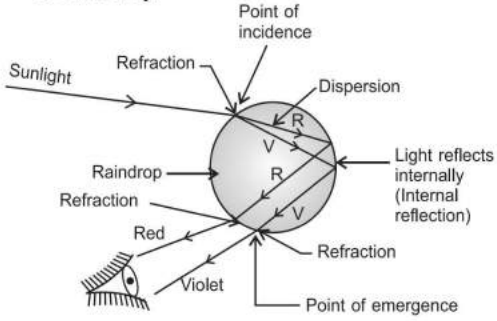
When and where does a rainbow appear in the sky? Draw a labelled ray diagram to show its formation. **[CBSE 2023]**

Ans. (*a*) **Dispersion:** The splitting up of white light into its component colours is called dispersion.

Cause of dispersion.

- From Snell's law of refraction, the angle of refraction of light in a glass prism depends on its refractive index which is different for different wavelength(λ) and for different speed (v) and ($n \propto \frac{1}{\lambda}$ and $n \propto \frac{1}{v}$).
- The red light bends the least as it has maximum wavelength/speed while violet bends the most due to its smaller wavelength/speed.
- The angle of deviation of other colours lies in between the angle of deviation of red and violet colour.
- Thus, when white light is incident on a glass prism, it splits into its constituent colour after being refracted through the glass prism. The different colour emerges along different angles and become distinct. This is called dispersion.

(*b*) **Rainbow:** It is an optical natural spectrum, produced by the nature in the sky, in the form of a multicoloured arc. It is always formed in the direction opposite to that of the sun after a rain shower. It is caused by the dispersion of sunlight by water droplets suspended in the atmosphere after rainfall. These water droplets act like small prisms. The Sunlight enters the water droplets. At the point of incidence, it refracts and disperses then gets reflected internally and finally gets refracted again at the point of emergence as it comes out of the rain-drop.



Formation of primary rainbow

Therefore, due to refraction, dispersion and internal reflection of the sunlight, different colours reach the observer's eye along different paths and become distinct. It creates a rainbow in the sky.

Hence "Rainbow is an example of dispersion of sunlight."

Necessary conditions for the formation of a rainbow.

(*i*) The presence of water droplets in the atmosphere, and

(*ii*) The sun must be at the back of the observer, i.e. the observer must stand with his back towards the sun.

PRACTICE QUESTIONS

1. The property of light used by the prism to form a spectrum is

(*a*) refraction of light

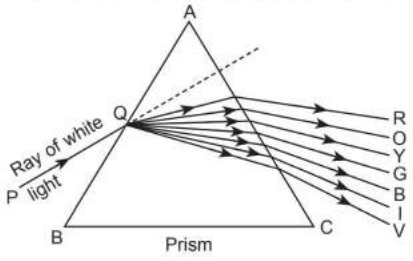
(*b*) reflection of light

(*c*) dispersion of light

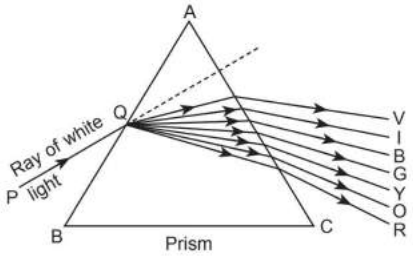
(*d*) diffused reflection of light.

2. Which of the following figures correctly represents dispersion of white light by the triangular glass prism?

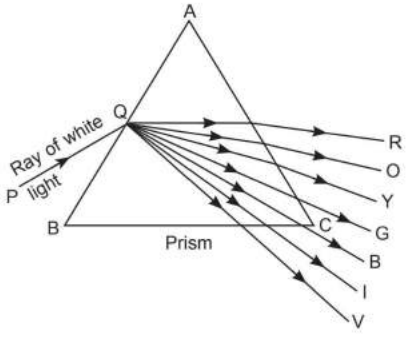
(*a*)



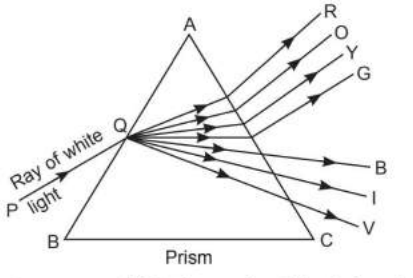
(*b*)



(*c*)



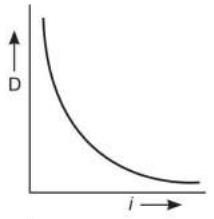
(*d*)



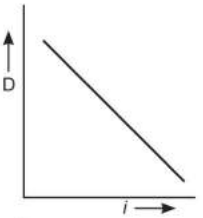
3. The factors on which the angle of deviation through a prism depends
   (*a*) angle of prism
   (*b*) angle of incidence
   (*c*) nature of the material of prism
   (*d*) all of the above

4. Which of the following graph represents the correct variation of angle of incidence (*i*) and angle of deviation (D) in the study of refraction of light through a triangular glass prism?

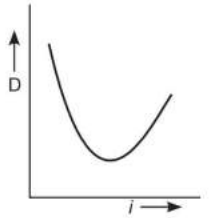
(*a*)



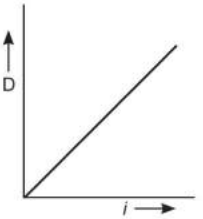
(*b*)



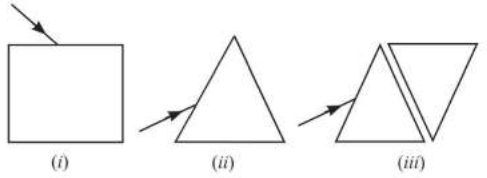
(*c*)



(*d*)



