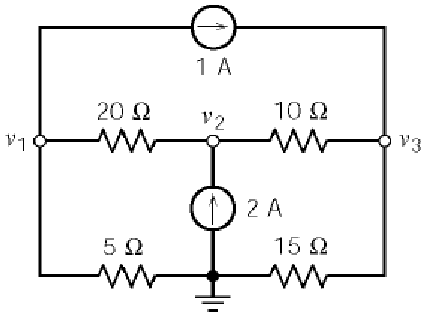
P4.3-2



KCL at node 1:

$$\frac{v_1 - v_2}{20} + \frac{v_1}{5} + 1 = 0 \quad \Rightarrow \quad 5\,v_1 - v_2 = -20$$

KCL at node 2:

$$\frac{v_1 - v_2}{20} + 2 = \frac{v_2 - v_3}{10} \quad \Rightarrow \quad -v_1 + 3\,v_2 - 2\,v_3 = 40$$

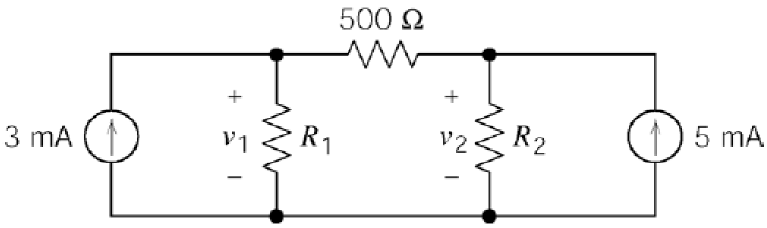
KCL at node 3:

$$\frac{v_2 - v_3}{10} + 1 = \frac{v_3}{15} \quad \Rightarrow \quad -3\,v_2 + 5\,v_3 = 30$$

Solving gives $v_1 = 2$ V, $v_2 = 30$ V and $v_3 = 24$ V.

(checked using LNAP 8/13/02)

P4.3-4



Node equations:

$$-.003 + \frac{v_1}{R_1} + \frac{v_1 - v_2}{500} = 0$$

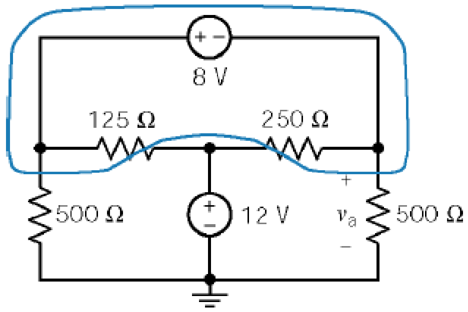
$$-\frac{v_1 - v_2}{500} + \frac{v_2}{R_2} - .005 \;=\; 0$$

When $v_1 = 1$ V, $v_2 = 2$ V

$$-.003 + \frac{1}{R_1} + \frac{-1}{500} \;=\; 0 \Rightarrow R_1 \;=\; \frac{1}{.003 + \frac{1}{500}} \;=\; \underline{200\,\Omega}$$

$$-\frac{-1}{500} + \frac{2}{R_2} - .005 = 0 \Rightarrow R_2 = \frac{2}{.005 - \frac{1}{500}} = \underline{667\,\Omega}$$

P4.4-4



Apply KCL to the supernode:

$$\frac{v_a+8}{500}+\frac{(v_a+8)-12}{125}+\frac{v_a-12}{250}+\frac{v_a}{500}=0$$

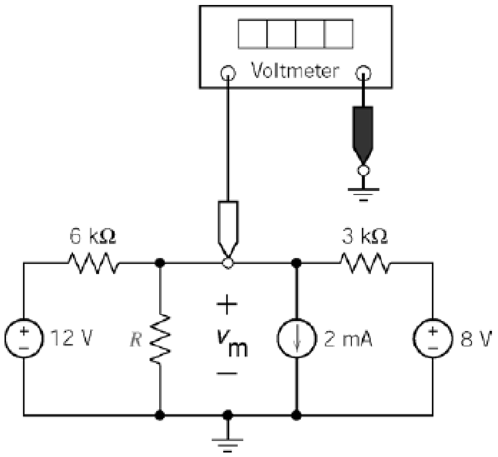
Solving yields

$$v_a = 4 \text{ V}$$

(checked using LNAP 8/13/02)

P4.4-6

Label the voltage measured by the meter. Notice that this is a node voltage.



Write a node equation at the node at which the node voltage is measured.

