EXERCISE 6(A)

Solution:

The deviation produced by the prism depends on the following four factors

(i) The angle of incidence – As the angle of incidence increases, first the angle of deviation decreases and reaches to a minimum value for a certain angle of incidence. By further increasing the angle of incidence, the angle of deviation is found to increase.

(ii) The material of prism (i.e, on refractive index) – For a given angle of incidence, the prism with a higher refractive index produces a greater deviation than the prism which has a lower refractive index.

(iii) Angle of prism- Angle of deviation increases with the increase in the angle of prism.

(iv) The colour or wavelength of light used - Angle of deviation increases with the decrease in wavelength of light.

Solution:

The deviation produced by a prism increases with the decrease in the wavelength of light incident on it.

Solution:

As the wavelength increases the speed of light in glass also increases

Solution:

Red colour travels fastest while blue colour travels slowest in glass

Solution:

Colour of light is related to its wavelength.

Question: 6

What is the range of wavelength of the spectrum of white light in (i) ^0A and (ii) nm?
Solution:

(i) The range of wavelength in ^0A is 4000 ^0A to 8000 ^0A
(ii) The range of wavelength in nm 400 nm to 800 nm

Question: 7
(a) Write the approximate wavelengths for (i) blue and (ii) red light.

(b) The wavelengths of violet and red light are 4000 ^0A respectively. Which of the two has the higher frequency?
Solution:

(a) For blue light, approximate wavelength is 4800 ^0A and for red light, approximate wavelength is 8000 ^0A
Red light has the higher frequency.

Question: 8
Write the seven prominent colours present in white light in the order of increasing wavelength
Solution:
Violet, indigo, blue, green, yellow, orange and red are the seven prominent colours present in white light in the order of increasing wavelength.

Question: 9
Name the seven prominent colours of the white light spectrum in order of their increasing frequencies.
Solution:
Red, orange, yellow, green, blue, indigo and violet are the seven prominent colours of the white light spectrum in order of their increasing frequencies.

Question: 10

Name four colours of the spectrum of white light which have wavelength longer than blue light.
Solution:
The colours which have wavelength longer than blue light are green, yellow, orange and red.

Question: 11
Which colour of the white light is deviated by a glass prism (i) the most and, (ii) the least?
Solution:
When white light falls on a glass prism, each colour in it is refracted by a different angle, from which red colour is least deviated and violet most.

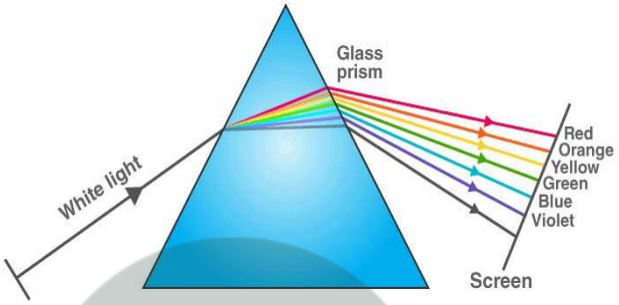
Question: 12
The wavelengths for the light of red and blue colours are nearly 7.8 x 10^{-7}m and 4.8 x 10^{-7} m respectively.
(a) Which colour has the greater speed in vacuum?
(b) Which colour has the greater speed in glass?
Solution:
(a) Both the colours have same speeds in vacuum.
(b) Red colour has a greater speed in glass.

Question: 13
Define the term dispersion of light.
Solution:
Dispersion of light is the phenomenon of splitting of a beam of white light into its seven constituent colours when passed through a transparent medium.

Question: 14
Explain the cause of dispersion of white light through a prism.
Solution:
When white light enters the first surface of a prism, light of different colours due to their different speeds in glass, gets deviated through different angles towards the base of the prism. Hence, the cause of dispersion of white light is the change in speed of light with wavelength.

Question: 15

Explain briefly, with the help of a neat labelled diagram, how does white light gets dispersed by a prism.
On which surface of prism, there is both the dispersion and deviation of light, and on which surface of prism, there is only the deviation of light?
Solution:
When white light enters the first surface of a prism, light of different colours due to their different speeds in glass, gets deviated through different angles towards the prism. Thus at the first surface of prism, the dispersion of white light into its constituent colours takes place.



