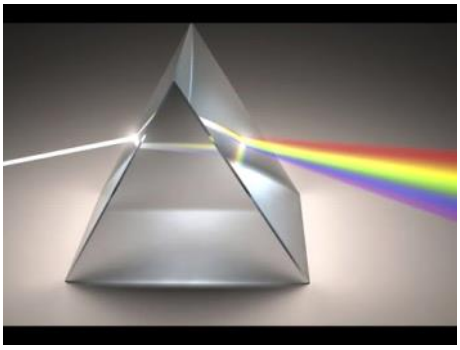
Chapter 11

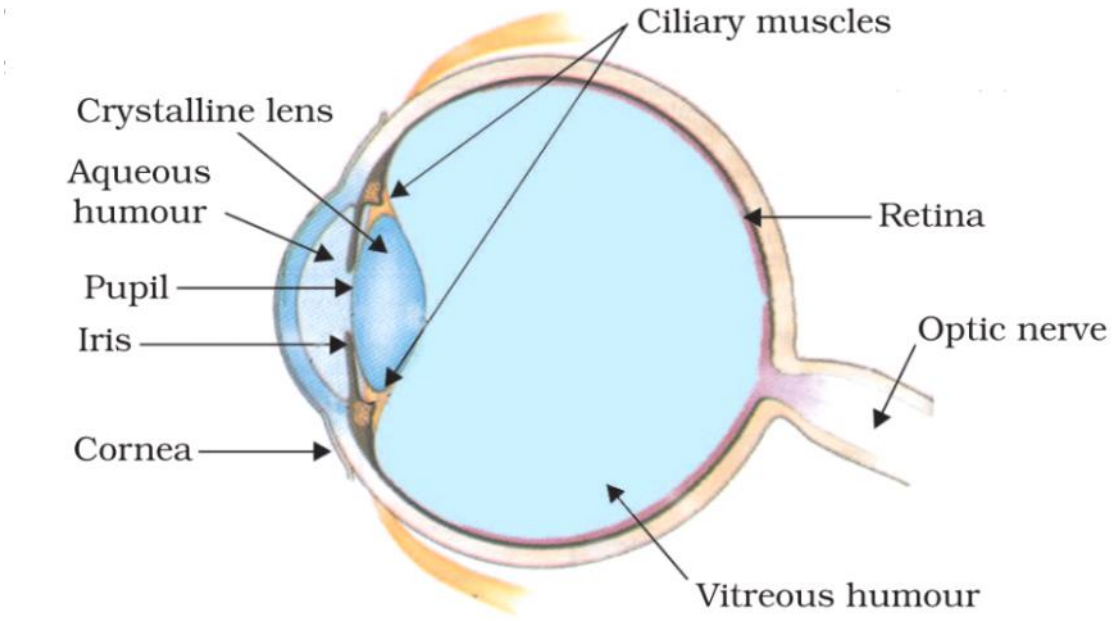
The Human Eye and the Colourful World



Human Eye

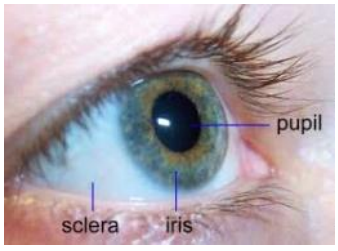
Human eye animated

Q. Draw a neat and label diagram of human eye.



→ Human Eye is the most valuable and sensitive sense organ that enables us to see the world around us.

→ Human Eye is like a camera.



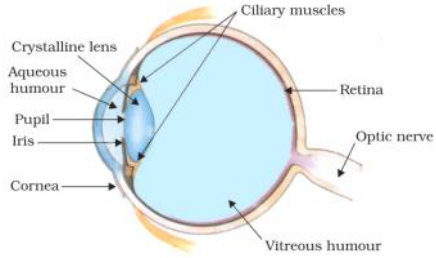
Sclera :- It is a tough white coat which protects the eyeball.

Cornea :- It is a transparent, thin and protective layer on the front surface of the eyeball.

→ Light enters through cornea.

2018

Function → Most of the refraction takes place at cornea.



2018
Function

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

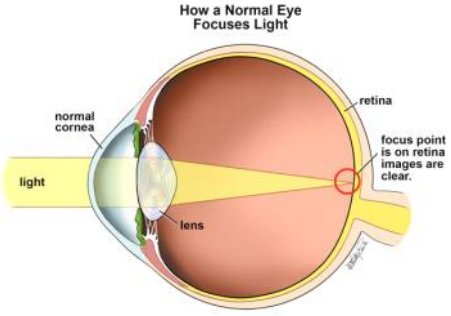
In dim light, iris expands the size of pupil.

In bright light, iris contracts the size of pupil.

Pupil :- It is a hole at the centre of the iris through which light enters in the eye.

Eye lens :- It is a crystalline convex lens which is made up of jelly-like material.

2018
Function It provides finer adjustment of focal length, so image will formed on retina.



2018
Function

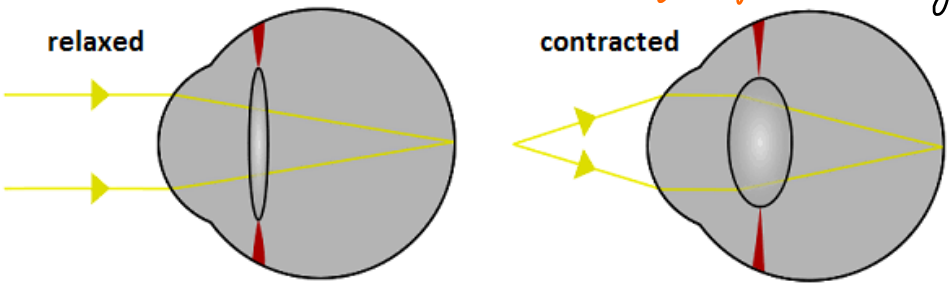
Ciliary Muscles :- They help in adjusting the focal length of the eye lens.

