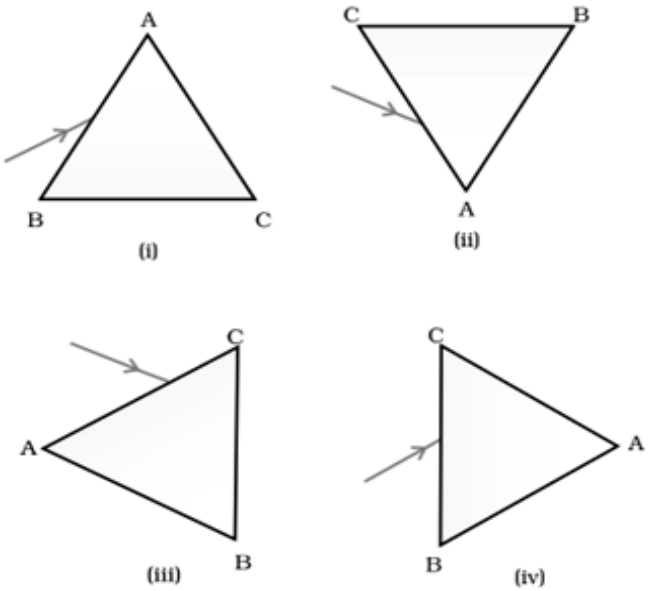
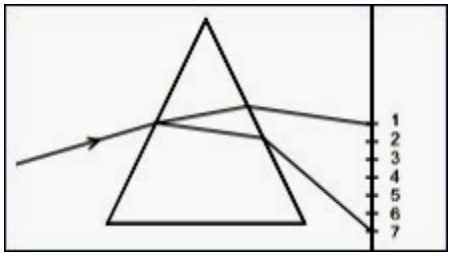
HUMAN EYE AND COLOURFUL WORLD

1. A prism ***ABC*** (with ***BC*** as base) is placed in different orientations. A narrow beam of white light is incident on the prism as shown in figure. In which of the following cases, after dispersion, the third colour from the top corresponds to the colour of the sky?



2. A person with myopic eye cannot see objects beyond 1.2 metre distinctly. What should be the nature of corrective lenses to restore proper vision?
3. A beam of white light falling on a glass prism gets split up into seven colours marked 1 to 7 as shown in the diagram. A student makes the following statements about the spectrum observed on the screen:
   (a) The colours at positions marked 3 and 5 are similar to the colour of the sky and the colour of gold metal respectively. Is the above statement made by the student correct or incorrect? Justify.
   (b) Which two positions correspond closely to the colour of:
   (i) Brinjal (ii) 'danger' or stop signal lights?

