PART 2

OLYMPIAD WALLAH

ADVANCED PHYSICS

FOR JEE & OLYMPIAD 2025

FOR 12th STANDARD STUDENTS

Ultimate Resource for NSEP Preparation

CONTENTS

EXERCISE-1

1. The velocity of electromagnetic waves in a dielectric medium ($\in_r = 4$) is :-
(A) 3×10^8 metre/second
(B) 1.5×10^8 metre/second
(C) 6×10^8 metre/second
(D) 7.5×10^7 metre/second

2. The radio station that broadcasts your favorite music is located exactly north of your home; it uses a horizontal electric dipole antenna directed north-south. In order to receive this broadcast, you need to
(A) orient the receiving antenna horizontally, north-south
(B) orient the receiving antenna horizontally, east-west
(C) use a vertical receiving antenna
(D) move to a town farther to the east or to the west.
(E) use a magnetic dipole antenna instead of an electric dipole antenna

3. Which of these statements correctly describes the orientation of the electric field $(\vec{E})$, the magnetic field $(\vec{B})$, and velocity of propagation $(\vec{v})$ of an electromagnetic wave?
(A) $\vec{E}$ is perpendicular to $\vec{B}$; $\vec{v}$ may have any orientation relative to $\vec{E}$.
(B) $\vec{E}$ is perpendicular $\vec{B}$; $\vec{v}$ may have any orientation perpendicular to $\vec{E}$
(C) $\vec{E}$ is parallel to $\vec{B}$: $\vec{v}$ is perpendicular to both $\vec{E}$ and $\vec{E}$.
(D) Each of the three vectors is perpendicular to the other two.

4. A dipole radio transmitter has its rod-shaped antenna oriented vertically. At a point due south of the transmitter, the radio waves have their magnetic field.
(A) oriented north-south
(B) oriented east-west
(C) oriented vertically
(D) oriented in any horizontal direction

5. A vertical electric dipole antenna
(A) radiates uniformly in all direction
(B) radiates uniformly in all horizontal directions but more strongly in the vertical direction.
(C) radiates most strongly and uniformly in the horizontal directions
(D) does not radiate in the horizontal directions.

6. The amplitude of electric field in a parallel light beam of intensity $4Wm^{-2}$ is:
(A) $35.5\ NC^{-1}$ (B) $45.5\ NC^{-1}$
(C) $49.5\ NC^{-1}$ (D) $54.8\ NC^{-1}$

7. Instantaneous displacement current of 1.0A in the space between the parallel plates of 1μF capacitor can be established by changing potential difference of:
(A) 10^{-6} V/s (B) 10^6 V/s
(C) 10^{-8} V/s (D) 10^8 V/s

8. A plane electromagnetic wave, $E_z = 100 \cos (6 \times 10^8 t + 4x)$ V/m propagates in a medium of dielectric constant:
(A) 1.5 (B) 2.0
(C) 2.4 (D) 4.0

9. A large parallel plane capacitor, whose plates have an area of 1 m^2 and are separated from each other by 1 mm, is being charged at a rate of 25.8 V/s. If the dielectric between the plates has the dielectric constant 10, then the displacement current at this instant is:-
(A) 251 μA (B) 11 μA
(C) 2.2 μA (D) l.1 μA

10. The rms value of the electric field of the light coming from the sun is 720 N/c. The average total energy density of the electromagnetic wave is:
(A) $4.58 \times 10^{-6}\ J/m^3$ (B) $6.37 \times 10^{-9}\ J/m^3$
(C) $81.35 \times 10^{-12}\ J/m^3$ (D) $3.3 \times 10^{-3}\ J/m^3$

11. A beam of light travelling along x-axis is described by the electric field, $E_y = (600\ Vm^{-1})\sin\omega(t - x/c)$ then maximum magnetic force on a charge q = 2e, moving along y-axis with a speed of $3.0 \times 10^7\ ms^{-1}$ is ($e = 1.6 \times 10^{-19}$ C):

(A) 19.2×10^{-17} N (B) 1.92×10^{-17} N

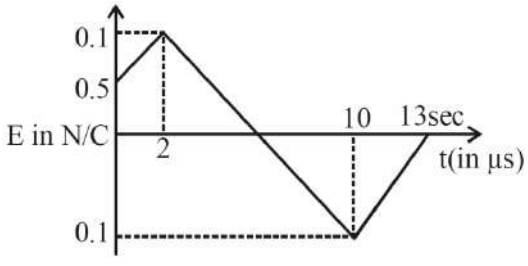
(C) 0.192 N (D) None of these

12. A plane electromagnetic wave travels in free space along x-axis. At a particular point in space, the electric field along y-axis is 9.3 Vm^{-1}. The magnetic induction is:

(A) 3.1×10^{-8} T (B) 3×10^{-5} T

(C) 3.1×10^{-6} T (D) 9.3×10^{-6} T

13. The electric field through an area of $2m^2$ varies with time as shown in the graph. The greatest displacement current through the area is at:-



(A) t = 1 sec.

