

The Human Eye And The Colorful World

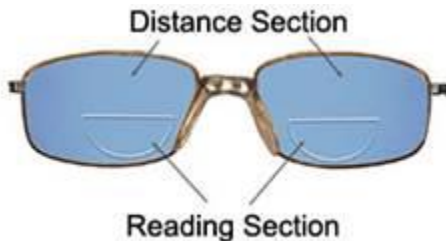
Periodic Test

Q.1. Define least distance of distinct vision.

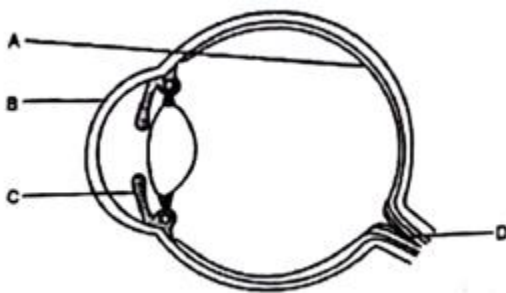
Answer: It is the minimum distance from which our eye can see the objects clearly (or able to produce a distinct image on the retina) without any strain in our eye. It is 25 cm for a human eye means that our eye can see up to 25cm without any strain on the eye. The least distance of distinct vision is less for young people and more for old people.

Q.2. What are bifocal lenses?

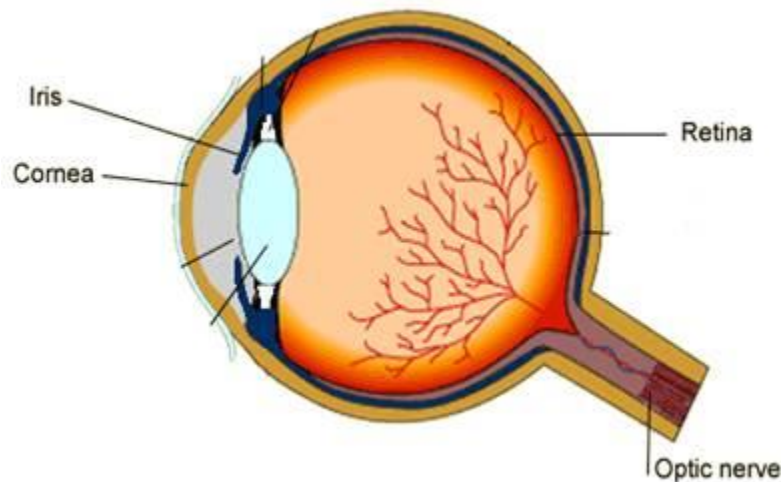
Answer: A bifocal lens consists of both convex lens as well as concave lens. It is used by the person suffering from myopia, hypermetropia, and presbyopia (not able to see very distant objects). Convex lens is used to correct hypermetropia (not able to see nearby objects clearly) and concave lens to correct myopia (not able to see far away objects clearly). The figure below shows the bifocal lens.



Q.3. The diagram below shows the structure of the eye. Choose words from the list below to label the parts A, B, C and D (ciliary muscles, pupil, retina, cornea, iris, optic nerve).



Answer: The figure below shows the labeled diagram.



A. Retina: Is a transparent, jelly-like mass located behind the lens. It acts as a 'suspension' for the lens so that the delicate lens is not damaged. It helps to maintain the shape of the posterior chamber of the eyeball.

B. Cornea: Helps to maintain the shape of the anterior chamber of the eyeball

C. Iris: A part of the retina that is directly opposite the pupil and contains only cone cells. It is responsible for good visual acuity (good resolution).

