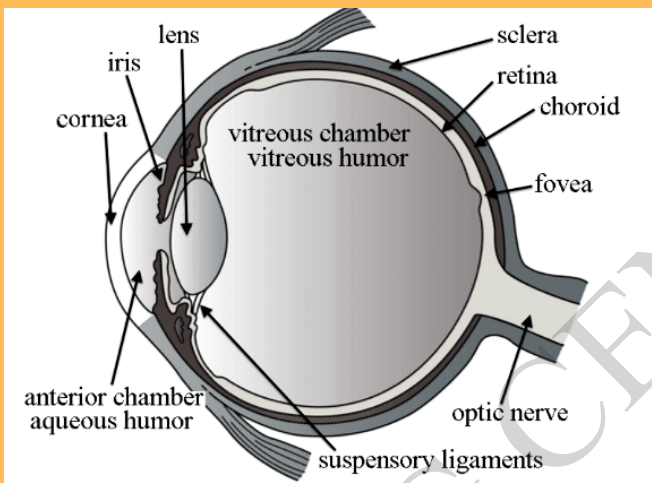
Human Eye

The Human eye is one of the most valuable and sensitive sense organs.

STRUCTURE OF HUMAN EYE



- **Cornea:** It is the front bulged out transparent portion of the eyeball. Light enters the eye through this thin membrane of the eye.
- **Aqueous humour**: It is a watery liquid filled in the space between the cornea and lens of eye, its function maintaining pressure and provide nutrients to the cornea and lens.
- **Vitreous humour**: It is a jelly like material filled in the space between eye lens and the retina. It help in holding its typical spherical shape.
- **Iris:** It is a dark muscular diaphragm between the cornea and the lens. It controls the size of Pupil. It is the colour of the iris that we call as colour of eye.
- **Pupil:** Small hole between the iris through which light enters the eye. In bright light, pupil contracts and in dim light pupil expands.
- **Retina:** It is the innermost layer in the backside of the eyeball. It consists of many-many light sensitive cells (about 125 million) called receptors. There are two type of light sensitive cells 'rod shaped' and 'cone shaped'.
- **Optic Nerve:** It consists of millions of nerve tissues connecting light sensitive cells of the retina to the brain. Signal from the light sensitive cells is transmitted to the brain through this nerve.
- **Eye Lens:** The eye lens is composed of a fibrous, jelly-like material. It provides finer adjustment required to focus objects on the retina.
- **Ciliary muscle**s: Attached to eye lens holds the lens in correct position and modified the curvature of the lens.

Kuch Kaam Ki Baat (K^3B) :

- **POWER OF ACCOMMODATION:** The power of accommodation of the eye is the maximum variation of its power for focusing on near and far (distant) objects. This is done by changing the curvature of the eye lens. Eyes loses its power of accommodation at old age.
- **Near Point:** The minimum distance at which objects can be seen most distinctly without strain is called near point of the eye. It is 25 cm for a normal human eye.
- **Far Point:** The farthest point up to which the eye can see object clearly is called the far point of the eye. It is infinity for a normal eye.
- **Why do we have two eyes for vision and not just one?**
    - A human being has a horizontal field of view of about 150° with one eye and of about 180° with two eyes. So, two eyes give a wider field of view. The ability to detect faint objects is enhanced with two eyes. Our eyes are separated by a few centimetres and each eye sees a slightly different image. Our brain combines the two images into one tells us how close or far away things are. Keeping both the eyes open provides the third dimension of depth.

