Question 1

By KCL, we may write: $5.6\text{ mA} = i_1 + i_2 + i_3$ (1)

We have $i_1 = 2i_2$ and $i_2 = 9i_3$, so $i_1 = 18i_3$

Substituting for i_1 and i_2 into equation (3),

$$5.6\text{ mA} = 18i_3 + 9i_3 + i_3 = 28i_3$$

Therefore, $i_3 = 0.2\text{ mA}$

The total voltage is given as 4 V across all circuit elements.

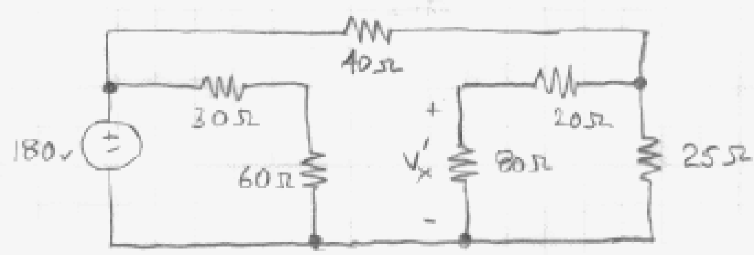
$$R_3 = \frac{V}{i_3} = \frac{4}{0.2\text{mA}} = 20\text{ K}\Omega$$

$$i_2 = 9i_3 = 1.8\text{mA}, \quad \text{so} \quad R_2 = \frac{4}{1.8\text{mA}} = 2222.2\Omega$$

$$i_1 = 2i_2 = 3.6\text{mA}, \quad \text{so} \quad R_1 = \frac{4}{3.6\text{mA}} = 1111.1\Omega$$

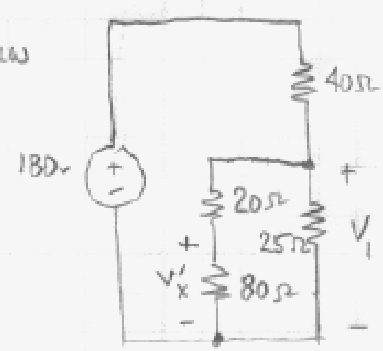
Question 2

Consider the 180 v source alone

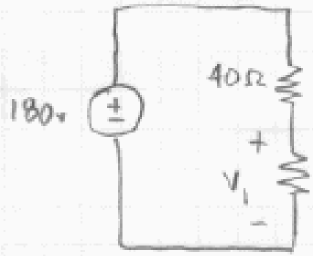


Note the 30Ω and 60Ω resistors do not influence V_x in any way

Redraw



Equivalently, combining resistors,



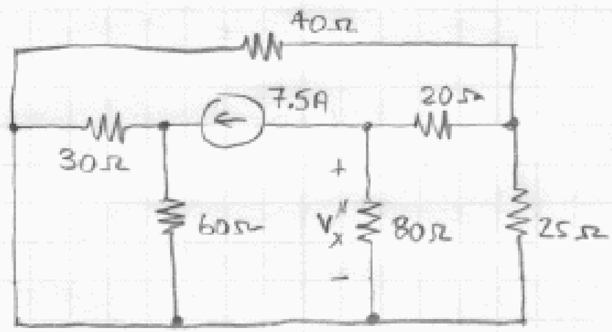
$$R_{eq} = (20 + 80) \,//\, 25 = 20\Omega$$

$$\text{Hence,} \quad V_1 = \frac{20}{20+40} \times 180 = 60\,v$$

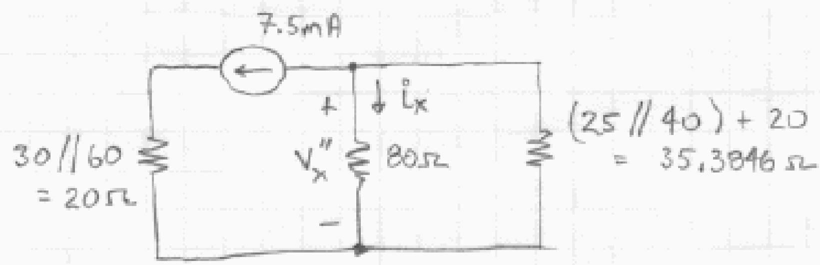
And after replacing Req with the original circuit,

$$V_x' = \frac{80}{80+20} \times V_1 = 48\,v$$

Now take the <u>current source</u> alone



After recognizing that we may combine several resistors,



Have a current divider :
$$i_x = -\frac{35.3846}{35.3846 + 80} \times 7.5\,mA$$
$$= -2.3\,mA$$

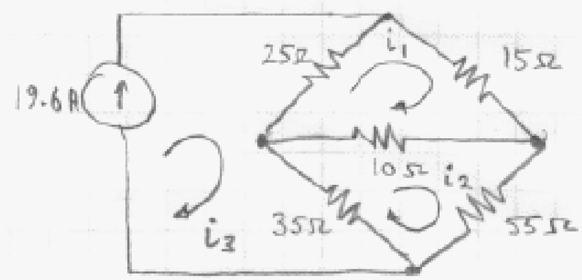
Therefore, $V_x'' = 80\, i_x = -184\,v$

Finally, $V_x = V_x' + V_x'' = -136\,v$

Question 3

(a) The mesh-current method would be simplest to use. There are three meshes. One mesh current is fixed at 19.6 A. Thus, we will have two equations, two unknowns.

