Homework #8

due 11/29/05

1. A glass rod is electrically charged by rubbing it with a piece of silk. The charged rod is then placed near a small piece of tin foil that is not electrically charged, and is resting on a wooden table. As the rod is brought near the tin foil, the foil jumps up to touch the rod, but then immediately flies away again. That is, the tin foil is initially attracted to the rod, but once it touches the rod, it is repelled by the rod. Explain this.

2. Answer the following questions using numerical constants that you find in your book or on the web.

(a) Suppose that 1% of the electrons in your body were transferred to the person sitting next to you 1 m away. What would be the force between you in pounds?

(b) Compare the electrical and gravitational forces between the electron and the proton in a hydrogen atom. How many times stronger is the electrical force?

3. Suppose that the proton did not have exactly the opposite charge of the electron. Sagredo and Salviati argue about what would happen. Sagredo says that this would mean that we would have a net charge, since each atom in our body has the same number of protons and electrons. We would then feel a large force between us (see problem 1 above). Salviati argues that this is not so, since if the proton charge were more than the electron charge (for example), extra electrons would be attracted to our bodies until the charge is approximately neutralized, and we would not feel a large force. Who is right? Explain.

4. Two charges of $+2$ C and -2 C are one meter apart along a straight line, with the $+2$ C charge to the left of the -2 C charge. Find the force on a third charge of size -1 C if that charge is placed at various posititions on the line.

(a) What is the force on the -1 C charge if it is 1 m to the left of the $+2$ C charge? What is the direction of the force?

(b) What is the force on the -1 C charge if it is 1 m to the right of the -2 C charge? What is the direction of the force?

(c) What is the force on the -1 C charge if it is halfway between the $+2$ C charge and the -2 C charge? What is the direction of the force?

5. The Coulomb law looks very similar to the Newton's law of gravity. This might give us the idea that the atom is like the solar system, with electrons orbiting the much heavier nucleus in the middle. We therefore expect a relationship like Kepler's third law $T^2 = KR^3$, where R is the orbital radius of the electron and T is the orbital period of the electron (the time it takes to make a complete revolution). Find the numerical value of K for the atom, assuming a circular orbit for the electron.