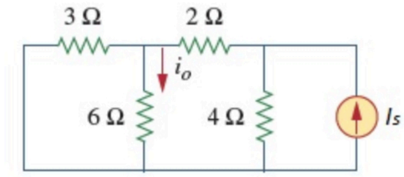
1. value:
10.00 points

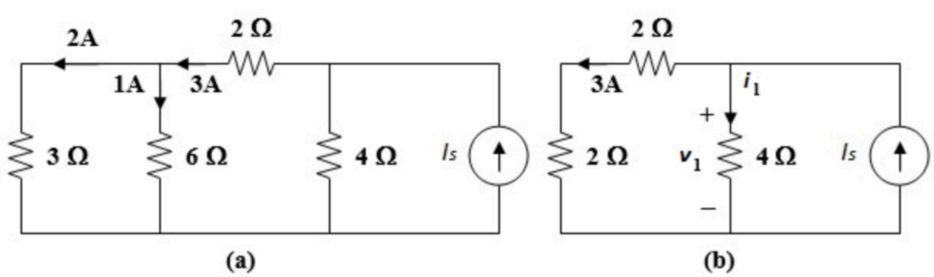
Assume I_o = 1 A and use linearity to determine I_o in the given circuit when I_S = 13 A.



The current I_o is equal to 2.17 ± 2% A.

Explanation:

If I_o = 1 A, the voltage across the 6-Ω resistor is 6 V so that the current through the 3-Ω resistor is 2 A.



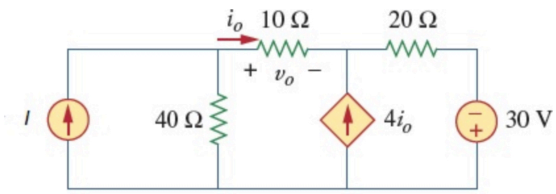
The equivalent resistance is given by 3 Ω || 6 Ω = 2 Ω.
Let v_o be the voltage across the two 2 ohm resistors in series in figure (b)
Since $v_o = 3 \times 4 = 12$ V, $i_1 = v_o / 4 = 3$ A.
Hence, $I_S = 3 + 3 = 6$ A.
When I_S = 6 A, I_o = 1 A.
Since I_S = 13 A, I_o = 13 / 6 A = 2.17 A.

The current I_o is equal to 2.17 A.

2.

value:
10.00 points

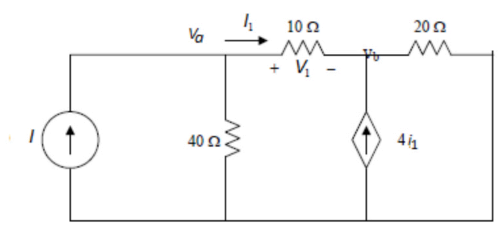
Use the superposition principle to determine the voltage across 10 Ω resistor due to 7-A current source and 30-V voltage source. Determine i_o and v_o in the given circuit where I = 7 A.



The voltage across 10 Ω resistor solely due to 7-A current source is *18.6598 ± 2%* V.
The voltage across the 10 Ω resistor solely due to 30-V voltage source is *2 ± 2%* V.
The value of v_o is *20.66 ± 2%* V.
The value of i_o is *2.07 ± 2%* A.

Explanation:

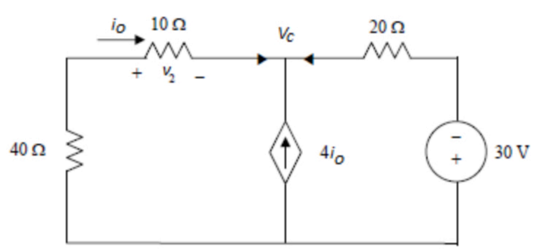
Let $v_o = v_1 + v_2$, where v_1 and v_2 are due to the 7-A and 30-V sources, respectively. To find v_1, consider the circuit below.



At node a, $7 = \frac{v_a}{40} + \frac{v_a - v_b}{10} \Rightarrow 280 = 5v_a - 4v_b$ (1)

At node b, $-i_1 - 4i_1 + \frac{(v_b - 0)}{20} = 0$ or $v_b = 100 i_1$

But $i_1 = (v_a - v_b) / 10$, which leads to $100(v_a - v_b)10 = v_b$ or $v_b = 0.9091\ v_a$ (2)
Substituting (2) in (1),
$5v_a - 3.636v_b = 280$ or $v_a = 205.28$ V and $v_a = 186.62$ V
However, $v_1 = v_a - v_b = 18.66$ V.
To find v_2, consider the circuit below.



