P214/Homework #4 Professor Lynn Cominsky Due 3/10/04

Problems are from Tipler Chapter 21:

(1) 6 Three charges $+q$, $+Q$ and $-Q$ are placed at the corners of an equilateral triangle as shown in Figure 21-32. The net force on charge $+q$ due to the other two charges is (a) vertically up (b) vertically down (c) zero (d) horizontal to the left (e) horizontal to the right.

(2) 8 If four charges are placed at the corners of a square as shown in Figure 21-33, the field $\vec{E}$ is zero at (a) all points along the sides of the square midway between two charges (b) the midpoint of the square (c) midway between the top two charges and midway between the bottom two charges (d) none of the above.

(3)16 True or False: (a) The electric field of a point charge always points away from the charge

(b) All macroscopic charges Q can be written as $Q = \pm Ne$ where N is an integer and e is the charge of the electron

(c) Electric field lines never diverge from a point in space

(d) Electric field lines never cross at a point in space

(e) All molecules have electric dipole moments in the presence of an external electric field

(4) 20 Two small spheres are connected to opposite ends of a steel cable of length 1 m and cross-sectional area 1.5 cm^2. A positive charge Q is placed on each sphere. Estimate the largest possible value Q can have before the cable breaks, given that the tensile strength of steel is 5.2×10^8 N/m^2

(5) 26 A charge equal to the charge of Avogadro's number of protons ($N_A = 6.02 \times 10^{23}$) is called a *faraday*. Calculate the number of coulombs in a faraday.

(6) 30 Three charges, each of a magnitude 3 nC, are at separate corners of a square of edge length 5 cm. The two charges (q_1 and q_3) at opposite corners are positive, and the other charge (q_2) is negative. Find the force exerted by these charges on a fourth charge $q_4 = +3$nC at the remaining corner. **NOTE: Put q_2 at the upper right hand corner of the square, and put q_4 at the bottom left hand corner.**

(7) 34 A charge of 5.0 μC is located at $x = 0$, $y = 0$ and a charge Q_2 is located at $x = 4.0$ cm, $y = 0$. The force on a 2 μC charge at $x = 8.0$ cm, $y = 0$ is 19.7 N, pointing in the negative x direction. When this 2 μC charge is positioned at $x = 17.75$ cm, $y = 0$, the force on it is zero. Determine the charge Q_2.

(8) 38 Two charges, each +4 μC, are on the x axis, one at the origin and the other at $x = 8$ m. Find the electric field on the x axis at (a) $x = -2$ m (b) $x = 2$ m (c) $x = 6$ m and (d) $x = 10$ m (e) At what point on the x axis is the electric field zero? (f) Plot E_x vs. x. **NOTE: You may wish to use Excel for this problem.**

(9) 40 The electric field near the surface of the Earth points downward and has a magnitude of 150 N/C. (a) Compare the upward electric force on an electron with the downward gravitational force (b) What charge should be placed on a penny of mass 3 g so that the electric force balances the weight of the penny near the Earth's surface?

(10) 42 A point charge of +5.0 μC is located at $x = -3.0$ cm, and a second point charge of -8.0 μC is located at $x = +4.0$ cm. Where should a third charge of +6.0 μC be placed so that the electric field at $x = 0$ is zero?