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ELECTROMAGNETIC WAVES

MCQs with One Correct Answer

1. If $\vec{E}$ and $\vec{B}$ represent electric and magnetic field vectors of the electromagnetic waves, then the direction of propagation of the waves will be along

(a) $\vec{B} \times \vec{E}$ (b) $\vec{E}$

(c) $\vec{B}$ (d) $\vec{E} \times \vec{B}$

2. In an apparatus, the electric field was found to oscillate with an amplitude of 24 V/m. The amplitude of the oscillating magnetic field will be

(a) 6×10^{-6} T (b) 2×10^{-8} T

(c) 8×10^{-8} T (d) 12×10^{-6} T

3. A plane electromagnetic wave of wave intensity 10 W/m^2 strikes a small mirror of area 20 cm^2, held perpendicular to the approaching wave. The radiation force on the mirror will be

(a) 6.6×10^{-11} N (b) 1.33×10^{-11} N

(c) 1.33×10^{-10} N (d) 6.6×10^{-10} N

4. Given below is a list of E.M spectrum and its use. Which one does not match?

(a) U.V. rays — finger prints detection

(b) I.R.. rays — for taking photography during the fog

(c) X- rays — atomic structure

(d) Microwaves — forged document detection

5. A point source of electromagnetic radiation has an average power output of 800 W. The maximum value of electric field at a distance 4.0 m from the source is

(a) 64.7 V/m (b) 97.8 V/m

(c) 86.72 V/m (d) 54.77 V/m

6. Which of the following has/have zero average value in a plane electromagnetic wave?

(a) Both magnetic and electric fields

(b) Electric field only

(c) Magnetic field only

(d) Magnetic energy

7. Which of the following is correct about the electromagnetic waves?

(a) they are transverse waves

(b) they have rest mass

(c) they require medium to propagate

(d) they travel at varying speed through vaccum

8. In an electromagnetic wave

(a) power is transmitted along the magnetic field

(b) power is transmitted along the electric field

(c) power is equally transferred along the electric and magnetic fields

(d) power is transmitted in a direction perpendicular to both the fields

9. An electro magnetic wave travels along z-axis. Which of the following pairs of space and time varying fields would generate such a wave

(a) E_x, B_y (b) E_y, B_x

(c) E_z, B_x (d) E_y, B_z

10. Which of the following statements is true?

(a) The frequency of microwaves is greater than that of UV-rays

(b) The wavelength of IR rays is lesser than that of UV-rays

(c) The wavelength of microwaves is lesser than that of IR rays

(d) Gamma rays has least wavelength in the electromagnetic spectrum.

11. For a plane electromagnetic wave, the magnetic field at a point x and time t is

$$\vec{B}(x,t) = [1.2\times10^{-7}\sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{k}]\text{T}$$

The instantaneous electric field $\vec{E}$ corresponding to $\vec{B}$ is:

(speed of light c = 3×10^8 ms^{-1})

(a) $\vec{E}(x,t) = [-36\sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{j}]\frac{\text{V}}{\text{m}}$

(b) $\vec{E}(x,t) = [36\sin(1\times10^{3}x + 0.5\times10^{11}t)\hat{j}]\frac{\text{V}}{\text{m}}$

(c) $\vec{E}(x,t) = [36\sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{k}]\frac{\text{V}}{\text{m}}$

(d) $\vec{E}(x,t) = [36\sin(1\times10^{3}x + 1.5\times10^{11}t)\hat{i}]\frac{\text{V}}{\text{m}}$

12. The energy associated with electric field is (U_E) and with magnetic fields is (U_B) for an electromagnetic wave in free space. Then :

(a) $U_E = \frac{U_B}{2}$ (b) $U_E > U_B$

(c) $U_E < U_B$ (d) $U_E = U_B$

13. An electromagnetic wave of frequency 1×10^{14} hertz is propagating along z-axis. The amplitude of electric field is 4 V/m. If $\varepsilon_0 = 8.8 \times 10^{-12}$ C^2/N-m^2, then average energy density of electric field will be:

(a) 35.2×10^{-10} J/m^3

(b) 35.2×10^{-11} J/m^3

(c) 35.2×10^{-12} J/m^3

(d) 35.2×10^{-13} J/m^3

14. A plane electromagnetic wave in a non-magnetic dielectric medium is given by $\vec{E} = \vec{E}_0(4\times10^{-7}x - 50t)$ with distance being in meter and time in seconds. The dielectric constant of the medium is :

(a) 2.4 (b) 5.8

(c) 8.2 (d) 4.8

15. 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

(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 $\vec{k} \parallel \vec{B}\times\vec{E}$

16. Chosse the **correct** option relating wavelengths of different parts of electromagnetic wave spectrum :

(a) $\lambda_{\text{visible}} < \lambda_{\text{micro waves}} < \lambda_{\text{radio waves}} < \lambda_{X-\text{rays}}$

