CHAPTER
11

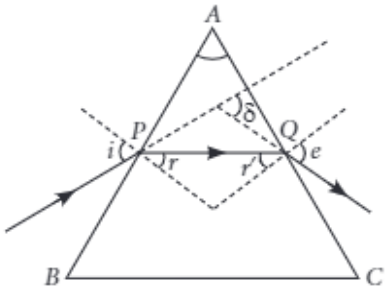
The Human Eye and the Colourful World

CASE STUDY / PASSAGE BASED QUESTIONS

1

Read the following and answer any four questions from 1(i) to 1(v).

A prism is a transparent refracting medium bounded by two plane surfaces inclined to each other at a certain angle. The refraction of light through a prism follows the laws of refraction. In the prism, refraction takes place on its refracting surface it means when the light enters the prism and when the light leaves the prism. The refraction through a prism is shown. Here, A is the angle of prism, $\angle i$ is the angle of incidence of the face AB and $\angle e$ is the angle of emergence at other face AC.



Syllabus

Refraction of light through a prism, dispersion of light, scattering of light, applications in daily life.

The incident ray suffers a deviation or bending through an angle δ due to the refraction through prism. This angle is called angle of deviation as shown in figure.

$$\angle i + \angle e = \angle \delta + \angle A$$

(i) The angle between the two refracting surfaces of a prism is called

(a) angle of prism (b) angle of incidence

(c) angle of deviation (d) angle of emergence

(ii) The angle between the incident ray and the emergent ray is called

(a) angle of emergence (b) angle of deviation

(c) angle of incidence (d) none of these

(iii) When a ray is refracted through a prism, then

(a) $\angle i = \angle \delta$ (b) $\angle i = \angle e + \angle \delta$

(c) $\angle \delta = \angle e$ (d) $\angle i > \angle r$

(iv) The angle of deviation depends on

(a) refractive index of prism (b) angle of incidence

(c) both (a) and (b) (d) none of these

(v) The rectangular surfaces of a prism are known as

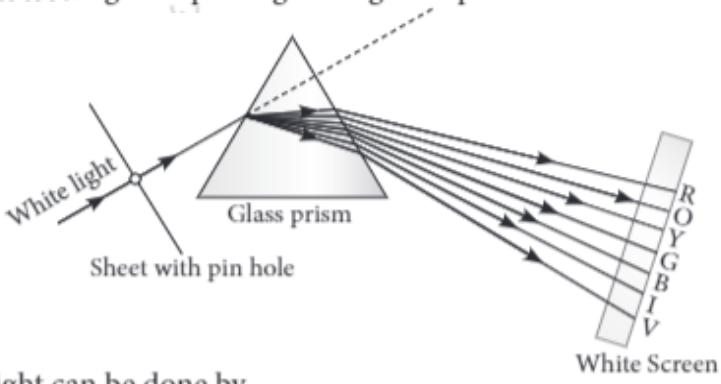
(a) reflecting surfaces (b) dispersing surfaces

(c) refracting surfaces (d) none of these.

2

Read the following and answer any four questions from 2(i) to 2(v).

When white light is incident on one refracting surface of the prism, the light splits up into constituent colours- violet, indigo, blue, green, yellow, orange and red. The process of splitting of white light into its seven constituent colours is called dispersion. When the dispersed white light is made to fall on a screen, we get the band of seven colours is called the spectrum of white light. Red colour bends the least on passing through the prism and violet colour bends through maximum angle on passing through the prism.



(i) The splitting of white light can be done by

(a) lens (b) prism (c) mirror (d) none of these

(ii) Which property of light is used by prism to form a spectrum?

(a) Reflection (b) Refraction (c) Dispersion (d) Scattering

(iii) Which of the following dispersion is correct?

(a)

(b)

(c)

(d)

(iv) When a red light passes through a prism, it

(a) will not split (b) will split into seven colours

(c) will split into white colour (d) will split into many different colours.

(v) The spectrum produced by the white light by a prism is called

(a) pure spectrum (b) impure spectrum

(c) monochromatic spectrum (d) none of these.

3

Read the following and answer any four questions from 3(i) to 3(v).

Light of all the colour travel at the same speed in vacuum for all wavelengths. But in any transparent medium (glass or water), the light of different colours travel with different speeds for different wavelength that means that the refractive index of a particular medium is different for different wavelength. As there is a difference in their speeds, the light of different colour bend through different angles. The speed of violet colour is maximum

and the speed of red colour is minimum in glass so, the red light deviates least and violet colour deviates most. Hence, higher the wavelength of a colour of light, smaller the refractive index and less is the bending of light.

