

Q1. JEE Main 2026 (21 January Shift 2)

An electromagnetic wave of frequency 100 MHz propagates through a medium of conductivity, $\sigma = 10 \text{ mho/m}$. The ratio of maximum conduction current density to maximum displacement current density is ____.

[Take $\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$]

Q2. JEE Main 2026 (23 January Shift 1)

Match List - I with List - II.

List - I

List - II

Relation

Law

A. $\oint \vec{E} \cdot d\vec{l} = -\frac{d}{dt} \oint \vec{B} \cdot d\vec{a}$

I. Ampere's circuital law

B. $\oint \vec{B} \cdot d\vec{l} = \mu_0 \left(I + \epsilon_0 \frac{d\phi_E}{dt} \right)$

II. Faraday's laws of

electromagnetic induction

C. $\oint \vec{E} \cdot d\vec{a} = \frac{1}{\epsilon_0} \int_V \rho dv$

III. Ampere - Maxwell law

D. $\oint \vec{B} \cdot d\vec{l} = \mu_0 I$

IV. Gauss's law of electrostatics

Choose the correct answer from the options given below :

(1) A-II, B-III, C-I, D-IV

(2) A-II, B-III, C-IV, D-I

(3) A-I, B-IV, C-III, D-II

(4) A-IV, B-I, C-II, D-III

Q3. JEE Main 2026 (23 January Shift 1)

The equation of the electric field of an electromagnetic wave propagating through free space is given by :

$E = \sqrt{377} \sin(6.27 \times 10^3 t - 2.09 \times 10^{-5} x) \text{ N/C}$

The average power of the electromagnetic wave is $(\frac{1}{\alpha}) \text{ W/m}^2$. The value of α is ____

(Take $\sqrt{\frac{\mu_0}{\epsilon_0}} = 377$ in SI units)

Q4. JEE Main 2026 (28 January Shift 2)

A plane electromagnetic wave is moving in free space with velocity $c = 3 \times 10^8 \text{ m/s}$ and its electric field is given as $\vec{E} = 54 \sin(kz - \omega t) \hat{j} \text{ V/m}$, where $\hat{j}$ is the unit vector along y -axis. The magnetic field vector $\vec{B}$ of the wave is:

(1) $+1.8 \times 10^{-7} \sin(kz - \omega t) \hat{i} \text{ T}$

(2) $1.4 \times 10^{-7} \sin(kz - \omega t) \hat{k} \text{ T}$

(3) $-1.8 \times 10^{-7} \sin(kz - \omega t) \hat{i} \text{ T}$

(4) $1.4 \times 10^{-7} \sin(kz - \omega t) \hat{i} \text{ T}$

Q5. JEE Main 2026 (22 January Shift 2)

A laser beam has intensity of $4.0 \times 10^{14} \text{ W/m}^2$. The amplitude of magnetic field associated with beam is ____ T.

(Take $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$ and $c = 3 \times 10^8 \text{ m/s}$)

- (1) 18.3 (2) 1.83 (3) 5.5 (4) 2.0

Q6. JEE Main 2026 (22 January Shift 1)

The electric field of a plane electromagnetic wave, travelling in an unknown nonmagnetic medium is given by,

$E_y = 20 \sin (3 \times 10^6 x - 4.5 \times 10^{14} t) \text{ V/m}$ (where x, t and other values have S.I. units). The dielectric constant of the medium is ____ (speed of light in free space is $3 \times 10^8 \text{ m/s}$)

Q7. JEE Main 2026 (23 January Shift 2)

The ratio of speeds of electromagnetic waves in vacuum and a medium, having dielectric constant $k = 3$ and permeability of $\mu = 2\mu_0$, is

(μ_0 = permeability of vacuum)

- (1) 36 : 1 (2) 3 : 2 (3) 6 : 1 (4) $\sqrt{6} : 1$

Q8. JEE Main 2026 (21 January Shift 1)

The electric field in a plane electromagnetic wave is given by :

$$E_y = 69 \sin [0.6 \times 10^3 x - 1.8 \times 10^{11} t] \text{ V/m.}$$

The expression for magnetic field associated with this electromagnetic wave is ____ T.