Defects of vision and their correction

MYOPIA

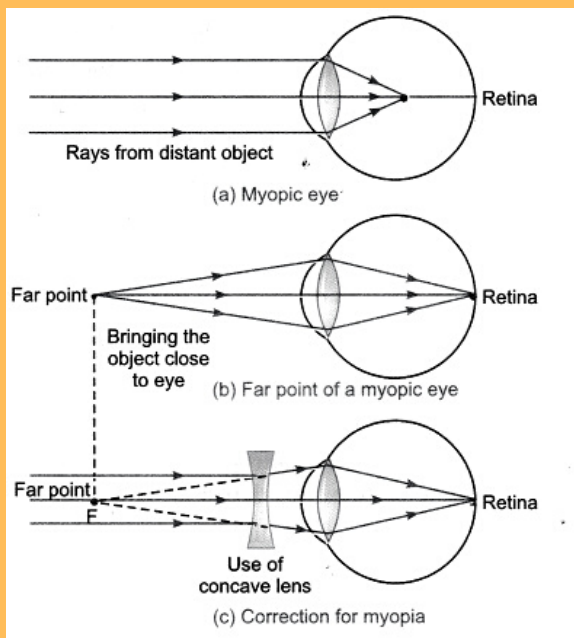
- It is also known as nearsightedness.
- A person with myopia can see nearby objects clearly but cannot see distant objects distinctly.
- It's far point is nearer than infinity. Image is formed before retina in a myopic eye.

Causes:

- Excessive curvature of the eye lens.
- Elongation of the eyeball.

Remedy:

- It can be corrected by using a concave lens of suitable power. It will bring back image on retina.



HYPERMETROPIA

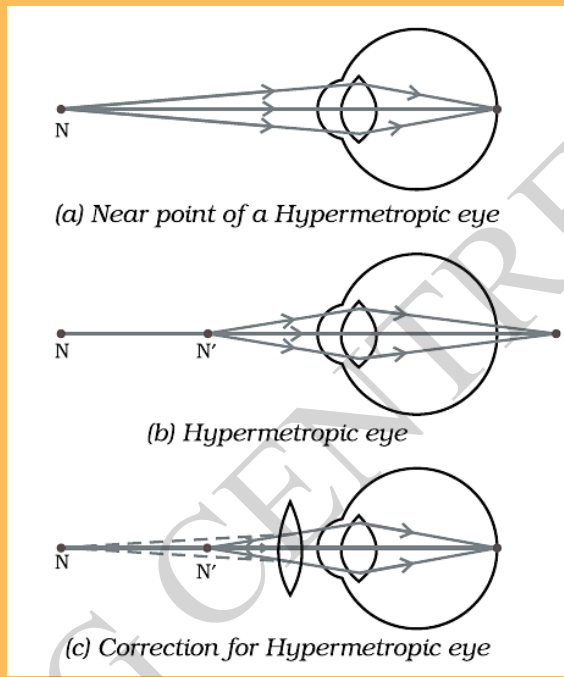
- It is also known as far-sightedness.
- A person with this can see distant objects clearly but cannot see nearby distinctly.
- It's near point more than 25 cm.
- Image is formed behind retina.

Causes:

- The focal length of the eye lens is too long.
- The eyeball has become too small

Remedy:

- It can be correct by using a convex lens of suitable power. It will bring back image on retina.



(a) Near point of a Hypermetropic eye

(b) Hypermetropic eye

(c) Correction for Hypermetropic eye

PRYSBYOPIA

- The power of accommodation of the eye usually decreases with ageing. It is also known as old age hypermetropia.
- It is the eye defect due to which an aged person fails to see nearby objects clearly due to shifting of his distance of distinct vision more than 25 cm.

Causes:

- Weakening of ciliary muscles with age
- Lack of flexibility of the eye lens.

Remedy:

