Prachand NEET 2025

Physics

Electromagnetic Waves

DPP : 01

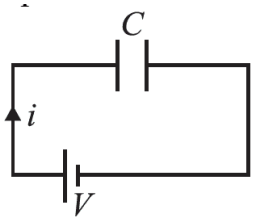
Q1 If electric field $\vec{E} = E_0 \sin(\omega t - kz)\hat{i}$ and magnetic field $\vec{B} = B_0 \sin(\omega t - kz)\hat{j}$, then electromagnetic wave travels along

(1) $+z$ direction
(2) $-y$ direction
(3) $+x$ direction
(4) $+y$ direction

Q2 Displacement current can be expressed as (symbols have their usual meanings)

(1) $\varepsilon_0 \frac{d\phi_E}{dt}$
(2) $\mu_0 \frac{d\phi_E}{dt}$
(3) $\mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$
(4) $\frac{1}{\mu_0 \varepsilon_0} \frac{d\phi_E}{dt}$

Q3 At a particular instant, the current in the circuit given below is i. The displacement current between the plates of the capacitor shown below is



(1) Zero
(2) i
(3) $\frac{i}{2}$
(4) $\frac{i}{4}$

Q4 All components of the electromagnetic spectrum in vacuum have the same;

(1) energy (2) velocity
(3) wavelength (4) frequency

Q5 Light is an electromagnetic wave. Its speed in vacuum is given by the expression

(1) $\sqrt{\mu_0 \varepsilon_0}$
(2) $\sqrt{\frac{\mu_0}{\varepsilon_0}}$
(3) $\sqrt{\frac{\varepsilon_0}{\mu_0}}$
(4) $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

Q6 The electric field in an electromagnetic wave was found to oscillate with an amplitude of $36\ \mathrm{Vm}^{-1}$. The amplitude of the oscillating magnetic field is,

(1) $6 \times 10^{-8}\ \mathrm{T}$
(2) $12 \times 10^{-8}\ \mathrm{T}$
(3) $18 \times 10^{-8}\ \mathrm{T}$
(4) $20 \times 10^{-8}\ \mathrm{T}$

Q7 The wavelength of the oscillatory magnetic field in a plane electromagnetic wave given by $B_y = 0.6 \times 10^{-5} \sin\left(4000\pi x - 5 \times 10^{10}\pi t\right)\ \mathrm{T}$ is (where x is in meter and t is in second)

(1) $0.4 \times 10^{-3}\ \mathrm{m}$
(2) $0.2 \times 10^{-3}\ \mathrm{m}$
(3) $0.5 \times 10^{-3}\ \mathrm{m}$
(4) $0.3 \times 10^{-3}\ \mathrm{m}$

Q8 An EM wave is passed through a region containing both electric and magnetic field then which of the following statements is correct ?

(1) It is deflected by both electric and magnetic field.
(2) It is deflected by electric field but not by magnetic field.
(3) It is not deflected by electric field but deflected by magnetic field.
(4) It is neither deflected by electric field nor by magnetic field.

Q9 If λ_v, λ_x and λ_m represent the wavelengths of visible light, X-rays and microwaves respectively, then

(1) $\lambda_m > \lambda_x > \lambda_v$
(2) $\lambda_m > \lambda_v > \lambda_x$
(3) $\lambda_v > \lambda_x > \lambda_m$
(4) $\lambda_v > \lambda_m > \lambda_x$

Q10 A plane electromagnetic wave travels in vacuum along z-direction. If the frequency of the wave is 40 *MHz*. Then its wavelength is;

(1) 5 *m* (2) 7.5 *m*
(3) 8.5 *m* (4) 10 *m*

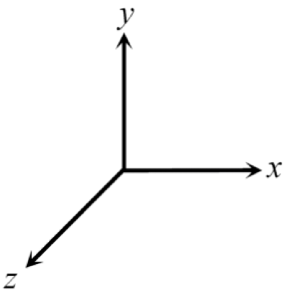
Q11 **Statement I:** The phase difference between electric and magnetic field in an EM wave is $\frac{\pi}{2}$.
Statement II: The oscillation of electric and magnetic field vectors are perpendicular to the direction of propagation of EM wave.

