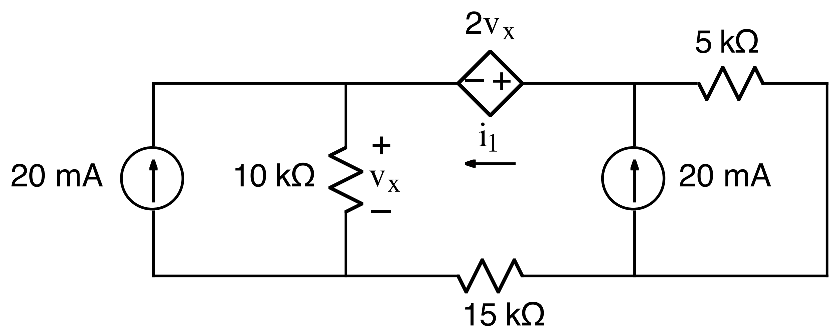
HOMEWORK #3 solution

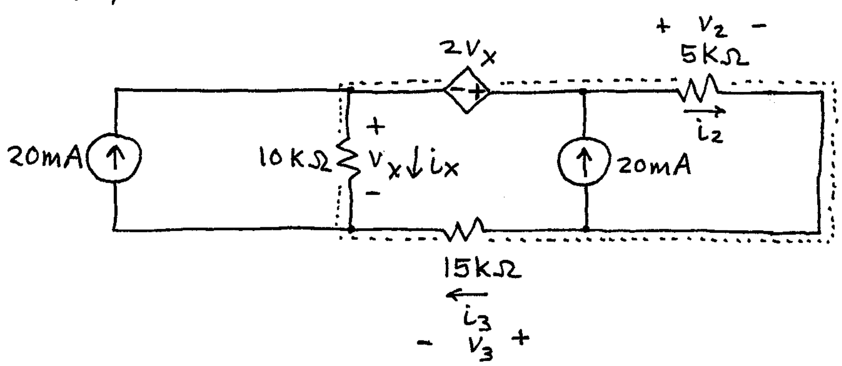
Ex:



Find v_X, i_1, and the power dissipated by the dependent source.

sol'n: We find i_1, the current for the dependent v-src <u>after</u> we solve the circuit.

First, label i's and v's for R's:



Second, write v-loop eq'ns for loops not containg current src's. There is only one such loop, indicated by the dotted line:

$$+v_X + 2v_X - v_2 - v_3 = 0V$$

Third, write current-sum eq'ns for nodes (unless nodes are connected only by v src's). We don't use the nodes on top since they are connected by only the $2v_X$ source.

For the node on the bottom, left of center, we have

$$+20mA - i_x - i_3 = 0A \qquad (1)$$

For the node on the bottom, right of center, we have

$$i_3 + 20mA - i_2 = 0A \qquad (2)$$

Fourth, we look components in series carrying the same current. Here, we lack any such components.

Fifth, we write Ohm's Law eq'ns for all the R's:

$$v_x = i_x \cdot 10k\Omega$$

$$v_2 = i_2 \cdot 5k\Omega$$

$$v_3 = i_3 \cdot 15k\Omega$$

Now substitute Ohm's Law for v's in v-loop eq'n:

$$i_x \cdot 10k\Omega + 2\, i_x \cdot 10k\Omega - i_2 \cdot 5k\Omega - i_3 \cdot 15k\Omega = 0V \qquad (3)$$

Solve one the three eq'ns (1-3) for a current:

$$i_3 = i_2 - 20mA$$

Substitute this in eq'ns (1) and (2):

$$20\,mA - i_x - (i_2 - 20\,mA) = 0\,A$$

$$i_x(10\,k\Omega + 20\,k\Omega) - i_2(5\,k\Omega) - (i_2 - 20\,mA)\,15\,k\Omega = 0\,V$$

Solving the first of these eq'ns for i_2 gives

$$i_2 = 40\,mA - i_x$$

Using this in the second of the two eq'ns gives:

$$i_x(30\,k\Omega) - (40\,mA - i_x)(5\,k\Omega + 15\,k\Omega) = -20\,mA \cdot 15\,k\Omega$$

or $$i_x(30\,k\Omega + 20\,k\Omega) = 40\,mA(20\,k\Omega) - 20\,mA \cdot 15\,k\Omega$$

or $$i_x(50\,k\Omega) = 500\,V$$

or $$i_x = \frac{500\,V}{50\,k\Omega} = 10\,mA$$

Now we can find i_1 from a current sum at the node on top to the left of center:

$$-20\,mA + i_x - i_1 = 0\,mA$$

or $$i_1 = -20\,mA + i_x = -20\,mA + 10\,mA = -10\,mA$$

The power dissipated by the dependent source is

$$p = i_1 \cdot 2v_x = -10\,mA \cdot 2 \cdot \overbrace{10\,\cancel{m}A \cdot 10\,\cancel{k}\Omega}^{v_x \text{ from Ohm's Law}}$$

or $$p = -2\,W$$