PH-214 Homework 1

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Problem 1

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

Problem 2

$$0.8e^{i\left(2*10^9 t - kx\right)}$$

Part a

$$\boxed{0.8}$$

Part b

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

Part c

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

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

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

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

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

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

Part b

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

$$\overrightarrow{S} = \boxed{\frac{1}{\mu_0}(4.16\hat{x} - 10.4\hat{y} + 0\hat{z})}$$

Problem 4

Part a

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

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

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

$$||k|| = \sqrt{6^2 + (-8)^2} = 10$$

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

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

Part b

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

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

$$f = \boxed{10c}$$