(B) t = 4 sec.

(C) t = 8 sec.

(D) t = 12 sec.

14. An electric dipole antenna is kept at the origin. The dipole is oriented along y-axis. As the antenna radiates electromagnetic waves, at a point on x-axis.

(A) There is no electromagnetic wave.

(B) Electric field is along y-direction and magnetic field along z-direction

(C) Electric field is along z-direction and magnetic field is along y-direction

(D) Electric field is along x-direction and magnetic field is along y-direction.

15. A plane electromagnetic wave travelling along the X-direction has a wavelength of 3mm. The variation in the electric field occurs in the Y-direction with an amplitude $66Vm^{-1}$. The equation for the electric and magnetic fields as a function of x and t are respectively.

(A) $E_y = 33\cos\pi \times 10^{11}\left(t - \frac{x}{c}\right)$:

$B_z = 1.1 \times 10^{-7}\cos\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

(B) $E_y = 11\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$;

$B_y = 1.1 \times 10^{-7}\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

(C) $E_x = 33\cos\pi \times 10^{11}\left(t - \frac{x}{c}\right)$;

$B_x = 1.1 \times 10^{-7}\cos\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

(D) $E_y = 66\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$;

$B_z = 2.2 \times 10^{-7}\cos 2\pi \times 10^{11}\left(t - \frac{x}{c}\right)$

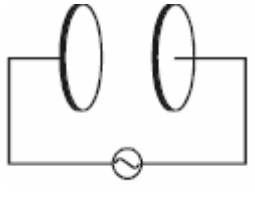
EXERCISE-2

1. A parallel plate capacitor (fig.) made of circular plates each of radius R = 6.0 cm has a capacitance C = 100 μF. The capacitor is connected to a 230 V ac supply with a (angular) frequency of 300 rad s^{-1}.

(a) What is the rms value of the conduction current?

(b) Is the conduction current equal to the displacement current?

(c) Determine the amplitude of B at a point 3.0 cm from the axis between the plates.



2. The amplitude of the magnetic field part of a harmonic electromagnetic wave in vacuum is $B_0 = 510\text{nT}$. What is the amplitude of the electric field part of the wave?

3. In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of $2.0 \times 10^{10}\text{Hz}$ and amplitude 48 V m^{-1}.

(a) What is the wavelength of the wave?

(b) What is the amplitude of the oscillating magnetic field?

(c) Show that the average energy density of the E field equals the average energy density of the B field. [$c = 3 \times 10^8$ m s^{-1}]

4. Suppose that the electric field part of an electromagnetic wave in vaccum is

E = {(3.l N/C) cos [(1.8 rad/m) y

+ $(5.4 \times 10^8$ rad/s)t] $\hat{i}$.

(a) What is the direction of propagation?

(b) What is the wavelength λ?

(c) What is the frequency v?

(d) What is the amplitude of the magnetic field part of the wave?

(e) Write an expression for the magnetic field part of the wave.

5. A plane electromagnetic wave traveling in the positive direction of x axis in vaccum has components

$E_x = E_y = 0$ and $E_z = (2.0\text{ V/m})$

cos [$(\pi \times 10^{15}\ S^{-1})$ (t – x/c)].

(a) What is the amplitude of the magnetic field component?

(b) Parallel to which axis does the magnetic field oscillate?

(c) When the electric field component is in the positive direction of the z axis at a certain point P, what is the direction of the magnetic field component there?

6. An open circuit consists of a 12 μF parallel plate capacitor charged to 200V and a 10 Ω resistor. At the instant when a switch closes the circuit (with no battery in it) the displacement current between the, plates of the capacitor is

7. Two coherent waves are described by the following expressions.

$$E_1 = E_0 \sin\left(\frac{2\pi x_1}{\lambda} - 2\pi ft + \frac{\pi}{6}\right);$$

$$E_2 = E_0 \sin\left(\frac{2\pi x_2}{\lambda} - 2\pi ft + \frac{\pi}{8}\right)$$

Determine the relationship between x_1 and x_2 that produces constructive interference when the two waves are superposed.

8. A nickel crystal is used as a diffraction grating for x-rays. Then the same crystal is used to diffract electrons. If the two diffraction patterns are identical, and the energy of each x-ray photon is E = 20.0 keV. What is the kinetic energy of each electron?

