PH-214 Homework 1

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Problem 1

Electromagnetic waves are tranzverse because the electric waves and the magnetic waves are both perpendicular to the direction of propogation.

Problem 2

$$0.8e^{i\left(2*10^9t-kx\right)} = 0.8 \text{ Re}\left[\cos\left(2*10^9-kx\right) - i\sin\left(2*10^9-kx\right)\right] = \cos\left(2*10^9-kx\right)$$

Part a

$$0.8$$

Part b

$$\text{Frequency: } f = \frac{\omega}{2\pi} = \frac{2*10^9}{2\pi} = 318.3*10^6 \text{ Hz}$$

Part c

$$k = \frac{2\pi}{\lambda}$$

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

$$\lambda = \frac{c}{f} = \frac{3*10^8 \text{ Hz}}{318.3*10^6 \text{ Hz}}$$

$$k = \frac{2\pi}{\lambda} = 6.67 \text{ rad/m}$$

Problem 3

$$\overrightarrow{E} = 80\hat{x} + 32\hat{y} + 64\hat{z} \qquad \overrightarrow{B} = 0.2\hat{x} + 0.08\hat{y} + 0.29\hat{z}$$

Part a

$$\overrightarrow{E} \cdot \overrightarrow{B} = (80*0.2) + (32*0.08) + (64*0.29) = 0$$

Part b

$$\frac{1}{\mu_0}\overrightarrow{E} \times \overrightarrow{B}$$

Problem 4

Part a

$$\overrightarrow{r} = x\hat{x} + y\hat{y} + z\hat{z}$$

$$\overrightarrow{k} \cdot \overrightarrow{r} = k_x x + k_y y + k_z z = 6y - 8z$$

$$k_x = 0 \qquad k_y = 6 \qquad k_z = -8$$

$$||k|| = \frac{(0\hat{x} + 4\hat{y} + 3\hat{z}) \cdot (0\hat{x} + 0\hat{y} + 1\hat{z})}{\sqrt{3^2 + 4^2}\sqrt{1^2}} = \frac{3}{5}$$

$$\cos\theta = \frac{k_z}{k}$$

$$\arccos\left(\frac{-8}{10}\right) = 143^\circ$$

Part b

$$\lambda = \sqrt{6^2 + 8^2} = 10$$

$$c = \frac{1}{\lambda} * f$$

$$f = 10c$$