March 13, 2009  

H132 Quiz 9  

Name: KEY

20 minutes

\( \mu_0 = 4\pi \times 10^{-7} \text{T.m/A} \);  
\( \varepsilon_0 = 8.85 \times 10^{-12} \text{C}^2\text{N}^{-1}\text{m}^{-2} \)

\[ I = \varepsilon_0 c (E_0^2 / 2); \quad S = \frac{1}{\mu_0} E \times B; \quad c = \frac{E}{B} = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \]

1. (7 pts) Write an equation describing a sinusoidal transverse wave traveling on a cord in the negative direction of a y-axis with wave number of 60 cm\(^{-1}\), a period of 0.20 sec and amplitude of 0.3 mm. Take the transverse direction to be the z direction.

\[ z = Z_m \sin(ky + wt) \]

\[ Z_m = 0.3 \text{ mm} \]
\[ k = 60 \text{ cm}^{-1} \]
\[ \omega = \frac{2\pi}{0.20} \text{ rad/sec} \]

What is the maximum transverse speed of a point on the string?

\[ \frac{dz}{dt} = z m \omega \cos(ky + wt) \]

\[ \frac{dz}{dt} \bigg|_{\text{max}} = \omega z_m = \left( \frac{2\pi}{0.20} \right) (0.3 \times 10^{-3}) \text{ m/sec} \]

2. (4 pts) A sinusoidal wave of frequency 500 Hz has a speed of 350 m/s. How far apart are two points that differ in phase by \( \pi/3 \) rad?

\[ \lambda = \frac{v}{f} = \frac{350}{500} = 0.7 \text{ m} \]

Phase diff. of \( 2\pi \) = 0.7 m

\( \frac{\pi}{3} \) diff

\[ \frac{0.7 \times \pi}{2\pi} \frac{1}{3} \]

\[ = \frac{0.7}{6} = 0.12 \text{ m} \]
3. (4 pts) What are the units of the Poynting vector?

\[ \text{Watts/m}^2 \quad \text{or} \quad \text{Joule/m}^2\text{Sec}. \]

4. (5 pts) An airplane flying at a distance of 10 km from a radio transmitter receives a signal of intensity 10\(\mu\)W/m\(^2\). Calculate the amplitude of the electric field at the airplane due to this signal.

\[ I = \frac{E_0 C E_0^2}{2} \]

\[ E_0^2 = \frac{2I}{E_0 C} \]

where

\[ I = 10 \times 10^{-6} \text{ W/m}^2 \]
\[ E_0 = 8.85 \times 10^{-12} \text{ C}^2\text{N}^{-1}\text{m}^{-2} \]
\[ C = 3 \times 10^8 \text{ m/sec} \]

 Substitute \(I\) to get \(E_0\)