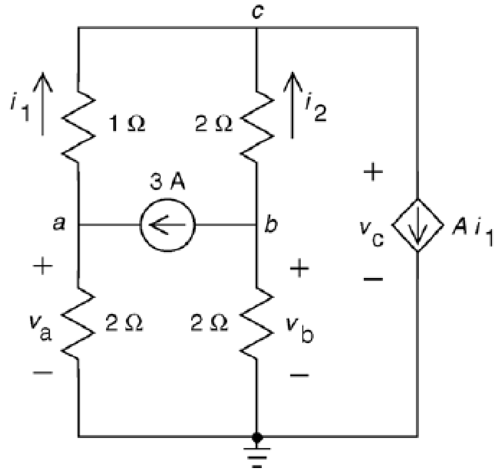
$$-\left(\frac{12-v_m}{6000}\right)+\frac{v_m}{R}+0.002+\frac{v_m-8}{3000}=0$$

That is

$$\left(3+\frac{6000}{R}\right)v_m=16 \quad\Rightarrow\quad R=\frac{6000}{\dfrac{16}{v_m}-3}$$

(a) The voltage measured by the meter will be 4 volts when R = 6 kΩ.
(b) The voltage measured by the meter will be 2 volts when R = 1.2 kΩ.

P4.5-1



Express the resistor currents in terms of the node voltages:

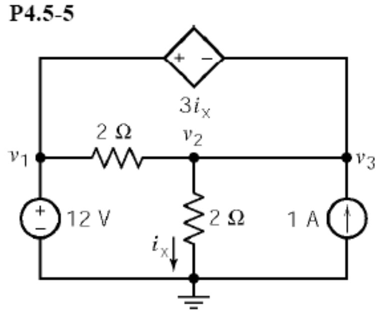
$$i_1 = \frac{v_a - v_c}{1} = 8.667 - 10 = -1.333 \text{ A and}$$
$$i_2 = \frac{v_b - v_c}{2} = \frac{2-10}{2} = -4 \text{ A}$$

Apply KCL at node c:

$$i_1 + i_2 = A\,i_1 \quad \Rightarrow \quad -1.333 + (-4) = A\,(-1.333)$$
$$\Rightarrow \quad A = \frac{-5.333}{-1.333} = 4$$

(checked using LNAP 8/13/02)

P4.5-5



First, express the controlling current of the CCVS in terms of the node voltages: $i_x = \frac{v_2}{2}$

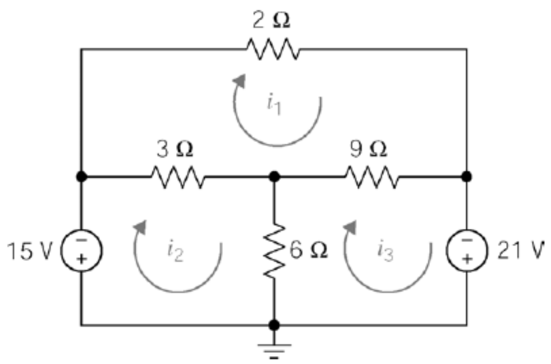
Next, express the controlled voltage in terms of the node voltages:

$$12 - v_2 = 3\,i_x = 3\,\frac{v_2}{2} \quad \Rightarrow v_2 = \frac{24}{5} \text{ V}$$

so i_x = 12/5 A = 2.4 A.

(checked using ELab 9/5/02)

P 4.6-1



$$2\,i_1 + 9\,(i_1 - i_3) + 3\,(i_1 - i_2) = 0$$
$$15 - 3\,(i_1 - i_2) + 6\,(i_2 - i_3) = 0$$
$$-6\,(i_2 - i_3) - 9\,(i_1 - i_3) - 21 = 0$$

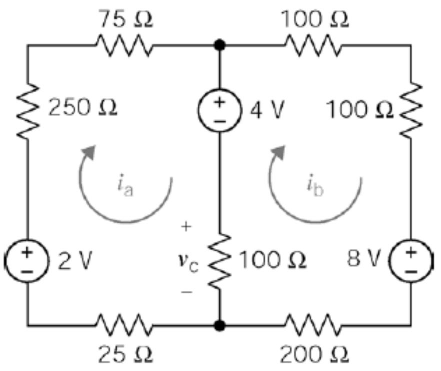
or

$$14\,i_1 - 3\,i_2 - 9\,i_3 = 0$$
$$-3\,i_1 + 9\,i_2 - 6\,i_3 = -15$$
$$-9\,i_1 - 6\,i_2 + 15\,i_3 = 21$$

so

i_1 = 3 A, i_2 = 2 A and i_3 = 4 A.

