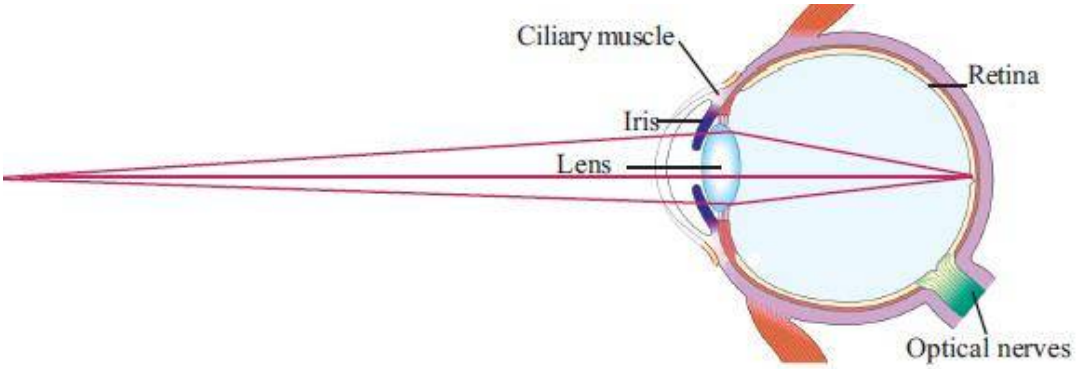
PHYSICS

CHAPTER -6- VISION AND THE WORLD OF COLOURS

Eye and Vision

Parts of human Eye



- Retina: image formation
- Ciliary muscle: used to contract or expand eye lens and support it.
- Lens- eye lens is a convex lens placed in side eye ball behind iris.

Near point

Near point is the nearest point at which the objects can be seen distinctly. The near point of an eye with healthy vision is 25 cm.

Far point

Far point is the farthest point at which the objects can be seen distinctly. The far point of an eye with healthy vision is at infinity.

Note:

- To get clear vision the image of objects from far point up to near point must be obtained on retina.
- When we look at nearer object, the ciliary muscles related to convex lens in our eyes are contracted and the curvature of the lens increases, the focal length decreases.
- When we look at far object, the ciliary muscles related to convex lens in our eyes are relaxed and the curvature of the lens decreases, the focal length increases.

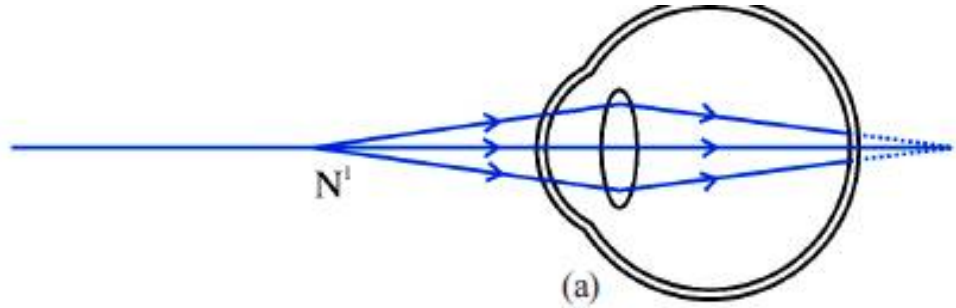
Power of Accommodation

The ability of the eye to form an image on the retina by adjusting the focal length of the lens in the eye, by varying the curvature of the lens, irrespective of the position of the object, is the power of accommodation.

Defects of Eye and its Rectification

1. Hypermetropia / Long-Sightedness

Since the image is not formed at the retina, instead of being formed at the retina, nearer objects cannot be seen clearly even though distant objects are clearly seen. This defect of the eye is the long sightedness. The near point of the eye of such a person will be at a distance of more than 25 cm.



(a)

Reason for the defect

- **Size of the eye ball smller**
- **Focal length of the lens increases**
- **Power of the lens -low**

