

**PS 8 Physics 201 March 3, 2010 R.Shankar Due March 22.**

1. An electromagnetic wave has an electric field

$$\mathbf{E} = \mathbf{k} 1000 \sin(20y + \omega t) \quad (1)$$

- (i) What is  $\omega$ ? (ii) What is the frequency  $f$ ? (iii) What is the direction of travel? (iv) What is  $\mathbf{B}$ ? (v) What is the average energy density  $\bar{u}$  in  $J/m^3$  and average intensity  $\bar{S}$  in  $W/m^2$ ?
2. I live 10 km from a  $50kW$  station. What is the peak strength of  $E$  and  $B$  in my house?
3. The smallest wave length the eye can see is roughly  $400nm$ . What is the frequency?
4. A plane wave traveling along the  $y$ -axis has

$$\mathbf{E} = (\mathbf{i} + \mathbf{k}) E_0 \sin(ky - \omega t).$$

Find the corresponding  $\mathbf{B}$  ( its magnitude, direction, and  $(y, t)$  dependence). You can use the example we did in class (polarized along  $\mathbf{k}$ ), superposition and rotational symmetry arguments to guess your answer.

5. Imagine a wave in vacuum traveling along the  $z$  axis with

$$\mathbf{E} = \mathbf{i} E_0 \cos(kz - \omega t) \quad \mathbf{B} = \mathbf{j} B_0 \cos(kz - \omega t) \quad (2)$$

(i) Show that the surface integrals of  $\mathbf{E}$  and  $\mathbf{B}$  obey the Maxwell equations. (ii) Consider the line integrals on three independent planes and write the corresponding equations relating  $\frac{\partial E_x}{\partial z}, \frac{\partial E_x}{\partial t}, \frac{\partial B_y}{\partial z}, \frac{\partial B_y}{\partial t}$ . Determine the relation between  $E_0$  and  $B_0$  and  $\omega$  and  $k$  that these imply. (Just modify what was done in class. Do not spend too much time on this one.)