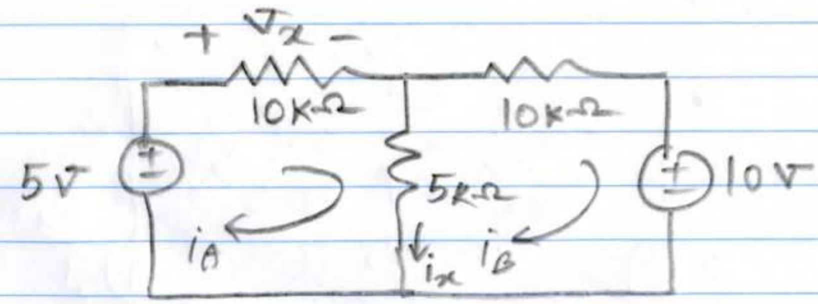
3-13

(a)



using inspection, we have;

$$\underbrace{\begin{bmatrix}(10+5)\times10^3 & -5\times10^3 \\ -5\times10^3 & (10+5)\times10^3\end{bmatrix}}_{A}\underbrace{\begin{bmatrix}i_A \\ i_B\end{bmatrix}}_{x} = \underbrace{\begin{bmatrix}5 \\ -10\end{bmatrix}}_{b}$$

$$\Rightarrow Ax = b$$

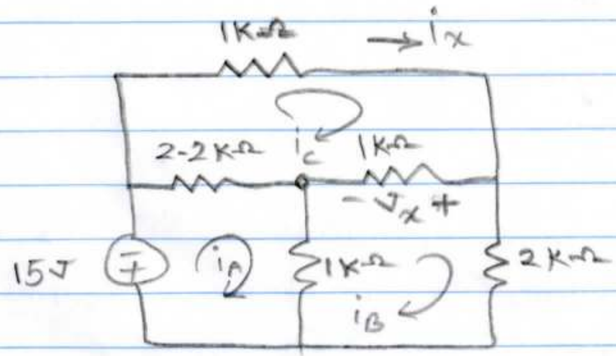
(b) $Ax = b \Rightarrow x = A^{-1}b \Rightarrow \begin{cases} i_A = 0.125\,mA \\ i_B = -0.625\,mA \end{cases}$

(c) $v_x = 10\times10^3\, i_A = 1.25V$

$i_x = i_A - i_B = 750\,\mu A$

3-14

(a)



using inspection, we have;

$$\underbrace{\begin{bmatrix} 3.2\times10^{3} & -10^{3} & -2.2\times10^{3} \\ -10^{3} & 4\times10^{3} & -10^{3} \\ -2.2\times10^{3} & -10^{3} & 4.2\times10^{3} \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix}}_{X} = \underbrace{\begin{bmatrix} -15 \\ 0 \\ 0 \end{bmatrix}}_{b}$$

$\Rightarrow AX = b$

(b) This equation can be solved using reverse of A as

$\Rightarrow X = A^{-1} b$

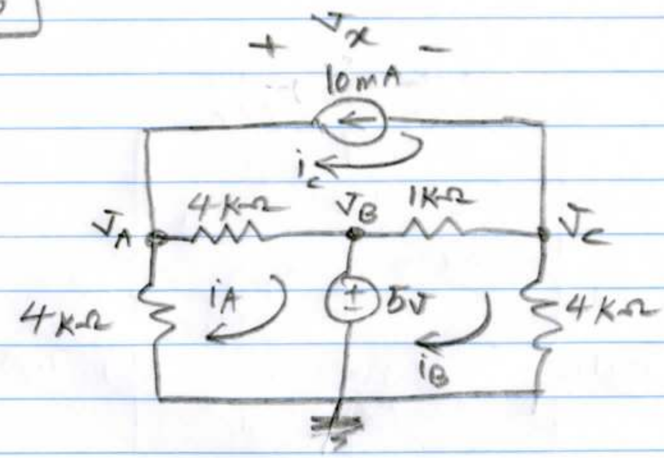
solving this equation $\Rightarrow \begin{cases} i_A = -0.01049 A \\ i_B = -0.00425 A \\ i_C = -0.00650 A \end{cases}$

(c) $v_x = 1\times10^{3}(i_c - i_B) = -2.25 V$

$i_x = i_c = -0.0065 A = -6.5 mA$

3-5

(a)



using inspection, we have:

$$\begin{array}{r} \text{Mesh A} \rightarrow \\ \\ \text{Mesh B} \rightarrow \end{array} \underbrace{\begin{bmatrix} (4+4)\times10^3 & 0 & -4\times10^3 \\ & & \\ 0 & (1+4)\times10^3 & -1\times10^3 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix}}_{x} = \underbrace{\begin{bmatrix} -5 \\ 5 \end{bmatrix}}_{b}$$

