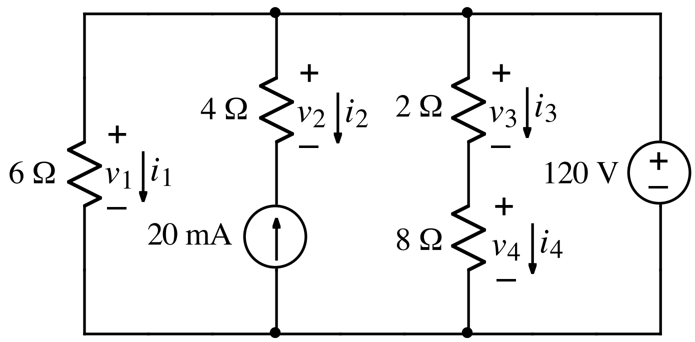
HOMEWORK #2 solution

EX:



a) For the circuit shown above, use Kirchhoff's laws to write equations relating voltages and currents.

b) Find the value of v_1 and i_2.

SOL'N: a) We look for voltage loops that are as small as possible without containing current sources, (since we avoid defining voltage drops for current sources). A voltage loop through the 6 Ω, 2 Ω, and 8 Ω proceeding in the clockwise direction yields the following equation:

$$v_1 - v_3 - v_4 = 0 \text{ V}$$

NOTE: A simpler alternative is to use the outer voltage loop for the first equation:

$$v_1 - 120 \text{ V} = 0 \text{ V}$$

A second loop on the right side yields a second equation:

$$v_4 + v_3 - 120 \text{ V} = 0 \text{ V}$$

Turning to current summations, if we try to sum the currents out of the top left node, we have a problem defining the current out of the node toward the right. To resolve this difficulty, we observe that all the wires connected to the top "rail" of the circuit may be thought of as connecting at a single point. Equivalently, we may argue that the current flowing out of any box drawn around some part of a circuit must sum to zero. We may consider a box drawn around the two nodes on the top rail of the circuit and sum the currents flowing out of it.

Having made this argument, we discover that the voltage source on the right side prevents us from writing a current summation equation for the top nodes, (since we avoid defining currents for voltage sources).

What remains is to write equations expressing the idea that the currents in components connected in series are the same. For the middle two branches, we obtain the following equations:

$$-20 \text{ mA} - i_2 = 0 \text{ A}$$

$$i_4 - i_3 = 0 \text{ A}$$

b) Two of the above equations yield values of voltage or current:

$$v_1 - 120 \text{ V} = 0 \text{ V} \Rightarrow v_1 = 120 \text{ V}$$

$$-20 \text{ mA} - i_2 = 0 \text{ A} \Rightarrow i_2 = -20 \text{ mA}$$