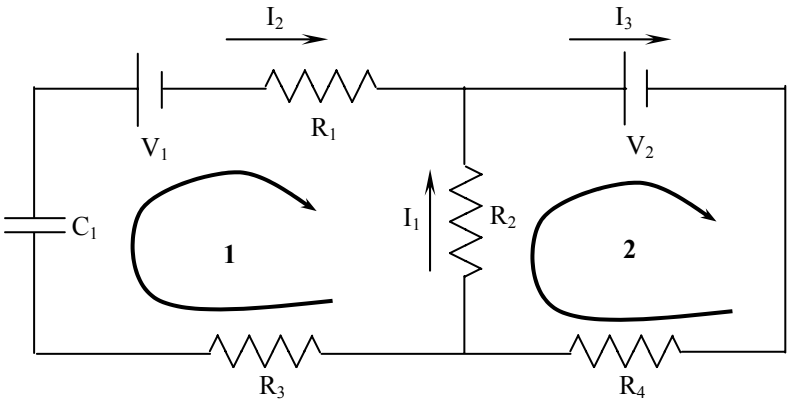
1. *(6 points)* For the following circuit, write three, independent equations that could be solved for the currents I_1, I_2, and I_3. (You must use the currents I have indicated.) **Do not solve for the currents.** Assume the charge on the capacitor is q_c, which is less than the maximum charge the capacitor will hold in this circuit.



Solution:

Loop 1:

$-I_2R_3 + q_c/C_1 - V_1 - I_2R_1 + I_1R_2 = 0$

Using $I = dq/dt \Rightarrow q_c = \int I_2 dt$

$-I_2R_3 + \int I_2 dt\,/C_1 - V_1 - I_2R_1 + I_1R_2 = 0$

Loop 2:

$-V_2 - I_3R_4 - I_1R_2 = 0$

Junction at top:

$I_1 + I_2 = I_3$

2. *(3 points)* The potential difference across an outlet in the wall is 120 V. When you plug in a 60 W light bulb, how much current flows through the bulb? What is the resistance of the bulb when it is plugged in? How does this resistance compare to the resistance of the bulb when the bulb is turned off?

Solution: $P = I\Delta V \rightarrow I = P/\Delta V = 60\text{ W}/120\text{ V} = 0.5\text{A}$

$\Delta V = IR \rightarrow R = \Delta V/I = 120\text{V}/0.5\text{ A} = 240\ \Omega$.

The resistance is function of the material properties of which it is composed. One of those properties is the resistivity of the metal (shape is also important). The resistivity is temperature dependent. As the bulb cools off, its resistivity decreases, so its resistance goes down.