Book Name: Selina Concise

EXERCISE- 6 (A)

Solution 1:

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

(a) 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.

(b) 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.

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

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

Solution 2:

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

Solution 3:

A glass prism deviates the violet light most and the red light least.

Solution 4:

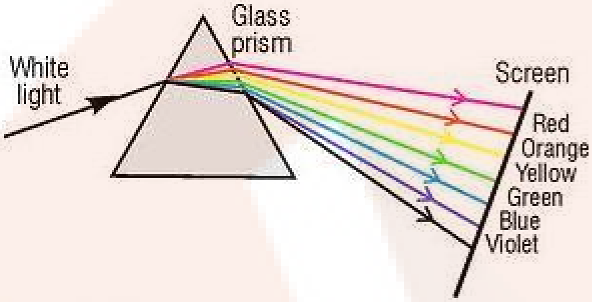
The phenomenon of splitting of white light by a prism into its constituent colours is known as dispersion of light.

Solution 5:

When white light is incident on the first surface of a prism and enters in glass, light of different colours due to different speeds in glass, is refracted or deviated through different angles. Thus the dispersion of white light into its constituent colours takes place at the first surface of prism. Thus the cause of dispersion is the change in speed of light with wavelength or frequency.

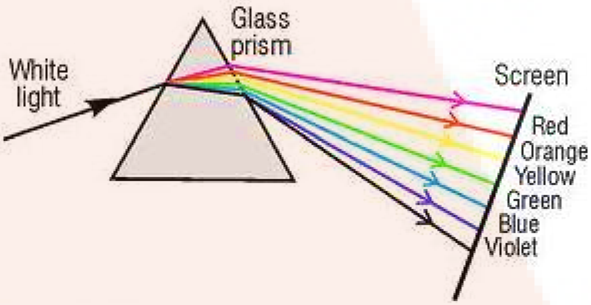
Solution 6:

When white light is incident on the first surface of a prism and enters in glass, light of different colours due to different speeds in glass, is refracted or deviated through different angles. Thus the dispersion of white light into its constituent colours takes place at the first surface of prism.



On the second surface, only refraction takes place and different colours are deviated through different angles. As a result, the colours get further separated on refraction at the second surface (violet being deviated the most and red the least).

Solution 7:



Solution 8:

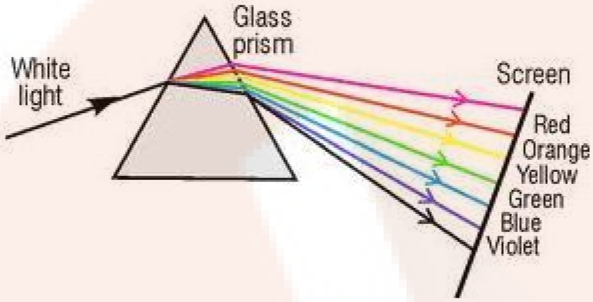
Speed of light increases with increase in the wavelength.

Solution 9:

Red colour travels fastest and Blue colour travels slowest in glass.

Solution 10:

(a) Constituent colours of white light are seen on the screen after dispersion through the prism.



(b) When a slit is introduced in between the prism and screen to pass only the light of green colour, only green light is observed on the screen.

(c) From the observation, we conclude that prism itself produces no colour.

Solution 11:

(a) If a monochromatic beam of light undergoes minimum deviation through an equi-angular prism,
then the beam passes parallel to the base of prism.

(b) White light splits into its constituent colours i.e., spectrum is formed.

(c) We conclude that white light is polychromatic.

Solution 12:

The colour band obtained on a screen on passing white light through a prism is called the spectrum.

Solution 13:

(a) Violet, Indigo, Blue, Green, Yellow, Orange, Red.

(b) No, different colours have different widths in the spectrum.

(c) (i) Violet colour is deviated the most. (ii) Red colour is deviated the least.

Solution 14:
(a) In vacuum, both have the same speeds.
(b) In glass, red light has a greater speed.

Solution 15:
Color of light is related to its wavelength.

