Name: _____   **ID:** _____

Physics 152 – Discussion Questions #2

Electric Charge

Background:

- Electric charge can q can be positive, negative, or zero. The unit of charge is the coulomb (C). Charges with the same sign (+ and +, or – and –) repel each other while charges with the opposite sign (+ and –) attract each other.

- Two charges q_1, q_2 separated by distance r feel an electric force

$$F_{elec.} = Kq_1q_2/r^2$$

where $K = 8.99e9$ N-m^2/C^2. Note that if the two charges have opposite signs, this equation gives $F_{elec.} < 0$, which means the force is attractive not repulsive.

- Matter is made up of a large number of protons (charge $+e$), electrons (charge $–e$) and neutrons (charge zero). The constant $e = +1.60e–19$ C. The number of electrons is nearly equal to the number of protons, so the net charge is much smaller than the charge of, say, all the electrons.

- The number of protons in a neutral atom is the same as the number of electrons, and is given by the atomic number Z.

1. Force between two charges. Consider two point charges $q_1 = +0.2$ C and $q_2 = –0.3$ C.

a) If the distance between the charges is 1.0 m, calculate the force between the two charges. Convert the force to pound-force (1 lbf = 4.45 N) – is this a reasonable, everyday force?

b) What should the distance between these two charges be for the force to be 1 lbf?

2. Force between a proton and an electron. Look up the mass of a proton and an electron, and the formula for the gravitational force F_{grav} between two masses.

a) Derive a formula for the ratio between the electric and gravitational forces between a proton and an electron, $F_{elec.} / F_{grav}$. Does this ratio depend on the distance between the two particles?

b) The distance between the electron and the proton in a hydrogen atom is about 0.05 nm. Compute (numbers, with units as appropriate) the two forces and their ratio. Do you think gravity will have much effect on the physics of a hydrogen atom?

3. Number of electrons in a piece of aluminum. The aluminum atom has atomic number $Z = 13$ and atomic mass number $A = 27$. Consider a 1.00 cm diameter sphere of aluminum metal (density 2700 kg/m³).

a) How many atoms are in this sphere?

b) How many electrons are in this sphere? How many protons?

c) What is the total charge of all the electrons?

d) Instead of having exactly the same number of electrons and protons, our sphere has a fraction 1.0×10^{-10} of the electrons missing. What is the net charge on the sphere?