5. In which of the following cases, the dispersion will take place when sunlight passes through it?



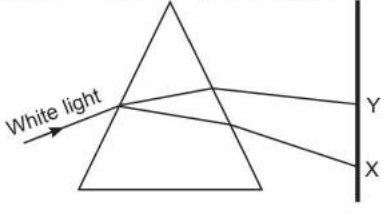
   (*a*) In figure (*i*) only (*b*) In figure (*ii*) only
   (*c*) In figure (*iii*) ony (*d*) In all three figures

6. A ray of light in incident on one of the refracting face of the prism. At condition of least deviation it emerges out from its other side making an angle of emergence
   (*a*) smaller than angle of incidence
   (*b*) equal to prism angle
   (*c*) equal to angle of incidence
   (*d*) greater than the angle of incidence

7. Draw a ray diagram to show the formation of a rainbow and mark the point where (*i*) dispersion, (*ii*) internal reflection occurs. **[Foreign 2012]**

8. (*a*) What is meant by dispersion of white light? Draw a ray diagram to show the dispersion of white light by a glass prism.
   (*b*) Light of two colours A and B pass through a prism. 'A' deviate more than 'B' from its path of incidence. Which colour has a higher speed in the prism?

9. A narrow beam of light produces a spectrum XY on passing through a triangular glass prism.



(*a*) State the colour at X and Y.
(*b*) Why do the different components of white light bend through different angles with respect to the incident beam of light? [DoE]

10. What is meant by dispersion and recombination? Explain with the help of a diagram. What is a spectrum? Name the various colours of spectrum of white light in proper sequence. [KVS]

TOPICS COVERED

Atmospheric Refraction and Scattering of Light

Multiple Choice Questions 1 Mark

1. **The air layer of atmosphere whose temperature is less then the hot layer behave as optically**
   (*a*) denser medium
   (*b*) rarer medium
   (*c*) inactive medium
   (*d*) either denser or rarer medium
2. **Refraction of light by the earth's atmosphere due to variation in air density is called**
   (*a*) atmospheirc reflection
   (*b*) atmospheric dispersion
   (*c*) atmospheric scattering
   (*d*) atmospheric refraction
3. **The deflection of light by minute particles and molecules of the atmosphere in all direction is called _____ of light.**
   (*a*) dispersion (*b*) scattering
   (*c*) interference (*d*) tyndell effect
4. **One cannot see through the fog, because**
   (*a*) refractive index of the fog is very high
   (*b*) light suffers total reflection at droplets
   (*c*) fog absorbs light
   (*d*) light is scattered by the droplets
5. **To an astronaut the sky on the moon appear dark because** [CBSE 2022]
   (*a*) there is no light on the moon.
   (*b*) there is no atmosphere on the surface of the moon.
   (*c*) moon is non-luminous object.
   (*d*) the surface of the moon absorbs all the sunlights.
6. **Rohan lit an incense stick in his room and after an hour observed that when a beam of sunlight entered his room through a small gap in the window, he was able to see the path of the beam. Which of the following is most likely TRUE about the air present in the room?** [CFPQ, CBSE]
   (*a*) It is a pure substance. (*b*) It is a compound.
   (*c*) It is a solution. (*d*) It is a colloid.
7. **Which one of the following is the correct reason for twinkling of stars?** [CBSE 2021C]
   (*a*) Atmospheric reflection of starlight
   (*b*) Atmospheric refraction of starlight
   (*c*) Scattering of starlight
   (*d*) Dispersion of starlight
8. **Blue colour of clear sky is due to**
   (*a*) refraction of light (*b*) absorption of light
   (*c*) reflection of light (*d*) scattering of light

Answers

1. (*a*) The cold air layer of the atmosphere acts as a optically denser medium than hot air because the molecules are closely packed together.
2. (*d*) This phenomena is called atmospheric refraction.
3. (*b*) The said phenomenon is called scattering of light.
4. (*d*) Objects are not visible through the fog because droplets scatter the light rays.
5. (*b*) 6. (*d*) 7. (*b*) 8. (*d*)

Very Short Answer Type Questions 2 Marks

9. **Nanda saw rays of sunlight entering into a dark room as shown below.**

He then did something to the air in the room after which he was NOT able to see the rays of sunlight in the room.
What is it that Nanda could have done to make the rays of sunlight invisible? Justify your answer. [CFPQ, CBSE]

Ans. Removing all the dust particles from the air in the room by passing the air through a very efficient filter. Filtering the air removes the suspended dust particles thus preventing the scattering of light which make the rays visible.

10. Space is mostly vacuum, devoid of any medium.
(*a*) What colour does the sun appear to the astronauts on International Space Station?
(*b*) Give reason for your answer to (*a*).
[CFPQ, CBSE]

Ans. (*a*) White
(*b*) Since there is no medium to disperse or scatter the light coming from the Sun, it appears white.

11. What is meant by scattering of light? State its two effects that are produced by the atmosphere.

Ans. **Scattering of Light:** The phenomenon in which light rays are directed in different direction when it interacts with 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.
The effects are
(*i*) Tyndall effect
(*ii*) Blue colour of sky

12. The colour of clear sky from the earth appears blue but from the space it appears black. Why?
[CBSE 2023]

Ans. When sunlight passes through the earth's atmosphere, it is scattered in all directions by the gaseous and other fine particles present in the atmosphere. The blue colour has a shorter wavelength than the red. So, according to Rayleigh scattering law, the blue colour of sunlight is scattered more strongly by the large number of fine particles having size smaller than the wavelength of visible light in the earth's atmosphere. The scattered blue light enters our eyes, hence the sky appears blue.
From space sky appears black because at such huge heights due to absence of atmosphere no scattering of light takes place.