(1) Statement I and Statement II both are correct.
(2) Statement I is correct, but Statement II is incorrect.
(3) Statement I is incorrect, but Statement II is correct.
(4) Statement I and Statement II both are incorrect.

Q12 In an electromagnetic wave, the amplitude of electric field is $2\ \mathrm{V/m}$. The frequency of the wave is $5 \times 10^{14}\ \mathrm{Hz}$. If the wave is propagating along the $+y$ axis, then the energy density of the electric field (in $\mathrm{J/m^3}$) is;

(1) 4.425×10^{-12}
(2) 8.85×10^{-12}
(3) 44.25×10^{-12}
(4) 88.5×10^{-12}

Q13 Light wave is travelling along y-direction. If the corresponding $\vec{E}$ vector at any time is along the x-axis, the direction of $\vec{B}$ vector at that time is along



(1) y-axis (2) x-axis
(3) $+z$-axis (4) $-z$-axis

Q14 The voltage between the plates of a parallel plate capacitor of capacitance $2\mu F$ is changing at the rate of $10\ \mathrm{V/s}$. What is the displacement current in the capacitor?

(1) $2 \times 10^{-5}\ \mathrm{A}$
(2) $10^{-5}\ \mathrm{A}$
(3) $3 \times 10^{-4}\ \mathrm{A}$
(4) $10^{-4}\ \mathrm{A}$

Q15 Which of the following is not transported by electromagnetic waves?

(1) Energy (2) Momentum
(3) Charge (4) Information

Q16 An electromagnetic wave passing through vacuum is described by the equation;
$E = E_0 \sin(kx - \omega t)$ and
$B = B_0 \sin(kx - \omega t)$, then

(1) $E_0 = B_0$
(2) $E_0\omega = B_0 k$
(3) $E_0 B_0 = \omega \mathrm{k}$
(4) $E_0 k = B_0 \omega$

Q17 Choose the **incorrect** statement among the following for EM waves.

(1) Electromagnetic waves are produced by accelerated charge and oscillating charge
(2) Electromagnetic waves travel in free space with speed equal to $3 \times 10^8\ \mathrm{m/s}$
(3) Electromagnetic waves require material medium for their propagation
(4) The velocity of electromagnetic wave in a medium is decided by electric and magnetic properties of medium.

Q18 For a transparent medium, relative permeability

and permittivity, μ_r and ϵ_r, are 1.0 and 1.44 respectively. The velocity of light in this medium would be

(1) 4.32×10^8 m/s
(2) 2.5×10^8 m/s
(3) 3×10^8 m/s
(4) 2.08×10^8 m/s

Q19 The nature of electromagnetic wave is:

(1) longitudinal
(2) longitudinal stationary
(3) transverse
(4) transverse stationary

Q20 Arrange the following electromagnetic radiations in the order of increasing energy.

a : Blue light
b : Yellow light
c : X-ray
d : Radio wave

(1) a, b, d, c (2) c, a, b, d
(3) b, a, d, c (4) d, b, a, c

Q21 A parallel plate capacitor of capacitance $20\mu F$ is being charged by a voltage source whose potential is changing at the rate of 3 V/s. The conduction current through the connecting wires, and the displacement current through the plates of the capacitor, would be, respectively

(1) zero, zero
(2) zero, $60\ \mu$A
(3) $60\ \mu$A, $60\ \mu$A
(4) $60\ \mu$A, zero

Q22 Which of the following electromagnetic wave play an important role in maintaining the earth warmth or average temperature through the greenhouse effect?

(1) Visible rays
(2) Infrared waves
(3) Gamma rays
(4) Ultraviolet rays

Q23 Match **List-I** with **List-II** to find out the **correct** option.

List-I		List-II	
a.	$\oint_S \vec{E} \cdot \vec{dS} = q/\varepsilon_0$	(I)	Faraday's law of EMI
b.	$\oint_S \vec{B} \cdot \vec{dS} = 0$	(II)	Gauss's law in magnetism
c.	$\oint \vec{E} \cdot \vec{dl} = -\frac{d\phi_B}{dt}$	(III)	Maxwell-Ampere's circuital law
d.	$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$	(IV)	Gauss's law in electrostatics

(1) a - (I), b - (II), c - (III), d - (IV)
(2) a - (IV), b - (II), c - (I), d - (III)
(3) a - (IV), b - (I), c - (III), d - (II)
(4) a - (II), b - (IV), c - (III), d - (I)

Q24 I. Microwaves are used in microwave oven for cooking purpose.
II. The frequency of microwaves is from 10^{14} to 10^{17} *Hz.*
Which amongst the given statement(s) is/are correct?

