Exam 4

Name: ______________________________ unid: u __________

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Show all work!!!!!!
Report all numbers to three significant figures!
Use the conversion constants and data given on the front page.

The following describes the E field of an electromagnetic wave:

\[ E = (4.20 \times 10^{-4} \text{ N/C}) \cos(6.12 \times 10^2 x + 1.50 \times 10^8 t - \pi/3) \]

(a) Calculate the maximum value for the magnetic field for this wave.
(b) Calculate the wavelength.
(c) Calculate the frequency.
(d) Calculate the average value of the Poynting vector for the wave.
(e) Is the wave moving in the positive or negative x-direction? Explain.

The form of a traveling wave is

\[ A \cos(kx - \omega t + \phi) \]

where
- \( A \) = amplitude / max value
- \( k = \frac{2\pi}{\lambda} \) = wavelength
- \( \omega = 2\pi f \) = frequency
- \( \phi \) = phase shift

a) \( E_{max} = 4.20 \times 10^{-4} \text{ N/C} \)

\[ B_{max} = \frac{E_{max}}{c} = \frac{4.20 \times 10^{-4}}{3.00 \times 10^8} \]

= \( 1.40 \times 10^{-12} \text{ T} \)

b) \( \lambda = \frac{2\pi}{k} = \frac{2\pi}{6.12 \times 10^2} \)

= \( 0.0103 \text{ m} \)

c) \( f = \frac{\omega}{2\pi} = \frac{1.50 \times 10^9}{2\pi} \)

= \( 2.39 \times 10^8 \text{ Hz} \)

d) \( S_{avg} = \frac{E_{max}^2}{2\mu_0 c} = \frac{(4.20 \times 10^{-4})^2}{2(4\pi \times 10^{-7})(3 \times 10^8)} \)

= \( 2.34 \times 10^{-10} \text{ W/m}^2 \)

e) The term involving \( \omega \) and \( k \) both have the same sign.
Therefore, the wave is moving in the negative x-direction.