SA Short Answer Type Questions 3 Marks

13. Explain giving reason why the sky appears blue to an observer from the surface of the earth. What should the appearance of the sky be during the day for an astronaut staying in the international space station orbiting the Earth? State reason to justify your answer. **[Foreign 2015]**

Or

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.
[Delhi 2014]

Ans. When sunlight passes through the earth's atmosphere, it is scattered in all directions by the gaseous and other fine particles present in the atmosphere. The blue colour has a shorter wavelength than the red. So, according to Rayleigh scattering law, the blue colour of sunlight is scattered more strongly by the large number of fine particles having size smaller than the wavelength of visible light in the earth's atmosphere. The scattered blue light enters our eyes, hence the sky appears blue.
For an astronaut, staying in the international space station orbiting the earth, the colour of the sky will be black, i.e. sky will appear dark.
Reason: Sunlight does not scatter in the absence of atmosphere.

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

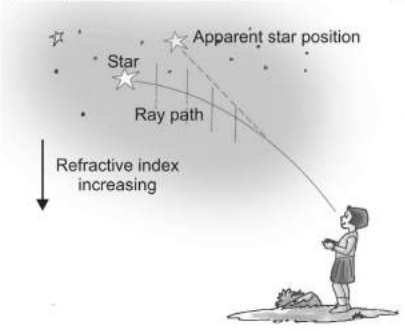
Ans. Tyndall effect: Scattering of beam of visible light by the colloidal particles present in the colloidal solution is called Tyndall effect. It occurs when the dimension of the dispersed particle that are causing the scattering are larger than the wavelength of incident light i.e 10^{-7} m. Accordingly, the colour of the scattered light depends on the size of the scattering particles in colloidal solution.
Four instances of observing the Tyndall effect are
(*a*) Headlight of a car shining through fog.
(*b*) When a fine beam of sunlight enters a smoke-filled room through a small hole.
(*c*) When sunlight passes through a canopy of a dense forest.
(*d*) Blue colour of sky.

LA Long Answer Type Questions 5 Marks

15. What is atmospheric refraction? Use this phenomenon to explain the following natural events.
(*a*) Twinkling of stars **[AI 2012]**
(*b*) Advanced sunrise and delayed sunset.
[Delhi 2014, Foreign 2015]
Draw diagrams to illustrate your answers.
[AI 2016]

Ans. **Atmospheric Refraction:** The refraction of light caused by the earth's atmosphere due to gradual change in the refractive indices of its different layers by the varying conditions of it, is called atmospheric refraction.
(*a*) **Twinkling of stars**
The hot layers (low densities) of air at a high altitude, behave as an optically rarer medium for the light rays, whereas the cold dense layers (high densities) of air near the earth's surface, behave as an optically denser medium for the light rays. So, when the light rays (starlight) pass through the various layers of atmosphere, they will get deviated and bent toward the normal. As a result, the apparent

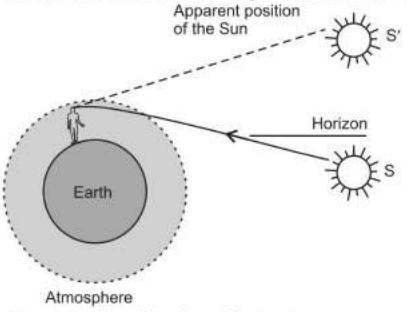
position of star is slightly different from its actual position. Thus, the stars appear slightly higher (above) than their actual positions in the sky.



The fluctuation in the positions of the stars occurs continuously due to the changing amount of light entering the eye. The stars sometimes appear brighter and at some other times, they appear fainter. This causes twinkling of stars.

(*b*) **Advanced sunrise and delayed sunset**

The sun is visible 2 minutes before sunrise and 2 minutes after sunset because of atmospheric refraction. This can be explained as below.



Atmospheric refraction effects at sunset or sunrise

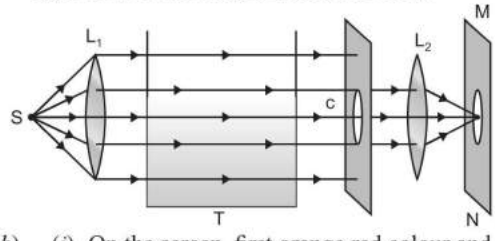
The figure shows the actual position of the sun *S* at the time of sunrise or sunset, just below the horizon while the apparent position *S′*, above the horizon as appear to us.

When the sun is slightly below the horizon, the light rays move through the different layers of varying refractive indices of air and get bent towards the normal. These rays appear to come from *S′*, which is the apparent position of the sun. That is why, the sun is visible to us when it has been actually below the horizon or before the actual crossing of horizon by the sun at the time of sunrise or sunset. So, due to the atmospheric refraction, the phenomenon of advanced advance sunrise and delayed sunset is observed.

16. (*a*) Draw a figure which shows the arrangement for observing the phenomenon of scattering of light in the laboratory.

(*b*) What colours would you observe in the experiment? Why?

Ans. (*a*) An arrangement for observing the scattering of light in the laboratory is as shown below.



(*b*) (*i*) On the screen, first orange red colour and then bright crimson red colour patch is observed.

(*ii*) From the other three sides of colloidal solution of sulphur in a glass tank (T), blue colour is observed.

This is because the very fine colloidal sulphur particles scatter away the blue colour from the path of beam and only red colour (least scattered) of the beam of white light reaches the screen through the solution.

PRACTICE QUESTIONS

1. Which of the following statements is not true for scattering of light? **[CBSE 2021]**
(*a*) Colour of the scattered light depends on the size of particles of the atmosphere.
(*b*) Red light is least scattered in the atmosphere.
(*c*) Scattering of light takes place as various colours of white light travel with different speed in air.
(*d*) The fine particles in the atmospheric air scatter the blue light more strongly than red. So the scattered blue light enters our eyes.