(b) Set up for mesh-current method



Mesh 1: $15i_1 + 10(i_1 - i_2) + 25(i_1 - i_3) = 0$

or $50i_1 - 10i_2 - 25i_3 = 0$

But $i_3 = 19.6$ A, so $50i_1 - 10i_2 = 490$ (1)

Mesh 2: $55i_2 + 35(i_2 - i_3) + 10(i_2 - i_1) = 0$

or $100i_2 - 10i_1 - 35i_3 = 0$

Again $i_3 = 19.6$A, so $-10i_1 + 100i_2 = 686$ (2)

Add equation (1) to 5 times equation (2)

$$\begin{array}{rl} & 50i_1 - 10i_2 = 490 \\ + & -50i_1 + 500i_2 = 3430 \\ \hline & 490i_2 = 3920 \end{array} \qquad \therefore\ i_2 = 8\text{ A}$$

From (1), $50i_1 - 80 = 490$ $\therefore\ i_1 = 11.4$ A

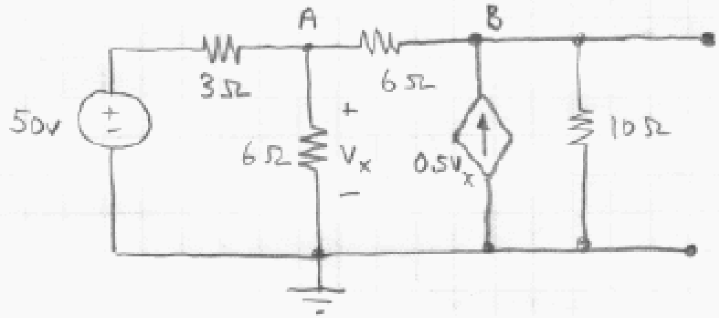
The power in the 10Ω resistor can be determined from the branch current, which is either $i_1 - i_2$ or $i_2 - i_1$

$i_1 - i_2 = 3.4$ A, so $P_{10} = (3.4)^2 10$

$P_{10} = 115.6$ W

Question 4

First, find the Thevenin voltage V_t



$+$

$V_{oc} = V_B = V_t$

$-$

Node-voltage method looks easiest.

Node A : $\dfrac{V_A - 50}{3} + \dfrac{V_A}{6} + \dfrac{V_A - V_B}{6} = 0$

or $2V_A - 100 + V_A + V_A - V_B = 0$

$$4V_A - V_B = 100 \qquad (1)$$

Node B : $\dfrac{V_B - V_A}{6} - 0.5V_x + \dfrac{V_B}{10} = 0$

or $5V_B - 5V_A - 15V_x + 3V_B = 0$

We may recognize that $V_x = V_A$ (this was a very popular mistake!)

so $5V_B - 5V_A - 15V_A + 3V_B = 0$

$$8V_B = 20V_A \qquad (2)$$

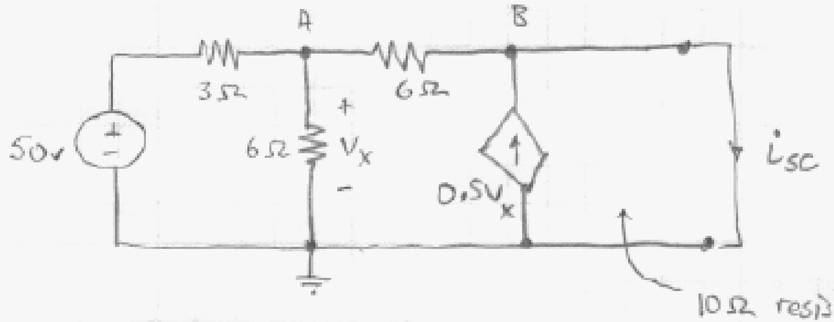
From (2), $V_A = (2/5)V_B$, so from (1)

$(8/5)V_B - V_B = 100$

$\therefore \quad V_B = 166.67\text{ v}$

$V_t = V_{oc} = V_B = 166.67\text{v}$

Next, we need to find i_{sc} to get <u>Thevenin resistance</u>



10Ω resistor shorted out, so remove

Sticking with the node voltage method,

Node A : Same as before : $4V_A - V_B = 100$ (1)

Node B : $\dfrac{V_B - V_A}{6} - 0.5V_x + i_{sc} = 0$

or $V_B - V_A - 3V_x + 6i_{sc} = 0$

As before, $V_x = V_A$. We also have, because of the short circuit, $V_B = 0$

$$-V_A - 3V_A + 6i_{sc} = 0$$

$$V_A = (3/2)\, i_{sc} \qquad (2)$$

Substitute (2) into (1) with $V_B = 0$,

$$6\, i_{sc} = 100 \qquad \therefore\ i_{sc} = 16.667\ A$$

Finally, $R_t = \dfrac{V_t}{i_{sc}} = \dfrac{166.667v}{16.667\ A}$

$$= 10\Omega$$