

Electromagnetic Waves — NEET Physics PYQ (2005-2021)

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NEET 2021

1. For a plane electromagnetic wave propagating in x-direction, which one of the following combination gives the correct possible directions for electric field (E) and magnetic field (B) respectively ?

- (A) $\hat{j} + \hat{k}, \hat{j} + \hat{k}$
- (B) $-\hat{j} + \hat{k}, -\hat{j} - \hat{k}$
- (C) $\hat{j} + \hat{k}, -\hat{j} - \hat{k}$
- (D) $-\hat{j} + \hat{k}, -\hat{j} + \hat{k}$

NEET 2020 · Q137

2. The ratio of contributions made by the electric field and magnetic field components to the intensity of an electromagnetic wave is : (c = speed of electromagnetic waves)

- (A) c : 1
- (B) 1 : 1
- (C) 1 : c
- (D) 1 : c²

NEET 2020 · Q150

3. Light with an average flux of 20 W/cm² falls on a non-reflecting surface at normal incidence having surface area 20 cm². The energy received by the surface during time span of 1 minute is :

- (A) 10×10^3 J
- (B) 12×10^3 J
- (C) 24×10^3 J
- (D) 48×10^3 J

NEET 2019 · Q8

4. Which colour of the light has the longest wavelength?

- (A) red
- (B) blue
- (C) green
- (D) violet

NEET 2019 · Q43

5. A parallel plate capacitor of capacitance 20 μ 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:

- (A) zero, 60 μ A
- (B) 60 μ A, 60 μ A
- (C) 60 μ A, zero
- (D) zero, zero

NEET 2018 · Q18

6. An em wave is propagating in a medium with a velocity $\vec{V} = V\hat{i}$. The instantaneous oscillating electric field of this em wave is along +y axis. Then the direction of oscillating magnetic field of the em wave will be along

- (A) -y direction
- (B) +z direction
- (C) -z direction
- (D) -x direction

7. Inside a parallel plate capacitor the electric field E varies with time as t^2 . The variation of induced magnetic field with time is given by:

- (A) no variation
- (B) t^3
- (C) t
- (D) t^2

8. A $100\ \Omega$ resistance and a capacitor of $100\ \Omega$ reactance are connected in series across a 220 V source. When the capacitor is 50% charged, the peak value of the displacement current is

- (A) 2.2 A
- (B) 11 A
- (C) 4.4 A
- (D) $11\sqrt{2}\text{ A}$

9. Out of the following options which one can be used to produce a propagating electromagnetic wave?

- (A) A charge moving at constant velocity
- (B) A stationary charge
- (C) A chargeless particle
- (D) An accelerating charge

10. A radiation of energy ' E ' falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (C = Velocity of light):

- (A) E/C^2
- (B) E/C
- (C) $2E/C$
- (D) $2E/C^2$

11. Light with an energy flux of $25 \times 10^4\text{ Wm}^{-2}$ falls on a perfectly reflecting surface at normal incidence. If the surface area is 15 cm^2 , the average force exerted on the surface is:

- (A) $2.50 \times 10^{-6}\text{ N}$
- (B) $1.20 \times 10^{-6}\text{ N}$
- (C) $3.0 \times 10^{-6}\text{ N}$
- (D) $1.25 \times 10^{-6}\text{ N}$

12. The dimensions of $(\mu_0\epsilon_0)^{-1/2}$ are

- (A) $[L^{1/2} T^{-1/2}]$
- (B) $[L^{-1}T]$
- (C) $[LT^{-1}]$
- (D) $[L^{1/2} T^{1/2}]$

13. The ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacuum is equal to :

- (A) the speed of light in vacuum
- (B) reciprocal of speed of light in vacuum
- (C) the ratio of magnetic permeability to the electric susceptibility of vacuum
- (D) unity

AIPMT 2012 Prelims

14. The electric field associated with an e.m. wave in vacuum is given by $E = \hat{i} 40 \cos(kz - 6 \times 10^8 t)$, where E , z and t are in volt/m, metre and seconds respectively. The value of wave vector k is