JEE MAINS PYQ

1. The rms value of the electric field of the light coming from the sun is 720 N/C. The average total energy density of the electromagnetic wave is :- **[AIEEE-2]**

(A) 4.58×10^{-6} J/m^3 (B) 6.37×10^{-9} J/m^3

(C) 81.35×10^{-12} J/m^3 (D) 3.3×10^{-3} J/m^3

2. An electromagnetic wave in vacuum has the electric and magnetic fields $\vec{E}$ 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 **[AIEEE-2012]**

(A) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$

(B) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$

(C) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$

(D) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$

3. During the propagation of electromagnetic waves in a medium : **[JEE-Mains 2014]**

(A) Electric energy density is equal to the magnetic energy density

(B) Both electric magnetic energy densities are zero

(C) Electric energy density is double of the magnetic energy density

(D) Electric energy density is half of the magnetic energy density.

4. An EM wave from air enters a medium. The electric field are $\vec{E}_1 = E_0\hat{x}\cos\left[2\pi\nu\left(\frac{z}{c}-t\right)\right]$ in ari and $\vec{E}_2 = E_{02}\hat{x}\cos\left[k(2z-ct)\right]$ in medium, where the wave number k and frequency ν refer to their values in air. The medium is non-magnetic. If ε_{r_1} and ε_{r_2} refer to relative permittivities of air and medium respectively, which of the following options is **correct?**

[JEE-Mains 2018]

(A) $\frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} = \frac{1}{2}$ (B) $\frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} = 4$

(C) $\frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} = 2$ (D) $\frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} = \frac{1}{4}$

5. 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 will be : **[JEE-Mains 2019]**

(A) $18.9\times10^{-8}\hat{k}T$ (B) $6.3\times10^{-8}\hat{k}T$

(C) $2.1\times10^{-8}\hat{k}T$ (D) $18.9\times10^{-8}\hat{k}T$

6. The energy associated with electric field is (U_E) and with magnetic field is (U_B) for an electromagnetic wave in free space. Then : **[JEE-Mains 2019]**

(A) $U_E = \frac{U_B}{2}$ (B) $U_E > U_B$

(C) $U_E < U_B$ (D) $U_E = U_B$

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

[JEE-Mains 2019]

(A) 4.5×10^4 N/C (B) 6×10^4 N/C

(C) 4×10^4 N/C (D) 3×10^4 N/C

8. The electric field of a plane polarized electromagnetic wave in free space at time t= 0 is given by an expression $\vec{E}(x,y) = 10\hat{j}\cos[(6x + 8z)]$. The magnetic field $\vec{B}$ (x, z, t) is given by: (c is the velocity of light)

[JEE-Mains 2019]

(A) $\frac{1}{c}\left(6\hat{k}+8\hat{i}\right)\cos\left[(6x-8z+10ct)\right]$

(B) $\frac{1}{c}\left(6\hat{k}-8\hat{i}\right)\cos\left[(6x+8z+10ct)\right]$

(C) $\frac{1}{c}\left(6\hat{k}-8\hat{i}\right)\cos\left[(6x+8z-10ct)\right]$

(D) $\frac{1}{c}\left(6\hat{k}+8\hat{i}\right)\cos\left[(6x+8z-10ct)\right]$

9. An electromagnetic wave of intensity 50 Wm^{-2} enters in a medium of refractive index 'n' without any loss. The ratio of the magnitudes of electric fields, and the ratio of the magnitudes of magnetic fields of the wave before and after entering into the medium are respectively, given by: **[JEE-Mains 2019]**

(A) $\left(\frac{1}{\sqrt{n}},\frac{1}{\sqrt{n}}\right)$ (B) $\left(\frac{1}{\sqrt{n}},\sqrt{n}\right)$

(C) $\left(\sqrt{n},\sqrt{n}\right)$ (D) $\left(\sqrt{n},\frac{1}{\sqrt{n}}\right)$

10. An amplitude modulated signal is plotted below:- **[JEE-Mains 2019]**

Which one of the following best describes the above signal?

(A) $(9 + \sin(4\pi\times10^4\,t))\sin(5\pi\times10^5 t)$V

(B) $(1 + 9\sin(2\pi\times10^4\,t))\sin(2.5\pi\times10^5 t)$V

(C) $(9 + \sin(2.5\pi\times10^5\,t))\sin(2\pi\times10^4 t)$V

(D) $(9 + \sin(2\pi\times10^4\,t))\sin(2.5\pi\times10^5 t)$V

11. A 27 mW laser beam has a cross-sectional area of 10 mm^2. The magnitude of the maximum electric field in this electromagnetic wave is given by [Given permittivity of space $\in_0 = 9 \times 10^{-12}$ SI units, Speed of light $c = 3 \times 10^8$ m/s]:-

[JEE-Mains 2019]

(A) 1.4 kV/m
(B) 1 kV/m
(C) 2 kV/m
(D) 0.7 kV/m

12. A light wave is incident normally on a glass slab of refractive index 1.5. If 4% of light gets reflected and the amplitude of the electric field of the incident light is 30V/m, then the amplitude of the electric field for the wave propagating in the glass medium will be:

[JEE-Mains 2019]

(A) 10 V/m
(B) 6 V/m
(C) 24 V/m
(D) 30 V/m

13. 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 :