Rectification of the defects

By using Convex Lens of suitable power

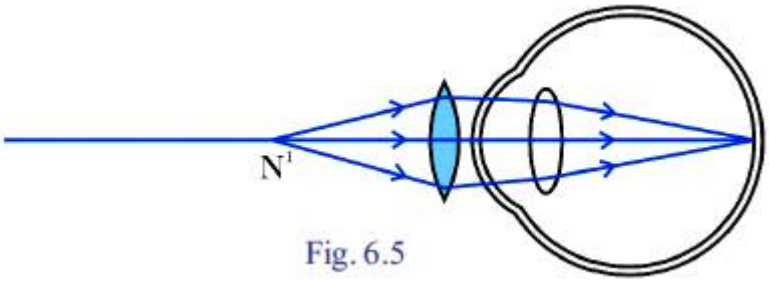
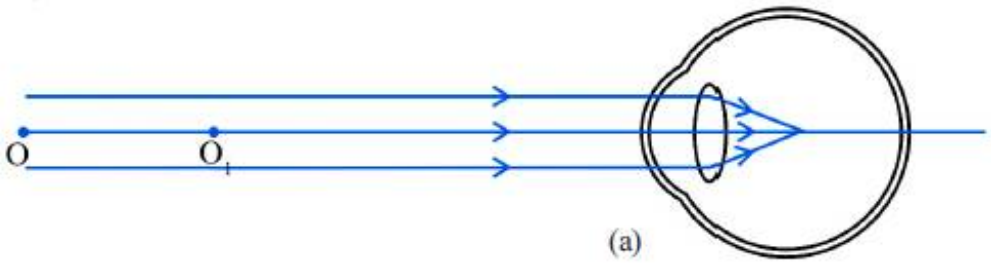


Fig. 6.5

2. Myopia / Near- Sightedness

For some persons, even though nearby objects can be seen clearly, they may not be able to see distant objects clearly. This defect is the nearsightedness. The near point of such persons will not be at infinity. It will be at a definite distance from the eye.



(a)

Reason for the defect

- **Size of the eye ball larger**
- **Focal length of the lens decreases**
- **Power of the lens -High/ Larger**

Rectification of the defect

By using concave lens of suitable power

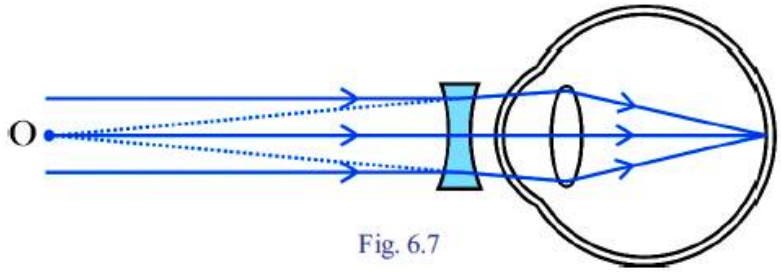


Fig. 6.7

3. **Presbyopia**

For elderly people the distance to the near point is greater than 25 cm. This is due to the diminishing ability of the ciliary muscles. For such people the power of accommodation will be less. This is presbyopia.

Rectification of the defect

By using a convex lens of suitable power

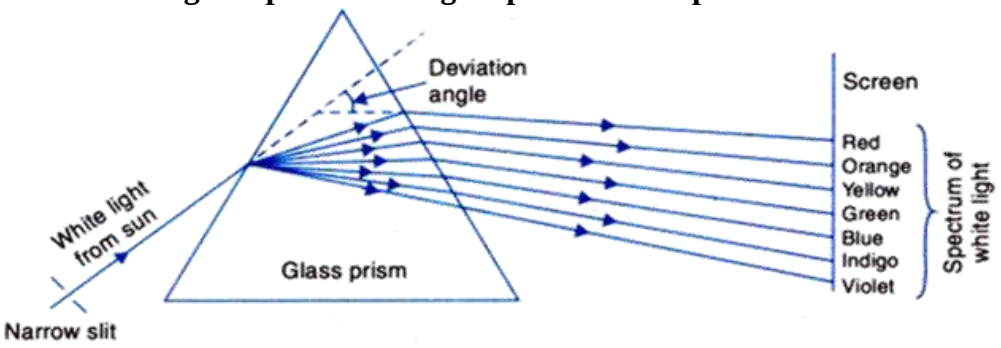
Phenomenon Related to Optics

I. Dispersion of Light

Dispersion is the phenomenon of splitting up of a composite light into its constituent colours. The regular array of colours formed by dispersion is the visible spectrum.

Example

When a sunlight is passed through a prism it will split into seven constituent colours



Q) when a torch light is fall into a prism the following colours are obtained at the screen

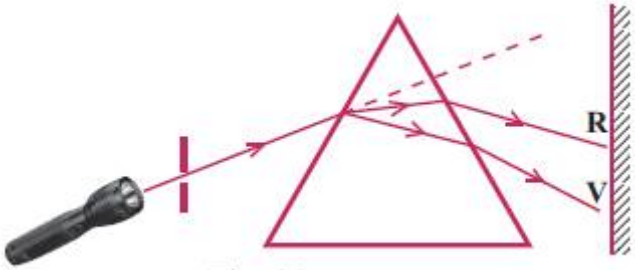


Fig. 6.9

a. **Why red colour deviates less?**
b. **Why blue colour deviates more?**

Ans) a. red colour has more wave length so it will deviate less.

b. blue colour has low wave length so it will deviate more.