Q. How we are able to see nearby and distant objects clearly ?

Working of ciliary muscles :-

→ When ciliary muscles relaxed, eye lens becomes thin and focal length increases. So, we can see distant objects clearly.

→ When ciliary muscles contract, eye lens becomes thick and focal length decreases. So, we can see nearby objects clearly.



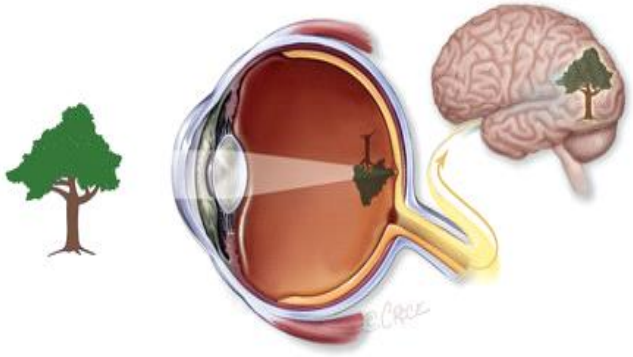
Retina :- It is a delicate membrane where real and inverted image is formed.

→ It consists of millions of light sensitive cells.

→ These light sensitive cells get activated when light falls on them and generate electric signals.

→ Light sensitive cells are of two types :-

1. Rods :- are sensitive to brightness.
2. Cones :- are sensitive to colour.



Optic nerve :- It carries nerve impulses to the brain.

Q. Define power of accommodation. ★ ★

Ans. The ability of the eye lens to adjust its focal length.

Q. Define least distance of distinct vision.
or
Q. Define near point of eye. Give value of near point.

Ans. The minimum distance at which objects can be seen distinctly without strain.

→ Near point is about 25 cm.

Q. Define far point of eye. Give value of far point.

Ans. The farthest point up to which eye can see objects clearly.

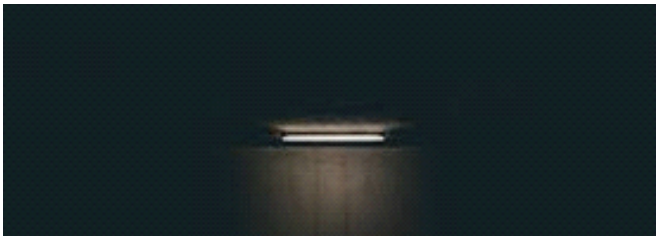
→ Far point is infinity.

Q. Write the range of distance for a person having normal vision.

Ans. 25 cm. to infinity.

Q. Sometimes when we enter into a dark room from bright sunlight we are unable to see objects clearly. Why ?

Ans. In bright light, iris contracts the size of pupil.
When we enter into a dark room, iris expands the size of pupil. But adjustment of pupil takes time.
So, we are unable to see objects initially.



Defects of vision

1. Myopia (Near-sightedness)
2. Hypermetropia (Far-sightedness)
3. Presbyopia

Myopia

(Near-sightedness)

Myopia :- In this defect, a person can see nearby objects clearly, but cannot see distant objects clearly

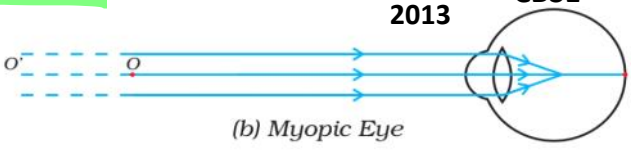
★ ★ ⋆ 2013

Causes :- CBSE

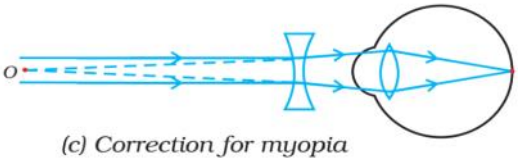
(i) excessive curvature of the eye lens.

(ii) elongation of the eye ball.

CBSE 2013



(b) Myopic Eye



(c) Correction for myopia

★ ★

Correction :- By using concave lens of suitable power.
−ve

(Far-sightedness)

Hypermetropia :- In this defect, a person can see distant objects clearly, but cannot see nearby objects clearly

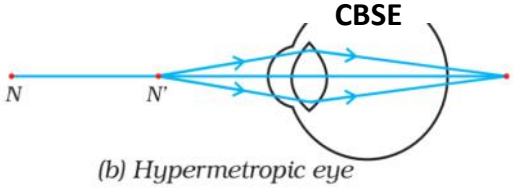
CBSE

Causes :-

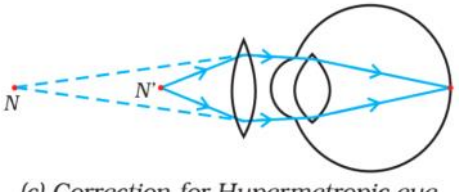
(i) Reduced curvature of the eye lens.

(ii) Shortening of the eye ball.

CBSE



(b) Hypermetropic eye



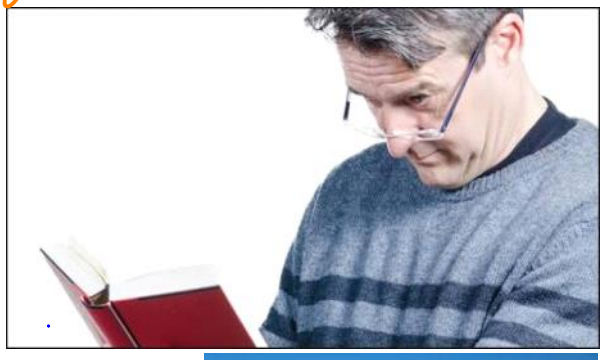
(c) Correction for Hypermetropic eye

(c) Correction for Hypermetropic eye

★ ★

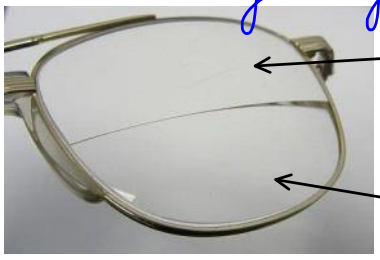
Correction :- By using convex lens of suitable power.
+ve

Presbyopia :- Power of accomodation decreases with ageing.
In this defect, a person cannot see nearby as well as distant objects clearly.