$$\frac{0-v_c}{50}+4i_o+\frac{(-30-v_c)}{20}=0$$

But $i_o = (0 - v_c) / 50$

$$-\frac{5v_c}{50}-\frac{(30+v_c)}{20}=0 \Rightarrow v_c= -10\text{ V}$$

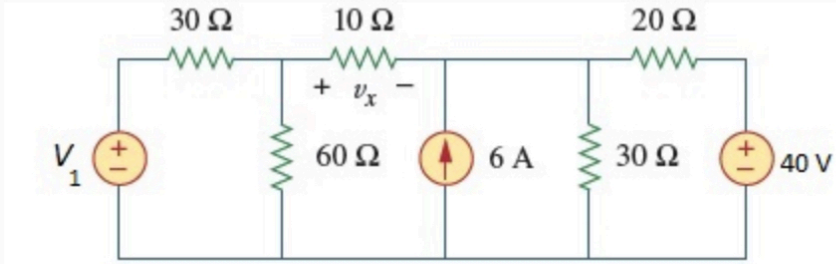
Therefore, $i_2=\frac{0-v_c}{50}=\frac{0+10}{50}=\frac{1}{5}$

$v_2 = 10i_2 = 2$ V
Therefore, $v_o = v_1 + v_2 = 18.66 + 2 = 20.66$ V
and $i_o = v_o / 10 = 2.07$ A.

The voltage across 10 Ω resistor solely due to 7-A current source is 18.6598 V.
The voltage across the 10 Ω resistor solely due to 30-V voltage source is 2 V.
The value of v_o is 20.66 V.
The value of i_o is 2.07 A.

3. value:
10.00 points

Consider the circuit given below where $V_1 = 84$ V.

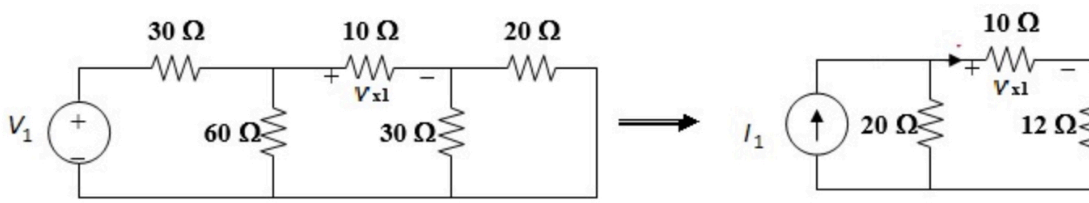


Use superposition to obtain v_x in the given circuit.

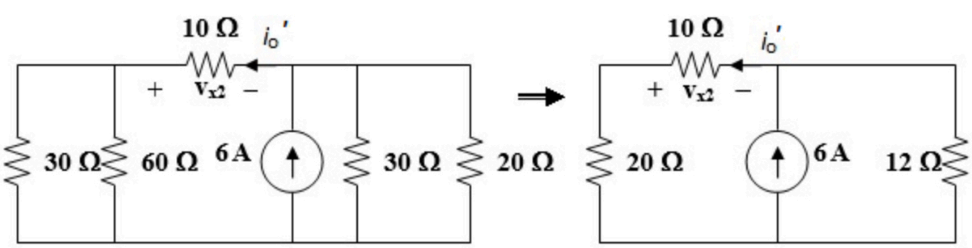
The value of v_x in the given circuit is -9.524 ± 2% V.
Assume v_{x1}, v_{x2}, and v_{x3} are due to 84-V, 6-A and 40-V sources.

Explanation:

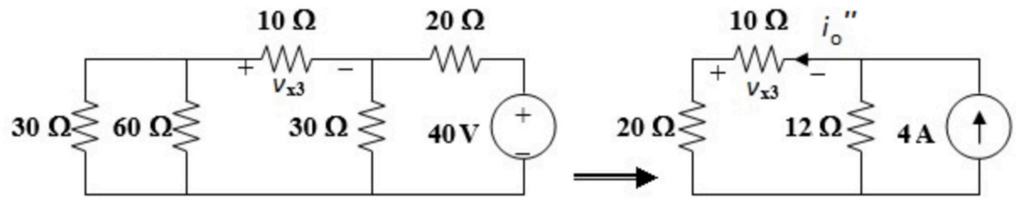
Let $v_x = v_{x1} + v_{x2} + v_{x3}$, where v_{x1}, v_{x2}, and v_{x3} are due to 84-V, 6-A, and 40-V sources.
For v_{x1}, consider the circuit below.



In the given figure, $I_1 = V_1 / 30 = 3$ A.
The equivalent resistance is calculated as follows:
20 || 30 = 12 Ω, 60 || 30 = 20 Ω
By using the current division principle,
$i_o = (20 / (22 + 20)) \times 3 = 1.333$ A
Therefore, $v_{x1} = 10 i_o = 13.333$ V.
For v_{x2}, consider the circuit below.



The current i_o' is calculated as follows:
$i_o' = (12 / (12 + 30)) \times 6 = 72 / 42$ A
Therefore, $v_{x2} = -10 i_o' = -17.143$ V.
For v_{x3}, consider the circuit below.

