P214/Homework #5 **Professor Lynn Cominsky** **Due 3/17/04**

Problems are from Tipler Chapter 21:

(1) 50 (a) Compute e/m for a proton, and find its acceleration in a uniform electric field with a magnitude of 100 N/C. (b) Find the time it takes for a proton initially at rest in such a field to reach a speed of $0.01c$ (where c is the speed of light).

(2) 54 A particle leaves the origin with a speed of 3×10^6 m s^{-1} at 35° to the x axis. It moves in a constant field $\vec{E} = E_y \hat{j}$. Find E_y such that the particle will cross the x axis at 1.5 cm if the particle is (a) an electron and (b) a proton

(3) 56 An electron with kinetic energy of 2×10^{-16} J is moving to the right along the axis of a cathode ray tube as shown in Figure 21-38. There is an electric field $\vec{E} = 2 \times 10^4$ N/ C $\hat{j}$ in the region between the deflection plates. Everywhere else $\vec{E} = 0$. (a) How far is the electron from the axis of the tube when it reaches the end of the plates (a distance in the x direction of 4 cm)? (b)At what angle is the electron moving with respect to the axis after it leaves this area? (c) At what distance from the axis will the electron strike the fluorescent screen **(NOTE: Assume the screen is flat, not curved as shown in the Figure.)**

(4) 58- slightly reworded A dipole of moment 0.5 e-nm is placed in a uniform electric field with a magnitude of 4.0×10^4 N/C. What is the magnitude of the torque on the dipole and its potential energy when (a) the dipole is parallel to the electric field (b) the dipole is perpendicular to the electric field (c) the dipole makes an angle of 30° to the electric field?

(5) 60 A water molecule has its oxygen atom at the origin, one hydrogen nucleus at $x = 0.077$ nm, $y = 0.058$ nm and the other hydrogen nucleus at $x =$ -0.077 nm, $y = 0.058$ nm. If the hydrogen electrons are transferred completely to the oxygen atom so that it has a charge of $-2e$, what is the dipole moment of the water molecule?

(6)66 In copper, about one electron per atom is free to move about. A copper penny has a mass of 3 g. **NOTE: Assume the penny is all copper.** (a) What percentage of the free charge would have to be removed to give the penny a charge of 15 μC? (b) What would be the force of repulsion between two pennies carrying this charge if they were 25 cm apart? Assume that the pennies are point charges.

(7) 67 Two charges q_1 and q_2 have a total charge of 6 μC. When they are separated by 3 m, the force exerted by one charge on the other has a magnitude of 8 mN. Find q_1 and q_2 if (a) both are positive so that they repel each other and (b) one is positive and the other is negative so that they attract each other.

(8)68 Three charges $+q$, $+2q$ and $+4q$ are connected by strings as shown in Figure 21-39. Find the tensions T_1 and T_2. **Hint: this is a superposition problem.**

(9) 72 A ball of known charge q and unknown mass m initially at rest, falls freely from a height h in a uniform electric field $\vec{E}$ that is directed vertically downward. The ball hits the ground at a speed $v = 2\sqrt{gh}$. Find m in terms of E, q and g.

(10) 82 For the dumbbell in Figure 21-44, let $m = 0.02$ kg, $a = 0.3$ m **(NOTE: a is the distance between the two bells)**, and $\vec{E} = (600$ N/ C$)\ \hat{\imath}$. Initially the dumbbell is at rest and makes an angle of 60° with the x axis. The dumbbell is then released, and when it is momentarily aligned with the electric field, its kinetic energy is 5×10^{-3} J. Determine the magnitude of q.