$i_c = -10\,mA$

$\Rightarrow Ax = b$

Solving the equations $\Rightarrow \begin{cases} i_A = -5.62\,mA \\ i_B = -1\,mA \end{cases}$

(b) $v_A = -4 i_A = 22.5\,V$

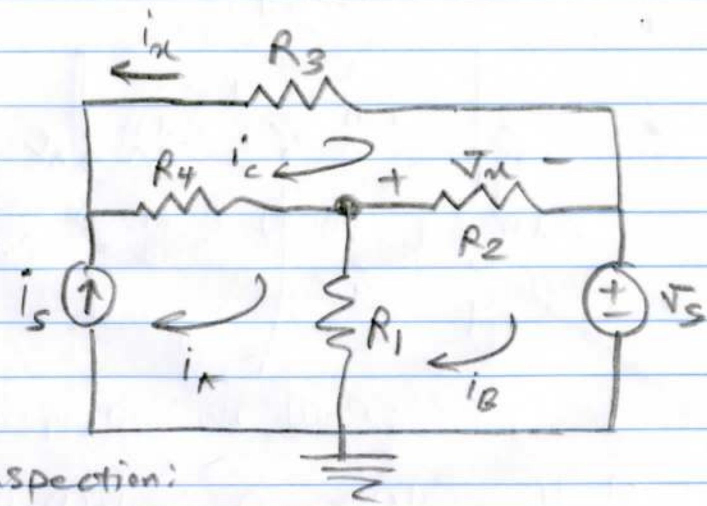
$v_c = 4 i_B = -4\,V$

(c) $v_x = v_A - v_c = 22.5 + 4 = 26.5\,V$

$i_x = i_A - i_B = -4.62\,mA$

3-6

(a)



using inspection:

$$\begin{array}{l} \text{Mesh B} \rightarrow \\ \\ \text{mesh C} \rightarrow \end{array} \begin{bmatrix} -R_1 & R_1+R_2 & -R_2 \\ \\ -R_4 & -R_2 & R_2+R_3+R_4 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix} = \begin{bmatrix} -v_s \\ 0 \end{bmatrix}$$

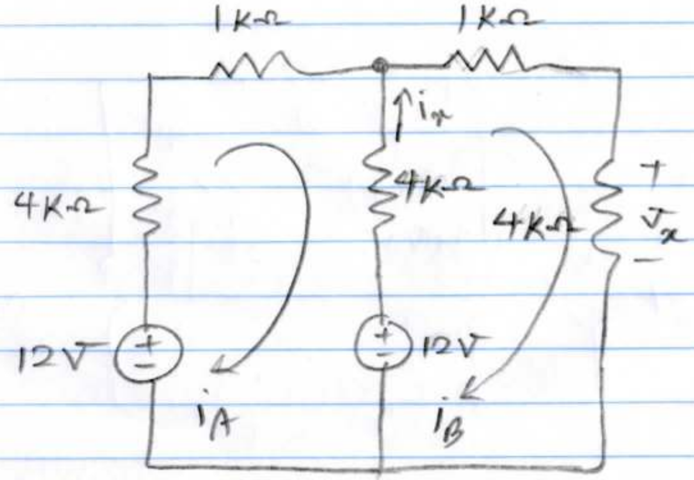
And $i_A = i_s$

(b) $\left.\begin{array}{l} i_A = i_s = 1\ mA \\ R_1 = R_2 = R_3 = R_4 = 10\,k\Omega \\ v_s = 25V \end{array}\right\} \Rightarrow \begin{array}{l} i_c = 0.1\ mA \\ i_B = -0.7 mA \end{array}$

$$\Rightarrow i_x = -i_c = -0.1\,mA$$
$$v_x = 10 \times (i_B - i_c)$$
$$= -8V$$

3-15

(a)



From inspection, we have;

$$\underbrace{\begin{bmatrix} (1+4+4)\times10^3 & -4\times10^3 \\ -4\times10^3 & (4+1+4)\times10^3 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} i_A \\ i_B \end{bmatrix}}_{x} = \underbrace{\begin{bmatrix} \underbrace{12-12}_{0} \\ 12 \end{bmatrix}}_{b}$$

