Electromagnetic Waves and Spectrum

Exercise – 1

Question 1.
What is the range of wavelength of visible light?

Answer:
Range of wavelength of visible light: 4000 A° to 8000 A°.

Question 2.
What do you understand by the term colour ?

Answer:
Colour : "Is a sensation produced in the brain and is not some thing material."
Or
"Is a sensation produced in the brain due to excitation of the retina, by an electromagnetic wave of some particular wave length.

Question 3.
(a) Define :

1. monochromatic light,
2. polychromatic light.

(b) Is white light polychromatic or monochromatic ? Explain your answer.

Answer:
(a) (i) Monochromatic light : "A light which consists of one colour (or one wave length) only is called monochromatic light)"
(ii) Polychromatic light : "A light which consists of a mixture of several colours (wave bands) is called polychromatic light".
(b) White light is a polychromatic light and has all the seven wavebands present in it.

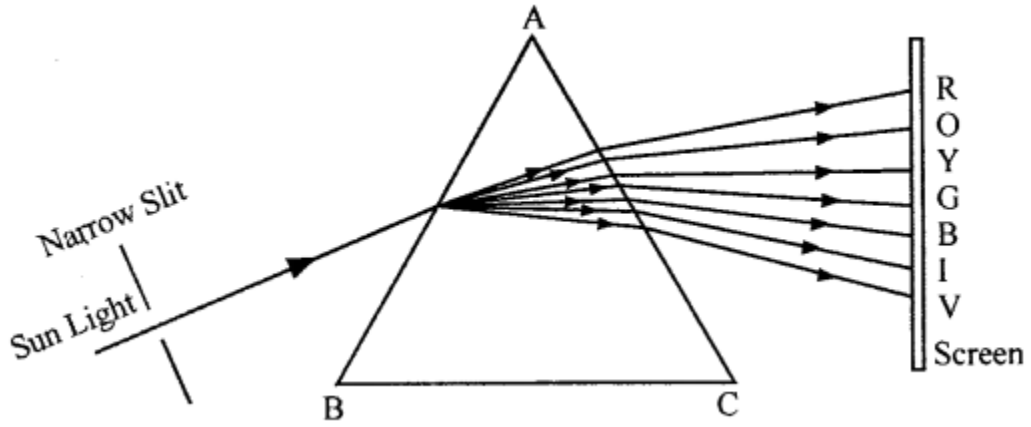
Question 4.
Define or explain the following terms :

1. dispersion of light
2. spectrum

Answer:
(i) Dispersion of light : "The phenomenon of splitting white light into its components (seven colours) when passed through a prisms is called dispersion."
(ii) Spectrum : "The band of colours obtained on the screen when a polychromatic (white) light splits into seven colours is called spectrum."

Question 5.
Draw a neat diagram for the dispersion of white light by a prism and label all the colours of the spectrum.

Answer:
Dispersion of white light by prism:

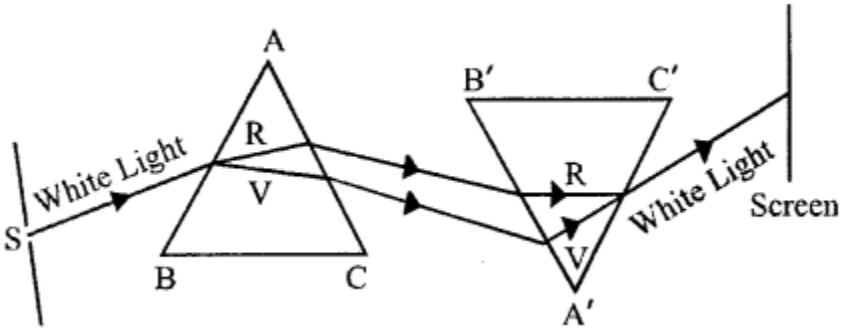


Question 6.
Is the spectrum obtained by an equilateral glass prism pure or impure ? Explain your answer.

Answer:
Spectrum obtained is impure as colours overlap each other.

