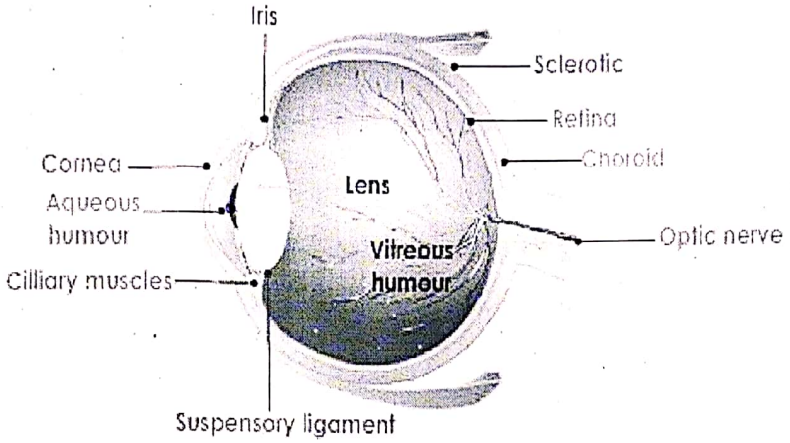
Unit- 2

Human Eye: The Colourful World

Human Eye

Q.1: Give the structure and function of different parts of Human eye?

Ans: Human eye is the most important natural optical instrument. The eye is nearly spherical in shape with a slight bulge in the front part. The important parts of the eye with their function are listed below:



1. Pupil: Pupil is the round black spot in front of eye. It regulates the amount of light entering the eyes. Pupil works like aperture of a camera. In case of dim light pupil dilate to allow more light to enter the eyes. In case of strong light pupil constrict allowing less light to enter.

2. Iris: Iris is made of muscles. They control the size of opening if pupil.

3. Lens: Lens lies just behind the pupil. Lens becomes thin to increase its focal length. This enables us to see distant objects clearly. To focus on nearer objects lens becomes thick to decrease its focal length. But there is a limit. The minimum distance of clear vision is 25 cm. Below this distance we cannot see things clearly.

4. Retina: Retina works like a screen or camera film. Retina is full of light and colour sensitive cells. These cells, upon receiving image send electrical signals to the brain, which processes these information to make a mental image of what we see.

Q.2: What are the advantages of binocular vision (Benefits of two eyes)?

Ans: One eye is having a field of vision of about 150 degrees. Both the eyes enable us to see upto a field of 180 degrees. Moreover, as two different images get juxtaposed in the brain, so we are able to see a three dimensional view of the world.

Power of accommodation

Q.3: Explain what is the power of accommodation of an eye.

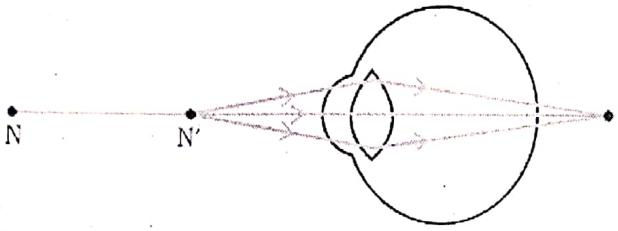
Ans: The ability of the eye lens to change its focal length to focus the images of all the objects, distant or nearby on the retina is known as the power of accommodation. The eye lens changes its focal length by changing its thickness with the help of its ciliary muscles.

Defects of vision & their correction

Q.4: What are the various defects of vision? How can they be corrected?

Ans: The various defects from which an eye can suffer are: -

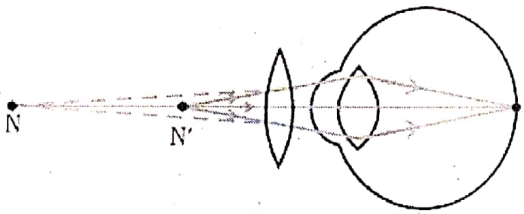
1. **Hypermetropia or long sightedness:** A person suffering from this defect can see distant objects clearly but cannot see nearby objects clearly. In this defect, the near point lies further away than 25cm.



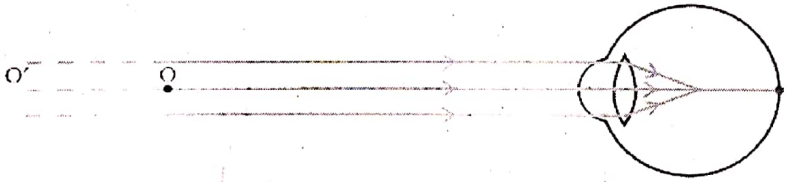
When the relaxed eye produces an image of a distant object behind the retina the condition is known as hypermetropia, and the person is said to be farsighted or long-sighted. With this defect, nearby objects are blurred. This defect is due to the following reasons: -

- Either the hypermetropia eye ball is too short or
- The Ciliary muscle is unable to change the shape of the lens enough to properly focus i.e. the focal length of the eyeball increases.