P4.6-4



KVL loop 1:

$$25\ i_a - 2 + 250\ i_a + 75\ i_a + 4 + 100\ (i_a - i_b) = 0$$
$$450\ i_a - 100\ i_b = -2$$

KVL loop 2:

$$-100(i_a - i_b) - 4 + 100\ i_b + 100\ i_b + 8 + 200\ i_b = 0$$
$$-100\ i_a + 500\ i_b = -4$$
$$\Rightarrow \underline{i_a = -6.5\text{ mA}},\ \underline{i_b = -9.3\text{ mA}}$$

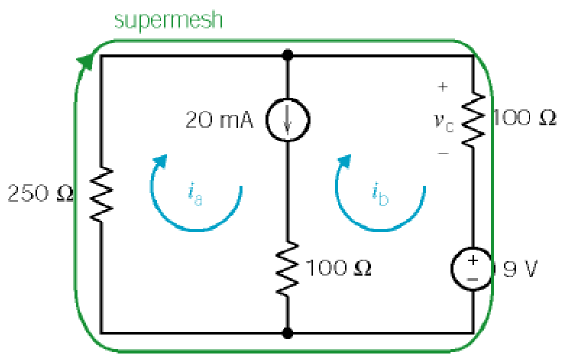
P4.7-4

Express the current source current in terms of the mesh currents:

$$i_b = i_a - 0.02$$

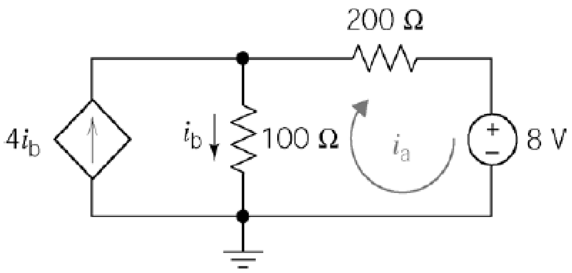
Apply KVL to the supermesh:

$$250\ i_a + 100\ (i_a - 0.02) + 9 = 0$$
$$\therefore i_a = -.02\text{ A} = -20\text{ mA}$$
$$v_c = 100(i_a - 0.02) = \underline{-4\text{ V}}$$



(checked using LNAP 8/14/02)

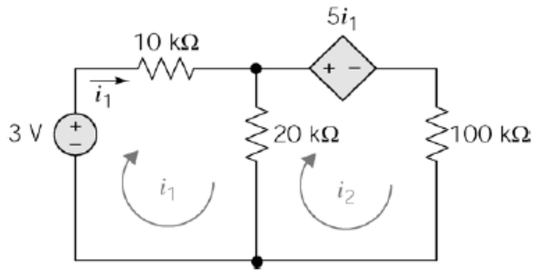
P 4.7-9



$$i_b = 4i_b - i_a \Rightarrow i_b = \frac{1}{3}\,i_a$$
$$-100\left(\frac{1}{3}i_a\right) + 200 i_a + 8 = 0$$
$$\Rightarrow \underline{i_a = -0.048\text{ A}}$$

(checked using LNAP 8/14/02)

P4.7-12



apply KVL to left mesh : $-3+10\times10^3\,i_1+20\times10^3\,(i_1-i_2)=\ 0 \Rightarrow \underline{30\times10^3\,i_1-20\times10^3\,i_2=3}$ (1)

apply KVL to right mesh : $5\times10^3\,i_1+100\times10^3\,i_2+20\times10^3\,(i_2-i_1)=0 \Rightarrow \underline{\ i_1\ =\ 8i_2}$ (2)

Solving (1) & (2) simultaneously $\Rightarrow\ i_1=\dfrac{6}{55}$ mA, $i_2=\dfrac{3}{220}$ mA

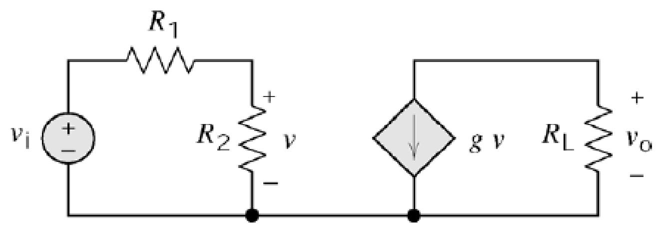
$$\text{Power delevered to cathode} \;=\; (5i_1)\ (i_2)+100(i_2)^2$$

$$=\; 5\left(\tfrac{6}{55}\right)\left(\tfrac{3}{220}\right)+100\left(\tfrac{3}{220}\right)^2 \;=\; 0.026\text{ mW}$$

