FE Review

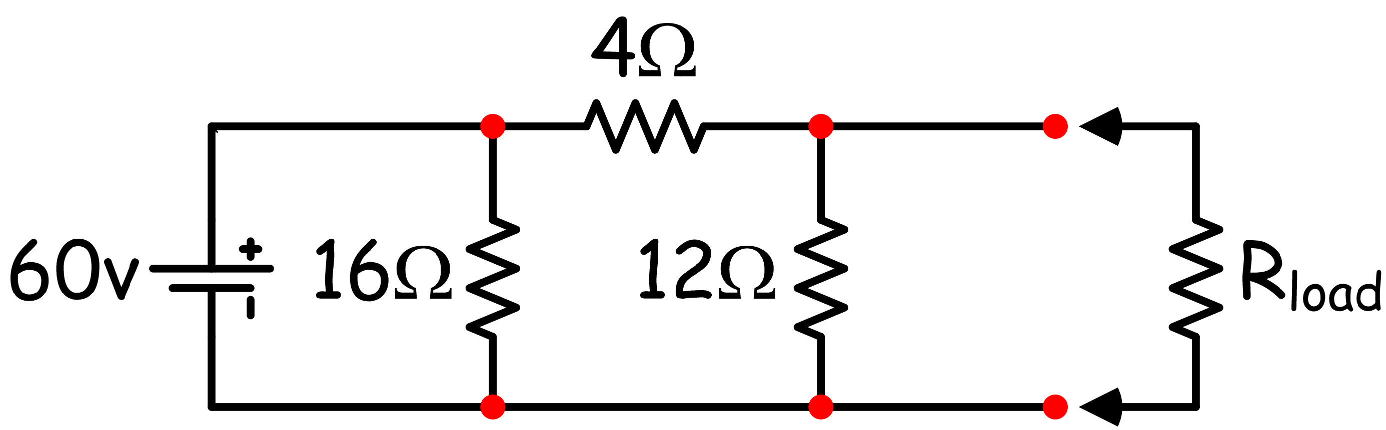
THEVENIN AND NORTON ANALYSIS

Thevenin's Theorem

Any linear, two-terminal network with dependent and independent sources can be represented by an equivalent circuit consisting of a single voltage source and a single series resistor representing the circuit from the **VIEWPOINT of the circuits load.**

Example

What is the Thevenin Equivalent circuit for the circuit below?



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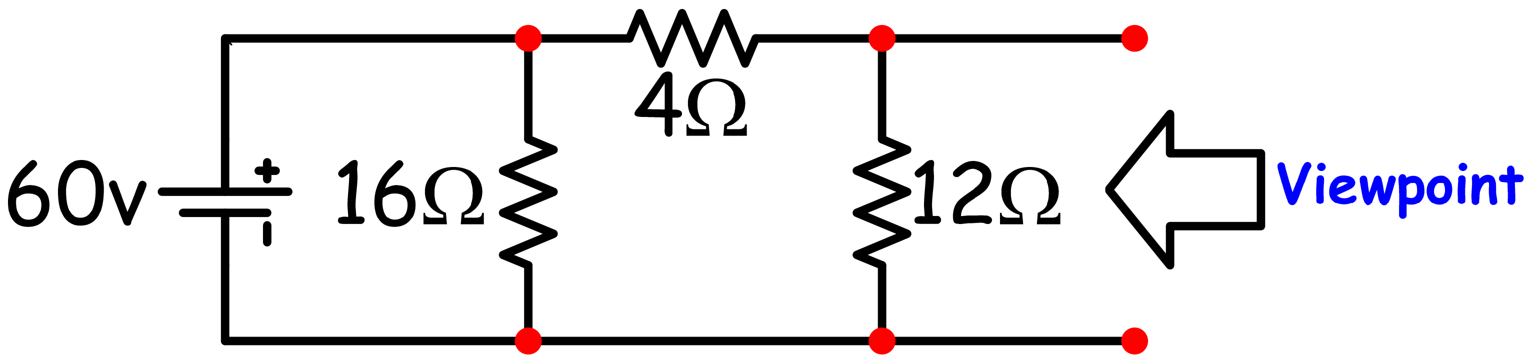
Example (continued)