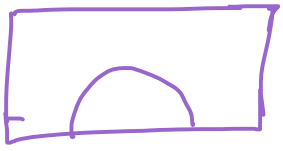


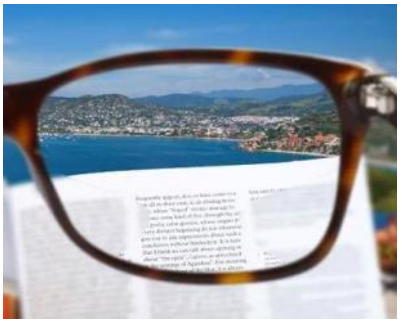
Causes :- (i) Weakening of ciliary muscles.
(ii) Reduced Flexibility of Eye lens.

Correction :- By using Bi-focal lens.



Bi-focal lens





→ Upper part consists of Concave lens used for distant vision.
→ Lower part consists of Convex lens used for near vision.

Q. A person need to use glasses for reading newspaper. Identify the defect in her vision and the type of lens she would need to correct it.

Ans. **Defect :-** Hypermetropia

Lens :- Convex lens of suitable power.

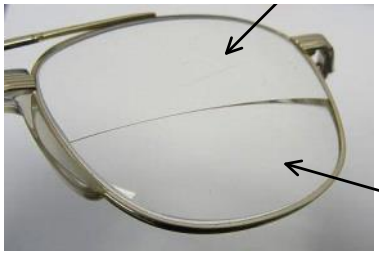
Q. A person is able to see objects clearly only when they are lying a distances between 50 cm and 300 cm from his eye. Identify the kind of defects of vision he is suffering from. Give reason for your answer.

Ans. Near point is 25cm. and far point is infinity for a person having normal vision.

But the person is able to see between 50 and 300 cm.

So, he is suffering from Presbyopia.

Concave lens



Bi-focal lens

NCERT

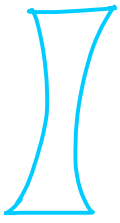
Q. A student has difficulty reading the black board while sitting in the last row . What could be the defect the child is suffering from ? How can it be corrected ?

Ans. **Defect :-** Myopia.

Correction :- By using concave lens of suitable power.
−ve

Q. A person with myopic eye cannot see objects beyond 1.2 m distinctly. What should be the type of corrective lens used to restore the vision.

Ans. Concave lens



P = −ve

Cataract

Q. What is a cataract ? How it can be corrected ?

Ans. **Cataract :-** The crystalline lens at old age becomes milky and cloudy which causes partial or complete loss of vision.

Correction :- It can be corrected through cataract surgery.

Numerical Myopic and Hypermetropic eye

★ ★ ★

NCERT

Q. The far point of a myopic person is 80 cm in front of the eye. What is the nature and power of the lens required to correct the defect ?

Ans.

Object distance $(u) = -\infty$ (infinity)

Image distance $(v) = -80$ cm.

Focal length $(f) = ?$

By Lens formula

$$\boxed{\frac{1}{f} = \frac{1}{v} - \frac{1}{u}}$$

$$\frac{1}{f} = \frac{1}{-80} - \frac{1}{-\infty}$$

$$\frac{1}{f} = -\frac{1}{80} + 0$$

$$f = -80 \text{ cm.}$$

$$f = \frac{-80}{100} \text{ cm.} = -0.8 \text{ m.}$$

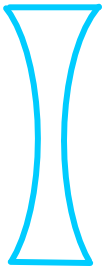
$$\boxed{P = \frac{1}{f}}$$

$$P = \frac{1}{-0.8}$$

$$P = -\frac{10}{8} = -\frac{5}{4}$$

$$P = -1.25 \text{ D}$$

Nature of lens :- Concave lens



NCERT

Q. The near point of hypermetropic eye is 1 m. What is the nature and power of the lens required to correct this defect ?

Ans.

Object distance $(u) = -25\ cm.$

Image distance $(v) = -1\ m. = -100\ cm.$

Focal length $(f) = ?$

By Lens formula

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{f} = \frac{1}{-100} - \frac{1}{-25}$$

$$\frac{1}{f} = \frac{-1}{100} + \frac{1}{25}$$

$$\frac{1}{f} = \frac{-1+4}{100} = \frac{3}{100}$$

$$f = \frac{100}{3}$$

$$f = \frac{100}{3 \times 100} = \frac{1}{3}\ m.$$

$$P = \frac{1}{f}$$

$$P = \frac{1}{\frac{1}{3}}$$

$$P = 1 \times \frac{3}{1}$$

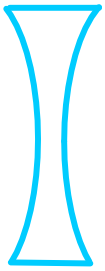
$$P = 3\ D$$

Nature of lens :- Convex lens

Q. The far point of a myopic eye is 60 cm. Find the focal length and power of the lens used to correct it.

Ans.

$f = -60\ cm.$ $P = -1.66\ D$ Nature of lens :- Concave lens



Q. The near point of hypermetropic eye is 75 cm. Calculate the focal length and power of the lens.

Q. The near point of hypermetropic eye is 75 cm. Calculate the focal length and power of the lens.

Ans. $f = 37.5$ cm.

$u = -25$ cm

$v = -75$ cm.