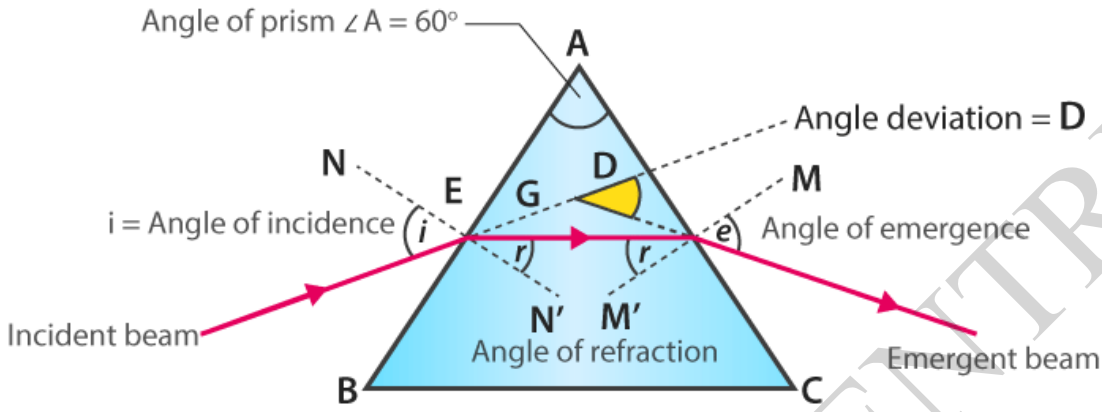
- This defect can be corrected by using bifocal or varifocal lenses which consist of both convex and concave lenses. The upper portion consists of a concave lens (for myopia) and lower portion consists of convex lens (for hypermetropia).

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 ar old age. This causes partial or complete loss of vision. It is possible to restore vision through a cataract surgery.

Prism [CBSE 2012,2017]

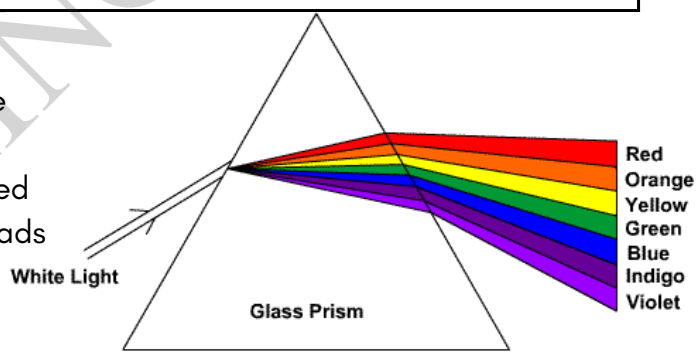
A transparent refracting medium bounded by at least two lateral surfaces inclined to each other at a certain angle.



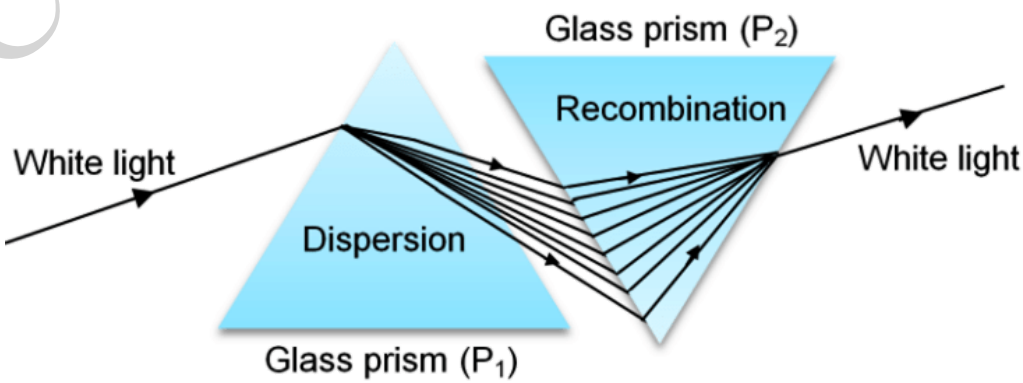
Dispersion Of White Light By A Glass Prism: [CBSE 2017] The phenomenon of splitting of white light into its constituent colours when it passes through a prism is called dispersion. This band of seven colours so obtained the VIBGYOR(violet, indigo, blue, green, yellow, orange, red) is called a spectrum.

Why Dispersion Occurs?

