PHYSICS 110B – HOMEWORK SET 4

Due Friday 4/30/04. Ten points per problem. Selected answers are provided.

Reading: Griffiths, Sections 9.1 and 9.2.

1.) Problem 9.2

2.) Problem 9.6. Answer to b):

\[ A_R = A_I \]
\[ \delta_R = \delta_I + \tan^{-1}\left(\frac{2\beta}{1 - \beta^2}\right) \]
\[ \beta = \frac{k_1}{\mu_1} \]

3.) Consider a plane wave with wavenumber \( \vec{k} \) and polarization \( \hat{n} \) (\( \vec{k} \cdot \hat{n} = 0 \)):

\[ \vec{E}(\vec{r}, t) = E_0 \exp[i(\vec{k} \cdot \vec{r} - \omega t)]\hat{n}. \]

Show that

\[ \vec{\nabla} \times \vec{E} = (ikE_0) \exp[i(\vec{k} \cdot \vec{r} - \omega t)]\hat{k} \times \hat{n}. \]

4.) Problem 9.8. In our contemporary view of electromagnetic interactions, electric and magnetic forces are mediated by the exchange of photons, the irreducible quantum of the electromagnetic field. In these exchanges, the photons are circularly polarized, so in this sense circular, and not linear, is the fundamental polarization state of electromagnetic radiation.

5.) Problem 9.9; don’t worry about the sketch if you prefer not to. Answer to b):

\[ \vec{E}(x, y, z, t) = E_0 \cos\left(\frac{\omega}{\sqrt{3c}}(x + y + z) - \omega t\right) \frac{\hat{x} - \hat{z}}{\sqrt{2}} \]
\[ \vec{B}(x, y, z, t) = \frac{E_0}{c} \cos\left(\frac{\omega}{\sqrt{3c}}(x + y + z) - \omega t\right) \frac{-\hat{x} + 2\hat{y} - \hat{z}}{\sqrt{6}} \]

6.) Problem 9.33 b); you first need to find B field as instructed in a), but don’t worry about the rest of a). Answer to b):

\[ I = \frac{A^2 \sin^2 \theta}{2\mu_0 cr^2} \hat{r}. \]