Step 1: Remove the load



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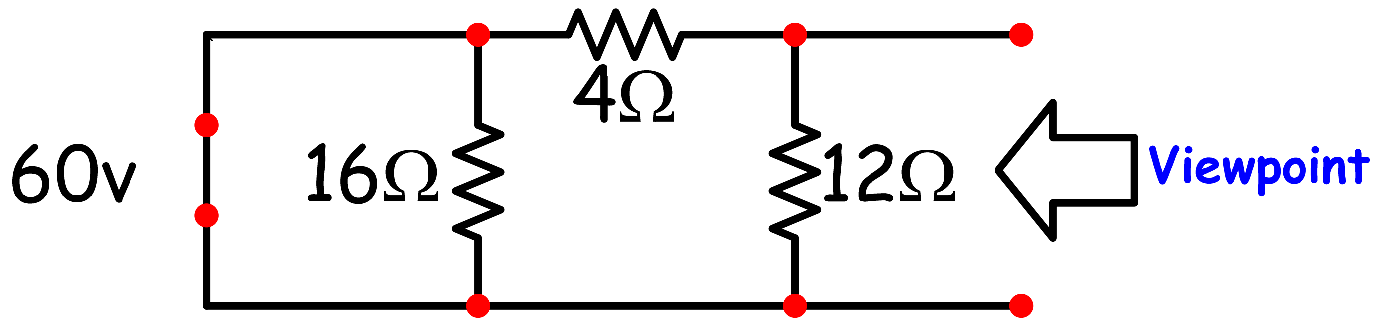
Step 2: Short all voltage sources, open-circuit all current sources



Step 3: Find the Equivalent Resistance from the viewpoint of the load

Note that the 16 ohm resistor is shorted out!

$$R_{th} = 4 \,||\, 12 = \frac{4\Omega(12\Omega)}{4\Omega + 12\Omega} = \frac{48\Omega}{16} = \boxed{3\Omega}$$

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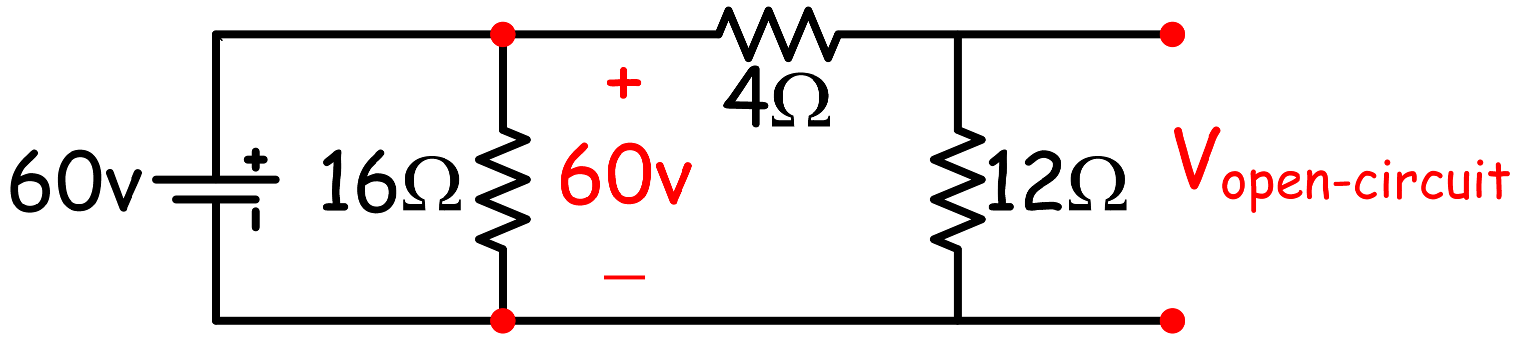
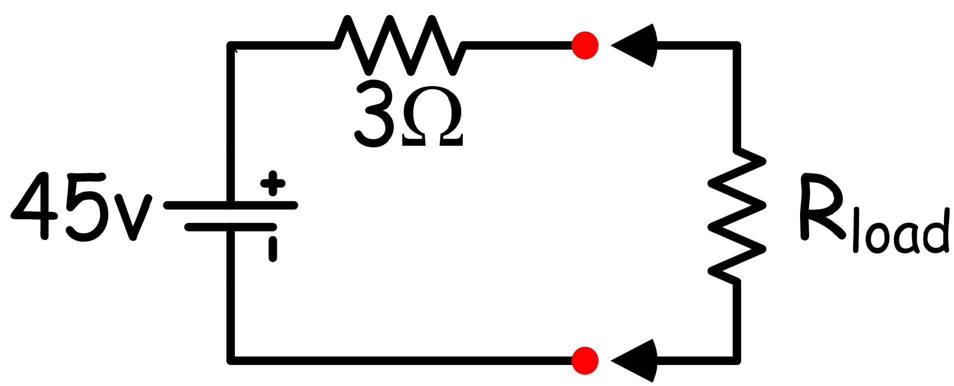
Step 4: Replace the source and find the open circuit voltage

