Physics 102– Pledged Problem 1

Time allowed: **2 hours at a single sitting**
Due 5PM Monday, January 22, 2007, in the boxes marked Phys 101-102 in the physics lounge. You may use your own textbook, your notes, and a non-programmed calculator. You may also consult the on-line solutions to the corresponding suggested problems. You should consult no other help. Show how you arrived at your answer; the correct answer by itself may not be sufficient.
Further instructions:
(a) Write legibly on **one** side of 8.5" x 11" white or lightly tinted paper.
(b) Staple all sheets together, including this one, in the upper left corner.
(c)Make one vertical fold.
(d) On the outside, staple side up, print your name in capital letter, your LAST NAME first followed by your FIRST NAME.
(e) Below your name, print the phrase "Pledged Problem 1", followed by the due date.
(f) Also indicate **start time** and **end time**.
(g) Write and sign the pledge, with the understanding that you may consult the materials noted above.

I. In class we discussed the fact that the electron and proton appear to have exactly the same charge, so that matter is electrically neutral. Suppose that is not the case, but rather that the proton's charge is slightly larger in magnitude. For purposes of this problem, assume the following:

The charge of the electron is -1.6022 $\times 10^{-19}$C and the charge of the proton is +1.6023 $\times 10^{-19}$C.
The mass of the earth is 5.98 $\times 10^{24}$ kg and the mass of the sun is 1.99 $\times 10^{30}$ kg.
The mass of the proton is 1.67 $\times 10^{-27}$ kg
The masses of the sun and earth are due entirely to the mass of the protons that make them up (that is, we will neglect the mass of the electrons).
The number of protons is equal to the number of electrons in both the earth and the sun.
Use the mean distance between the earth and the sun which is 1.50 $\times 10^{11}$ m.

(a) How many protons and electrons are there in the sun?
(b) How many protons and electrons are there in the earth?
(c) Determine the net charge of the earth, under the assumptions above.
(d) Determine the net charge of the sun, under the assumptions above.
(e) Determine the electrical force between the earth and the sun. Be sure to indicate the direction as well as the magnitude.
(f) Determine the gravitational force between the earth and the sun.
(g) Could we have a stable solar system if the magnitudes of the proton and electron charge were even slightly different from each other?

II. A positive charge of +Q is located at the origin, and a second charge of +3Q is located on the x-axis at $x = a$. A third positive charge $+q$ of mass m is located on the y-axis at $y = 2a$.
(a) Determine the net force on the positive charge $+q$.
(b) Determine the net force on the charge $+Q$ at the origin.
(c) If the charge $+q$ is released from rest, what is its initial acceleration?