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\frac{1}{f} = \frac{1}{-75} - \frac{1}{-25}$$

$$\frac{1}{f} = \frac{-1}{75} + \frac{1}{25}$$

$$\frac{1}{f} = \frac{-1+3}{75}$$

$$\frac{1}{f} = \frac{2}{75}$$

$$f = \frac{75}{2 \times 100} \times 3 = \frac{3}{8}\ m.$$

$P = 2.66$ D

Nature of lens :- Convex lens

Q. A person has hypermetropic eye and near point of him becomes 60 cm. Write the type of lens used by him. Also find the power of that lens.

Ans. Object distance $(u) = -25$ cm.

Image distance $(v) = -60$ cm

Focal length $(f) = ?$

Lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$$\frac{1}{f} = \frac{-1}{60} - \frac{1}{-25}$$

$$\frac{1}{f} = -\frac{1}{60} + \frac{1}{25}$$

$$\frac{1}{f} = \frac{-5+12}{300}$$

$$\frac{1}{f} = \frac{7}{300}$$

$$f = \frac{300}{7 \times 100}$$

$$f = \frac{3}{7}\ m.$$

$$P = \frac{1}{f} \rightarrow m.$$

$$P = \frac{1}{\frac{3}{7}} = 1 \times \frac{7}{3}$$

$P = 2.33$ D

Type of lens :- Convex lens

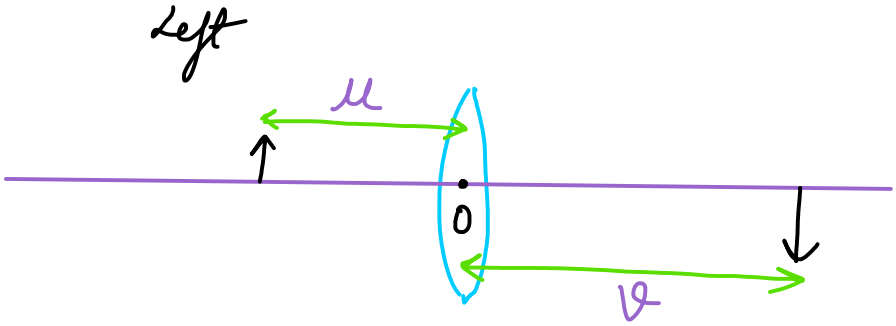
$60 = 2 \times 2 \times 3 \times 5$

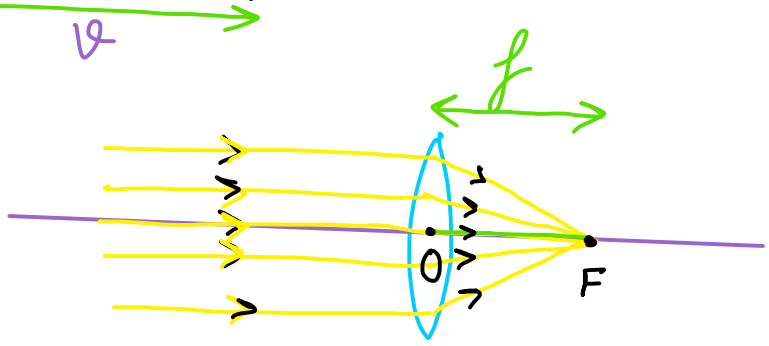
$25 = 5 \times 5$

2	60
2	30
3	15
5	5
	1

$LCM = \underbrace{2 \times 2 \times 3}_{12} \times \underbrace{5 \times 5}_{25} = 300$

5	25
5	5





$u \rightarrow$ object distance

$v \rightarrow$ image distance

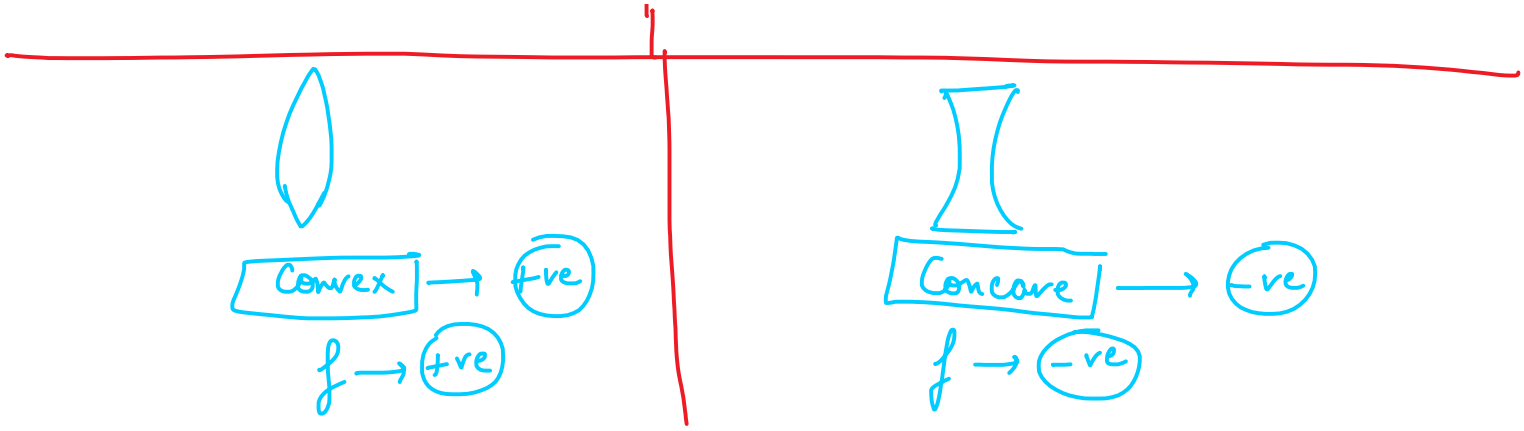
$f \rightarrow$ focal length

Lens Formula

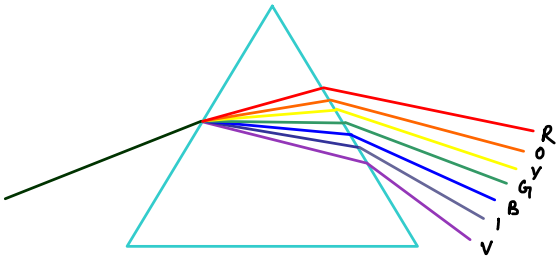
$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