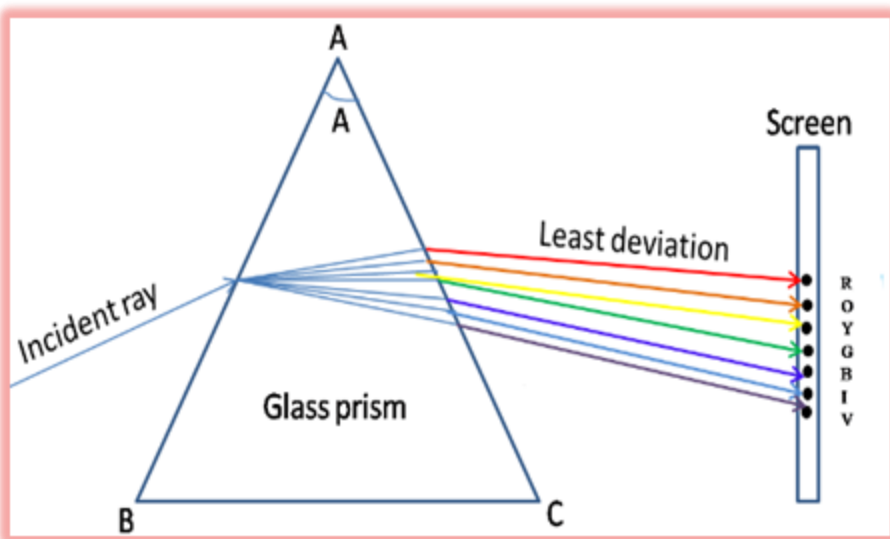
D. Optic nerve: The optic nerve is the second cranial nerve and is responsible for vision. Each nerve contains approx. one million fibers transmitting information from the rod and cone cells of the retina.

Q.4. (i) A ray of white light breaks up into its components while passing through a glass prism. Draw a ray diagram to show the path of rays.

(ii) Mark the least deviated color in your diagram.

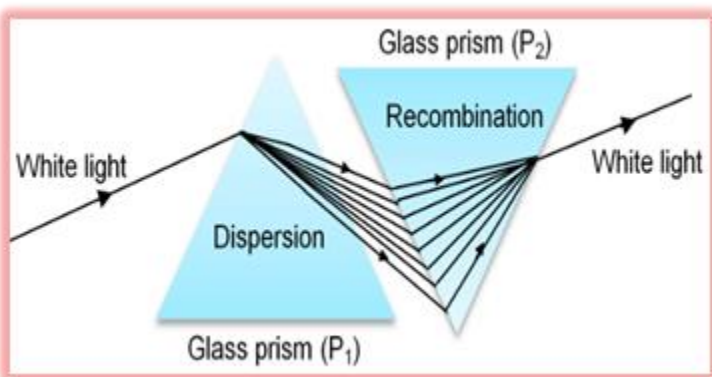
Answer: When white light is incident on a prism, it splits into seven colors (Violet, indigo, blue, green, orange, red). And among these colors, the Red light suffers the least deviation because it has the Maximum wavelength.

The figure below shows the diagram for the same.



Q. 5. When a beam of white light is passed through a prism, it splits to form lights of seven colours. Is it possible to recombine the lights of seven colours to obtain the white light again? Explain your answer.

Answer: Yes it is possible to obtain the white color from the recombination of the seven colors which are obtained by dispersion of light by prism. Figure below shows the set up for the same.



We take two glass prism and place the second one upside down w.r.t to the first one. The first prism splits the white light into seven colors. When these colors fall on the inverted prism, it recombines all the colors into white light which is observed ultimately as a patch of white light on the screen.

Q.6. A child sitting in a classroom is not able to read clearly the writing on the blackboard.

(a) Name type of defect from which his eye is suffering.

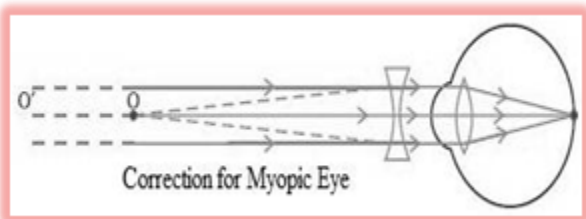
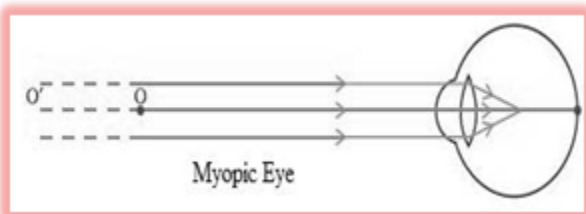
(b) With the help of a ray diagram show how this defect can be remedied.