[JEE-Mains 2019]

(A) 10^2T
(B) 10^{-4}T
(C) 1T
(D) 10^{-2}T

14. A plane electromagnetic wave travels in free space along the x-direction. The electric field component of the wave at a particular point of space and time is E = 6 Vm^{-1} along y-direction. Its corresponding magnetic field component, B would be **[JEE-Mains 2019]**

(A) 6×10^{-8} T along x-direction
(B) 2×10^{-8} T along z-direction
(C) 2×10^{-8} T along y-direction
(D) 6×10^{-8} T along z-direction

15. The magnetic field of and electromagnetic wave is given by : **[JEE-Mains 2019]**

$$\vec{B} = 1.6\times10^{-6}\cos(2\times10^{7}\,z + 6\times10^{15}\,t)(2\hat{i}+\hat{j})\frac{Wb}{m^2}$$

The associated electric field will be:

(A) $\vec{E} = 4.8\times10^{2}\cos(2\times10^{7}\,z + 6\times10^{15}\,t)(2\hat{i}+\hat{j})\frac{V}{m}$

(B) $\vec{E} = 4.8\times10^{2}\cos(2\times10^{7}\,z + 6\times10^{15}\,t)(\hat{i}-2\hat{j})\frac{V}{m}$

(C) $\vec{E} = 4.8\times10^{2}\cos(2\times10^{7}\,z + 6\times10^{15}\,t)(-\hat{i}+2\hat{j})\frac{V}{m}$

(D) $\vec{E} = 4.8\times10^{2}\cos(2\times10^{7}\,z + 6\times10^{15}\,t)(-2\hat{j}+\hat{i})\frac{V}{m}$

16. An electromagnetic wave is represented by the electric field $\vec{E} = E_0\hat{n}\sin[\omega t + (6y - 8z)]$. Taking unit vectors in x, y and z directions to be $\hat{i}, \hat{j}, \hat{k}$ the direction of propagation $\hat{s}$ is:

[JEE-Mains 2019]

(A) $\hat{s} = \frac{4\hat{j}-3\hat{k}}{5}$

(B) $\hat{s} = \frac{3\hat{i}-4\hat{j}}{5}$

(C) $\hat{s} = \left(\frac{-3\hat{j}+4\hat{k}}{5}\right)$

(D) $\hat{s} = \frac{-4\hat{j}+3\hat{j}}{5}$

17. A plane electromagnetic wave having a frequency v = 23.9 GHz propagates along the positive z-direction in free space. The peak value of the Electric Field is 60 V/m. Which among the following is the acceptable magnetic field component in the electromagnetic wave?

[JEE-Mains 2019]

(A) $\vec{B} = 2\times10^{-7}\sin(0.5\times10^{3}\,z - 1.5\times10^{11}\,t)\hat{i}$

(B) $\vec{B} = 2\times10^{-7}\sin(0.5\times10^{3}\,z + 1.5\times10^{11}\,t)\hat{i}$

(C) $\vec{B} = 60\sin(0.5\times10^{3}x + 1.5\times10^{11}t)\hat{k}$

(D) $\vec{B} = 2\times10^{-7}\sin(1.5\times10^{2}x + 0.5\times10^{11}\,t)\hat{j}$

18. Match List-I with List-II. **[JEE-Mains 2021]**

List-I		List-II	
(1)	Source of microwave frequency	(i)	Radioactive decay on nucleus
(2)	Source of infrared frequency	(ii)	Magnetron
(3)	Source of Gamma Rays	(iii)	Inner shell electrons
(4)	Source of X-rays	(iv)	Vibration of atoms and molecules
		(v)	LASER
		(vi)	RC circuit

Choose the correct answer from the options given below:

(A) (1)-(vi), (2)-(iv), (3)-(i), (4)-(v)

(B) (1)-(vi), (2)-(v), (3)-(i), (4)-(iv)

(C) (1)-(ii), (2)-(iv), (3)-(vi), (4)-(iii)

(D) (1)-(ii), (2)-(iv), (3)-(i), (4)-(iii)

19. A plane electromagnetic wave of frequency 500 MHz is travelling in vacuum along y-direction. At a particular point in space and time, $\vec{B} = 8.0\times10^{-8}\hat{z}T$. The value of electric field at this point is: (speed of light $= 3\times10^{8}\ ms^{-1}$) $\hat{x},\hat{y},\hat{z}$ are unit vectors along x, y and z-direction. **[JEE-Mains 2021]**

(A) $-24\hat{x}$ V/m (B) $2.6\hat{x}$ V/m

(C) $24\hat{x}$ V/m (D) $-2.6\hat{x}$ V/m

20. A plane electromagnetic wave propagating along y-direction can have the following pair of electric field $(\vec{E})$ and magnetic field $(\vec{B})$ components. **[JEE-Mains 2021]**