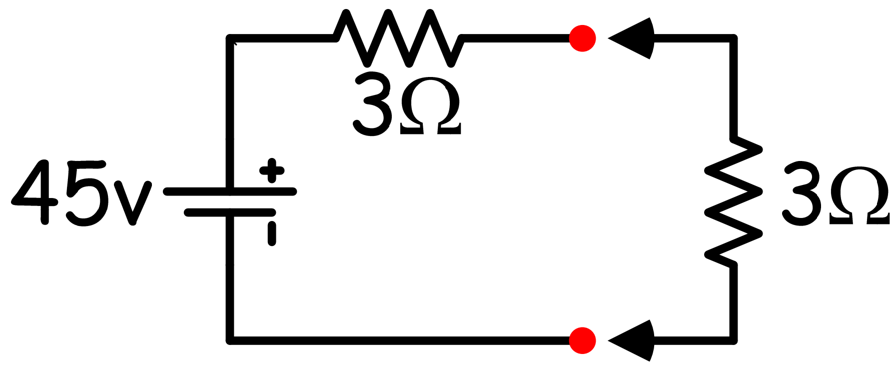


$$V_{Thevenin} = V_{open-circuit} = \frac{60v\,(12\Omega)}{4\Omega + 12\Omega} = \frac{720v}{16} = \boxed{45v}$$



Maximum Power Transfer

Maximum power will be transferred to the load when the value of the load is equal to $R_{Thevenin}$.

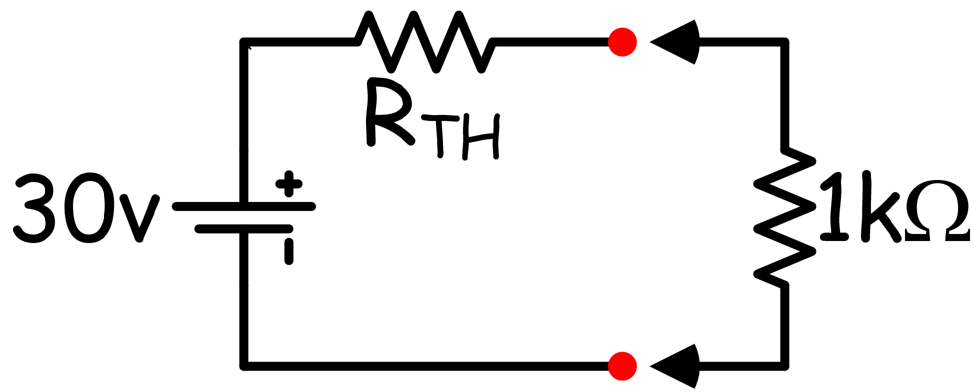


$$I = \frac{45v}{6\Omega} = 7.5A$$

$$P_{load} = I^2 R_{load} = (7.5A)^2 (3\Omega) = \boxed{168.8W}$$

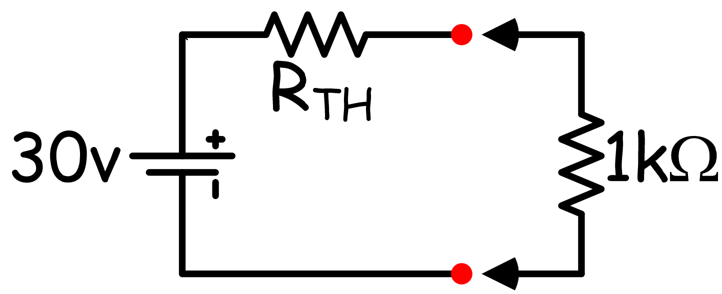
Maximum Power Transfer

Another way the question may be asked: What value of R_{TH} is necessary below for max power transfer to the load?