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

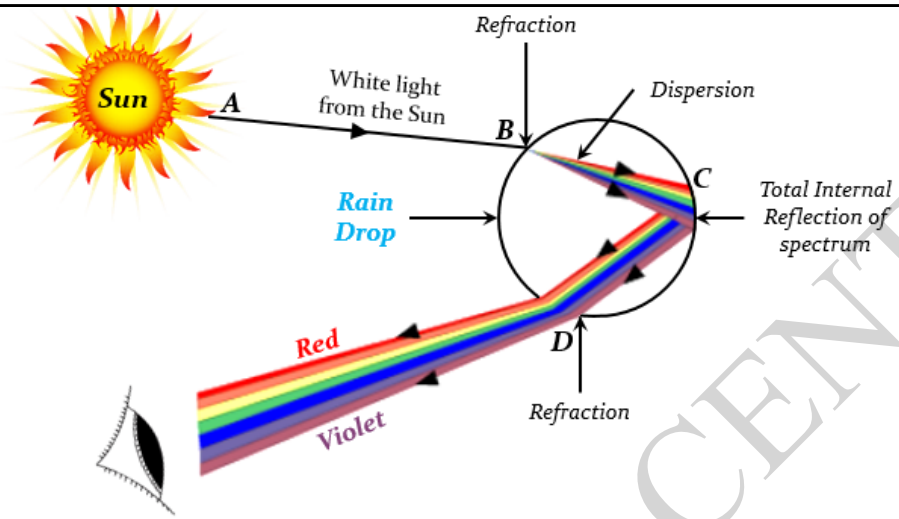


Recombination Of White Light: [CBSE 2016,2017,2020] Reverse of dispersion is also possible. Seven coloured light of the spectrum can be recombined to give back white light by passing two prism one by upside down.



Rainbow: A natural spectrum produced by the dispersion of sunlight by raindrops in the atmosphere.

- Water droplets acts as a small prisms
- Water droplets refract and disperse the incident sunlight then refract internally and finally refract it again when it comes out of the raindrop.



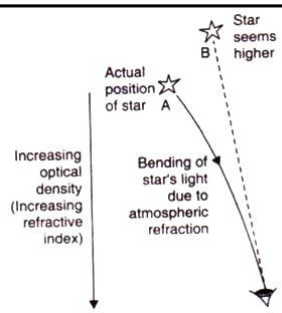
Atmospheric Refraction

When refraction takes place between two mediums and if one of the medium is earths atmospheric then the process is known as atmospheric refraction.

Effects of Atmospheric Refraction:

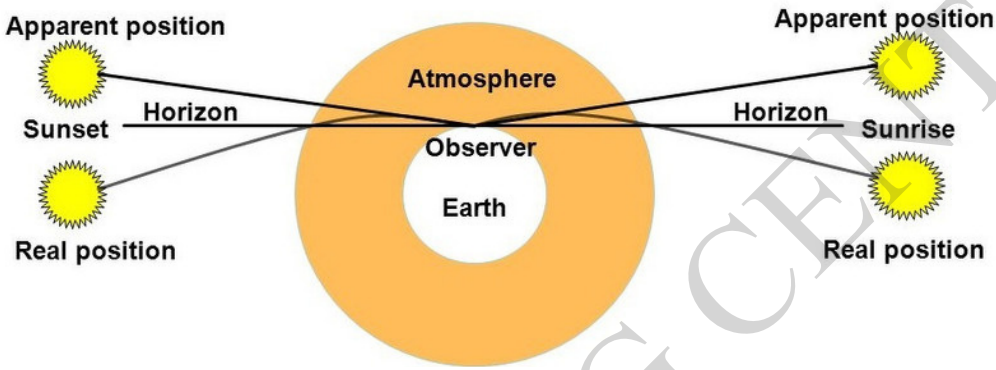
Twinkling of stars: [CBSE 2016,2018] The twinkling of stars is due the atmospheric refraction of starlight, the starlight on entering the earth's atmosphere undergoes refraction continuously before it reaches the earth. In this way the starlight reaching our eyes increases and decreases continuously and the stars appear to twinkle at night.

Stars seem higher than they actually appear: [CBSE 2017] 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.



