Human Eye & The Colorful World

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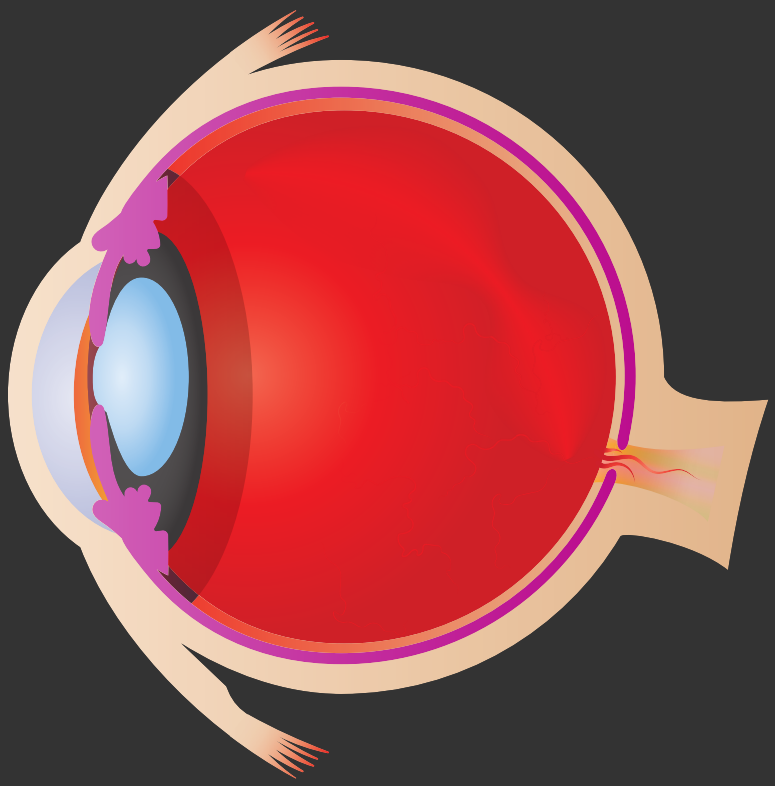

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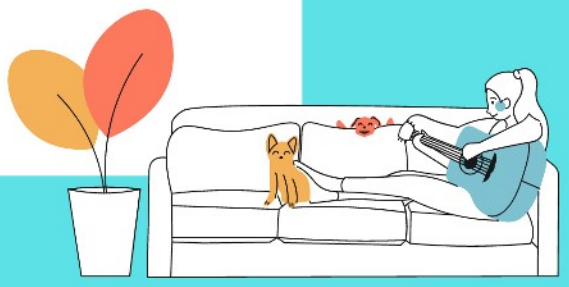

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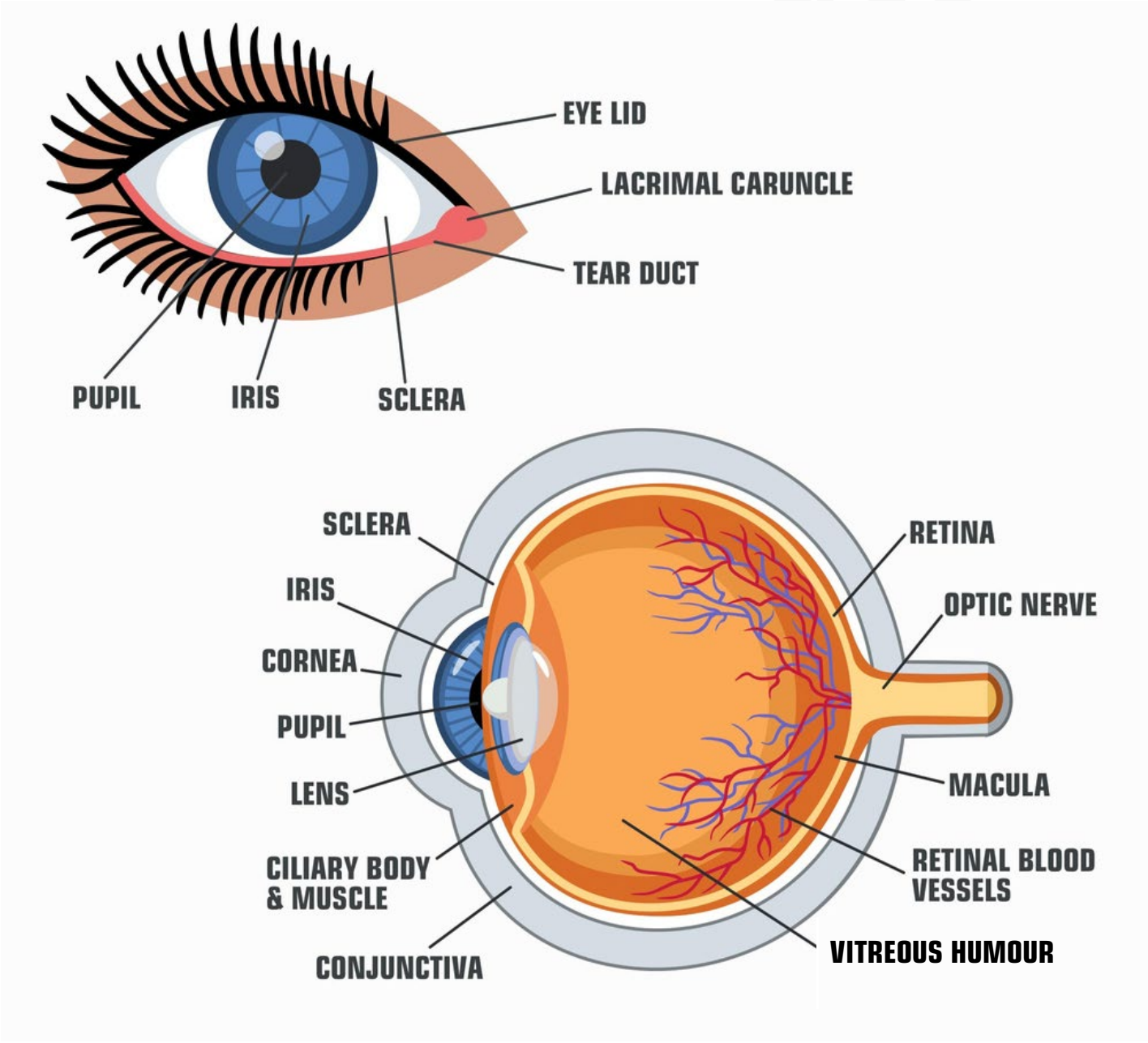
Human Eye

Sense organ that helps us to see.

- Located in eye sockets in skull.
- Diameter of Eye is 2.3 cm (Size of eye remains same throughout our whole life)



Parts of Human Eye

1) Cornea –

It is the outermost, transparent part. It provides most of the refraction of light.

2) Lens –

It is composed of a fibrous, jelly like material. Provides the focused real and inverted image of the object on the Retina. This is convex lens that converges light at Retina.

3) Iris –

It is a dark muscular diaphragm that controls the size of the pupil.

4) Pupil –

It is the window of the eye. It is the central aperture in Iris. It regulates and controls the amount of light entering the eye.

5) Ciliary Muscles –

They hold the lens in position and help in modifying the curvature of lens.

6) Retina –

It is a delicate membrane having enormous number of light sensitive cells.

