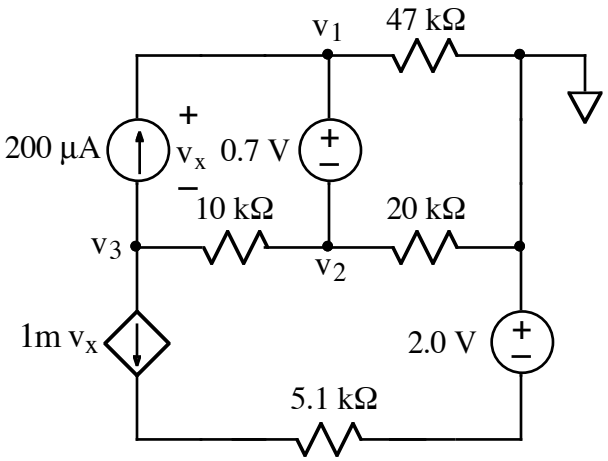
Ex:



Use the node-voltage method to find v_1, v_2, and v_3.

soln: We have v_1, v_2 supernode since v-src without resistor is between nodes. Thus, we sum all currents out of bubble, (arrows),

$$-200\mu A + \frac{v_1 - 0V}{47k\Omega} + \frac{v_2 - v_3}{10K\Omega} + \frac{v_2 - 0V}{20\,k\Omega} = 0A$$

we add a v-drop eq'n:

$$v_2 + 0.7V = v_1$$

Then we finish with the current sum for node v_2:

$$200\mu A + \frac{v_3 - v_2}{10k\Omega} + \frac{1m}{\Omega}\cdot(v_1 - v_3) = 0A$$

← v_x in terms of node v's

↖ added to make units correct

Now we do the algebra: (1st & 3rd eqns first)

$$V_1 \cdot \frac{1}{47k\Omega} + V_2\left(\frac{1}{10k\Omega} + \frac{1}{20k\Omega}\right) + V_3\left(\frac{-1}{10k\Omega}\right) = 200\mu A$$

$$V_1 \cdot 1m + V_2 \frac{-1}{10k\Omega} + V_3\left(\frac{1}{10k\Omega} - 1m\right) = -200\mu A$$

Multiply both sides by 20kΩ to clear most fractions:

$$V_1 \frac{20k\Omega}{47k\Omega} + V_2 \cdot 3 + V_3(-2) = 4\ V$$

$$V_1 \cdot 20 + V_2(-2) + V_3\underbrace{(2-20)}_{-18} = -4V$$

Use v-drop eqn to substitute for V_1:

$$(V_2 + 0.7V)\frac{20}{47} + V_2(3) + V_3(-2) = 4V$$

$$(V_2 + 0.7)\ 20 + V_2(-2) + V_3(-18) = -4V$$

Now multiply 1st eqn by (-9) and sum eqns:

$$+\quad (-9)(V_2 + 0.7V)\frac{20}{47} + (-9)V_2(3) + (-9)V_3(-2) = (-9)4V$$

$$\Rightarrow\quad (V_2 + 0.7V)\left[(-9)\frac{20}{47} + 20\right] + V_2(-29) = -40V$$

$$\Rightarrow\quad V_2\left((-9)\frac{20}{47} + 20 - 29\right) = -40V - 0.7\left[(-9)\frac{20}{47} + 20\right]V$$

$$\text{or}\quad V_2(-9)\left(\frac{20}{47} + 1\right) = -40V - 0.7\left[(-9)\left[\frac{20}{47} + 1\right] + 29\right]V$$

$$\text{or} \quad V_2(-9)\left[\frac{20}{47}+1\right] = -40V - 0.7(29)V - 0.7\left[\frac{20}{47}+1\right]V$$

$$\text{or} \quad V_2 = \frac{-40V - 0.7(29)V - 0.7V}{-9\left(\frac{20}{47}+1\right)}$$

$$= \frac{-\frac{400}{10}V - \frac{7}{10}(29)V - 0.7V}{-9\cdot\frac{67}{47}}$$

$$= \frac{-603}{(-9)10}\cdot\frac{47}{67}V - 0.7V$$

$$= \frac{-9}{-9}\,\frac{47}{10}V - 0.7V$$

$$= 4.7V - 0.7V$$

$$V_2 = 4.0\,V$$

$$V_1 = V_2 + 0.7V = 4.7V$$

$$V_1\left(\frac{20}{47}\right) + V_2(+3) + V_3(-2) = 4V$$

$$4.7\left(\frac{20}{47}\right) + 4.3 + V_3(-2) = 4V$$

$$\text{or} \quad V_3 = 5V$$