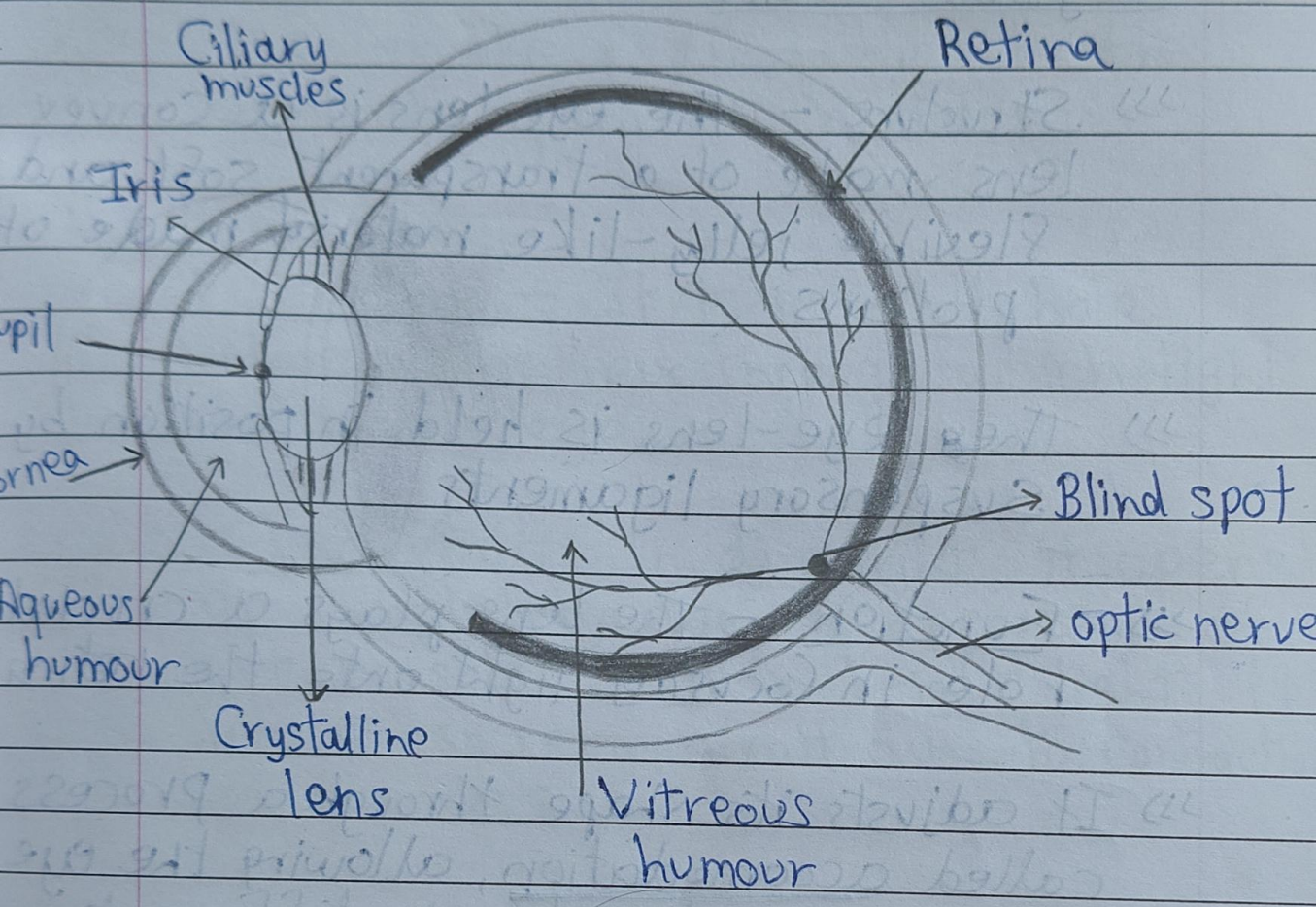
HUMAN EYE AND THE COLOURFUL WORLD



1. **Cornea:**

» **Structure** - It is the transparent bulged out spherical membrane covering the front of the eye.

» Light enters eye through this membrane

» **Function** - Most of the refraction of light rays entering the eye occurs at the outer surface of the cornea.

2. Crystalline lens

» Structure - The eye lens is a convex lens made of a transparent soft and flexible jelly-like material made of proteins.

» The eye-lens is held in position by suspensory ligaments

» Function - The lens plays a crucial role in focusing light onto the retina.

» It adjusts its shape through a process called accomodation, allowing the eye to focus on objects at different distances.

3. Iris

» Structure - It is a dark muscular diaphragm between the cornea and the lens.

» It is the colour of the iris that we call as the colour of the eye.

»» Function - The iris controls the size of the pupil, which is the central opening in the iris.

4. Pupil

»» Structure - It is a small hole between the iris through which light enters the eye.

»» Function - In dim light, it opens up completely due to expansion of eye muscles, but in bright light, it becomes very small due to contractio of muscles.

5. Ciliary muscles

»» Structure - It is located in the eye and surrounds the lens

»» Function - They hold the lens in position and help in modifying the curvature of the eye lens.

»»

6. Retina

» Structure — It is the light-sensitive surface of the eye on which the image is formed.

» Function - The retina is responsible for capturing and processing visual information

» Rods are more sensitive to dim light and help us see in low-light conditions.

» Cones are responsible for color vision and visual acuity in bright light.

7. Optic nerve

» Structure — The optic nerve is a bundle of nerve fibres that connects the retina to the brain.

» Function - It transmits visual information from the retina to the brain.

8. Sclera

» Structure — The sclera is the tough,

White, outer layer of the eye that forms the visible "white" part of the eye.

»» Function - It maintains the shape of the eye and helps to keep the internal structures in place.

9. Blind Spot

~~»» Structure~~

»» It is the point at which the optic nerve leaves the eye.

»» It contains no rods and cones, so an image formed at this point is not sent to the brain.

~~10 Aqeous~~

10. Aqueous Humor

»» Structure - The aqueous humour is a clear fluid that fills the space between the cornea and the lens.

»» Function - It helps the refracted light to be focused on retina.

11. Vitreous Humour

» Structure - The space between the eye lens and retina is filled with another liquid known as vitreous humour

» Function - It helps to maintain the shape of the eye, provide support to the retina, and transmit light to the retina.

TERMS RELATED TO HUMAN EYE

1. Accommodation

» It is the ability or the property of the eye lens to focus both near and distant objects by adjusting its focal length

» However, the focal length cannot be decreased or increased beyond a certain limit, due to which a healthy person cannot view clearly, if the object is held too close (i.e. less than 25 cm) or too far from the eye.