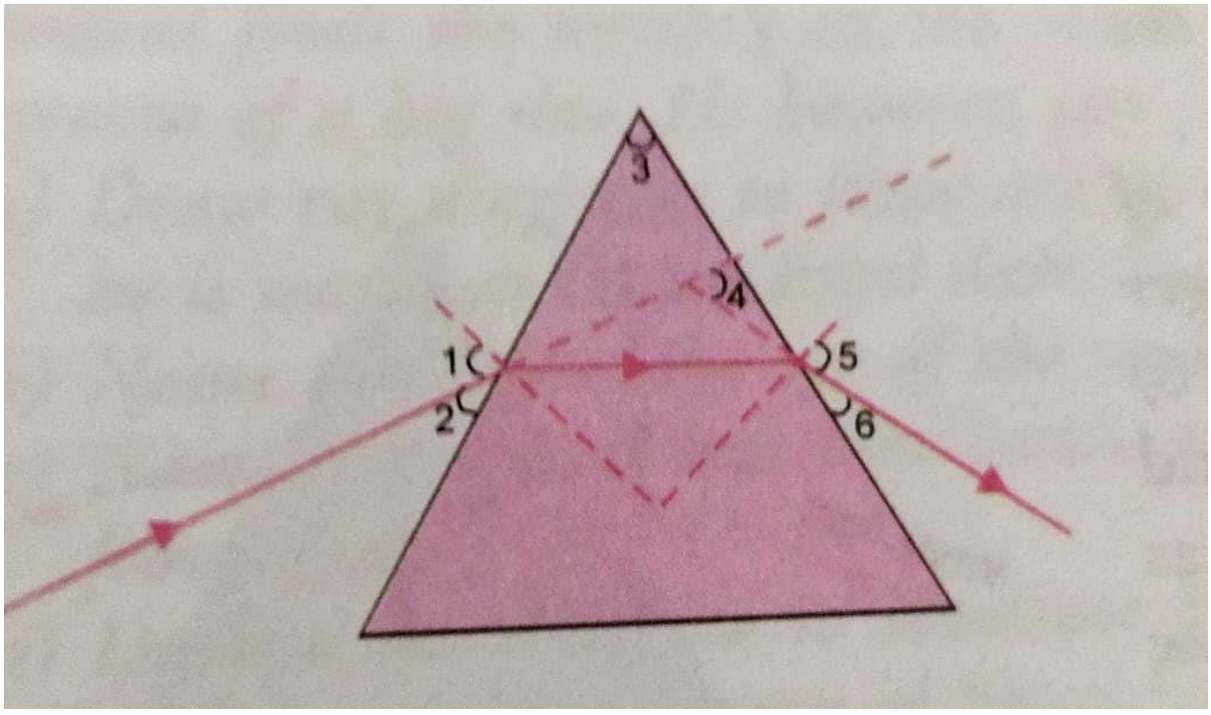


4. A glass prism is able to produce a spectrum when white light passes through it but a glass slab does not produce any spectrum. Explain. Why is it so?
5. The far point of a myopic the person is 80 cm in front of the eye. What is the nature and power of the lens required to correct the problem?
6. Why does the Sun appear reddish early in the morning?

7. Why does the sky appear dark instead of blue to an astronaut?
8. When a monochromic light having only one wavelength, passes through a prism, will it show dispersion?
9. The sun can be seen about two minutes before actual sunrise and two minutes after actual sunset. Why?
10. Name the component of white light that deviates the least and the component that deviates the most while passing through a glass prism.
11. Why there is no dispersion of light refracted through a rectangular glass slab?
12. How will you use two identical prisms so that a narrow beam of white light incident on one prism emerges out of the second prism as white light?
13. Is the position of a star as seen by us in its true position? Justify your answer.
14. Draw a neat diagram to show the refraction of a light ray through a glass prism, and label it.
15. Why does the Sun appear white at noon?

16. <u>Read the following and answer any four questions from 16 (i) to 16 (v)</u>

And when light rays pass through the atmosphere having air layers of different optical densities, then refraction of light takes place. The refraction of light caused by the earth's atmosphere (having air layers of varying optical densities) is called atmospheric refraction. When light from any source passed through a glass prism gets refracted and scattered in constitute colours (VIBGYOR). Blue colour has least wavelength and red colour has highest wavelength. Bending of red colour is least while of blue colour is highest.



i) Which of the following is correct decreasing order of wavelength

a) Red>blue>orange>indigo
b) Blue>green>yellow>orange
c) Red>orange>yellow>blue
d) Blue>indigo>violet>red

ii) Why red colour light is used in train during fog?

a) It has low wavelength and least scattered
b) It has high wavelength and highly scattered
c) It has high wavelength and least scattered
d) It has low wavelength and highly scattered

iii) In the above figure, angle of prism, incident angle, angle of deviation, and angle of emergence are represented respectively as:

a) 1,3,5,4
b) 2,6,5,3
c) 5,4,1,3
d) 3,1,4,5

iv) Out of red, green, blue and violet, which colour deviates the most in glass prism

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

v) A white light falls on a surface of a glass prism. Four students A, B, C, D recorded the sequence of colours from top to bottom of screen. Which of the student recorded the correct sequence?

a) Student A: violet, blue, green, yellow, red
b) Student B: red, blue, green, yellow, violet
c) Student C: red, yellow, green, blue, violet
d) Student D: red, green, yellow, blue, violet

