TEST

JEE Mains PYQs Electromagnetic Waves (Physics Master Academy)

QUESTIONS

SECTIONS

1. Section A - 25 Questions

Section 1 : Section A - 25 Questions

SECTION INSTRUCTIONS

This section contains 25 MCQs. +4 for every correct answer, -1 for every incorrect answer.

1 Electric keld of plane electromagnetic wave propagating through a non magnetic medium is given by E = 20 cos $(2\times10^{10}$ t – 200x(V/m. The dielectric constant of the medium is equal to (Take $m_r = 1$)

- 9
- 2
- 1/3
- 3

Correct: +4 · Incorrect: -1

2 The magnetic keld vector of an electromagnetic wave is given by B = $B_0\frac{\hat{i}+\hat{j}}{\sqrt{2}}\cos(kz-\omega t)$ where

$\hat{i}$

$\hat{j}$

represents unit vector along x and y axis respectively. At t = 0, two electric charges q_1 of 4π coulomb and q_2 of 2π coulomb located at (0, 0, π/k) and (0, 0, 3π/k) respectively, have the same velocity 0.2 c

$\hat{i}$

, (where c is the velocity of light). The ratio of the fore acting on charge q_1 to q_2 is

- $2\sqrt{2}:1$
- $1:\sqrt{2}$

○ 2: 1

- ○ $\sqrt{2}:1$

Correct: +4 · Incorrect: -1

3 Electric keld in a plane electromagnetic wave is given by E = 5 sin (500x – 10 × 10^{10}t) V/m. The velocity of electromagnetic wave in this medium is (Given C = speed of light in vacuum)

- ○ 3/2 C
- ○ C
- ○ 2/3 C
- ○ C/2

Correct: +4 · Incorrect: -1

4 A plane electromagnetic wave with frequency of 30 MHz travels in free space. At particular point in space and time, electric keld is V/m. The magnetic keld at this point will be x × 10^{-8}T. The value of x is ___

- ○ 1
- ○ 2
- ○ 3
- ○ 4

Correct: +4 · Incorrect: -1

5 The relative permittivity of distilled water is 81. The velocity of light in it will be (Given μ_s = 1)

- ○ 4.33×10^7m/s
- ○ 2.33×10^7m/s
- ○ 3.33×10^7m/s
- ○ 5.33×10^7m/s

Correct: +4 · Incorrect: -1

6 A plane electromagnetic wave of frequency 100 MHz is travelling in vacuum along the x direction. At a particular point in space and time, $\vec{B}$ = 2.0×10^{-8} $\hat{k}$ T. (where $\hat{k}$ is unit vector along z direction). What is $\vec{E}$

at this point? (speed of light c = 3 $\vec{E}$ 10^8 m/s)

- 6.0 $\hat{j}$ V/m
- 0.6 $\hat{j}$ V/m
- 0.6 $\hat{k}$ V/m
- 6.0 $\hat{k}$ V/m

Correct: +4 · Incorrect: -1

7 For an electromagnetic wave travelling in free space, the relation between average energy densities due to electric (U_e) and magnetic (U_m) kelds is

- $U_e > U_m$
- $U_e = U_m$
- $U_e \neq U_m$
- $U_e < U_m$

Correct: +4 · Incorrect: -1

8 An electromagnetic wave of frequency 5 GHz, is travelling in a medium whose relative electric permittivity and relative magnetic permeability both are 2. Its velocity in this medium is___$\times 10^7$ m/s.

- 5
- 10
- 15
- 20

Correct: +4 · Incorrect: -1

9 A radiation is emitted by 1000W bulb and is generates an electric keld and magnetic keld at P, placed at a distance of 2m. The efkciency of the bulb is 1.25%, The value of peak electric keld is x $\times 10^{-1}$V/m. Value of x is___(Rounded off to nearest integers) [Take $\varepsilon_0 = 8.85\times 10^{-12}$ $C^2N^{-1}m^{-2}$, $c = 3\times 10^8 ms^{-1}$]

- 132
- 135

- 134
- 137

Correct: +4 · Incorrect: -1

10 An electron is constrained to move along the y axis with a speed of 0.1c(c is the speed of light) in the presence of electromagnetic wave, whose electric keld is $\vec{E}$ = 30 $\hat{j}$ sin ($1.5\times10^{7}t - 5\times10^{-2}x$)V/m. The maximum magnetic force experienced by the electron will be (given c = 3×10^{8} ms^{-1} and electron charge = 1.6×10^{-19}C)