- (A) 3 m^{-1}
- (B) 2 m^{-1}
- (C) 0.5 m^{-1}
- (D) 6 m^{-1}

AIPMT 2011 Prelims

15. The dimensions of $(\mu_0 \epsilon_0)^{-1/2}$ are

- (A) $[L^{-1/2} T^{1/2}]$
- (B) $[L^{1/2} T^{-1/2}]$
- (C) $[L^{-1} T]$
- (D) $[LT^{-1}]$

AIPMT 2011 Prelims

16. The electric and the magnetic field, associated with an e.m. wave, propagating along the $+z$ -axis, can be represented by

- (A) $E = E_0 \hat{j}$, $B = B_0 \hat{k}$
- (B) $E = E_0 \hat{i}$, $B = B_0 \hat{j}$
- (C) $E = E_0 \hat{k}$, $B = B_0 \hat{i}$
- (D) $E = E_0 \hat{j}$, $B = B_0 \hat{i}$

AIPMT 2011 Prelims

17. The decreasing order of wavelength of infrared, microwave, ultraviolet and gamma rays is

- (A) Infrared, microwave, ultraviolet, gamma rays
- (B) Microwave, infrared, ultraviolet, gamma rays
- (C) Gamma rays, ultraviolet, infrared, microwaves
- (D) Microwaves, gamma rays, infrared, ultraviolet

AIPMT 2010 Mains · Q67

18. The electric field of an electromagnetic wave in free space is given by $E = 10 \cos(10^7 t + kx) \hat{j} \text{ V/m}$, where t and x are in seconds and metres respectively. It can be inferred that

- (a) The wavelength λ is 188.4 m
- (b) The wave number k is 0.33 rad/m
- (c) The wave amplitude is 10 V/m
- (d) The wave is propagating along $+x$ direction

Which one of the following pairs of statements is correct?

- (A) (c) & (d)
- (B) (a) & (b)
- (C) (b) & (c)
- (D) (a) & (c)

AIPMT 2010 Prelims · Q22

19. Which of the following statement is false for the properties of electromagnetic waves?

- (A) These waves do not require any material medium for propagation
- (B) Both electric and magnetic field vectors attains the maxima and minima at the same place and same time
- (C) The energy in electromagnetic wave is divided equally between electric and magnetic vectors
- (D) Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave

20. The electric field part of an electromagnetic wave in a medium is represented by

$$E_x = 0;$$

$$E_y = 2.5 \text{ (N/C)} \cos[(2\pi \times 10^6 \text{ rad/s}) t - (\pi \times 10^{-2} \text{ rad/m}) x];$$

$E_z = 0$. The wave is:

- (A) moving along x direction with frequency 10^6 Hz and wave length 100 m
- (B) moving along x direction with frequency 10^6 Hz and wave length 200 m
- (C) moving along $-x$ direction with frequency 10^6 Hz and wave length 200 m
- (D) moving along y direction with frequency $2\pi \times 10^6$ Hz and wave length 200 m

21. The velocity of electromagnetic radiation in a medium of permittivity ϵ_0 and permeability μ_0 is given by

- (A) $\sqrt{(\mu_0/\epsilon_0)}$
- (B) $\sqrt{(\epsilon_0/\mu_0)}$
- (C) $\sqrt{(\mu_0\epsilon_0)}$
- (D) $1/\sqrt{(\mu_0\epsilon_0)}$

22. The electric and magnetic field of an electromagnetic wave are

- (A) in opposite phase and perpendicular to each other
- (B) in opposite phase and parallel to each other
- (C) in phase and perpendicular to each other
- (D) in phase and parallel to each other

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

- (A) $\lambda_m > \lambda_x > \lambda_v$
- (B) $\lambda_v > \lambda_m > \lambda_x$
- (C) $\lambda_m > \lambda_v > \lambda_x$
- (D) $\lambda_v > \lambda_x > \lambda_m$

Answer key and explanations

1. Answer: (B) $-\hat{j} + \hat{k}$, $-\hat{j} - \hat{k}$

E and B must be perpendicular and $E \times B$ must point along $+x$. For $E = -\hat{j} + \hat{k}$ and $B = -\hat{j} - \hat{k}$: $E \cdot B = 1 - 1 = 0$, and $E \times B = (-\hat{j}) \times (-\hat{k}) + \hat{k} \times (-\hat{j}) = \hat{i} + \hat{i} = 2\hat{i}$. The pairs with E and B along the same or opposite lines (such as $\hat{j} + \hat{k}$ with $-\hat{j} - \hat{k}$) give $E \times B = 0$.