2. Tyndall effect is colloidal solution is due to
(*a*) reflection of light (*b*) absorption of light
(*c*) scattering of light (*d*) refraction of light

3. At noon, the sun appears white as **[CBSE 2016]**
(*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.

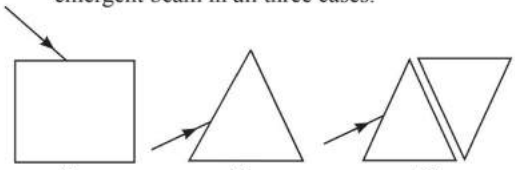
4. The apparent flattening of the sun's disc at sunrise and sunset is due to: **[CBSE 2021(C)]**
(*a*) Dispersion of light
(*b*) Scattering of light
(*c*) Atmospheric refraction of light
(*d*) Tyndall effect

5. What is the colour of the clear sky during daytime? Give reason for it.
6. Is the position of star as seen by us in its true position? Justify your answer.
7. What is the basic cause of atmospheric refraction?
8. State the reason behind the following phenomenon/ observations.
   (*a*) Pathway of light visible in foggy atmosphere or a dusty room/smoke filled room.
   (*b*) The apparent flattering of the sun's disc at sunrise and sunset.
   (*c*) Danger signal lights are red in colour.
9. Imagine you and your family members are astronauts on the space station now. You record the following observations from your spaceship and send them to a friend by e-mail.
   (*a*) Star appears to twinkle while the planets do not similar to as observed from the earth.
   (*b*) Sky appears black in colour.
   (*c*) The length of the day is same as observed on the earth.

   How can each observation be justified by your friend?

INTEGRATED (MIXED) QUESTIONS

1. (*a*) Which part of the eye has delicate membrane and containing large number of light sensitive cells?
   (*b*) A person is advised to wear spectacles with convex lenses. What type of defect of vision is he suffering from? **(2 Marks)**
2. A glass prism is able to produce a spectrum when white light passes through it but a glass slab does not produce any spectrum. Explain why is it so? **(2 Marks)**
3. (*a*) A person can see objects if they are placed at 1.5 m. What kind of lens would be required to read a book at a distance of 25 cm? What kind of eye defect is it? Calculate the power of lens used to correct the defect.
   (*b*) The limitation of an eye is that the distance from the eye lens to where the image formed is always the same. How is then it possible for the eye to form focussed images from the objects that are located at varying distances from the eye? **(3 Marks)**
4. (*a*) A very thin narrow beam of white light is made incident on three glass objects as shown below. Comment on the nature of behaviour of the emergent beam in all three cases.



   (*b*) There is a similarity between two of the emergent beams. Identify the two. **(3 Marks)**
5. Differentiate between a glass slab and a glass prism. What happens when a narrow beam of (*a*) a monochromatic light, and (*b*) white light passes through (*i*) glass slab and (*ii*) glass prism?
   [CBSE 2020] (3 Marks)
6. (*a*) Explain the following terms used in relation to defects in vision and correction provided by them:
   (*i*) Myopia (*ii*) Bifocal lenses
   (*iii*) Far-sightedness.
   (*b*) Why is the normal eye unable to focus on an object placed within 10 cm from the eye? **(5 Marks)**
7. Instruction: Read the passage carefully and answer the following questions given below it.
   You are given that the diameter of the eyeball is about 2.3 cm and a normal eye can adjust the focal length of its eye lens to see objects situated anywhere from 25 cm to an infinite distance away from it.
   (*a*) What is the power of the (normal) eye lens, when ciliary muscles are fully relaxed?
   (*b*) What is the power of the (normal) eye lens, when ciliary muscles are in their maximum contract position?
   (*c*) The maximum variation in the power of the eye lens, when it adjust itself, from the normal relaxed position to the position where the eye can see the nearby object clearly? **[HOTS] (5 Marks)**
8. (*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 is seated 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. **[CBSE Sample Paper 2019] (5 Marks)**

9. (*a*) (*i*) What is meant by scattering of light? [CBSE 2023]

(*ii*) State the factors on which the colour of scattered light perceived by us depends. [AI 2015]

(*b*) Which of the two is scattered more easily-light of short wavelength or light of longer wavelength? Give reason.

(*c*) How is the eye defect of old person differing from near-sightedness and far-sightedness? [HOTS]

(5 Marks)

ASSERTION AND REASON QUESTIONS

In the following Questions, the Assertion and Reason have been put forward. Read the statements carefully and choose the correct alternative from the following:

(*a*) Both the Assertion and the Reason are correct and the Reason is the correct explanation of the Assertion.

(*b*) The Assertion and the Reason are correct but the Reason is not the correct explanation of the Assertion.

(*c*) Assertion is true but the Reason is false.

(*d*) The statement of the Assertion is false but the Reason is true.

1. **Assertion:** The near-point of a hypermetropic eye is more than 25 cm away.
   Reason: Hypermetropia is corrected using spectacles containing concave lenses.
2. **Assertion:** Myopia is the defect of vision in which a person cannot see the distant objects clearly.
   Reason: This due to eye-ball being too short.
3. **Assertion:** Pupil is black in colour.
   Reason: Pupil is black in colour as no light is reflected back.
4. **Assertion:** The rainbow is a man made spectrum of sunlight in the sky.
   Reason: The rainbow is formed in the sky when the sun is shining and presence of water droplets at the same time.
5. **Assertion:** Sky appears blue in the day time.
   Reason: White light is composed of seven colours. [CBSE 2022]
6. **Assertion:** When objects are observed through a turbulent stream of hot air, they appear to be flickered.
   Reason: Hotter air has a refractive index less than that of the cooler air.
7. **Assertion:** A person suffering from myopia cannot see the distant object clearly.
   Reason: Converging lens is used for the correction of myopic eye as it can form real as well as virtual images of the objects placed in front of it. [CBSE 2023]
8. **Assertion:** The angle through which a ray of light bends on passing through a prism is called the angle of deviation.
   Reason: The peculiar shape of a prism makes the emergent ray bend at angle to the direction of the incident ray. [CBSE 2023]

CASE-BASED QUESTIONS

The following questions are source-based/case-based questions. Read the case carefully and answer the questions that follow.