- 3.2×10^{-18}N
- 2.4×10^{-18}N
- 4.8×10^{-19}N
- 1.6×10^{-19}N

Correct: +4 · Incorrect: -1

11 A plane electromagnetic wave, has frequency of 2.0×10^{10}Hz and its energy density is 1.02×10^{-8}J/m^3 in vacuum. The amplitude of the magnetic keld of the wave is close to

$\left(\frac{1}{4\pi\varepsilon_0}=9\times10^{0}\frac{N\,m^2}{C^2}\wedge speed\ of\ light\ 3\times10^{8}\,ms^{-1}\right)$

- 150nT
- 160 nT
- 180 nT
- 190 nT

Correct: +4 · Incorrect: -1

12 In a plane electromagnetic wave, the direction of electric keld and magnetic keld are represented by $\hat{k}$ and 2 $\hat{i}$ − 2 $\hat{j}$, respectively. What is the unit vector along direction of propagation of the wave.

- $\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$

○ $\frac{1}{\sqrt{2}}(\hat{j}+\hat{k})$

○ $\frac{1}{\sqrt{5}}(\hat{i}+2\hat{j})$

○ $\frac{1}{\sqrt{5}}(2\hat{i}+\hat{j})$

Correct: +4 · Incorrect: -1

13 A lane electromagnetic wave is propagating along the $\frac{\hat{i}+\hat{j}}{\sqrt{2}}$ direction with its polarization along the direction $\hat{k}$. The correct form of the magnetic keld of the wave would be (here B_0 is an appropriate constant).

○ $B_0\frac{\hat{i}-\hat{j}}{\sqrt{2}}\cos\left(\omega t-k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

○ $B_0\frac{\hat{j}-\hat{i}}{\sqrt{2}}\cos\left(\omega t-k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

○ $B_0\hat{k}\cos\left(\omega t-k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

○ $B_0\frac{\hat{i}+\hat{j}}{\sqrt{2}}\cos\left(\omega t-k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

Correct: +4 · Incorrect: -1

14 A plane electromagnetic wave of frequency 25GHz is propagating in vacuum along the z direction. At a particular point is space and time, the magnetic keld is given by $\vec{B} = 5\times 10^{-8}\hat{j}$ T. The corresponding electric keld $\vec{E}$ is (speed of light, c = 3×10^8 ms^{-1})

○ $1.66\times10^{-6}\hat{i}$ V/m

○ $-1.66\times10^{-6}\hat{i}$ V/m

○ $-15\hat{i}$ V/m

○ $15\hat{i}$ V/m

Correct: +4 · Incorrect: -1

15 IF the magnetic keld in a plane electromagnetic wave is given by $\vec{B} = 3\times10^{-8} \sin(1.6\times10^{3}x + 48 \times 10^{10}t)$ $\hat{j}$ T, then what will be expression for electric keld?

- $\vec{E} = (60 \sin(1.6\times10^{3}x + 48\times10^{10}t)\,\hat{k}$ V/m)
- $\vec{E} = (9 \sin(1.6\times10^{3}x + 48\times10^{10}t)\,\hat{k}$ V/m)
- $\vec{E} = (3\times10^{8} \sin(1.6\times10^{3}x + 48\times10^{10}t)\,\hat{k}$ V/m)
- $\vec{E} = (3\times10^{8} \sin(1.6\times10^{3}x - 48\times10^{10}t)\,\hat{k}$ V/m)

Correct: +4 · Incorrect: -1

16 A plane electromagnetic wave of frequency 50 MHz travels in free space along the positive direction. At a particular point in space and time, $\vec{E}$ = 6.3 $\hat{j}$ V/m. The corresponding magnetic keld $\vec{B}$ at point is

- $18.9 \times10^{-8}\,\hat{k}$ T
- $2.1 \times10^{-8}\,\hat{k}$ T
- $6.3 \times10^{-8}\,\hat{k}$ T
- $18.9 \times10^{8}\,\hat{k}$ T

Correct: +4 · Incorrect: -1

17 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 exerted on 1m^2 surface area will be close to (e = 3×10^{8}m/s)