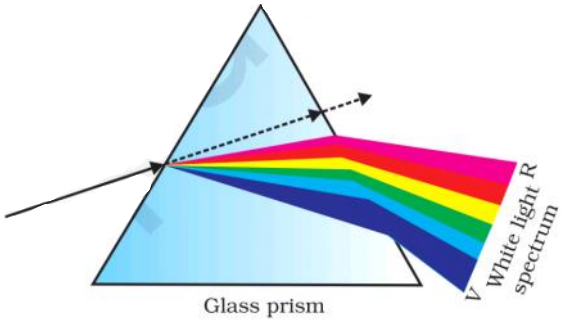
Power

$$P = \frac{1}{f}$$


Convex
+ve
f → +ve
Concave
-ve
f → -ve

Dispersion of light through Prism





Q. Define :-

(i) Spectrum :- ★ The band of seven colours of light. (VIBGYOR) → wavelength increase

(ii) Dispersion :- ★ The splitting of white light into its seven component colours.

★★

Q. What is the cause of dispersion ?

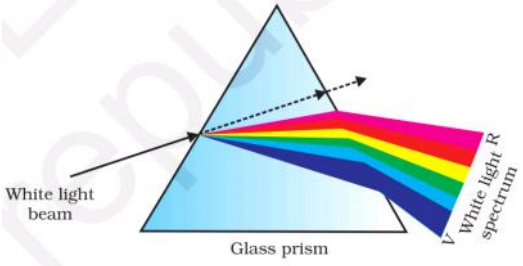
Ans. When light passes through a prism then each colour is deviated by different angles because refractive index of prism is different for different colours depending on their wavelengths.

