# Phys 110C: Problems for HW 6

C. Gwinn

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## 1 HW6 1: Wave from a Sheet Current

Consider the vector potential wave:

$$\vec{A}(\vec{r},t) = \begin{cases} A_0\ \hat{x}\ \exp\left\{i(-kz-\omega t)\right\}, & z<0 \\ A_0\ \hat{x}\ \cos\left\{i(\ \ kz-\omega t)\right\}, & z>0. \end{cases} \tag{1}$$

Suppose that the scalar potential $V = 0$. For this wave, assume that $\omega/k = c$.

a) Are these potentials in the Lorentz gauge? Is it in the Coulomb gauge? (Recall that these are not exclusive). If the wave travels through *vacuum*, does the requirement that $\omega/k = c$ arise from the equations for the potentials, from the gauge condition, or must you appeal to the full set of Maxwell's Equations to show this?

b) Find the electric and magnetic fields. Show that the charge density is zero everywhere, and that the current density is zero except in the plane $z = 0$.

c) Find the current density as a function of time at $z = 0$. (Hint: You may use the magnetic field and boundary conditions, or appeal to your knowledge of the potential for a charged sheet in electrostatics and the Poisson equation.)

d) Now consider the wave

$$\vec{A}(\vec{r},t) = A_0\ \hat{z}\ \exp\left\{i(kz-\omega t)\right\} \tag{2}$$

(This is of course identical to the wave for $z > 0$ above, except that here, $\vec{A}$ is parallel to the wave direction.) Again, $V = 0$. (You need not assume that $\omega/k = c$ for this wave.)

Is this a possible potential? If so, is it in the Lorentz or Coulomb gauge, both, or neither? And, what are the charge and current densities? If not possible, why not?

## 2 Problems from Griffiths

10.1, 10.2, 10.3, 10.5, 10.7