Maximum Power Transfer

Another way the question may be asked: What value of R_{TH} is necessary below for max power transfer to the load?



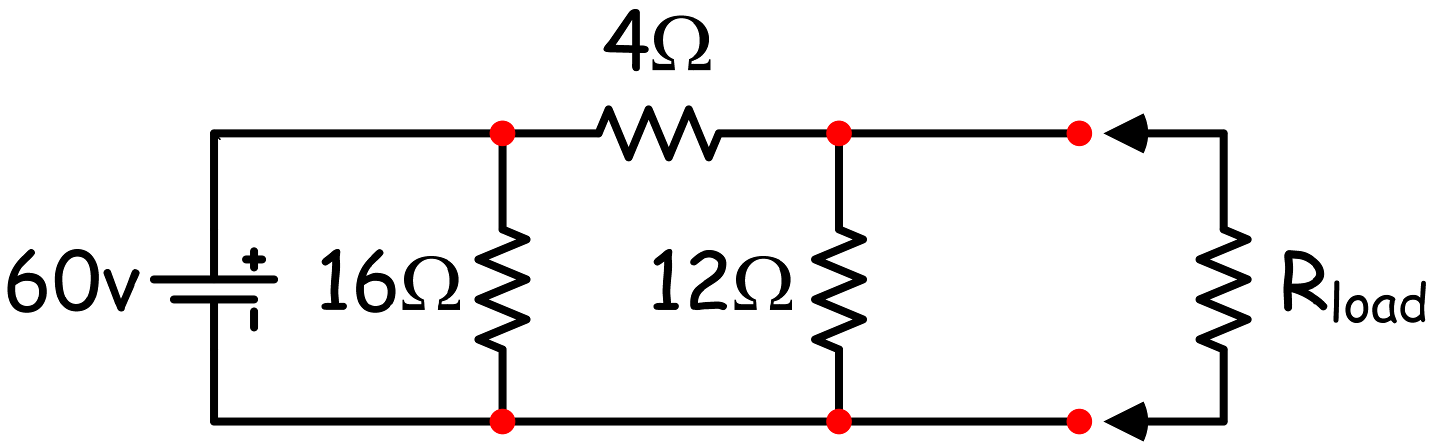
The answer is '0 ohms'. The difference here is that the load is no longer the variable.

Norton's Theorem

- Any linear, two-terminal network with dependent and independent sources can be represented by an equivalent circuit consisting of a single current source and a single parallel resistor representing the circuit from the **VIEWPOINT of the circuits load.**

Example

What is the Norton Equivalent circuit for the circuit below?



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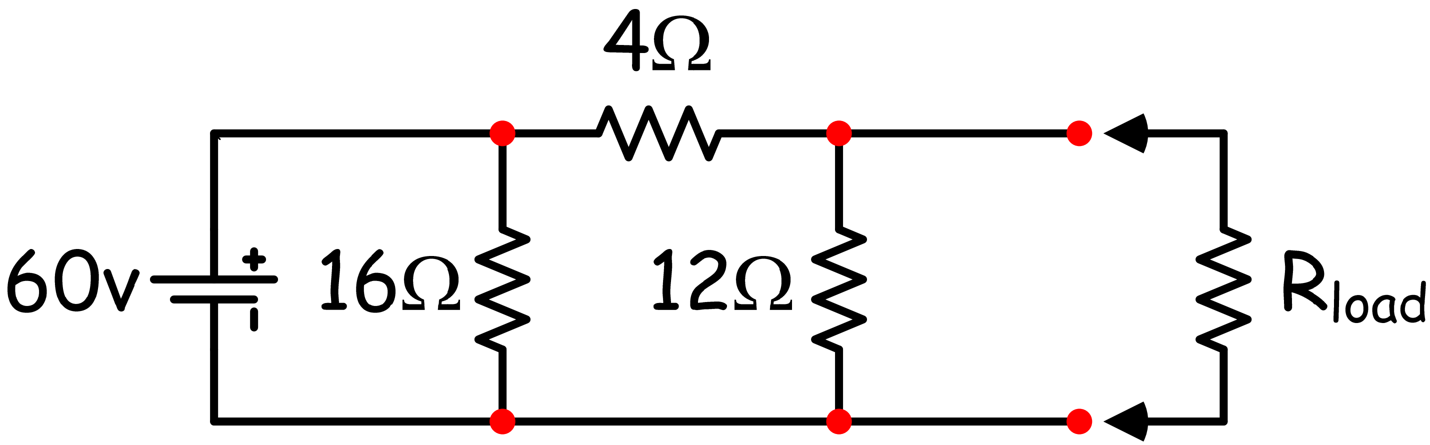
Example (continued)

What is the Norton Equivalent circuit for the circuit below?