Q) Define composite light?

Any light that is composed of more than one colour is a composite light.

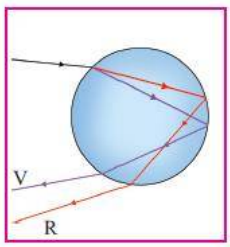
Example for composite lights are sun light and white light

Q) define spectrum of light

Ans) The arrangement of colours in the order of their wave length in visible light is called spectrum of light

Application of dispersion of light: Rainbow formation

RAINBOW FORMATION



Formation of Rainbow

Sunlight, when it passes through water droplets, undergoes refraction and internal reflection. The light ray emerging from the water droplets which make the same angle with the line of vision have the same colour. These droplets appear in the form of an arc of a particular colour. Thus there is red colour at the upper edge and violet colour at the lower edge. All the other colours are seen in between, depending on their wavelengths.

Note:

- **Red colour is at the upper edge**
- **Violet colour is at the lower edge**
- **When rainbow is at west sun is at east**
- **When rainbow is at east sun is at west**
- **When looking through aeroplane it will appeared as circle**
- **When sun is much above the horizon rainbow disappear**
- **It has arc shape because each ray of colour emerging from the water drop makes a definite angle ranging from 40.8^0 (violet) to 42.7^0(red)**
- **Inside the water droplet Light ray undergo two times refraction, one-time internal reflection and dispersion.**

II. Recombination of colours

When a white light is passed through a prism the light split into its constituent colours, but when another prism is placed near to the first prism with bases are parallel the constituent colours will **recombine** to form white light.

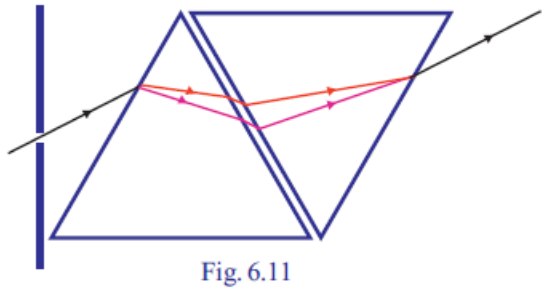


Fig. 6.11

III. Persistence of Vision

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 $\left(\frac{1}{16}s\right)$ 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.

Examples for persistence of vision

- **Newton's colour disk. When rotated at very high speed appears as white disk.**
- **A torch rotated rapidly appears as an illuminated circle.**
- **Rain drop falling vertically downwards with very high speed appears as glass rod**
- **When pictures run at very high speed it will look like moving.**

IV. Scattering of Light

Scattering is the change in direction brought out by the irregular and partial reflection of light when it hits the particles of the medium.

Examples

a. Blue colour of Sky

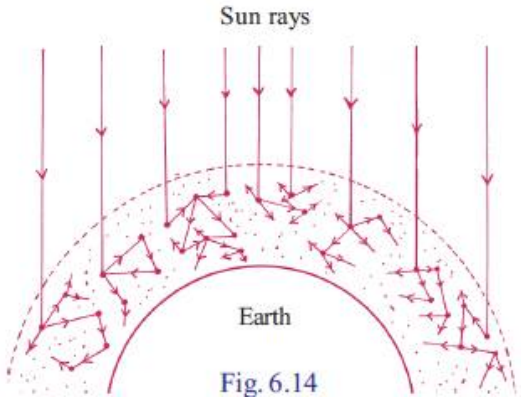
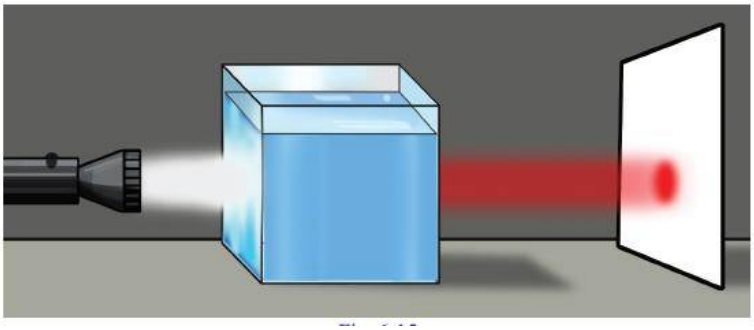


Fig. 6.14

Reason: *When sunlight passes through atmosphere, rays of light are reflected by tiny particles of atmosphere as a result the lower wave length colours such as violet, indigo, blue will have higher rate of scattering and they will spread in the sky, so sky appears as blue*

b. Experiment in Sodium Thiosulphate Solution



Experiment: allow torch light to pass through water taken in the beaker the path of light will appear as blue. But when sodium thiosulphate is added with hydrochloric acid the colour of path changed to red as shown in the picture.