- (1) $B_z = 2.3 \times 10^{-7} \sin [0.6 \times 10^3 x - 1.8 \times 10^{11} t]$
(2) $B_z = 2.3 \times 10^{-7} \sin [0.6 \times 10^3 x + 1.8 \times 10^{11} t]$
(3) $B_y = 69 \sin [0.6 \times 10^3 x + 1.8 \times 10^{11} t]$
(4) $B_y = 2.3 \times 10^{-7} \sin [0.6 \times 10^3 x - 1.8 \times 10^{11} t]$

Q9. JEE Main 2026 (28 January Shift 1)

The electric field of an electromagnetic wave travelling through a medium is given by

$$\vec{E}(x, t) = 25 \sin (2.0 \times 10^{15} t - 10^7 x) \hat{n}$$

then the refractive index of the medium is ____.

(All given measurement are in SI units)

- (1) 1.5 (2) 1.2 (3) 1.7 (4) 2

Q10. JEE Main 2026 (24 January Shift 1)

Match the LIST-I with LIST-II

	List-I		List-II
A.	Radio-wave	I.	is produced by Magnetron valve
B.	Micro-wave	II.	due to change in the vibrational modes of atoms
C.	Infrared-wave	III.	due to inner shell electrons moving from higher to lower energy level
D.	X-ray	IV.	due to rapid acceleration of electrons

Choose the correct answer from the options given below:

(1) A-IV, B-II, C-I, D-III

(2) A-IV, B-I, C-II, D-III

(3) A-IV, B-III, C-I, D-II

(4) A-II, B-IV, C-III, D-I

ANSWERS AND SOLUTIONS

1. 1800 2. (2) 3. 2 4. (3) 5. (2) 6. 4 7. (4) 8. (1)
9. (1) 10. (2)

1. (1800) For an electromagnetic wave in a conducting medium, the maximum conduction current density is $J_{c,max} = \sigma E_0$ and maximum displacement current density is $J_{d,max} = \epsilon_0 \omega E_0$.

The ratio is: $\frac{J_{c,max}}{J_{d,max}} = \frac{\sigma}{\epsilon_0 \omega}$.

With $\sigma = 10 \text{ mho/m}$, $f = 100 \text{ MHz}$

So $\omega = 2\pi \times 10^8 \text{ rad/s}$, and $\epsilon_0 = \frac{10^{-9}}{36\pi} \text{ F/m}$: $\frac{J_{c,max}}{J_{d,max}} = \frac{10 \times 36\pi}{10^{-9} \times 2\pi \times 10^8} = \frac{10 \times 36}{2 \times 10^{-1}} = 1800$.

2. (2) Theoretical
A-II, B-III, C-IV, D-I

A. $\oint \vec{E} \cdot d\vec{l} = -\frac{d}{dt} \oint \vec{B} \cdot d\vec{a} \rightarrow$ Faraday's law of electromagnetic induction (II)

B. $\oint \vec{B} \cdot d\vec{l} = \mu_0 \left(I + \epsilon_0 \frac{d\Phi_E}{dt} \right) \rightarrow$ Ampere-Maxwell law (III)

C. $\oint \vec{E} \cdot d\vec{a} = \frac{1}{\epsilon_0} \int \rho dv \rightarrow$ Gauss's law of electrostatics (IV)

D. $\oint \vec{B} \cdot d\vec{l} = \mu_0 I \rightarrow$ Ampere's circuital law (I)

3. (2) From the electric field equation, amplitude:

$$E_0 = \sqrt{377} \text{ N/C}$$

Average intensity of EM wave:

$$I_{avg} = \frac{E_0^2}{2Z_0} \text{ where } Z_0 = \sqrt{\mu_0/\epsilon_0} = 377 \Omega$$

$$I_{avg} = \frac{(\sqrt{377})^2}{2 \times 377} = \frac{377}{2 \times 377} = \frac{1}{2} \text{ W/m}^2$$

$$\text{Given } I_{avg} = \frac{1}{\alpha} \text{ W/m}^2, \text{ we have } \frac{1}{\alpha} = \frac{1}{2}$$

Therefore, $\alpha = 2$

4. (3) For an electromagnetic wave, the relationship between electric and magnetic field amplitudes is $B_0 = \frac{E_0}{c}$.

Here $E_0 = 54 \text{ V/m}$ and $c = 3 \times 10^8 \text{ m/s}$.

$$\text{So, } B_0 = \frac{54}{3 \times 10^8} = 1.8 \times 10^{-7} \text{ T.}$$

The electric field is along the $\hat{j}$ direction.

Since the wave travels in the $+z$ direction, the magnetic field direction is determined by $\vec{E} \times \vec{B}$ pointing in the $+z$ direction.