$$\therefore\ \text{Energy in 24 hr.} = Pt \;=\; \left(2.6\times10^{-5}\text{ W}\right)(24\text{ hr})\left(3600\ \tfrac{\text{s}}{\text{hr}}\right)$$

$$\underline{=\ 2.25\text{ J}}$$

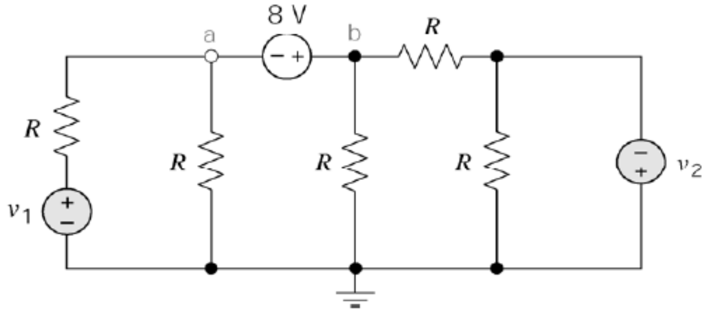
P4.7-13



(a) $$v_o=-g\,R_L v\ \text{ and } v=\frac{R_2}{R_1+R_2}v_i\quad\Rightarrow\frac{v_o}{v_i}=-g\,\frac{R_L R_2}{R_1+R_2}$$

(b) $$\therefore\ \frac{v_o}{v_i}=-g\frac{\left(5\times10^3\right)\left(10^3\right)}{1.1\times10^3}=-170\quad\Rightarrow \underline{g=0.0374\ \text{ S}}$$

DP 4-2



Express the voltage of the 8 V source in terms of its node voltages to get $v_b - v_a = 8$. Apply KCL to the supernode corresponding to the 8 V source:

$$\frac{v_a - v_1}{R} + \frac{v_a}{R} + \frac{v_b}{R} + \frac{v_b - (-v_2)}{R} = 0 \quad \Rightarrow \quad 2\,v_a - v_1 + 2\,v_b + v_2 = 0$$

$$\Rightarrow \quad 2\,v_a - v_1 + 2\,(v_a + 8) + v_2 = 0$$

$$\Rightarrow \quad 4\,v_a - v_1 + v_2 + 16 = 0$$

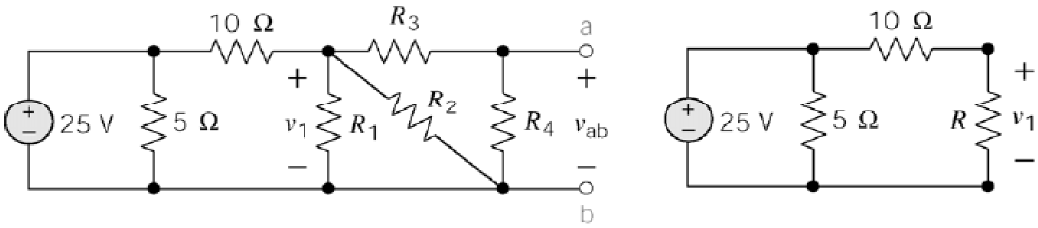
$$\Rightarrow \quad v_a = \frac{v_1 - v_2}{4} - 4$$

Next set $v_a = 0$ to get

$$0 = \frac{v_1 - v_2}{4} - 4 \quad \Rightarrow \quad v_1 - v_2 = 16 \text{ V}$$

For example, $v_1 = 18$ V and $v_2 = 2$ V.

DP 4-4



Equivalent resistance: $R = R_1 \parallel R_2 \parallel (R_3 + R_4)$

Voltage division in the equivalent circuit: $v_1 = \dfrac{R}{10+R}(25)$

We require v_{ab} = 10 V. Apply the voltage division principle in the left circuit to get:

$$10 = \frac{R_4}{R_3 + R_4}\ v_1 = \frac{R_4}{R_3 + R_4} \times \frac{\left(R_1 \| R_2 \| \ (R_3 + R_4)\right)}{10 \ + \ \left(R_1 \| R_2 \| \ (R_3 + R_4)\right)} \times 25$$

This equation does not have a unique solution. Here's one solution:

$$\text{choose } R_1 = R_2 \ = \ 25\,\Omega \text{ and } R_3 + R_4 = 20\,\Omega$$

$$\text{then } 10 = \frac{R_4}{20} \times \frac{(12.5 \| 20\ )}{10 \ + \ (12.5 \| 20\ )} \times 25 \ \Rightarrow \ \underline{R_4 = 18.4\Omega}$$

$$\text{and } R_3 + R_4 = 20 \Rightarrow \underline{R_3 = 1.6\,\Omega}$$