For Distant (Far) Objects

- Ciliary muscles = Relaxed
- Eye lens = Thin
- Focal length = Increase
- Power = Decrease

For Near Objects

- Ciliary muscles = Contracted
- Eye lens = Thick
- Focal length = Decrease
- Power = Increase

---

2. Power of Accommodation

- It is the maximum variation in power of eye lens for focusing nearby or far objects, clearly at retina.

- For a young adult with normal vision the power of accommodation is about 4D.

- The eye loses its power of accommodation at old age.

3. Far point of the eye

- It is the farthest point up to which the eye can see clearly.

» It is infinity for normal eye vision.

4. Near point of the eye

» The minimum distance, at which an object can be seen most distinctly without any strain is called the least distance of distinct vision.

» For a normal eye of an adult, it is 25 cm.

» It is also called near point of the eye.

DEFECTS OF VISION AND THEIR CORRECTION

» ~~Some~~ Three common refractive defects of vision:

(i) Myopia or near-sightedness
(ii) Hypermetropia or far-sightedness
(iii) Presbyopia

» These defects can be corrected by the use of suitable spherical lenses

Myopia [near-sightedness]

» In this defect, a person can see nearby objects distinctly but cannot see distant [far] objects clearly.

» In this case, image is formed before retina and not on the retina.

* Causes

» A person with this defect has a far point nearer than infinity.

» This defect arises due to the decrease in focal length of the lens because of:
(i) excessive curvature of eye lens
(ii) elongation of the eyeball

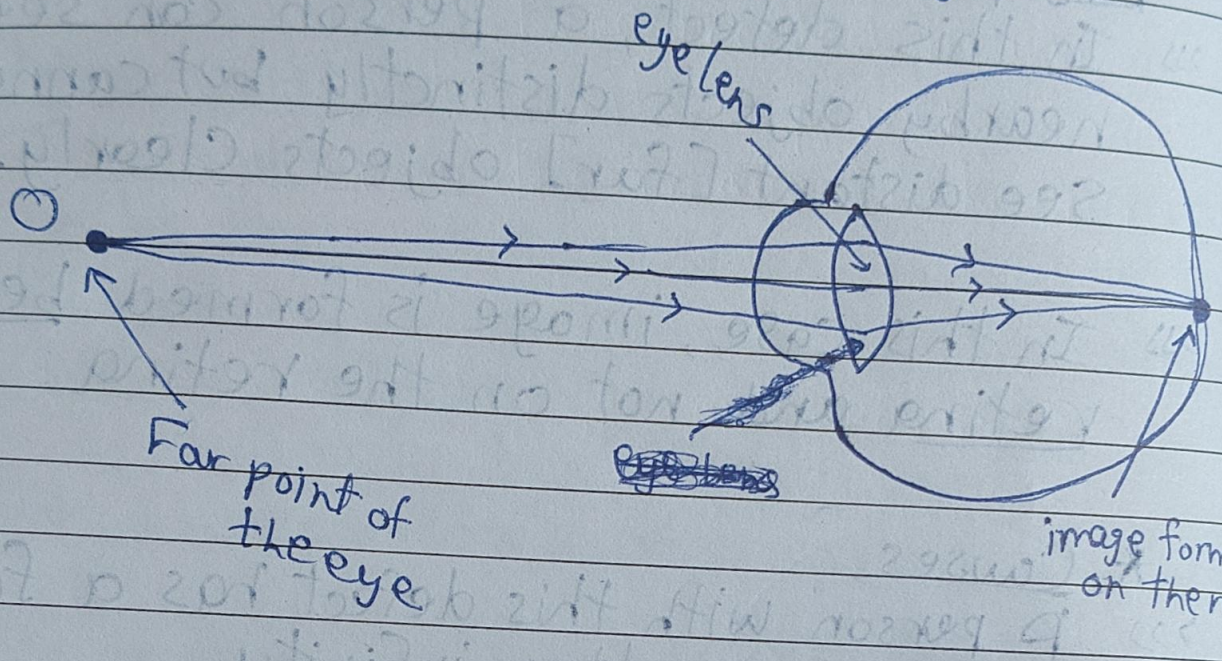
» As a result, image is formed before retina.

* Remedy

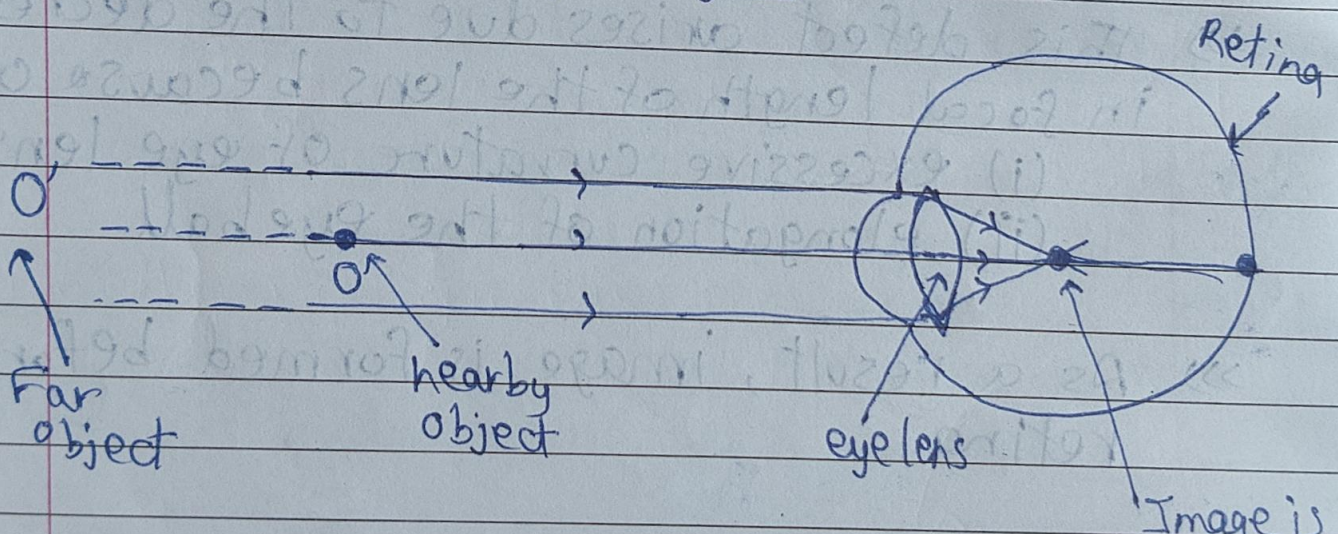
» This defect can be corrected by using concave lens.

» A concave lens of suitable power will bring back the image on retina.