R_{Norton} is found the same way as $R_{Thevenin}$ and is still equal to 3 ohms.

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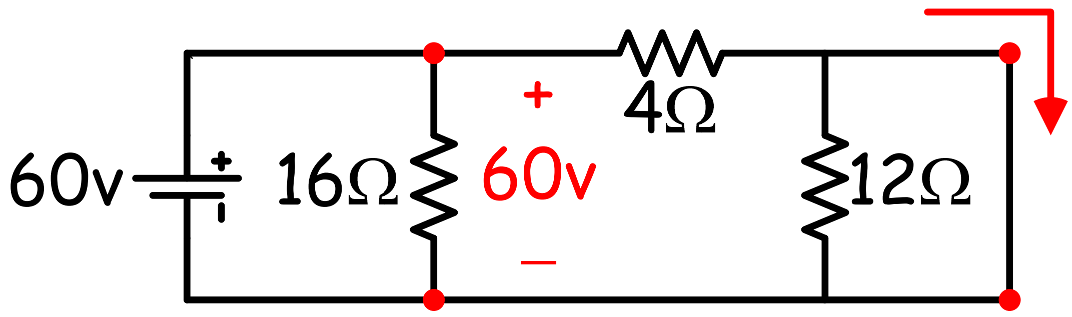
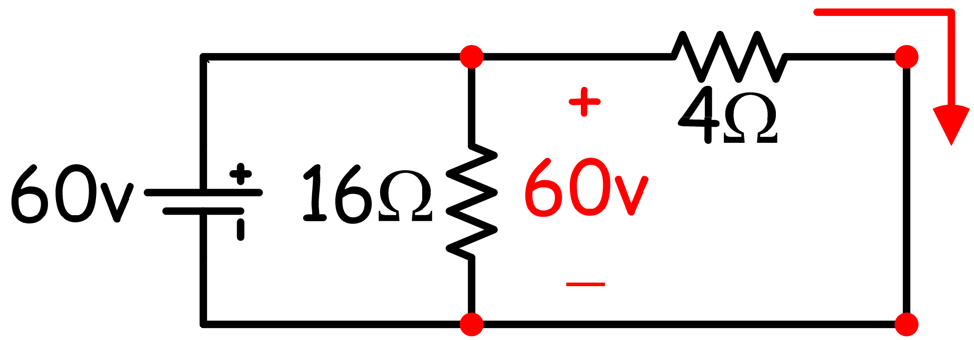
Replace the load with a SHORT CIRCUIT and find the short-circuit current.



$I_N = I_{short\text{-}circuit}$

Note that the 12 ohm resistor is shorted out.