Solution 16:
i. $4000\,\overset{0}{A}$ to $8000\,\overset{0}{A}$
ii. 400 nm to 800 nm

Solution 17:
(i) For blue light, approximate wavelength=4800 Å
(ii) For red light, approximate wavelength=8000 Å

Solution 18:
Seven prominent colours of the white light spectrum in order of their increasing frequencies:
Red, Orange, Yellow, Green, Blue, Indigo, Violet

Solution 19:
Green, Yellow orange and red have wavelength longer than blue light.

MULTIPLE CHOICE TYPE:

Solution 1:
Both deviation and dispersion.
Hint: When a white light ray falls on the first surface of a prism, light rays of different colours due to their different speeds in glass get refracted (or deviated) through different angles. Thus, the dispersion of white light into its constituent colours takes place at the first surface of prism.

Solution 2:

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

Hint: The angle of deviation decreases with the increase in wavelength of light for a given angle of incidence. Since the red light has greatest wavelength, it gets deviated the least and is seen on the extreme end opposite to the base of prism.

NUMERICALS:

Solution 1:

Given, wavelength $\lambda = 550 \text{ nm} = 550 \times 10^{-9}$ m

Speed of light, $c = 3 \times 10^{8}$ m/s

We know that,

Frequency = $\frac{Speed\ of\ light}{wave\ length}$

Or, frequency = $\frac{3 \times 10^{8}}{550 \times 10^{-9}} = 5.4 \times 10^{14}$ HZ

Solution 2:

Speed of light, $c = 3 \text{ x } 10^{8}$m/s

Frequency range = $3.75 \text{ x } 10^{14}$ Hz to $7.5 \text{ x } 10^{14}$ Hz.

Speed of light = frequency x wavelength

For frequency = $3.75 \text{ x } 10^{14}$Hz

$$\Lambda = \frac{c}{\nu} = \frac{3 \times 10^{8} \text{ m/s}}{3.75 \times 10^{14} \text{ Hz}} = 8 \times 10^{-7} \text{ m} = 8000 \text{ Å}$$

For frequency =$7.5 \text{ x } 10^{14}$Hz

$$\Lambda = \frac{c}{\nu} = \frac{3 \times 10^{8} \text{ m/s}}{7.5 \times 10^{14} \text{ Hz}} = 4 \times 10^{-7} \text{ m} = 4000 \text{ Å}$$

Wavelength range = 4000 Å to 8000 Å

EXERCISE. 6 B

Solution 1:

(a) Five radiations, in the order of their increasing frequencies are:
Infrared waves, Visible light, Ultraviolet, X-rays and Gamma rays.

(b) Gamma rays have the highest penetrating power.

Solution 2:

(a) Gamma rays, X-rays, infrared rays, micro waves, radio waves.

(b) Microwave is used for satellite communication.

Solution 3:

(a) Gamma ray.

(b) Gamma rays have strong penetrating power.

Solution 4:

(a) X-rays are used in the study of crystals.

(b) It is also used to detect fracture in bones.

Solution 5:

(a) Gamma rays-wavelength shorter than 0.1 Å

(b) X-rays-wavelength range 0.1 Å to 100 Å

(c) Ultraviolet rays-wavelength range 100 Å to 4000 Å

(d) Visible light-wavelength range 4000 Å to 8000 Å

(e) Infrared radiations-wavelength range 8000 Å to 10^7 Å

(f) Microwaves-wavelength range 10^7 Å to 10^{11} Å

(g) Radio waves-wavelength above 10^{11}Å

Solution 6:

4000 Å to 8000 Å .

Solution 7:
(i) Infrared
(ii) Ultraviolet

Solution 8:
The part of spectrum beyond the red and the violet ends is called the invisible spectrum as our eyes do not respond to the spectrum beyond the red and the violet extremes.
If the different radiations from the red part of the spectrum to the violet end and beyond it, are made incident on the silver-chloride solution, it is observed that from the red to the violet end, the solution remains unaffected. However just beyond the violet end, it turns violet and finally it becomes dark brown. Thus there exist certain radiations beyond the violet end of the spectrum, which are chemically more active than the visible light, called ultraviolet radiations.
Now, if a thermometer with a blackened bulb is moved from the violet end towards the red end, it is observed that there is a slow rise in temperature, but when it is moved beyond the red region, a rapid rise in temperature is noticed. It means that the portion of spectrum beyond the red end has certain radiations which produce a strong heating effect, but they are not visible. These radiations are called the infrared radiations.

