Group Problem, Physics 208, Tue, Apr 7, 2009

The magnetic field of an electromagnetic wave is given by
\[ \vec{B}(z,t) = (1.2 \times 10^{-6} T) \sin \left[ 2\pi \left( \frac{z}{240m} - \frac{t}{8 \times 10^{-7}s} \right) \right] \hat{y}, \] in SI units.

a) What is the amplitude of the \( B \)-field of the wave?

b) What are the wavelength (m) and frequency (Hz) of the wave?

c) What is the direction of propagation of the wave?

d) At time \( t=6 \times 10^{-7} \text{s} \) and position \( z=0 \), what is the direction of the electric field of the wave?
e) The relation between electric and magnetic field is $B = E/c$, where $c$ is the speed of light $3 \times 10^8$ m/s. Find the amplitude of the $E$-field, and show that the units for the $E$-field amplitude are correct.

f) We showed in class that the density of energy stored in a uniform electric field is $\varepsilon_o E^2 / 2$, and the density of energy stored in a uniform magnetic field is $B^2 / 2\mu_o$. At time $t=0$, sketch the energy density as a function of position $z$. On the same graph, sketch the energy density at time $t=2 \times 10^{-7}$ s.

g) How fast is the energy in the wave traveling?