(1) Only I
(2) Only II
(3) Both I and II
(4) Neither I nor II

Q25 In a plane electromagnetic wave, which of the following has/have zero average value in one complete cycle?

a. Magnetic field
b. Magnetic energy
c. Electric field
d. Electric energy

(1) a, c (2) b, c
(3) a, d (4) All of these

Q26 Which radiations are used in treatment of muscles ache?

(1) Ultraviolet (2) Infrared
(3) Microwave (4) X-rays

Q27 The magnetic field in a plane electromagnetic wave is given by
$B_y = 2 \times 10^{-7} \sin\left(0.5 \times 10^3 x + 1.5 \times 10^{11} t\right)$ T

Write an expression for the electric field.

(1) $E_y = 60\ \sin\left(0.5 \times 10^3 x\ + 1.5 \times 10^{11}\ t\right)\ \mathrm{Vm}^{-1}$

(2) $E_x = 60\ \sin\left(0.5 \times 10^3 x\ + 1.5 \times 10^{11}\ t\right)\ \mathrm{Vm}^{-1}$

(3) $E_z = 60\ \sin\left(0.5 \times 10^3 x\ + 1.5 \times 10^{11}\ t\right)\ \mathrm{Vm}^{-1}$

(4) $E_y = 60\ \cos\left(0.5 \times 10^3 x\ + 1.5 \times 10^{11}\ t\right)\ \mathrm{Vm}^{-1}$

Q28 Average magnetic energy density in plane electromagnetic wave is x. The average electric energy density is

(1) x

(2) $2x$

(3) $\frac{x}{2}$

(4) $\sqrt{x}$

Q29 Which of the following rays is not an electromagnetic wave?

(1) X-rays (2) γ-rays

(3) β-rays (4) Heat rays

Q30 **Assertion :** Displacement current goes through the gap between the plates of a capacitor when the charge of the capacitor does not change.

Reason : The displacement current arises in the region in which the electric field is constant with time.

(1) Assertion is true, Reason is true; Reason is a correct explanation of Assertion.

(2) Assertion is true, Reason is true; Reason is not a correct explanation of Assertion.

(3) Assertion is true, Reason is false.

(4) Both Assertion and Reason are false.

Answer Key

Q1	(1)
Q2	(1)
Q3	(2)
Q4	(2)
Q5	(4)
Q6	(2)
Q7	(3)
Q8	(4)
Q9	(2)
Q10	(2)
Q11	(3)
Q12	(2)
Q13	(4)
Q14	(1)
Q15	(3)
Q16	(4)
Q17	(3)
Q18	(2)
Q19	(3)
Q20	(4)
Q21	(3)
Q22	(2)
Q23	(2)
Q24	(1)
Q25	(1)
Q26	(2)
Q27	(3)
Q28	(1)
Q29	(3)
Q30	(4)

Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Text Solution:

(1)

$\vec{E} \times \vec{B}$ give the direction of EM wave propagation

$\hat{i} \times \hat{j} = \hat{k}$

So, the wave travels along positive z direction.

Video Solution:

Q2 Text Solution:

(1)

$$i_d = \varepsilon_0 \left(\frac{d\phi_E}{dt} \right)$$

Video Solution:

Q3 Text Solution:

(2)

Displacement current = conduction current

$i_d = i$

Video Solution:

Q4 Text Solution:

(2)

All components of electromagnetic spectrum travel in vacuum with velocity $3 \times 10^8 \text{ m/s}$.

Video Solution:

Q5 Text Solution:

(4)

$$\mu_0 = 4\pi \times 10^{-7} \, N/A^2,$$

$$\varepsilon_0 = 8.85 \times 10^{-12} \frac{\text{C}^2}{\text{N} - \text{m}^2}$$

so $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} = 3 \times 10^8 \frac{\text{meter}}{\text{sec}}$.

