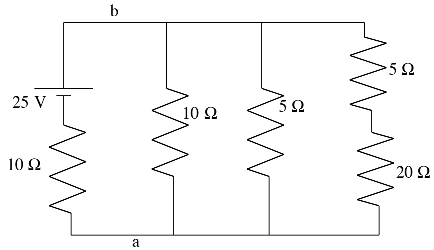
Problem 18.9

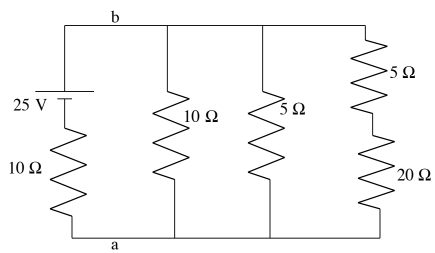
a.) Determine the potential difference between Points "a" and "b."



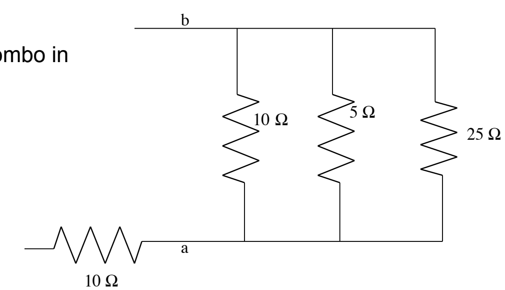
b.) Determine the current in the 20 ohm resistor.

a.) Determine the potential difference between Points "a" and "b."

To get the potential difference between Points "a" and "b," we need to determine the current through the battery's branch. The easiest way to do that is to determine the equivalent resistance for the entire circuit, then use that to determine the current being drawn from the battery. Doing so yields:



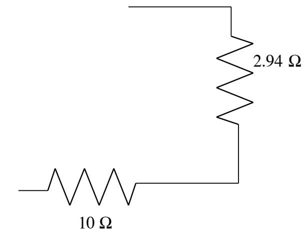
i.) combining the series combo in the far right branch yields:



ii.) combining the three parallel resistors in the far right section yields:

$$\frac{1}{R_{eq,parallel}} = \frac{1}{10\ \Omega} + \frac{1}{5\ \Omega} + \frac{1}{25\ \Omega}$$

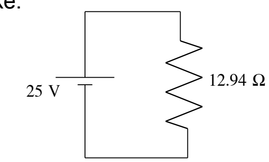
$$\Rightarrow \quad R_{eq,parallel} = 2.94\ \Omega$$



iii.) finally, combining that parallel equivalent resistance with the series 10 ohm resistor yields an overall equivalent resistance of:

$$R_{equ} = 12.94\ \Omega$$

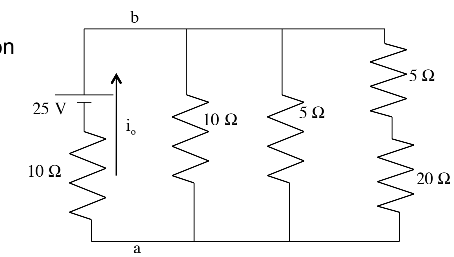
That means our equivalent circuit looks like:



Using this and Ohm's Law, we can determine the current being drawn from the battery: →

$$i_o = \frac{\varepsilon}{R_{equ}} = \frac{25\ V}{12.94\ \Omega} = 1.93\ A$$

So here's the thinking. Start at Point a. Current flows from the higher voltage side of a resistor to the lower, so as we are traversing in the direction of the current, we see a voltage DROP of iR. We then enter the low end of the battery and proceed through it (i.e., from lower to higher voltage), which means we see a voltage INCREASE of 25 volts. Putting this all together, we get:



$$\Delta V_{AtoB} = - \quad i_o \quad R_{10} \quad + \quad \varepsilon$$
$$= -(1.94\ A)(10\ \Omega) + (25\ V) = 5.6\ V$$
$$= 5.6\ V$$