Answer: (a) Since the student is not able to read distinctly the words written on the blackboard the student is suffering from Myopia or nearsightedness.

A myopic eye has its far point nearer than infinity. It forms the image of a distant object in front of its retina. This defect of vision occurs when the eyeball slightly elongates from front to back.

(b) This defect of vision can be remedied by using the appropriate concave lens, the concave lens is the diverging lens, therefore, it does not form the image on the retina thereby curing the defect.

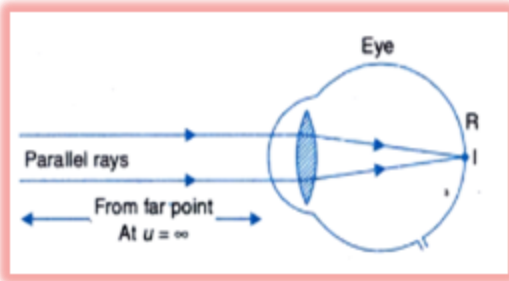
Figure below shows the myopic eye without concave lens and with concave lens.



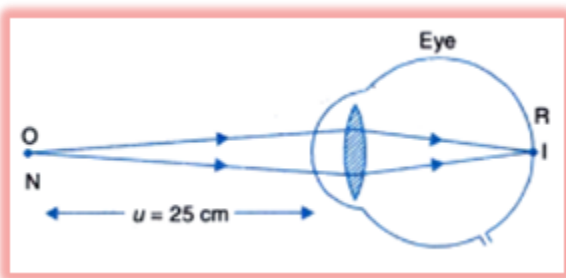
Q.7. What do you mean by the term accommodation? Explain how the eye can see objects at far and near distances.

Answer: Accommodation is the ability or property of the eye lens to change its curvature or focal length so that images of objects at various distances can be formed on the same retina. Ciliary muscles help in changing the focal length.

Viewing Of Far Off Objects: When the ciliary muscles are completely relaxed, the eye lens is thin and its focal length is maximum (equal to distance between retina and eye lens). The rays which are coming from the distant object are parallel to each other and they are focused at the retina. Formation of image on retina is illustrated in the figure below.



Viewing nearby Objects: Ciliary muscles contract when we look at nearby objects. The eye lens bulges out and becomes thick. Focal length is reduced as a result. This focuses light from the nearby object on retina as shown in the figure below.



Q.8. The near point of a person suffering from hypermetropia is at 50 cm from his eye. What is the nature and power of the lens needed to correct this defect? (Assume that the near point of the normal eye is 25 cm.)

Answer: According to the question

Object Distance (u) = -25 cm

Image Distance (v) = -50 cm

By Lens Formula

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

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

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

Since focal length is positive hence the lens is convex lens.

$$\text{Power} = \frac{1}{\text{Focal length}}$$

$$\text{Focal length} = 50 \text{ cm} = 0.5 \text{ m}$$

$$1 \text{ m} = 100 \text{ cm.}$$

$$\Rightarrow \text{Power} = \frac{1}{0.5} = \frac{1}{\frac{1}{2}} = 2$$

Hence the Power is 2 Diopter

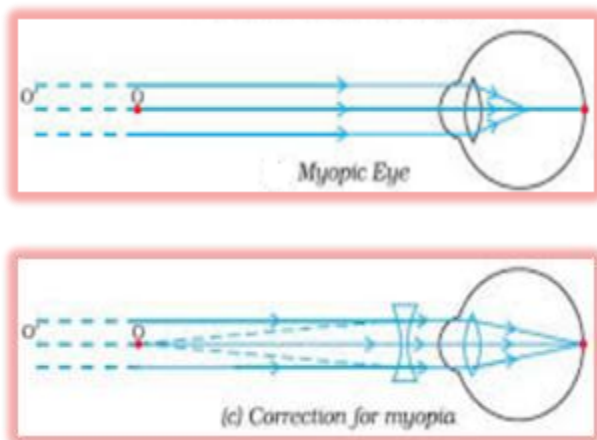
Q. 9. What is the cause for (i) Myopia and (ii) Hypermetropia? Shaw the defective eye and explain how it is corrected?