17. The danger signals installed at the top of tall buildings are red in colour. These can be easily seen from a distance because among all other colours, the red light

(a) is scattered the most by smoke or fog

(b) is scattered the least by smoke or fog

(c) is absorbed the most by smoke or fog

(d) moves fastest in air

18. When light rays enter the eye, most of the refraction occurs at the

(a) crystalline lens

(b) outer surface of the cornea

(c) iris

(d) pupil

19. **Draw a ray diagram showing the dispersion through a prism when a narrow beam of white light is incident on one of its refracting surfaces. Also, indicate the order of the colours of the spectrum obtained.**
20. **How does refraction take place in the atmosphere? Why do stars twinkle but not the planets?**
21. i) Demonstrate an activity with a well labelled diagram to prove that white light is made up of seven colours.

ii)Which colour of light bends least and which one the most while passing out from the prism? Also, state the reason for the same.

ANSWERS

A1. **(ii) Explanation:** Inverted position of prism (II) gives the same colour (blue) at third top as that of sky.

A2. To correct, the object at infinity has to be brought to image at 1.2 m or

v = - 120 cm, u = - ∞

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

$\frac{1}{f} = \frac{1}{-120} - \frac{1}{\infty}$

∴ f = - 120 cm

P = $\frac{100}{f} = \frac{100}{-120}$ = -0.83 D

A3. The position marked on number 3rd is YELLOW. Yellow is not the colour of the sky. Similarly, the position marked on number 5th is BLUE. Blue is not the colour of the core of the hard-boiled egg. Hence, the statement made by the student of no 3rd as the colour of sky and no. 5th as the colour of the core of the hard-boiled egg is incorrect.

A4. A glass prism is able to produce a spectrum, which is a patch of light obtained due to dispersion. This is because the opposite refracting faces of a glass prism are not parallel. Thus, the incident ray is not parallel to the emergent ray and is deviated by the angle of deviation.

A glass slab is a rectangular structure in which the opposite refracting faces are parallel to each other. The result is that, the emergent is parallel to the incident ray but is literally displaced from it.

Thus, a rectangular glass slab is unable to produce a spectrum due to the refracting faces being parallel to each other.

A5. To correct the myopia the person concerned should use concave lens (diverging lens) of suitable focal length.

For myopic eye: Far point of normal eye = u = at infinity ⇒ u = - ∞ The virtual image is formed at the far point of myopic person ⇒ v = - 80 cm

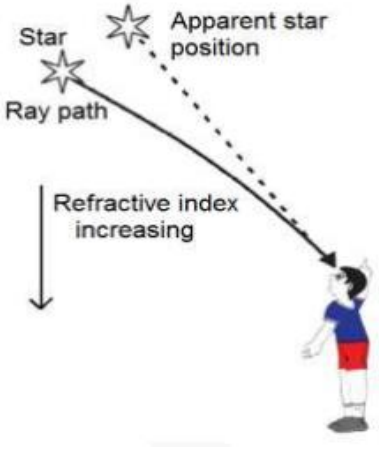
From lens formula,

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

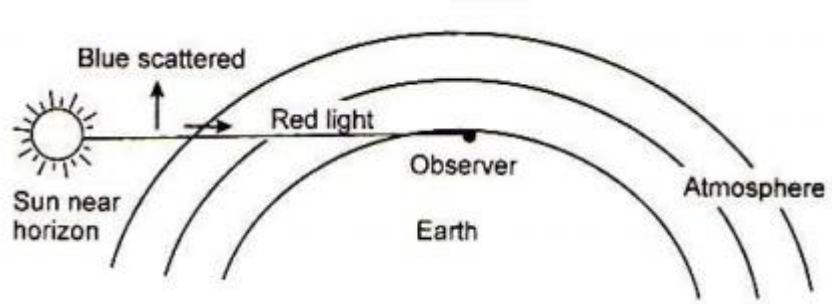
$$\frac{1}{f} = \frac{1}{-80} - \frac{1}{\infty}$$

∴ f = - 80 cm

P = $\frac{100}{f} = \frac{100}{-80}$ = -1.25 D



A6. In the early morning, the sun is situated near the horizon. Light from the Sun passes through thicker layers of air and cover larger distance before reaching our eyes. Therefore, blue light scattered the most and red light least. This is why the sun appears reddish early in the morning.



