

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 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

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

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