Answer: Myopia: Those who suffer from myopia can see near objects clearly, but not the far away objects. This defect of vision occurs when the eyeball slightly elongates from front to back.

Below, we can see how images are focused on the retina of someone with myopia. It is also called as Short sightedness.

Myopia is corrected with a concave lens, which curves inward like the inside of a bowl. The lens changes the focus, so images fall on the retina as they should.

Figure below shows the defected and the corrected eye.

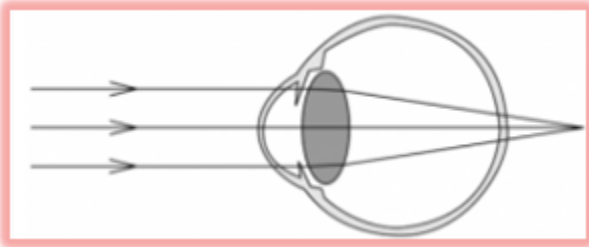


Hypermetropia: Hypermetropia is also known as hyperopia or farsightedness. Those who deal with hyperopia have difficulty seeing things that are near to them but have better vision for objects that are far away.

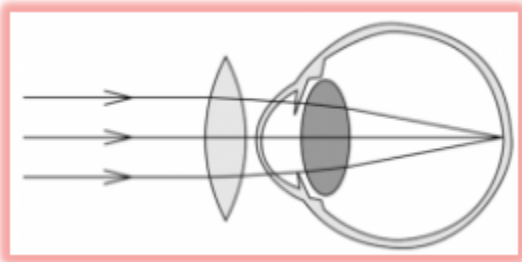
This defect of vision arises when the lens or cornea is out of place or insufficiently curved, leading to reduced vision quality.

Depending on by how much the focal length has been altered due to the effects of hyperopia, powered convex lenses can be used for the remedy of this defect. Figure below shows the defected and the corrected eye.

Defected Eye



Corrected Eye



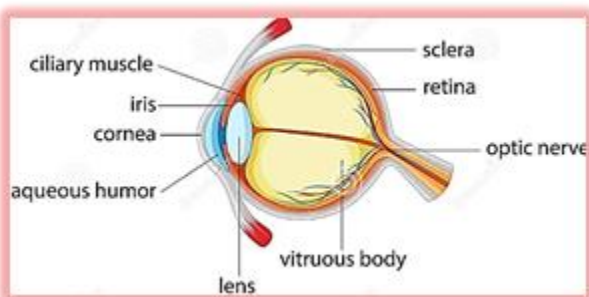
Q.10. Draw a labeled diagram of human eye and explain the image formation.

Answer: The figure below shows the labeled diagram of the human eye. The main parts of eye are-

Cornea, Iris, Pupil, Ciliary muscles, Eye lens, retina and optical nerves which are labeled in the diagram below.

Image Formation: The light rays coming from object enter through cornea of eye, pass through the pupil of the eye and fall on the eye lens. The eye lens is a convex lens, so it produces real and inverted image of object.

The optical nerve conveys the image formed on retina to brain and we get sensation of vision.



Comprehensive Exercises (MCQ)

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

- A. Persistence of vision**
- B. Near sightedness**
- C. Accommodation**
- D. Far sightedness**

Answer: Accommodation is the ability or property of the eye lens to change its focal length so that images of objects at various distances can be formed on the same retina. Ciliary muscles help in changing the accommodation.

