PHYS 942 homework assignment #03

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PHYS 942
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Names ($\leq$3, write clearly): _____

Due: Wednesday, October 12, at the lecture. **Show all your steps!**

1. (*30 points*) Jackson, problem 7.4. Hint: The problem is easier to solve with an appropriately defined complex ϵ. A very poor conductor is defined by $\sigma \ll \epsilon\omega$.

2. (*30 points*) Jackson, problem 7.13. Add a part c): The Russian Sputnik I satellite transmitted its (in)famous "beep – beep – beep" at frequencies of 20 and 40 MHz. Why was this a useful scientific experiment, apart from the propaganda value?

3. (*30 points*) Consider a circularly polarized plane wave propagating in a homogeneous medium in the z-direction. The wave has a ***finite extent*** in x and y given by $E_0(x, y)$, such that the lateral extent of the wave is large compared to its wavelength and that $E_0(x, y)$ is slowly varying. Such a wave could be produced, for example, by a laserpointer.

   Show that

   (a) the electric field of the wave is given by

   $$\mathbf{E}(x, y, z, t) = \Big[E_0(x, y)(\mathbf{e}_x \pm i\mathbf{e}_y) + \frac{i}{k}(\frac{\partial E_0}{\partial x} \pm i\frac{\partial E_0}{\partial x})\mathbf{e}_z\Big]e^{ikz-i\omega t}.$$

   (b) the magnetic field is approximately given by

   $$\mathbf{B} \simeq \pm\, i\sqrt{\mu\epsilon}\,\mathbf{E}.$$

   (c) assuming that E_0 is real, the ratio of the z-component of the angular momentum density ($\mathbf{L} = \epsilon\mathbf{x}\times(\mathbf{E}\times\mathbf{B})$) to the energy density is

   $$\frac{L_z}{U} = \pm\,\omega^{-1}.$$

   What does this imply for the quantization of photons?

4. (*30 points*) Jackson, problem 8.2.