CHAPTER # 12

ELECTROMAGNETIC SPECTRUM

Q 1. What is dispersion of light?

DISPERSION OF LIGHT

Splitting white light into its constituent colours when it passes through a glass prism is called dispersion of white light.

Q 2. Describe the dispersion of light when passing through glass prism.

DISPERSION OF LIGHT THROUGH A PRISM

When a narrow beam of white light splits, the colour sequence produced in the spectrum is indicated by the acronym V I B G Y O R which stands for Violet, Indigo, Blue, Green. Yellow, Orange, and Red. The speed and direction of white light vary depending on the wavelength. The red colour has a maximum speed in the glass prism, with the slightest deviation. In contrast, the violet colour has minimum speed, which with most deviation because colour has its own refracted path in the air and becomes distinct on the spectrum.

Q 3. What is spectrum?

SPECTRUM

The colour pattern produced in the dispersion is called a spectrum of light

Q 4. Explain how rainbow is produce in a rainy day or water droplet?

DISPERSION OF LIGHT THROUGH WATER DROPLETS

The rainbow is one of nature's most beautiful creations. When a rainbow appears, it serves as an excellent demonstration of light dispersion and further evidence that visible light has a spectrum of wavelengths, each of which is associated with a distinct colour. At an angle of approximately 40 degrees above ground level, you must look into an area of atmosphere with suspended droplets of water, or even a light mist, in order to see a rainbow in the sky. Every droplet of water acts as a tiny prism, dispersing and reflecting light to your eye. When you look at the sky, droplets emit wavelengths of light associated with a colour. There are several ways sun rays can enter through a drop. The bending toward and away from the normal is a defining characteristic of each and every path. The path of light as it enters the droplet, internally reflects, and then refracts out of the droplet is an important consideration when discussing rainbows.

Q 5. List the different color of wave length along with their wave length and refractive index.

COLOR	WAVELENGTH/ nm	REFRECTIVE INDEX
Red	650	1332
Orange	625	1.333

Yellow	575	1.334
Green	525	1.336
Blue	450	1.34
Indigo	425	1.342
Violet	400	1.344

Q 6. A ray of blue light deviates more than a ray of red when passing through a prism. Explain why?

Ans. Blue light deviates more than a ray of red when passing through a prism because blue light have smaller frequency then red light.

Q 7. Give the sequence of colours produced in the dispersion through a prism.

Ans.

1. Violet
2. Indigo
3. Blue
4. Green
5. Yellow
6. Orange
7. Red

which stands for V I B G Y O R

Q 8. Give the characteristics of electromagnetic wave.

CHARACTERISTICS OF ELECTROMAGNETIC WAVE

1. Electromagnetic waves are transverse waves in nature.
2. It can not carry electric charge.
3. It can travel through space, traveling at the speed of light 3 x 10^8 m/s.
4. It will travel through a transparent medium; however, they will slow down when traveling through a denser medium like water or glass.
5. It obeys the laws of reflection, refraction, and diffraction.
6. Its frequencies depend only on the source that produces the wave. Thus, frequencies do not change when it travels from one medium to another (air to glass).

Q 9. Discus the types of electromagnetic waves along with their source and application

TYPE OF ELECTRO MAGNETISE WAVE

RADIO AND TV

SOURCES Accelerating point charges

APPLICATION

Communications

remote control devices
Magnetic Resonance
Imaging (MRI)

MICROWAVES

SOURCES Accelerating point charges and thermal agitations

APPLICATION

Communications
microwave ovens
radar

INFRARED

SOURCES Thermal agitations and electronic transitions

APPLICATION

Heating
Heat therapy
Thermal imaging

VISIBLE LIGHT

SOURCES Thermal agitations and electronic transitions

APPLICATION

All pervasive
optical fiber
Human vision,
Photosynthesis

ULTRAVIOLET

SOURCES Thermal agitations and electronic transitions

APPLICATION

Cancer Control
Sterilization
Sunbeds
Vitamin D
production

X-RAYS

SOURCES Inner electronic transitions and fast collisions

APPLICATION

Imaging
Cancer
Therapy
Medical diagnosis

GAMMA RAYS

SOURCES Nuclear decay

APPLICATION

Nuclear medicine

Radiography

Cancer therapy

Q 10. Define fluorescents

FLUORESCENT:

When absorbed in ultraviolet, some materials convert their energy into light and glow. This phenomenon is called fluorescence

Q 11. What do you know about sunbeds?

