EXAM II Physics 208 2010

Name..Section Number......

USEFUL INFORMATION

For two point particles

$$\vec{F} = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \hat{r}$$

$$\frac{d\vec{r}}{dt} = \frac{dx}{dt}\vec{i}_x + \frac{dy}{dt}\vec{i}_y = \frac{dr}{dt}\vec{i}_r + r\frac{d\theta}{dt}\vec{i}_\theta$$

$$V(\vec{r_2}) - V(\vec{r_1}) = -\int_{\vec{r_1}}^{\vec{r_2}} \vec{E} \cdot d\vec{r}$$

$$C = \frac{Q}{V} \qquad R = \rho\frac{l}{A}$$

$$\oint \vec{E} \cdot d\vec{S} = \frac{Q_{inside}}{\epsilon_0}$$

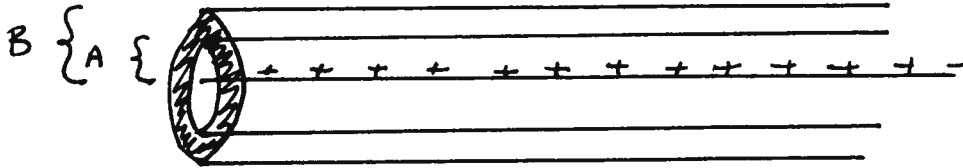$$V = iR \qquad \vec{E} = \rho\vec{j}$$

1.

2.

3.

4.

1. (25 points)An infinitely long, conducting, cylindrical shell has inner radius A and outer radius B. There is an infinitely long line of charge at the axis of the shell with constant charge per unit length λ.

Find the electric potential difference between a point inside the shell a distance $\frac{A}{2}$ from the center and a point a distance $2B$ from the center.

2. (25 points)In the circuit below, R_1, R_2, R_3 and R_4 and V_1 are known.
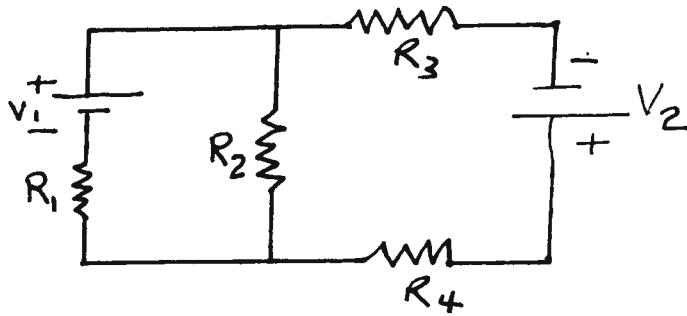
(13 points) a. What must V_2 be in order for there to be no current in R_2?

(12 points) b. If R_2, is replaced by a capacitor, capacitance C, find the charge on it if V_2 has the value determined in part a.

3. (25 points)A conducting spherical shell has inner radius A_1 and thickness T. There is a larger, uncharged, concentric spherical conducting shell with inner radius B_1 and thickness T. The inner shell is given a charge Q_0.
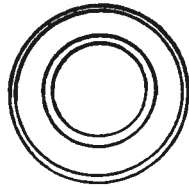

(5 points) a. Find the charge per unit area everywhere. (Show this in the figure above.)

(12 points) b. Find the electric potential difference between a point on the inside surface of the inner shell and a point on the outside surface of the outer shell.

(3 points) c. What is the capacitance of this system?

(5 points) d. If a second system of concentric spherical shells, with thickness T, and one with inner radius A_2 and the second with inner radius B_2 is attached to the above system by the wires shown, one going through tiny holes in the outer shells, what will be the final charges on the four shells, assuming the second system was originally neutral?
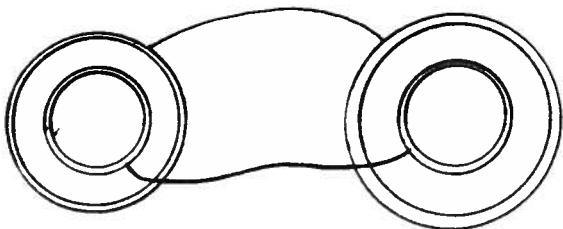
4. (25 points) A composite wire is made of two materials, one having resistivity ρ_1 and the other ρ_2. The wire has length L and has a rectangular cross section as shown in the figure below. A battery, voltage V, is connected to the ends of the wire.
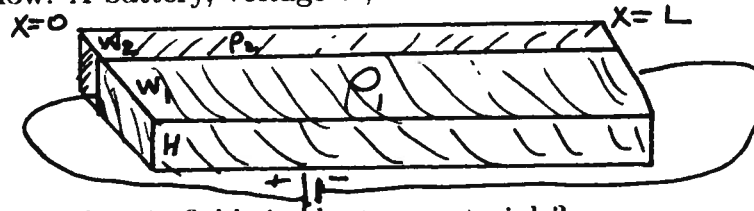
(9 points) a. What will be the electric fields in the two materials?

(9 points) b. What current will flow in each material?

(7 points) c. If, instead of ρ_2 being constant, $\rho_2 = \rho(x) = \rho_0(1 + \frac{x}{L})$ what total current would flow through the wire?