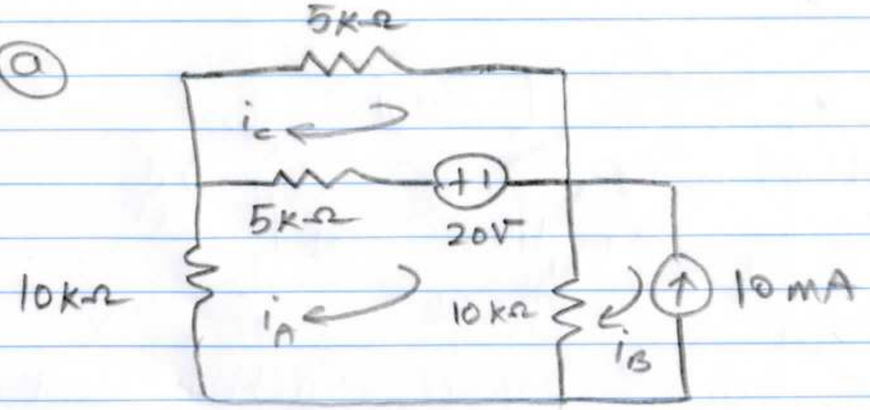
(b) $Ax = b \Rightarrow x = A^{-1}b \Rightarrow \begin{cases} i_A = 738.4615\ \mu A \\ i_B = 1.6615\ mA \end{cases}$

(c) $v_x = 4\times10^3\, i_B = 6.6462\ V$

$i_x = i_B - i_A = 923.0769\ \mu A$

3-26

(a)



From inspection;

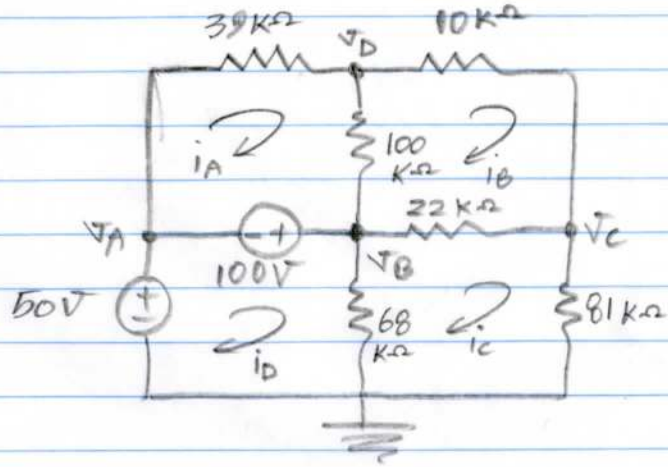
$$\begin{array}{l} \text{Mesh A} \rightarrow \\ \\ \text{mesh C} \rightarrow \end{array} \begin{bmatrix} (10+5+10)\times10^3 & -10\times10^3 & -5\times10^3 \\ & & \\ -5\times10^3 & 0 & 10\times10^3 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix} = \begin{bmatrix} -20 \\ 20 \end{bmatrix}$$

And $i_B = -10\,mA$

(c) In general, when equations involve less unknown parameters to be solved, then that method is easier for calculation. In this specific example, both mesh and node analyses involve two unknown parameters to solve. Therefore, both methods in this question have same degree of difficulty. One may think, that mesh analysis is easier here as you don't need any source transformation as we used for node analysis.

(d) $i_A = -4.88\,mA$
$i_C = -0.44\,mA$

3-27



(a) using inspection, we have;

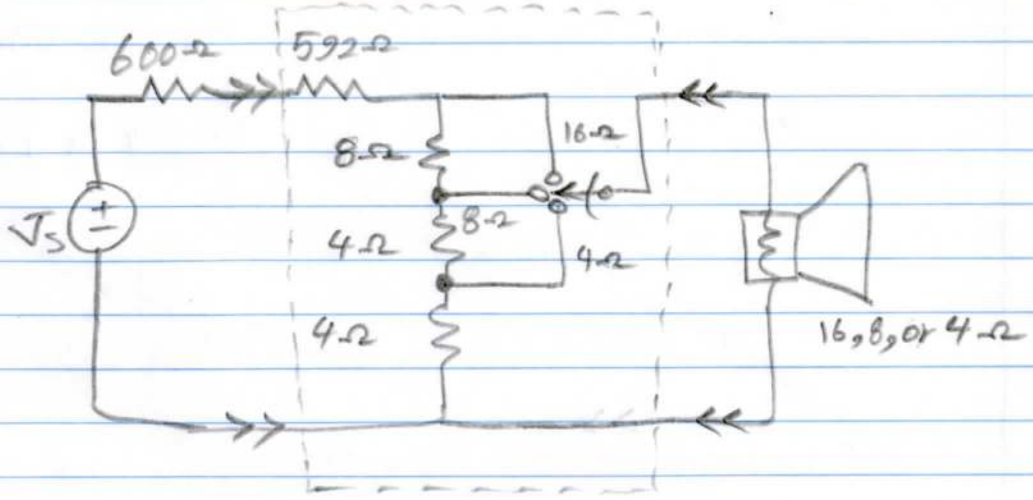
$$\underbrace{\begin{bmatrix} (39+100)\times10^3 & -100\times10^3 & 0 & 0 \\ -100\times10^3 & (10+100+22)\times10^3 & -22\times10^3 & 0 \\ 0 & -22\times10^3 & (22+81+68)\times10^3 & -68\times10^3 \\ 0 & 0 & -68\times10^3 & 68\times10^3 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} i_A \\ i_B \\ i_C \\ i_D \end{bmatrix}}_{X} = \underbrace{\begin{bmatrix} -100 \\ 0 \\ 0 \\ +150 \end{bmatrix}}_{b}$$

