ADVANCED DYNAMICS — PHY–4241/5227

HOMEWORK 6

(February 8, 2003)

Due on Monday, February 17, 2003

PROBLEM 16

(Problem 9.9 Griffiths)

Write down the (real) electric and magnetic fields for a monochromatic plane wave of amplitude E_0, frequency ω, and linear polarization $\hat{\mathbf{n}}$ that is:

a) Traveling in the negative x direction and polarized in the z direction.

b) Traveling in the direction from the origin to the point $(1, 1, 1)$ with polarization parallel to the xz plane.

In each case sketch the wave and give the explicit Cartesian components of $\hat{\mathbf{k}}$ and $\hat{\mathbf{n}}$.

PROBLEM 17 and 18

Consider a magnetic field given by the following expression:

$$
\begin{aligned}
B_x(x, y, z, t) &= -\imath B_0 \sin\left(\frac{\pi x}{a}\right) e^{i(kz-\omega t)} \ , \\
B_y(x, y, z, t) &\equiv 0 \ , \\
B_z(x, y, z, t) &= B_0 \cos\left(\frac{\pi x}{a}\right) e^{i(kz-\omega t)} \ .
\end{aligned}
$$

a) Use $\nabla \cdot \mathbf{B} = 0$ to express the wavenumber k in terms of a (and perhaps other well-known constants).

b) Use the Ampere-Maxwell law (with $\mathbf{J} = 0$) to compute the electric field $\mathbf{E}$. Hint: Assume that $\mathbf{E}(\mathbf{r}, t) = \mathbf{E}(\mathbf{r})e^{-i\omega t}$.

c) Verify that the electric field $\mathbf{E}$ satisfied Gauss' law (with $\rho = 0$).

d) Use Faraday's law to express the frequency ω in terms of the wavenumber k.