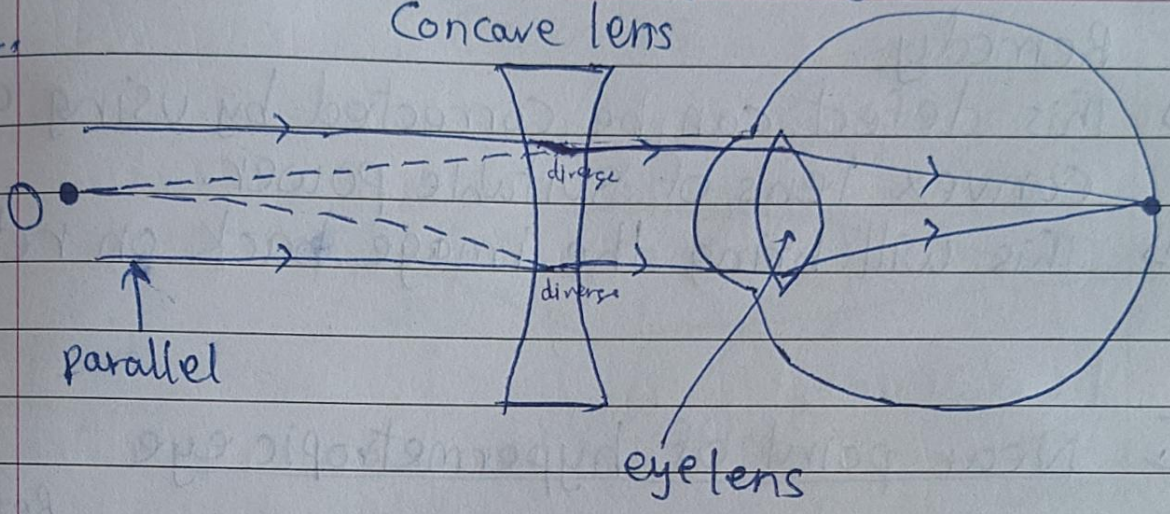
I. Far point of mypic eye



II. Myopic eye



III. Correction of myopic eye



Hypermetropia [far-sightedness]

» In this defect, a person can see distant objects clearly but cannot see nearby objects clearly.

» A ~~pers~~ person with this defect has the near point farther away from normal near point (25 cm).

» In this case, the image is formed beyond retina.

* Causes

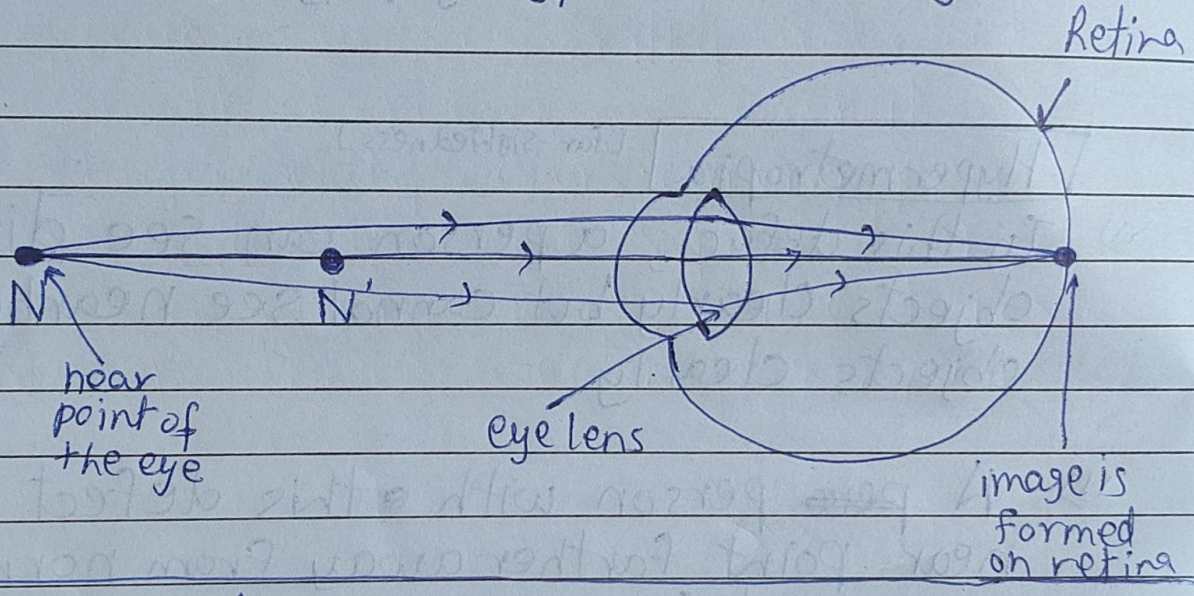
» Focal length of eye lens becomes large.

» Eyeball becomes too short, so that the image is formed behind retina.

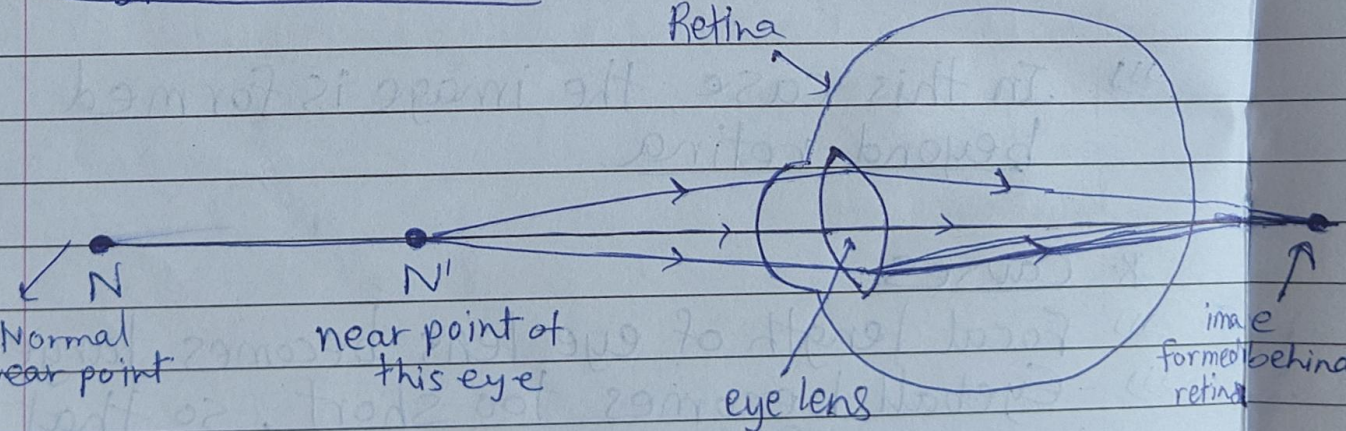
Remedy:

- This defect can be corrected by using a convex lens of suitable power.
- This will bring the image back on retina.