(A) E_y, B_y or E_z, B_z

(B) E_y, B_x or E_x, B_y

(C) E_x, B_z or E_z, B_x

(D) E_x, B_y or E_y, B_x

21. For an electromagnetic wave travelling in free space, the relation between average energy densities due to electric (U_e) and magnetic (U_m) fields is: **[JEE-Mains 2021]**

(A) $U_e = U_m$ (B) $U_e > U_m$

(C) $U_e < U_m$ (D) $U_e \neq U_m$

22. A plane electromagnetic wave of frequency 100 MHz is travelling in vacuum along the x-direction. At a particular point in space and time, $\vec{B} = 2.0\times10^{-8}\hat{k}T$. (where, $\hat{k}$ unit vector along z-direction) What is Er at this point? **[JEE-Mains 2021]**

(A) $0.6\hat{j}$ V/m (B) $6.0\hat{k}$ V/m

(C) $6.0\hat{j}$ V/m (D) $0.6\hat{k}$ V/m

23. In an electromagnetic wave the electric field vector and magnetic field vector are given as $\vec{E} = E_0\hat{i}$ and $\vec{B} = B_0\hat{k}$ respectively. The direction of propagation of electromagnetic wave is along: **[JEE-Mains 2021]**

(A) $(\hat{k})$ (B) $\hat{J}$

(C) $(-\hat{k})$ (D) $(-\hat{j})$

24. Intensity of sunlight is observed as 0.092 Wm^{-2} at a point in free space. What will be the peak value of magnetic field at that point?

($\varepsilon_0 = 8.85 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$) **[JEE-Mains 2021]**

(A) 2.77×10^{-8} T

(B) 1.96×10^{-8} T

(C) 8.31 T

(D) 5.88 T

25. The relative permittivity of distilled water is 81. The velocity of light in it will be:

(Given $\mu_r = 1$) **[JEE-Mains 2021]**

(A) 4.33×10^{7} m/s

(B) 2.33×10^{7} m/s

(C) 3.33×10^{7} m/s

(D) 5.33×10^{7} m/s

36. The electric field in a plane electromagnetic wave is given by **[JEE-Mains 2021]**

$$\vec{E} = 200\cos\left[\left(\frac{0.5\times10^3}{m}\right)x - \left(1.5\times10^{11}\frac{rad}{s}\times t\right)\right]\frac{V}{m}\hat{j}$$

If this wave falls normally on a perfectly reflecting surface having an area of 100 cm^2. If the radiation pressure exerted by the E.M. wave on the surface during a 10 minute exposure is $\frac{x}{10^9}\frac{N}{m^2}$. Find the value of x.

37. An electromagnetic wave of frequency 3 GHz enters a dielectric medium of relative electric permittivity 2.25 from vacuum. The wavelength of this wave in that medium will be ____ $\times 10^{-2}$ cm. **[JEE-Mains 2021]**

38. A light beam is described by $E = 800\sin\omega\left(t - \frac{x}{c}\right)$ **[JEE-Mains 2021]**

An electron is allowed to move normal to the propagation of light beam with a speed of 3×10^7 ms^{-1}. What is the maximum magnetic force exerted on the electron?

(A) 1.28×10^{-18} N (B) 1.28×10^{-21} N

(C) 12.8×10^{-17} N (D) 12.8×10^{-18} N

39. The intensity of the light from a bulb incident on a surface is 0.22 W/m^2. The amplitude of the magnetic field in this light-wave is _____$\times10^{-9}$ T. (Given: Permittivity of vacuum $\in_0 = 8.85\times10^{-12}$ $C^2N^{-1}m^{-2}$, speed of light in vacuum c = 3×10^8 ms^{-1}) **[JEE-Mains 2022]**

40. The displacement current of 4.425 μA is developed in the space between the plates of parallel plate capacitor when voltage is changing at a rate of 10^6 Vs^{-1}. The area of each plate of the capacitor is 40 cm^2. The distance between each plate of the capacitor is $x\times10^{-3}$m. The value of x is, (Permittivity of free space, $E_0 = 8.85\times10^{-12}$ C^2 N^{-1} m^{-2}) **[JEE-Mains 2022]**

41. An EM wave propagating in x-direction has a wavelength of 8 mm. The electric field vibrating y-direction has maximum magnitude of 60 Vm^{-1}. Choose the correct equations for electric and magnetic fields if the EM wave is propagating in vacuum : **[JEE-Mains 2022]**

(A) $E_y = 60\sin\left[\frac{\pi}{4}\times10^3\left(x - 3\times10^8 t\right)\right]\hat{j}Vm^{-1}$

$B_z = 2\sin\left[\frac{\pi}{4}\times10^3\left(x - 3\times10^8 t\right)\right]\hat{k}T$

(B) $E_y = 60\sin\left[\frac{\pi}{4}\times10^3\left(x - 3\times10^8 t\right)\right]\hat{j}Vm^{-1}$

