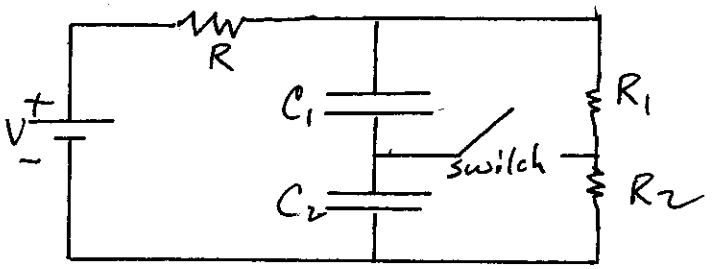
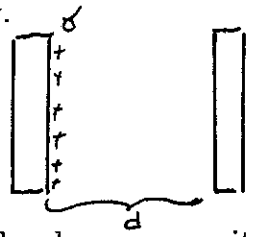
1. (25 points) In the circuit below assume the switch has been open for a long time. The voltage on the battery, the values of the resistors and capacitors are all known.



a. Find all currents and the charges on the capacitor plates.

b. If the switch is now closed, find all currents and the charges on the capacitor plates after a long time, i.e. in the steady state.

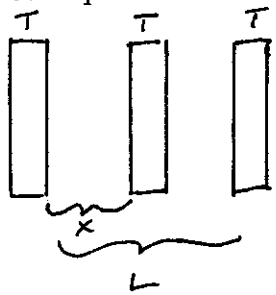
2. (25 points) Two parallel conducting plates, each with very large area A and thickness T are shown below.



a. If the left plate had a charge per unit area σ find the electric field everywhere between the plates.

b. Derive the expression for the capacitance of this system.

c. If a third conducting plate were placed between them in the position shown, find the electic potential difference between the original two plates.



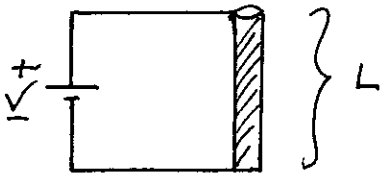
3. Consider a spherical shell, inner radius A and outer radius B. It is made of material that has resistivity ρ. You are **given** that a current i flows from the inner surface to the outer surface.

a. What is the current density vector as a function of r, the distance from the center of the spheres?

b. What will be the voltage difference between the inner and the outer surfaces?

c. What is be the charge per unit volume between A and B? Explain your answer, ten words or less.

4. (25 points)A wire of length L and cross-sectional area A is attached to a battery,V by the usual, resistance free wires.



a. If the resistivity of the wire is ρ what current will flow through the wire and which way? (Assume steady state.)

b. What will be the current density vector in the wire?

c. If the connecting wires also have cross-sectional area A, what will be the current density vector in them?

d. What will be the charge at the place where the resistance free wires are connected to the wire with resistance ρ?