# Human Eye and Colourful world

## Structure of human eye

The working of human eye is based on refraction by a lens. Some components of human eye ar
Sclerotic: Outermost covering of the human eye from inside. It protects the eye from internal damage and is opaque.
Cornea: Outermost covering of the human eye from outside. It protects the eye from external damage and is colourless.
Retina: Acts as a screen on which image is formed. It is made up of two types of cells- rods (cylindrical) and cones (conical cells). Rods are sensitive to dim light. Cones are sensitive to bright light and responsible for colour identification.
Iris: Dark-coloured muscular diaphragm with a small circular opening in the middle. It regulates the amount of light entering the eye by adjusting the size of the pupil. It provides colour to the ey
Pupil: Central circular aperture of iris. Its size increases or decreases depending upon the intensity of incident light.
Crystalline lens: It refracts the light for the formation of the image on the retina. It is a convex lens of variable focal length made of a transparent jelly-like material.
Ciliary muscles: Ciliary muscles are attached to the lens. It helps to change the size and focal length of the lens.
Aqueous humour: Fluid between cornea and lens. It helps the eye meet for its proper function.
Vitreous humour: Fluid between lens and retina. It helps keep the eye wet.

## Power of accommodation

The ability of the eye-lens to change its power to accommodate the near and far off distances on the retina is called the power of accommodation. For a healthy human eyes, visible range is from 25 cm to infinity. The distant of the closest object that a human eye can see is called the near-point and the distant of the farthest object that a human eye can see is called the far-point.

## Working of human eye

Light enters the human eye via pupil. When light intensity is more, iris compress to reduce the size of pupil and protect it from overexposure of light. When light intensity is less, iris expand to increase the size of pupil and increase the amount of light entering the eye for more clarity. After this light enters the eye-lens which is convex in nature. The focal length of the eye-lens is changed by ciliary muscles in a manner so that the image is formed on the retina. The medium between the eye-lens and retina consists of aqueous humour which also helps in refraction of light, provides nutrition and protection to the eye and maintains the shape of the eye. Image formed on retina is converted into signals which are carried with the help of optical nerves to the brain.

Near point:
The closest distance for which the lens can focus light on the retina is called the least distance of distinct vision, or the near point.
Far point:
If the eye-lens focusses the incoming light at a point called the far point behind the retina, a convergent lens is needed to compensate for the defect in vision.
Definition
Persistence of vision
When an object is viewed by a person, its image remains in the retina of the eye for a time interval of 0.0625s after seeing it. This phenomenon is called persistence of vision. If more than one scene is viewed within 0.0625s, the effect of all these scenes will be felt by the eye simultaneously.

Defects of vision

Defects of vision is the loss of power of accommodation of the human eye. They are mainly of three types:
Myopia/ near-sightedness: The person can see nearby objects clearly but is unable to see objects beyond some distance. For such a person, far point changes to infinity to some finite distance. It is corrected with the help of a concave lens. The power of the lens is set so that its focal length is equal to the far-point of the eye.
Hypermetropia/ far-sightedness: The person can see far objects clearly but is unable to see nearby objects clearly. For such a person, near point increases to a distance greater than 25 cm. It is corrected with the help of a convex lens. The power of the lens is set so that the image of an object kept at 25 cm from the lens is formed at near-point of the eye.
Presbyopia: This defect is common in old-people and is caused by the weakening of ciliary muscles. In this defect, both the near-point and the far-point are affected. It is corrected with the help of a bifocal length which is a combination of convex lens and a concave lens.
Diagram
Hypermetropia
.Hypermetropia/ far-sightedness: The person can see far objects clearly but is unable to see nearby objects clearly. For such a person, near point increases to a distance greater than 25 cm. It is corrected with the help of a convex lens.

Hypermetropia

A person with hypermetropia can see distant objects clearly but cannot see nearby objects distinctly. The near point, for the person, is farther away from the normal near point (25 cm). This is because the light rays from a closeby object are focussed at a point behind the retina as shown in Fig. This defect arises either because (i) the focal length of the eye lens is too long, or (ii) the eyeball has become too small. This defect can be corrected by using a convex lens of appropriate power. This is illustrated in Fig. Eye-glasses with converging lenses provide the additional focussing power required for forming the image on the retina.

Terms related to prism

Angle of prism: The angle between the two sides of the reflecting faces of prism is called angle of p
Angle of deviation (δ): Angle between the incident ray and the emergent ray is called the angle of deviation.

Angle of deviation

The angle of deviation through a triangular prism is defined as the angle between the incident ray and the emerging ray (angle ). It can be shown that when the angle of incidence i is equal to the angle of refraction r for the emerging ray, the angle of deviation is at a minimum.

