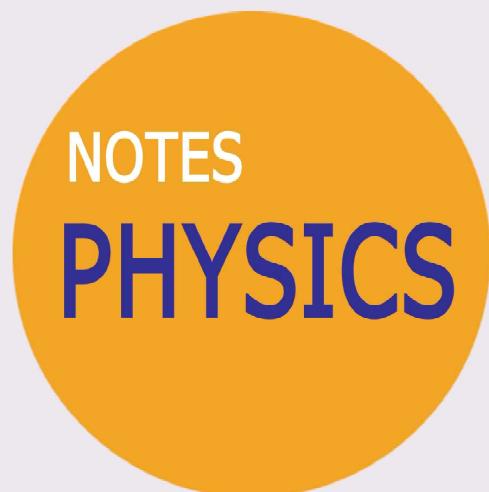


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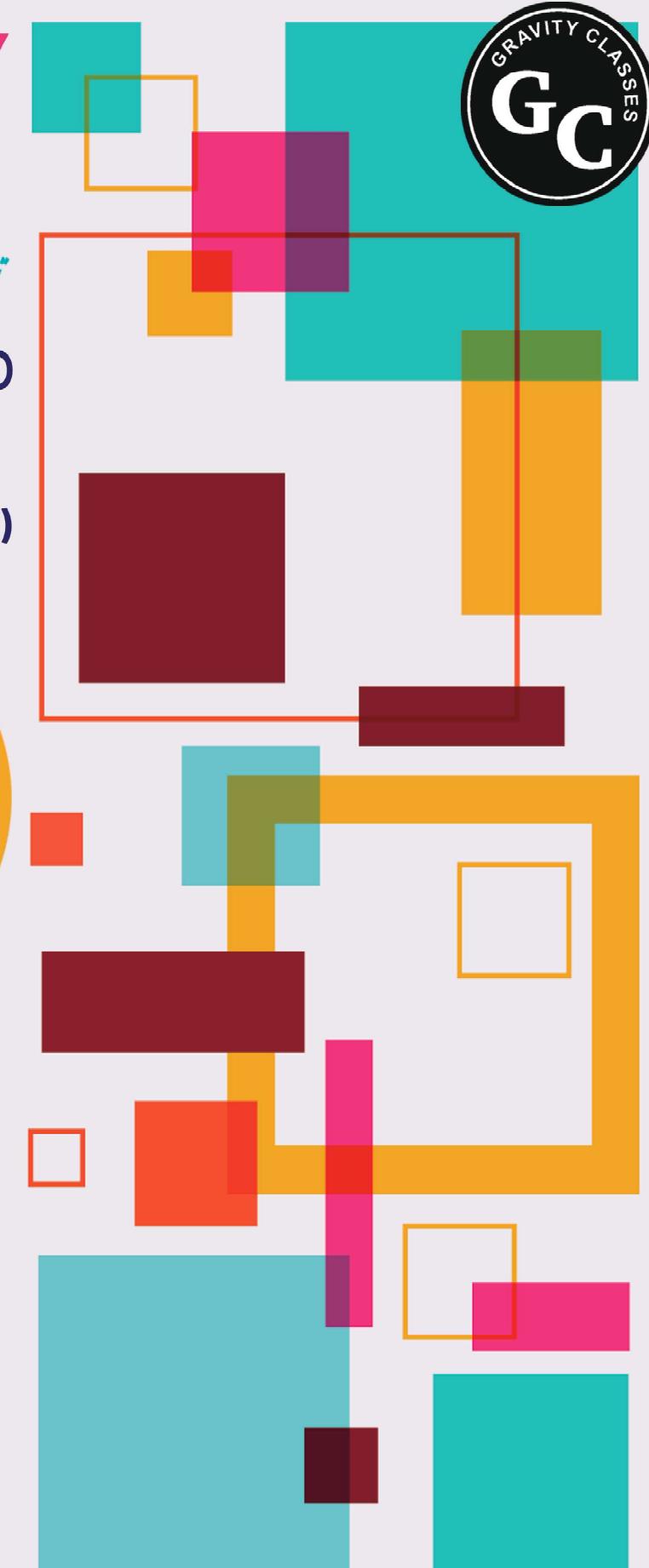