(b) $\lambda_{\text{radio waves}} > \lambda_{\text{micro waves}} > \lambda_{\text{visible}} > \lambda_{x-\text{rays}}$

(c) $\lambda_{x-\text{rays}} < \lambda_{\text{micro waves}} < \lambda_{\text{radio waves}} < \lambda_{\text{visible}}$

(d) $\lambda_{\text{visible}} > \lambda_{x-\text{rays}} > \lambda_{\text{radio waves}} > \lambda_{\text{micro waves}}$

17. Photons of an electromagnetic radiation has an energy11 keV each. To which region of electromagnetic spectrum does it belong ?

(a) X-ray region

(b) Ultra violet region

(c) Infrared region

(d) Visible region

18. The mean intensity of radiation on the surface of the Sun is about 10^8 W/m^2. The rms value of the corresponding magnetic field is closest to :

(a) 1 T (b) 10^2 T

(c) 10^{-2} T (d) 10^{-4} T

19. Arrange the following electromagnetic radiations per quantum in the order of increasing energy :

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

20. The frequency of *X*-rays; γ-rays and ultraviolet rays are respectively *a*, *b* and *c* then

(a) $a < b; b > c$ (b) $a > b ; b > c$

(c) $a < b < c$ (d) $a = b = c$

Numeric Value Answer

21. A plane electromagnetic wave of frequency 50 MHz travels in free space along the positive *x*-direction. At a particular point in space and time, $\vec{E} = 6.3\,\hat{j}$ V / m. The corresponding magnetic field $\vec{B}$, at that point is x × 10^{-8} $\hat{k}$T. Find the value of x.

22. If the magnetic field of a plane electromagnetic wave is given by (The speed of light = 3 × 10^8 m/s)

$$B = 100 \times 10^{-6} \sin\left[2\pi \times 2 \times 10^{15}\left(t - \frac{x}{c}\right)\right]$$

then the maximum electric field (in N/C) associated with it is:

23. A 27 mW laser beam has a cross-sectional area of 10 mm^2. The magnitude of the maximum electric field (in kV/m) in this electromagnetic wave is given by :

[Given permittivity of space $\in_0 = 9 \times 10^{-12}$ SI units, Speed of light c = 3 × 10^8 m/s]

24. The mean intensity of radiation on the surface of the Sun is about 10^8 W/m^2. The rms value of the corresponding magnetic field (in tesla) is :

25. The magnetic field of a plane electromagnetic wave is given by:

$$\vec{B} = B_0\hat{i}[\cos(kz - \omega t)] + B_1\hat{j}\cos(kz + \omega t)$$

Where $B_0 = 3 \times 10^{-5}$ T and $B_1 = 2 \times 10^{-6}$ T. The rms value of the force (in newton) experienced by a stationary charge Q = 10^{-4} C at z = 0 is :

26. 50 W/m^2 energy density of sunlight is normally incident on the surface of a solar panel. Some part of incident energy (25%) is reflected from the surface and the rest is absorbed. The force (in newton) exerted on 1m^2 surface area will be (c = 3 × 10^8 m/s):

27. A light beam travelling in the *x*-direction is described by the electric field $E_y = 300\sin\omega\left(t - \frac{x}{c}\right)$. An electron is constrained to move along the *y*-direction with a speed of 2.0 × 10^7 m/s. Find the maximum electric force (in newton) on the electron.

28. A plane electromagnetic wave of wave intensity 10 W/m^2 strikes a small mirror of area 20 cm^2, held perpendicular to the approaching wave. The radiation force (in newton) on the mirror will be

29. The magnetic field in a travelling electromagnetic wave has a peak value of 20 nT. The peak value of electric field strength (in volt m^{-1}) is

30. Light is incident normally on a completely absorbing surface with an energy flux of 25 Wcm^{-2}. If the surface has an area of 25 cm^2, the momentum (in Ns) transferred to the surface in 40 min time duration will be:

ANSWER KEY																			
1	(d)	**4**	(d)	**7**	(a)	**10**	(d)	**13**	(c)	**16**	(b)	**19**	(c)	**22**	(3×10^4)	**25**	(0.64)	**28**	(1.33×10^{-10})
2	(c)	**5**	(d)	**8**	(d)	**11**	(a)	**14**	(b)	**17**	(a)	**20**	(a)	**23**	(1.4)	**26**	(20×10^{-8})	**29**	(6)
3	(c)	**6**	(a)	**9**	(a)	**12**	(d)	**15**	(b)	**18**	(d)	**21**	(2.1)	**24**	(6×10^{-4})	**27**	(4.8×10^{-7})	**30**	(5×10^{-3})