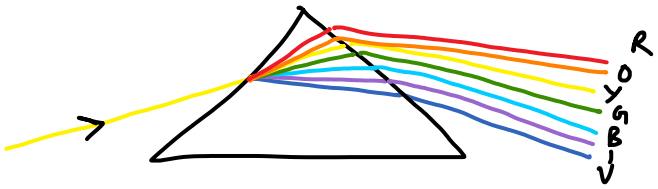
Longest wavelength :- Red

Shortest wavelength :- Violet

Least Deviated :- Red

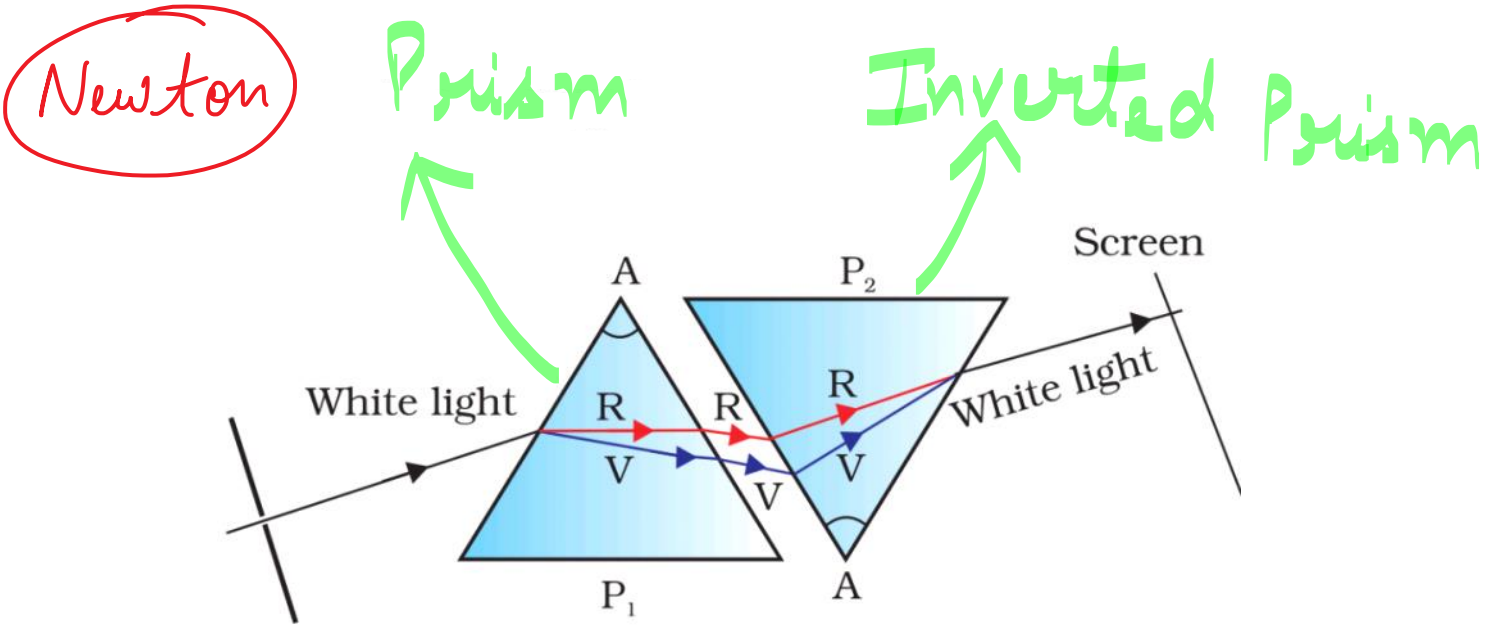
Most Deviated :- Violet

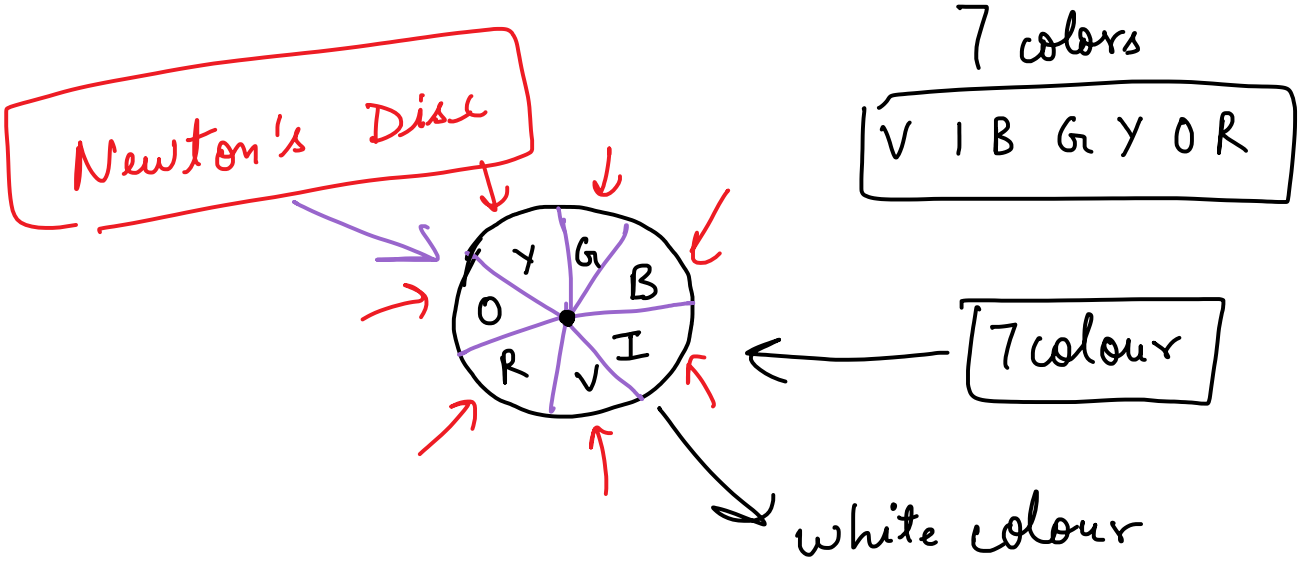




Q. Draw the diagram of recombination of spectrum of white light.

Ans.





Rainbow

Q. What is rainbow ?

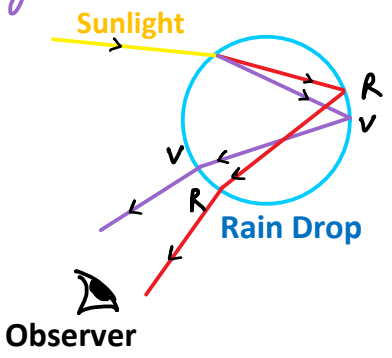
Ans. It is a natural phenomenon caused by tiny water droplets in atmosphere.

how rainbow f...

2013

Q. How rainbow is formed ? Explain with the help of a diagram.

Ans. We can see rainbow after a shower. The tiny water droplets act like prisms. They refract and disperse the incident sunlight, then reflect it internally & finally refract it again when it comes out of it. Due to dispersion of light and internal reflection, different colours reaches our eyes.



2013

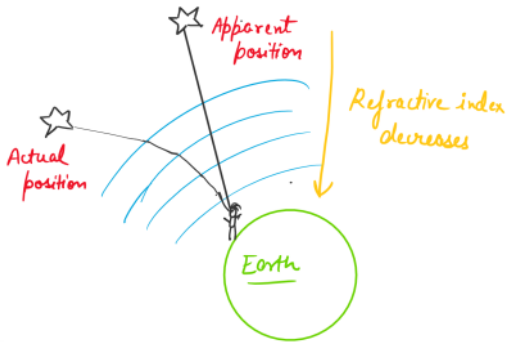
Q. What are the two necessary conditions to observe a rainbow ?

Ans.
- It is seen in the sky only after a rain shower.
- The position of sun should always behind the observer.

Atmospheric Refraction

Q. Define atmospheric refraction.

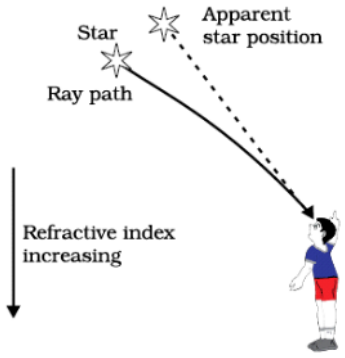
Ans. The refraction of light by different layers of earth's atmosphere.



Stars seem higher th...

Q. Why stars appear higher than they actually are ?

Ans. As the optical density increases towards the earth Starlight travels from rarer to denser layers, bending everytime towards the normal & reaches the observer's eye. So, stars seems higher than they actually are.



2018

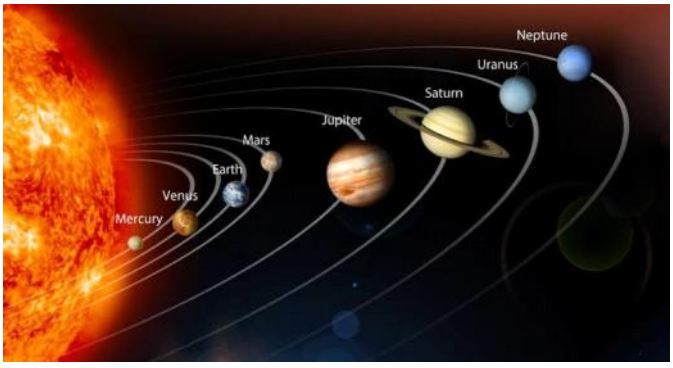
Q. Why do stars twinkle ?

Ans. As the stars are very distant, they are point sized source of light. Due to refraction of light, path of light changes slightly. So, when more light enters our eyes, star appear brighter & when less light enters our eyes, star appear fainter which creates twinkling effect.