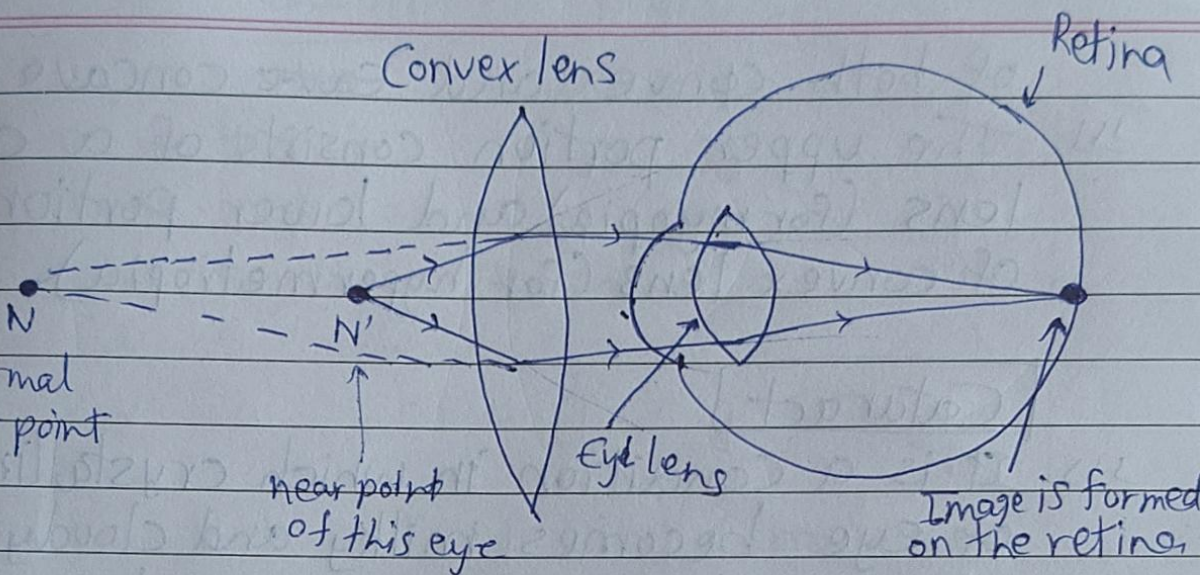
I. Near point of hypermetropic eye



II. Hypermetropic eye



II.



Correction for hypermetropic eye

Presbyopia

- It is found in old people.
- For most of the people, the near point gradually recedes with away age.
- Sometimes, a person may suffer from both myopia and hypermetropia.

* Causes

- Weakness of ciliary muscles
- Hardening or loss of elasticity of eye lens.

* Remedy

- This defect can be corrected by using bifocal or varifocal lenses which consist

of both convex and ~~cave~~ concave lenses.

» The upper portion consists of a concave lens (for myopia) and lower portion consists of convex lens (for hypermetropia).

Cataract

» It is a condition in which crystalline lens of eye becomes milky and cloudy due to growth of membrane over it.

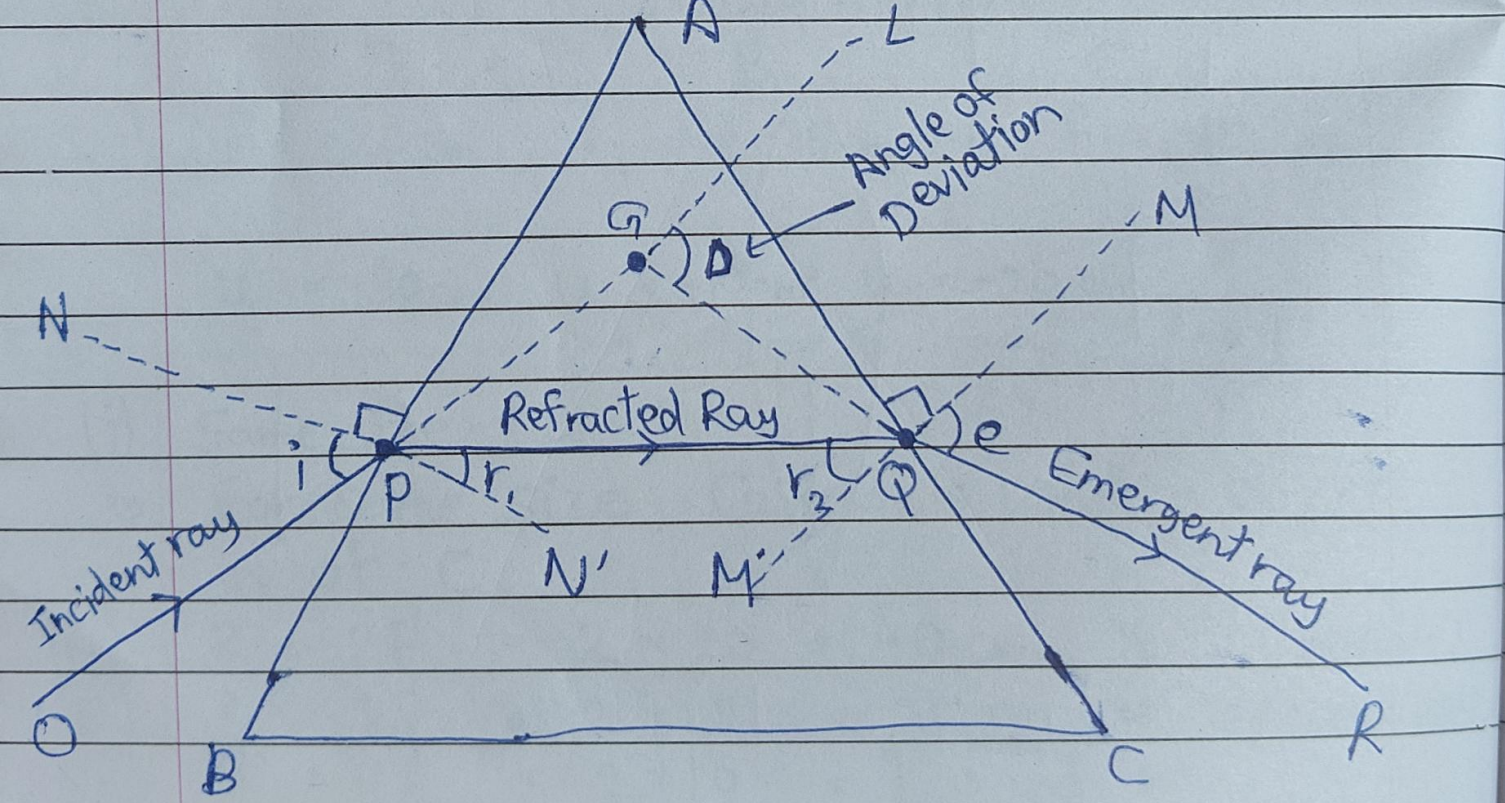
» It generally occurs among people at old age. This causes partial or complete loss of vision. It is possible to restore vision through a cataract surgery.