$\lambda_r > \lambda_v$ and $r_n < v_n$. Also frequency, $\upsilon = \frac{c}{\lambda}$.

(i) Which of the following statements is correct regarding the propagation of light of different colours of white light in air?

(a) Red light moves fastest.
(b) Blue light moves faster than green light.
(c) All the colours of the white light move with the same speed.
(d) Yellow light moves with the mean speed as that of the red and the violet light.

(ii) Which of the following is the correct order of wavelength?

(a) Red > Green > Yellow
(b) Red > Violet > Green
(c) Yellow > Green > Violet
(d) Red > Yellow > Orange

(iii) Which of the following is the correct order of speed of light in glass?

(a) Red > Green > Blue
(b) Blue > Green > Red
(c) Violet > Red > Green
(d) Green > Red > Blue

(iv) Which colour which has maximum frequency

(a) Red (b) Violet (c) Blue (d) Green

(v) Which of the following is the correct order of angle of deviation?

(a) Red > Green > Blue
(b) Blue > Yellow > Orange
(c) Orange > Red > Green
(d) Blue > Green > Violet

4

Read the following and answer any four questions from 4(i) to 4(v).

The spreading of light by the air molecules is called scattering of light. The light having least wavelength scatters more. The sun appears red at sunrise and sunset, appearance of blue sky it is due to the scattering of light. The colour of the scattered light depends on the size of particles. The smaller the molecules in the atmosphere scatter smaller wavelengths of light. The amount of scattering of light depends on the wavelength of light. When light from sun enters the earth's atmosphere, it gets scattered by the dust particles and air molecules present in the atmosphere. The path of sunlight entering in the dark room through a fine hole is seen because of scattering of the sun light by the dust particles present in its path inside the room.

(i) To an astronaut in a spaceship, the colour of earth appears

(a) red (b) blue (c) white (d) black

(ii) At the time of sunrise and sunset, the light from sun has to travel.

(a) longest distance of atmosphere
(b) shortest distance of atmosphere
(c) both (a) and (b)
(d) can't say

(iii) The colour of sky appears blue, it is due to the

(a) refraction of light through the atmosphere
(b) dispersion of light by air molecules
(c) scattering of light by air molecules
(d) all of these.

(iv) At the time of sunrise and sunset

(a) Blue colour scattered and red colour reaches our eye
(b) Red colour scattered and blue colour reaches our eye
(c) Green and blue scattered and orange reaches our eye
(d) None of these

(v) The danger signs made red in colour, because

(a) the red light can be seen from farthest distance (b) the scattering of red light is least

(c) both (a) and (b) (d) none of these

5

Read the following and answer any four questions from 5(i) to 5(v).

Atmospheric refraction is the phenomenon of bending of light on passing through earth's atmosphere. As we move above the surface of earth, density of air goes on decreasing. Local conditions like temperature etc. also affect the optical density of earth's atmosphere. On account of atmospheric refraction, stars seen appear higher than they actual are; advanced sunrise; delayed sunset, oval appearance of the sun at sunrise and sunset; stars twinkle, planets do not.

(i) Due to atmospheric refraction, apparent length of the day

(a) increases (b) decreases (c) remains the same (d) all of these

(ii) Apparent position of the star appears raised due to

(a) atmospheric refraction (b) scattering of light

(c) both (a) and (b) (d) none of these

(iii) The sun appears oval shaped or flattened due to

(a) dispersion (b) scattering

(c) atmospheric refraction (d) cannot say

(iv) Twinkling of stars and non-twinkling of planets is accounted for by

(a) scattering of light (b) dispersion of light

(c) atmospheric refraction (d) none of these

(v) In absence of atmosphere, the colour of sky appears

(a) blue (b) black (c) red (d) yellow

ASSERTION & REASON

For question numbers 6-15, two statements are given-one labelled Assertion (A) and the other labelled Reason (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 correct explanation of the assertion.

(b) Both A and R are true, but R is not the correct explanation of the assertion.

(c) A is true, but R is false.

(d) A is false, but R is true.

6. **Assertion :** The scattering of longer wavelengths of light increases as the size of the particles increases.
Reason : Large particles scatter lights of all wavelengths equally well.

7. **Assertion :** The scattered light makes path of light visible.
Reason : Scattering of light is the result of Tyndall effect.

