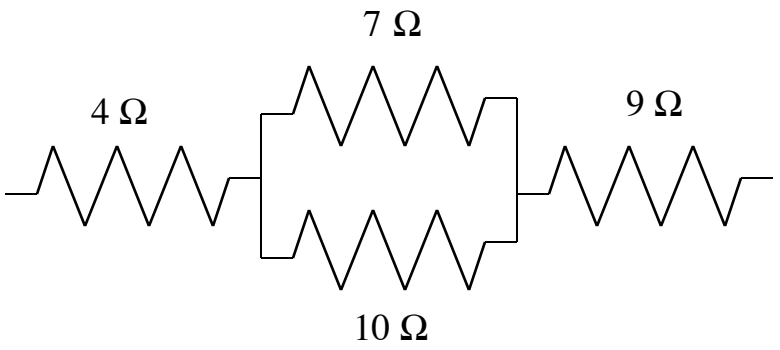
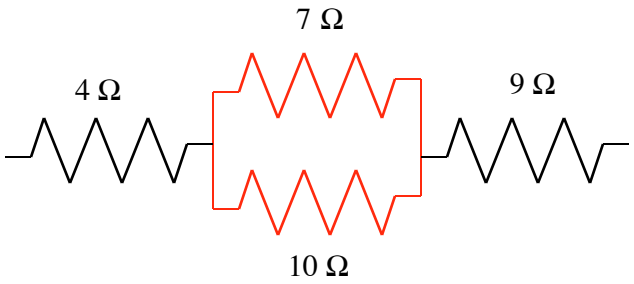
Problem 18.5

a.) Equivalent resistance?



b.) Calculate the current through each resistor if the voltage between a and b is 34 volts:

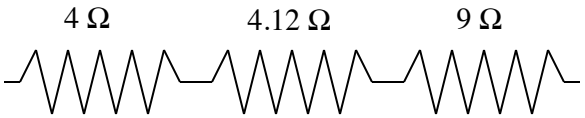
a.) Equivalent resistance?



$$\frac{1}{R_{eq,parallel}} = \frac{1}{7} + \frac{1}{10}$$

$$= .2429$$

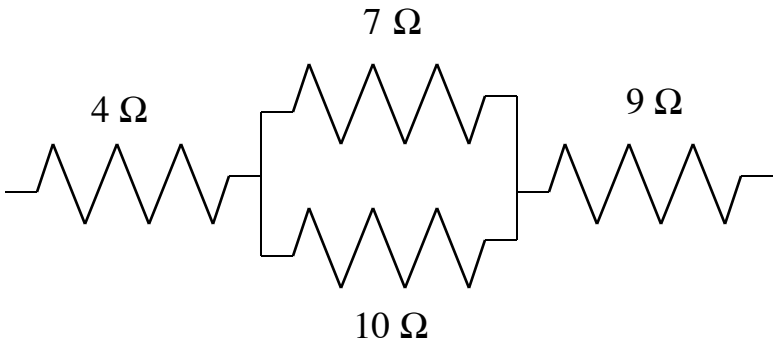
$$\Rightarrow R_{eq,parallel} = 4.12\ \Omega$$



$$R_{eq} = 4\ \Omega + 4.12\ \Omega + 9\ \Omega$$

$$= 17.12\ \Omega$$

b.) What is the current through each resistor is the voltage is 34 volts.



The net current through the combination can be determined using the fact that:

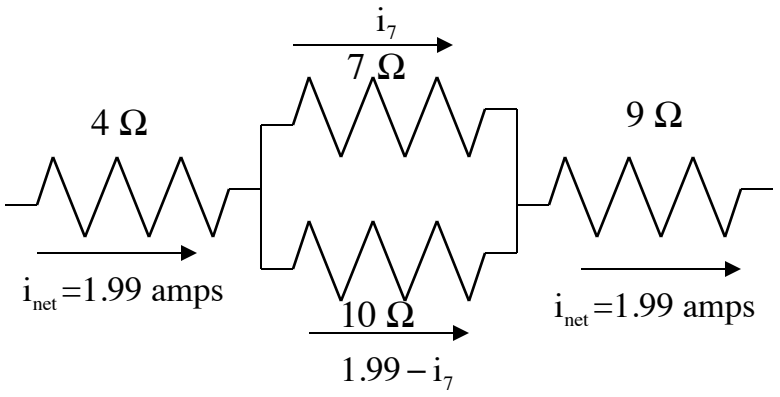
$$i_{total} = \frac{V_o}{R_{eq}}$$
$$= \frac{(34 \text{ volts})}{(17.12 \text{ ohms})}$$
$$= 1.99 \text{ amps}$$

This total current will be the current through both the 4 and 9 ohm resistors, so we can write:

$$V_4 = i_{total} R_4$$
$$= (1.99 \text{ amps})(4 \text{ ohms})$$
$$= 7.96 \text{ volts}$$

$$V_9 = i_{total} R_9$$
$$= (1.99 \text{ amps})(9 \text{ ohms})$$
$$= 17.91 \text{ volts}$$

The temptation is to assume that you have to work with current to do this. If you went that route, the 1.99 amps would split when it got to the parallel combination with more current going through the smaller resistor (the 7 ohm resistor) and less through the larger resistor. What would be in that case would be voltage, so if you assumed that I went through the 7 ohm resistor and 1.99-I went through the 10 ohm resistor, you could use Ohm's Law to write:



$$V_7 = V_{10}$$

$$i_7(7\ \Omega) = (1.99 - i_7)(10\ \Omega)$$

$$\Rightarrow \quad i_7 = 1.17 \text{ amps}$$

$$\Rightarrow \quad V_7 = i_7(7\ \Omega) = (1.17 \text{ amps})(7\ \Omega) = 8.18 \text{ volts and}$$

$$\Rightarrow \quad V_7 = (1.99 - i_7)(10\ \Omega) = (1.99 - 1.17 \text{ amps})(10\ \Omega) = 8.2 \text{ volts}$$

Huzzah! They are the same (give a take a bit for round-off).

This is the hard way. The easy way is to realize that 34 volts is the total voltage. It spans the 4 ohm, 9 ohm and parallel combination or resistors. The voltage across the 4 ohm resistor is V=ir=(1.99 amps)(4 ohms)=7.96 volts. The voltage across the 9 ohm resistor is V=ir=(1.99 amps)(9 ohms)=17.91 volts. The sum of the two is 25.87 volts. What's left over, approximately 8.2 volts, must be the voltage that spans both of the resistors in the parallel combination (remember, what's common in parallel combinations is the voltage across each element).