- 15×10^{-8}N
- 20×10^{-8}N
- 10×10^{-8}N
- 35×10^{-8}N

Correct: +4 · Incorrect: -1

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 keld is closest to

- 1T
- 10^2T
- 10^{-2}T
- 10^{-4}T

Correct: +4 · Incorrect: -1

19 If the given keld of a plane electromagnetic wave is given by (The speed of light = 3×10^8m/s) B = $100\times10^{-6}\sin\left[2\pi\times2\times10^{15}\left(t-\frac{x}{c}\right)\right]$ then the maximum electric keld associated with it is

- 6×10^4 N/C
- 3×10^4 N/C
- 4×10^4 N/C
- 4.5×10^4 N/C

Correct: +4 · Incorrect: -1

20 Magnetic keld in a plane electromagnetic wave is given by $\vec{B} = B_0 \sin(kx + wt)\hat{j}$ T. Expression for corresponding electric keld will be: where c is speed of light.

- $\vec{E} = B_0 c \sin(kx + \omega t)\hat{k}$ V/m
- $\vec{E} = B_0/c \sin(kx + \omega t)\hat{k}$ V/m
- $\vec{E} = -B_0 c \sin(kx + \omega t)\hat{k}$ V/m
- $\vec{E} = B_0 c \sin(kx - \omega t)\hat{k}$ V/m

Correct: +4 · Incorrect: -1

21 Choose the correct option relating wavelengths of different parts of electromagnetic wave spectrum:

- $\lambda_{visible} < \lambda_{microwaves} < \lambda_{radio\ waves} < \lambda_{X\text{-}rays}$

- radio waves > $\lambda_{microwaves} > \lambda_{visible} > \lambda_{X\text{-}rays}$
- X-rays $< \lambda_{microwaves} < \lambda_{radio\ waves} < \lambda_{visible}$
- visible > $\lambda_{X\text{-}rays} > \lambda_{radio\ waves} > \lambda_{microwaves}$

Correct: +4 · Incorrect: -1

22 Arrange the following electromagnetic radiations per quantum in the order of increasing energy: A: Blue light, B: Yellow light, C: X rays, D: Radiowave

- C, A, B, D
- B, A, D, C
- D, B, A, C
- A, B, D, C

Correct: +4 · Incorrect: -1

23 Microwave oven acts on the principle of

- giving rotational energy to water molecules
- giving translational energy to water molecules
- giving vibrational energy to water molecules
- transferring electrons from lower to higher energy levels in water molecules

Correct: +4 · Incorrect: -1

24 In microwaves, X rays, infrared, gamma rays, ultra-violet, radio waves and visible parts of the electromagnetic spectrum are denoted by M, X, I, G, U, R and V then which of the following is the arrangement in ascending order of wavelength?

- R, M, I, V, U, X and G
- M, R, V, X, U, G and I
- G, X, U, V, I, M and R
- I, M, R, U, V, X and G

Correct: +4 · Incorrect: -1

25 The frequency of X rays, γ-rays and ultra violet rays are respectively a, b and c then

- ○ a < b; b > c
- ○ a > b; b > c
- ○ a < b < c
- ○ a = b = c

Correct: +4 · Incorrect: -1

TEST

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ANSWERS

SECTIONS

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1 9

2 2: 1

3 2/3 C

4 2

5 3.33×10^{7}m/s

6 $6.0\,\hat{j}$ V/m

7 $U_e = U_m$

8 15

9 137

10 4.8×10^{-19}N

11 160 nT

12 $\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$

13 $B_0\frac{\hat{i}-\hat{j}}{\sqrt{2}}\cos\left(\omega t-k\frac{\hat{i}+\hat{j}}{\sqrt{2}}\right)$

14 15 $\hat{i}$ V/m

15 $\vec{E}$ = (9 sin (1.6×10^{3}x + 48×10^{10}t) $\hat{k}$ V/m)

16 2.1 ×10^{-8} $\hat{k}$ T

17 20×10^{-8}N

18 10^{-4}T

19 3× 10^4 N/C

20 $\vec{E}$ = B_0c sin (kx + ωt)$\hat{k}$V/m

21 radio waves > $\lambda_{microwaves}$ > $\lambda_{visible}$ > $\lambda_{X\text{-}rays}$

22 D, B, A, C

23 giving vibrational energy to water molecules

24 G, X, U, V, I, M and R

25 a < b; b > c

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