A7. The sky appears dark instead of blue to an astronaut because there is no atmosphere containing air in the outer space to scatter sunlight. As there is no scattered light to reach our eyes in outer space, so the sky appears dark.

A8. No, it will not show dispersion. It will only show deviation.

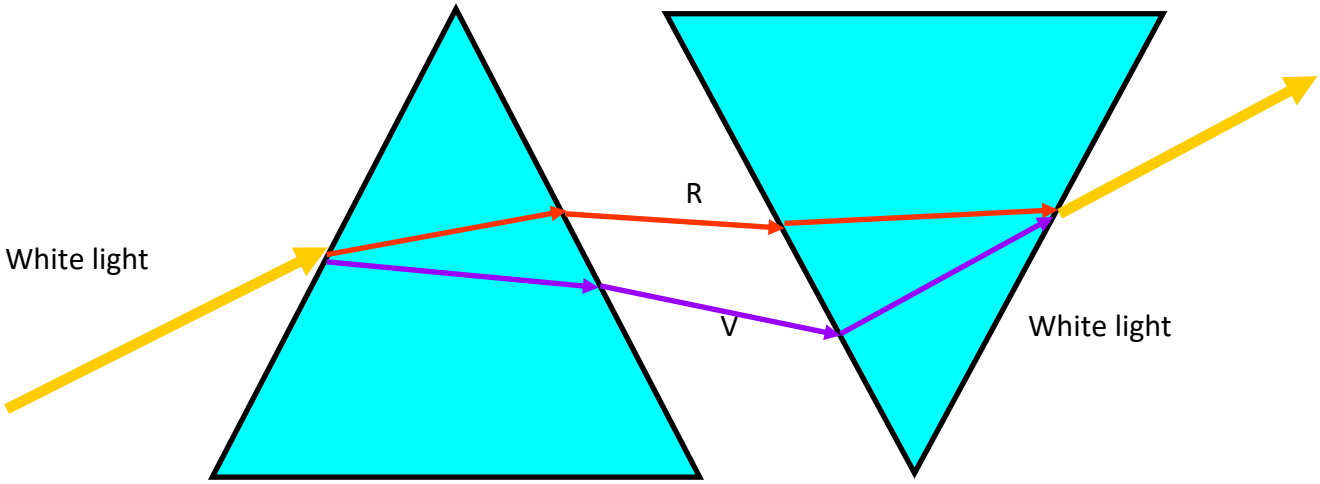
A9. The sun can be seen about two minutes before actual sunrise and two minutes after actual sunset because atmospheric refraction.

A10. Least deviated component: Red

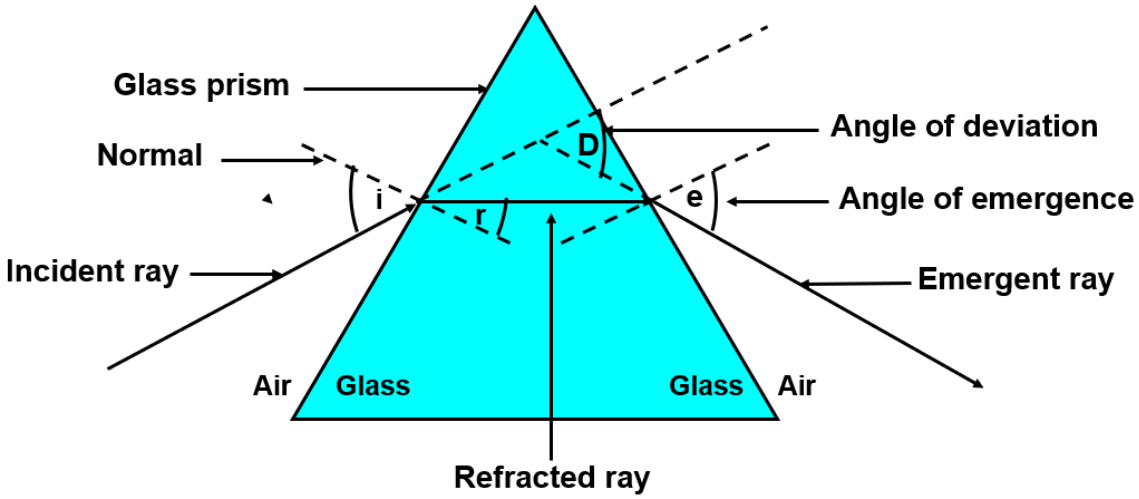
Most deviated component: Blue

A11. 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. As rays of all colours emerge in same direction, i.e., the direction of the incidence of white light, there is no dispersion. However, there is a lateral displacement.

A12. By using two identical prisms, one placed inverted with respect to other, we get a narrow beam of white light incident on one prism emerges out the second as white light.



A3. No, light from stars undergoes atmospheric refraction which occurs in medium of gradually changing refractive index. So, we see the apparent position of the star after refraction by atmosphere.



A14.

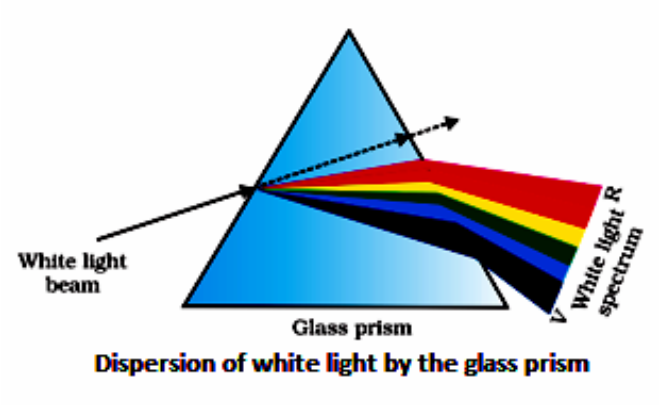
A15. The light is least scattered at noon.

A16. i) c
ii) c
iii) d
iv) d
v) c

A17. (b) is scattered the least by smoke or fog

A18. (b) outer surface of the cornea

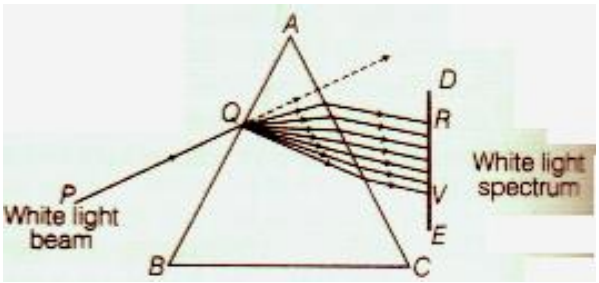
A19.



Dispersion of white light by the glass prism

A20. 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 atmosphere, it tends to bend towards the normal.
Stars are very far from us; compared to planet. Due to this, stars serve as point source 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 source of light. Hence, minor changes in their apparent position are not perceived by us. Hence, planets do not appear to twinkle.

A21. i) The phenomenon of splitting of a beam of white light into its seven constituent colours when passed through a transparent medium is known as dispersion, which was first discovered by Issac Newton in 1666. To understand this phenomenon, let us take a thick sheet of cardboard and make a small hole or narrow slit in its middle allow sunlight to fall on the slit. This gives a narrow beam of white light. Now, take a glass prism and allow this white light to fall one of its faces as shown in figure. Turn the prism slowly until the light that comes out of it appears on a nearby screen.
We see a beautiful band of seven colours on the screen called visible spectrum. The sequence of colours seen from the lower part of the screen is violet (V), indigo (I), blue (B), green (G), yellow (Y), orange (O) and red (R). The acronym for this is VIBGYOR.

ii) 

Red light has the maximum wavelength and violet light has the minimum wavelength, so in a transparent medium except air and vacuum, red light having the largest wavelength suffers the least deviation while violet light having the least wavelength bends the most.