Refraction of Light through a Prism

- Prism is a transparent refracting medium bounded by at least two lateral surfaces, inclined to each other at a certain angle.

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

- The angle between two lateral surfaces is called angle of prism (A).



- In the diagram given above, a ray of light PQ is entering from air to glass at the first surface AB.
- The light ray on reflection is bent toward the normal.
- At the second surface AC, the light ray enters from glass to air, so it bends away from the normal.

Deviation Angle

- It is the angle at which the emergent ray (extended backward) makes with the incident ray (extended forward).
- It depends upon angle of prism, i.e. $\angle A$, angle of incidence ($\angle i$) and angle of emergence ($\angle e$) and is given by

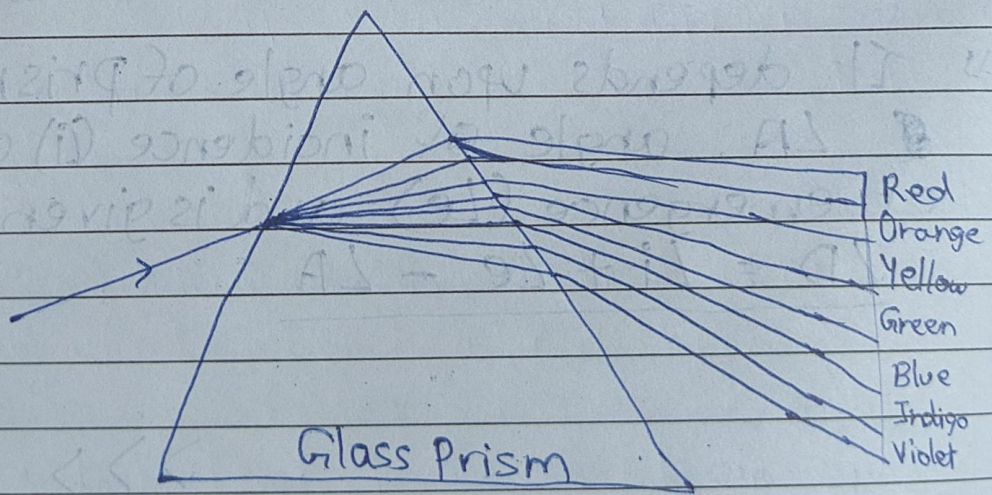
$$\angle D = \angle i + \angle e - \angle A$$

Dispersion of white light by a glass prism

» The phenomenon of splitting of white light into its constituent colours when it passes through a prism is called dispersion.

» The band of seven colours obtained, VIBGYOR, is called spectrum.

V - Violet
I - Indigo
B - Blue
G - Green
Y - Yellow
O - Orange
R - Red



Dispersion

Causes of Dispersion

- Light rays of different colours travel with the same speed in vacuum and air but in any other medium, they travel with different speeds and bend through different angles, which leads to dispersion of light.

- Red light has the maximum wavelength and violet light has the ~~minum w~~ minimum wavelength.
- So, in any medium, red light travels fastest and deviates least, while violet light travels slowest and deviates maximum

↓

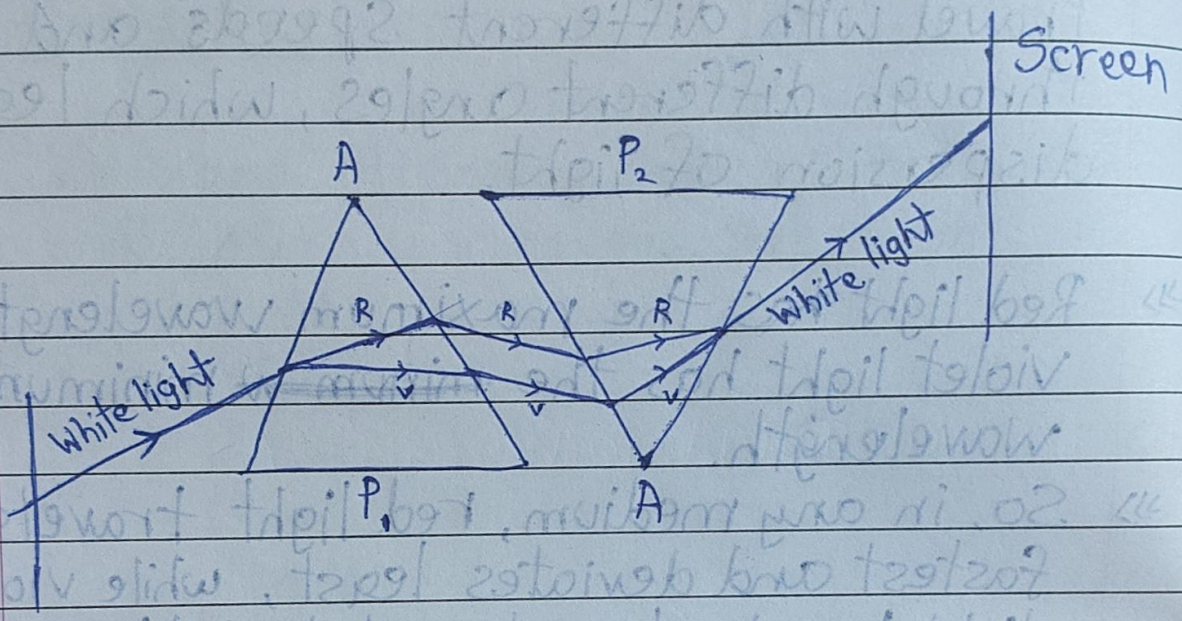
- Wavelength $\propto$ Velocity $\propto \frac{1}{\text{Deviation}}$

RECOMBINATION OF WHITE LIGHT

- Newton showed that the reverse of dispersion of light is also possible.
- He kept two prisms close to each other, one in

erect position and the other in an inverted position.

- The light gets dispersed when passes through the first ~~Prism~~ prism.



- The second prism receives all seven coloured rays from first prism and recombines them into original white light.

- This observation shows that sunlight is made up of seven colours.

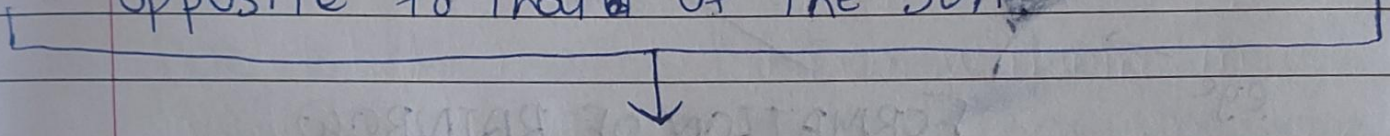
- ~~Any~~ light that gives spectrum similar to ~~to~~ that of sunlight is called white light.

RAINBOW

» A rainbow is a natural spectrum appearing in the sky after a rain shower.