8. **Assertion :** Rainbow is an example of the dispersion of sunlight by the water droplets.
Reason : Light of shorter wavelength is scattered much more than light of larger wavelength.

9. **Assertion :** Higher the refractive index of the prism material, lower is the angle of deviation.
Reason : The angle of deviation is directly proportional to the angle of prism.

10. **Assertion :** The twinkling of stars is due to the fact that refractive index of the earth's atmosphere fluctuates.
Reason : When light propagates from one medium to another its direction of propagation changes.

11. **Assertion :** The light of violet colour deviates the most and the light of red colour the least, while passing through a prism.
Reason : For a prism material, refractive index is highest for red light and lowest for the violet light.

12. **Assertion :** The rainbow is seen when the sun is behind the observer.
Reason : Rainbow is produced due to dispersion of white light by small rain drops hanging in the air after the rain.

13. **Assertion :** Danger signals are red.
Reason : Red colour has smallest wavelength.

14. **Assertion :** A beam of white light gives a spectrum on passing through a hollow prism.
Reason : Speed of light outside the prism is different as the speed of light inside the prism.

15. **Assertion :** There is no dispersion of light refracted through a rectangular glass slab.
Reason : Dispersion of light is the phenomenon of splitting of a beam of white light into its constituents colours.

HINTS & EXPLANATIONS

1. **(i) (a):** The angle between the two refracting surfaces of a prism is called angle of prism.

(ii) (b): The angle between the incident ray and the emergent ray is called angle of deviation.

(iii) (d): As the ray of light enters from rarer medium (air) to denser medium (glass), the angle of incidence is more than angle of refraction.

(iv) (c): More be the refractive index, more be the angle of deviation and it also depends on the refractive index of prism.

(v) (c): The refraction of light takes place through rectangular surfaces.

2. **(i) (b)**

(ii) (b)

(iii) (a): The deviation is maximum for violet and minimum for red, so option (a) is correct.

(iv) (a): The red light has a single wavelength and when enters a prism, it will not split into other different colours.

(v) (b): The boundaries of colours in the spectrum produced by prism are not sharp, so the spectrum is impure.

3. **(i) (c):** All the colours of the white light move with the same speed in air.

(ii) (c): The increasing order of wavelength of visible spectrum is
Violet < Indigo < Blue < Green < Yellow < Orange < Red
So, the correct order is
Yellow > Green > Violet

(iii) (b): The more be the wavelength, more be the speed.

(iv) (b): Frequency is inversely proportional to the wavelength. Violet has minimum wavelength among all these colours, so violet has maximum frequency.

(v) (b): The angle of deviation is more for more refractive index.

4. **(i) (b):** Light is scattered by the air molecules present in atmosphere.

(ii) (a): As the distance between us and sun is more at the time of sunrise and sunset.

(iii) (c): Due to the more scattering of blue colour by molecules of air.

(iv) (a): Red light being of largest wavelength blue scatter more, red scattered least.

(v) (c): Scattering is least but velocity of red light is more.

5. **(i) :** Due to atmospheric refraction, apparent length of the day increases by 4 minutes.

(ii) **(a) :** Apparent position of the star appears raised due to atmospheric refraction.

(iii) **(c)**

(iv) **(c) :** Twinkling of stars and non-twinkling of planets is on account of atmospheric refraction.

(v) **(b) :** Due to no scattering of light.

6. **(b)** **7.** **(b)**

8. **(b) :** The rainbow is an arch of seven colours visible in the sky which is produced by the dispersion of sun's light by raindrops in the atmosphere.

9. **(d) :** Higher the refractive index of the prism material, greater is the angle of deviation.

10. **(a) :** The continuously changing atmosphere is able to cause variation in the light coming from a point-sized star because of which the star appears to be twinkling.

11. **(c) :** For a prism material refractive index is highest for violet light and lowest for the red light.

12. **(b) :** Just after the rain, a large number of small droplets of water remain suspended in the air. Each drop acts like a small prism. When sunlight falls on these drops, the white light splits into seven colours. The dispersed light from a large number of drops forms a continuous band of seven colours.

13. **(c) :** Red colour has longest wavelength.

14. **(d) :** Dispersion of light cannot occur on passing through air contained in a hollow prism. Dispersion takes place because the refractive index of medium for different colours is different.

15. **(b) :** After refraction at two parallel faces of a glass slab, a ray of light emerges in a direction parallel to the direction of incidence of white light on the slab. As rays of all colours emerge in same direction, hence there is no dispersion only lateral displacement takes place.