$$I_N = \frac{60V}{4\Omega}$$

$$= \boxed{15A}$$

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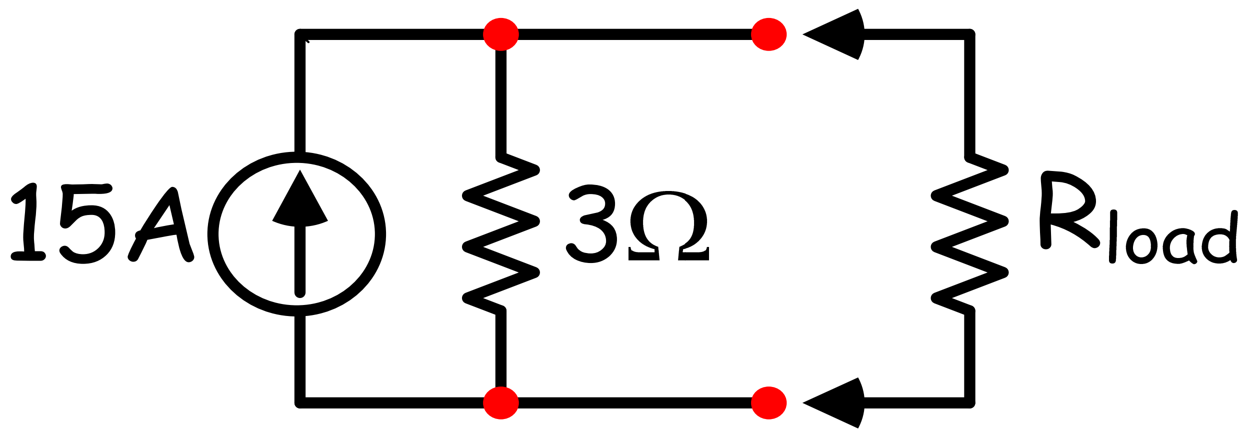
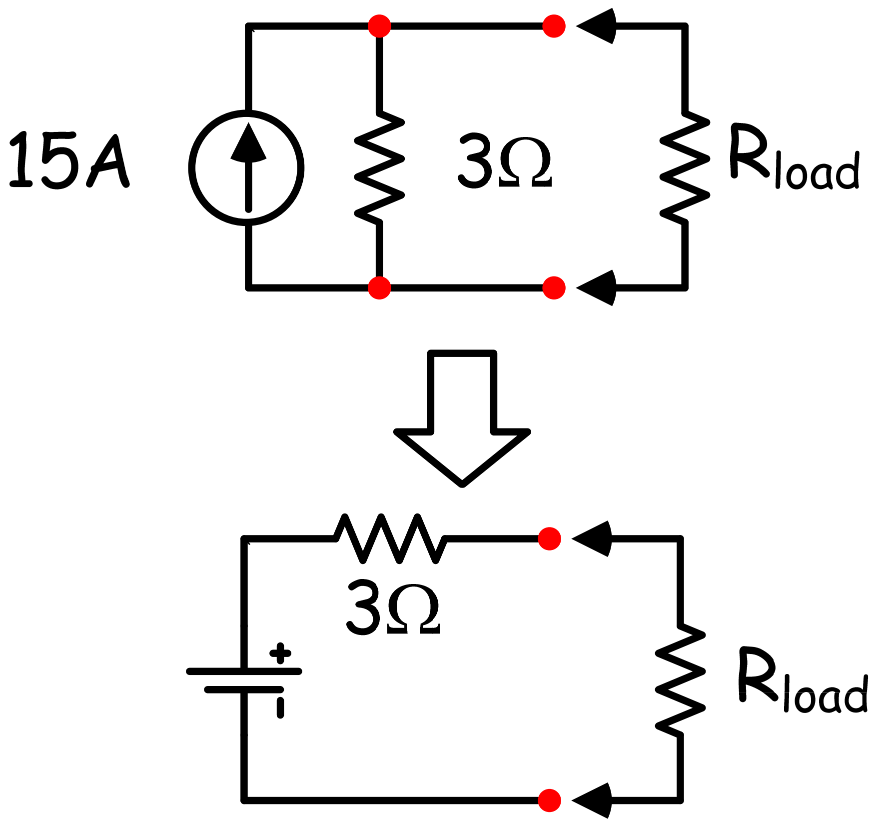
Norton Equivalent Circuit