7) Optic Nerve –

It transmits visual information from retina to Brain.

8) Blind Spot –

The point at which the optic nerve leaves the eye.

9) Aqueous Humour –

Between the cornea and eye lens, there is a space filled with transparent liquid is called the aqueous humour which helps the refracted light to be focused on retina. It also provides nutrition to eye.

10) Vitreous Humour –

Space between eye lens and retina is filled with a liquid called Vitreous Humour.

Far Point of Eye –

Maximum distance to which eye can see clearly, is called far point of eye.

- For a normal eye, it's value is Infinity

Near Point of Eye –

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, it's value is 25cm.

❖ Range of Human Vision is from 25 cm to Infinity

Power of Accommodation

It is the ability of eye-lens to adjust its focal length.

- किसी Object को clear देखने के लिए और उस पर focus करने के लिए Focal Length change करनी होती है
- अगर Object पास में है तो Focal Length कम करनी होगी
- अगर Object दूर है तो Focal Length बढ़ानी होगी
- ये सब करने में Ciliary Muscles help करती है

Case 1) To see far Objects

Ciliary Muscles - Relaxed

Eye Lens – Thin

Focal length - Increase

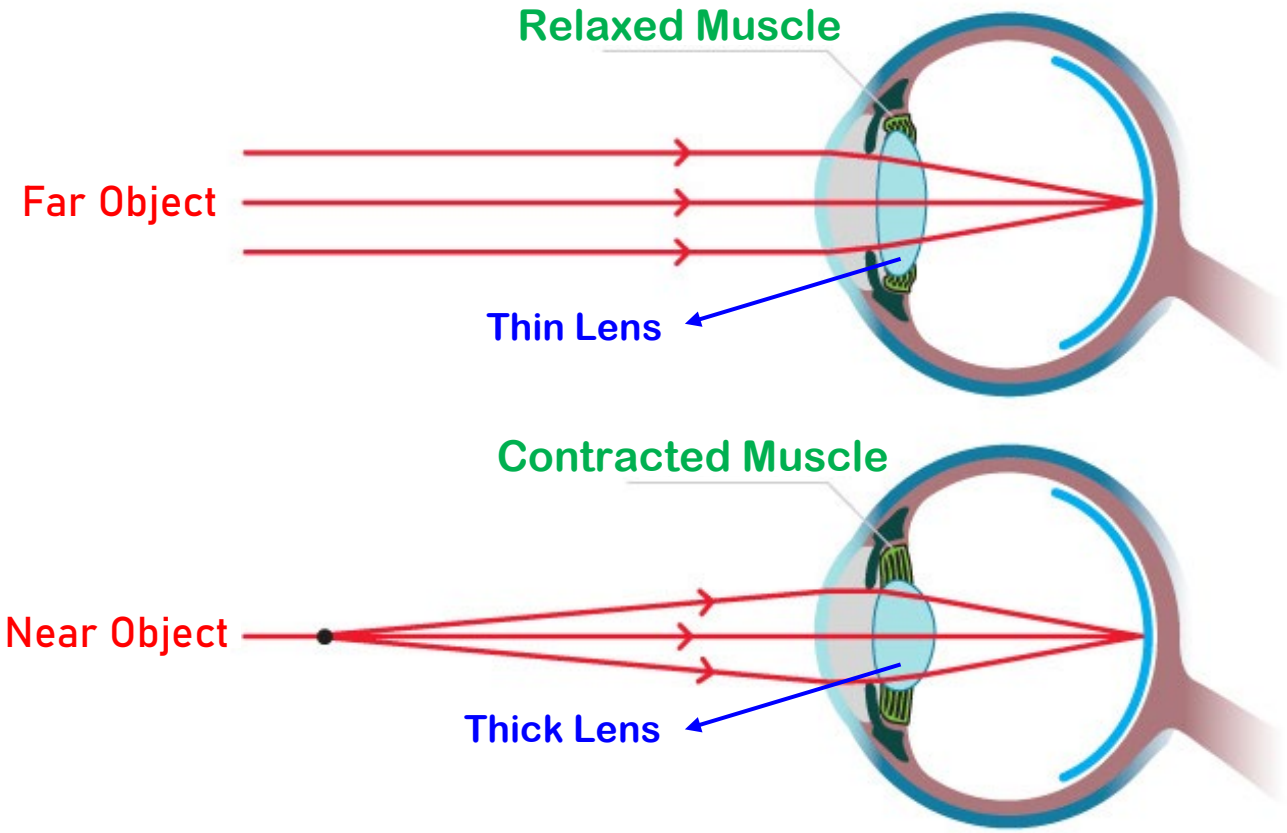
Case 2) To see near Objects

Ciliary Muscles - Contract

Eye Lens – Thick

Focal length - Decrease

HOW OUR EYES FOCUS?



1) Myopia (Near Sightedness) दूर की नज़र कमज़ोर होना

- A myopic person can see nearby objects clearly but cannot see distant objects clearly.
- Image is formed in front of Retina.

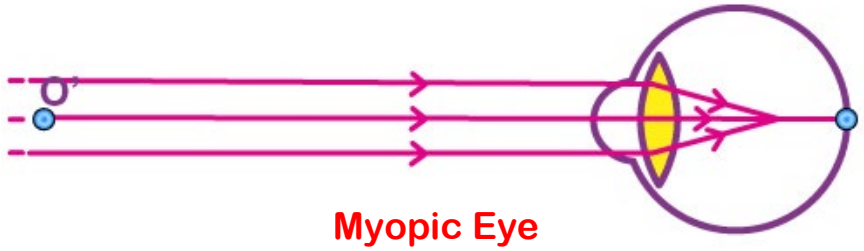
Causes of Myopia

- Excessive curvature of eye lens
- Stretching of eye ball

Correction

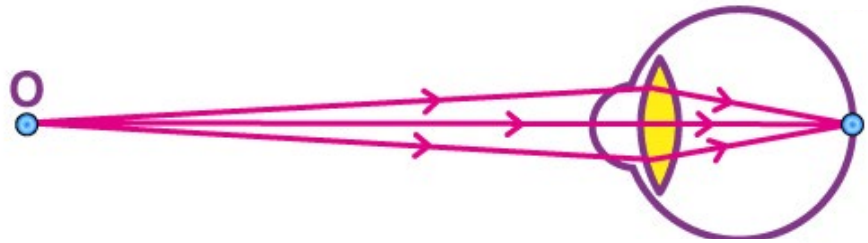
It is done by using concave lens of appropriate power.

a) In a myopic eye, image of distant object is formed in front of the retina (not on retina)



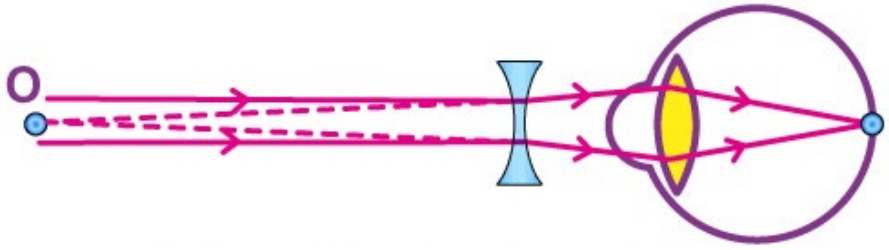
Myopic Eye

b) The far point (F) of a myopic eye is less than infinity.