Planets do not Twinkle: The planets are much closer to the earth and are considered a collection of a large number of sized sources of light, the total amount of light entering from all the individual point sized sources will average out to zero thereby nullifying the twinkling effect.

Advance sunrise and Delayed sunset: [CBSE 2014,2016] The sun is visible to us two minutes before the actual sunrise and about two minutes after the actual sunset. This is due to the atmospheric refraction.



Scattering of light

The reflection of light from an object in all directions is called scattering of light. It depends on type of particle

- Very fine particles scatter mainly in blue colour.
- Large sized particle scatter light of longer wavelength
- Shorter wavelength greater will be the scattering

Effects Of Scattering Of Light

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

Colour of Sky is blue: [CBSE 2012,2015] The molecules of air and other fine particles in the atmosphere have smaller size and are more effective in scattering light of shorter wavelength at the blue end than light of longer wavelengths at the end. Thus when sunlight passes through the atmosphere the tiny particles in air scatter the blue colour more strongly than red. The scattered blue light enters our eyes which makes the colour of sky blue.

Kuch Kaam Ki Baat (K^3B) :

- If earth had no atmosphere then there would not have been any scattering then the sky would have looked dark. The sky appears dark to the passengers flying at very high altitudes.
- Danger signal lights are **RED** in colour as the red is least scattered by fog or smoke therefore it can be seen in the same colour from a particular distance.

Colour of Sun at Sunrise and Sunset: [CBSE 2013] Light from the sun near the horizon passes through thicker layers of air and layer distances in the earth's atmosphere before reaching our eyes.
Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles. Therefore, the light that reaches our eyes is of longer wavelengths . This gives rise to reddish appearance of sun.

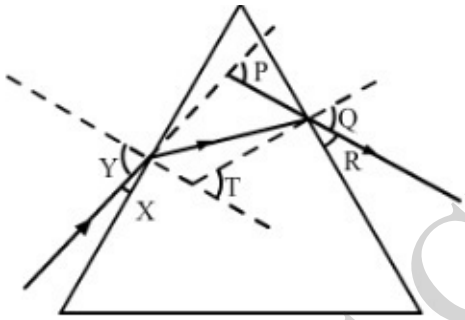
-- PREVIOUS YEAR QUESTIONS --

1 MARK QUESTIONS (INCLUDING MCQs)

Q1. Why does sky look blue on a clear day? [1M, 2009]

Ans 1. Sky looks blue on a clear day because blue colour of light is scattered most by the particles present in the atmosphere.

Q2. In the following diagram, the path of a ray of light passing through a glass prism is shown: [1M,2014]



In this diagram the angle of incidence, the angle of emergence and the angle of deviation respectively are (select the correct option) :

(A) X, R and T

(B) Y, Q and T

(C) X, Q and P

(D) Y, Q and P

Ans 2. (D) Y,Q and P

Q3. A student very cautiously traces the path of a ray through a glass slab for different values of the angle of incidence 'r'. He then measures the corresponding values of the angle of refraction 'r' and the angle of emergence 'e' for every value of the angle of incidence. On analysing these measurement of angles, his conclusion would be. [1M,2017]

(A) i> r> e

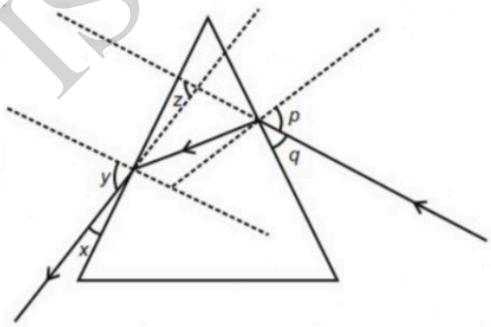
(B) i = e>r

(C)i<r< e

(D)i= e<r

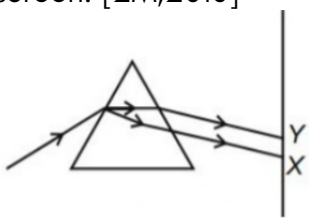
Ans 3. (B) i = e > r

Q4. Study the following ray diagram:



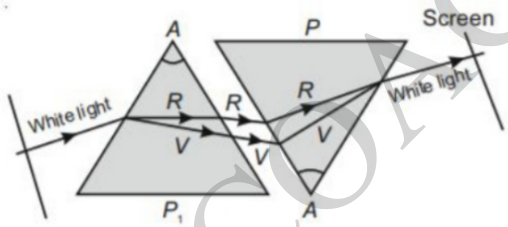
In this diagram, the angle of incidence, the angle of emergence and the angle of deviation respectively have been represented by [1M,2017]
(A) y, p, z (B) x, q, z
(C) p, y, z (D) p,z,y
Ans 4. (A) y, p, z

2 MARKS QUESTIONS
Q5. A triangular glass prism. After passing through the prism it produces a spectrum XY on a screen. [2M,2010]



(a) State the colour seen at X and Y.
(b) Why do different colours of white light bend through different angles with respect to the incident beam of light?
Ans 5. (a) Red colour will be seen at Y and violet colour will be seen at X.
(b) Different colours of white light travel at different speeds through the glass prism.
Hence, they bend through different angles with respect to the incident beam of light.

Q6. When we place a glass prism in the path of a narrow beam of white light, a spectrum is obtained. What happens when a second identical prism is placed in an inverted position with respect to the first prism? Draw a labelled ray diagram to illustrate it. [2M,2012]
Ans 6. When a second identical prism is placed in an inverted position with respect to the first prism, recombination of the spectrum occurs and it forms white light again.

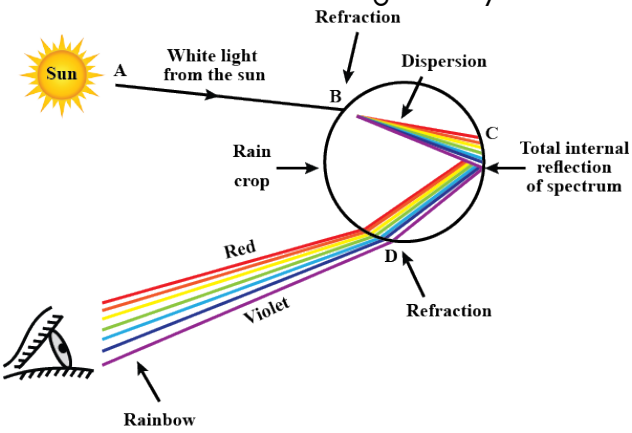


3 MARKS QUESTIONS
Q7. With the help of scattering Of light, explain the reason for the difference in colours of the Sun as it appears during sunset/sunrise and noon. [3M,2015]

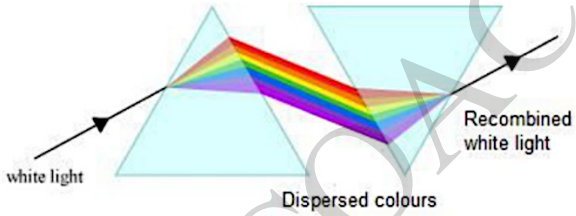
Ans 7. When there is sunrise or sunset the sun is near the horizon, so the light rays have to cover large distance and hence the blue colour scatters away and far from earth but the red colour scatters near the earth and lesser than blue colour because red has maximum wavelength. At noon the sun is at least possible distance from earth, so the blue colour scatters very less due to that distance and hence we see sun as white in colour, and as blue has minimum wavelength, so the rest of the colours would also not get scattered.

Q8. What is a rainbow? Draw a labelled diagram to show the formation of a rainbow

[3M,2019]
Ans 8. Rainbow is a natural optical phenomenon caused by the dispersion of sunlight by tiny water droplet in the Earth's atmosphere. Rainbow is an arch of colours visible in the sky, caused by the refraction and dispersion of the sun's light by rain or other water droplets in the atmosphere. The colours of the rainbow are generally said to be red, orange, yellow, green, blue, indigo, and violet.