Q. 2. Cinematography makes use of:

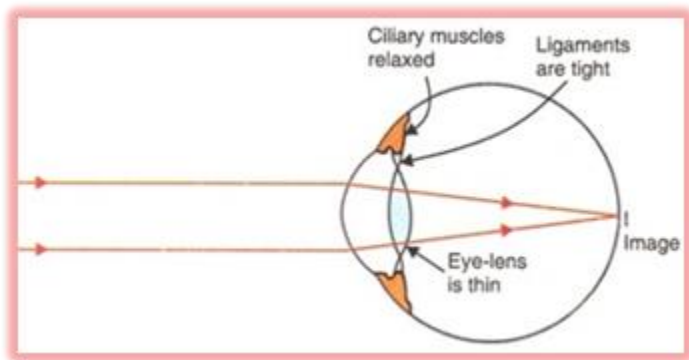
- A. Accommodation**
- B. Persistence of vision**
- C. Least distance of distinct vision**
- D. Bifocal lens system**

Answer: When an object is flashed through the eye at a rate faster than $\frac{1}{16}$ th of a second, the eye perceives the object as if it is in motion. This concept is used in the cinematography.

Q. 3. The human eye forms the image of an object at its:

- A. Cornea**
- B. pupil**
- C. Iris**
- D. retina**

Answer: Figure below shows the formation of the image on retina where eye acts as the convex lens.



Q.4. The change in focal length of an eye lens to focus the image of objects at varying distances is done by the action of the:

- A. pupil
- B. retina
- C. ciliary muscles
- D. blind spot

Answer: Ciliary muscles help in changing the focal length or the curvature of the eye lens so that we can see the object clearly. This is called as the accommodation.

Q.5. The colour of light which is deviated the least by a prism in the spectrum of white light:

- A. red
- B. green
- C. violet
- D. yellow

Answer: Red color has the maximum wavelength and amount of scattering is inversely proportional to the wavelength. Therefore the Red light scatters the least.

Q.6. Which of the following is correct?

- A. $\lambda_{\text{blue}} > \lambda_{\text{yellow}} > \lambda_{\text{green}}$
- B. $\lambda_{\text{yellow}} > \lambda_{\text{green}} > \lambda_{\text{blue}}$
- C. $\lambda_{\text{yellow}} > \lambda_{\text{blue}} > \lambda_{\text{green}}$
- D. $\lambda_{\text{green}} > \lambda_{\text{blue}} > \lambda_{\text{yellow}}$

Answer: Wavelength of yellow is between 597 to 577 nm.

Wavelength of green is between 577 to 492 nm

Wavelength of blue is between 492 to 455 nm

Q.7. In case of human eye, 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**

Answer: Most of the refraction occurs at the light occurs at the first surface of the eye, and crystalline lens has the property to refract the light by bending it towards or away from the normal.

Q.8. Reddish appearance of the sun at sunrise or sunset is significantly due to:

- A. dispersion of light**
- B. scattering of light**
- C. total internal reflection of light**
- D. reflection of light from the earth**

Answer: At sunrise and sunset sun lies below the horizon. The shorter violet and blue wavelengths are scattered away from our field of vision but longer wavelengths of light like red do not scatter and the sky looks red as shown in the figure below.



Q.9. Identify the correct statement 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.**

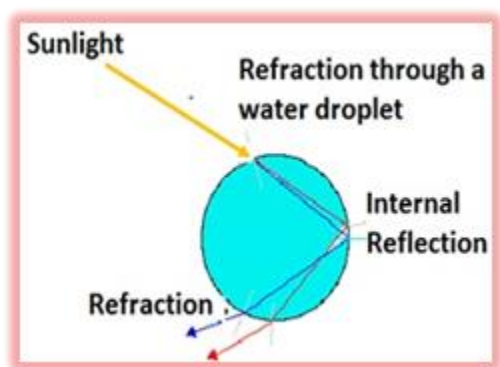
Answer: The speed of propagation of light which is an electromagnetic wave in a medium depends only on the refractive index of that medium. Thus the wavelength or the color of the light does not affect the speed of the light if they are in the same medium because the refractive index will be same.