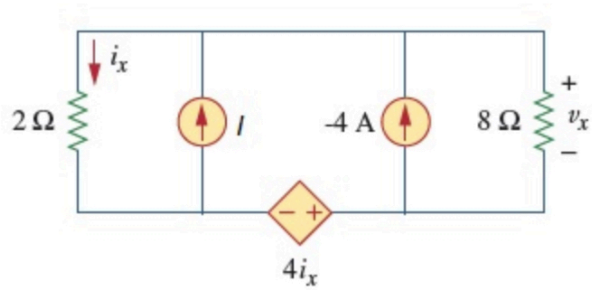


The current i_o" is calculated as follows:
i_o" = (12 / (12 + 30)) × 2 = 24 / 42 A
Therefore, $v_{x3} = -10i_o'' = -5.714$ V.
Hence, $v_x = v_{x1} + v_{x2} + v_{x3}$ = 13.333 V + (–17.143) V + (–5.714) V = -9.524 V.

The value of v_x in the given circuit is -9.524 V.

5. value:
10.00 points

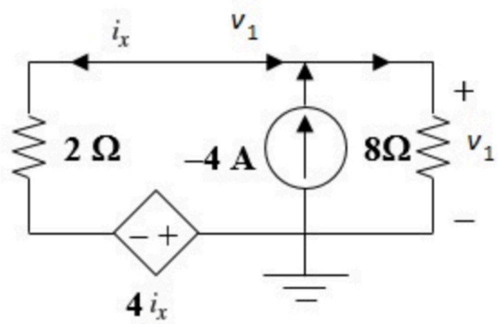
Use superposition to solve for v_x in the given circuit where I = 24 A.



The value of v_x in the given circuit is -53.33 ± 2% V.
Assume v_1 and v_2 are due to 4-A and 24-A sources.

Explanation:

Let $v_x = v_1 + v_2$, where v_1 and v_2 are due to 4-A and 24-A sources, respectively.
To find v_1, consider the given circuit.

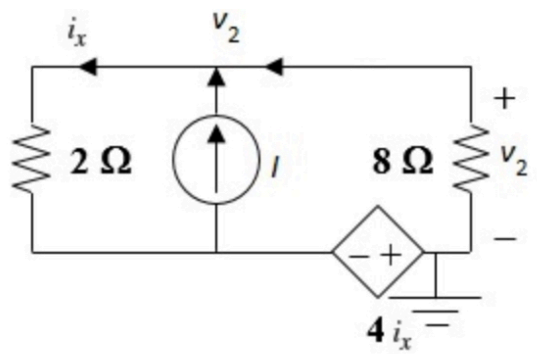


$$\frac{(v_1-0)}{8} - (-4) + \left[\frac{(v_1-(-4i_x))}{2}\right] = 0 \quad \text{or} \quad (0.125+0.5)\,v_1 = -4 - 2i_x$$

or

$$v_1 = -6.4 - 3.2i_x$$

But, $i_x = (v_1 - (-4i_x)) / 2$ or $i_x = 0.5\,v_1$
Therefore, $v_1 = -6.4 + 3.2(0.5v_1)$, which leads to $v_1 = 6.4 / 0.6 = 10.667$ V.
To find v_2, consider the given circuit.



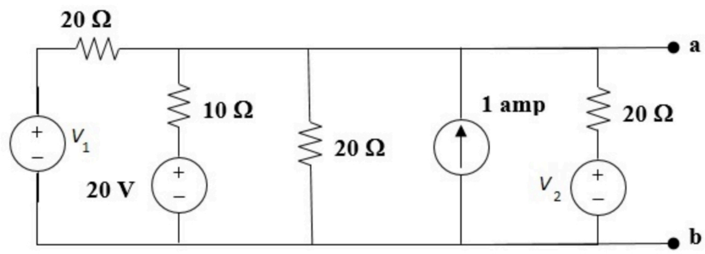
$$\frac{v_2}{8} - 24 + \frac{(v_2-(-4i_x))}{2} = 0 \quad \text{or} \quad v_2 + 3.2\,i_x = \frac{24\times 8}{5} = 38$$

But $i_x = -0.5\,v_2$. Therefore, $v_2 + 3.2(-0.5v_2) = 38$, which leads to $v_2 = -64.00$ V.
Hence, $v_x = v_1 + v_2 = 10.667 + (-64.00) = -53.33$ V.

The value of v_x in the given circuit is -53.33 V.

6. value:
10.00 points

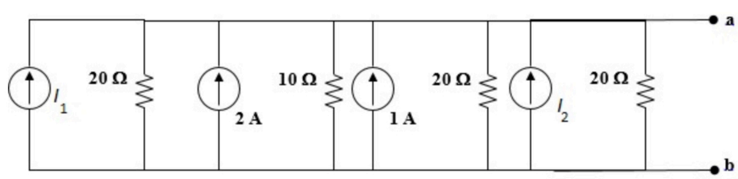
Consider the given figure where V_1 = 30 V and V_2 = 35 V. Use source transformations to reduce the circuit between terminals a and b to a s voltage source in series with a single resistor.