2. Answer: (B) 1 : 1

The electric energy density $\frac{1}{2}\epsilon_0 E^2$ equals the magnetic energy density $B^2/2\mu_0$ because $E = cB$ and $c^2 = 1/\mu_0\epsilon_0$, so both fields contribute equally to intensity. The ratio $E/B = c$ is about field amplitudes, not about energy.

3. Answer: (C) 24×10^3 J

Power received = $20 \text{ W/cm}^2 \times 20 \text{ cm}^2 = 400 \text{ W}$, and in 60 s the energy is $400 \times 60 = 24 \times 10^3 \text{ J}$.

Doubling for reflection is not needed because the surface is non-reflecting; that only affects momentum transfer anyway.

4. Answer: (A) red

In the visible spectrum wavelength decreases from red (about 700 nm) to violet (about 400 nm), so red has the longest wavelength. Violet is the shortest-wavelength end.

5. Answer: (B) 60 μ A, 60 μ A

Conduction current $I = C \, dV/dt = 20 \times 10^{-6} \times 3 = 60 \, \mu\text{A}$. Displacement current between the plates equals the conduction current in the wires, so both are 60 μA . Saying the displacement current is zero ignores Maxwell's correction.

6. Answer: (B) $+z$ direction

The direction of propagation is along $E \times B$. With E along $\hat{j}$ and propagation along $\hat{i}$, B must be along $\hat{k}$ because $\hat{j} \times \hat{k} = \hat{i}$. Choosing $-z$ would reverse the propagation direction.

7. Answer: (C) t

The induced magnetic field comes from the displacement current, $I_d = \epsilon_0 d\Phi_E/dt$, which is proportional to dE/dt . If $E \propto t^2$, then $dE/dt \propto t$, so $B \propto t$. $B \propto t^2$ would wrongly assume the field depends on E itself rather than on its rate of change.

8. Answer: (A) 2.2 A

The displacement current between the plates equals the conduction current in the circuit. Impedance $Z = \sqrt{(100^2 + 100^2)} = 100\sqrt{2} \Omega$, and the peak voltage of a 220 V (rms) supply is $220\sqrt{2}$ V, so the peak current is $220\sqrt{2}/(100\sqrt{2}) = 2.2$ A. The '50% charged' detail does not change the peak value.

9. Answer: (D) An accelerating charge

Only an accelerating charge produces time-varying electric and magnetic fields that detach and propagate as an electromagnetic wave. A stationary charge gives only a static field and a uniformly moving charge gives a steady current-like field that does not radiate.

10. Answer: (C) $2E/c$

Radiation of energy E carries momentum E/c . A perfect reflector sends it back with the same magnitude, so the change in momentum is $E/c - (-E/c) = 2E/c$. E/c would be the answer only for a perfectly absorbing surface.

11. Answer: (A) 2.50×10^{-6} N

For a perfect reflector the momentum change doubles, $F = 2IA/c = 2 \times 25 \times 10^4 \times 15 \times 10^{-4}/(3 \times 10^8) = 2.5 \times 10^{-6}$ N. Using IA/c (absorbing surface) would give half this.

12. Answer: (C) $[LT^{-1}]$

Since $c = 1/\sqrt{(\mu_0\epsilon_0)}$, the quantity $(\mu_0\epsilon_0)^{-1/2}$ is simply the speed of light and has dimensions $[LT^{-1}]$. The inverse $[L^{-1}T]$ would be the dimensions of $\sqrt{(\mu_0\epsilon_0)}$ itself.

13. Answer: (B) reciprocal of speed of light in vacuum

In vacuum $E_0 = cB_0$, so $B_0/E_0 = 1/c$, the reciprocal of the speed of light. The speed of light itself is the ratio E_0/B_0 , the reverse.