Q. 10. Identify the phenomena of light involved in the formation of a rainbow.

- A. reflection, refraction and dispersion.**
- B. refraction, dispersion and total internal reflection.**
- C. dispersion, scattering and total internal reflection.**
- D. refraction, dispersion and internal reflection.**

Answer: A collection of suspended water droplets in the atmosphere serves as a refractor of light, the refraction occurs at the outer surface of drops. They also act as the small prism which scatters the white light and we see the seven colors.

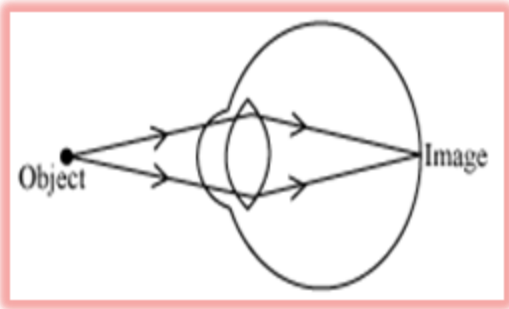
On the inner surface, the internal refraction occurs. And the as shown below.



Q. 11. The focal length of the eye lens increases when eye muscles:

- A. Contract and lens becomes thinner.**
- B. contract and lens becomes thicker.**
- C. Are relaxed and lens becomes thicker.**
- D. Are relaxed and lens becomes thinner.**

Answer: It is the ciliary muscles that change the focal length of the eye lens to see the distant object the focal length of the eye increases. The lens becomes thicker and relaxed. The figure below shows the lens at that time.



Q.12. At noon the sun appears white as:

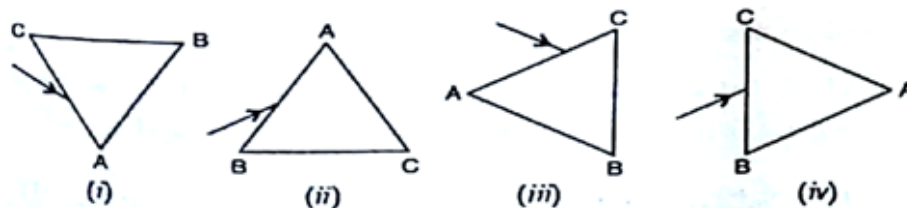
- A. blue colour is scattered the most.**
- B. all the colours of the white light are scattered away.**
- C. light is least scattered.**
- D. red colour is scattered the most.**

Answer: At noon the sun is overhead and the light travels a relatively shorter distance through the atmosphere to reach the earth. Due to this short journey of the light only blue light is scattered and most of the light is not scattered. Therefore, the sun appears white.

Figure below shows the sun at noon.

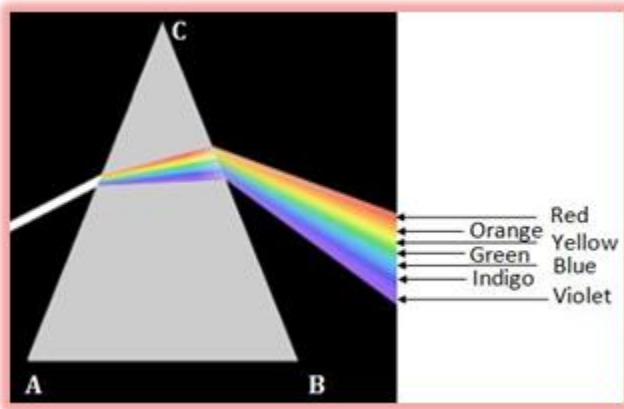


Q. 13. A prism ABC, with base BC, is placed in four different orientations as shown. A narrow beam of white light is incident on the prism as shown. In which of the following cases, after dispersion, the third colour from the top corresponds to the colour of the sky?