The equivalent resistor is 4 ± 2% Ω.
The equivalent voltage is 25 ± 2% V.

Explanation:

This problem is most easily solved by converting all the voltage sources in series with resistors to current sources in parallel with resistors.



In the above figure, I_1 = 30 / 20 = 2 A and I_2 = 35 / 20 = 1.75 A.
Now all we need is to add the current sources together algebraically and place all the resistors in parallel and combine them. Finally, all we need to do is to change the current source and resistance back into a single voltage source in series with a resistor.
The total current = 2 + 2 + 1 + 1.75 = 6.25 A.
The equivalent resistance is calculated as follows:

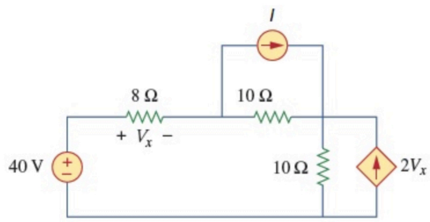
$$\frac{1}{R_{eq}} = \frac{1}{20} + \frac{1}{10} + \frac{1}{20} + \frac{1}{20} \Rightarrow R_{eq} = 4\,\Omega$$

Finally, V_{eq} = 6.25 × 4 = 25 V.

The equivalent resistor is 4 Ω.
The equivalent voltage is 25 V.

7. value:
10.00 points

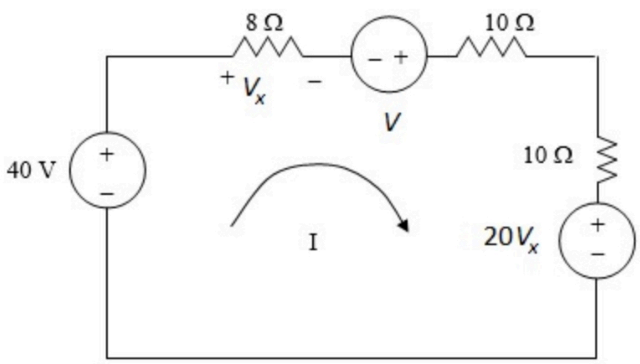
Use source transformation to find the voltage V_x in the given circuit where I = 7 A.



The voltage V_x in the given circuit is 4.681 ± 2% V.

Explanation:

Transforming the two current sources in parallel with the resistors into their voltage source equivalents yields a 70-V source in series with a 10-Ω resistor and a $20V_x$-V sources in series with a 10-Ω resistor.
We now have the following circuit.



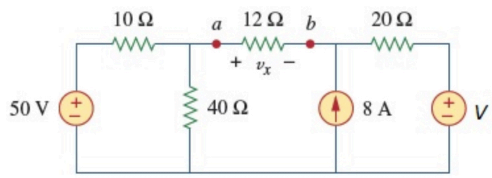
In the above figure, $V = 7 \times 10 = 70$ V.
We now write the following mesh equation and constraint equation, which will lead to a solution for V_x,
$28I - (40 + 70) + 20V_x = 0$ or $28I + 20V_x = 110$
But, $V_x = 8I$, which leads to $28I + 160I = 110 \rightarrow I = 0.585$ A or $V_x = 4.681$ V.

The voltage V_x in the given circuit is 4.681 V.

8.

value:
10.00 points

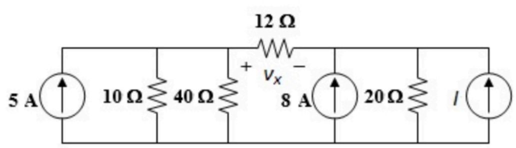
Apply source transformation to find v_x in the given circuit where V = 55 V.



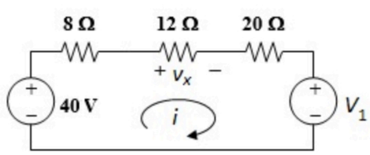
The value of v_x in the given circuit is *-52.5 ± 2%* V.

Explanation:

Transforming the voltage sources to current sources gives the following circuit where 10 || 40 = 8 Ω and I = 55 / 20 = 2.75 A.



Transforming the current sources to voltage sources yields the following circuit where V_1 = (2.75 + 8) × 20 = 215 V.



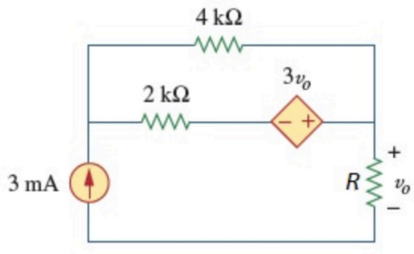
Applying KVL to the loop,
–40 + (8 + 12 + 20)i + 215 = 0 leads to i = -4.375 A
Therefore, v_x = 12i = 12 × -4.375 = -52.5 V.