The conditions can be corrected with a converging or convex lens.



2. **Myopia or short sightedness:** - A person suffering from this defect cannot see distant objects clearly but can see nearby objects clearly. In this case, light from a distant object is focused in front of the retina. The distinguishing feature of this condition is that distant objects are not seen clearly.



This defect occurs either:

- When the eye ball is longer than normal
- When the maximum focal length of the lens is insufficient to produce a clearly formed image on the retina.

Near sightedness can be corrected with a diverging or concave lens.

Human Eye And The Colourful World

Q Defects of Vision:

1. Presbyopia:

It is that defect of human eye, due to which an old person can't read and write comfortably. It is also known as old age hypermetropia or presbyopia.

With increasing age, the ciliary muscles holding the eye lens weaken and the eye lens loses some of its flexibility or elasticity. This is the cause of presbyopia. Obviously, it is a sort of hypermetropia, where near point recedes to a distance more than 25cm from the eye. Old persons suffering from presbyopia find it difficult to see nearby objects distinctly without using corrective eye glasses.

Correction:

It is corrected by placing a convex lens of suitable focal length before the eye.

2. Astigmatism:

When the cornea loses its original shape and has different curvatures in different planes, the eye can't view all directions with equal clarity. This defect is

called Astigmatism.

Correction:

This defect is Corrected by using cylindrical lens.

3. Cataract:

The eye, lens is made up of proteins arranged in a regular pattern. Because of this regular arrangement the eye-lens is transparent. In some eyes, the regular pattern gets disturbed and this decreases the transparency of the eye-lens. If the arrangement distrubs to a greater extent it may lead to an opaque eye-lens. This is called Cataract and is usually found in old age.

Correction:

This defect can't be Corrected by placing a suitable lens before the eye-lens. Instead, it is Corrected by a surgical operation by replacing the affected lens by an artifical lens.

4. Colour Blindness:

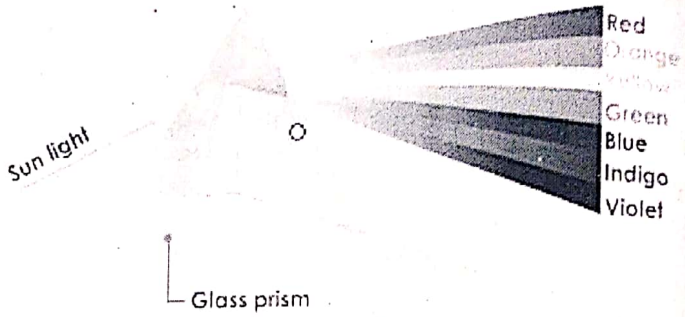
Human Eye And The Colourful World:

Colour blindness is a defect created due to lack of some type of cone cells that respond to certain colours. Therefore, a colour blind person does not have the ability to differentiate between certain colours. This is because retina of eye of such a person does not possess some specific cone cells. For example a person who is blind to red-green colour may be deficient in cone shaped cells having red and green pigment in the retina of his eyes.

It is more common in males than in females. It is a genetic disorder which occurs by inheritance and is not curable. Sometimes, Colour blindness is also called Daltonism.

Q.9: Explain the dispersion of white light by a prism.

Ans: Even though all colours of the visible spectrum travel with same speed in vacuum, the speed of the colours of the visible spectrum varies when they pass through a transparent medium like glass and water. That is, the refractive index of glass is different for different colours.



When a polychromatic light like white light is incident on the first surface of the prism and enters it, each constituent of the white colour is refracted through a different angle, i.e., white light gets dispersed. When these colours are incident on the second surface of the prism they again undergo refraction (they get refracted from a denser to rarer medium) and the colours are separated further. Thus a beam of white light incident on a prism splits into its constituent colours to form a spectrum.

Each constituent of the white light is deviated towards the base of the prism. Violet colour suffers the maximum deviation and red the least. The spectrum obtained is impure as the colours in the spectrum do not have any sharp boundaries i.e., each colour merges gradually into the next.

Atmospheric refraction

Q.10: Define Atmospheric Refraction.

Ans: Atmospheric refraction is the shift in apparent direction of a celestial object caused by the refraction of light rays as they pass through Earth's atmosphere.