SUNBEDS

Ultraviolet lamps that emit UVA and UVB radiation are used in sunbeds for artificial tanning. It is popular in countries with long periods of limited sunlight. Under medically controlled supervision, sunbeds beautify, provide the body with vitamin D, and treat certain skin conditions

Q 12. Describe the sterilization

STERILIZATION

as ultraviolet kills harmful bacteria, strong UVB and UVC radiations are used to sterilize food and medical equipment in hospitals.

Q 13. Give some uses of electromagnetic waves

RADIO WAVES

1. Radio waves are also used in television communication.
2. Radio waves of very high-frequency VHF and ultra high-frequency UHF waves are used to telecast television programs.
3. These waves have shorter wavelengths, and they do not diffract around hills. So, there must be a straight path between the transmitting and receiving antenna for good reception.

MICROWAVES

1. Satellite phones use microwaves for communication, and satellite television uses microwaves to receive satellite television programs.
2. Microwaves can penetrate haze, light rain, clouds, and smoke as they have a higher frequency of all ranges of radio waves.
3. These waves are highly directional, the satellite dish and related components must be aligned appropriately, without any obstruction between the transmitted satellite signals and receiving satellite dish.

INFRA-RED

1. These rays are use in house hold electric appliances i.e. in wireless remote controllers etc.
2. These rays are used for security purposes, particularly in military technology.

ULTRA-VIOLET

1. These rays are use in sunbeds, fluorescent tubes, sterilization,
2. They are commonly used in lighting houses, shops, and offices for decorating purposes.
3. as ultraviolet kills harmful bacteria, strong UVB and UVC radiations are used to sterilize food and medical equipment in hospitals.

X -RAYS

1. x-rays to produce the x-ray images to diagnose the fracture in the bones or even tooth decay, tumours, and abnormal masses inside the body.
2. Computed Tomography (CT) scan is a computational diagnostic tool for detecting diseases and injuries. It uses a series of low-frequency X-rays and a computer to produce a 3D image of soft tissues and bones.
3. Industrial radiography is a technique of inspecting materials to detect inside defects by using high-frequency X-rays.

GAMMA RAYS

1. Gamma rays are used to treat cancer.
2. These high-energy rays are directed at the cancerous tumour to kill cancer cells in oncology.
3. Gamma rays are highly penetrating and can pass through metals; because of their extreme power, gamma rays used to radiograph holes and defects in metal castings and other structural parts.

Q 14. What do you know about PET?

Positron Emission Tomography (PET) is a functional medical imaging method.
In a PET scan, a short-lived positron-emitting radioactive sampling taken suitable for a particular function (e.g., brain function) is injected into the body. Radiated positrons quickly fuse with nearby electrons and lead to two gamma rays of 511-keV traveling in opposite directions. After detecting the gamma rays, a computer generates an image that highlights the location of the biological process being examined.

Worked Example 1

Ruby laser emits the beam of red light having a wavelength of 694.3 nm. Calculate its frequency.

Book Numerical

1. Electromagnetic radiation having a 15.0 μm wavelength is classified as infrared radiation. What is its frequency? Given that the speed of light is $3x10^8$ m/s. (2×10^{13} Hz)
2. What is the frequency of the 193-nm ultraviolet radiation used in laser eye surgery? ($1.55x\ 10^{15}$Hz)
3. Calculate the wavelength of 100-MHz radio waves used in an MRI unit? (3m)
4. The distance from earth to sun is 1.49×10^{11} meters. How long a radio pulse radiated from the sun takes to reach on the earth? (496.67 sec)
5. Distances in space are often measured in units of light-years, the distance light travels in one year. Find the distance in kilometres in a light-year? ($9.33x\ 10^{12}$Km)
6. What is the frequency of green light with a wavelength of 5.5×10^7m? (5.45Hz, 5.45×10^{14}Hz)
7. A typical household microwave oven operates at a frequency of 2.45-GHz What is the wavelength of this radiation? (0.1224m or 122.4mm)