Stars twinkle

Q. Why planets do not twinkle ?

Ans. Planets are much closer to earth. A planet can be considered as a collection of large number of point-sized source of light. Amount of light entering our eye from these points does not changes, hence no twinKling occurs.

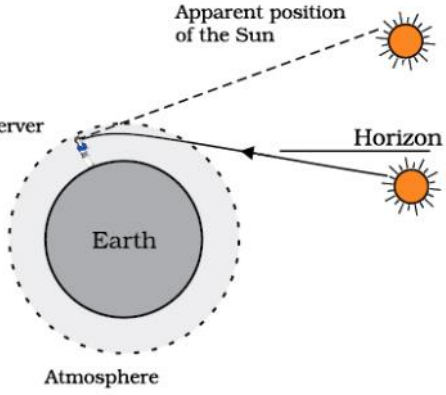


Q. Explain advance sunrise and delayed sunset with the help of diagram.

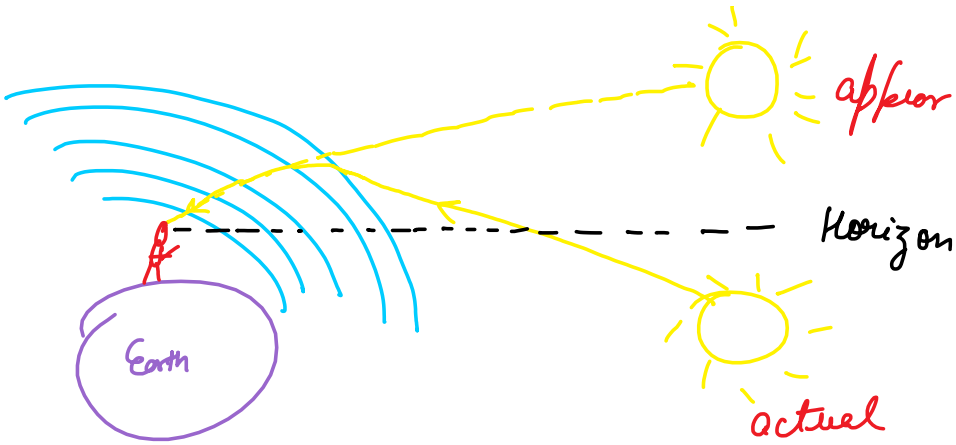
Ans. As the optical density increases towards the earth. Sunlight travels from rarer to denser layers, bending everytime towards the normal & reaches the observer's eye.

- Due to atmospheric refraction, the sun becomes visible when it is below the horizon.
- Due to this effect we can see sun 2 minutes before sunrise & 2 minutes after actual sunset.

∴ Increases daytime by 4 minutes.



Atmospheri c Refraction


apparent
Horizon
Earth
actual

Scattering of Light

Q. Define scattering of light.

Ans. The phenomenon of change in the direction of propogation of light caused by large number of particles present in the atmosphere.

2014

Q. Why sky appear blue to us ?

Ans. Our atmosphere consists of mainly 78 % nitrogen and 21 % oxygen. These gases have very fine particles, So, they scatter light colour of shorter wavelength i.e. blue.

Sky appears blue

Sky appears blue

Q. Why danger signals are red ?

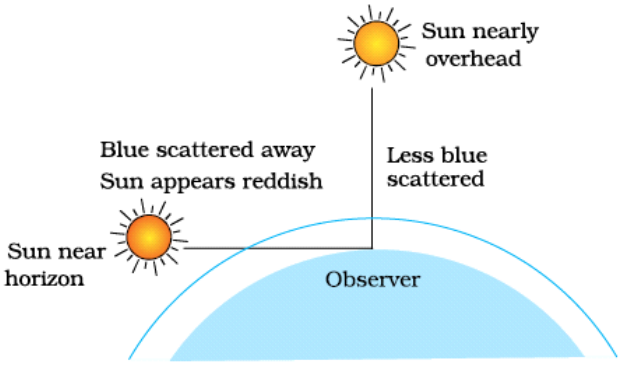
Ans. Red is least scattered by smoke, fog and red colour has longest wavelength. So, it can be seen from a distance.

Wavelength - Why r...

2018

Q. Why does the sun appear reddish during sunrise and sunset ? Will this phenomenon be observed by an astronaut on the moon ? Give reason to justify your answer.

Ans. During sunrise and sunset, sun is near the horizon and sunrays travel longer distance to reach us. Most of the blue colour & colour of shorter wavelengths scattered away. Therefore the light that reaches our eyes is of longer wavelength i.e. red.



