PHGN 462 Homework 11

1) (From Pollack and Stump 15.2). I like this one a lot. Ever since Phys 200 we've been talking about the field made by an infinite current-carrying wire, but we couldn't talk about the part where we actually turn on the current. Now we can.

Suppose that at $t = 0$ a current I is suddenly established throughout an infinite wire that lies on the z axis. Show that the resulting electric and magnetic fields are:

$$\vec{E}(r,t) = \frac{-\mu_0 I c}{2\pi\sqrt{c^2t^2 - r^2}}\hat{k}$$

$$\vec{B}(r,t) = \frac{\mu_0 I}{2\pi r}\frac{ct}{\sqrt{c^2t^2 - r^2}}\hat{\varphi}$$

Also show that after a long time, $t \gg r/c$, the magnetic field is the same as the static field of a long wire with constant current I. What is the electric field for $t \gg r/c$?

Note: The sheet current video works through an example problem that has a lot in common with this one.