On the second surface of prism, only refraction takes place and different colours are deviated through different angles, Thus the colours get further separated on refraction at the second surface (violet is deviated the most and red the least).

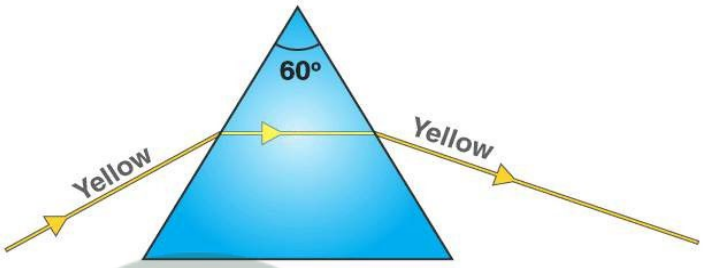
Question: 16
What do you understand by the term spectrum?
Solution:
On passing white light through a prism, the band of colours seen on a screen is called the spectrum.

Question: 17
A ray of white light is passed through a glass prism and spectrum is obtained on a screen.
(a) Name the seven colours of the spectrum in order.
(b) Do the colours have the same width in the spectrum?
(c) Which of the colour of the spectrum of white light deviates (i) the most?
(ii) the least?
Solution:
(a) Violet, Indigo, Blue, Green, Yellow, Orange and Red are the seven colours of the spectrum.
(b) No, different colours have different width in the spectrum.
(c) (i) The colour which deviated the most is violet and

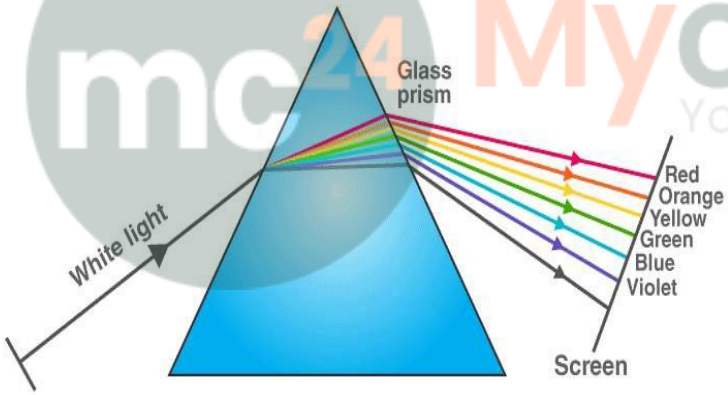
(ii) The colour which deviated the least is red

Question: 18

The diagram shown below shows the path taken by a narrow beam of yellow monochromatic light passing through an equiangular glass prism. If the yellow light is replaced by a narrow beam of white light incident at the same angle, draw another diagram to show the passage of the beam through the prism and label it to show the effect of prism on the white light.

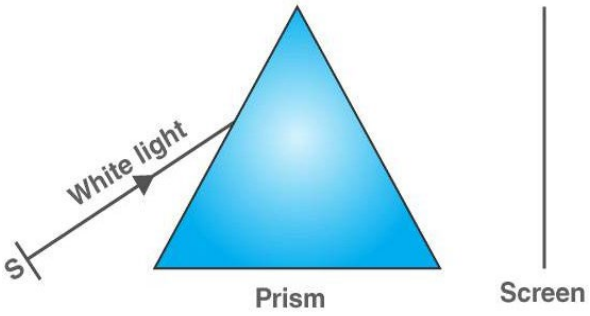


Solution:

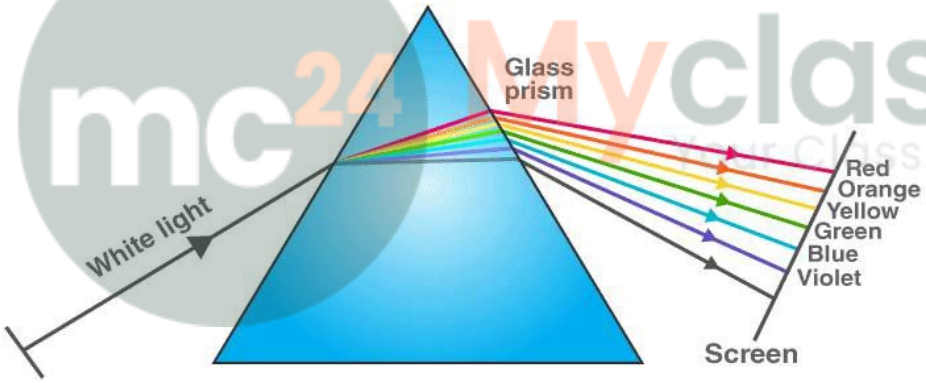


Question: 19

Figure shows a thin beam of white light from a source S striking on one face of a prism.



(a) Complete the diagram to show the effect of prism on the beam and to show what is seen on the screen.
(b) A slit is placed in between the prism and the screen to pass only the light of green colour. What will you then observe on the screen?
(c) What conclusion do you draw from the observation in part (b) above?
Solution:
(a) After dispersion through the prism, constituent colours of white light are seen on the screen.



(b) When a slit is introduced in between the prism and screen to pass only the light of green colour then only green light is observed on the screen.
(c) We conclude from the observation, that prism itself produces no colour.

Question: 20
(a) A beam of monochromatic light undergoes minimum deviation through an equiangular prism, how does the beam pass through the prism, with respect to its base?
(b) If white light is used in same way as in part (a) above, what change is expected in the emergent beam?
(c) What conclusion do you draw about the nature of white light in part (b)?
Solution:
(a) The light beam inside the Prism will be parallel to the base.

Under minimum deviation,
angle of incidence = angle of emergence

(b) White light splits into its constituent colours. That is spectrum is formed.
(c) We conclude that white light is polychromatic in nature.

MULTIPLE CHOICE TYPE

Question: 1

When a white light ray falls on a prism, the ray at its first surface suffers:

(a) no refraction
(b) only dispersion
(c) only deviation
(d) both deviation and dispersion

Solution:

When a white light ray falls on a prism, the ray at its first surface suffers both deviation and dispersion.

Question: 2

In the spectrum of white light by a prism, the colour at the extreme end opposite to the base of prism is:

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

Solution:

The colour at the extreme end opposite to the base of prism is red.

Question: 3

The wavelength range of white light is

(a) 4000 nm to 8000 nm
(b) 40 nm to 80 nm
(c) 400 nm to 800 nm
(d) 4 nm to 8 nm

Solution:

The wavelength range of white light is 400 nm to 800 nm

NUMERICALS

Question: 1

Calculate the frequency of yellow light of wavelength 550 nm. The speed of light is 3 $\times 10^8$ m s^{-1}.

Solution:

Given,
Wavelength $\lambda = 550$ nm
$= 550 \times 10^{-9}$ m
Speed of light, $C = 3 \times 10^{8}$ m / s
We know that
Frequency = Speed of light / Wavelength
Frequency = $(3 \times 10^{8}) / (550 \times 10^{-9})$
Frequency = 5.4×10^{14} Hz

Question: 2

The frequency range of visible light is from 3.75×10^{14} Hz to 7.5×10^{14} Hz. Calculate its wavelength range. Take speed of light = 3×10^{8} m s^{-1}

Solution:

Given,
Speed of light, $c = 3 \times 10^{8}$ m / s
Frequency range = 3.75×10^{14} Hz to 7.5×10^{14} Hz
Speed of light = frequency × wavelength
For frequency = 3.75×10^{14} Hz
$\lambda = c / v$
$\lambda = (3 \times 10^{8}\ m / s) / (3.75 \times 10^{14}\ Hz)$
$\lambda = 8 \times 10^{-7}$

$\lambda = 8000\ \overset{0}{A}$

For frequency = 7.5×10^{14} Hz
$\lambda = c / v$
$\lambda = (3 \times 10^{8}\ m / s) / (7.5 \times 10^{14}\ Hz)$
$\lambda = 4 \times 10^{-7}$ m

$\lambda = 4000\ \overset{0}{A}$

Therefore wavelength range is $4000\ \overset{0}{A}$ to $8000\ \overset{0}{A}$