Question 7.
Draw a diagram showing that white light can be dispersed and then recombined by using two similar equilateral prisms.

Answer:
Dispersion and recombination of white light:



Question 8.

(a) What is ultraviolet spectrum ? What is the range of its wavelength in A° ?
(b) State four important properties of ultraviolet rays.
(c) State four uses of ultraviolet rays.

Answer:
(a) Ultraviolet spectrum : "The region of spectrum which extends beyond the violet colour of visible spectrum is called ultraviolet spectrum."
(b) Four properties of ultra violet :

1. They are electromagnetic waves and are not effected by: Electric Or Magnetic fields.
2. They obey the laws of refraction and reflection.
3. They travel with velocity 3×10^5 km/sec
4. "I'hey produce chemical effect in silver salts.

(c) Four uses of U.V. :

1. U.V. arc used to detect adulteration in ghee because of its property of fluorescence.
2. Used to sterilise surgical instruments and drinking water.
3. U.v. absorbed by skin stimulates body to produce vitamin D, which is very good for growth of bones and teeth.
4. U.V. are used to detect original diamonds from fake diamonds.

Question 9.

(a) What are infrared rays ? What is the range of wavelengths of infrared rays in A° ?
(b) State four important properties and four uses of infrared rays ?

Answer:
(a) Infrared rays : "The electromagnet radiations beyond redend of the visible spectrum are called infrared rays : Their range is 8000 A° to 10^7 A°.
(b) Four properties of infra red rays :

1. I.R. rays are least scattered by fog, mist etc. as they have long wavelength.
2. They can be detected by a thermopile or a thermometer with a blackend bulb, as they produce heating effect.
3. They travel with vel. of light i.e. 3×10^8 ms^{-1}
4. They are electromagnetic wave and hence are not affected by electromagnetic fields.

Four uses of infra red rays :

1. They are used to detect diseases in crops which are used to find any change in heat radiation pattern and help in early warning to save crops.
2. Patients with swollen joints, muscles, etc. feel relieved when exposed to these radiations.
3. These are used in night vision devices.
4. They are used in surface to air missiles for tracking and destroying enemy planes.

Question 10.
Write the names of all the components of electromagnetic spectrum in the order of increasing frequency.

Answer:
Components of electromagnetic spectrum in order of increasing frequency :
Radio wave microwave infra-red visible ultra violet, X rays, Gama rays
→ $3 \times 1o^7$ Hz 3×10^{11} HZ 7.5×10^{14} 3.75×10^{14} – 3×10^{16} HZ 3×10^{19} HZ

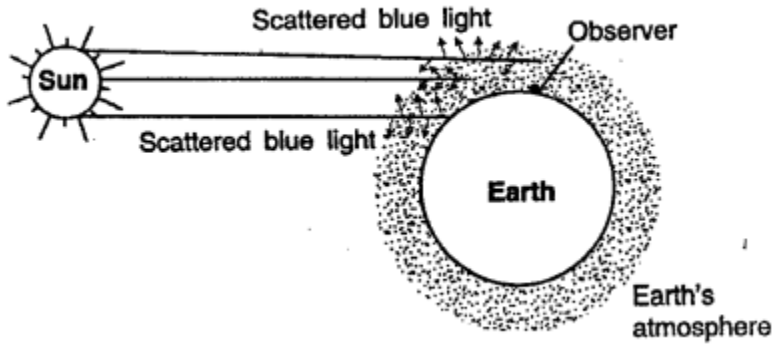
Question 11.
What do you understand by the term "scattering of light"? Which colour of white light is scattered the least and why?

Answer:
Scattering : "When an incident light strikes a particle which has a diameter greater than the wavelength of incident light, then the incident light is absorbed by the particle and transmitted in all possible directions. This phenomenon is called scattering."
Red colour of white light is scattered the least.

