3/31/2005. **Due:** Thursday, April 7, 2005 (in class).

Physics 302/572: Electromagnetic Theory II

Read: Griffiths 10.2-10.3

"**G**, **PS**" refer to Griffiths and Pollack & Stump books respectively.
Problems with stars are not for credit and will NOT be graded.

Homework 7

Exercise 1 (G 10.11)

Suppose $\vec{J}(\vec{r})$ is constant in time. In this case it is easy to show that the charge density is a linear function of time $\rho(\vec{r},t) = \rho(\vec{r},0) + \dot{\rho}(\vec{r},0)t$. Show that

$$\vec{E}(\vec{r},t) = \frac{1}{4\pi\epsilon_0}\int \frac{\rho(\vec{r}\,',t)}{R^2}\hat{R}\,d\tau';$$

that is, Coulomb's law holds, with the charge density evaluated at the *non-retarded* time.

Exercise 2 (G 10.18)

Suppose a point charge q is constrained to move along the x axis. Show that the fields at points on the axis to the *right* of the charge are given by

$$\vec{E} = \frac{q}{4\pi\epsilon_0}\frac{1}{R^2}\left(\frac{c+v}{c-v}\right)\hat{x}, \quad \vec{B} = 0.$$

What are the fields on the axis to the *left* of the charge?

*Exercise 3 (G 10.19)

Using the formulas for electric and magnetic fields of a point charge moving with a constant velocity

a) Calculate the electric field at a distance d from an infinite straight wire carrying a uniform line charge λ, moving at a constant speed v down the wire.

b) Calculate the *magnetic field* of this wire.

Exercise 4 (G 10.24)

One particle, of charge q_1, is held at rest at the origin. Another particle, of charge q_2, approaches along the x axis, in hyperbolic motion:

$$x(t) = \sqrt{b^2 + (ct)^2};$$

it reaches the closest point, b, at time $t = 0$, and then returns out to infinity.

a) What is the force F_2 on q_2 (due to q_1) at time t?

b) What total impulse ($I_2 = \int_{-\infty}^{+\infty} F_2\, dt$) is delivered by q_2 to q_1?

*c) What is the force F_1 on q_1 (due to q_2) at time t?

*d) What total impulse ($I_1 = \int_{-\infty}^{+\infty} F_1\, dt$) is delivered by q_1 to q_2?

Answer: $I_2 = -I_1 = \frac{q_1 q_2}{4\epsilon_0 bc}$.

Exercise 5 (PS 15.21)

Calculate the Poynting vector and energy density of the electromagnetic field of a charged particle moving with constant velocity. Show that the field energy is carried along with the particle.