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## 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  $\omega$ ? (ii) What is the frequency f? (iii) What is the direction of travel? (iv) What is **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

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

(i) Show that the surface integrals of **E** and **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.)

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