The value of v_x in the given circuit is -52.5 V.

9.

value:
10.00 points

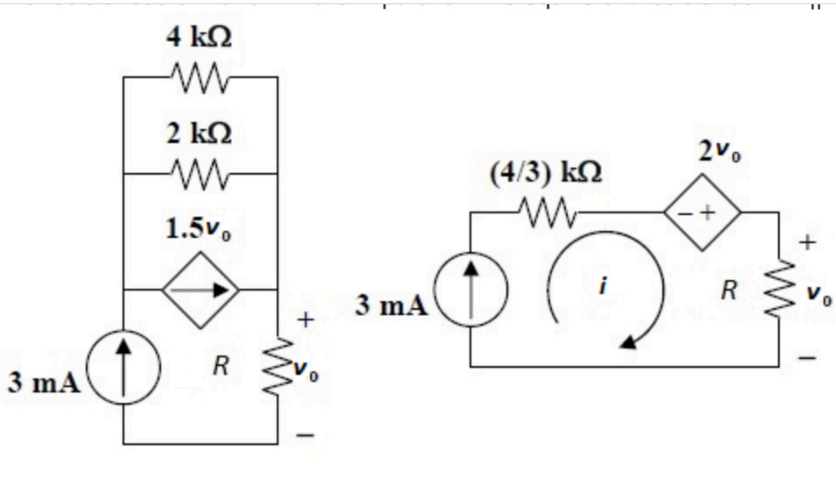
Use source transformation to find v_o in the circuit in the following figure if R = 2 kΩ.



The voltage v_o is 6 ± 2% V.

Explanation:

Transform the dependent voltage source to a current source as shown in Fig. (a).
The resistances 3 Ω and 4 Ω are in parallel. The equivalent resistance = 2 || 4 = (4/3) kΩ.



(a) (b)

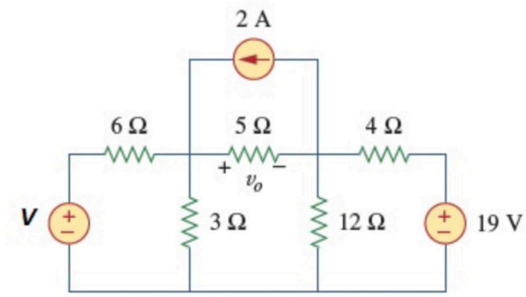
It is clear that i = 3 mA, which leads to v_o = 2 × 1000 i = 6 V.

The voltage v_o is 6 V.

10.

value:
10.00 points

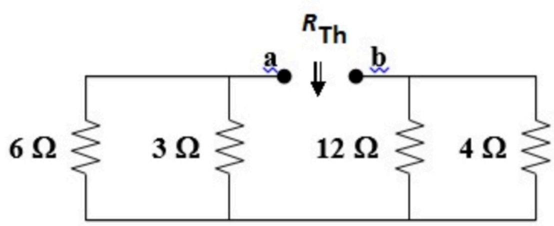
Use Thevenin's theorem to find v_o in the given circuit where V = 8 V.



The value of v_o in the given circuit is -792 ± 2% mV.

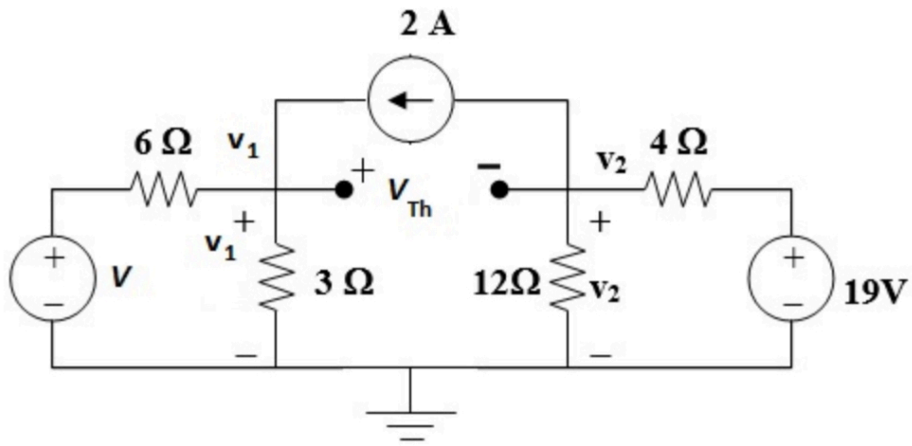
Explanation:

To find R_{Th}, consider the following circuit.