1. Two children went to the park with their grandfather. On reaching the park, the children joined others to play, while their grandfather after taking three rounds of the park, sat on the chair, took out newspaper from his bag and began to read with the help of his spectacle. After sometime, he realised that it was too long to see the children, he looked around, but though he has worn spectacle, he couldn't see anything. He then realised that he had forgotten his other spectacle, which he used to see the far away places, were left at home. He began calling them by their names, but due to the large distance, his voice was not reaching the children. Another man sitting beside him realised the problem and helped him to reach the children.

   (*a*) Name the defect of vision the grandfather is suffering from.

   (*b*) Which type of lens is used to correct this eye defect?

   (*c*) State the cause of eye defect by which grandfather is suffering.

   Or

   (*c*) If a grandfather wears lens of power –6D for the distant vision and for correcting his near vision, he needs a lens of +2D. Determine the focal length of the lenses in both the cases.

2. A rainbow is one of the most spectacular natural light shows observed in the sky. A number of scientist

and mathematician including Aristotle, Bacon, Theodoric, Descartes, Newton, Young, Airy and Mie have worked on the explanation of various observations on rainbows.

To understand the formation of rainbow one should actually study the refraction, internal reflection, dispersion and total deviation of white light by the spherical water drop.

A rainbow is produced when sunlight falls and gets diverted to the eyes of the observer due to a large number of water droplets in the sky on a rainy day.

In addition to primary Rainbow there is a secondary rainbow. It occurs in the same manner as the primary rainbow but due to two internal reflections. In nature we can observe only primary and secondary rainbows. Higher order rainbows are never seen since they are weaker than (*i*) the background sky brightness (*ii*) the light reflected from the outside surface of the drops and (*iii*) the light transmitted through the process with no internal reflections.

(*a*) What is refraction?

(*b*) List two essential conditions for observing a rainbow.

(*c*) What is the shape of a rainbow?

Or

(*c*) Why the red appears on the top of rainbow?

3. Pranav has too much enthusiasm to celebrate the end of winter season and welcomes the season of fruitfulness with family members and relatives. In the evening all family members gather up and move in a circle around the bonfire. At particular moment, Pranav observe that the apparent position of object, as seen through the hot air or beyond and above the fire changes continuously. After sometimes, he find that this phenomena can also be used to explain several observation around us.

(*a*) Name the phenomenon which could explain the wavering of objects above a fire.

(*b*) Define the phenomena observed by Pranav.

(*c*) Name two observations which can be explained by the above phenomena.

Or

(*c*) How does the refractive index of earth's atmosphere vary with height?

4. The foundation of modern optics lays in 1672 when Sir Isaac Newton publishes his paper on the bending of light through prism. His experiments in bending of light through prisms led, eventually, to the revolutionary discovery of distinct coloured rays in white light and, distinguishable when refracted through a prism. In his experiment, he set up a prism near his window, and projected a beautiful spectrum 22 feet onto the far wall. Further, to prove that the prism was not colouring the light, he refracted the light back together by placing the second identical prism in an inverted position with respect to the first prism.

(*a*) State the phenomenon of light used by the prism to form spectrum.

(*b*) How does the angle of minimum deviation of glass prism vary if the incident violet light is replaced by red light?

(*c*) The refractive index of the material of the prism is $\sqrt{2}$ and angle of prism is 30°. One of the two refracting surfaces of the prism is made a mirror inwards with a silver coating. At what angle of incidence, a beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface)?

Or

(*c*) What conclusion would you like to draw about angle of incident and angle of emergence in the case of refraction of light through a triangular glass prism?

5. A student sitting at the back bench in a class has difficulty in reading. He observed that he has no difficulty in reading if he seated at front seat of the class. Doctor prescribed him a suitable lens of negative power and explain him that this lens shifts the image back onto the retina instead of in front of it. He is now able to read the blackboard while sitting at the back bench in the class.

(*a*) Name the defect of vision in the student's eye.

(*b*) If the doctor prescribes the lenses of power -0.5D write the type of these lenses.

(*c*) Why the student is unable to see distinctly written on the blackboard from the back bench of the class?

Or

(*c*) Write the function of retina in human eye.

6. Glasses are among the most common forms of eye wear to correct sight, adding or subtracting power to manage near-sightedness (myopia), far-sightedness (hypermetropia), misshapen corneas (astigmatism i.e., imperfection in the curvature of eye's cornea or lens), or farsightedness associated with age (presbyopia).

An eye exam helps to detect eye problems at their earliest stage. Regular eye exams give your eye care professional a chance to help you correct or adapt to vision changes and provide you with tips on caring for your eyes and give you a prescription for corrective lenses.

Single vision prescriptions are for patients who have trouble seeing either near or far (but not both). Cylindrical lens and axis both together are required to correct the astigmatism while multifocal lenses

eyeglasses are used to correct presbyopia. Three prescriptions for three persons having different eye diseases are shown below:

For person A

Spectacles	Right Eye (OD)					Left Eye (OS)				
	Sph	Cyl	Axis	Prism and Base	V/A	Sph	Cyl	Axis	Prism and Base	V/A
Distance	–1.5				6/6	–2.25				6/6
Near										

For person B

Spectacles	Right Eye (OD)					Left Eye (OS)				
	Sph	Cyl	Axis	Prism and Base	V/A	Sph	Cyl	Axis	Prism and Base	V/A
Distance										
Near	+1.00				6/6	+0.25				6/6

For person C

Spectacles	Right Eye (OD)					Left Eye (OS)				
	Sph	Cyl	Axis	Prism and Base	V/A	Sph	Cyl	Axis	Prism and Base	V/A
Distance	–0.5	+1.25	50°		6/6		–1.00	75°		6/6
Near	+2.50					+2.50				

(*a*) What does the number in the column of spherical lens represents?