Video Solution:

Q6 Text Solution:

(2)

$$B_0 = \frac{E_0}{c} = \frac{36}{3 \times 10^8} = 12 \times 10^{-8} \text{ T}$$

Video Solution:

Q7 Text Solution:

(3)

Comparing with

$B = B_0 \sin(kx - \omega t)$

$k = 4000\pi$

$$\frac{2\pi}{\lambda} = 4000\pi$$
$$\Rightarrow \lambda = 0.5 \times 10^{-3}\ \text{m}$$

Video Solution:

Q8 **Text Solution:**

(4)

EM wave is not deflected by both electric and magnetic field.

Video Solution:

Q9 **Text Solution:**

(2)

In visible light, X-rays and microwaves,
X-ray has lowest wavelength and microwaves has highest wavelength.

$$\lambda_m > \lambda_v > \lambda_x$$

Video Solution:

Q10 **Text Solution:**

(2)

$\lambda = \frac{c}{f} = \frac{3\times10^8}{40\times10^6} = 7.5\ m$

Video Solution:

Q11 **Text Solution:**

(3)

In EM wave, oscillating electric and magnetic field are in phase and perpendicular to each other and also perpendicular to the wave propagation.

Video Solution:

Q12 **Text Solution:**

(2)

Energy density due to electric field is given by

$$u_E = \frac{1}{2}\varepsilon_0 {E_{rms}}^2 = \frac{1}{2}\varepsilon_0\left(\frac{E_0}{\sqrt{2}}\right)^2$$
$$= \frac{1}{4}\varepsilon_0 E_0^2 = \frac{1}{4} \times 8.85 \times 10^{-12} \times 2^2$$
$$= 8.85 \times 10^{-12}\ \text{J/m}^3$$

Video Solution:

Q13 **Text Solution:**

(4)

Direction of wave propagation is given by $\vec{E} \times \vec{B}$.

$Direction\ of\ E \rightarrow \hat{i}$

$Direction\ of\ wave\ propagation \rightarrow \hat{j}$

$\hat{i} \times -\hat{k} = \hat{j}$

So magnetic field will be along $-\hat{k}$, i.e. negative z axis.

Video Solution:

Q14 **Text Solution:**

(1)

$$I_D = \varepsilon_0 \frac{d}{dt}(\phi_E) = \varepsilon_0 \frac{d}{dt}(EA)$$
$$= \varepsilon_0 \frac{d}{dt}\left(\frac{V}{d}A\right) = \frac{\varepsilon_0 A}{d}\left(\frac{dV}{dt}\right) = C \times \frac{dV}{dt}$$
$$= \left(2 \times 10^{-6}\right) \times 10 = 2 \times 10^{-5}\ \text{A}$$

Video Solution:

Q15 **Text Solution:**

(3)

An electromagnetic wave transports energy, momentum and communication signals (information transported by radio waves), but it does not transport the charge.

Video Solution:

Q16 **Text Solution:**

(4)

We know $\frac{E_0}{B_0} = c =$ speed of EM wave

$$\Rightarrow \quad \frac{E_0}{B_0} = \frac{\omega}{k}$$
$$\Rightarrow \quad E_0 k = B_0 \omega$$

Video Solution:

Q17 **Text Solution:**

(3)

Electromagnetic waves do not require material medium for their propagation.

Video Solution:

Q18 **Text Solution:**

(2)

$$v = \frac{1}{\sqrt{\mu \in}} = \frac{c}{\sqrt{\mu_r \epsilon_r}} = \frac{3 \times 10^8}{\sqrt{1 \times 1.44}}$$
$$= \frac{3 \times 10^8}{1.2} = 2.5 \times 10^8\ \text{m/s}$$

Video Solution:

Q19 **Text Solution:**

(3)

EM waves are transverse in nature. Electric and magnetic fields in the wave oscillate in a plane that is perpendicular to the direction of the

wave's propagation.