Far Point of a Myopic Eye

c) The concave lens placed in front of eye forms a virtual image of distant object at far point (F) of the myopic eye.



Correction of Myopic Eye

2) Hypermetropia (Far Sightedness) पास की नज़र कमज़ोर होना

- Affected person can see far objects clearly but can't see nearby objects clearly.
- The near point of eye moves away.
- Image is formed behind the retina.

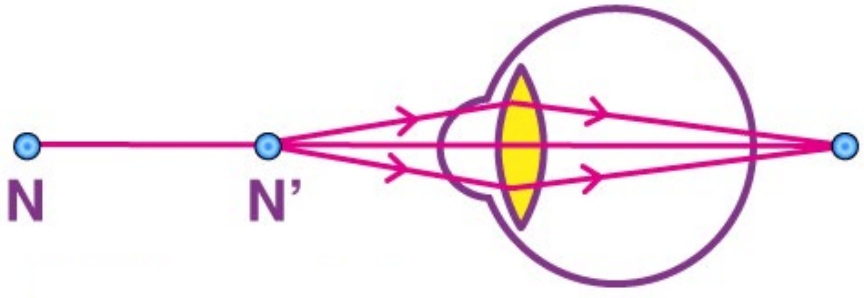
Causes of Hypermetropia

- Focal length of eye lens becomes too long.
- Eye ball becomes too small.

Correction

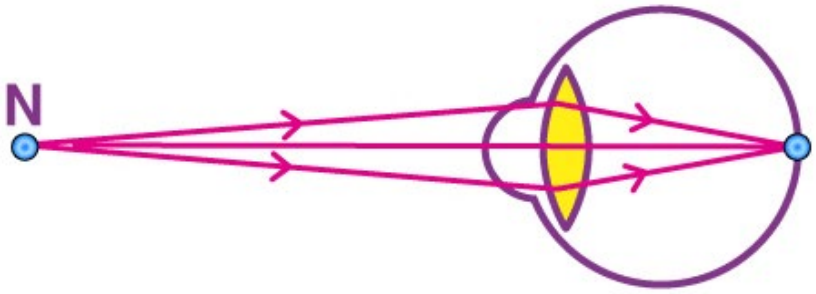
It is done by using convex lens of appropriate power.

a) In a hypermetropic eye, image of distant object is formed behind the retina (not on retina)



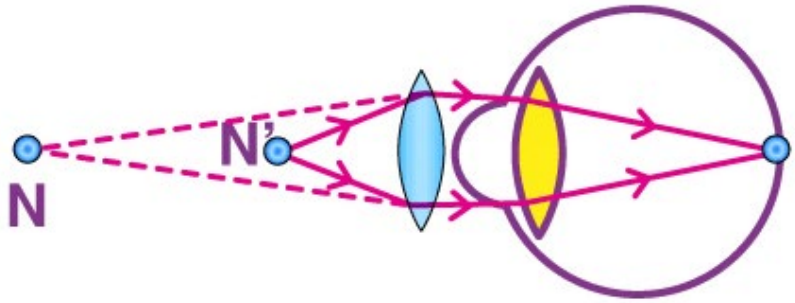
Hypermetropic Eye

b) The near point (N) of a hypermetropic eye is more than 25cm.



Near Point of Hypermetropic Eye

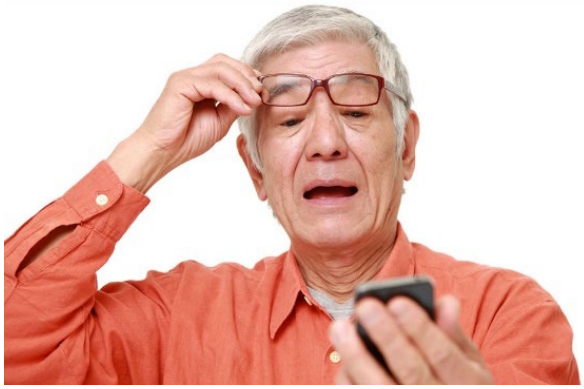
c) Correction of hypermetropia. The convex lens placed in front of eye forms a real image of near object on Retina.



Correction of Hypermetropic Eye

3) Presbyopia (Old age Hypermetropia)

बुजुर्ग लोगों की पास की नजर खराब हो जाती है, कुछ लोगों को अखबार पढ़ने में problem आती है बुढ़ापे में आपने देखा होगा अपने आस पास (grandparents)



- It is a defect of vision due to which an old person can't see nearby objects clearly due to loss of power of accommodation of eye.
- The near point of old person having presbyopia becomes more that 25 cm.

Causes of Presbyopia

- Weakening of Ciliary Muscles.
- Decreasing flexibility of eye lens.

Correction

- It is done by using convex lens of appropriate power.
- Sometimes a person may suffer from both myopia and hypermetropia. Such people require bifocal lens for correction.

Advantage of eyes in front of the face

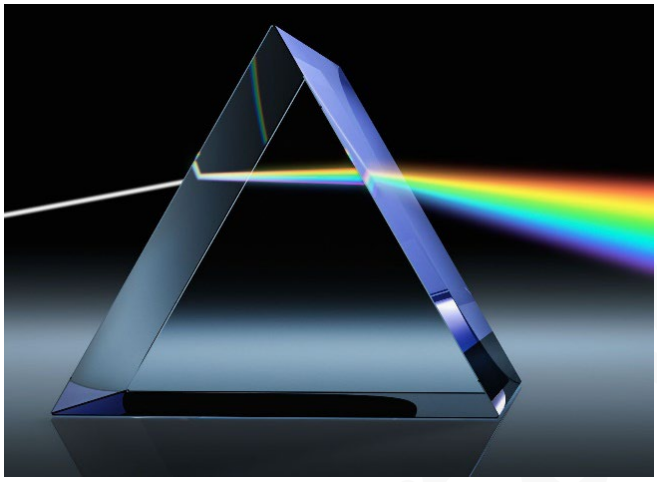
- It gives a wider field of view.
- It provides three-dimensional view.

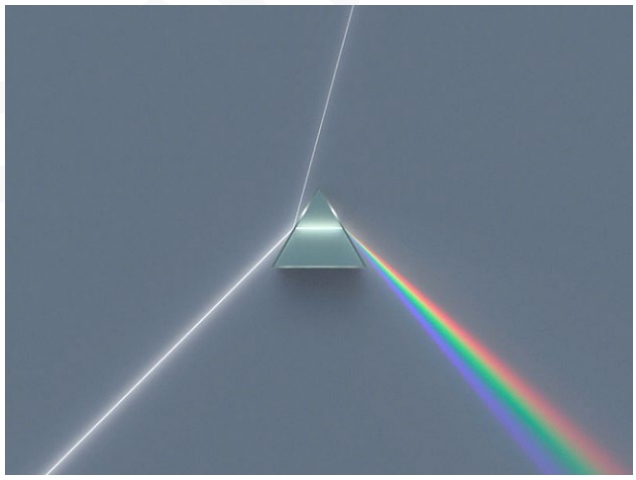
Prism

It is a pyramidal piece of glass with two triangular bases and three rectangular faces.

Dispersion of White Light by a Glass Prism –

- The phenomenon of splitting of white light into its 7 colors, when it passes through a prism is called Dispersion.