» It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere.

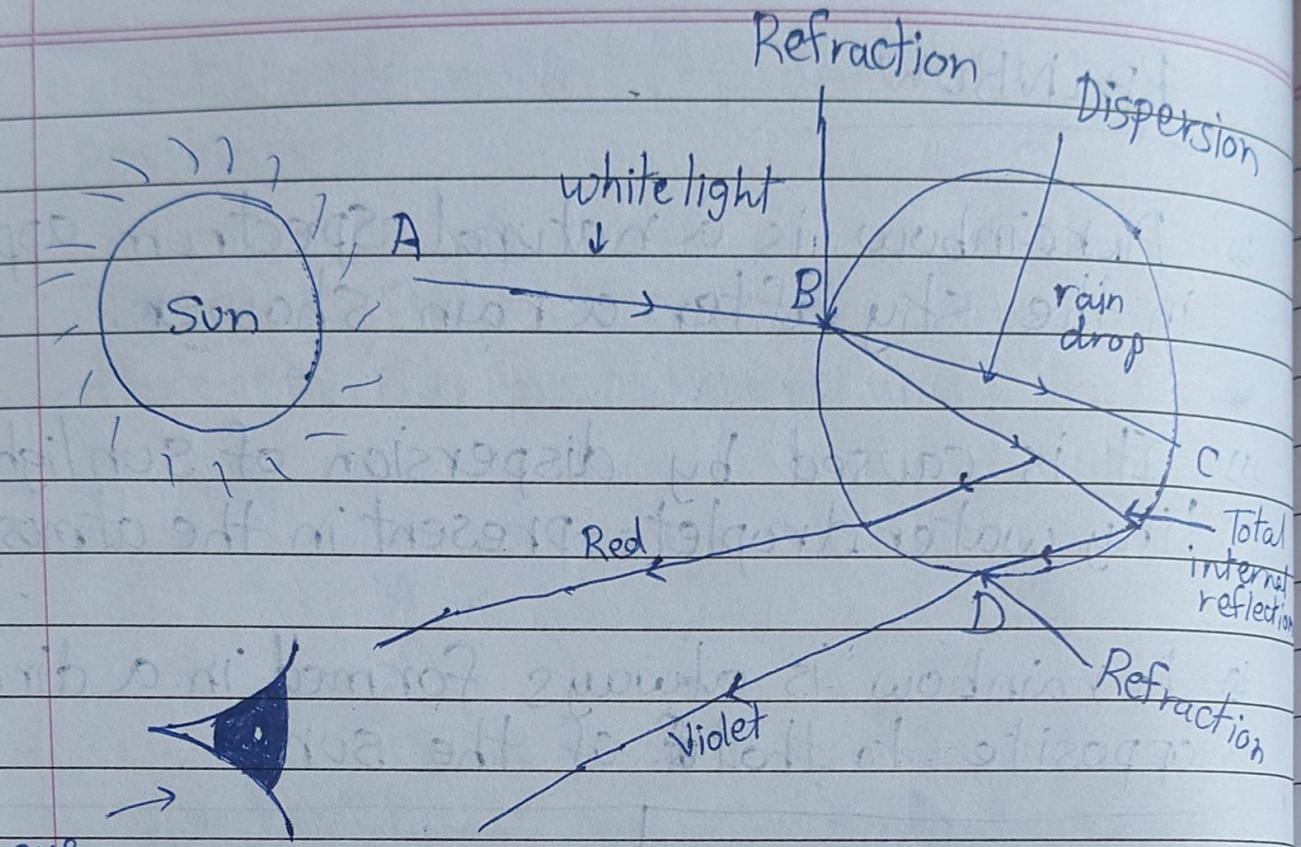
» A rainbow is always formed in a direction opposite to that of the sun.



» The water droplets act like small prisms. They refract and disperse the incident sunlight, the reflect it internally and finally, refract it again when it comes out of the raindrop.

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

» The rainbow can also be seen on a sunny day by looking at the sky through a waterfall or through a water fountain, with the Sun behind you.

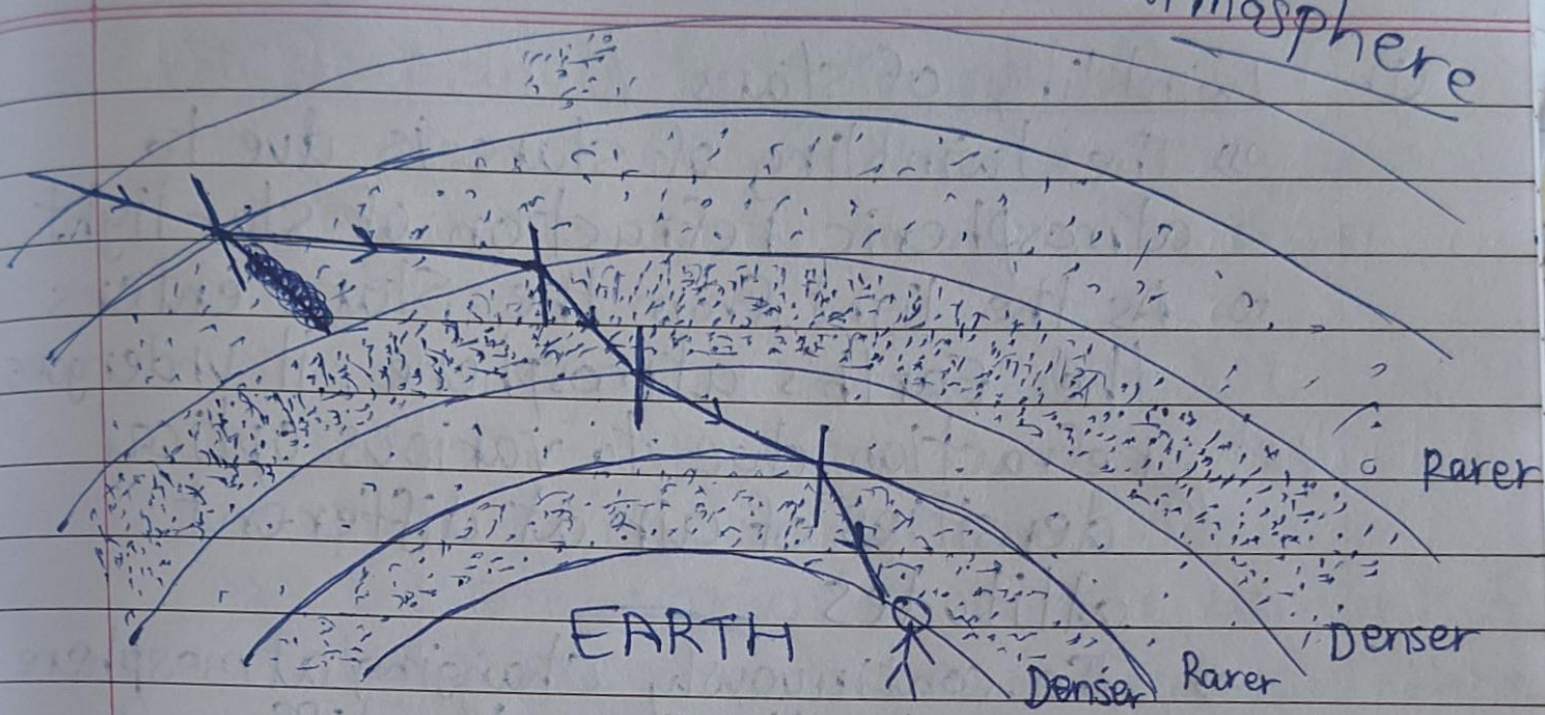


FORMATION OF RAINBOW

ATMOSPHERIC REFRACTION

» The earth's atmosphere is not uniform throughout, and its density goes on changing as we move up.