14. Answer: (B) 2 m^{-1}

From $E = E_0 \cos(kz - \omega t)$, $\omega = 6 \times 10^8 \text{ rad s}^{-1}$. In vacuum $c = \omega/k$, so $k = 6 \times 10^8/(3 \times 10^8) = 2 \text{ m}^{-1}$. 0.5 m^{-1} comes from inverting the ratio.

15. Answer: (D) $[LT^{-1}]$

Since $c = 1/\sqrt{(\mu_0\epsilon_0)}$, the quantity $(\mu_0\epsilon_0)^{-1/2}$ is simply the speed of light and has dimensions $[LT^{-1}]$. The inverse $[L^{-1}T]$ would be the dimensions of $\sqrt{(\mu_0\epsilon_0)}$ itself, not its inverse root.

16. Answer: (B) $E = E_0\hat{i}$, $B = B_0\hat{j}$

An EM wave travels along $E \times B$, with E and B perpendicular to each other and to the propagation direction. With E along $\hat{i}$ and B along $\hat{j}$, $\hat{i} \times \hat{j} = \hat{k}$, i.e. $+z$. E along $\hat{j}$ with B along $\hat{i}$ gives $\hat{j} \times \hat{i} = -\hat{k}$, the reverse direction.

17. Answer: (B) Microwave, infrared, ultraviolet, gamma rays

In the EM spectrum wavelength falls from microwaves (mm-cm) to infrared (μm) to ultraviolet ($\sim 100 \text{ nm}$) to gamma rays ($< 0.01 \text{ nm}$). The order starting with gamma rays is increasing, not decreasing, wavelength.

18. Answer: (D) (a) & (c)

Here $\omega = 10^7 \text{ rad/s}$, so $k = \omega/c = 10^7/(3 \times 10^8) = 0.033 \text{ rad/m}$ and $\lambda = 2\pi/k \approx 188.4 \text{ m}$; the amplitude is 10 V/m . So the wavelength and amplitude statements are correct. The wave number is 0.033 , not 0.33 rad/m , and the phase $(\omega t + kx)$ means the wave travels along $-x$, not $+x$.

19. Answer: (D) Both electric and magnetic field vectors are parallel to each other and perpendicular to the direction of propagation of wave

In an electromagnetic wave E and B are perpendicular to each other and both perpendicular to the direction of propagation, so saying they are parallel to each other is false. The other statements (no medium needed, in-phase maxima, equal energy sharing) are true.

20. Answer: (B) moving along x direction with frequency 10^6 Hz and wave length 200 m

Comparing with $E_0 \cos(\omega t - kx)$: $\omega = 2\pi \times 10^6 \text{ rad/s}$ gives $f = 10^6 \text{ Hz}$, and $k = \pi \times 10^{-2} \text{ rad/m}$ gives $\lambda = 2\pi/k = 200 \text{ m}$. The $(\omega t - kx)$ form means propagation along $+x$. Taking $f = 2\pi \times 10^6 \text{ Hz}$ confuses ω with f .

21. Answer: (D) $1/\sqrt{\mu_0\epsilon_0}$

Maxwell's equations give the wave speed $v = 1/\sqrt{\mu\epsilon}$; with ϵ_0 and μ_0 this is $c = 1/\sqrt{\mu_0\epsilon_0} \approx 3 \times 10^8$ m/s. $\sqrt{\mu_0\epsilon_0}$ is its inverse, with dimensions of time per length, and $\sqrt{\mu_0/\epsilon_0}$ is the impedance of free space (in ohms), not a speed.

22. Answer: (C) in phase and perpendicular to each other

In a plane EM wave, E and B oscillate in phase (both reach maxima together) and are perpendicular to each other and to the direction of propagation.

23. Answer: (C) $\lambda_m > \lambda_v > \lambda_x$

In the EM spectrum microwaves (mm-cm) are longer than visible light (400–700 nm), which is longer than X-rays (≈ 0.01 –10 nm). So $\lambda_m > \lambda_v > \lambda_x$.

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