### The Human Eye and the Colourful World

### Construction of human eye

The outermost black part of the eye is called cornea. The iris is present behind it. The hole present in the iris is called pupil. Behind this a crystalline lens is present which is held by ciliary muscles. The retina is the innermost part of the eye which is connected by the optic nerves. The liquid present between the iris and the eye lens is called aqueous humour and the liquid present between the eye lens and the retina is called vitreous humour.

### Functions of

Cornea : It refracts the light falling on it.

Iris: Iris controls the size of the pupil.

Pupil: It controls the amount of light entering the eye.

**Crystalline lens**.: It is a convex lens which converges the light rays coming from the object to form an image on retina.

**Ciliary muscles**: They hold the lens and change its focal length by pressing or stretching it.



**Retina:** It is a delicate membrane having light sensitive cells which generate electrical impulses.

### Working of eye

The light falling on the eye gets refracted through the cornea. This amount of light is controlled by the pupil. The eye lens converges the light rays and forms an image on the retina. The focal length of the lens is controlled by the ciliary muscles. Retina converts the light rays into electrical signals which are sent by optic nerves to the brain. The brain interprets these signals and we see the objects as it is.

### Power of accommodation

The ability of an eye to focus the distant objects as well as nearby objects on the retina clearly by changing the focal length of lens is called power of accommodation. A normal eye has a power of accommodation which enables the objects as far as infinity and as close as 25 cm to be focused on retina.



Fovea (point of central focus)

Macula

Blind

spot

Optic

## Eye lens

An eye lens is composed of fibrous jelly like material. Its focal length can be changed by ciliary muscles by pressing or stretching it. To increase the focal length, the ciliary muscles are in the relaxed position and the lens is thin.

### Near point or least distance of distinct vision

The minimum distance at which an object placed can be seen clearly without strain is called near point or least distance of distinct vision. For a healthy human eye, near point is 25 cm.

### Far point

The farthest point up to which the eye can see the object clearly is called the far point of the eye. The far point for a healthy human eye is at infinity.

### Cataract

The condition in which the lens of the eye of a person becomes cloudy and milky resulting in blurred vision is called cataract.

### Cause of formation of cataract

Cataract develops when the eye lens of a person becomes cloudy due to the formation of a membrane of proteins over it.

Reason of having two eyes for vision.

Two eyes give a wider field of view.

Two eyes enable us to judge the distance more accurately.

Defects of vision

## Myopia or near sightedness short sightedness

The defect of vision in which a person can see the nearby objects clearly but is unable to see the distant objects clearly is called short sightedness or myopia. In the myopic eye the image of the distant object is formed in front of the retina.

### Causes of myopia

- Due to thick eye lens i.e. excessive curvature.
- Due to elongation of eyeball or eyeball becomes too long.
- Correction Myopia can be corrected by using a concave lens of suitable focal length.



## Hypermetropia or long sightedness or far sightedness

The defect of vision in which a person cannot see the nearby objects clearly but is able to see the distant objects clearly is called long sightedness or hypermetropia. In the hypermetropic eye the image of the object is formed behind the retina.

### Causes of hypermetropia

- Due to thin eye lens or low converging power of eye lens.
- Due to eyeball being too short.
- Correction : This defect can be corrected by using a convex lens of suitable focal length.

## Presbiopia (old sight)

The defect of vision due to which an old person cannot see the nearby objects clearly is called presbiopia.

### Reasons

It occurs due to the loss of power of accommodation of eye because of wakening of ciliary muscles and reducing flexibility.

### Prism

The transparent object made of glass having two triangular ends and three rectangular faces kept at an angle is called prism.

Angle of prism The angle between the surfaces of the prism is called the angle of prism.

### Angle of deviation

The angle between the indcident ray and the emergent ray in the refraction through prism is called angle of deviation.

### Spectrum

The band of seven different colours formed by splitting white light through a prism is called prism.

Red colour deviates least while violet colour deviates most.

Wavelength of red colour is maximum while of violet colour is minimum.

**Dispersion of light** 



The phenomenon of splitting of white light into its component colours is called dispersion of light. It takes place because of the angles of refraction of light for different colours are different.

## Formation of rainbow

After a rain shower, the tiny droplets of water act as tiny prisms and cause dispersion of sunlight. Due to this dispersion rainbow is forms. It is the beautiful example of dispersion of white light in nature after a rain shower. A rainbow always forms in the direction opposite to the sun. The essential condition for observing a rainbow is that the observer must stand with his back towards the sun.

# Atmospheric refraction

The atmosphere has different layers of air with varying optical densities. The refraction caused by theses layers of atmosphere is called atmospheric refraction.

# Twinkling of stars

The light of stars undergoes refraction many times before reaching the observer due to varying densities of different layers of atmosphere. So the light of stars reaching our eye increases and decreases continuously and the stars appear twinkling.

# Advance sunrise and delayed sunset

We can see the sun about 2 minutes before the actual sunrise and 2 minutes after the actual sunset because of atmospheric refraction. So the length of the day is increased by 4 minutes.

Scattering of sunlight Light is scattered when it falls on various objects. The colour of the scattered light depends on the size of the scattering particle. Very fine particles scatter mainly blue light while particles of larger size scatter light of longer wavelengths i.e. red colour. If the size of the particle is very large, the scattered light may appear white.

# Tyndall effect

The scattering of light by colloidal particles in their path is called Tyndall effect. Tyndall discovered that when white light is passed through a clear liquid having small suspended particles in it, the blue colour of white light having shorter wavelength is scattered much more than the red colour having larger wavelength.

## Colour of the sky

Colour of the sky is blue Colour of the sky is blue because when sunlight passes through the atmosphere, the fine particle in the air scatter the blue light of shorter wavelength more strongly than red and the blue light enters our eye.

## White colour of clouds



Clouds are seen due to scattering of light from lower parts of earth's atmosphere containing large particles of dust, water, etc. So all the colours are scattered equally and the clouds appear white.

### What would happen in absence of atmosphere?

- If the earth has no atmosphere, the atmospheric refraction would not take place and we would see the actual sunrise and sunset. The day would have been shorter by 4 minutes. Also, there would not have been any scattering and the sky would have looked dark.
- Danger signals are red in colour Danger signals are red in colour because the red colour is scattered least by smoke and fog and so can be seen from a longer distance due to its longer wavelength.
- Sun appears red at sunrise and at sunset Light from the sun near the horizon has to travel the larger distance through thicker layers of atmosphere. Due to this, most of the blue colour present in the sunlight has been scattered out and most of the red colour reaches our eye.
- Stars appear to be twinkle while planets do not. The continuously changing atmosphere causes variations in the light coming from point sized star due to refraction. So the stars appear to be twinkle. The atmospheric refraction cannot cause variations in the light coming from big sized planets and they do not twinkle.
- Glass prism forms spectrum while glass slab does not A glass slab can be assumed as the combination of two prisms. The first prism decomposes the white light into seven colours and the second prism (placed inverted) recomposes the seven colours into white light. It takes some time to see the image clearly when enter into dim room.
- When we enter into a dim room, the iris takes some time to adjust the size of the pupil so that more amount of light may pass through it.
- The blue coloured light present in white light is scattered 10 times more easily than the red light.
- Very fine particles mainly scatter blue light
- For a myopic person, u = 8 and for a hypermetropic person u = 25cm.
- At very high altitudes, there is nothing to scatter the sunlight. So the sky appears dark to the astronauts.

