Assignment I, HONS 158 (Honors Physics II)
Spring 2016
Due 1/13/16 at start of class

As always, please put your answers on separate paper.

1. Find the total electric charge of:
   a) 2.5 kg of electrons
   b) 2.5 kg of protons
2. A container holds a gas consisting of 3 moles of oxygen molecules. One in a billion of these molecules has lost a single electron.
   a) What is the net charge of the gas?
   b) How much mass has been removed by removing these electrons?
3. The attractive electrostatic force between two point charges has a magnitude of 1.24 N when the separation between the charges is 1.47 m. One of the point charges is 8.44 μC. What is the sign and magnitude of the other charge?
4. A point charge $q = -0.42$ nC is fixed at the origin. Where must an electron be placed in order for the electric force acting on it to be exactly opposed by its weight. (In other words, where would an electron need to be placed so that it would have no net force on it?) (Let the y axis be vertical and the x axis be horizontal, and assume that gravity acts in the $-y$ direction, and we're near the surface of the Earth).

(More on back)

5. A system consists of two positive point charges, q_1 and q_2 ($q_2 > q_1$). The total charge of this system is $+73.0\ \mu$ C, and each charge experiences an electrostatic force of magnitude 113 N when the separation between them is 0.27 m. Find q_1 and q_2.

6. Two otherwise identical metal (conducting) spheres carry charges of $2Q$ and $-3Q$, respectively. The sphere centers are initially separated by distance d.

   a) What is the initial force between the spheres? (Let + indicate a repulsive force, and - indicate an attractive force).

   b) The two spheres are brought to touch. After touching, the total net charge is equally distributed over the two spheres. (This is true because the spheres are (i) conducting, and (ii) identical, implying that they are the same size). After touching, the spheres are returned to their initial positions separated by distance d. What is the final force between the spheres? (Again, let + indicate a repulsive force, and - indicate an attractive force).

   c) Let us assume each sphere has a radius $R = d/5$. How much work was done in initially taking the spheres (with their initial separation of d and charges of $+2Q$ and $-3Q$) and getting them to a position right before touching? (Recall: $W = \int_{\text{initial}}^{\text{final}} \vec{F} \cdot \mathrm{d}\vec{r}$).

   d) How much work is done in taking the spheres right after they touch and moving them back to their initial position?

   e) You should have found that the sign to your solution to parts (c) and (d) are the same. Yet, at the end, you have two charged spheres that are separated a distance d. Why isn't this work equal and opposite?