(*b*) After analysing the table, state the persons who have suffered from myopia and hypermetropia.

(*c*) Is the defect in vision a disease? If not, why?

Or

(*c*) State the nature of corrective lens and its focal length for the right eye of person B as prescribed by the doctor.

7. In an experiment, Pooja used a equilateral triangular glass prism and projected a narrow beam of white light source from one side of the surface of the prism. She placed a screen on the other side and saw many colours appearing as patches on the screen. But when she used a red light source, she could only see a red patch on the screen. Similarly she used a blue and green light source and could only see one colour patch on both occasions.

(*a*) State the phenomenon that she was trying to demonstrate.

(*b*) Give reason: Why she could not see any other colour when the red light was used?

(*c*) She also could relate to another natural phenomenon that we observe on a rainy humid day as sun comes out. What could be that phenomenon?

Or

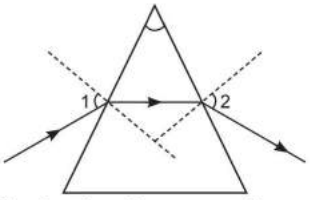
(*c*) State the reason that Pooja can give to her friends to explain the phenomenon observed by her in the experiment.

8. Light seems to travel along straight line paths in a transparent medium. But when light enters obliquely from one transparent medium to another, some changes are observed. This is because different mediums have different optical densities. The extent of the change in the direction of light that takes place when it enters obliquely in a given pair of media is expressed in terms of a constant: Light travels the fastest in vacuum. Light gets refracted through a transparent prism. Several phenomena are observed due to the reflection, refraction, dispersion and scattering of light by various medium.

[CBSE 2021(C)]

(*a*) Which phenomena is/are responsible for the formation of rainbow?

(*b*) What the angles marked $\angle 1$ and $\angle 2$ represents respectively in the given diagram showing refraction of a narrow beam of a monochromatic light through a glass prism?



(*c*) Why the clear sky appears blue to us?

Or

(*c*) Consider the following statements.

I. Violet light bends the least while red light bends the most when a beam of white light passes through a glass prism.

II. The path of the beam of light passing through a true solution is not visible while visible through a colloidal solution.

III. The refractive index of hotter air is slightly less than that of the cooler air.

Choose the correct statement(s) from above.

NCERT ZONE

NCERT INTEXT QUESTIONS

Page 164

1. What is meant by power of accommodation of the eye?

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

2. A person with a myopic eye cannot see objects beyond 1.2 m distinctly. What should be the type of the corrective lens used to restore proper vision?

Ans. A person with myopic eye defect should use concave lens of focal length 1.2 m to restore his proper vision.

3. What is the far point and near point of the human eye with normal vision? [KVS]

Ans. For normal vision, the near point is about 25 cm and far point is infinity. Thus, a normal eye can see objects clearly that are between 25 cm and infinity.

4. A student has difficulty reading the blackboard while sitting in the last row. What could be the defect the child is suffering from? How can it be corrected?

Ans. Child is suffering from myopia or short sightedness. The defect is corrected by using a concave lens of suitable power placed in front of eye defective.

NCERT EXERCISES

1. The human eye can focus objects at different distances by adjusting the focal length of the eye lens. This is due to

(*a*) presbyopia. (*b*) accommodation.
(*c*) near-sightedness. (*d*) far-sightedness.

Ans. (*b*) accomodation.

2. The human eye forms the image of an object at its

(*a*) cornea. (*b*) iris.
(*c*) pupil. (*d*) retina.

Ans. (*d*) retina.

3. The least distance of distinct vision for a young adult with normal vision is about

(*a*) 25 m. (*b*) 2.5 cm.
(*c*) 25 cm. (*d*) 2.5 m.

Ans. (*c*) 25 cm.

4. The change in focal length of an eye lens is caused by the action of the

(*a*) pupil. (*b*) retina.
(*c*) ciliary muscles. (*d*) iris.

Ans. (*c*) ciliary muscles.

5. A person needs a lens of power –5.5 dioptres for correcting his distant vision. For correcting his near vision he needs a lens of power +1.5 dioptre. What is the focal length of the lens required for correcting

(*i*) distant vision (*ii*) near vision?

Ans. (*i*) Focal length of the lens for distant vision

$$= \frac{1}{\text{Power}} = \frac{100}{-5.5}\ \text{cm} = -18\ \text{cm (approx.)}$$

(*ii*) Focal length of the lens for near vision

$$= \frac{100}{1.5}\ \text{cm} = 66.66\ \text{cm}$$

6. The far point of a myopic person is 80 cm in front of the eye. What is the nature and power of the lens required to correct the problem?

Ans. The far point of a normal eye is infinity. Since the far point of the defective eye is given as 80 cm, the eye is short-sighted. To correct it, the lens should be such that an object at infinity must form its image at the far point of defective eye.

$\therefore u = -\infty, v = -80$ cm

Using lens formula,

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

$$\therefore \quad \frac{1}{f} = \frac{1}{-80} - \frac{1}{(-\infty)}$$

$$= -\frac{1}{80}$$

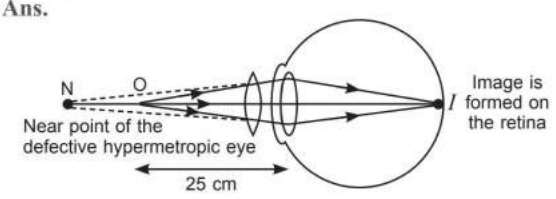
$\therefore$ Focal length of lens is – 80 cm.