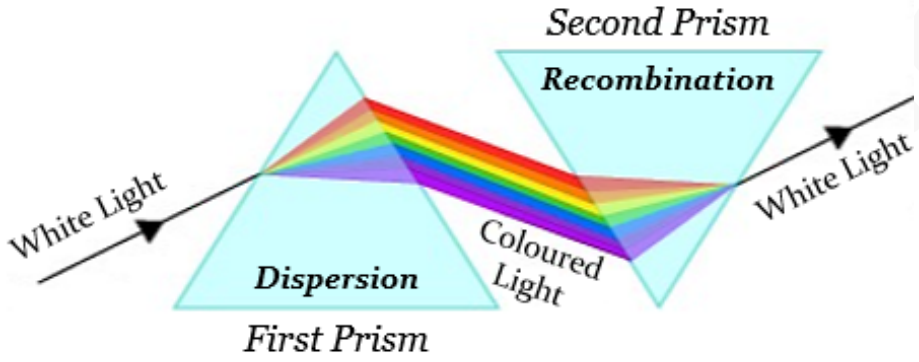
- This band of seven colors VIBGYOR (Violet, Indigo, Blue, Green, Yellow, Orange, red) is called Spectrum

Ques) Why Dispersion Occurs?

Ans - Light rays of different colors, 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.

Recombination of White Light

- Reverse of dispersion is also possible
- Seven Colored lights of the spectrum can be recombined to give back white light by placing two prisms, one upside down.



Total Internal Reflection

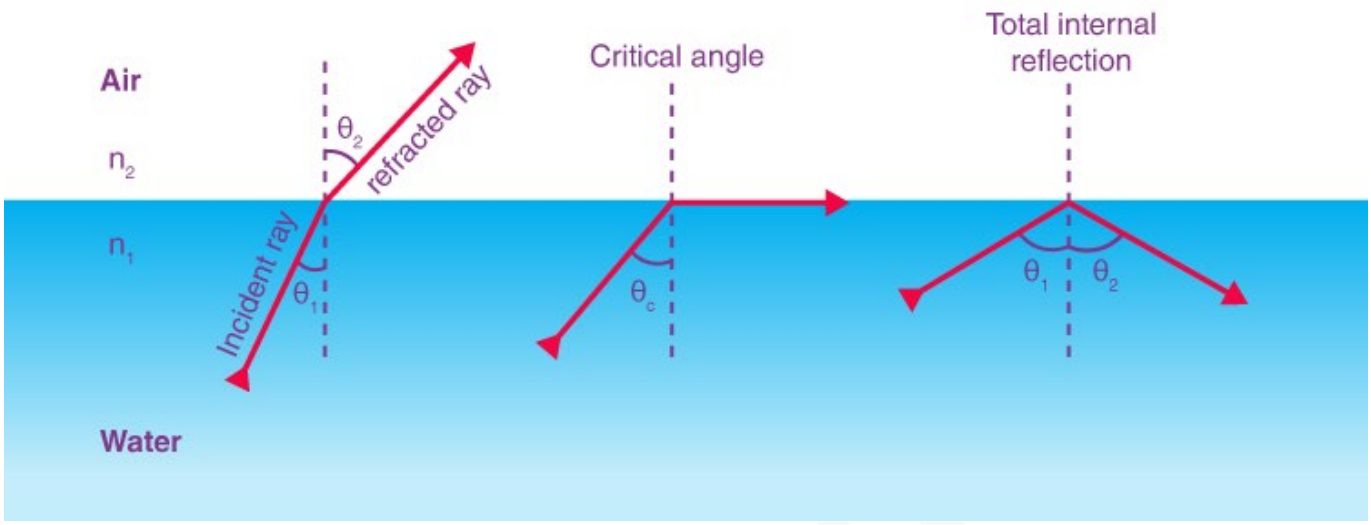
When light enters obliquely from a denser medium to a rarer medium and the angle of incidence exceeds critical angle, the light reflects in the denser medium. This is called Total Internal Reflection.

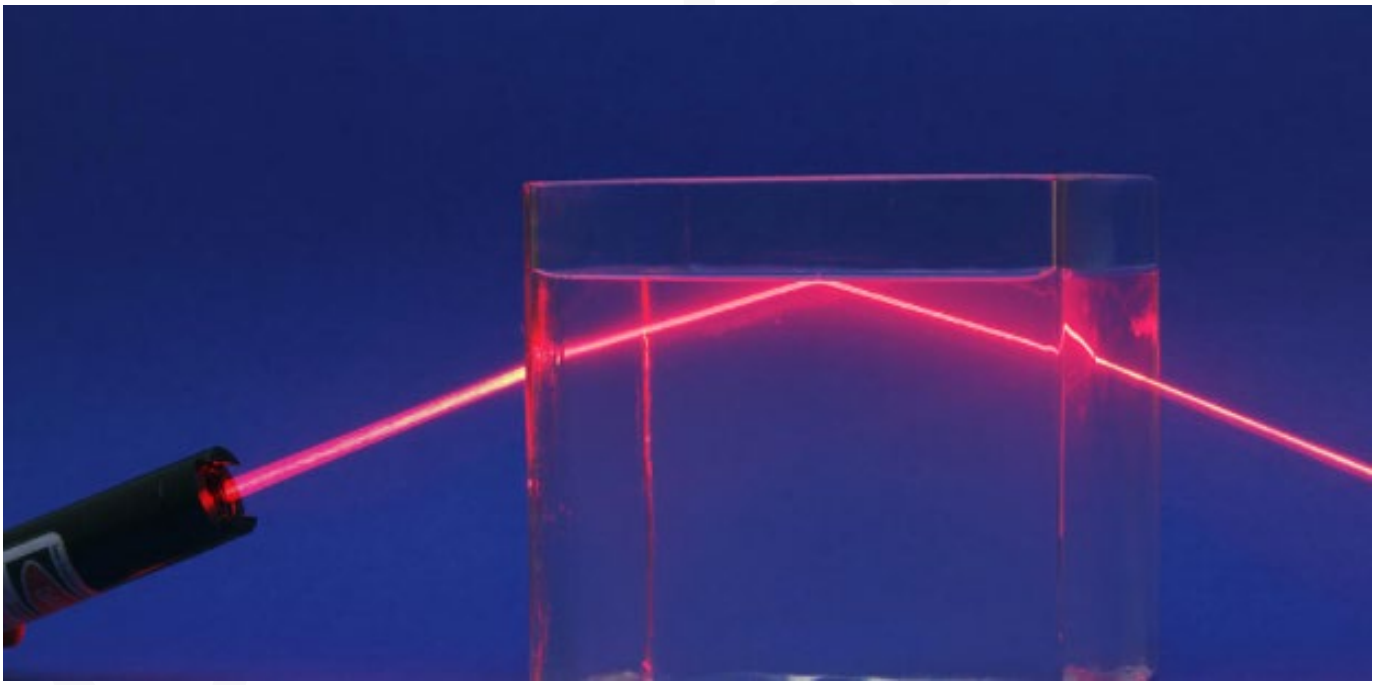
Conditions necessary for Internal Reflection

i) Light should enter obliquely from a denser to a rarer medium.

ii) The angle of incidence should exceed critical angle, the light reflects in the denser medium.