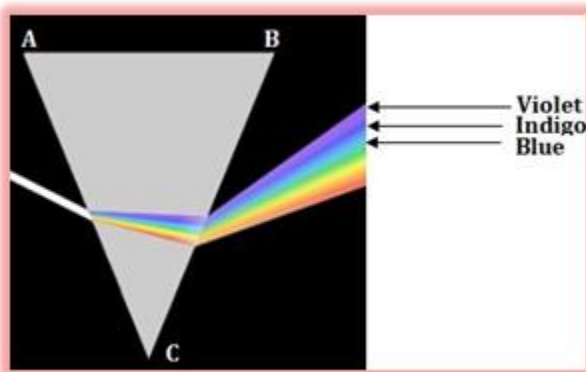


- A. (i)
- B. (ii)
- C. (iii)
- D. (iv)

Answer: The third color from the top is blue. In the orientation (ii) the third color from the top is yellow as shown in the figure below.



Hence if the prism is inverted then the third color from the top is blue which is the color of the sky. Therefore, we get the orientation (i) as shown in the figure below



Q. 14. A person cannot see distinctly objects kept beyond 2m. This defect can be corrected by using a lens of power:

- A. -0.2 D
- B. -0.5 D
- C. $+0.2\text{ D}$
- D. $+0.5\text{ D}$

Answer: The person is having myopia. In this defect, a person cannot see objects beyond near point or far objects but can see the near objects clearly

This defect can be corrected by using convex lens.

Given distance of far point (D) = 2m

Let f be the focal length of eye lens.

$$\Rightarrow f = -D = -2 \text{ cm.}$$

$$\text{Power of a lens} = \frac{1}{\text{Focal length}}$$

$$\Rightarrow \text{Power} = -\frac{1}{2} = -0.5$$

Hence the power of the lens is -0.5 D

Comprehensive Exercises (T/F)

Q.1. Write true or false for the following statements:

Accommodation means the adjustment of light going into the eye for image formation.

Answer: False

Accommodation is the property of the eye lens to change its focal length so that images of objects at various distances can be formed on the same retina. Ciliary muscles help in changing the accommodation.

Q. 2. Write true or false for the following statements:

A near sighted person can see only nearer objects.

Answer: False.

Nearsightedness, or myopia, actually means that seeing things at a distance is difficult for you. We may be able to read books with no problem but street signs that are far away appears blurry to you.

Nearsightedness is caused by light not falling directly on your eye's retina but in front of it.

Q.3. Write true or false for the following statements:

Presbyopia is a type of far sightedness.

Answer: False

Presbyopia is an age-related condition in which the lens of the eye becomes less flexible. Seeing details like words in a book or an online article, or adjusting focus between far-away and nearby objects is difficult this condition is most common in people between the ages of 40 and 50.

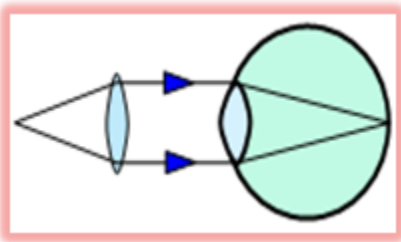
While in far sightedness it's hard to see things close up. People of any age, including babies, can be farsighted.

Q.4. Write true or false for the following statements:

Convex lens can be used to correct long-sightedness.

Answer: True.

Those who deal with long sightedness have difficulty seeing things that are near to them, but have better vision for objects that are far away. Therefore a Convex lens can be used for the remedy of this defect because it is converging lens, hence will form an image on the retina as shown in the figure below.



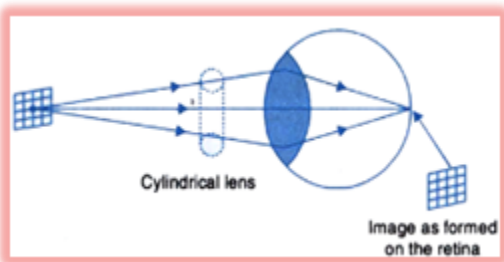
Q.5. Write true or false for the following statements:

To correct astigmatism we use cylindrical lens.