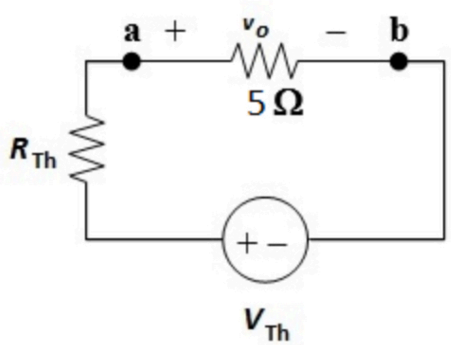


R_{Th} = R_{ab} = 6 || 3 + 12 || 4 = 2 + 3 = 5 Ω

To find V_{Th}, consider the following circuit.



At node 1,
$2 + (8 – v_1) / 6 = v_1 / 3$, or $v_1 = 6.67$
At node 2,
$(19 – v_2) / 4 = 2 + v_2 / 12$, or $v_2 = 33 / 4$
But, $–v_1 + V_{Th} + v_2 = 0$, or $V_{Th} = v_1 – v_2 = 6.67 – 33 / 4 = -1.58$ V.

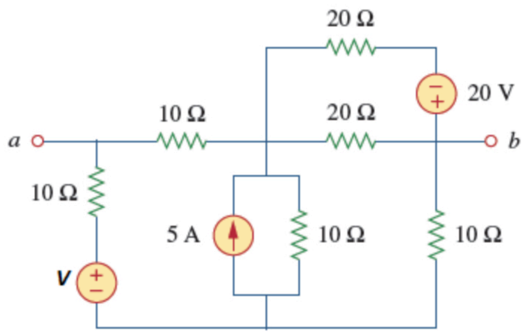


$v_o = V_{Th} / 2 = -1.58\times 1000 / 2 = -792$ mV

The value of v_o in the given circuit is -792 mV.

11. value:
10.00 points

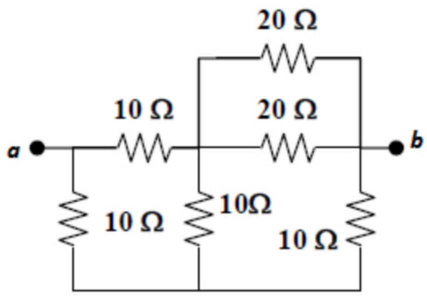
For the circuit given below, find the Thevenin equivalent between terminals *a* and *b*, where $V = 34$ V.



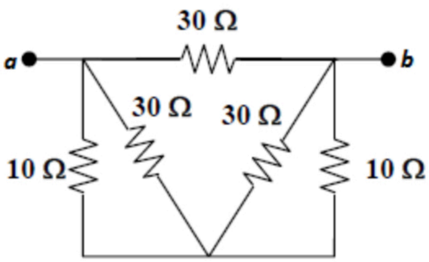
R_{Th} = 10 ± 2% Ω
V_{Th} = 12.0 ± 2% V

Explanation:

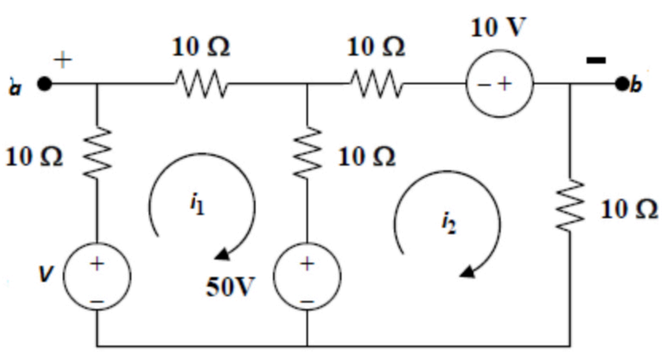
The Thevenin equivalent between terminals *a* and *b* is calculated as follows:
To find R_{Th}, consider the circuit given below:



20 || 20 = 10 Ω
Transform the wye sub-network to a delta as shown in the circuit given below:



10 || 30 = 7.5 Ω
$R_{Th} = R_{ab}$ = 30 || (7.5 + 7.5) = 10 Ω
To find V_{Th}, we transform the 20-V and the 5-A sources. We obtain the circuit given below:



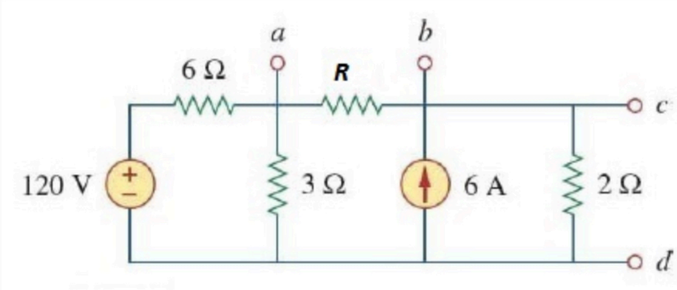
For loop 1, $-34 + 50 + 30i_1 - 10i_2 = 0$ (1)
For loop 2, $-50 - 10 + 30i_2 - 10i_1 = 0$ (2)
Solving (1) and (2), i_1 = 0.15 A and i_2 = 2.05 A.
Applying KVL to the output loop,
$-V_{ab} - 10i_1 + 34 - 10i_2 = 0 \rightarrow V_{ab} = 12.0$ V
$V_{Th} = V_{ab}$ = 12.0 V.