The correction is done by using a concave lens of focal length 80 cm.

$$\text{Power of the lens} = \frac{100}{f(\text{in cm})} = -\frac{100}{80} = -1.25 \text{ D}$$

7. Make a diagram to show how hypermetropia is corrected. The near point of a hypermetropic eye is 1 m. What is the power of a lens required to correct this defect? Assume that near point of the normal eye is 25 cm.

Ans.



To correct the defect, the image of an object at 25 cm should be brought at 100 cm.

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

$$= \frac{1}{-100} - \frac{1}{-25}$$

$$\Rightarrow \quad \frac{1}{f} = \frac{-1}{100} + \frac{1}{25} = \frac{-1+4}{100} = \frac{3}{100}$$

$$\therefore \quad f = +\frac{100}{3} = +33.3 \text{ cm}$$

So, a convex lens of focal length 33.3 cm is required.

$$\text{Power, } P = \frac{100}{33.3} = 3.0 \text{ D}$$

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

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

9. What happens to the image distance in the eye when we increase the distance of an object from the eye?

Or

If we increase the distance of an object from the eye, how will the distance of image formed in the eye change? **[DoE]**

Ans. In eye, the image is always formed on the retina. The image distance is the distance between the eye lens and the retina. When we increase the distance of the object from the eye, the focal length of the eye lens increases due to the action of ciliary muscles so that the image of object is formed on the retina and therefore, the image distance remains the same.

10. Why do stars twinkle? **[Foreign 2016]**

Ans. The stars twinkle at night, because the intensity of starlight reaching our eyes increases and decreases continuously due to atmospheric refraction. When the starlight reaching our eyes increases, the stars look bright and when the starlight reaching our eyes decreases, they appear dim. This gives us the twinkling effect.

11. Explain why the planets do not twinkle. **[Foreign 2015, KVS]**

Ans. The planets are much nearer to the earth as compared to the stars so they can be treated as a collection of large number of point-sized source of light. Due to varying condition of atmosphere, the darkest part of the twinkling effect from one point source may be overlapped by the focussed light from the point source of other region of planet, so the total amount of light entering into the eye remains constant. Thus, the planets look steady and do not appear twinkle.

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

Ans. At such huge heights due to absence of atmosphere, no scattering of the light takes place. Therefore, sky appears dark.

SELECT NCERT EXEMPLAR PROBLEMS

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

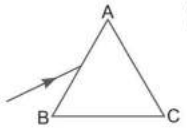
(*a*) + 0.5 D
(*b*) – 0.5 D
(*c*) + 0.2 D
(*d*) – 0.2 D

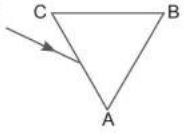
Ans. (*b*) Person cannot see distant objects clearly. So he is suffering from myopia. The defect is corrected by using concave lens of power

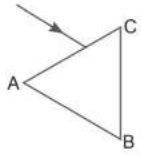
$$P = \frac{1}{f} = \frac{1}{-2 \text{ m}} = -0.5 \text{ D}$$

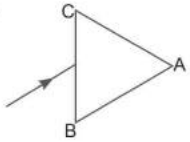
2. A prism ABC (with BC as base) is placed in different orientations. A narrow beam of white

light is incident on the prism as shown in figure. In which of the following cases, after dispersion, the third colour from the top corresponds to the colour of the sky?

(*a*) 

(*b*) 

(*c*) 

(*d*) 

Ans. (*b*) In figure (*a*) base BC of the prism is at the bottom, then violet colour lies at the bottom but in figure (*b*), the base BC is at the top, then violet would be at the top after dispersion, and third colour would be blue.

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.

Ans. (*b*) Twinkling of star is due to atmospheric refraction of starlight caused by the gradual change in refractive index of different air layers at different height, the apparent position of star keeps on changing.

4. The clear sky appears blue because
(*a*) blue light gets absorbed in the atmosphere.
(*b*) ultraviolet radiations are absorbed in the atmosphere.
(*c*) violet and blue lights get scattered more than lights of all other colours by the atmosphere.
(*d*) light of all other colours is scattered more than the violet and blue colour lights by the atmosphere.

Ans. (*c*) Violet and blue colour have shorter wavelength. So, they scattered more than lights of other colour by the molecules present in the atmosphere.

5. The danger signals installed at the top of tall buildings are red in colour. These can be easily seen from a distance because among all other colours, the red light
(*a*) is scattered the most by smoke or fog
(*b*) is scattered the least by smoke or fog
(*c*) is absorbed the most by smoke or fog
(*d*) moves fastest in air

Ans. (*b*) Red colour has longer wavelength so least scattered by smoke or fog.

6. The bluish colour of water in deep sea is due to
(*a*) the presence of algae and other plants found in water
(*b*) reflection of sky in water
(*c*) scattering of light
(*d*) absorption of light by the sea

Ans. (*c*) The fine water molecules mainly scatter blue light due to its shorter wavelength.

7. 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

Ans. (*b*) Most of the refraction for light rays entering the eye occurs at the outer surface of cornea which acts a primary lens converging in nature.

8. The focal length of the eye lens increases when eye muscles
(*a*) are relaxed and lens becomes thinner
(*b*) contract and lens becomes thicker
(*c*) are relaxed and lens becomes thicker
(*d*) contract and lens becomes thinner

Ans. (*a*) Cilliary muscles modify the curvature of eye lens. When eye muscles are relaxed, eye lens becomes thinner thereby increase in the focal length of eye lens.

9. A student sitting on the last bench can read the letters written on the blackboard but is not able to read the letters written in his text book. Which of the following statements is correct?
(*a*) The near point of his eyes has receded away
(*b*) The near point of his eyes has come closer to him
(*c*) The far point of his eyes has come closer to him
(*d*) The far point of his eyes has receded away

Ans. (*a*)

10. 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

Ans. (*c*)

11. Which of the following statements is correct regarding the propagation of light of different colours of white light in air?
(*a*) Red light moves fastest.
(*b*) Blue light moves faster than green light.
(*c*) All the colours of the white light move with the same speed.
(*d*) Yellow light moves with the mean speed as that of the red and the violet light.