Answer: True.

If a person is suffering from astigmatism than he cannot simultaneously see both horizontal and vertical view of the object with same clarity.

Cylindrical lens has different curvature in horizontal and vertical direction which can enable the person to see the object clearly as shown in the figure below.

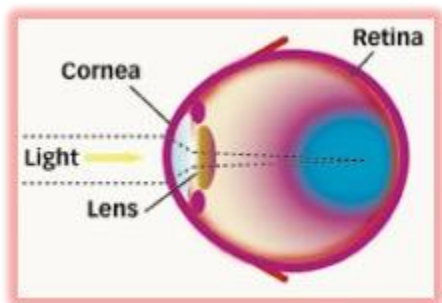


Q.6. Write true or false for the following statements:

Short-sightedness is caused due to elongation of the eyeball.

Answer: True

Those who suffer from Short-sightedness can see near objects clearly, but not the far away objects. This defect of vision occurs when the eye ball slightly elongates from front to back. The figure below shows it.



Q.7. Write true or false for the following statements:

Abnormalities in the normal vision of the eye are called defects of vision.

Answer: True.

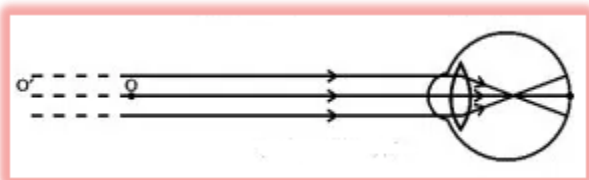
When the person is not able to see the objects clearly or he is having difficulty in seeing the objects he may have defect of vision like myopia, hypermetropia, presbyopia, astigmatism.

Q.8. Write true or false for the following statements:

For a person suffering from myopia, the image of the object is formed in front of the retina.

Answer: True.

In myopia person is not able to see faraway objects due to elongation of the eyeball. The image is formed in front of the retina as shown in the figure below.

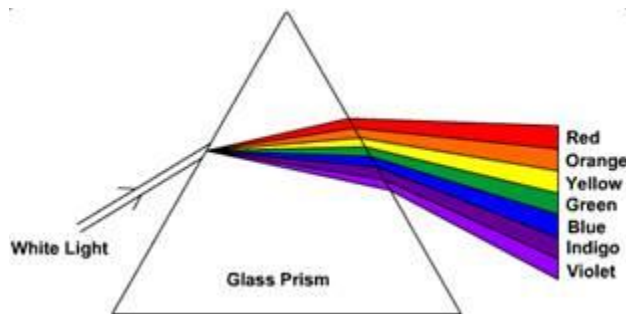


Q. 9 Write true or false for the following statements:

Light coming from the sun is white light and contains seven colors.

Answer: True

The white light coming from the sun is the spectrum of the seven colors violet, indigo, blue, green, yellow, orange, red. This can be proved by passing the white light through the prism As shown in the figure below.



Q.10. Write true or false for the following statements:

When a beam of white light is passed through the prism, violet color bends the most and red color the least.

Answer: True

The scattering\bending of the light is inversely proportional to the wavelength of light. Therefore violet color having the least wavelength bends the most while the red color having the highest wavelength bends the least.

Q.11. Write true or false for the following statements:

Every color travels with the same speed in a transparent medium.

Answer: False

Light of all colors travel with same speed in vacuum. But, in any transparent medium, such as glass or water the lights of different color travel with different speeds because the relative refractive index is different for the different colors of light. The red light travels the fastest and the violet light slowest of all the seven colors.

Q.12. Write true or false for the following statements:

Dispersion of white light occurs because every color travels with a different speed in a transparent medium.

Answer: True.

Due to the difference in the speed the light of different colors bend at the different angles. In any transparent medium, The red light travels the fastest and the violet light slowest of all the seven colors. Therefore, the red light bends the least, and the violet light bends the most.

Thus dispersion of white light into seven colors occurs because the light of different colors travels at the different speed.