Critical Angle – The angle of incidence for which the angle of refraction is 90°

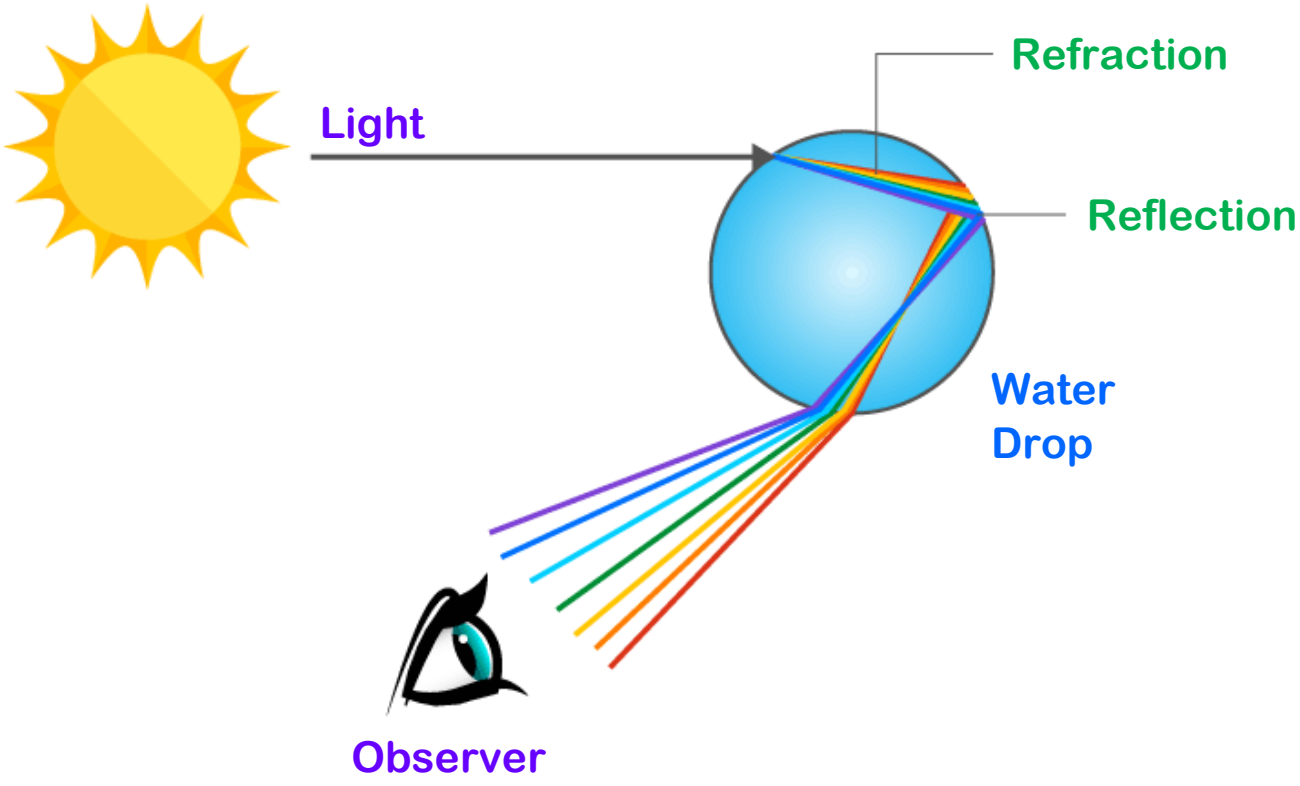




Rainbow

A natural spectrum appearing in sky after rain.

- Some Water droplets remain in air after Rain. These droplets act as small prisms.
- Water droplets refract and disperse the incident sunlight, then reflect internally and finally, reflect it again when it comes out of raindrop.
- Rainbow is always in opposite side of Sun.



Rainbow Formation

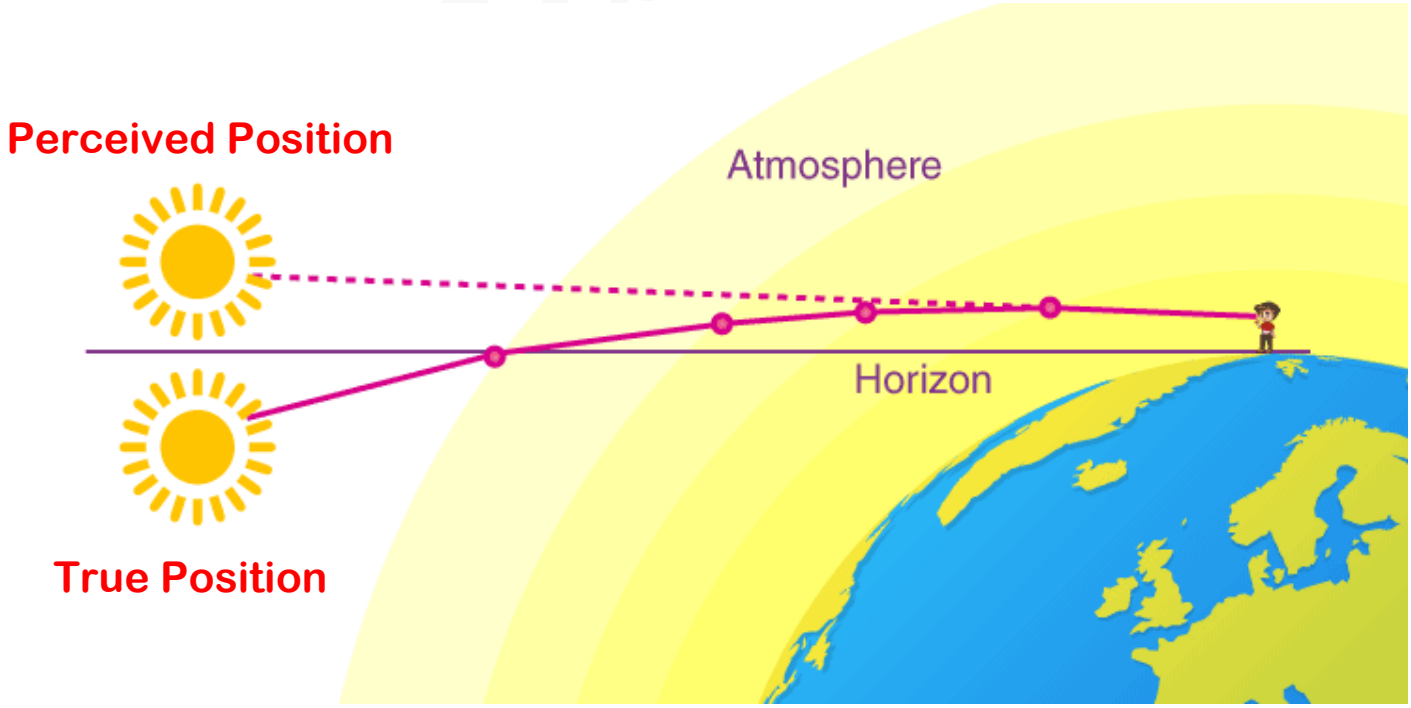
Atmospheric Refraction

The refraction by different layers of atmosphere is called Atmospheric Refraction.

Effects of Atmospheric Refraction –

1) Advanced Sunrise

- The sun appears about two minutes earlier than actual sunrise and the sun remains visible for about two minutes after actual sunset.
- When the sun is below horizon, the rays have to pass from rarer to denser medium. So rays bend towards the normal. As a result the sun appears higher than its actual position.



