Electromagnetic Waves

Question1

If electromagnetic waves of power 600 W incident on a non-reflecting surface, then the total force acting on the surface is

TG EAPCET 2025 (Online) 2nd May Evening Shift

Options:

A.

12×10^{-6} N

B.

9×10^{-9} N

C.

6×10^{-6} N

D.

2×10^{-6} N

Answer: D

Solution:

When light waves with a power of 600 W hit a surface that absorbs all the light (does not reflect any), the force on the surface can be found using a formula.

The formula is: $F = \frac{P}{C}$

Here, F is the force, P is the power (600 W), and C is the speed of light (3×10^8 m/s).

Now substitute the values: $F = \frac{600}{3 \times 10^8}$

Solve this to get: $F = 2 \times 10^{-6}$ Newton

▪

Question2

The dielectric constant of a medium is 8 and its relative permeability is 200 . If an electromagnetic wave of frequency 100 MHz travels in this medium, then its wavelength is

TG EAPCET 2025 (Online) 2nd May Morning Shift

Options:

A.

15 m

B.

15 cm

C.

7.5 m

D.

7.5 cm

Answer: D

Solution:

Velocity of electromagnetic wave in medium

$$
\begin{aligned}
& v=\frac{c}{\sqrt{\mu_r \varepsilon_r}}=\frac{3 \times 10^8}{\sqrt{200 \times 8}} \\
& v=7.5 \times 10^6 \mathrm{~m/s} \\
\Rightarrow \quad & v\lambda=7.5 \times 10^6 \\
\Rightarrow \quad & \lambda=\frac{7.5 \times 10^6}{v}=\frac{7.5 \times 10^6}{100 \times 10^6} \\
& =0.075 \mathrm{~m}=7.5 \mathrm{~cm}
\end{aligned}
$$

Question3

If the peak value of the magnetic field of an electromagnetic wave is 30×10^{-9} T, then the peak value of the electric field is

TG EAPCET 2024 (Online) 10th May Morning Shift

Options:

A. $3 \mathrm{Vm}^{-1}$

B. $12 \mathrm{Vm}^{-1}$

C. $6 \mathrm{Vm}^{-1}$

D. $9 \mathrm{Vm}^{-1}$

Answer: D

Solution:

Given,

B_0 (Peak value of magnetic field)

$= 30 \times 10^{-9}$ T

Using the relation of B_0 and E_0 (Peak value of electric field)

$E_0 = c \times B_0$

where c is speed of light

$E_0 = 30 \times 10^{-9} \times 3 \times 10^8$

$E_0 = 9 \mathrm{~V/m}$

Question4

A plane electromagnetic wave of electric and magnetic fields E_0 and B_0 respectively incidents on a surface. If the total energy transferred to the surface in a time of t is U, then the magnitude of the total momentum delivered to the surface for complete absorption is

TG EAPCET 2024 (Online) 9th May Evening Shift

▪ **Options:**

A. $\frac{UE_0}{B_0}$

B. $\frac{UB_0}{E_0}$

C. $\frac{U_0}{E_0 B_0}$

D. $\frac{UB_0}{E_0^2}$

Answer: B

Solution:

We know that the momentum transferred by EM wave $=\frac{U}{c}$ Also we know that, $\frac{E_0}{B_0}=c$

$\therefore$ Momentum transferred $=\frac{U}{E_0}\times B_0$

Question5

If the amplitude of the magnetic field part of a harmonic electromagnetic wave in vacuum is 270 nT , the amplitude of the electric field part of the wave is

TG EAPCET 2024 (Online) 9th May Morning Shift

Options:

A. $90 \mathrm{NC}^{-1}$

B. $81 \mathrm{NC}^{-1}$

C. $9 \mathrm{NC}^{-1}$

D. $30 \mathrm{NC}^{-1}$

Answer: B

Solution:

Given that,

$B_0=270 \mathrm{nT}=270\times 10^{-9}\ \mathrm{T}$

- Speed of light, $c = 3 \times 10^8 \text{ m/s}$

Here, $E_0 = B_0 \times c$

$E_0 = 270 \times 10^{-9} \times 3 \times 10^8 = 810 \times 10^{-1}$
$E_0 = 81 \text{NC}^{-1}$

The amplitude of the electric fields part of the wave is 81NC^{-1}.

Question6

The correct statement among the following is

TS EAMCET 2023 (Online) 12th May Evening Shift

Options:

A. Electromagnetic waves cannot travel in vacuum

B. Electromagnetic waves are longitudinal waves

C. Electromagnetic waves are produced by charges moving with uniform velocity

D. Electromagnetic waves carry both energy and momentum as they propagate through space.

Answer: D

Solution:

Electromagnetic waves are unique in that they consist of oscillating electric and magnetic fields and do not require a medium to travel, which allows them to propagate through a vacuum.

These waves differ from mechanical waves as they are not longitudinal. Instead, electromagnetic waves are transverse, meaning that the oscillations of the fields are perpendicular to the direction of wave propagation.

Electromagnetic waves carry both energy and momentum. The energy carried by a wave is given by the equation:

$E = h\nu$

where h is Planck's constant and ν is the frequency of the wave.

The momentum carried by electromagnetic waves can be described using the equation:

$p = \frac{h}{\lambda}$

- where p is the momentum and λ is the wavelength of the wave. This relationship illustrates how electromagnetic waves convey momentum as they move through space.

Question7

If a plane electromagnetic wave has electric field oscillations of frequency 3 GHz , then the wavelength of the wave is (speed of light in vacuum $= 3 \times 10^8 \text{ ms}^{-1}$)

TS EAMCET 2023 (Online) 12th May Morning Shift

Options:

A. 0.1 m

B. 0.2 m

C. 100 m

D. 0.003 m

Answer: A

Solution:

To find the wavelength of a wave, you can use the formula:

$\lambda = \frac{c}{f}$

where:

λ is the wavelength,

c is the speed of light (in vacuum, which is 3×10^8 m/s),

f is the frequency.

Given that:

$f = 3\,\text{GHz} = 3 \times 10^9\text{ Hz}$

Plug the values into the formula:

$\lambda = \frac{3\times10^8\text{ m/s}}{3\times10^9\text{ Hz}} = 0.1\,\text{m}$

Thus, the wavelength of the wave is 0.1 m, which corresponds to Option A.