$B_z = 2\times10^{-7}\sin\left[\frac{\pi}{4}\times10^3\left(x - 3\times10^8 t\right)\right]\hat{k}T$

(C) $E_y = 2\times10^{-7}\sin\left[\frac{\pi}{4}\times10^3\left(x - 3\times10^8 t\right)\right]\hat{j}Vm^{-1}$

$B_z = 60\sin\left[\frac{\pi}{4}\times10^3\left(x - 3\times10^8 t\right)\right]\hat{k}T$

(D) $E_y = 2\times10^{-7}\sin\left[\frac{\pi}{4}\times10^4\left(x - 4\times10^8 t\right)\right]\hat{j}Vm^{-1}$

$B_z = 60\sin\left[\frac{\pi}{4}\times10^4\left(x - 4\times10^8 t\right)\right]\hat{k}T$

42. Match List-I with List-II:

List-I		List-II	
(a)	Ultraviolet	(i)	Study crystal structure
(b)	Microwave	(ii)	Greenhouse effect
(c)	Infrared waves	(iii)	Sterilizing surgical instrument
(d)	X-rays	(iv)	Radar system

Choose the correct answer from the options given below: **[JEE-Mains 2022]**

(A) (a) – (iii), (b) – (iv), (c) – (ii), (d) – (i)

(C) (a) – (iii), (b) – (i), (c) – (ii), (d) – (iv)

(C) (a) – (iv), (b) – (iii), (c) – (ii), (d) – (i)

(D) (a) – (iii), (b) – (iv), (c) – (i), (d) – (ii)

43. Given below are two statements: **[JEE-Mains 2022]**

Statement-I: A time varying electric field is a source of changing magnetic field and vice-versa. Thus a disturbance in electric or magnetic field creates EM waves.

Statement-II: In a material medium. The EM wave travels with speed $v = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both statement-I and statement-II are true.
(B) Both statement-I and statement-II are false.
(C) Statement-I is correct but statement-II is false.
(D) Statement-I is incorrect but statement-II is true.

44. If electric field intensity of a uniform plane electro magnetic wave is given as

$E = [-301.6\sin(kz - \omega t)\,\hat{a}_x + 452.4\sin(k - \omega t)\,\hat{a}_y]\frac{V}{m}$

Then, magnetic intensity H of this wave in Am^{-1} will be:

[Given: Speed of light in vacuum $c = 3 \times 10^8\ ms^{-1}$, permeability of vacuum $\mu_0 = 4\pi \times 10^{-7}\ NA^{-2}$] **[JEE-Mains 2022]**

(A) $+0.8\sin(kz - \omega t)\,\hat{a}_y + 0.8\sin(kz - \omega t)\,\hat{a}_x$
(B) $+1.0\times10^{-6}\sin(kz - \omega t)\,\hat{a}_y + 1.5 \times 10^{-6}(kz - \omega t)\,\hat{a}_x$
(C) $-0.8\sin(kz - \omega t)\,\hat{a}_y - 1.2\sin(kz - \omega t)\,\hat{a}_x$
(D) $-1.0\times10^{-6}\sin(kz - \omega t)\,\hat{a}_y - 1.5 \times 10^{-6}(kz - \omega t)\,\hat{a}_x$

45. In free space, an electromagnetic wave of 3 GHz frequency strikes over the edge of an object of size $\frac{\lambda}{100}$, where λ is the wavelength of the wave in free space. The phenomenon, which happens there will be: **[JEE-Mains 2022]**

(A) Reflection (B) Refraction
(C) Diffraction (D) Scattering

46. Which is the correct ascending order of wavelengths? **[JEE-Mains 2022]**

(A) $\lambda_{visible} < \lambda_{X-ray} < \lambda_{gamma\text{-}ray} < \lambda_{microwave}$
(B) $\lambda_{gamma\text{-}ray} < \lambda_{X-ray} < \lambda_{visible} < \lambda_{microwave}$
(C) $\lambda_{X\text{-}ray} < \lambda_{gamma\text{-}ray} < \lambda_{visible} < \lambda_{microwave}$
(D) $\lambda_{microwave} < \lambda_{visible} < \lambda_{gamma\text{-}ray} < \lambda_{X\text{-}ray}$

47. The electric field in an electromagnetic wave is given by $E = 56.5\sin\omega(t - x/c)\ NC^{-1}$. Find the intensity of the wave if it is propagating along x-axis in the free space. **[JEE-Mains 2022]**

(Given $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2\ N^{-1}\ m^{-2}$)

(A) $5.65\ Wm^{-2}$ (B) $4.24\ Wm^{-2}$
(C) $1.9 \times 10^{-7}\ Wm^{-2}$ (D) $56.5\ Wm^{-2}$