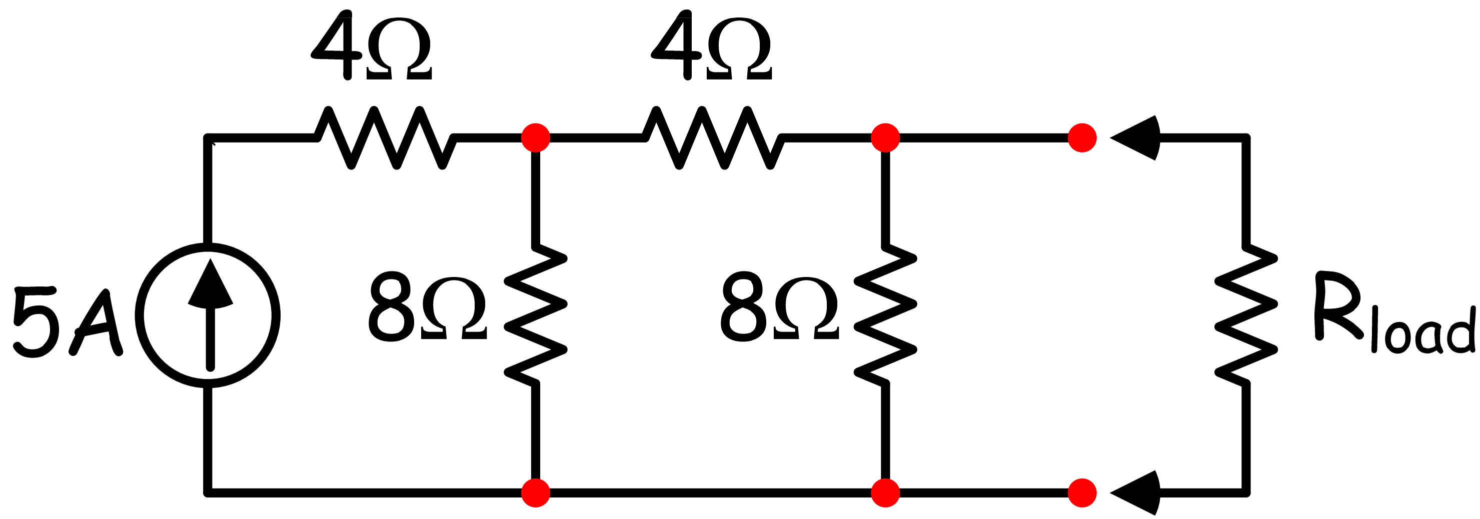


Source Conversion



$$V_{Th} = I_{SC}\left(R_N\right)$$
$$= 15A\left(3\Omega\right)$$
$$= 45V$$

One more example



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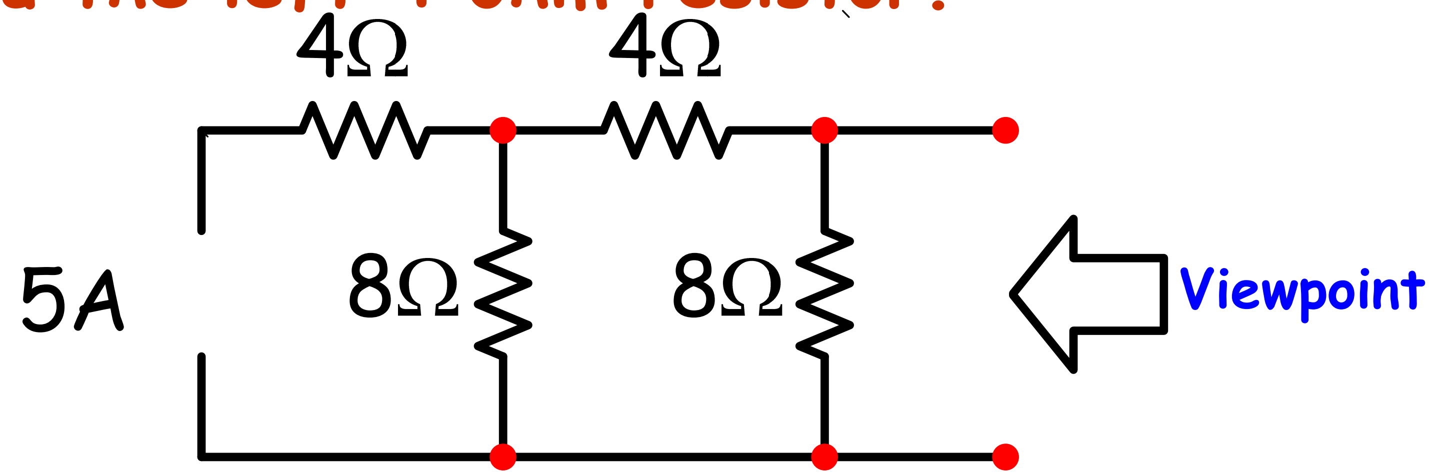
Example (continued)

Note that there is no current flowing thru the left 4 ohm resistor.



$$R_{Th} = (4\Omega + 8\Omega) \,||\, 8\Omega = 12\Omega \,||\, 8\Omega$$

$$= \frac{12\Omega(8\Omega)}{12\Omega + 8\Omega} = \frac{96\Omega}{20} = \boxed{4.8\Omega}$$