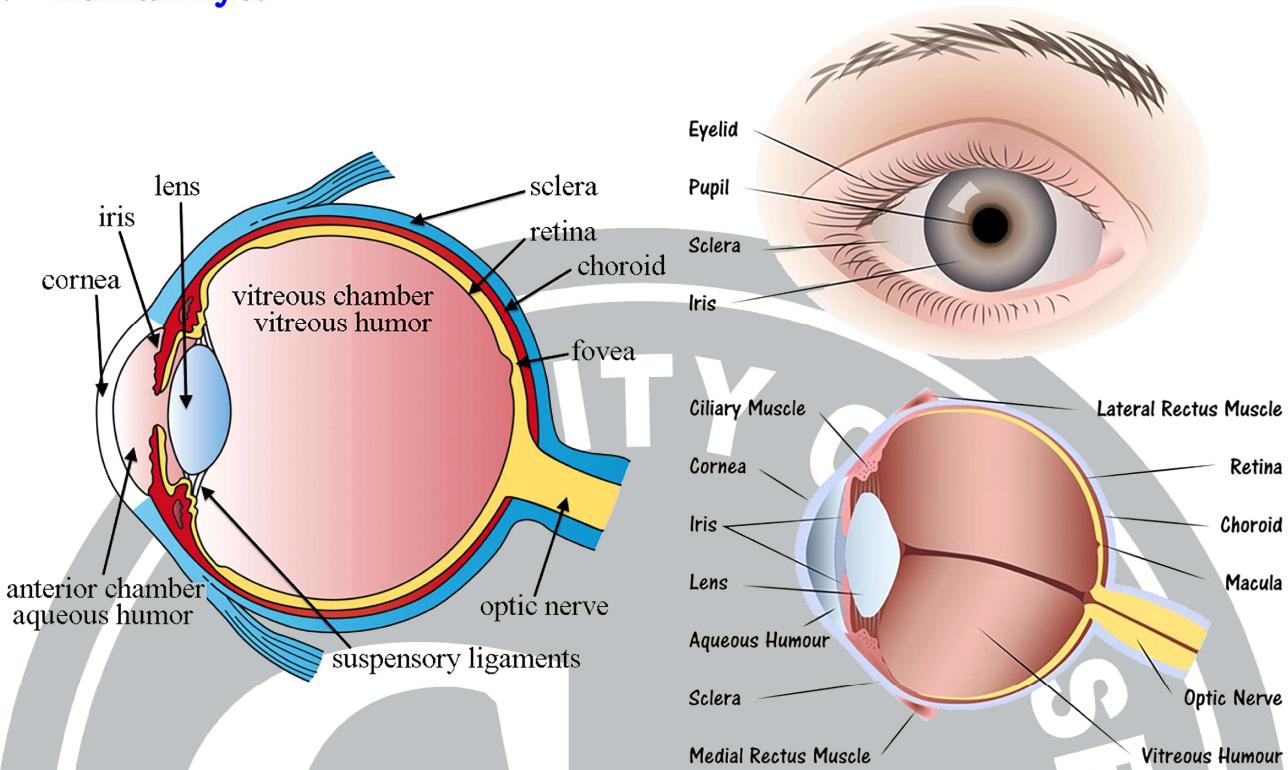
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HUMAN EYE**# Human Eye:-**

- The human eye is almost a spherical ball with a slight bulge in the front part.
- The eyeball is approximately **spherical** in shape. Its **diameter** in a grown up person is **2.3 cm to 2.5 cm**.
- **Cornea:-** It is the **front bulging** portion of the eye. It is made of **transparent tissues** and contains **no blood vessels**. It allow to light to enter the eye ball.
- * (Most of the refraction of light takes place while passing through cornea).
- **Choroid:-** It is a **grey membrane** attached to the sclerotic from the inner side. Its **function is to nourish the outer layer of the retina** and to darken the eye from inside.
- **Optic nerve:-** It is a **bundle of nerves** **orginating from the brain** and **entering the eye ball** from the posterior side. The **left eye receives optic nerves** from the **right side of the brain** and the **right eye from the left side of the brain**. Its **function** to carry the **optical messages to the brain**.
- **Crystalline lens:-** It is a **double convex lens**, more bulging on the posterior side. It is made of **transparent, flexible tissues** like **jelly made of protein**. Being flexible, it can **change its shape** (thin or thick) **to focus light** on to the retina.
- **Ciliary muscles:-** It is a **ring of muscles**, which along with the **suspensory ligament**, holds the crystalline lens in position. When these muscle **contract**, they **decrease the focal length** of the crystalline lens. Similarly, when these **muscles relax**, they **increase the focal length** of the crystalline lens.

- **Iris:-** It is a **flat**, coloured, ring-shaped membrane **behind the cornea of the eye**.
 - Its function is to control the amount of light entering the eye. The iris automatically **adjust the size** of the pupil according to the intensity of light received by the eye. When the **muscles contract**, they **increase** the size of the pupil, thus allowing more light to enter the eye and vice-versa.
- Note:-** The colour of iris depends upon the **race, geographic location** and **genes of a person**.
 - The **pupil** appears **black** in all kinds of human eyes, because it is a **hole** through which light energy can enter the **eyeball**, but no light energy is reflected back from the eye ball.
- **Retina:-** The screen on which the **image is formed** is called retina. It is a delicate membrane having enormous number of **light sensitive cells**. The light-sensitive cells get activated upon illumination and generate **electrical signals**. The optic nerve on entering the eye ball spreads like a canopy and each nerve attaches itself to the choroid. Any **inverted image** formed on the retina by the eye lens, is **converted** into **optical impulses**, which are then **sent** to the **brain**. The retina has two very important regions, which are called the **yellow spot** and the **blind spot**. The function of the retina is to **receive** the **optical image** of an object and then **convert it into electrical pulses** which are finally **sent to the brain** through the **optic nerve**.
 - The nerve endings in the retina are of two kinds i.e., **rod-like** endings or **cone-like** endings.
 - The rod shaped nerve endings are **sensitive to intensity** of **white light**, i.e., they give the sensation of various shades of white and black, depending upon its intensity.
 - The **cone shaped** nerve endings are sensitive to primary **colours** i.e., red, blue and green, However, they do not respond if the intensity of light is low.
 - The retina of human eye is sensitive to only white light or its constituents.
 - The retina of honey bees is sensitive to white as well as ultraviolet light.
 - The chicken is almost blind at night, because their retina has very large number of cone shaped cells which are insensitive to dim light.
- **Yellow Spot:-** It is situated at the **centre of the retina** and is **slightly raised**. It has a little depression called **Fovera-Centralis**, which is **extremely sensitive** to light. Its function is to form an **extremely clear image**, i.e., when we want to examine an object **very minutely**, its image is brought to **focus at this point**.
- **Blind Spot:-** The region on the retina, where the **optic nerve enters** the **eye ball** is called the **blind spot**. It has **no nerve endings** and hence is **insensitive to the light**. Apparently it has **no function**. Any image formed at this spot is not visible.
- **Vitreous Humour:-** It is a **dense, jelly like fluid**, slightly **grey** in colour, filling the posterior part of the eye ball. It has the following functions:-
 - (a) It **prevents the eye ball from collapsing** due to the changes in the atmospheric pressure.
 - (b) It partially helps in focussing the image clearly on the retina.

- **Aqueous Humour:-** It is **watery, saline fluid**, filling the anterior portion of the eye. It has the following function.
 - It prevents the anterior portion of the eye from collapsing due to the changes in the **atmospheric pressure**.
 - When we **wink our eyes**, a tiny drop of the aqueous humour flows out from the side of the eye. Then it **washes** the eye and keeps the **cornea moist**. Otherwise the cornea will shrivel (Dry) and become **opaque**.

Accommodation of the Eye:-

- The process by which the **ciliary muscles** alter the focal length of the crystalline lens, so as to focus nearer or far-off objects clearly on the retina is called the **accommodation of the eye**.
- The minimum distance at which an object be placed such that a normal eye may see it clearly is called as the least distance of distinct vision. The least distance is **about 25 cm**. The farthest point is **infinity** for a normal eye.

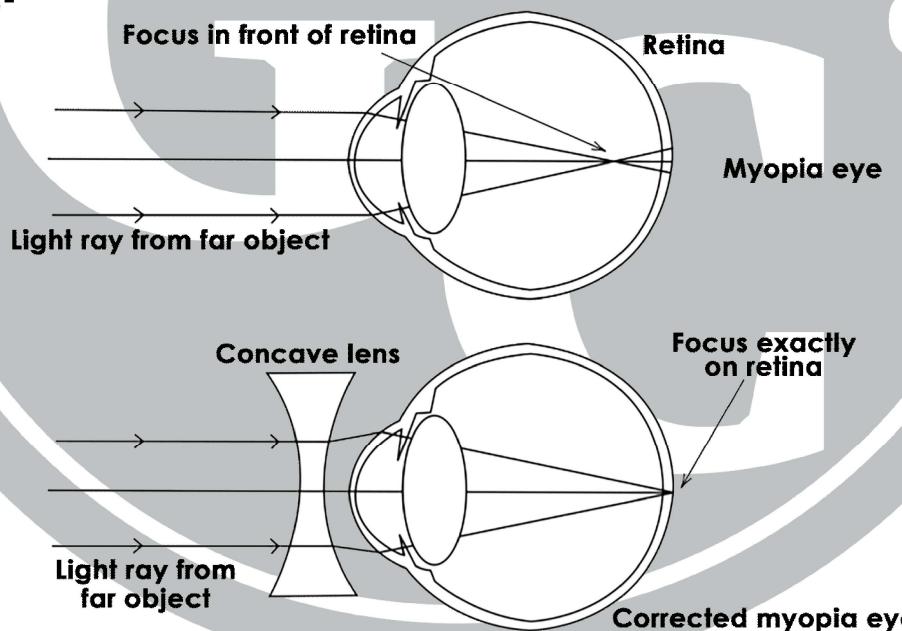
● Defects of vision and Their Correction:-

The most common defects of vision

1. Short-sightedness or myopia
2. Long-sightedness or hypermetropia
3. Presbyopia

1. **Short-Sightedness or Myopia:-** A person suffering from this defect can see the **nearer objects clearly**, but cannot see the far-off objects clearly.

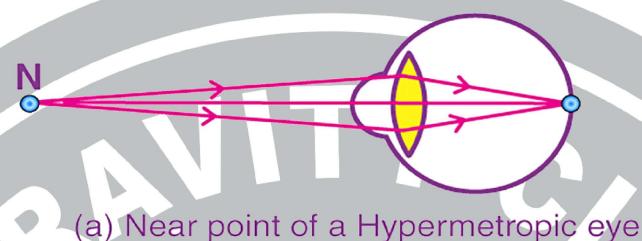
Causes:-



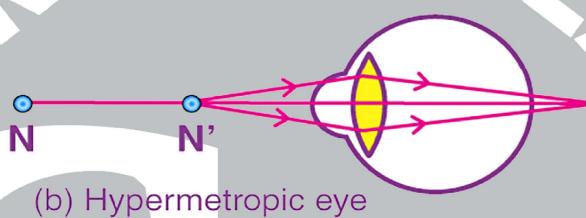
- (i) Due to some disease or age, the **ciliary muscles** attached to the lens get **weak**. They are unable to relax sufficiently to make the crystalline lens thinner to **reduce** its **converging power**. So due to greater converging power of lens, the image of the far-off object is formed **in front of the retina** and hence appears blurred.
- (ii) Sometimes the **eyeball gets elongated** due to which the retina is at a **larger distances** from the lens and therefore the images of far-off objects are formed in front of the retina.

- **Correction of short-sighted eye:-** A short-sighted person can see clearly to some distance (say 4m). Beyond this distance the images get blurred. The farthest point from which a short-sighted person can see clearly is called far-off point of clear vision. Generally, the **lens used** is a **concave** lens and its focal length depends upon the degree of abnormality in the eye.
 - The focal length of a concave lens in case of myopic eye is always equal to the distance of the **far point** from the eye, because the virtual image is always formed at far point.

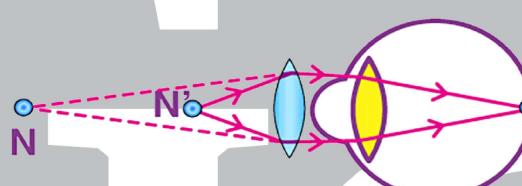
2. Long-sightedness or Hypermetropia:-



(a) Near point of a Hypermetropic eye



(b) Hypermetropic eye



(b) Correction for Hypermetropic eye

- A person suffering from this defect can see far-off objects clearly, but **cannot** see clearly the objects situated at a distance of **25 cm** or **at the least distance** of distinct vision.
- The near-point of hypermetropia eye is **more than 25 cm**.

Causes:-

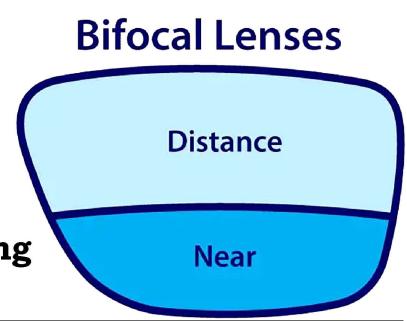
- Due to some disease or age, the **ciliary muscles** becomes stiff and hence they **do not contract**.
- Due to some disease the eye ball **becomes smaller** in size due to which the retina is at a smaller distance from the crystalline lens.

- **Correction of long-sightedness:-** The lens used is **convex lens**.

- The whole purpose of using a convex lens in this case is to increase the converging power of the crystalline lens.

3. Presbyopia:-

- In old age the **power of accommodation** of the eye usually decreases. It arise due to the **gradual weakening** of the **ciliary muscles** and **diminishing flexibility of the eye lens**. For most of the old



persons, the near point gradually recedes away. They find it difficult to see nearby objects comfortably and distinctly without corrective eye-lenses. This defect is **known as presbyopia**.

→ A bifocal lens can be used. It is possible to correct the refractive defects with contact **lenses** or through **surgical** interventions.

● Advantages of having Two Eyes in Human:-

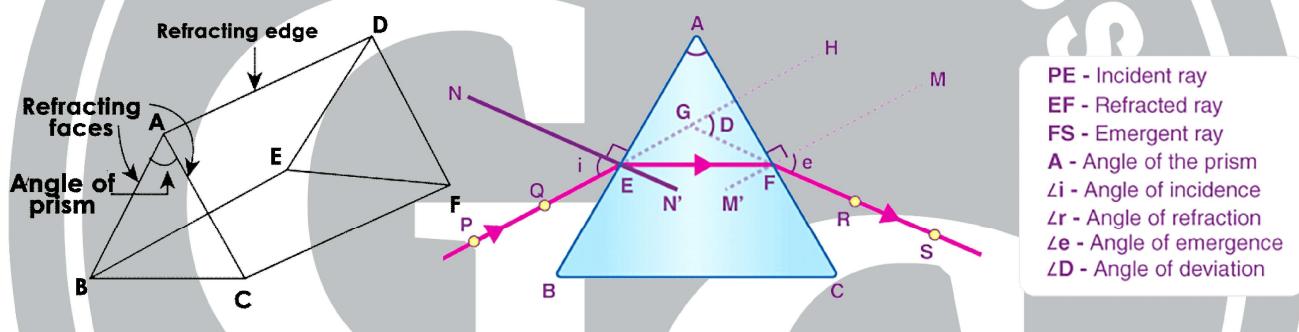
→ A **single** human **eye** has a horizontal field of view of **150°**. However, with **two eyes**, separated by few centimetres, the horizontal field of view increases to **180°**. Furthermore the ability to detect faint objects is enhanced with **two eyes**.

→ Ability to judge the **depth** or **distance** of the object more accurately. This phenomenon is called **stereopsis**.

→ It is interesting to note that most of the **animals** and **birds** have two eyes, placed almost diametrically on their head. Thus, animals or birds have **almost 360°** view. However they **do not have sensation of depth**.

Refraction of Light Through an Equilateral Prism:-

→ Prism is a piece of glass or any other transparent material, bounded by two triangular and three rectangular surfaces.



→ Angle of incidence + angle of emergence = angle of prism + angle of deviation
 or $\angle i + \angle e = \angle A + \angle D$

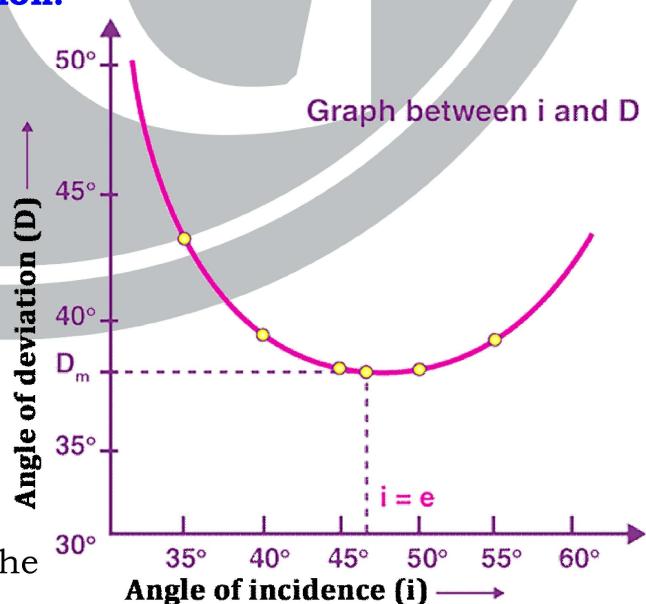
→ Generally the prisms used in laboratory are equilateral prisms.

● Factors Affecting Angle of Deviation:-

1. **Angle of Incidence**:- For an equilateral prism of a given material, on the increase of angle of incidence (say from 25° to 60°) the angle of deviation, first decreases and then increases.

2. **Angle of Prism**:- The angle of deviation is **directly proportional** to the angle of prism.

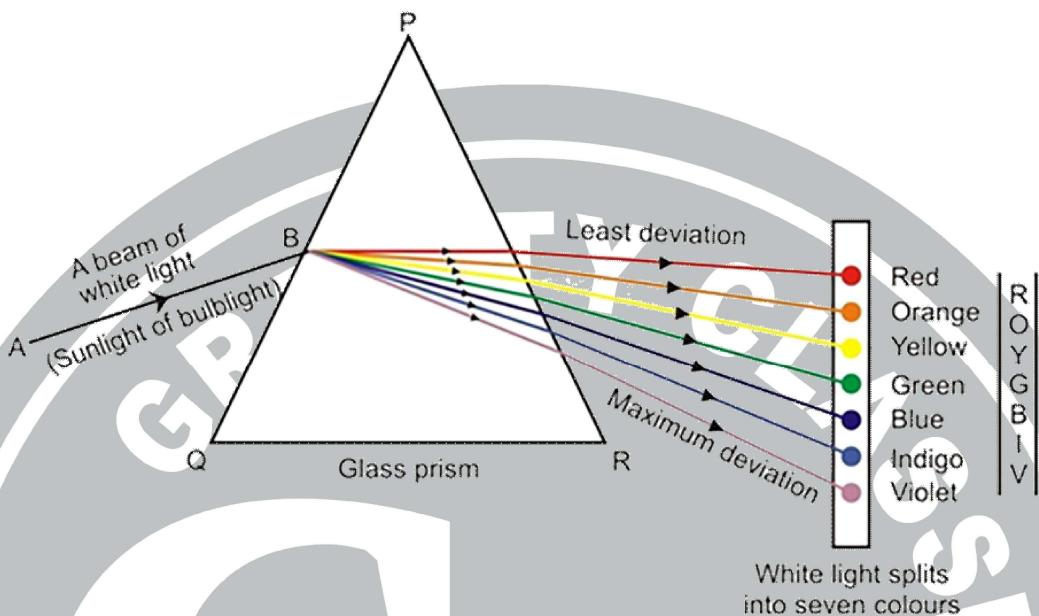
3. **Refractive Index of the Material of Prism**:- **More is the angle of deviation more refractive index of the material.**



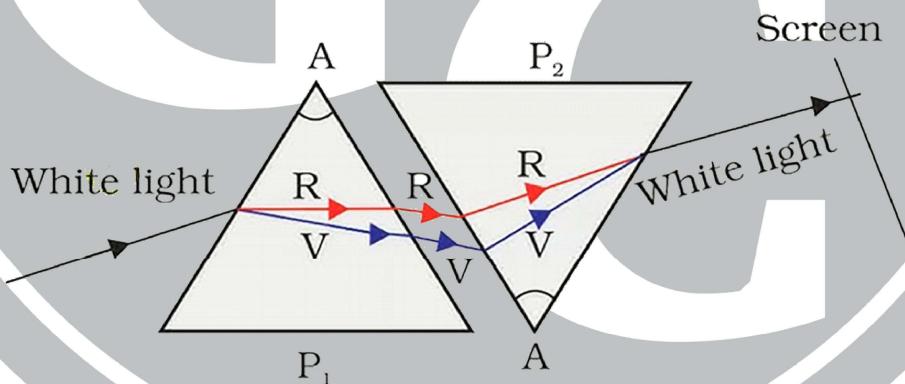
4. **Colour of Light:-** More is the wavelength of light, less is the angle of deviation.

Dispersion of White Light by a Glass Prism:-

- **Dispersion:-** The phenomenon due to which white light splits into its component colours, when passed through a transparent medium like a glass prism is called **dispersion**.



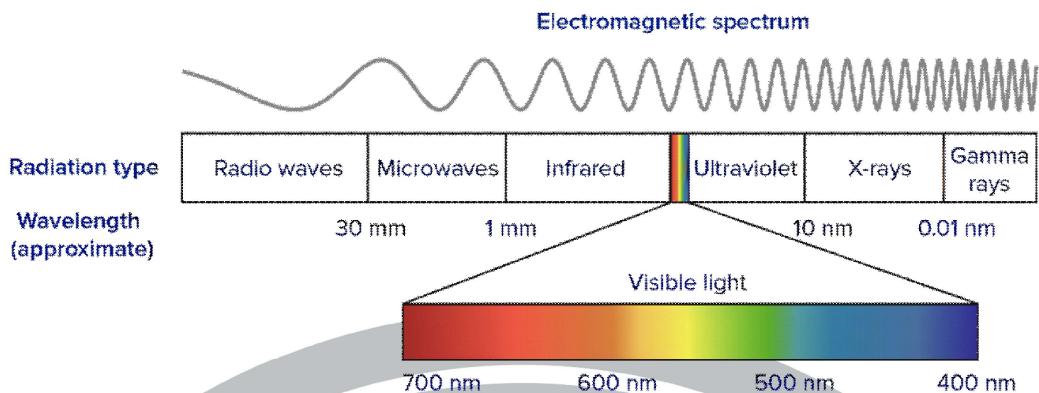
- **Spectrum:-** The band of **seven colours** obtained on the screen, when a white light splits into its component colours when passed through a glass prism is called the **spectrum**.
- * **Recombination of white light:-**



- In fact prisms A and B, collectively act like a glass slab with parallel sides. The prisms A disperses white light and is called the **dispersing prism**, whereas prism B recombines dispersed light and is called the **recombination prism**.
- The formation of spectrum of seven colours shows that white light is made up of lights of seven different colours mixed together. Thus, we can say, white light is a **composition of seven colours** or seven coloured light.

Q. What causes dispersion of white light ?

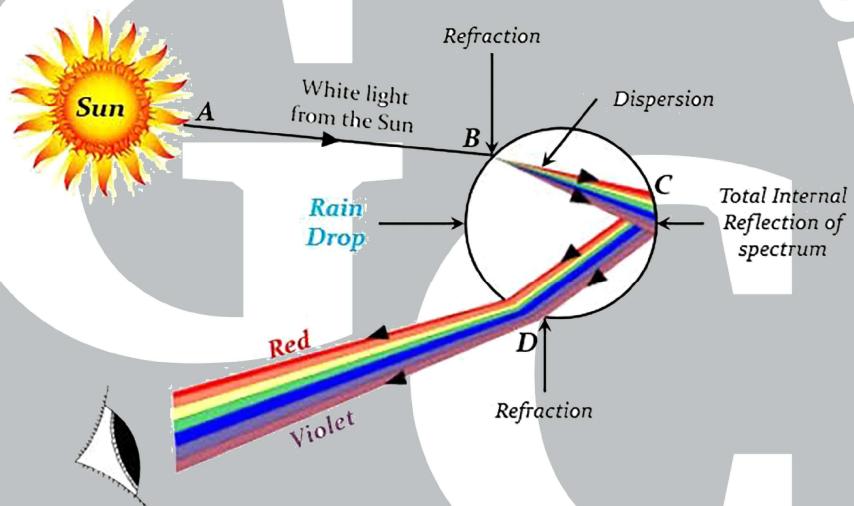
A. White light is a mixture of several waves of electromagnetic radiations, whose wavelength vary from **700 mm to 400 mm**.

● Monochromatic Light:-

- Light of a single colour or single wavelength is called **monochromatic light**.
- Light emitted by **sodium vapour** is golden yellow in colour and is a monochromatic light.
- The word chrome means colour.

● Polychromatic Light:-

- A light which is made of **two or more colours** is called polychromatic light.
- Sunlight is polychromatic as it is made up of **seven colours**.

● Rainbow:-

- Rainbow is one of the most beautiful examples of spectrum formed due to the dispersion of light in nature. The rainbow is produced due to the **dispersion** of sunlight by **tiny droplets of water suspended** in air, just after rain. It is an arch of seven colours visible in the sky. It is actually a natural spectrum of sunlight in the sky.
- The suspended tiny droplets of water act as small prisms. They **refract** and disperse the incident sunlight, **then reflect** it **internally** and **finally refract** it again when it emerges out of the raindrop.
- Rainbow is always formed in the direction opposite to that of the sun.

Atmospheric Refraction:-

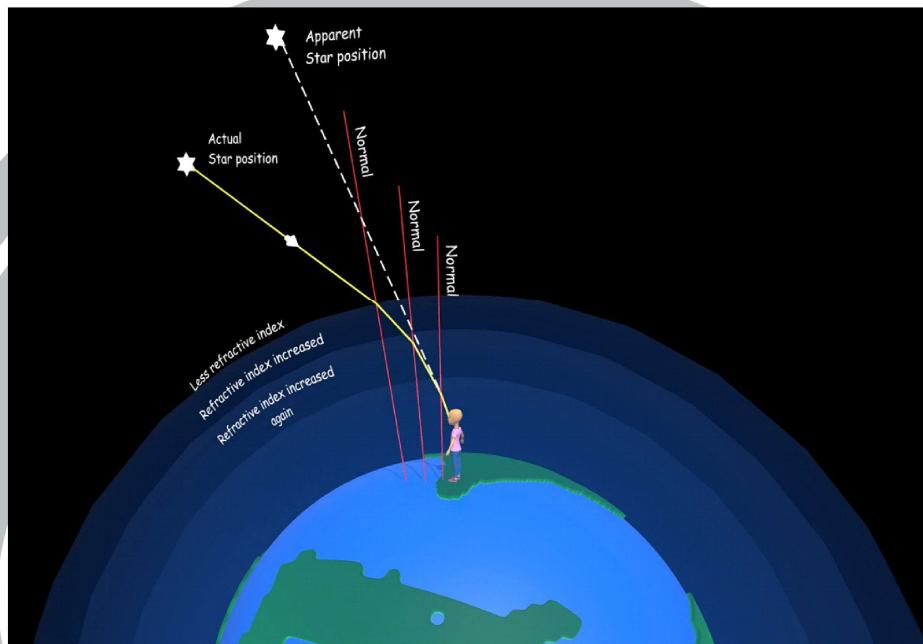
- The refraction of light takes place, when light rays **pass through** the **atmosphere** having air layers of **different optics densities**. The refraction of light caused by such earth's atmosphere is called **atmospheric refraction**.

1. When we sit around a **campfire**, the face of a person sitting opposite to you, appears to shimmer.

2. Apparent position and twinkling of stars.

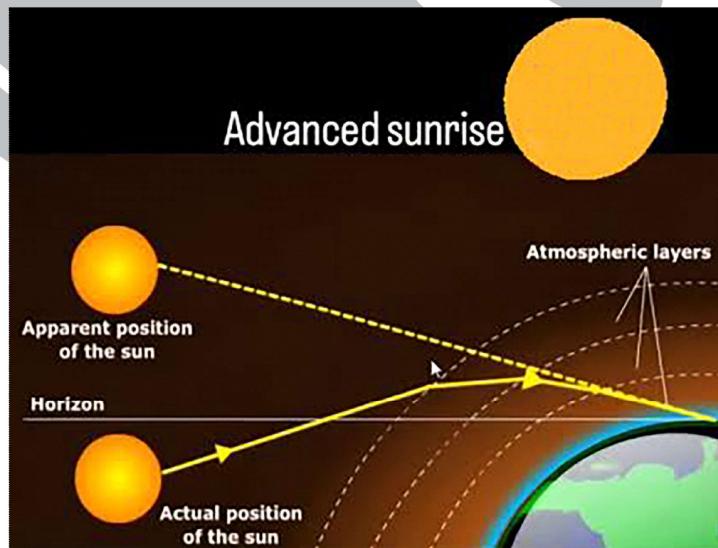
→ The **twinkling** can be explained by saying, that as the layers of air of different densities mix, they change the apparent position of star. Thus, when a star is within the line of sight, it is visible. However, when it falls out of the **line of sight**, it is no longer **visible**. The collective effect of the above changes in apparent position of a star is that it appears to twinkle.

3. Why do planets not twinkle ?



→ Planets are very close to us as compared to stars. Thus, unlike stars they do not act as point source. Their apparent position also changes with the **change in density** of different layers of atmosphere. However, the size of their apparent image is still fairly large, such that it seldom falls outside the line of sight. Hence, they do not appear to twinkle.

4. Why does sun appear bigger during sunset or sunrise and also why we observe early sunrise and delayed sunset ?



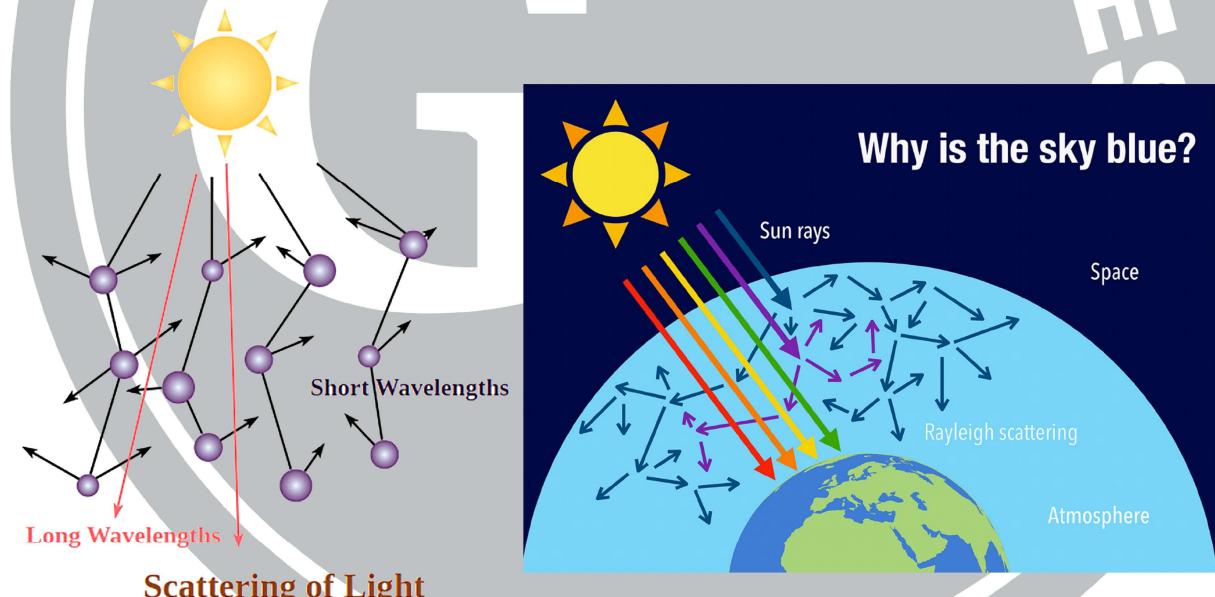
- As already pointed out, the apparent position of a star is higher than its actual position in horizon. Moreover, due to refraction the **apparent image of star is closer to eye than its actual position**. Since during sunset or sunrise, the **rays of light travel** through **maximum length of atmosphere**, therefore refraction is also maximum. Hence, apparent image of sun is very much closer to eye. Thus, it appears bigger.
- Further on even when sun is below horizon, its rays manage to reach earth due to refraction. It has been found that sun is visible to us about 2 minutes **before** the actual sunrise and **2 minutes after** the actual sunset, **because of atmospheric refraction**.

- **Scattering of Light:-**

- The **scattering** of light by **particles** in its path is called **Tyndall effect**. The path of sunlight becomes visible to us, when a beam of light enters a **dusty room** through a window. Because the **tiny dust particles** present in the air of the **room scatter the beam of light** all around the room, thus we can see the beam of light when this scattered light enters our eyes.

- **What is Scattering ?**

- It has been established that when an incident ray of light strikes a particle which has a diameter greater than the wavelength of incident light, then incident light is first absorbed by the particle and then transmitted in all possible directions. This is called **scattering of light**.



- A large particle whose diameter is **greater than the wavelength** of the **blue** light, **but smaller** than the **wavelength of red light**. Now when a mixture of red and blue light is made incident on such a particle, then the **blue light is absorbed** by the particles and then transmitted in all possible directions, i.e., the blue light is scattered. The **red light**, however continues moving straight as it is not absorbed or scattered.

- **Some common Phenomena of Atmospheric Scattering:-**

1. **Why does sky appear blue ?**

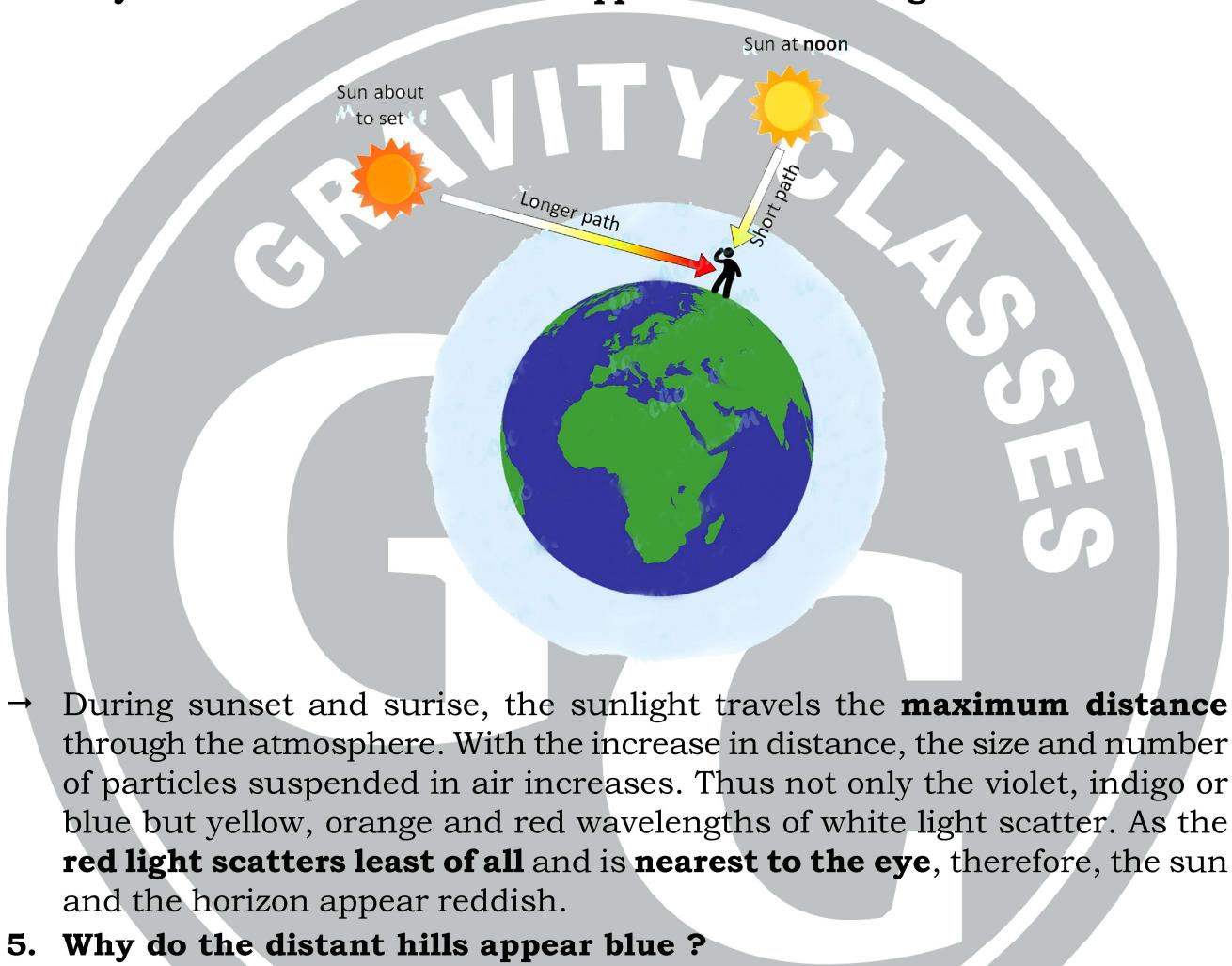
- The scattering of blue component of the white sunlight by air molecules present in the atmosphere causes the blue colour of the sky.

2. Why is the sunlight reaching the earth yellowish ?

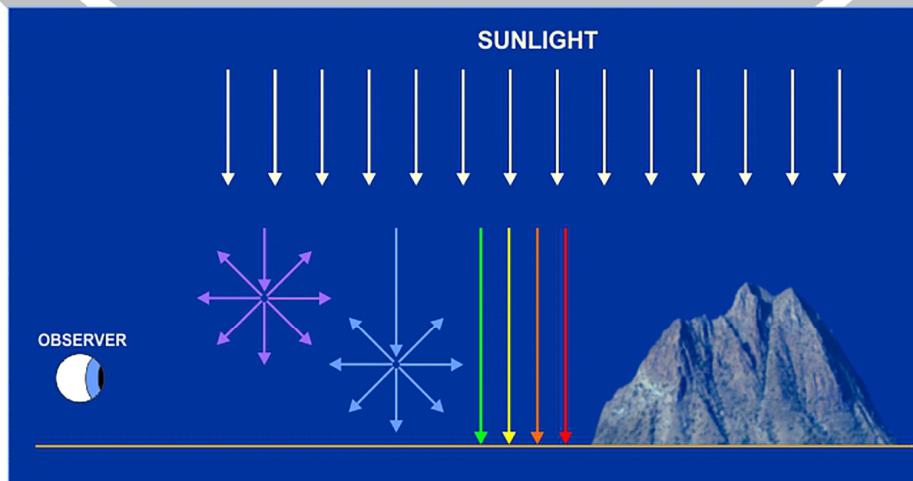
- When the **white sunlight** passes through **upper atmosphere**, the violet, indigo and blue colours scatter which makes the sky to appear blue. However, the white light gets deficient in violet, indigo and blue colours on account of scattering. Thus it appears yellowish instead of white.

3. Why does the sky appear dark instead of blue to an astronaut ?

- In space no particles are present. Thus, no scattering of light takes place. Hence, the sky appears dark as light by its **own nature is invisible** but produces in use the sensation of vision.

4. Why do the sun and the horizon appear reddish during sunset or sunrise?

- During sunset and sunrise, the sunlight travels the **maximum distance** through the atmosphere. With the increase in distance, the size and number of particles suspended in air increases. Thus not only the violet, indigo or blue but yellow, orange and red wavelengths of white light scatter. As the **red light scatters least of all** and is **nearest to the eye**, therefore, the sun and the horizon appear reddish.

5. Why do the distant hills appear blue ?

→ In the thick growth of trees on the hills there are always present some amount of tiny droplets of water in the air. When the white light passes through this **moisture laden air**, the **blue light is scattered**. When this scattered light reaches our eyes, the hills appear blue.

6. Why does smoke coming out of coal fired chimney appear blue on a misty day ?

→ The tiny particles of smoke and moisture scatter blue colour of the white light passing through it. When this scattered blue light reaches our eyes, the smoke appears blue.

7. Why does a motorist use orange lights, rather than normal white light on a foggy day ?

8. Why is red light used as a universal danger signal ?