Q.11: Twinkling of stars is due to atmospheric refraction of starlight. Explain

Ans: The twinkling of a star is due to atmospheric refraction of starlight. The starlight, on entering the earth's atmosphere, undergoes refraction continuously before it reaches the earth. The atmospheric refraction occurs in a medium of gradually changing refractive index. As the path of rays of light coming from the star goes on varying slightly, the apparent position of the star fluctuates and the amount of starlight entering the eye flickers – the star sometimes appears brighter, and at some other time, fainter, which is the twinkling effect.

Q.12: What is meant by Advance sunrise and delayed sunset

Ans: The Sun is visible to us about 2 minutes before the actual sunrise, and about 2 minutes after the actual sunset because of atmospheric refraction. By actual sunrise, we mean the actual crossing of the horizon by the Sun. The time difference between actual sunset and the apparent sunset is about 2 minutes. The apparent flattening of the Sun's disc at sunrise and sunset is also due to the same phenomenon.

Q.13: Why sky appears blue to us? Why sun looks reddish in colour at sunrise and sunset?

Ans: A large number of molecules are present in the earth's atmosphere. These molecules scatter light in various directions. The air is composed of many tiny particles including dust and water vapour. As the sunlight passes through the air, the shorter blue light

waves are reflected and refracted by the particles while the other coloured light waves being longer are unaffected and are not reflected by the water vapour or dust in the air. Blue, therefore, is scattered the most and this explains the bluish colour of the sky. At sunset or sunrise, the sunrays have to cover large atmospheric distances to reach us and most of the blue light gets scattered and doesn't reach us. The sky as well as the sun, at sunrise and sunset, therefore looks reddish.

Q.14: (a) What will be colour of the sky in the absence of atmosphere?
(b) Why are the traffic light signals (or danger signals) of red colour?

Ans: (a) In the absence of any atmosphere, there will be no scattering of sunlight and the sky will appear dark.

In the visible spectrum, the red colour has the largest wavelength. The red colour is least scattered by fog or dust particles. Therefore, we can observe red colour easily even in foggy and dusty conditions.

Q.15: Why does the sky appear dark and black to an astronaut instead of blue?

Ans: This is because there is no atmosphere containing air in the outer space to scatter light. Since there is no scattered light, which can reach our eyes in outer space, therefore, the sky looks dark and black there. This is why the astronauts who go to outer space find the sky to be dark and black instead of blue.

Q.16: Explain why, when the sun is overhead at noon, it appears white?

Ans: When the sun is overhead at noon, then the light coming from the sun has to travel a relatively shorter distance through the atmosphere to reach us. As a result, only a little of the blue colour of the white light is scattered (most of the blue light remains in it). Since the light coming from the overhead sun has almost all its components colours in the right proportion, therefore, the sun appears white.

Q.5: Define dispersion.

Ans: The phenomenon by which. a ray of light splits into its constituent colours. when passed through a transparent medium. is known as dispersion.

Q.6: Name any one source of polychromatic light.

Ans: The sun gives out white light. It is the largest source of polychromatic light.

Q.7: What do you mean by recomposition of white light?

Ans: Recombination of the seven colours of the dispersed white light to get white light is known as recomposition of light.

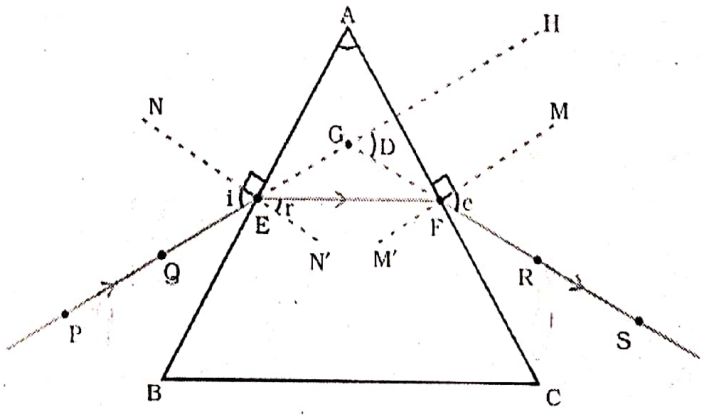
Q.8: Draw a neat-labeled diagram of refraction through glass prism. What are the different colours present in the white light? Arrange them in the increasing order of their wavelength.

Ans: - The different colours in the white light are

1. VIOLET, 2. INDIGO, 3. BLUE, 4. GREEN, 5. YELLOW, 6. ORANGE 7. RED.

Increasing order of their wavelength is: -

1. VIOLET, 2. INDIGO, 3. BLUE, 4. GREEN, 5. YELLOW, 6. ORANGE 7. RED.



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