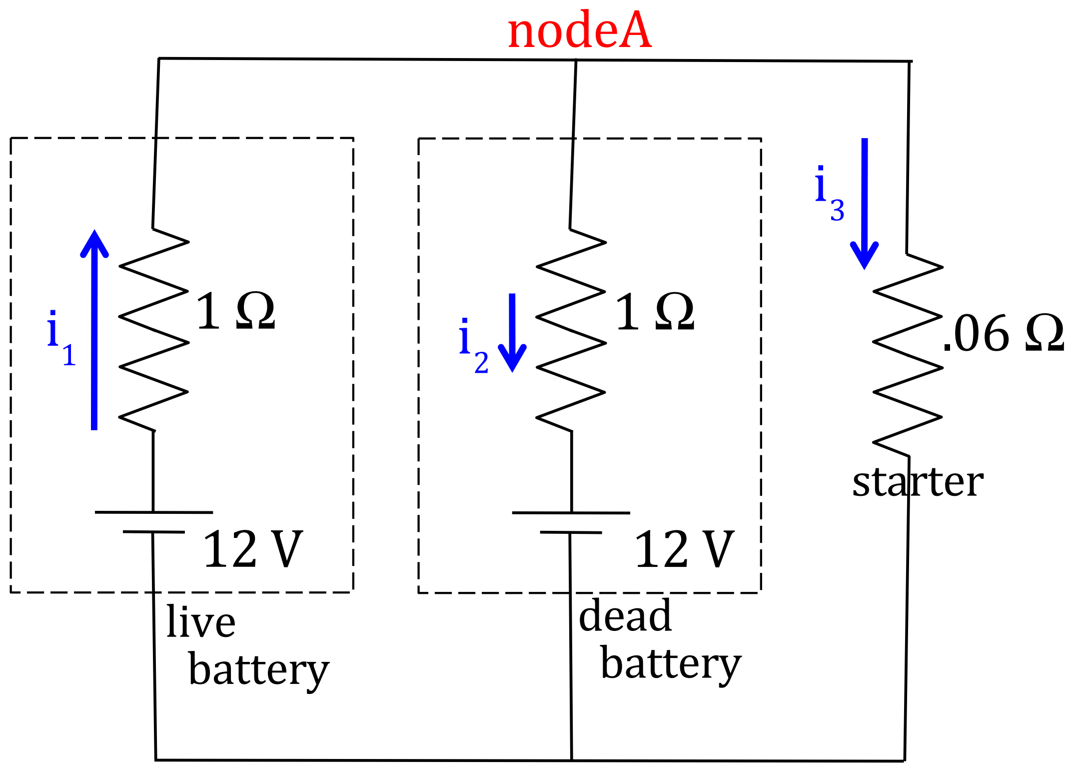
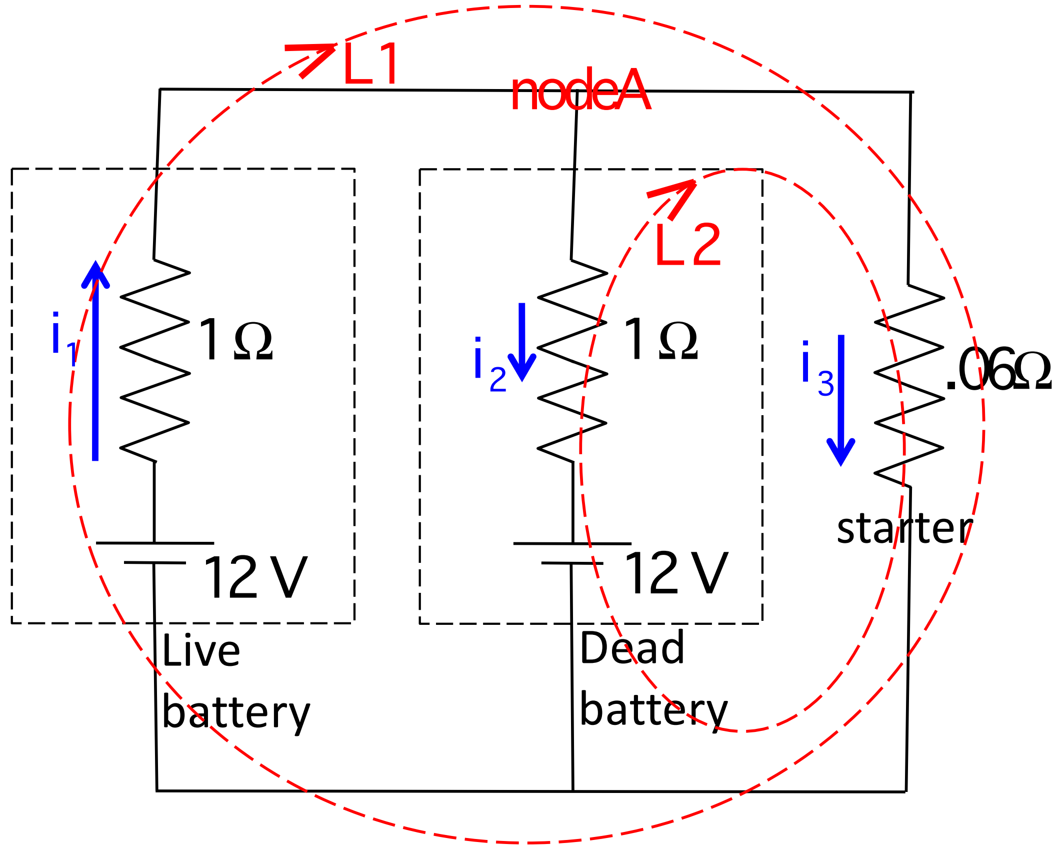
Problem 28.24