Solution 9:
(i)Ultraviolet rays-wavelength range 100 Å to 4000 Å
(ii)Visible light-wavelength range 4000 Å to 8000 Å
(iii)Infrared radiations-wavelength range 8000 Å to 10^7 Å

Solution 10:
(i)Infrared radiations are longer than 8×10^{-7}m.
(ii) ultraviolet radiations are shorter than 4×10^{-7} m.

Solution 11:
X-rays and ultraviolet rays are electromagnetic waves of frequency greater than that of violet light.

Uses:
X-rays are used for studying atomic arrangement in crystals.
Ultraviolet rays are used for detecting the purity of gems, eggs, ghee etc.

Solution 12:

(i)Microwaves are used for satellite communication.
(ii)Ultraviolet radiations are used for detecting the purity of gems, eggs, ghee etc.
(iii)Infrared radiations are used in remote control of television and other gadgets.
(iv)Gamma rays are used in medical science to kill cancer cells.

Solution 13:

(i)Gamma rays are of highest frequency.
(ii)Infrared rays are used for taking photographs in dark.
(iii)Gamma rays are produced by the changes in the nucleus of an atom.
(iv)X-Rays are of wavelength nearly 0.1 nm.

Solution 14:

(a) A- Gamma rays, B-infrared radiations
(b) Ratio of speeds of these waves in vacuum is 1:1 as all electromagnetic waves travel with the speed of light in vacuum.

Solution 15:

All heated bodies such as a heated iron ball, flame, fire etc., are the sources of infrared radiations.
The electric arc and sparks give ultraviolet radiations.

Solution 16:

Infrared radiations are the electromagnetic waves of wavelength in the range of 8000Å to 10^7Å.
Detection: If a thermometer with a blackened bulb is moved from the violet end towards the red end, it is observed that there is a slow rise in temperature, but when it is moved beyond the

red region, a rapid rise in temperature is noticed. It means that the portion of spectrum beyond the red end has certain radiations which produce a strong heating effect, but they are not visible. These radiations are called the infrared radiations.
Use: The infrared radiations are used for therapeutic purposes by doctors.

Solution 17:

The electromagnetic radiations of wavelength from 100Å to 4000Å are called the ultraviolet radiations.
Detection: If the different radiations from the red part of the spectrum to the violet end and beyond it, are made incident on the silver-chloride solution, it is observed that from the red to the violet end, the solution remains unaffected. However just beyond the violet end, it first turns violet and finally it becomes dark brown. Thus there exist certain radiations beyond the violet end of the spectrum, which are chemically more active than visible light, called ultraviolet radiations.
Use: Ultraviolet radiations are used for sterilizing purposes.

Solution 18:

(a) Ultraviolet radiations travel in a straight line with a speed of 3×10^8 m in air (or vacuum).
(b) They obey the laws of reflection and refraction.
(c) They affect the photographic plate.

Solution 19:

(a) Ultraviolet radiations produce fluorescence on striking a zinc sulphide screen.
(b) They cause health hazards like cancer on the body.

Solution 20:

(a) Infrared radiations travel in straight line as light does, with a speed equal to 3×10^8m/s in vacuum.
(b) They obey the laws of reflection and refraction.
(c) They do not cause fluorescence on zinc sulphide screen.

Solution 21:

(a) Infrared radiations are invisible.

(b) They do not affect the ordinary photographic film.

Solution 22:

(i) Infrared radiations are used in photography in fog because they are not much scattered by the atmosphere, so they can penetrate appreciably through it.

(ii) Infrared radiations are used as signals during the war as they are not visible and they are not absorbed much in the medium.

(iii) Infrared lamps are used in dark rooms for developing photographs since they do not affect the photographic film chemically, but they provide some visibility.

(iv) Infrared spectrum can be obtained only with the help of a rock-salt prism since the rock-salt prism does not absorb infrared radiations whereas a glass prism absorbs them.