48. The electromagnetic waves travel in a medium at a speed of 2.0×10^8 m/s. The relative permeability of the medium is 1.0. The relative permittivity of the medium will be: **[JEE-Mains 2022]**

(A) 2.25 (B) 4.25
(C) 6.25 (D) 8.25

49. Match List-I with List-II.

List-I		List-II	
(a)	UV rays	(i)	Diagnostic tool in medicine
(b)	X-rays	(ii)	Water purification
(c)	Microwave	(iii)	Communication, Radar
(d)	Infrared wave	(iv)	Improving visibility in foggy days

Choose the correct answer from the options given below: **[JEE-Mains 2022]**

(A) (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)
(B) (a)-(ii), (b)-(i), (c)-(iii), (d)-(iv)
(C) (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)
(D) (a)-(iii), (b)-(i), (c)-(ii), (d)-(iv)

50. A beam of light travelling along X-axis is described by the electric field $E_y = 900 \sin\omega(t - x/c)$. The ratio of electric force to magnetic force on a charge q moving along Y-axis with a speed of $3 \times 10^7\ ms^{-1}$ will be: [Given speed of light = $3 \times 10^8\ ms^{-1}$] **[JEE-Mains 2022]**

(A) 1 : 1 (B) 1 : 10
(C) 10 : 1 (D) 1 : 2

60. Match **List I** with **List II**

List I		List II	
A.	Gauss's Law in Electrostatics	I.	$\phi\vec{E}-.\vec{dl}=-\frac{d\phi_B}{dt}$
B.	Faraday's Law	II.	$\oint\vec{B}-.\overrightarrow{dA}=0$
C.	Gauss's Law in Magnetism	III.	$\oint\vec{B}-.\vec{dl}=\mu_0 i_c$ $+\mu_0\in_0\frac{d\phi_E}{dt}$
D.	Ampere-Maxwell Law	IV.	$\oint\vec{E}-.\overrightarrow{dss}=\frac{q}{\epsilon_0}$

Choose the correct answer from the options given below: **[JEE-Mains 2023]**

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

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

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

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

61. Given below are two statements:

Statement I: Electromagnetic waves are not deflected by electric and magnetic field.

Statement II: The amplitude of electric field and the magnetic field in electromagnetic waves are related to each other as $E_0=\sqrt{\frac{\mu_0}{\varepsilon_0}}B_0$.

[JEE-Mains 2023]

In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are true

(B) Statement I is true but statement II is false

(C) Both Statement I and Statement II are false

(D) Statement I is false but statement II is true

62. Match List I with List II

List I		List II	
A.	Microwaves	I.	Physiotherapy
B.	UV rays	II.	Treatment of cancer
C.	Infra-red light	III.	Lasik eye surgery
D.	X-ray	IV.	Aircraft navigation

Choose the correct answer from the options given below: **[JEE-Mains 2023]**

(A) A - IV, B - III, C - I, D – II

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

(C) A - IV, B - I, C - II, D – III

(D) A - III, B - II, C - I, D – IV

63. If a source of electromagnetic radiation having power 15kW produces 10^{16} photons per second, the radiation belongs to a part of spectrum is. (Take Planck constant $h=6\times10^{-34}$ Js)

[JEE-Mains 2023]

(A) Micro waves

(B) Ultraviolet rays

(C) Radio waves

(D) Gamma rays

64. Match List I with List II: **[JEE-Mains 2023]**

List I		List II	
A.	Microwaves	I.	Radio active decay of the nucleus
B.	Gamma rays	II.	Rapid acceleration and deceleration of electron in aerials
C.	Radio wave	III.	Inner shell electrons
D.	X-rays	IV.	Klystron valve

Choose the correct answer from the options given below:

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

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

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

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

73. Arrange the following in the ascending order of wavelength:

a. Gamma rays (λ_1)

b. x - rays (λ_2)

c. Infrared waves (λ_3)

d. Microwaves (λ_4)

Choose the most appropriate answer from the options given below **[JEE-Mains 2024]**

(A) $\lambda_1 < \lambda_2 < \lambda_3 < \lambda_4$

(B) $\lambda_2 < \lambda_1 < \lambda_4 < \lambda_3$

(C) $\lambda_4 < \lambda_3 < \lambda_2 < \lambda_1$

(D) $\lambda_4 < \lambda_3 < \lambda_1 < \lambda_2$

74. Match List I with List II :

LIST-I EM-Wave		LIST-II Wavelength Range	
A.	Infra-red	I.	10^{-3} nm
B.	Ultraviolet	II.	400 nm to 1 nm
C.	X-rays	III.	1 mm to 700 nm
D.	Gamma rays	IV.	1 nm to 10^{-3} nm

Choose the correct answer from the options given below: **[JEE-Mains 2024]**

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

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

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

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

75. Electromagnetic waves travel in a medium with speed of $1.5\times10^8\,\text{m s}^{-1}$. The relative permeability of the medium is 2.0. The relative permittivity will be: **[JEE-Mains 2024]**