Reason: *when sodium thiosulphate react with hydrochloric acid sulphur is precipitated. As the size of sulphur particle increases the nature of scattering changes*

Wave Length and Rate of Scattering

Rate of scattering and the size of the particles are interrelated. As the size of the particle increases, the rate of scattering also increases. If the size of the particles is greater than the wavelength of light, then the scattering is same for all colours.

c. Colours of Rising and Setting Sun

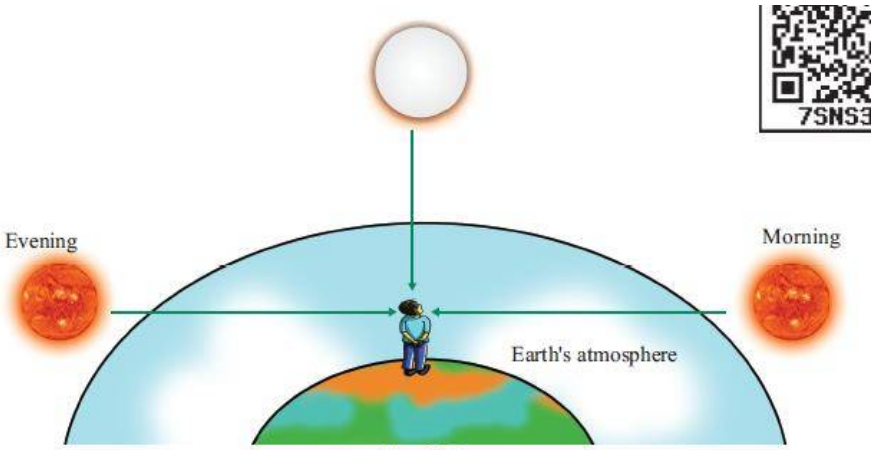


Fig. 6.16

Reason:

During sunrise and sunset, light reaching us from the horizon has to travel long distances through the atmosphere. During this long journey, colours of shorter wavelength would be almost fully lost due to scattering. Then, the red light which undergoes only less amount of scattering decides the colour of the horizon. That is why the sun appears red during sunset and sunrise.

Q) why red colours are used in signal lamps and tail lamps of vehicles?

Ans) red colour have high wavelength as wavelength increases rate of scattering decreases hence loss due to scattering decreases hence red colour is used in signal lamps.

V. Tyndall Effect

When ray of light pass through a colloidal fluid or suspension tiny particles get illuminated due to scattering, because of this path of light is visible this phenomenon is Tyndall effect.

Example:

- **In the misty morning the path of smog is visible**
- **When looking through key hole of room the path of light is visible**
- **The path of light from light house can be visible to shipmen**

Light Pollution

The use of light in excess in a non-judicious manner is referred as light pollution

Q) what will the consequences of light pollution

- **The life cycle of living beings will be affected adversely**
- **Sky watching becomes impossible due to diminished sky vision**
- **The light from tall flats misleads the migrating birds it affects the accuracy of their judgement of direction.**
- **The excess light from high beam headlight of vehicle causes a hinderance of vision and leads to accidents**

Q) how can you reduce light pollution?

- **By using LDR lights in street lights**
- **Avoid the excess use of ordinary light in day time**
- **Avoid the use of high beam lights in vehicle unnecessarily**
- **Use of maximum sun light in day time**

International Dark Sky Association

International Dark Sky Association is an association which deals with the task of reducing light pollution. Every year, the week of the new moon in April is celebrated as International Dark Sky Week. This is the idea originated from Jennifer Barlow, a high school student from Virginia.

Practice Questions

1. How is the condition of the ciliary muscles while watching a distant object? How does this influence the focal length of the eye lens?
2. A child sitting at the back bench of a classroom is unable to see the letters on the board clearly. What is the defect of the eye of the child? How can it be remedied? Draw its ray diagram.
3. A person is not able to see objects beyond 1.3 m. What remedy can you suggest for this defect?
4. In what colour does the sky appear for an astronaut?
5. Red light is used as signal lamps to indicate danger. Explain.
6. What is the reason for using yellow light as fog lamps?
7. Which is the phenomenon behind dispersion of light?
   (a) Reflection (b) Refraction
   (c) Tyndal Effect (d) Scattering
8) During dispersion, different colours deviate differently. Explain why.
9. The telescope called 'Chandra X – ray Observatory' is placed in the outerspace. What is the advantage of placing it there? Explain with reference to the scattering of light in the atmosphere.