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

1. An electromagnetic wave has an electric field

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

(i) What is ω? (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

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

(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 ω and k that these imply. (Just modify what was done in class. Do not spend too much time on this one.)