Physics 102– Pledged Problem 3

Time allowed: **2 hours at a single sitting**
Due 5PM Monday, Februray 5, 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. Make one vertical fold.
(c) On the outside, print your name in capital letters, your LAST NAME followed by your FIRST NAME.
(d) Below your name, print the phrase "Pledged Problem 3", followed by the due date.
(e) Write and sign the pledge, with the understanding that you may consult the materials noted above.
(f) Indicate your **start time** and **end time**.

I. A hollow conducting spherical shell has an inner radius of a and outer radius b. The shell carries a total charge of $+2Q$. The coordinate r measures the distance from the center of the spherical shell.

(a) Determine the total charge on the inner surface of the shell ($r = a$) and on the outer surface ($r = b$).
(b) Determine the electric field $\vec{E}(r)$ for all r and sketch $\vec{E}(r)$ vs. r.

Now suppose a positive point charge of $+Q$ is suspended from a thin string and placed at the center of the shell, at $r = 0$.

(c) For this situation, determine the total charge on the inner surface ($r = a$) and the outer surface ($r = b$).
(d) Determine the electric field $\vec{E}(r)$ for all r and sketch $\vec{E}(r)$ vs. r.
(e)Suppose that the point charge $+Q$ is inside the shell but not located exactly at the center. Would the total charge on the inner and outer surfaces of the shell change? Would the distribution of the charges on the inner and outer surfaces change?

II. A very long, hollow, conducting cylindrical shell carries a uniform, linear charge density $+\lambda$. The shell has inner radius a and outer radius b. The coordiate r measures the distance from the axis of the cylinder.

(a) Determine the linear charge density on the inner surface $r = a$, and on the outer surface $r = b$.
(b) Determine the electric field $\vec{E}(r)$ for all r and sketch $\vec{E}(r)$ vs. r.

Now suppose a thin wire with negative linear charge density $-\lambda$ is placed inside the hollow cylinder, exactly along the axis of the cylinder, $r = 0$.

(c) For this situation, determine the charge density on the inner and outer surfaces of the cylindrical shell.
(d) Determine the electric field $\vec{E}(r)$ for all r and sketch $\vec{E}(r)$ vs. r for all r.