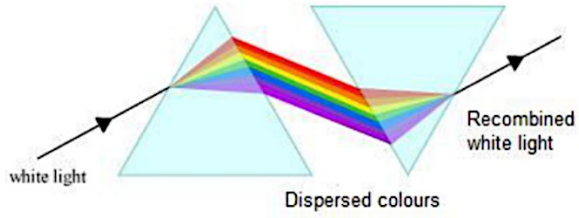


Q9. What is "dispersion of white light"? Draw a labelled diagram to illustrate the recombination of the spectrum of white light. Why is it essential that the two prisms used for the purpose should be identical and placed in an inverted position with respect to each other? [3M,2017]
Ans 9. The splitting of white light into seven colours on refraction is called dispersion of light.
The dispersion of white light occurs because colours of white light travel at different speeds through the glass prism. The amount of refraction depends on the speed of coloured light in glass. The two prisms should be identical because if they are different, their refractive index would be different resulting in further dispersion and not recombination. If the prisms are identical then both have equal and opposite refractive index which would help in recombination. Prisms are inverted so that from the first prism the lights will get diverged and from the second it will converge.



Q10. State the cause of dispersion of white light passing through a glass prism. How did Newton show that white light of sun contains seven colours using two identical glass prisms. Draw a ray diagram to show the path of light when two identical glass prisms are arranged together in inverted positions with respect to each other and a narrow beam of white light is allowed to fall obliquely on one of the focus of the first prism. [3M,2016]
Ans 10. Newton's experiment with two identical prisms: . When a beam of white light is passed through a glass prism, a band of seven colours is formed on a white screen. Newton showed that the seven coloured lights of the spectrum can be recombined to give back white light
The cause of dispersion is the change in speed of light with wavelength when white light enters the first surface of a Prism ,light of different colours due to their different speeds in glasses gets deviated towards the base of the prism through different angles that is the Dispersion of white light into its constituent colours takes place at the first surface of prism.

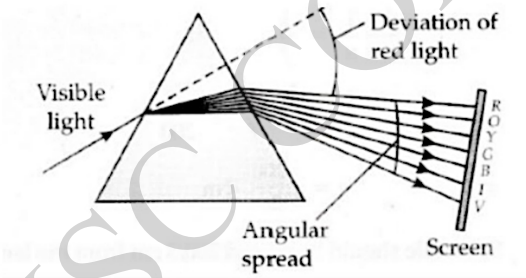
Newton's experiment- Newton allowed white light from the sun to enter a dark room with through a small aperture in a window and placed a glass prism in the path of white light .the light coming out of the prism was received on a white screen. On the screen a coloured patch like a rainbow was found which was termed as spectrum .starting from the side of the base of the prism the colours of the spectrum on the screen in the following order violet Indigo blue green yellow orange and red the order of colouring.



Q11. How does refraction of light take place in the atmosphere? Explain the reason why stars appear to twinkle and planets do not twinkle? [3M,2017]
Ans 11. - Atmosphere is made up of several layers. The layer at the top is optically rare, while the layer at the bottom is optically denser. Due to this, when light travels through different layers of the atmosphere, refraction takes place. Since light passes through denser and denser layer as it moves through the atmosphere, it tends to bend towards the normal.

- Stars are very far from us; compared to planets. Due to this, stars serve as point sources of light. As a result, even a slightest change in their apparent position in the sky is clearly perceived by us. Hence, stars appear to twinkle.
- Planets, on the other hand, are near to us. Hence, they do not serve as point sources of light.
- Hence, minor changes in their apparent position are not perceived by us. Hence, planets do not appear to twinkle.

Q12. Define angle of deviation. Why do different components of white light split up into spectrum when it passes through a triangular glass prism? Show the angle of deviation for red colour when white light passes through a prism. [3M,2014]
Ans 12. The angle between the extended incident ray and the emergent ray is called the angle of deviation. This is because the different colours travel through a glass prism at different speeds.