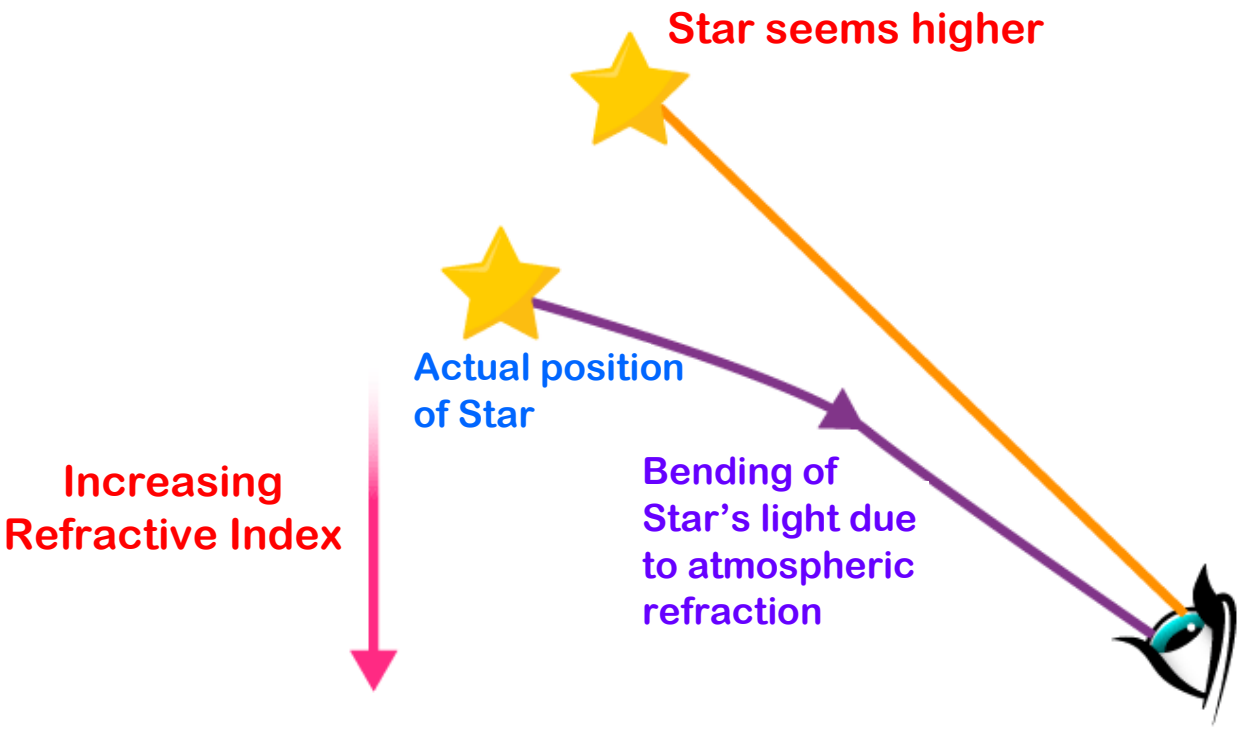
2) An object placed behind the fire appears to flicker

- The air above hot surface becomes hot and rises. The space is occupied by cool air. The refractive index of hot air is less than that of cool air. So the physical condition of the medium are not constant. Due to changing Refractive Index of medium, the light appears to come from different directions. It results in fluctuations in apparent position of object.

Flickering ←

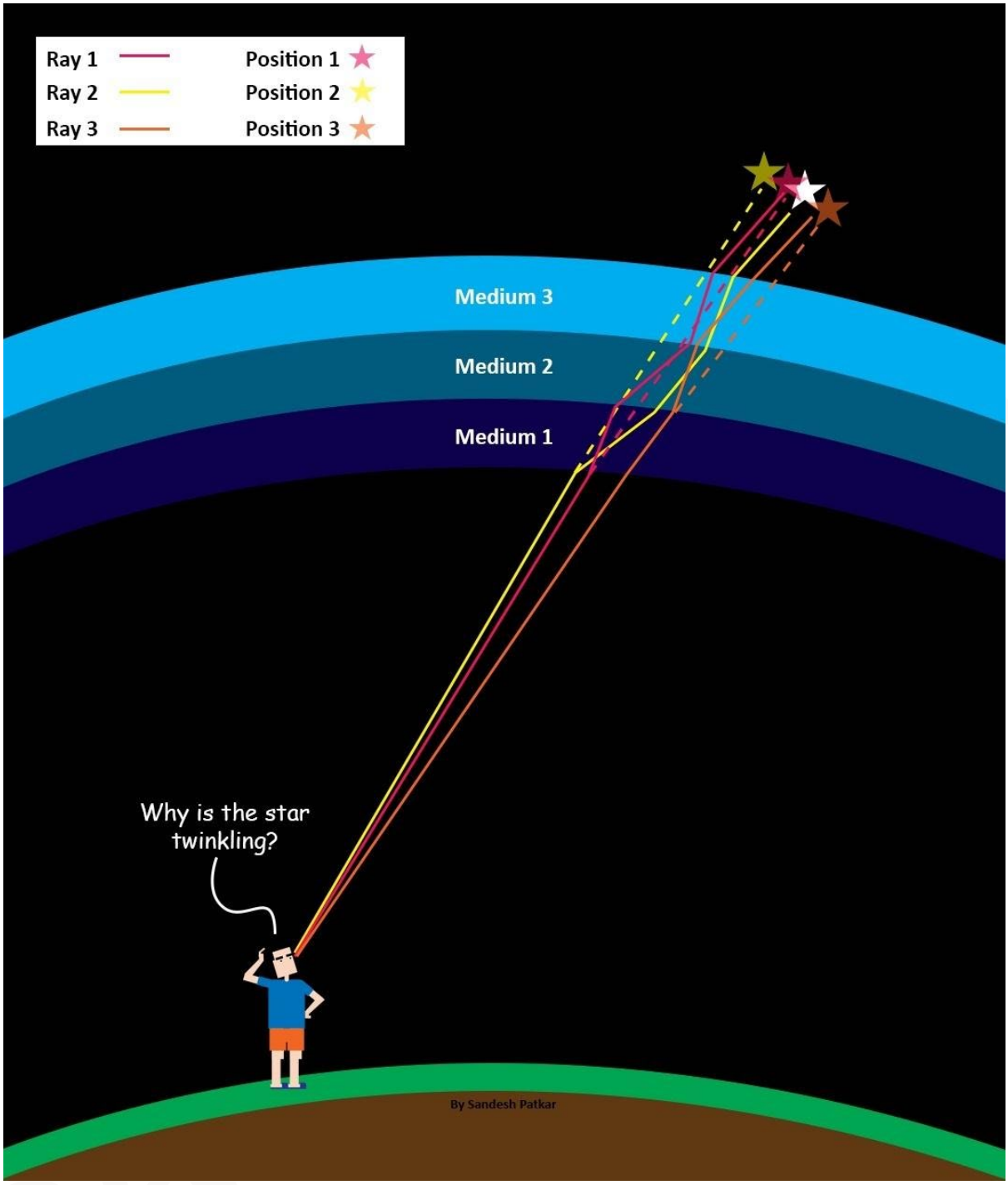
3) Star seen higher than they actually are

- The refractive index of earth's atmosphere in general increases from top to bottom. So, the light coming from a star near the horizon has to travel from rarer to denser medium and it bends towards the normal. Due to which stars appears higher.