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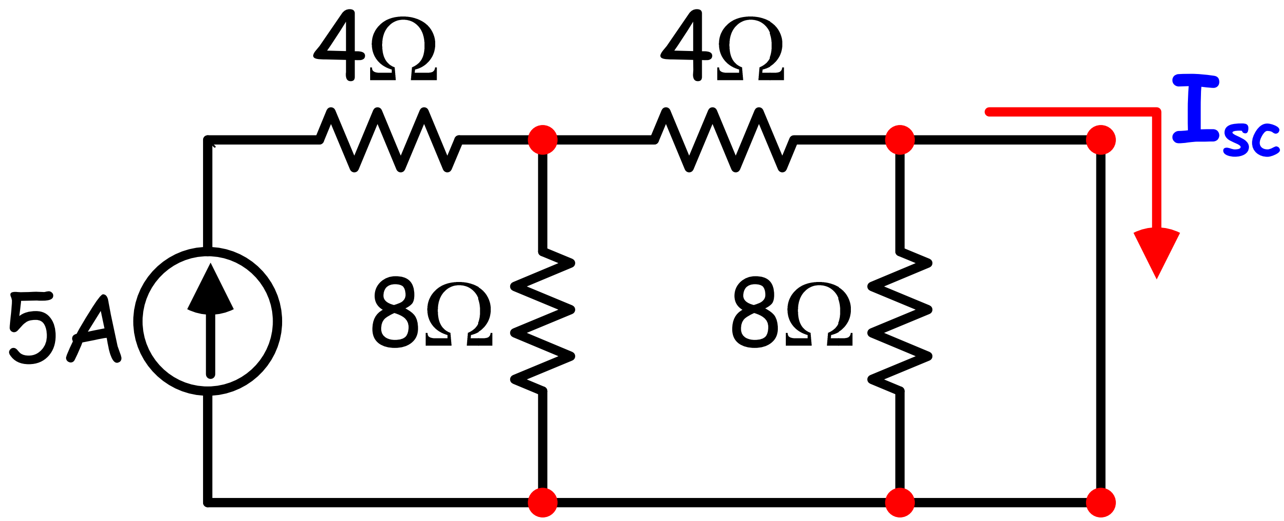
It will be simpler finding I_{Norton} first.



Note that the right hand 8 ohm resistor is shorted out

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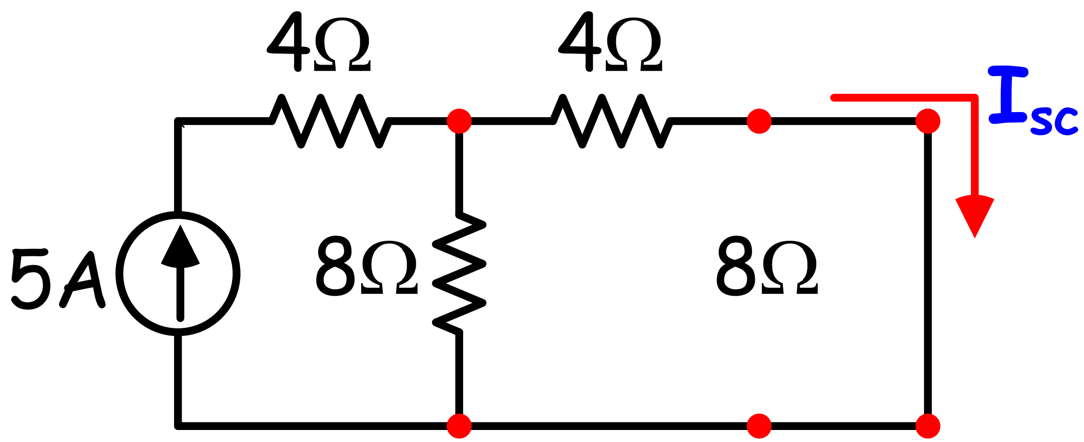
Example (continued)



$$I_{sc} = \frac{5A\,(8\Omega)}{8\Omega + 4\Omega} = \frac{40A}{12} = \boxed{3.33A}$$

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Example (continued)

Final Thevenin circuit