MCQ 5b

(9)

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Part II. Solve the following problems

(20 points)

The electric field component of a beam of polarized light is

$$E_y = 5\sin\left(10^6 z + \omega t\right) \quad in\, V/m$$

a. What are the wavelength, the frequency, the period and the intensity of this light?
b. Write an expression for the magnetic field component of the wave. Parallel to which axis does the magnetic field oscillate?

a) $k = 10^6\ m^{-1}$; $\lambda = \frac{2\pi}{10^6} = 6.28\times10^{-6}\ m$ ✓

$I = \frac{E_m^2}{2\mu_0 c} = \frac{(5)^2}{2\times3\times10^8\times4\pi\times10^{-7}} = 0.033\ W/m^2$ ✓

(12) $\omega = 2\pi f$

$f = \frac{\omega}{2\pi}\ (Hz)$ $\quad T = \frac{1}{f} = \frac{2\pi}{\omega}\ (s)$

Continuation of Part (a) → on 2nd Page →

b) $cB_m = E_m \Rightarrow B_m = \frac{E_m}{c} = \frac{5}{3\times10^8} = 1.67\times10^{-8}\ T$

(6) $B = 1.67\times10^{-8}\sin\left(10^6 z + \omega t\right)$

$B_x = 1.67\times10^{-8}\sin\left(10^6 z + 3\times10^{14} t\right)\ in\ (T)$

✗ Parallel To the Z-axis the Magnetic Field oscillate.

In My conclusion: Direction is in −(ve) Sense $\vec{B}\times\vec{E}$ is in −(ve) z direction

a) $v = \lambda f$

$\lambda = \frac{2\pi}{k}$; $2\pi f = \omega$

$v = \left(\frac{2\pi}{k}\right)\left(\frac{\omega}{2\pi}\right) = \frac{\omega}{k}$ and since here it is Polarized light $\Rightarrow$ $v = c = 3 \times 10^8$ m/s

$3 \times 10^8 \times 10^6 = \omega = 3 \times 10^{14}$ rad/s. ✓

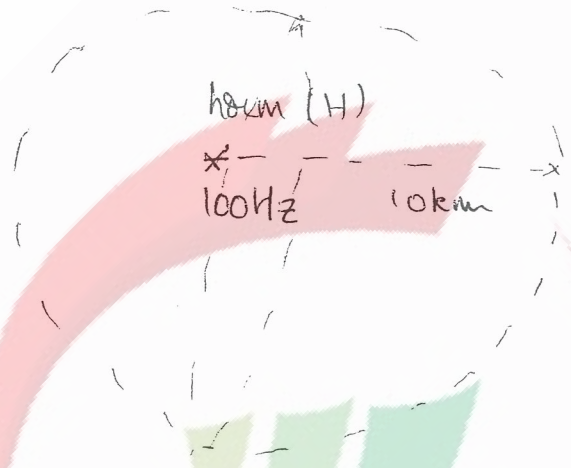
$\omega = 2\pi f \Rightarrow f = \frac{\omega}{2\pi} = \frac{3 \times 10^{14}}{2\pi} = 4.77 \times 10^{13}$ Hz ✓

$T = \frac{1}{f} = 2.09 \times 10^{-14}$ sec. ✓

(17 points)

At a distance of 10 km, a 100 Hz horn, assumed to be an isotropic point source, is barely audible.

a. What is the power of the horn?
b. At what distance would it begin to cause pain?



a) $\frac{\text{Power}}{A} = I \Rightarrow \text{Power} = I \cdot A = 4\pi(10\times10^{3})^{2} \times I$

$I = \frac{P_s}{A}$

Since barely audible then $I = I_0 = 10^{-12}\ W/m^2$

(Minimum sound the ear could hear)

$\text{Power} = 10^{-12} \times 4\pi \times (10^{4})^{2} = 1.256\times10^{-3}\ W$

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b) If Begin To cause Pain at $I_{pain} = 1\ W/m^2$

$\text{Power} = I \cdot A$

$\frac{P_s}{I} = A = \frac{1.256\times10^{-3}}{1} = 4\pi r^2$

$r^2 = 10\times10^{-5}\ m^2$

$r = 10\times10^{-3}\ m$

$r = 10\ mm$