Question 12.
Explain the following :

(a) Why does the sun appear red during sunrise or sunset?
(b) Why does the sky appear blue on the earth, but black on the moon ?
(c) Why are orange or yellow lights used as fog lights in automobiles ?
(d) Why do the distant hills appear blue ?
(e) Why does the sky appear blue, instead of violet ?

Answer:
(a) Sun appears red during sun rise or sun set : Blue colour of short wave length scatters the most, while red light of long wave length scatters least (white-blue = red) red light reaches us and sun appears red



(b) Sky appears blue on earth but black on moon : Light from sun has to travel longer distance to reach us. Short wave length blue colours scatters more than red colour. Light reaching our eye from all directions is scattered blue, hence sky appears blue. Where as there is no atmosphere on moon, no scattering of light takes place and it appears black on moon.
(c) Red colour of longer wave length scatters least by air molecules of atmosphere and red light can be seen from farthest distance (without getting weak) hence are used as fog lights in automobiles.
(d) Distant hills appear : Blue because of scattering of blue light by water vapours present in air.
(e) As light passes through atmosphere indigo and blue both scatter because size of particles of present in air goon increasing and sky appears blue because blue light reaches us from particles scattering blue colour which are nearest to the eye.

Multiple Choice Questions

Tick (✓) the most appropriate option.

1. Visible light has electromagnetic waves between :

(a) 8000 A° to 6000 A°
(b) 8000 A to 1000 A°

(c) 8000 A° to 4000 A°
(d) 8000 A to 2000 A°

Answer:

(c) 8000 A° to 4000 A°

2. 1 Angstrom unit (A°) is equal to :

(a) 10^{-10} m
(b) 10^{-12} m
(c) 10^{-8} m
(d) 10^{6} m

Answer:

(a) 10^{-10}

3. The most visible colour of visible spectrum is :

(a) blue
(b) red
(c) green
(d) orange

Answer:

(b) red

4. The. band of seven colours formed, when white light passes through an equilateral prism is called :

(a) dispersion
(b) colour band
(c) spectrum
(d) none of these

Answer:

(c) spectrum

5. Violet, green, red and yellow are the four colours formed on a white screen when a polychromatic light is dispersed. The arrangement of colours in the decreasing order of wave lengths is :

(a) green, red, yellow and violet
(b) red, yellow, green and violet
(c) violet, green, yellow and red
(d) violet, green, red and yellow

Answer:

(b) red, yellow, green and violet

6. The angle of deviation is maximum for ……. when the dispersion of polychromatic light takes place

(a) red
(b) violet
(e) green
(d) blue

Answer:

(b)violet

7. Which is not a source of ultraviolet radiations ?

(a) Sun
(b) Arc lamp
(c) Electric heater
(d) Star

Answer:

(c) Electric heater

8. The electromagnetic radiation which are useful in night photography is:

(a) infrared rays
(b) ultraviolet rays
(e) visible light
(d) X-rays

Answer:

(a) infrared rays

9. The electromagnetic wave associated with high energy is:

(a) ultraviolet ray
(b) X-ray
(e) gamma ray
(d) infrared ray

Answer:

(c) gamma ray

10. During the Sunset the colour which scatters closest to the eye of observer is:

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

Answer:

(b) red

11. Infrared rays with very large wavelength are easily reflected by

(a) air
(b) glass
(c) carbon dioxide molecules
(d) both (b) and (c)

Answer:

(c) carbon dioxide molecules

12. X-rays are produced by

(a) oscillating circuits in special vacuum tubes
(b) excitation of outermost electronic shell of an atom
(c) excitation of inner electron of atom and is sudden annihilation of high energy free electrons.
(d) nucleus of an atom, by the destruction of high energy particle.

Answer:

(c) excitation of inner electron of atom and is sudden annihilation of high energy free electrons.

Questions from ICSE examination papers 2005

2005

Question 1.
Name any two electromagnetic waves which have a frequency higher than that of violet light. State one use of each.
Answer:
Two ELECTROMAGNETIC WAVES are :

1. **X-rays Use :** are used for medical purposes.
2. **Gamma-rays :** Use : are used to cure cancer.

Question 2.
A glass slab is placed over a page on which the word vibgyor is printed wit!, each letter in its corresponding colour.

(a) Will the image of all the letters be in the same place ?
(b) If not, which letter will be raised to the maximum. Give a reason for your answer.

Answer:

(a) No, the image of all letters will not be at the same place.
(b) Letter V will be raised maximum. This is because the refractive index of a material depends inversely upon the wavelength of light. On the other hand the shift in the image depends directly on the refractive index. Since the refractive index of a material is

maximum for violet light, therefore letter V which is written with violet colour is raised the maximum.

2006

Question 3.
Give one use each of the following electromagnetic radiations given below

(a) Microwaves
(b) Ultraviolet radiation,
(c) Infrared radiation.

Answer:
Uses of:

(a) microwaves _____ for cooking, In radar for communication.
(b) Ultraviolet radiation _____ for sterilising purposes.
(c) Infrared radiation _____ used in remote control of T.V. and as signals during war.

2007

Question 4.
Why are infrared radiations preferred over ordinary visible light for taking photographs in fog ?
Answer:
INFRARED RADIATIONS have very long wavelength, they do not easily get scattered in fog or smoke. Thus they can be used for taking infra-red photographs with suitable photographic plates and filters in foggy weather.

Question 5.
(a) A particular type of high energy invisible electromagnetic rays help us to study the structure of crystals. Name these rays and give another important use of these rays,
(b) How does the speed of light in glass change on increasing the wavelength of light ?
Answer:
(a) The high energy invisible electromagnetic rays used in the study of the structure of crystals are X-rays. These X-rays find a wide application in locating the presence of foreign bodies in the human body.
(b) The speed of the waves of higher wavelength is more i.e., the speed increase with wavelength.

2009

Question 6.

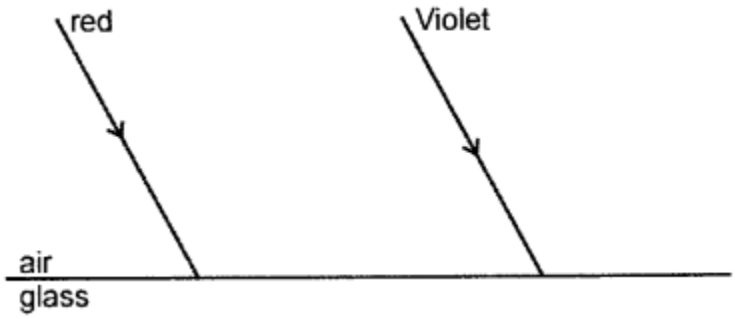
(a) Why is white light considered to be polychromatic in nature?
(b) Give the range of the wavelength of those electromagnetic waves which are visible to us.

Answer:

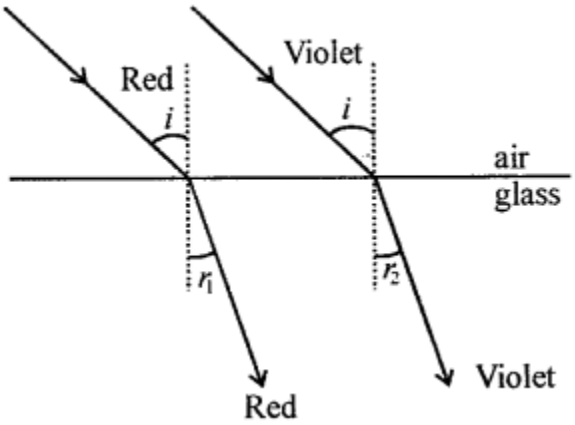
(a) White light is made up of 7 colours vibgyor. As all seen colours have same speed in vacuum/air, so it appears white. Polychromatic means – number of colours combined so white light is actually polychromatic in nature.
(b) Visible waves has wavelength range between 4000 A° – 8000 A° (where 1 A° = 10^{-10} m)

2010

Question 7.
Two parallel rays of Red and Violet travelling through air, meet the air-glass boundary as shown in the figure:



(a) Will their paths inside the glass be parallel ? Give a reason for your answer.
(b) Compare the speeds of the two rays inside the glass.
Answer:



The two refracted rays inside glass are not parallel . Because the refractive index of glass is less for Red light,
while it is more for violet light ($\mu_r < \mu_v$), So RED ray is deviated less while the violet is deviated more i.e. angle of refraction r_1 for red is more than angle of refraction r_2 for violet ray.
(a) Since the refractive index of glass for violet colour is more. ($\mu_r < \mu_v$) SO, in glass, the red light travel faster than violet light. The paths inside the glass will not be parallel.
(b) Velocity of red colours will be more than that of the violet colour.

2011

Question 8.
(a) Suggest one way, in each case, by which we can detect the presence of:

1. Infrared radiations.
2. Ultraviolet radiations.

(b) Give one use of Infrared radiations.
Answer:
(a) Way to detect :
1. Infrared radiations : It we move a thermometer with blackend bulb from violet to red end of a visible spectrum, there is a slight rise in temperature and if the bulb is moved in the region beyond red, there is sudden rise in temperature, this proves that the region beyond red is not visible and produces heating effect is Infrared region.
2. Ultraviolet radiations : When a silver chloride (Ag Cl) paper is placed in the region beyond violet, the paper first turns violet, then BROWN and finally black. This proves that there is a region beyond violet which is invisible and produces. Strong chemical effect in silver chloride is known as Ultraviolet regions.
(b) One use of infrared radiation : Used in remote control of t.v. and other gadgets.

2012

Question 9.

(a) What is meant by 'Dispersion of light' ?
(b) In the atmosphere which colour of light gets scattered the least ?

Answer:

(a) The phenomenon due to which white light splits into component colours on passing through a prism is called dispersion of light.
(b) Red colour scatters least in the atmosphere.

2013

Question 10.
Name the radiations :

(a) that are used for photography at night
(b) used for detection of fracture in bones.
(c) whose wavelength range is from 100 A to 4000 A (or 10 nm to 400 nm).

Answer:

(a) infrared radiation
(b) X-rays
(c) Ultraviolet radiation.

2014

Question 11.

(a) Name the prism required for obtaining a spectrum of Ultraviolet light.
(b) Name the radiations which can be detected by a thermopile.

Answer:

(a) Quartz prism.
(b) Infrared radiations can be detected by thermopile.

Question 12.
Why is red colour used as a sign of danger?
Answer:
Since the wavelength of red light is maximum in the visible light, the light of red colour is scattered least by the air molecules of the atmosphere and therefore it can reach to a longer distance.

2015

Question 13.

(a) Why does the Sun appear red at sunrise?
(b) Name the subjective property of light related to its wave-length.

Answer:

(a) The Sun appears red at sunrise because of the scattering of light by the atmospheric particles. During sunrise, the light from the Sun has to travel a longer distance through the atmosphere to reach the observer. During this, most of the shorter wave-lengths present in it are scattered away from our line of sight by the molecules of air and other fine particles in the atmosphere. So, the light reaching us directly from the rising Sun consists mainly of longer wavelength red colour due to which the Sun appears red.
(b) The subjective property of light related to its wavelength is frequency.

Question 14.

(a) Name the high energetic invisible electromagnetic waves which help in the study of the structure of crystals.
(b) State an additional use of the waves mentioned in part (a).

Answer:

(a) X-rays are used in the study of structure of crystals.
(b) X-rays are used in the detection of fracture in bones and teeth.

2016

Question 15.
What do you understand by the term “Scattering of light”? Which colour of white light is scattered least and why ?
Answer:
Scattering of light is the phenomenon due to which a particle having a diameter greater than the wavelength of light incident on it absorbs the light and then transmits it in all possible directions.
The red colour of the white light is scattered the least because scattering of light depends inversely upon the four power of wavelength. As red colour has the maximum wavelength in the visible region, therefore, it scattered the least.