CHAPTER 22

Electromagnetic Waves

1. *Electromagnetic waves are transverse in nature* is evident by **[2002]**
(a) polarization (b) interference
(c) reflection (d) diffraction

2. An electromagnetic wave of frequency $v = 3.0$ MHz passes from vacuum into a dielectric medium with permittivity $\epsilon = 4.0$. Then **[2004]**
(a) wave length is halved and frequency remains unchanged
(b) wave length is doubled and frequency becomes half
(c) wave length is doubled and the frequency remains unchanged
(d) wave length and frequency both remain unchanged.

3. An electromagnetic wave in vacuum has the electric and magnetic field $\vec{E}$ and $\vec{B}$, which are always perpendicular to each other. The direction of polarization is given by $\vec{X}$ and that of wave propagation by $\vec{k}$. Then **[2012]**
(a) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$
(b) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$
(c) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$
(d) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$

4. The magnetic field in a travelling electromagnetic wave has a peak value of 20 nT. The peak value of electric field strength is : **[2013]**
(a) 3 V/m (b) 6 V/m
(c) 9 V/m (d) 12 V/m

5. During the propagation of electromagnetic waves in a medium: **[2014]**
(a) Electric energy density is double of the magnetic energy density.
(b) Electric energy density is half of the magnetic energy density.
(c) Electric energy density is equal to the magnetic energy density.
(d) Both electric and magnetic energy densities are zero.

6. Match List - I (Electromagnetic wave type) with List - II (Its association/application) and select the correct option from the choices given below the lists: **[2014]**

List 1		List 2	
1.	Infrared waves	(i)	To treat muscular strain
2.	Radio waves	(ii)	For broadcasting
3.	X-rays	(iii)	To detect fracture of bones
4.	Ultraviolet rays	(iv)	Absorbed by the ozone layer of the atmosphere

	1	2	3	4
(a)	(iv)	(iii)	(ii)	(i)
(b)	(i)	(ii)	(iv)	(iii)
(c)	(iii)	(ii)	(i)	(iv)
(d)	(i)	(ii)	(iii)	(iv)

7. Arrange the following electromagnetic radiations per quantum in the order of increasing energy : **[2016]**
A : Blue light B : Yellow light
C : X-ray D : Radiowave.
(a) C, A, B, D (b) B, A, D, C
(c) D, B, A, C (d) A, B, D, C

Answer Key														
1	2	3	4	5	6	7								
(a)	(a)	(b)	(b)	(c)	(d)	(c)								

SOLUTIONS

1. **(a)** The phenomenon of polarisation is shown only by transverse waves.

2. **(a)** Frequency remains constant during refraction

$$v_{med} = \frac{1}{\sqrt{\mu_0 \in_0 \times 4}} = \frac{c}{2}$$

$$\frac{\lambda_{med}}{\lambda_{air}} = \frac{v_{med}}{v_{air}} = \frac{c/2}{c} = \frac{1}{2}$$

$\therefore$ wavelength is halved and frequency remains unchanged

3. **(b)** $\because$ The E.M. wave are transverse in nature i.e.,

$$= \frac{\vec{k} \times \vec{E}}{\mu\omega} = \vec{H} \quad \ldots(i)$$

where $\vec{H} = \frac{\vec{B}}{\mu}$

and $\frac{\vec{k} \times \vec{H}}{\omega\varepsilon} = -\vec{E}$ $\ldots$ (ii)

$\vec{k}$ is $\perp$ $\vec{H}$ and $\vec{k}$ is also $\perp$ to $\vec{E}$

or In other words $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$

4. **(b)** From question,

$B_0 = 20\ nT = 20 \times 10^{-9} T$

($\because$ velocity of light in vacuum $C = 3 \times 10^8$ ms^{-1})

$\vec{E}_0 = \vec{B}_0 \times \vec{C}$

$|\vec{E}_0| = |\vec{B}| . |\vec{C}| = 20 \times 10^{-9} \times 3 \times 10^8$

$= 6\ V/m.$

5. **(c)** $E_0 = CB_0$ and $C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

Electric energy density $= \frac{1}{2}\varepsilon_0 E_0^2 = \mu_E$

Magnetic energy density $= \frac{1}{2}\frac{Bo^2}{\mu_0} = \mu_B$

Thus, $\mu_E = \mu_B$

Energy is equally divided between electric and magnetic field

6. **(d)**

(1) Infrared rays are used to treat muscular strain because these are heat rays.

(2) Radio waves are used for broadcasting because these waves have very long wavelength ranging from few centimeters to few hundred kilometers

(3) X-rays are used to detect fracture of bones because they have high penetrating power but they can't penetrate through denser medium like dones.

(4) Ultraviolet rays are absorbed by ozone of the atmosphere.

7. **(c)** E, Decreases →

γ-rays X-rays uv-rays Visible rays (VIBGYOR) IR rays Microwaves Radio waves

Radio wave < yellow light < blue light < X-rays

(Increasing order of energy)