Ans. (*c*)

12. Which of the following statement is correct?

(*a*) A person with myopia can see distant objects clearly.

(*b*) A person with hypermetropia can see nearby objects clearly.

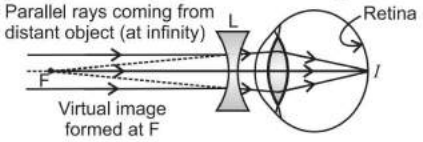
(*c*) A person with myopia can see nearby objects clearly.

(*d*) A person with hypermetropia cannot see distant objects clearly.

Ans. (*c*)

13. A student sitting at the back of the classroom cannot read clearly the letters written on the blackboard. What advice will a doctor give to him? Draw ray diagram for the correction of this defect.

Ans. The student is suffering from short-sightedness. Doctor will advise to him to wear a concave lens having suitable power for correcting the vision.



14. How are we able to see the nearby as well as distant objects clearly?

Ans. Accommodation: The ability of the ciliary muscles to adjust the curvature and thereby the focal length of eyelens to get a clear view of the objects is called accommodation. There is always a limit up to which ciliary muscles can increase or decrease the focal length of eye lens. This change enables us to see nearer and far-off objects clearly.

15. A person needs a lens of power – 4.5 D for correction of his vision.

(*a*) What kind of defect in vision is he suffering from?

(*b*) What is the focal length of the corrective lens?

(*c*) What is the nature of the corrective lens?

Ans. (*a*) The defect is myopia (short-sightedness).

(*b*) Focal length $= \frac{1}{\text{Power}} = -\frac{100}{4.5} = -22.2$ cm

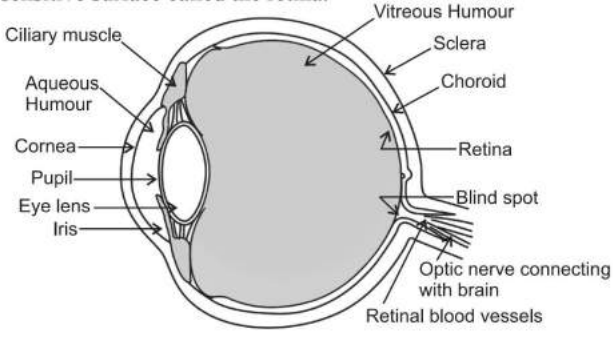
(*c*) The lens is a concave lens.

16. Is the position of a star as seen by us its true position? Justify your answer.

Ans. Light from the star passing through various layers of the atmosphere bends towards the normal due to the changing refractive indices of different layers of the atmosphere and appears as if it is coming from a higher level than their true position. As a result, the star appears slightly higher than its actual position.

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

Ans. Human Eye: The natural optical device through which one could see objects around him. It forms an inverted and real image on a light sensitive surface called the retina.



The parts of human eye and its functions:

(*i*) **Cornea:** It is a thin membrane, covering the surface of eyeball, through which light enters. It acts as a primary lens, which provides the refraction for light rays entering the eye.

(*ii*) **Aqueous Humour:** It is a transparent gelatinous fluid, secreted from ciliary muscles and fills the space between the cornea and the eye lens. It provides nutrition to the eye tissues and increases the protection against dust, wind, pollen grains, etc.

(*iii*) **Iris:** It is a dark muscular diaphragm that controls the size of the pupil and is located just behind the cornea in the eye.

(*iv*) **Pupil:** The black opening between the aqueous humour and the eye lens. Since light does not get reflected from it, so its appearance is dark. The amount of light entering the eye is controlled by the size of the pupil. In dim light, it opens up completely through the iris, but in bright light, it becomes very small.

(*v*) **Ciliary Muscle:** (*a*) It modifies the curvature and thereby the focal length of the eye lens by contracting or relaxing itself to focus the image of an object on the retina according to the distance of the object. (*b*) It holds the eye lens in position.

(*vi*) **Eye Lens:** It is converging in nature, made by the jelly-like proteinaceous material. The focal length of the eye lens is changed by the ciliary muscles. Its function is to focus the incoming light rays from the object on the retina using its refractive property.

(*vii*) **Vitreous Humour:** It is a transparent, colourless gelatinous mass that fills the space between the eye lens and the retina of the eyeball. It helps to keep retina in place by pressing it against the choroid.

(*viii*) **Retina:** It is a delicate membrane. It acts like a screen on which a real, inverted and diminished image of the object, is formed by the crystalline lens of the eye. It contains enormous number of light sensitive cells. These light receptors are known as rod and cone cells which generate electrical signals upon illumination. These electrical impulses are sent to the brain via optic nerves for further processing.

(*ix*) **Rods and Cones:** These are the light sensitive cells present in retina and get activated upon illumination. Rods respond to the intensity of light, whereas cones respond to the colour. There are around 125 million rodsand cone cells. These cells generate electrical signals which are transmitted to the brain through optical nerves. The brain processes the information via these electric signals and gives the impression of erect image to us.

To see nearby as well as distant objects, ciliary muscles modify the curvature of eye lens. This leads to the variation in focal length of the eye lens as explain below.

(*a*) When ciliary muscles are relaxed, the lens becomes thin. The focal length of the lens increases and has maximum value, equal to the distance from the retina. So, the parallel rays coming from the distant objects entering the eye, get focussed on the retina. This enables us to see distant objects clearly.

(*b*) When the eye looks at nearby objects, the ciliary muscles are strained/ contract. This increases the curvature of the eye lens and it becomes thicker. As a result, its focal length decreases but increases its converging power. Hence, the sharp image of the nearby objects again forms on the retina. This enables us to see nearby objects clearly.

This phenomenon is called the power of accommodation of the eye.