Video Solution:

Q20 **Text Solution:**

(4)

Increasing order of frequency for the given waves is

$\nu_{radio} < \nu_{yellow} < \nu_{blue} < \nu_{X-ray}$

$E = h\nu$

$E \propto \nu$

Increasing order of energy will be

$E_{radio} < E_{yellow} < E_{blue} < E_{X-ray}$

Video Solution:

Q21 **Text Solution:**

(3)

Here, $C = 20\ \mu\text{F}$

The rate of change of potential $= 3\ \text{V/s}$

The charge on the capacitor, $Q = CV$

$$\therefore \frac{dQ}{dt} = I_D = C\frac{dV}{dt} = 20\mu F \times \frac{3V}{s}$$
$$= 60\mu\text{A}$$

Displacement current in equal to the conduction current.

Video Solution:

Q22 **Text Solution:**

(2)

The greenhouse effect is a natural process that warms the Earth's surface. When the Sun's energy reaches the Earth, it is absorbed by the surface and then radiated back to the atmosphere as infrared radiation (heat). Greenhouse gases in the atmosphere, such as carbon dioxide, methane, and water vapor, absorb and re-emit this infrared radiation. This process traps heat in the atmosphere, preventing it from escaping into space and thereby warming the Earth.

So, Infrared waves play an important role in maintaining the earth warmth or average temperature through the greenhouse effect

Video Solution:

Q23 **Text Solution:**

(2)

$\oint_S \vec{E} \cdot \vec{dS} = q/\varepsilon_0$ --- Gauss's law in electrostatics

$\oint_S \vec{B} \cdot \vec{dS} = 0$ -----Gauss's law in magnetism

$\oint \vec{E} \cdot \vec{dl} = -\frac{d\phi_B}{dt}$ ------Faraday's law of EMI

$\oint \vec{B} \cdot \vec{dl} = \mu_0 I_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$ -----Maxwell-Ampere's circuital law

Video Solution:

Q24 **Text Solution:**

(1)

Microwaves are used in a microwave oven for cooking purposes, as they generate heat by causing water molecules within food to vibrate, effectively cooking the food quickly and efficiently

The frequency of microwaves is

from $10^9\ Hz\ to\ 10^{12}\ Hz$

Only I is correct.

Video Solution:

Q25 **Text Solution:**

(1)

$E = E_0 \sin(\omega t - kx)$

$B = B_0\ \sin(\omega t - kx)$

The average value of sinusoidal function is zero over one cycle

Video Solution:

Q26 **Text Solution:**

(2)

Infrared radiations are used in treatment of muscles ache

Video Solution:

Q27 **Text Solution:**

(3)

Accorrding to the given equation,

$\mathrm{B_0}\ =\ 2\ \times 10^{-7}\ \mathrm{T}$

The em wave is travelling along negative x axis and the direction of magnetic field is along Y axis.

The peak value of electric field is

$\mathrm{E_0}\ =\ \mathrm{cB_0}$

$\mathrm{E_0}\ = 3 \times 10^8 \times 2 \times 10^{-7}$

$\mathrm{E_0}\ =\ 60\ \mathrm{V/m}$

The direction of em wave is given by $\overrightarrow{\mathrm{E}}\ \times\ \overrightarrow{\mathrm{B}}$

Thus, the electric field travels along z axis.

The equation of electric field is given by

$\mathrm{E_z}\ = 60\ \sin\left(0.5 \times 10^3\ \mathrm{x}\ +\ 1.5 \times 10^{11}\ \mathrm{t}\right)$ $\mathrm{V/m}$

Video Solution:

Q28 **Text Solution:**

(1)

For an electromagnetic wave, the average electric energy density is equal to average magnetic energy density.

Video Solution:

Q29 **Text Solution:**

(3)

Electromagnetic waves are radiated by an oscillatory charge, and are made up of varying electric and magnetic fields that are perpendicular to each other and to the direction of the wave's propagation

Beta rays are fast-moving electrons emitted by radioactive elements. These are not EM waves.

Video Solution:

Q30 **Text Solution:**

(4)

Displacement current arises when electric field in a region is changing with time, which is given by

$I_D = \varepsilon_0 \frac{d\phi_E}{dt} = \varepsilon_0 \frac{d(EA)}{dt} = \varepsilon_0 A \frac{dE}{dt}$

It will happen when charge on capacitor does not remain constant but changes with time.

Both Assertion and Reason are false.

Video Solution: