

CHAPTER – 11

The Human Eye and the Colourful World

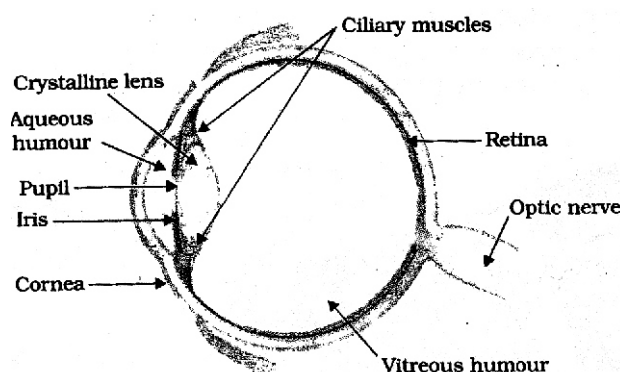
In this chapter we will study Human eye that uses the light and enable us to see the objects.

We will also use the idea of refraction of light in some optical phenomena in nature i.e. Rainbow formation, twinkling of star, blue and red colour of sky etc.

Human Eye : A Sensitive sense organ

It acts like a camera, enable us to capture the colourful picture of the surroundings.

It forms an inverted, real image on light sensitive surface Retina



The Various parts of eye and their functions

1. **Cornea :** It is a thin membrane through which light enters. It forms the transparent bulge on the front of eyeball. Most of the refraction occurs at the outer surface of the cornea.
2. **Eyeball :** it is approximately spherical in shape, with a diameter of about 2.3cm.
3. **Iris :** It is a dark muscular diaphragm that controls the size of pupil. It is behind the cornea.
4. **Pupil :** It regulates and control the amount of light entering the eye. It is the black opening between aqueous humour & lens.
5. **Crystalline eye lens :** Provide the focussed real & inverted image of the object on the retina. It is composed of a fibrous, jelly like material. This is convex lens that converges light at retina.

6. **Ciliary muscles** : It helps to change the curvature of eyelens and hence changes its focal length so that we can see the object clearly placed at different position.
7. **Retina** : Thin membrane with large no. of sensitive cells.
8. When image formed at retina, light sensitive cells gets activated and generate electrical signal. These signals are sent to brain via optic nerve. Brain analyse these signals after which we perceive object as they are.

How pupil works ?

Example : You would have observed that when you come out of the cinema hall after watching movie in the bright sun light, your eyes get closed . And when you entered the hall from the bright light, you won't be able to see and after some time you would be able to see.

Here the pupil of an eye provide a variable aperture, whose size is controlled by iris

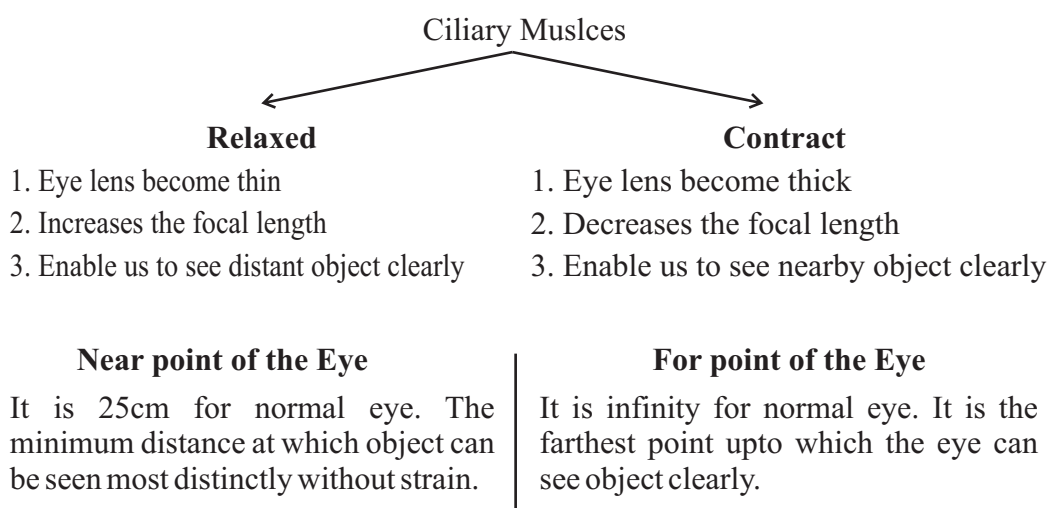
- a) When the light is bright : Iris contracts the pupil, so that less light enters the eye.
- b) When the light is dim : Iris expand the pupil, so that more light enters the eye.

Pupil open completely, when iris is relaxed.

Persistence of Vision : It is the time for which the sensation of an object continue in the eye. It is about $1/16^{\text{th}}$ of a second.

Power of Accommodation :

The ability of eye lens to adjust its focal length is called accommodation with the help of ciliary muscles.



DEFECTS OF VISION AND THEIR CORRECTION

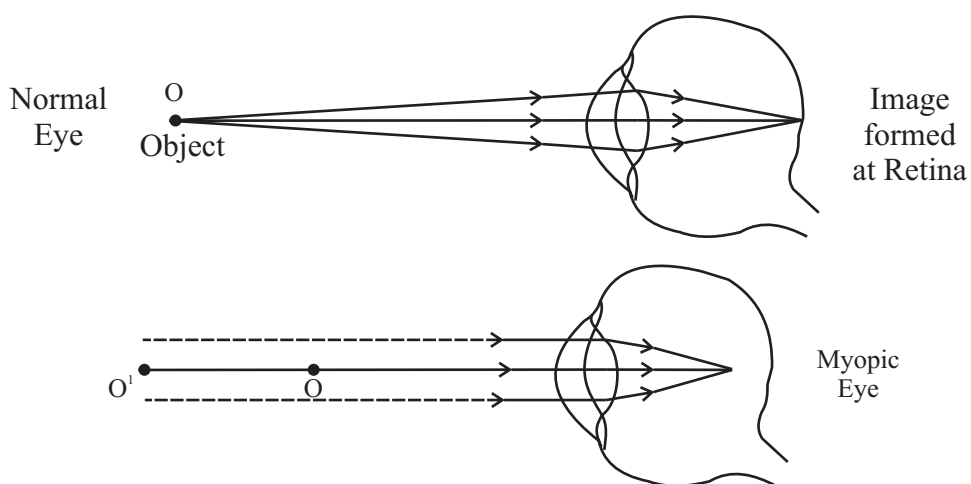
1. **CATARACT** : The image can not be seen distinctly because eye lens become milky and cloudy. This condition is known as cataract, it can cause complete or partial loss of vision.

This can be corrected by surgical removal of extra growth (cataract surgery)

2. **Myopia** : (Near Sightedness)

A person can see nearby object clearly, but cannot see distant object distinctly.

Image formed in front of the retina.

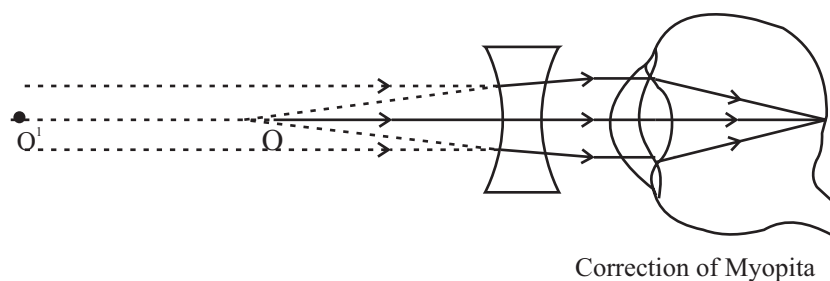


The Reason of defect

1. Excessive curvature of eye lens (thick, decrease focal length)
2. Elongation of the eye ball.

CORRECTION

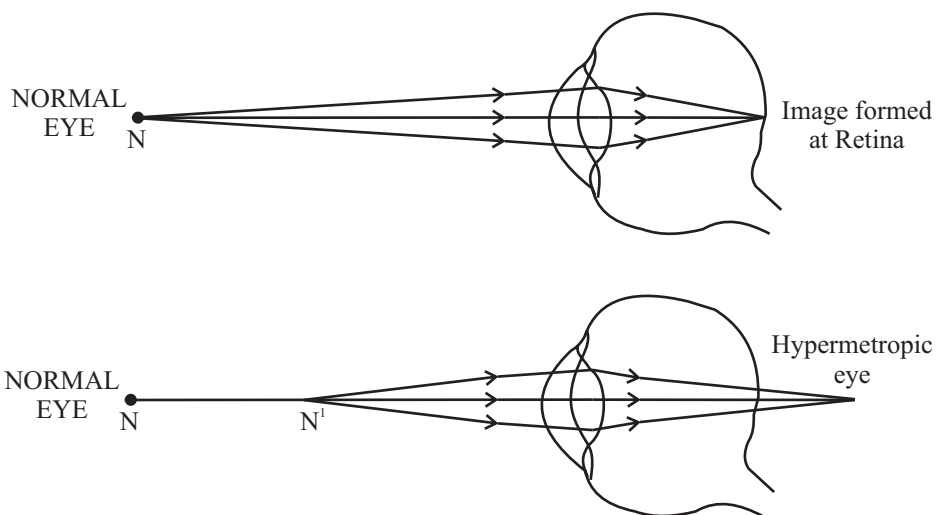
Corrected by using a Concave Lens of appropriate power.



(3) Hypermetropia (Far - Sightedness) –

A person cannot see nearby object clearly, but can see distant object distinctly.

Image formed at a point behind the retina

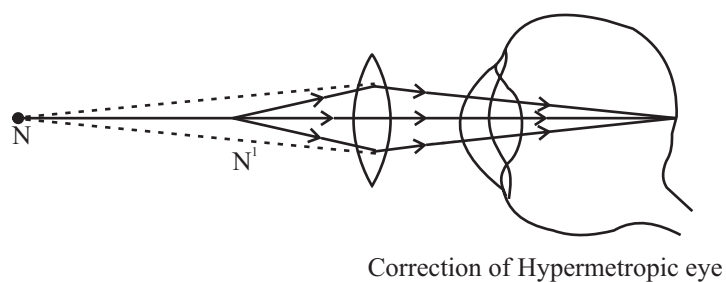


The Reason of defect

1. Increase in focal length of the eye lens (Thin eye lens)
2. Eye ball has become too small.

CORRECTION

Corrected by using a Convex Lens of appropriate power.



4. Presbyopia

As we become old, the power of accommodation of the eye usually decreases, the near point gradually recedes away.

This defect is called Presbyopia. Person may suffer from both myopia and hypermetropia.

Reason of defect- Gradual weakening of ciliary muscles and decreasing the flexibility of the eye lens.

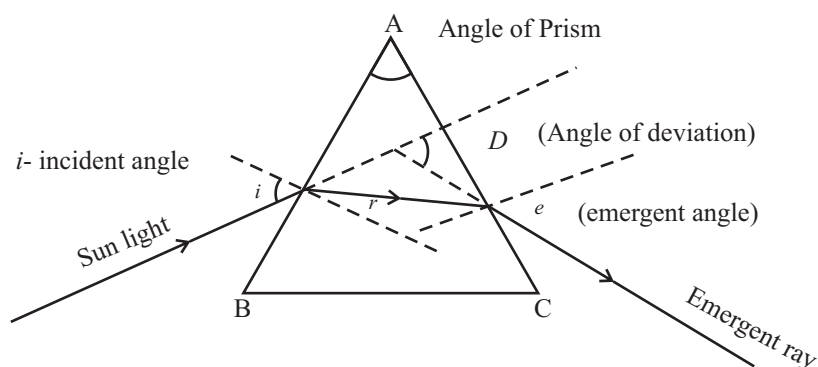
Correction- Using of **Bifocal lens** with appropriate power.

Bifocal lenses consist of both concave and convex lens, upper position consist of concave lens and lower portion consist of convex lens.

Refraction of light through a Prism

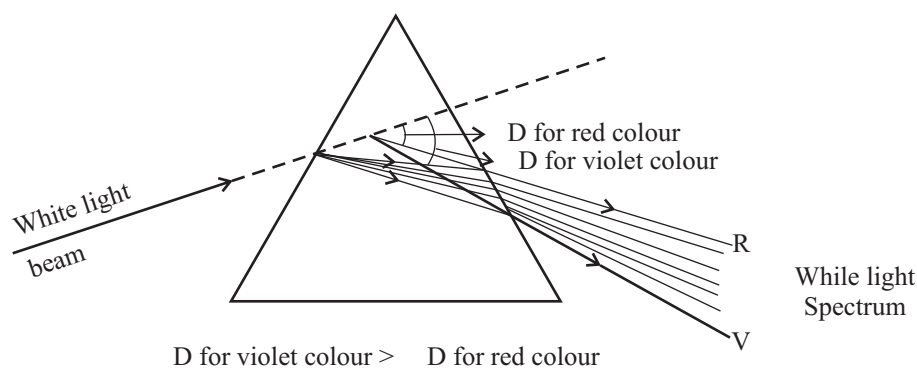
Prism- It has two triangular bases and three rectangular lateral surfaces.

These surfaces are inclines to each other. The angle between its two lateral faces is called **Angle of Prism**.



Angle of Deviation (D) The angle between the incident ray and emergent ray.

Dispersion of white light by a Glass Prism



Inclined refracting surfaces of glass prism show exciting phenomenon.

Splitting of White light into band of colours

The band of the coloured components of light beam as called **Spectrum** i.e. VIBGYOR

The splitting of light into its component colours is called **Dispersion**.

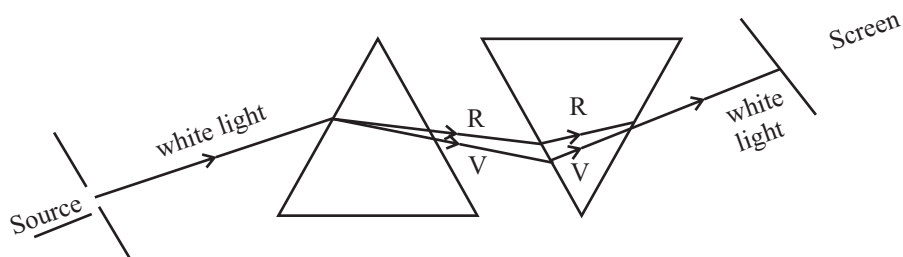
The different component colour of light bends at different angle with respect to incident angle the red light bends the least while the violet bends most.

ISSAC NEWTON He was the first, who obtained spectrum of sunlight by using glass prism.

He tried to split the spectrum of white light more by using another similar prism, but he could not get any more colours.

He repeated the experiment using second prism in an inverted position with respect to the first prism.

Allowed all the colours of spectrum to pass through second prism. He found white light emerges on the other side of second prism.



He concluded that sun is made up of seven visible colour 'VIBGYOR'

RAINBOW It is the spectrum of sunlight in nature. It is formed due to the dispersion of sunlight by the tiny water droplet, present in atmosphere.

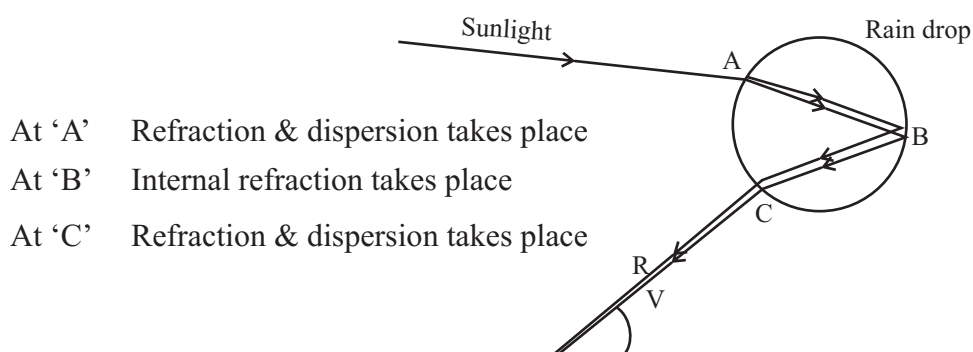
Water droplet act like prism.

It refract and disperse the incident sunlight, then reflect it internally (internal reflection) and finally refract it again, when it emerges out of the water droplet.

A rainbow is always formed in a direction opposite to that of sun.

Due to dispersion and internal reflection of light different colours reach to observer's eye.

Red colour appears on top & violet at the bottom of rainbow



Atmospheric Refraction –

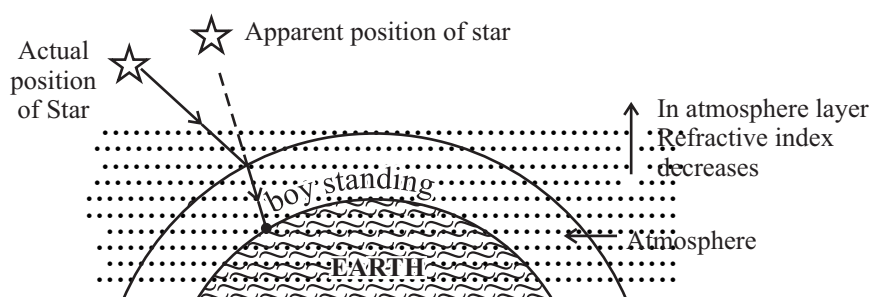
1. **Apparent Star Position**– It is due to atmospheric refraction of star light.

The temperature and density of different layer of atmosphere keeps varying. Hence we have different medium.

Distant star act as point source of light. When the starlight enter the earth's atmosphere it undergoes refraction continuously, due to changing refractive index i.e. from Rarer to denser. It bends towards the normal.

Due to this the apparent position of the star is different from actual position.

The star appear higher than its actual position.



2. **Twinkling of Star**– It is also due to atmospheric refraction

Distant star act like a point source of light. As the beam of starlight keeps deviating from its path, the apparent position of star keeps on changing because physical condition of earth's atmosphere is not stationary

Hence the amount of light enters our eyes fluctuate some time bright and some time faint.

This is the “Twinkling effect of star”

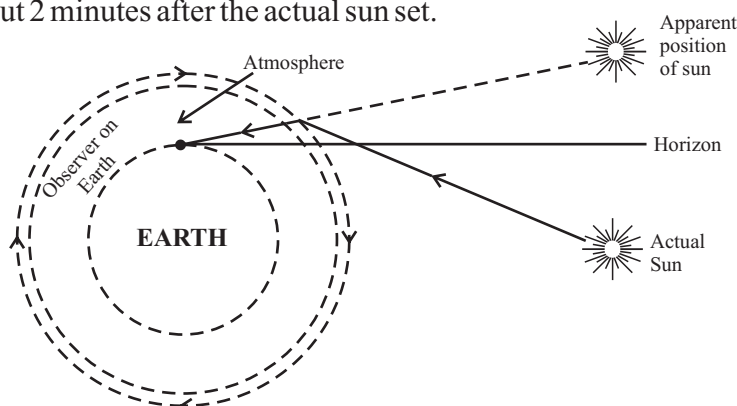
Q. Why Planet do not twinkle?

Ans. Planets are closer to earth and are seen as extended source of light i.e. the collection of large no: of point sized sources of light. Therefore the total amount of light entering our eyes from all individual point source will nullify the twinkling effect.

(3) Advance Sunrise and delayed sunset

This is also due to atmospheric refraction.

Because of this sun is visible about 2 minutes earlier than actual sunrise and about 2 minutes after the actual sun set.



Apparent flattening of the sun's disc at sun set and sun rise is due to atmospheric refraction.

Scattering of Light

Tyndall Effect– When a beam of light strikes the minute particle of earth's atmosphere suspended particles of dust and molecule of air the path of beam become visible. The phenomenon of scattering of light by the colloidal particle gives rise to Tyndall Effect.

It can be observed when sunlight passes through a canopy of a dense forest.

