Single loop KVL tricks

For simple loops, there are a few simplifying steps we can take to quickly find the current I. Since the loop is a series circuit, the same current I flows through all elements. When we write the KVL equation and do the Ohm's law substitution we obtain a sum of voltages. Since addition is commutative we can add the elements in any order. This means we can rearrange the equation as well as the circuit. For example, our KVL equation was written:

$$-120 + 30I + 30 + 15I = 0$$

It is also correct to write it this way:

$$30 - 120 + 30I + 15I = 0$$

Which means our circuit could be drawn as shown below in the schematic diagram on the left. After rearranging the circuit, we see that the two voltage sources are connected so as to oppose each other. Furthermore, the 120V source is the bigger one thus the algebraic sum is $120 - 30$ volts. This result can be seen in the schematic on the right where the series combination of the two sources is redrawn as single source of 90V with the polarity of the bigger source.

Since we know that resistors in series add directly, they may be summed and result in one 45 Ohm resistor. With this reduced circuit shown on the right side of figure 1, it is easy to compute the current.

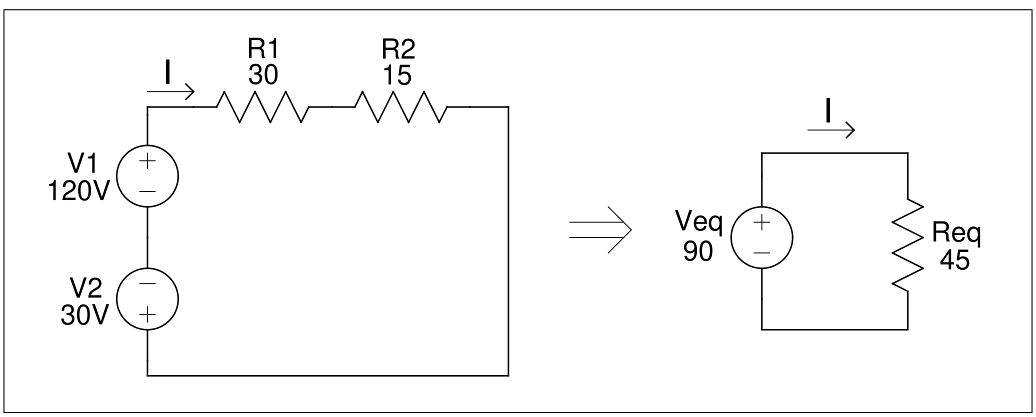

Figure 1: Adding resistors and voltage sources in series

Sometimes you need to find the voltage between two points in the single loop KVL circuit that are *unusual* or do not use what would be considered a convenient reference point. There is a visual method that can be used to help determine the voltage. For example, suppose we have the circuit in figure 2 and are supposed to find the value of V_x. We have already found the value of I to be 2 Amps.

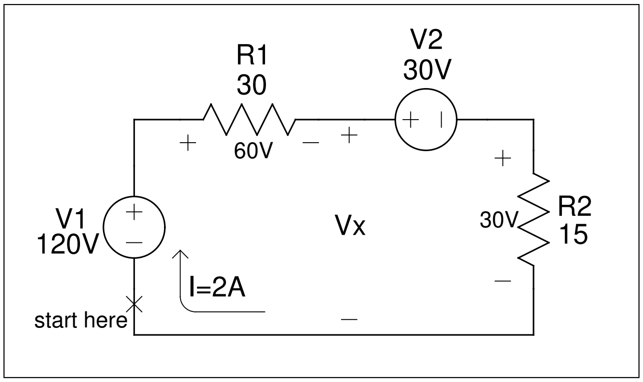

Figure 2: Find awkwardly placed V_x

The negative sign of V_x marks the point from which we are to find the voltage. In other words, we are to find the voltage with reference to where the negative sign is positioned. To visualize this, imagine a set of stairs. Going up the stairs indicates a voltage increase, going down is a voltage decrease relative to where we were. You begin on a staircase at the reference point which is 0 Volts.

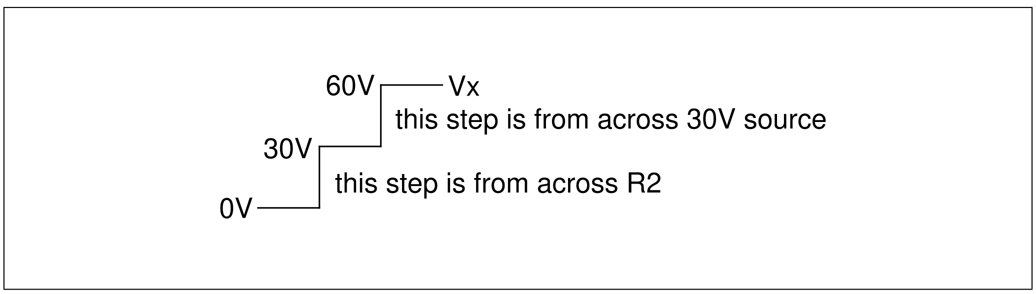

Figure 3: Finding V_x via a *voltage staircase*

As electrons flow through a circuit, they experience either a potential increase or decrease as they pass through an element. Starting at the negative sign, we traverse the circuit first encountering V_{R2} which is 30 volts. As we pass through R_2 we experience a increase in voltage potential as we approach its positive terminal With the staircase we can show a step up of 30 volts. Next, we pass through the 30V source experiencing another 30 volt rise in potential as we approach the positive terminal. This is shown as another step up. Now we have reached the positive terminal of V_x, the point at which we are to determine the voltage. We are 60 volts above our reference, therefore V_x = 60V.