» It can be considered to be consisting of layers of different densities which act as a rarer or denser medium with respect to each other.



» Due to this, when light rays pass through the Earth's atmosphere, they undergo refraction, and this type of refraction of light caused by these layers is called atmospheric refraction.

Some Natural Phenomena Based ~~On~~ On Atmospheric Refraction

1. Twinkling of stars
2. The stars seem higher than they actually are.
3. Advanced sunrise and delayed sunset

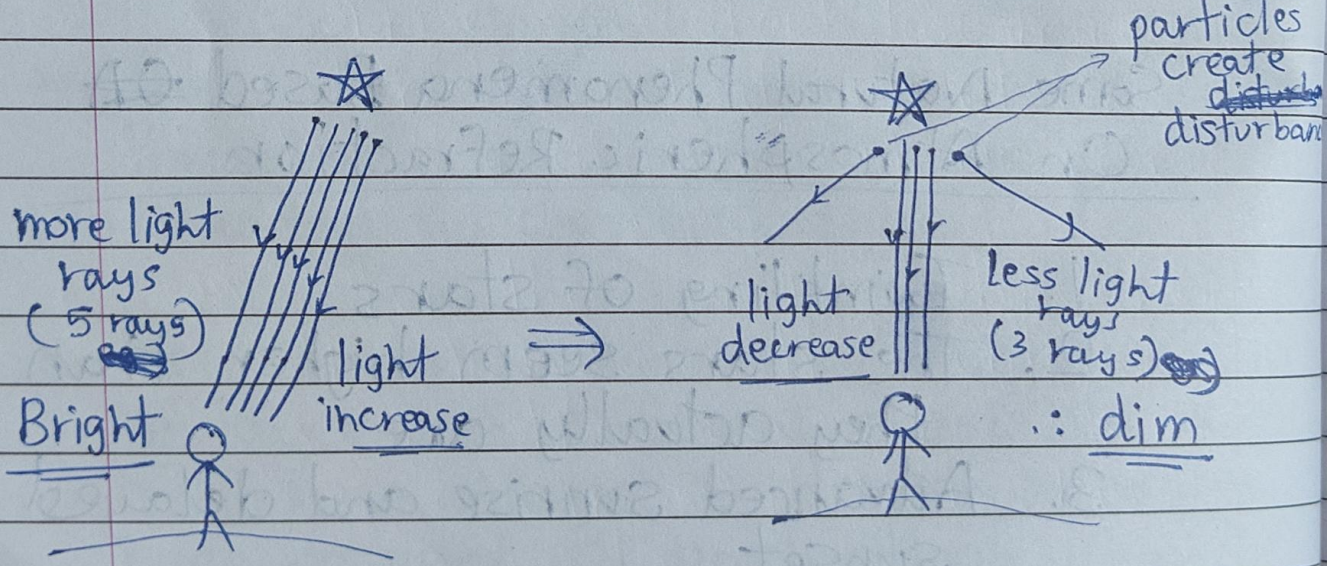
① Twinkling of stars

» The twinkling of stars is due to atmospheric refraction of star light

» As the light from the stars enters the Earth's atmosphere, it undergoes refraction due to various optical densities of air at different altitudes.

» The continuously changing atmosphere refracts the light by different amounts.

» That's why the star light reaching our eyes increase and decrease continuously, and the star appears to twinkle.



Why do planets not twinkle?

- As planets are of larger size and much closer to the earth than stars.
- So, they can be considered as a collection of large number of point-sized sources of light.
- The total variation in the amount of light entering the eye from all these individual points will average out to zero, which nullify the twinkling effect of each other

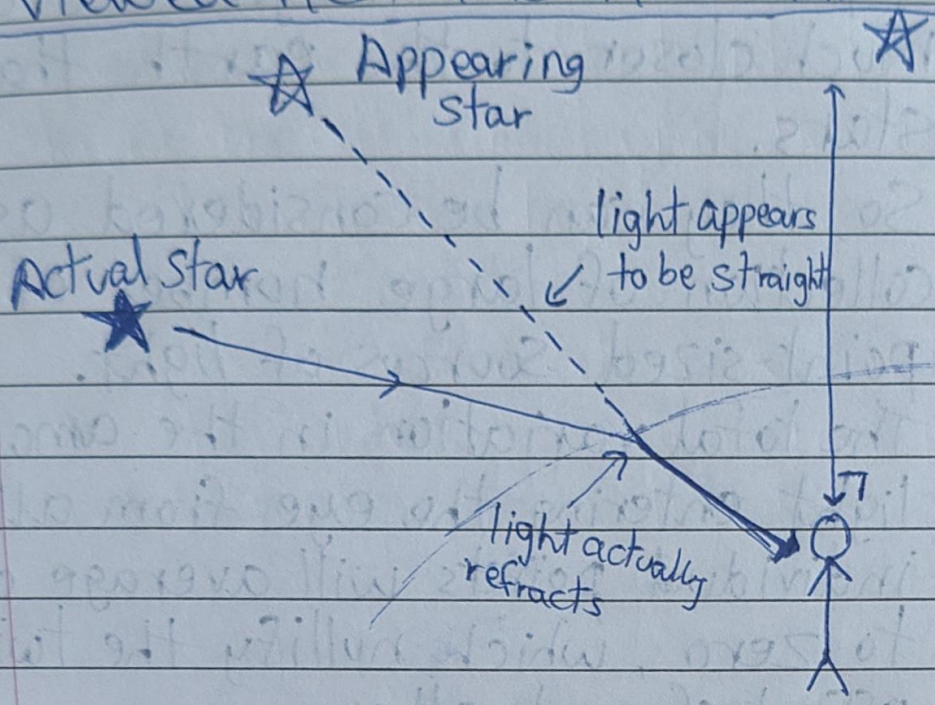
(2) Why do stars seem higher than they actually are?

