Last Name..................................First Name.....................Section Number......

USEFUL INFORMATION

For two point particles

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

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

$$V(\vec{r}_2) - V(\vec{r}_1) = -\int_{\vec{r}_1}^{\vec{r}_2} \vec{E} \cdot d\vec{r}$$

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

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

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

For parallel plates $C = \frac{A\epsilon_0}{d}$

WARNING: In any circuit problem, failure to indicate the direction of currents and/or the failure to indicate where charges are located on capacitors will result in no credit being given.
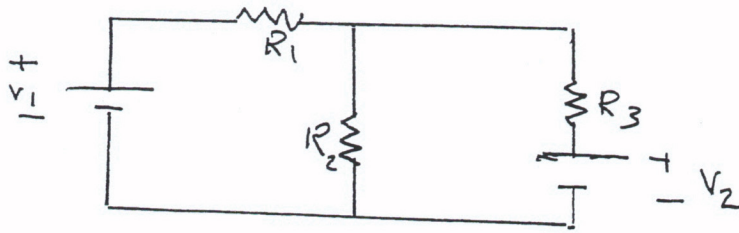
1.

2.

3.

4.

1. (25 points)In the circuit below, all the $R's$ and $V's$ are known. The circuit was put together a long time ago so that it is in the steady state. Obtain a sufficient number of equations so that you could solve for all currents.
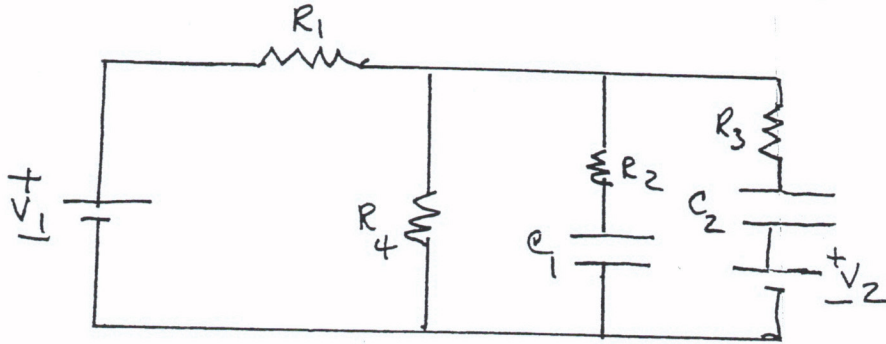

Laws or Definitions

Application

Result

2. (25 points)In the circuit below, all the $R's$, $C's$ and $V's$ are known. The circuit was put together a long time ago so that it is in the steady state. Obtain a sufficient number of equations so that you could solve for all currents and the charges on the capacitors. Find the numerical values of all the currents and charges if $V_1 = 10$ volts, $V_2 = 2$ volts, $R_1 = 2\Omega$, $R_2 = 7\Omega$, $R_3 = 9\Omega$, $R_4 = 3\Omega$, $C_1 = 3$farads, and $C_2 = 4$farads.
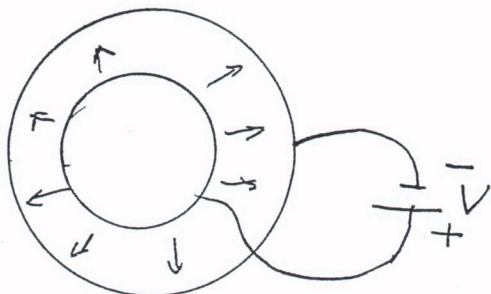

Laws or Definitions

Application

Result

3. (25 points) A spherical shell has inner radius a and outer radius b. It is made of material with resistivity ρ which varies with the distance from the center of the shells, r, according to $\rho(r) = \rho_0\left(\frac{r^2}{b^2}\right)$ A battery with known voltage V is connected as shown so that a constant current is made to flow radially out from the inner surface to the outer. Find the current. Also find the charge contained inside a spherical surface of radius r with $a < r < b$.
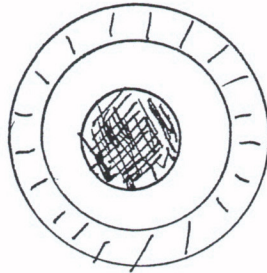

Laws or Definitions

Application

Result

4. (25 points) A spherical conducting shell has inner radius A and outer radius B. At its center is a sphere of radius D that has a charge Q uniformly spread throughout it. Find the difference in the electric potential between a point at the center of the sphere and a point $2B$ from the center.

Laws or Definitions

Application

Result