4) Twinkling of Stars

- Stars are very far from us, so they behave as point source of light. Since the physical conditions of the earth's atmosphere are not constant the light from stars appears to come from different directions. This results in fluctuation of apparent position of star.
- The amount of light coming from stars also vary due to changing Refractive Index of atmosphere.
- The stars appears bright when more light from star reaches our eyes and the same star appears dull when less amount of light reaches our eyes. This causes twinkling of Stars.



Ques) Why do planets not twinkle?

Ans - The planets are much closer to the earth and are considered a collection of many point sized sources of light, the total amount of light entering our eye from all the individual point sized sources will average out to zero, thereby nullifying the twinkling effect.

Scattering of Light

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

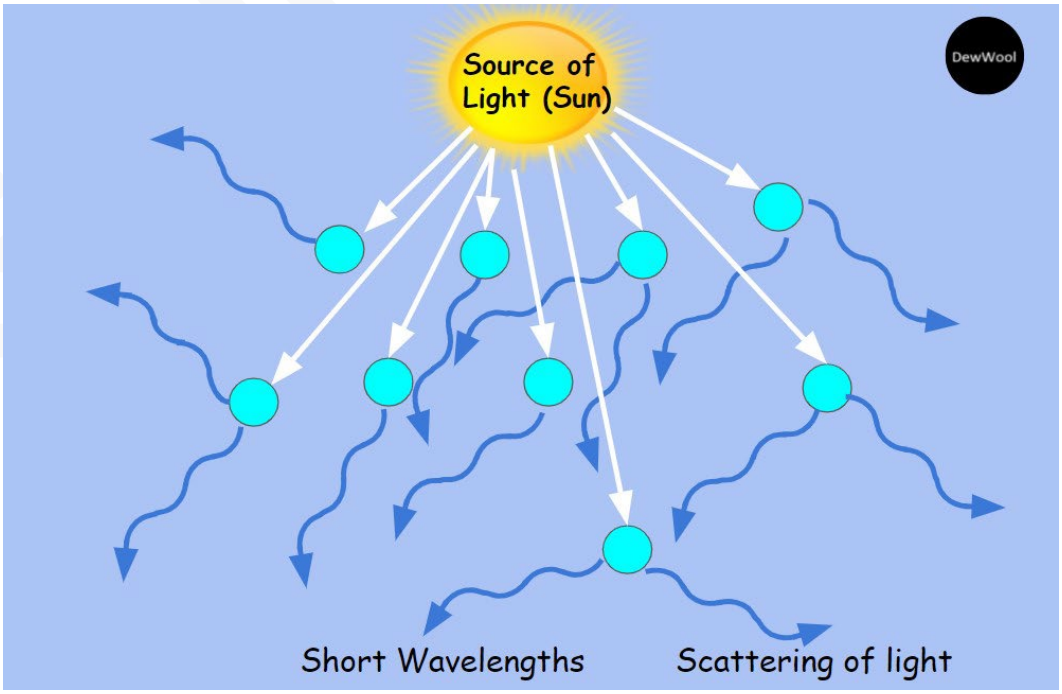
- It depends on the size of particle (जिस Particle से टकराकर Scatter हुई है Light)

  i) Small size particles scatter blue color of light (Shorter wavelength)

  ii) Medium size particles scatter red color of light (Longer wavelength)

  iii) Large size particles scatter all the colors of light that's why it appears white

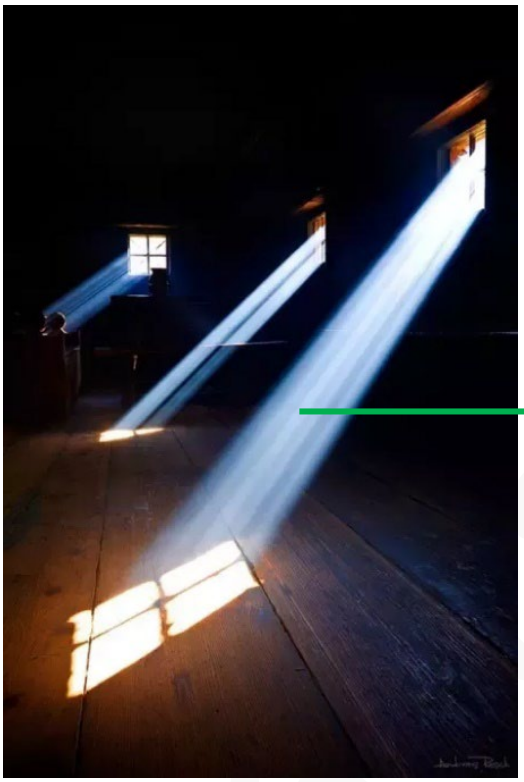
$$\text{Scattering} \propto \frac{1}{\text{wavelength}}$$



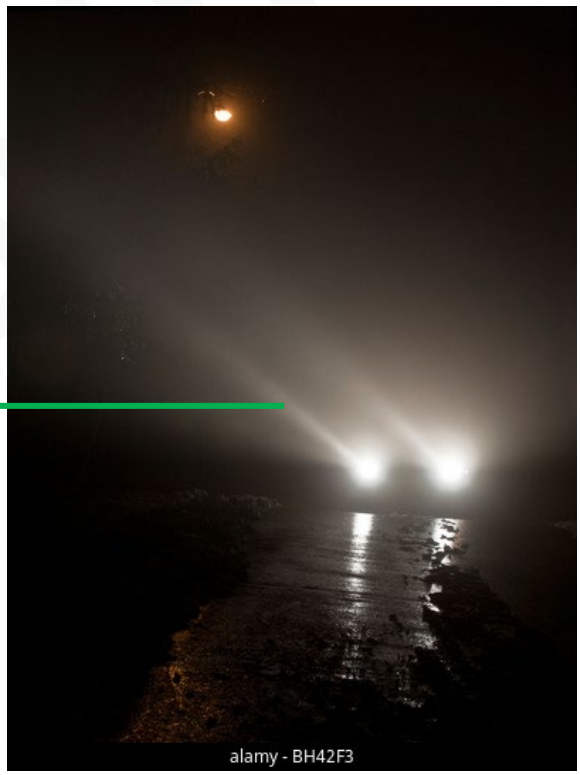
Effects of Scattering of Light -

1) Tyndall Effect

- The earth's atmosphere is a heterogeneous mixture of minute particles of smoke, tiny water droplets, dust in air which becomes visible due to scattering of light.

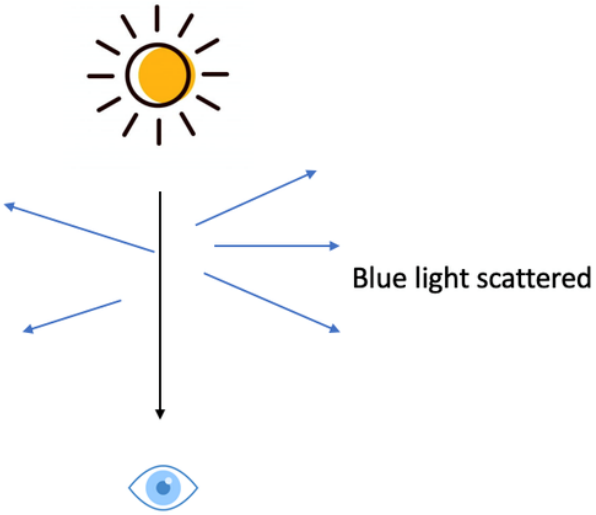


Tyndall Effect



2) Color of Sky is Blue

- The upper layer of atmosphere contains very small particles of water vapours and gases. These particles are more effective in scattering of light of shorter wavelength mainly blue color, So sky appears blue.