Using the right-hand rule: $\hat{j} \times (-\hat{i}) = \hat{k}$ (positive z direction), confirming the magnetic field is in the $-\hat{i}$ direction.

$$\text{Therefore, } \vec{B} = -1.8 \times 10^{-7} \sin(kz - \omega t) \hat{i} \text{ T.}$$

5. (2) The intensity of an electromagnetic wave is

$$I = \frac{1}{2} \epsilon_0 c E_0^2.$$

From the relation $E_0 = cB_0$, we get $I = \frac{1}{2}\epsilon_0 c^3 B_0^2$.

Solving for magnetic field amplitude:

$$B_0 = \sqrt{\frac{2I}{\epsilon_0 c^3}} = \sqrt{\frac{2 \times 4.0 \times 10^{14}}{8.85 \times 10^{-12} \times (3 \times 10^8)^3}} = \sqrt{\frac{8.0 \times 10^{14}}{2.39 \times 10^{14}}} \\ = \sqrt{3.347} = 1.83 \text{ T.}$$

6. (4) From the wave equation $E_y = 20 \sin(3 \times 10^6 x - 4.5 \times 10^{14} t)$:

Wave number: $k = 3 \times 10^6 \text{ m}^{-1}$

Angular frequency: $\omega = 4.5 \times 10^{14} \text{ rad/s}$

Speed of wave in medium: $v = \frac{\omega}{k} = \frac{4.5 \times 10^{14}}{3 \times 10^6} = 1.5 \times 10^8 \text{ m/s}$

Speed of light in vacuum: $c = 3 \times 10^8 \text{ m/s}$

Refractive index: $n = \frac{c}{v} = \frac{3 \times 10^8}{1.5 \times 10^8} = 2$

For a nonmagnetic medium: $n = \sqrt{\epsilon_r}$

Dielectric constant: $\epsilon_r = n^2 = 4$

7. (4) Speed of electromagnetic wave in vacuum: $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$

Speed in a medium with permeability $\mu = 2\mu_0$ and dielectric constant $k = 3$:

$$v = \frac{1}{\sqrt{\mu\epsilon}} = \frac{1}{\sqrt{2\mu_0 \times 3\epsilon_0}} = \frac{1}{\sqrt{6\mu_0 \epsilon_0}}$$

$$v = \frac{1}{\sqrt{6}} \times \frac{1}{\sqrt{\mu_0 \epsilon_0}} = \frac{c}{\sqrt{6}}$$

Ratio of speeds: $\frac{c}{v} = \sqrt{6}$

Therefore: $c : v = \sqrt{6} : 1$

8. (1) Given $E_y = 69 \sin[0.6 \times 10^3 x - 1.8 \times 10^{11} t] \text{ V/m}$

Wave propagates along +x (form $kx - \omega t$), $\vec{E}$ is along y.

For EM wave: $\vec{E} \times \vec{B}$ = direction of propagation

$\hat{j} \times \hat{k} = \hat{i}$, so $\vec{B}$ is along z-direction.

$$B_0 = \frac{E_0}{c} = \frac{69}{3 \times 10^8} = 2.3 \times 10^{-7} \text{ T}$$

E and B are in phase for plane EM wave.

$$B_z = 2.3 \times 10^{-7} \sin[0.6 \times 10^3 x - 1.8 \times 10^{11} t] \text{ T}$$

9. (1) The electric field is $E(x, t) = 25 \sin(2.0 \times 10^{15} t - 10^7 x) \text{ V/m}$.

This is in the standard form $E = E_0 \sin(\omega t - kx)$ where angular frequency $\omega = 2.0 \times 10^{15} \text{ rad/s}$ and wave number $k = 10^7 \text{ rad/m}$.

The speed of the wave in the medium is $v = \frac{\omega}{k} = \frac{2.0 \times 10^{15}}{10^7} = 2.0 \times 10^8 \text{ m/s}$.

The refractive index is defined as $n = \frac{c}{v}$ where $c = 3.0 \times 10^8 \text{ m/s}$ is the speed of light in vacuum.

$$\text{Therefore, } n = \frac{3.0 \times 10^8}{2.0 \times 10^8} = 1.5$$

10. (2) Matching electromagnetic wave sources:

Radio-wave (A) - produced by rapid acceleration of electrons in antennas and transmitters, matches IV.

Micro-wave (B) - produced by Magnetron valve, matches I.

Infrared-wave (C) - due to change in vibrational modes of atoms and molecules, matches II.

X-ray (D) - due to inner shell electrons moving from higher to lower energy levels, matches III.

Correct pairing: A-IV, B-I, C-II, D-III