Homework 22
Physics 2220

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December 2, 2014

Problem 1

Wavenumber is

$$k = \frac{2\pi}{\lambda} = \frac{2\pi}{453 \times 10^{-9}\, m} \doteq 1.38 \times 10^{7}\, m$$

Problem 2

The field is at maximum when the phase is $\pi/2$, thus

$$\frac{\pi}{2} = kz_{max} - \underbrace{\omega t}_{0} = kz_{max}$$

So

$$z_{max} = \frac{\pi}{2k} \doteq 113.25\, nm$$

Problem 3

Maximum of the electric field is related to the maximum of the magnetic field[1]

$$E_{max} = cB_{max} = c\,|\hat{\imath} + \hat{\jmath}|\, B_1 = \sqrt{2}c\, B_1 \doteq 3818\, V/m$$

Problem 4

In order to determine y-component of E-vector, we need to use RIGHT-HAND RULE, which will give us *negative* sign and for the size we will have

$$|E_y| = (c(\hat{\imath} + \hat{\jmath})\, B_1)_y = cB_1$$

Therefore

$$E_y = -2700\, V/m$$

[1] B_1 is not the maximum because $\hat{\imath} + \hat{\jmath}$ is NOT a unit vector.

Problem 5

The answer is #2:

$$\vec{E} = \left[\frac{E_{max}}{\sqrt{2}} \sin(kz - \omega t) \right] (\hat{\imath} - \hat{\jmath})$$

because

- E-vector is *in phase* with B-vector $\Rightarrow$ SINE
- B-vector points in the direction of $\hat{k} \times \vec{E} \Rightarrow \hat{\imath} - \hat{\jmath}$

Problem 6

Again, the maximum is attained when phase is at $-\pi/2$, hence

$$-\frac{\pi}{2} = \underbrace{kz}_{0} - \omega t_{max} = -\frac{2\pi}{T} t_{max} = -\frac{2\pi c}{\lambda} t_{max}$$

Hence we get

$$t_{max} = \frac{\lambda}{2c} \doteq 3.78 \times 10^{-16}\, s$$

Problem 7

Here we can use the result of `Problem 5`(see above) from which we can see that our E-field is *independent* of coordinates x & y. Therefore the E-vector is the same in the whole x-y plane.

Therefore

$$E_{x1} = E_{x2}$$