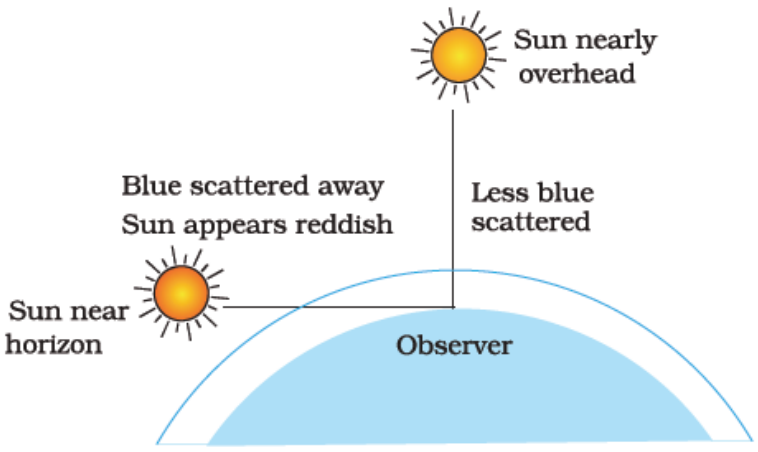
- If earth had no atmosphere than there would not have been any scattering of light because at higher altitude there are no particles that's why sky of other planets is dark because there is no atmosphere in planets like Mars.
- So sky appears dark to an Astronaut in space or to a passenger of jet plane

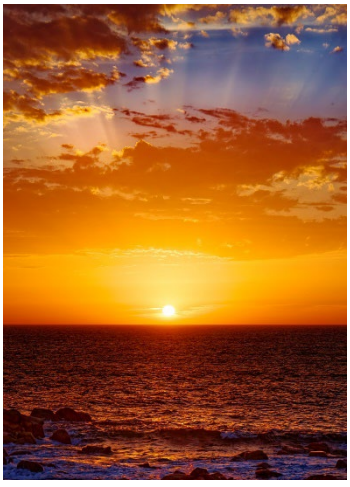
3) Danger Signs are of Red Color

- Red is the least scattered color. It is least scattered by fog and smoke can be seen in the same color over a long distance. So, danger signs are made in red color.

4) Color of Sun at Sunrise and Sunset

- 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 color) will reach our eye. This is why sun appear red in color.





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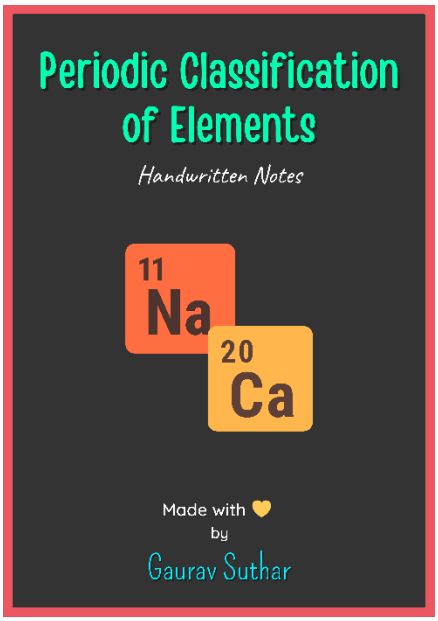
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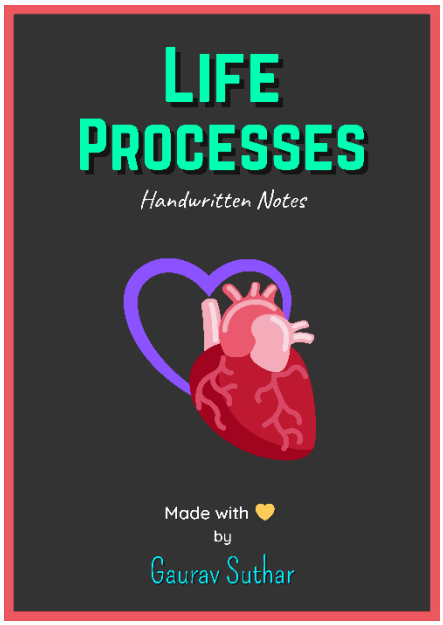
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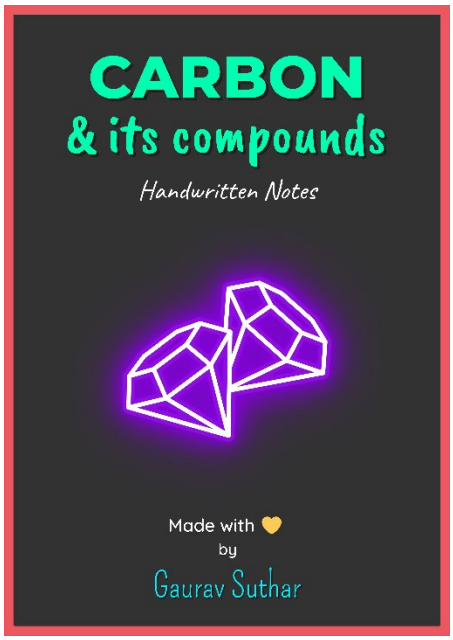
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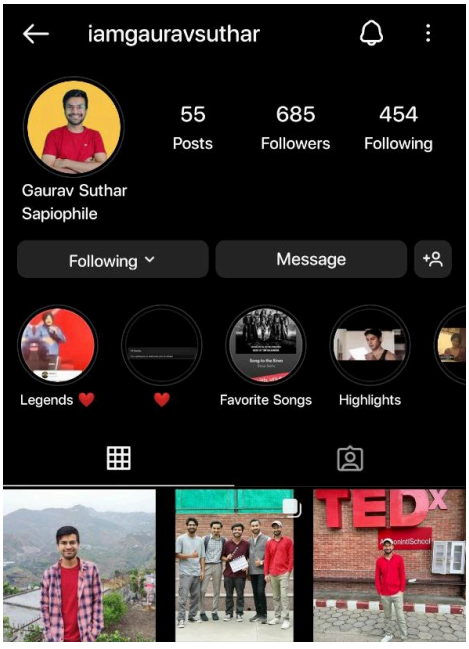
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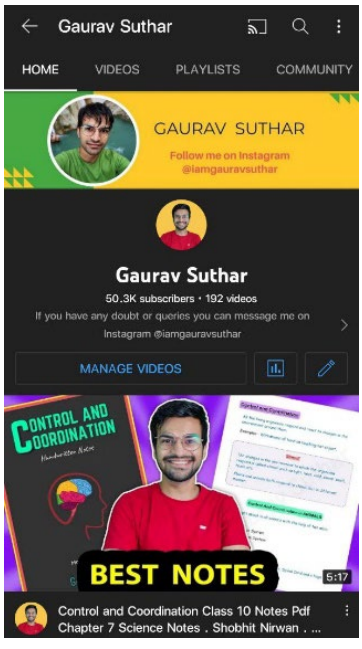
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