(v) A quartz prism is used to obtain the spectrum of the ultraviolet radiations as they are not absorbed by quartz, whereas ordinary glass absorbs the ultraviolet light.

(vi) Ultraviolet bulbs have a quartz envelope instead of glass as they are not absorbed by quartz, whereas ordinary glad absorbs the ultraviolet light.

MULTIPLE CHOICE TYPE:

Solution 1:

Gamma rays

Solution 2:

Carbon arc-lamp

Solution 3:

Infrared radiation

Hint: Infrared radiations produce strong heating effect.

NUMERICALS

Solution 1:

(a) Frequency = 500MHz = 500 x 10^6Hz

Wavelength = 60 cm = 0.6 m

Velocity of wave = frequency x wavelength

= 500x 10^6 x 0.6 = 3 x 10^8m/s

(b) Electromagnetic wave is travelling through air.

Solution 2:

Wavelength = 0.01Å = 0.01 x 10^{-10} m

Speed of X-rays = 3 x 10^8m/s

Speed of light = frequency x wavelength

C = **νλ**

$$\boldsymbol{\nu} = \frac{c}{\lambda} = \frac{3 \times 10^{a} m/s}{0.01 \times 10^{-10}\, m} = 3 \times 10^{20} \text{ Hz}$$

EXERCISE. 6 (C)

Solution 1:

When white light from sun enters the earth's atmosphere, the light gets scattered i.e., the light spreads in all directions by the dust particles, free water molecules and the molecules of the gases present in the atmosphere. This phenomenon is called scattering of light.

Solution 2:

The intensity of scattered light is found to be inversely proportional to the fourth power of wavelength of light. This relation holds when the size of air molecules is much smaller than the wavelength of the light incident.

Solution 3:

Violet colour is scattered the most and red the least as the intensity of scattered light is found to be inversely proportional to the fourth power of wavelength of light.

Solution 4:

Since the wavelength of red light is the longest in the visible light, the light of red colour is scattered the least by the air molecules of the atmosphere and therefore the light of red colour can penetrate to a longer distance. Thus red light can be seen from the farthest distance as compared to other colours of same intensity. Hence it is used for danger signal so that the signal may be visible from the far distance.

Solution 5:

On the moon, since there is no atmosphere, therefore there is no scattering of sun light incident on the moon surface. Hence to an observer on the surface of moon (space), no light reaches the eye of the observer except the light directly from the sun. Thus the sky will have no colour and will appear black to an observer on the moon surface.

Solution 6:

Scattering property of light is responsible for the blue colour of the sky as the blue colour is scattered the most due to its short wavelength.

Solution 7:

As the light travels through the atmosphere, it gets scattered in different directions by the air molecules present in its path. The blue light due to its short wavelength is scattered more as compared to the red light of long wavelength. Thus the light reaching our eye directly from sun is rich in red colour, while the light reaching our eye from all other directions is the scattered blue light. Therefore, the sky in direction other than in the direction of sun is seen blue.

Solution 8:

At the time of sunrise and sunset, the light from sun has to travel the longest distance of atmosphere to reach the observer. The light travelling from the sun loses blue light of short wavelength due to scattering, while the red light of long wavelength is scattered a little, so is not lost much. Thus blue light is almost absent in sunlight reaching the observer, while it is rich in red colour.

Solution 9:
At noon, the sun is above our head, so we get light rays directly from the sun without much scattering of any particular colour. Further, light has to travel less depth of atmosphere; hence the sky is seen white.

Solution 10:
The clouds are nearer the earth surface and they contain dust particles and aggregates of water molecules of sizes bigger than the wavelength of visible light. Therefore, the dust particles and water molecules present in clouds scatter all colours of incident white light from sun to the same extent and hence when the scattered light reaches our eye, the clouds are seen white.

MULTIPLE CHOICE TYPE:

Solution 1:
Blue colour
Hint: When light of certain frequency falls on that atom or molecule, this atom or molecule responds to the light, whenever the size of the atom or molecule comparable to the wavelength of light. The sizes of nitrogen and oxygen molecules in atmosphere are comparable to the wavelength of blue light. These molecules act as scattering centers for scattering of blue light. This is also the reason that we see the sky as blue.