The values of the Thevenin equivalent between terminals *a* and *b* are as follows:
R_{Th} = 10 Ω
V_{Th} = 12.0 V

12.

value:
10.00 points

Given the circuit in the following figure, obtain the Norton equivalent as viewed from the following terminals if $R = 6\ \Omega$.

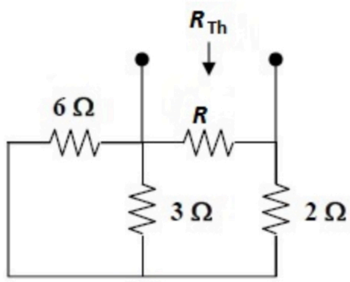


Terminals *a-b*

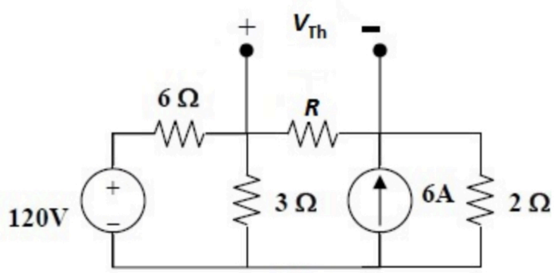
R_N = 2.40 ± 2% Ω
I_N = 7.00 ± 2% A

Explanation:

From the circuit in Fig. (a),
$R_N = 6 \,||\, (2 + 6 \,||\, 3) = 2.40\ \Omega$

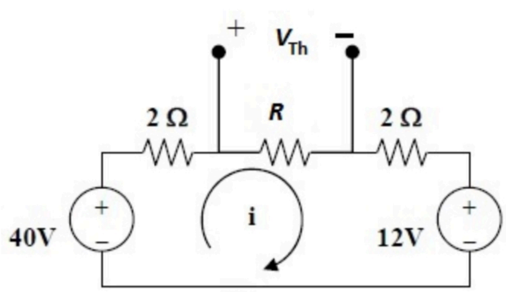


(a)



(b)

For I_N or V_{Th}, consider the circuit in Fig.(b). After some transformations, the circuit becomes that shown in Fig. (c).



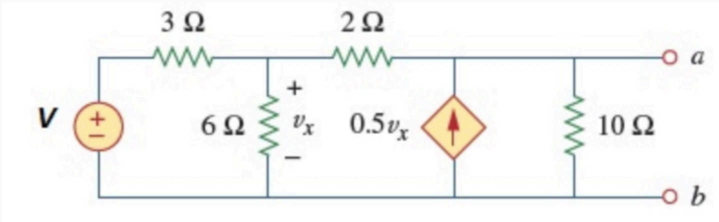
(c)

Applying KVL to the circuit in Fig. (c),
$-40 + (2.40 + 6 + 2)i + 12 = 0$, which gives $i = 2.80$
$V_{Th} = 6\text{ i} = 6 \times 2.80 = 16.80$. Therefore, $I_N = V_{Th} / R_N = 7.00$ A.

The calculated parameters are as follows:
$R_N = 2.40\ \Omega$
$I_N = 7.00$ A

13. value:
10.00 points

Consider the given circuit where $V = 90$ V.

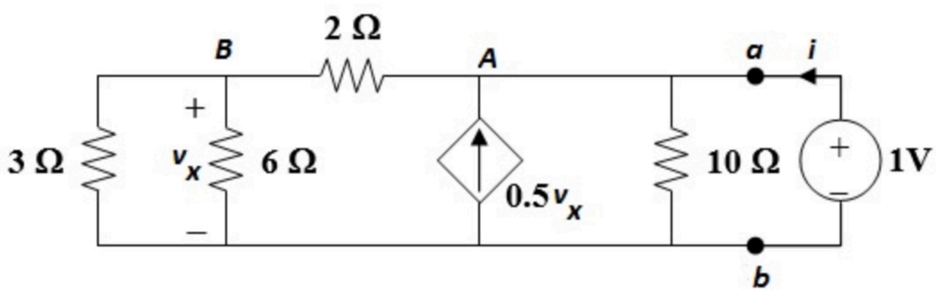


Determine the Norton equivalent circuit at terminals *a*-*b* of the given circuit.

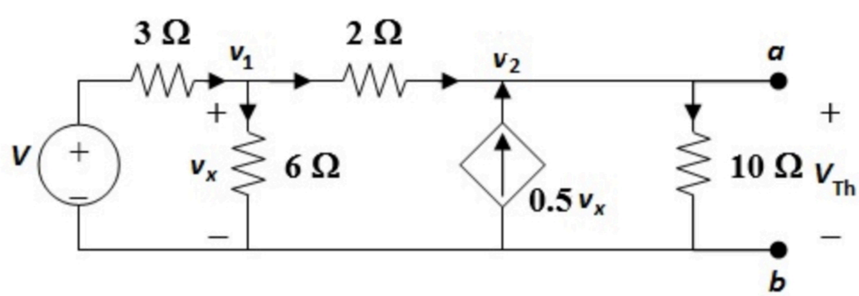
R_N = 10.00 ± 2% Ω
I_N = 30.00 ± 2% A

Explanation:

To find R_{Th}, remove the 90-V source and insert a 1-V source at *a*-*b*, as shown in the given figure.