a.) In Parts a and b, we are looking for currents. That means we will be using Kirchoff's Laws. Unfortunately, the problem is a bit obscure in the sense that I've always assumed a dead battery was one in which the voltage across the leads had gone to zero. That would make the sketch misleading. Instead (it finally dawned on me), they want you to assume the deadness is modeled by the high resistance to charge flow in the branch of the circuit that has the dead battery.

Even an "approximately zero-volts" model would suggest that the live battery would force current into the dead battery, charging it. I've made that assumption in defining the current in the dead-battery branch. Fortunately, if I've goofed, the math will cover me by giving me a negative sign in front of any errantly defined currents. Let's hear it for "the math!"

a.) We are going to be using Kirchoff's Laws to solve for all of the currents, so even though this questions asks only for the current through the starter, I'm going to write out all the Kirchoff equations starting with a node equation for node A. Doing so yields:



Node A: $i_1 = i_2 + I_3$

For the loops shown:

L1: $V_{livebattery} - i_1R_1 - i_3R_3 = 0$

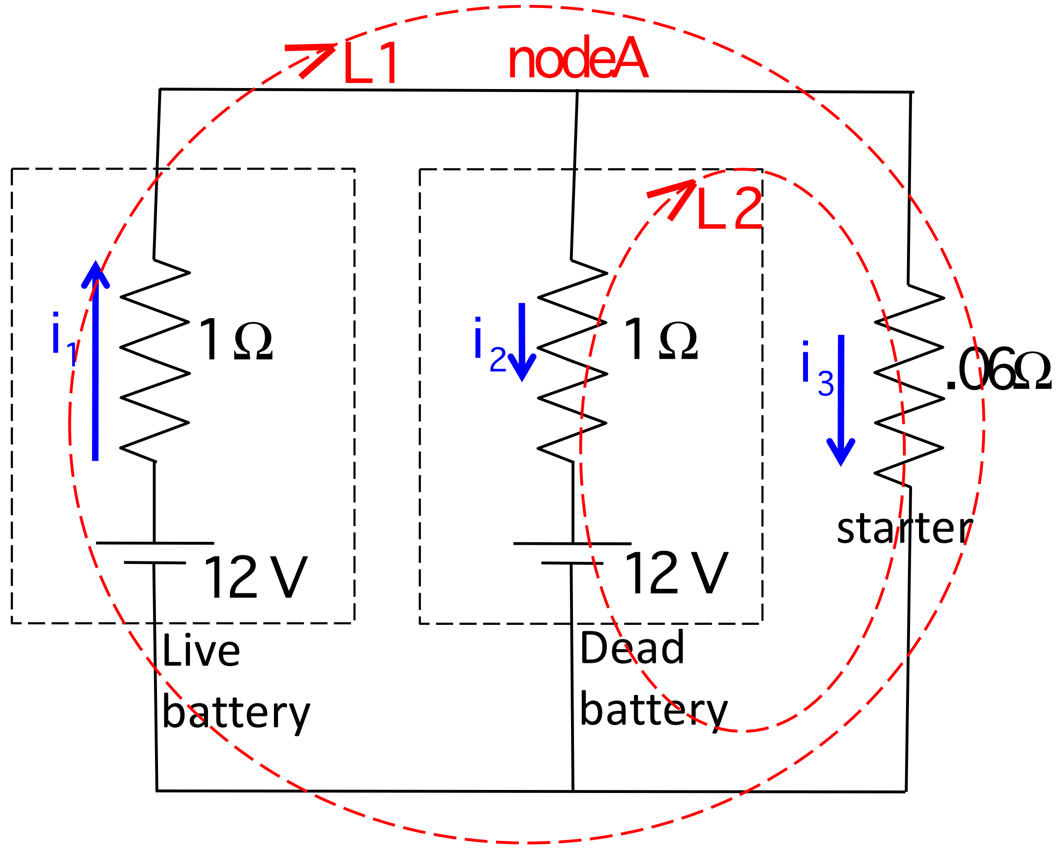
L2: $V_{deadbattery} + i_2R_2 - i_3R_3 = 0$

With numbers:

L1: $(12\ V) - i_1(.01\ \Omega) - i_3(.06\ \Omega) = 0$ (equation B)

L2: $(12\ V) + i_2(1\ \Omega) - i_3(.06\ \Omega) = 0$ (equation C)

Solving Equations A, B and C simultaneously, we find that the current provided to the starter motor is 172 amps.



b.) From the solutions alluded to above, the dead-battery's current solves to -1.7 volts. As I discussed on the previous page, the negative sign simply means that current through the dead-battery branch is not downward but, rather, upward.

c.) Apparently, the dead battery isn't completely dead but is, rather, providing a small trickle of charge (small in comparison to that provided by the live-battery) motivating the starter to turn.