The colour of the scattered light depends on the size of the scattering particles

Very fine particle (scatter mainly blue colour short wave length)	Large size particle (Scatter light of longer wave length i.e. red)	Very large enough (The sky appear white)
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- (1) Why cloud Appear white**– The size of water droplet (scattering particle) is very large, hence scattered all wavelength of light almost equally.
- (2) Why colour of sky is blue**– The molecules of air and other fine particles in the atmosphere have size smaller than the wavelength of visible light. Since the blue has shorter wavelength than red, hence it will scattered the most.

According to Rayleigh scattering

$$\text{Scattering of light} \propto \frac{1}{\lambda^4} \quad \text{-- Wavelength}$$

Scattering of light decreases with increase in wavelength

Q. If there is no earth's atmosphere? What will happen to scattering phenomenon?

Ans. There will be no scattering and sky will appear dark.

(3) Colour of the Sun of Sunrise and Sunset

While sunset and sunrise, the colour of the sun and its surrounding appear red.

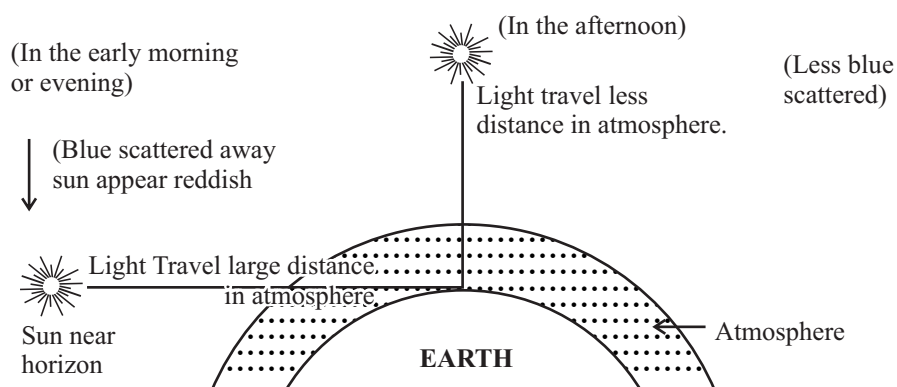
During sunset and sunrise, the sun is near horizon, and therefore the sunlight has to travel larger distance in atmosphere. Due to this most of the blue light (shorter wavelength) are scattered away by the particles. The light of longer wavelength (red colour) will reach our eye. This is why sun appear red in colour.

(4) Why the danger signal or sign are made of red colour.

Red colour scattered the least when strikes the small particle of fog and smoke because it has the maximum wavelength (visible spectrum). Hence at large distance also, we can see the red colour clearly.

(4) At noon sun appear white–

At noon the, sun is overhead and sunlight would travel shorter distance relatively through the atmosphere. Hence, at noon, the Sun appear white as only little of the blue and violet colours are scattered.



EXERCISE

(Question Bank)

Very Short Answers (1 Mark)

1. What is the phenomenon responsible for the blue colour of sky?
2. What is the near and far point of a normal eye?
3. Name the component of eye that is responsible for the adjustment of eyelens?
4. To an astronaut why does the sky appear dark instead of blue?
5. How can you remove the defect of vision 'Presbyopia'.
6. Name three primary colours? (Ans. RED, BLUE, GREEN)
7. Write the nature of image formed by our eye?
8. What do you understand by Dispersion of light?
9. What is Tyndall Effect?
10. A student has difficulty reading the black board while sitting in the last row. What is the defect of vision and how it can be corrected?

Short Answers (2 Marks)

1. Name the phenomenon responsible for formation of rainbow? Explain it with the help of diagram?
2. What is power of accommodation. How ciliary muscles help in accommodation?
3. Why does the sun appear red at sunset and sunrise. Explain?
4. Why do stars twinkle but not Earth?
5. Explain the function of
(i) Iris (ii) Pupil (iii) Retina
6. Explain the refraction of light through a glass prism with the help of a diagram. Show angle of emergence and angle of deviation?

Long Answer Type Questions (5 Marks)

1. What is myopia. State the two causes of myopia? With the help of a labelled ray diagram show
(1) Eye defect
(2) Correction of myopia
2. What is hypermetropia. State the two causes? With the help of a labelled ray diagram show
(1) Eye defect
(2) Correction of hypermetropia.
3. Draw the labelled diagram of human eye and explain the image formation?