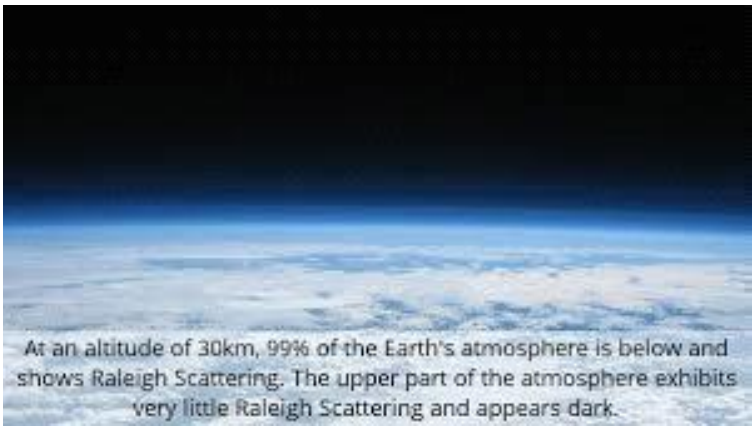
sunset red

2014 2018

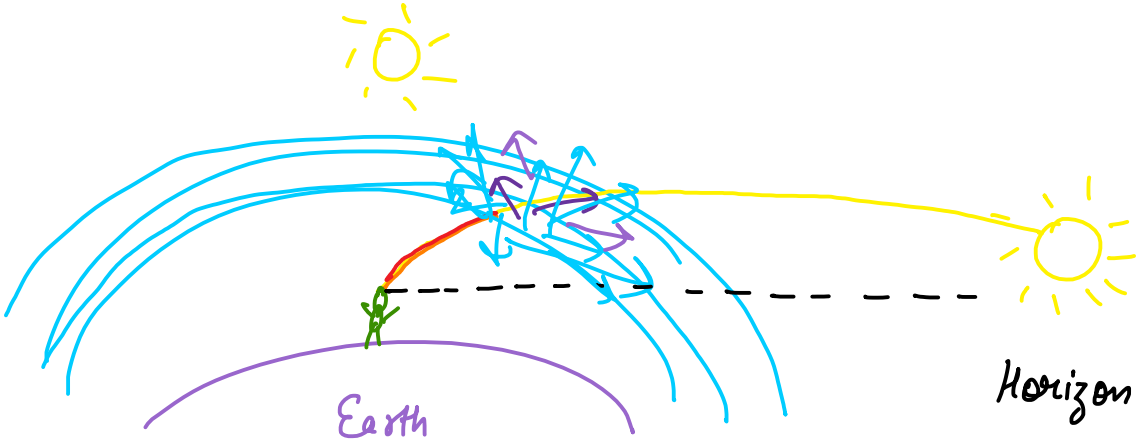
Q. Why sky appears dark instead of blue to an astronaut in space ?

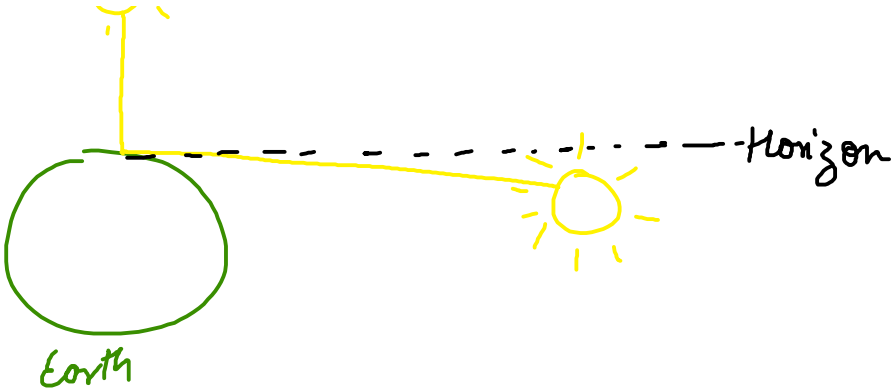
Sky does not have atmosphere so scattering of light

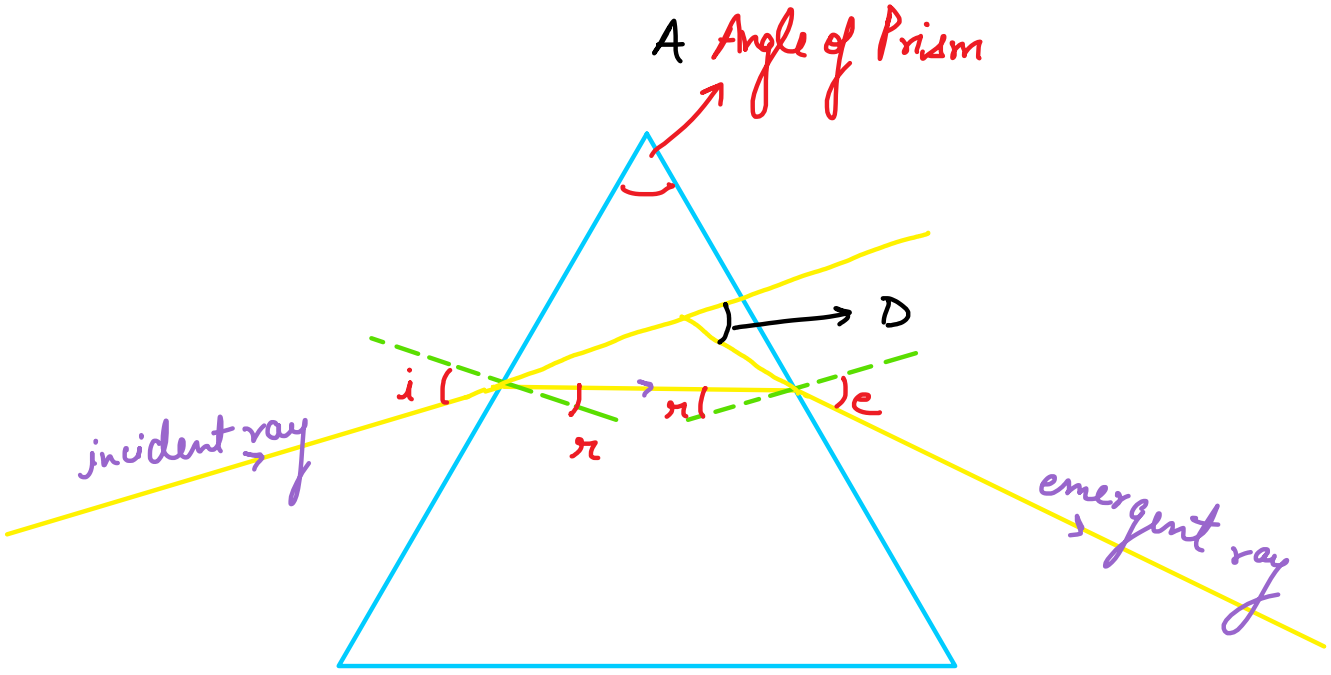
Ans. Space does not have atmosphere, so scattering of light does not takes place.



At an altitude of 30km, 99% of the Earth's atmosphere is below and shows Raleigh Scattering. The upper part of the atmosphere exhibits very little Raleigh Scattering and appears dark.




Horizon
Earth



$$i + e = A + D$$