We apply nodal analysis. At node A,
$i + 0.5v_x = (1 / 10) + (1 - v_x) / 2$, or $i + v_x = 0.6$ (1)
At node B,
$(1 - v_o) / 2 = (v_x / 3) + (v_x / 6)$, and $v_x = 0.5$ (2)
From (1) and (2), $i = 0.1$ and $R_{Th} = 1 / i = 10.00\ \Omega$
To get V_{Th}, consider the circuit in the figure below.



At node 1, $(90 - v_1) / 3 = (v_1 / 6) + (v_1 - v_2) / 2$, or $180 = 6v_1 - 3v_2$ (3)

At node 2, $0.5v_x + (v_1 - v_2) / 2 = v_2 / 10$, $v_x = v_1$ and $v_1 = 0.6v_2$ (4)

From (3) and (4), $v_2 = V_{Th} = 300.00$ V

$I_N = V_{Th} / R_{Th} = 30.00$ A

$R_N = R_{Th} = 10.00\ \Omega$

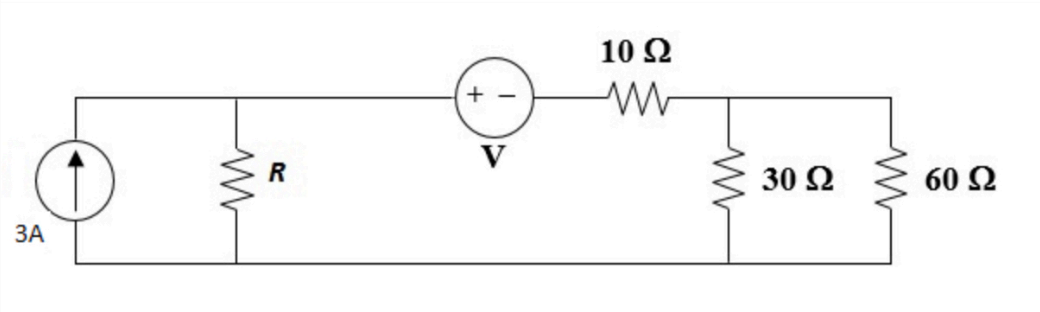
The calculated parameters are as follows:

$R_N = 10.00\ \Omega$

$I_N = 30.00$ A

14. value:
10.00 points

Consider the given circuit where V = 60 V.



Now let R = 0 Ω, 110 Ω, and ∞. Calculate the power delivered to the 30-Ω resistor in each case.

The power delivered to the 30-Ω resistor when R = 0 Ω is *53.33 ± 2%* W.
The power delivered to the 30-Ω resistor when R = 110 Ω is *49.59 ± 2%* W.
The power delivered to the 30-Ω resistor when R = ∞ is *120 ± 2%* W.

Explanation:

When R = 0 Ω, the Thevenin equivalent resistance is calculated by the formula
R_{eq} = 60(0 + 10) / (0 + 10 + 60) = 8.5714 Ω.
The Thevenin voltage is calculated by the formula:
V_{oc} = 60[(3R – 60)/(R + 10 + 60)] = -51.43 V.
The power is calculated by the formula:

$$P = \frac{\left(\frac{V_{oc} \times 30}{R_{eq} + 30}\right)^2}{30}$$ = 53.33 W

When R = 110 Ω, the Thevenin equivalent resistance is calculated by the formula:
R_{eq} = 60(110 + 10) / (110 + 10 + 60) = 40 Ω.
The Thevenin voltage is calculated by the formula:
V_{oc} = 60[(3R – 60)/(R + 10 + 60)] = 90.00 V.
The power is calculated by the formula:

$$P = \frac{\left(\frac{V_{oc} \times 30}{R_{eq} + 30}\right)^2}{30}$$ = 49.59 W

When R = ∞, the Thevenin equivalent resistance is calculated by the formula:
R_{eq} = 60 Ω.
The Thevenin voltage is calculated by the formula:
V_{oc} = 180 V.
The power is calculated by the formula:

$$P = \frac{\left(\frac{V_{oc} \times 30}{R_{eq} + 30}\right)^2}{30}$$ = 120 W

The power delivered to the 30-Ω resistor when R = 0 Ω is 53.33 W.
The power delivered to the 30-Ω resistor when R = 110 Ω is 49.59 W.
The power delivered to the 30-Ω resistor when R = ∞ is 120 W.