**Assignment II, HONS 158 (Honors Physics II)**
**Spring 2016**
**Due 1/20/16 at start of class**

As always, please put your answers on separate paper.

1. Let the following charges exist:

$$q_1 = 970 \text{ nC} \qquad \text{at} \qquad 2 \text{ m}\hat{\imath} - 1.5 \text{ m}\hat{\jmath}$$
$$q_2 = -1.3 \ \mu\text{C} \qquad \text{at} \qquad 2 \text{ m}\hat{\imath}$$
$$q_3 = 1.8 \ \mu\text{C} \qquad \text{at} \qquad -0.3 \text{ m}\hat{\imath} - 1.0 \text{ m}\hat{\jmath}$$

   a) If $q_4$ had charge $-2.1\ \mu$C and was at $1.5 \text{ m}\hat{\imath} - 1.0 \text{ m}\hat{\jmath}$, what would the force on this charge be due to the presence of $q_1$, $q_2$, and $q_3$? (You may assume $q_1$, $q_2$, and $q_3$ remain stationary). Remember, force is a vector quantity.

   b) If $q_4$ had charge $+380$ nC and it was at $1.5 \text{ m}\hat{\imath} - 1.0 \text{ m}\hat{\jmath}$ (the same position as part (a)), what would the force on this charge $q_4$ be due to the presence of $q_1$, $q_2$, and $q_3$? Again – you may assume that the other charges are stationary. (There may be a shortcut to this one if you've already done part (a)).

2. A ping-pong ball has a mass of about 2.7 grams. Let us say I was able (somehow) to put a total net charge of $-34.6$ nC on its surface. What minimum strength (and direction) of electric field would be required to levitate the ping-pong ball (near the surface of the Earth). (When you report the direction, report it as "up" or "down" or "East" or "West" or "North" or "South"; don't use $\hat{\imath}, \hat{\jmath}, \hat{k}$ unless it is obvious to me how that relates back to the Earth).

3. A Helium nucleus is made up of two protons and two neutrons. (For this problem, assume a neutron has the same mass as a proton, but does not have any charge). Assume that this Helium nucleus is placed in a uniform electric field of $1.35 \times 10^5$ N/C$\hat{\imath}$.

   a) Assume the Helium nucleus is released from rest at the origin at time $t = 0$. Find the speed of the Helium nucleus after it travels 1.00 cm.

   b) The speed of light in a vacuum is $3 \times 10^8$ m/s. No matter can actually move that fast (we'll find out why later this semester). However, if matter *could* travel that fast (and all the results you learned in HONS 157 hold), where would the nucleus be when it reaches the speed of light?

   c) How long does it take the Helium nucleus to reach the location identified in part (b) above?

(Over)

4. The Earth – near its surface – has its own electric field of approximately 150 N/C (pointing towards the center of the Earth).

   a) What is the approximate net charge of the Earth? (Treat the Earth as a point-mass and point-charge at its center).

   b) What magnitude and sign of net charge would a person have to obtain in order to levitate due to the superposition of gravitational and electric forces?

   c) Let's say two people have the charge calculated in part (b). What would their force of repulsion be if they were 1 meter apart?

5. If you didn't know, inkjet printers work through an electromechanical interaction. What happens is that drops of ink are "spit" at the paper from a nozzle. The ink drops each have a mass of about 150 ng and travel toward the paper at about 20 m/s. During their travel, the drops go through a "charging unit" that assigns each drop some positive charge $q$ by removing some electrons. The drops then pass between parallel plates that are about 2 cm long where a uniform electric field of magnitude about 80 kN/C is applied. (The plates are oriented so that they can apply some horizontal motion to the droplet). If a drop needs to be deflected 0.4 mm by the time it reaches the end of the deflection plates, how many electrons were removed from the drop?