$$AX = b$$

(b) $AX = b \Rightarrow X = A^{-1}b$ solving this equation, we have;

$$\begin{cases} i_A = -1.2380 \text{ mA} \\ i_B = -720.8214 \ \mu A \\ i_C = 1.3023 \text{ mA} \\ i_D = 3.5082 \text{ mA} \end{cases}$$

3-91



(I) If switch 16 Ω is connected:

$$R_{in} = 592 + 16 \| (8+4+4) = 600\,\Omega$$

$$R_{out} = (4+4+8) \| (592+600) = 15.79\,\Omega$$

(II) If switch 8 Ω is connected:

$$R_{in} = (592+8) + (4+4) \| 8 = 604\,\Omega$$

$$R_{out} = (4+4) \| (8+592+600) = 7.95\,\Omega$$

(III) If switch 4 Ω is connected:

$$R_{in} = (592+8+4) + (4 \| 4) = 606\,\Omega$$

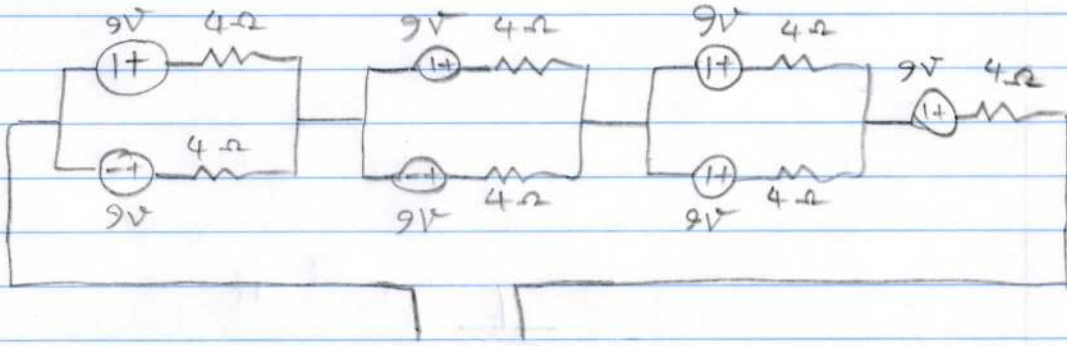
$$R_{out} = 4 \| (4+8+592+600) = 3.99\,\Omega$$

so, the claim is true.

$\boxed{3-94}$

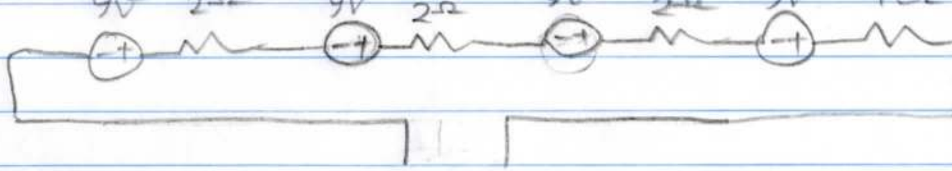
There are different answers to this question in which they can satisfy the required conditions in the question.

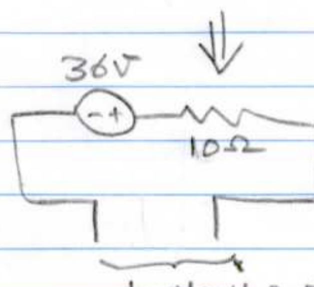
Here is one possible answer;



circuit weight = 210g battery output

using source transforation of voltage to current and then current to voltage for all three parallel circuits, the above circuit can simplify as;





battery output

$\boxed{3-95}$

Both circuits satisfy the voltage requirement.

But circuit 2 satisfies the source power rating

because in circuit 1, the bottom part of 100Ω

resistor (Short circuit part) reduces the total

resistor in this branch and as a result this

branch gets more current from source meaning

consuming more power from the source.