Angle of deviation

Definition:
The angle through which ray of light turns away from its original path on passing through a prism is called angle of deviation.

Prism

A prism is a transparent refracting medium bounded by five plane surfaces inclined at some angles. It bends a light two times and emergent ray is at an angle to the incident ray.

Minimum angle of deviation for a prism
At the minimum deviation Dm, the refracted ray inside the prism becomes parallel to its base.
i.e i=e□r1=r2=r
Then r=A2
and Dm=2i−A
where i is the angle of incidence,
e is the angle of emergence.
r1,r2 are the angles of refraction and A is the angle of the prism.

Dispersion by prism

The figure shows the dispersion of light wave by a prism.
When white light incident on a glass prism, the emergent light is seen to be consisting of several colors(violet, indigo, blue, green, yellow, orange and red). The red light bends the least, while the violet light bends the most(as shown in figure).

The phenomenon of splitting of light into its component colours is known as dispersion. The pattern of colour components of light is called the spectrum of light.

## Dispersion of light

The phenomenon of splitting of visible light into its component colours is called dispersion. Dispersion of light is caused by the change of speed of light ray (resulting in angle of deviation) of each wavelength by a different amount.

Note: White light comprises of seven visible colours (VIBGYOR) whereas black (or dark) signifies the absence of light rays.

### Definition

### Splitting of white light

White light is made up of ranges of colours of which seven are not seen in a separated pattern. The splitting up of white light into its constituent colours is called dispersion. In the rainbow you may not see all the seven colours. It is due to overlapping of colours. The degree of bending of the light's path depends on the angle that the incident beam of light makes with the surface, and on the ratio between the refractive indices of the two media (Snell's law) and results in splitting all the seven colours present in white light.

With the help of a narrow beam of light, glass prism and arrangement of lenses it is possible to produce the band of seven colours using white light. This band is called spectrum. There are many types of spectrum.

It is not necessary that the source of light should always be white to get a spectrum. Composite light which contains a range of 3 to 4 colours also produces a band of 3 to 4 colours. A glowing 40W tungsten filament bulb does not produce pure white light. It is a source of composite light.It will also produce a spectrum but the spectrum may not be the same as the spectrum of white light. The type of spectrum depends upon the nature of source of light.

### Definition

### Rainbow Formation

A rainbow is an arc of color in the sky that can be seen when the sun shines through falling rain. The pattern of colors starts with red on the outside and changes through orange, yellow, green, blue, indigo to violet on the inside.

A rainbow is created when white light is bent (refracted) while entering a droplet of water, split into separate colours, and reflected back. On the ground, the bottom part is hidden, but in the sky, like from a flying airplane, it can be seen as a circle around the point opposite the Sun.

## Rainbow

A rainbow is a meteorological phenomenon that is caused by reflection, refraction and dispersion of light in water droplets resulting in a spectrum of light appearing as a circular arc in the sky. It is often visible after rainfall due to highly humid atmosphere and absence of air pollution.

Primary and Secondary rainbow

Primary Rainbow:

A rainbow occurs when light hits the water drops in the atmosphere at a certain angle. It is an atmospheric phenomenon that is formed through optical processes such as refraction, dispersion, internal reflection and secondary refraction.

If the light source is the sun, then the rainbow will be colorful and bright. As shown in Fig. when a beam of sunlight enters the water drop the degree of refraction of the different colors is variable. Violet light has the shortest wavelength therefore, its degree of refraction is also the greatest; red light has a longer wavelength therefore its degree of refraction is the smallest. The degrees of refraction of the other colors lie within this range.

Therefore, a solar halo with violet light in the innermost and red at the outermost edge is formed, and that's why the rainbow we see is always violet on the inside and red on the outside. The visual angle (the angle from the ground surface to the vertex of the rainbow) is about 42o.

Secondary Rainbow:

A secondary rainbow is different from a primary rainbow only in that it is formed by secondary reflection of light within the raindrops. Therefore, when we see the light reflected by the raindrops the spectrum of the light is the exact opposite from that of a primary rainbow, which means the secondary rainbow is red on the inside and violet on the outside. It has a visual angle of about 50o and is concentric with the primary rainbow.

Examples of scattering
Some effects of scattering in everyday life are:
Red colour of sun at sunrise and sunset.
White colour of sky at noon.
Blue colour of sky.
Red colour used as danger signal.
Definition
Scattering
Scattering is the process of absorption and then re-emission of light energy. In scattering, light spreads in all directions. The air molecules of size smaller than the wavelength of incident light absorb the energy of incident light and re-emit it without change in its wavelength. Intensity of scattered light is a function of the wavelength of the light ray.
I□1λ4
Hence, violet is scattered the most and red the least.