(A) 4 (B) 1

(C) 2 (D) 5

76. In the given electromagnetic wave $E_y = 600\sin(\omega t - kx)\text{Vm}^{-1}$, intensity of the associated light beam is (in W/m^2 : (Given $\epsilon_0 = 9\times10^{-12}\text{C}^2\,\text{N}^{-1}\,\text{m}^{-2}$) **[JEE-Mains 2024]**

(A) 486 (B) 729

(C) 243 (D) 972

77. Average force exerted on a non-reflecting surface at normal incidence is $2.4\times10^{-4}\,\text{N}$. If $360\,\text{W/cm}^2$ is the light energy flux during span of 1 hour 30 minutes, Then the area of the surface is: **[JEE-Mains 2024]**

(A) $20\,\text{m}^2$ (B) $0.2\,\text{m}^2$

(C) $0.1\,\text{m}^2$ (D) $0.02\,\text{m}^2$

78. A plane EM wave is propagating along x direction. It has a wavelength of 4 mm . If electric field is in y direction with the maximum magnitude of 60Vm^{-1}, the equation for magnetic field is: **[JEE-Mains 2024]**

(A) $B_z = 2\times10^{-7}\sin\left[\frac{\pi}{2}\left(x - 3\times10^8 t\right)\right]\text{kT}$

(B) $B_z = 2\times10^{-7}\sin\left[\frac{\pi}{2}\times10^3\left(x - 3\times10^8 t\right)\right]\text{kT}$

(C) $B_z = 60\sin\left[\frac{\pi}{2}\left(x - 3\times10^8 t\right)\right]\text{kT}$

(D) $B_x = 60\sin\left[\frac{\pi}{2}\left(x - 3\times10^8 t\right)\right]\hat{i}\text{T}$

JEE ADVANCED PYQ

1. A pulse of light of duration 100 ns is absorbed completely by a small object initially at rest. Power of the pulse is 30 mW and the speed of light is $3\times10^8\,\text{ms}^{-1}$. The final momentum of the object is **[JEE-Adv. 2013]**

(A) $0.3\times10^{-17}\,\text{kg ms}^{-1}$

(B) $1.0\times10^{-17}\,\text{kg}-\text{ms}^{-1}$

(C) $3.0\times10^{-17}\,\text{kg}-\text{ms}^{-1}$

(D) $9.0\times10^{-17}\,\text{kg}-\text{ms}^{-1}$

2. In terms of potential difference V, electric current I, permittivity ε_0, permeability μ_0 and speed of light c, the dimensionally correct equation(s) is(are): **[JEE-Adv. 2015]**

(A) $\mu_0 I^2 = \varepsilon_0 V^2$ (B) $\varepsilon_0 I = \mu_0 V$

(C) $I = \varepsilon_0 cV$ (D) $\mu_0 cI = \varepsilon_0 V$

Answer Key

EXERCISE-1

1.	(B)	**2.**	(D)	**3.**	(D)	**4.**	(B)
5.	(C)	**6.**	(D)	**7.**	(B)	**8.**	(D)
9.	(C)	**10.**	(A)	**11.**	(B)	**12.**	(A)
13.	(D)	**14.**	(B)	**15.**	(D)		

EXERCISE-2

1. (a) $I_{rms} = V_{rms}\,\omega C = 6.9$ A

(b) Yes

(c) $B_0 = \frac{\mu_0}{2\pi}\frac{r}{R^2} i_0$, $B0 = 1.63 \times 10^{-5}$T

2. 153 N/C

3. (a) $\lambda = (c/v) = 1.5 \times 10^{-}2$ m

(b) $B_0 = (E_0/c) = 1.6 \times 10^{-7}$ T

(c) Energy density in E field:

$u_E = (1/2)\varepsilon_0 E^2$

Energy density in B field: $uB = (1/2\ \mu)\ B^2$

Using $E = cB$, and $c = \frac{1}{\sqrt{\mu_0\varepsilon_0}}$, $u_E = u_B$

4. (a) $-\hat{j}$ (b) 3.5 m

(c) 86 MHz (d) 10.3nT

(e) $[(10.3\text{nT})\cos((1.8\text{rad/m})\,y + (5.4 \times 10^8\text{rad/s})t)]\,\hat{k}$

5. (a) 6.7 nT; (b) y ;

(c) negative direction of y.

6. 20A

7. $\left(n - \frac{1}{48}\right)\lambda = x_1 - x_2$

8. (391 eV)

OLYMPIAD WALLAH

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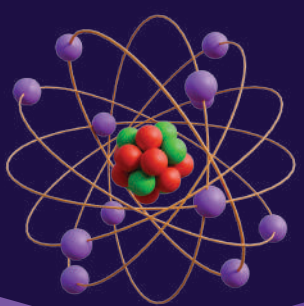

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