- As the light from a star enters the Earth's atmosphere, it undergoes refraction and bends towards the normal each time due to the atmospheric refraction.

- Therefore, the apparent position of the star is slightly different from its actual position.

- The star appears to be slightly

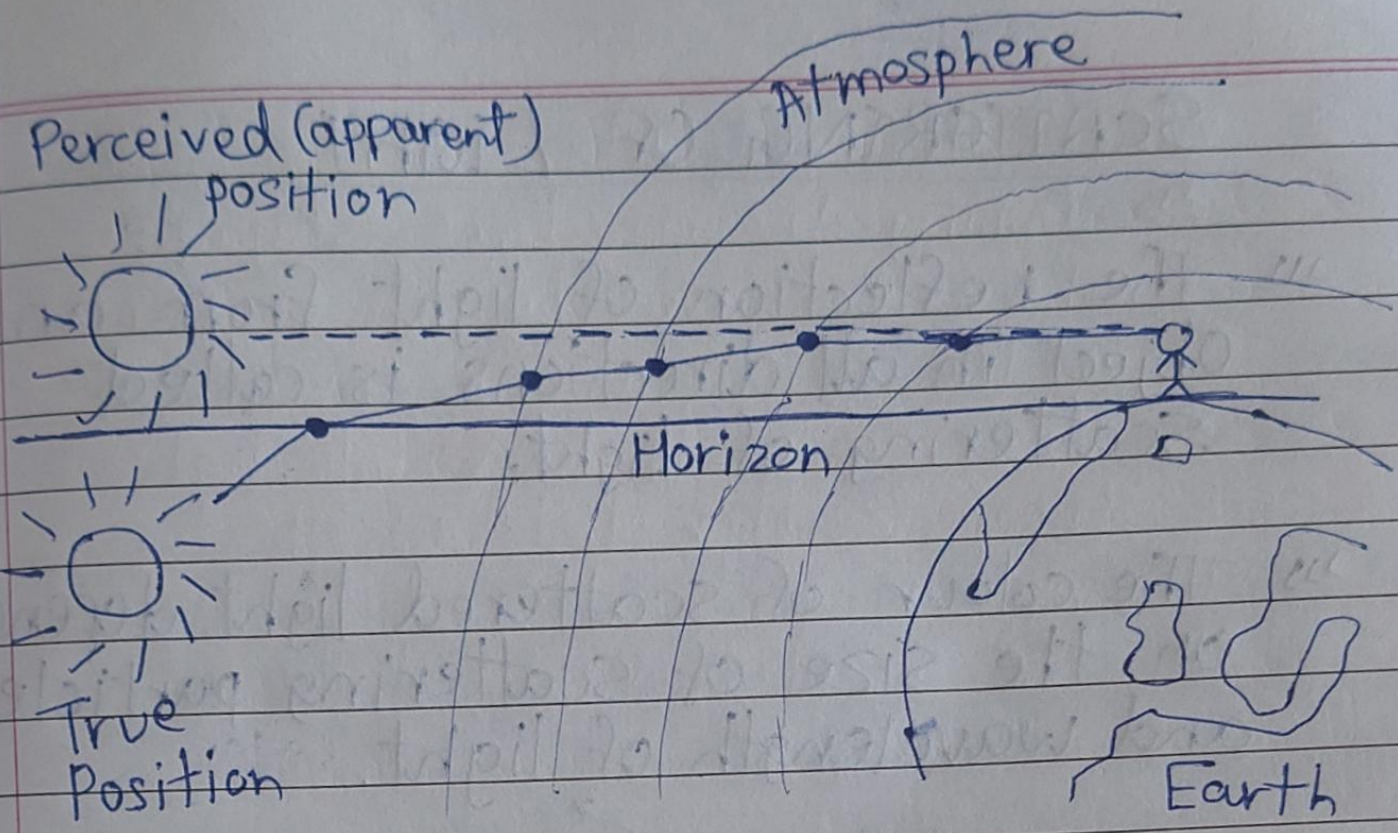
higher than its actual position, when viewed near the horizon.



③ Advanced Sunrise and Delayed sunset

» The sun is visible to us about two minutes before the actual sunrise and about two minutes after the actual sunset. This is because of atmospheric refraction.

» When the Sun is slightly below the horizon, the sunlight coming from the less dense to more dense air, ~~is it~~ is refracted downwards.



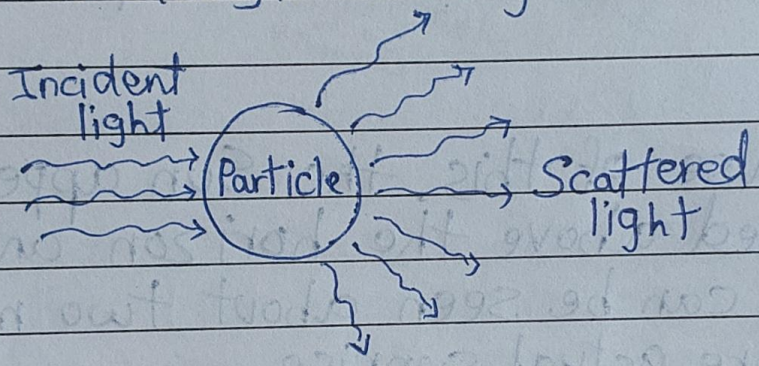
» Because of this, the Sun appears to be raised above the horizon and so the Sun can be seen about two minutes before actual sunrise.

»» Similarly, due to atmospheric refraction the Sun can be seen for about two minutes even after the Sun has set below the horizon.

SCATTERING OF LIGHT

» The reflection of light from an object in all directions is called scattering of light.

» The colour of scattered light depends on the size of scattering particles and wavelength of light.



» Very fine particles scatter ~~poi~~ mainly blue light while particles of larger size scatter light of longer wavelength (red light). If the size of the scattering particles is large enough, then the scattered light may even appear white.

» The blue light present in the sunlight is ~~sa~~ scattered 10 times more than the red light.

»» Scattering $\propto d^6$ [where, d = diameter of particle]

»» Scattering $\propto \frac{1}{\lambda^4}$ [where, λ = wavelength of particle]

SOME PHENOMENA BASED ON SCATTERING OF LIGHT

1. **Tyndall Effect**

»» A beam of light passing through a true solution is not scattered.

»» The scattering of light when it passe through a colloidal solution is called Tyndall effect.

»» The earth's atmosphere is a heterogenous mixture of minute particle of smoke, tiny water droplets, suspended particles of dust and molecules of air which becomes visible due to scattering of light.

>>>

2. Why is the sky blue [redacted]?

» During the day time, sky appears blue

» This is because the size of particles in the atmosphere is smaller than the wavelength of visible light, so they scatter light of shorter wavelengths.

» The scattered blue light enters our eyes.