Q13. Enlist at least six phenomena observed in nature subsequent to the scattering of light. [3M]
Ans 13. Six phenomena observed in nature subsequent to the scattering of light are:
(a) Sun appears red near the horizons(during sunrise and sunset) and white when overhead.
(b) Bluish colour of sky.
(c) Visible path of light as it enters a dark room.
(d) Danger signals or stop signals are usually red. ed, in

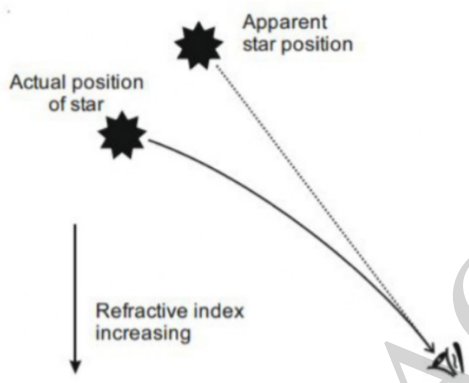
(e) Blueness of distant mountains.
(f) Sunlight filtering through clouds.

5 MARKS QUESTIONS

Q14. (a) A student is unable to see clearly the words written on the black board placed at a distance of approximately 3 m from him. Name the defect of vision of the boy is suffering from. State the possible causes of this defect and explain the method of correcting it.
(b) Why do stars twinkle? Explain. [5M,2018]

Ans 14. The boy is suffering from near-sightedness or Myopia in which a person cannot see the distant objects clearly though he can see the nearby objects clearly.
Myopia is caused -
- due to less converging power of eye-lens (because of its short focal length), and
- due to elongation of the eyeball.
- due to uncontrolled diabetes. Some unattended cataract growths may also lead to myopia.

This defect can be corrected by placing a concave lens in front of the eye. Using concave lens of suitable focal length in the spectacles of such a person can correct this defect.
(b) The stars appear very-very small, so stars can be considered to be point sources of light as they are far away from the earth. The continuously changing atmosphere is able to cause variations in the light coming from a point-sized star due to atmospheric refraction because of which the star appears to be twinkling.



Q15. (a) Out of syllabus....
(b) Why does the Sun appear reddish early in the morning? Will this phenomenon be observed by an astronaut on the Moon? Give reason to justify your answer. [5M,2018]

Ans 15. (b)Colour of the sun at sunrise and sunset At the time of sunrise and sunset, the position of the sun is very far away from us. The sunlight travels longer distance through the atmosphere of the earth before reaching our eyes. Scattering of blue light is more than the scattering of red light. As a result of this, more red light reaches our eyes than any other colour. Therefore at sunset and sunrise sun appears red.

ASSERTION AND REASONING QUESTIONS

Rule : Assertion is labelled as (A) and the Reason is labelled as (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below :
(a) Both (A) and (R) are true and (R) is the correct explanation of the assertion (A).
(b) Both (A) and (R) are true, but (R) is not the correct explanation of the assertion (A).
(c) (A) is true, but (R) is false.
(d) (A) is false, but (R) is true

Q16. Assertion: On a clear summer night twinkling of stars is observed.
Reason: The twinkling of stars is caused by dispersion of star light by the atmosphere.
Ans 16. (c) Assertion (A) is correct, reason (R) is incorrect.

Q17. Assertion : A white light on passing through prism splits into its component colours as such that the red light emerges nearest to the base of the prism
Reason : Wavelength Of red light is more than other component colours and hence, red light deviates least
Ans 17. (d) Assertion (A) is incorrect, reason (R) is correct.

Q18. Assertion : Sunlight reaches us without dispersion in the form of white light and not as its components.
Reason Dispersion takes place due to variation of refractive index for different wavelength but in vacuum the speed of light is independent of wavelength and hence vacuum is a non-dispersive
Ans 18. (a) Both assertion (A) and reason (R) are correct and reason is the correct explanation of assertion.