Electrical Technology

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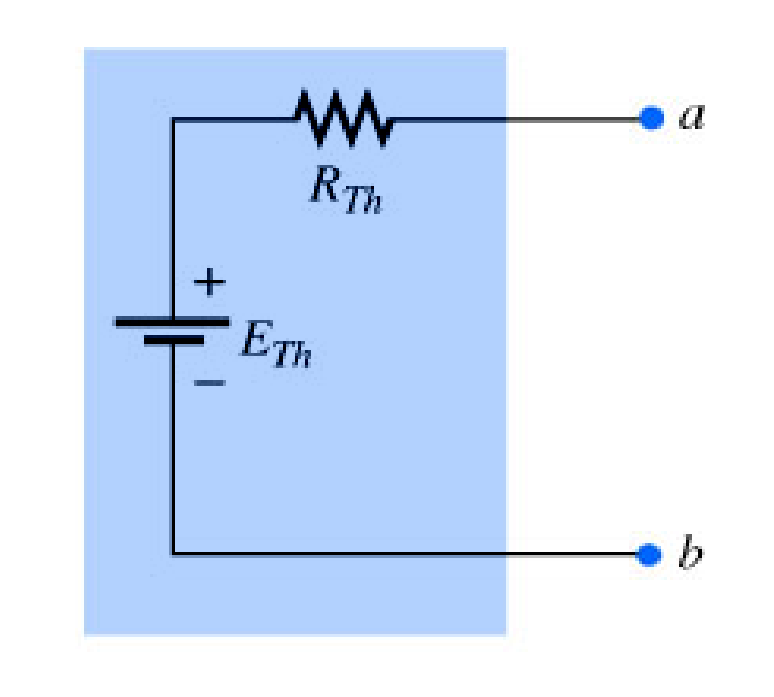
Thévenin's Theorem

- Any two-terminal dc network can be replaced by an equivalent circuit consisting of a voltage source and a series resistor.



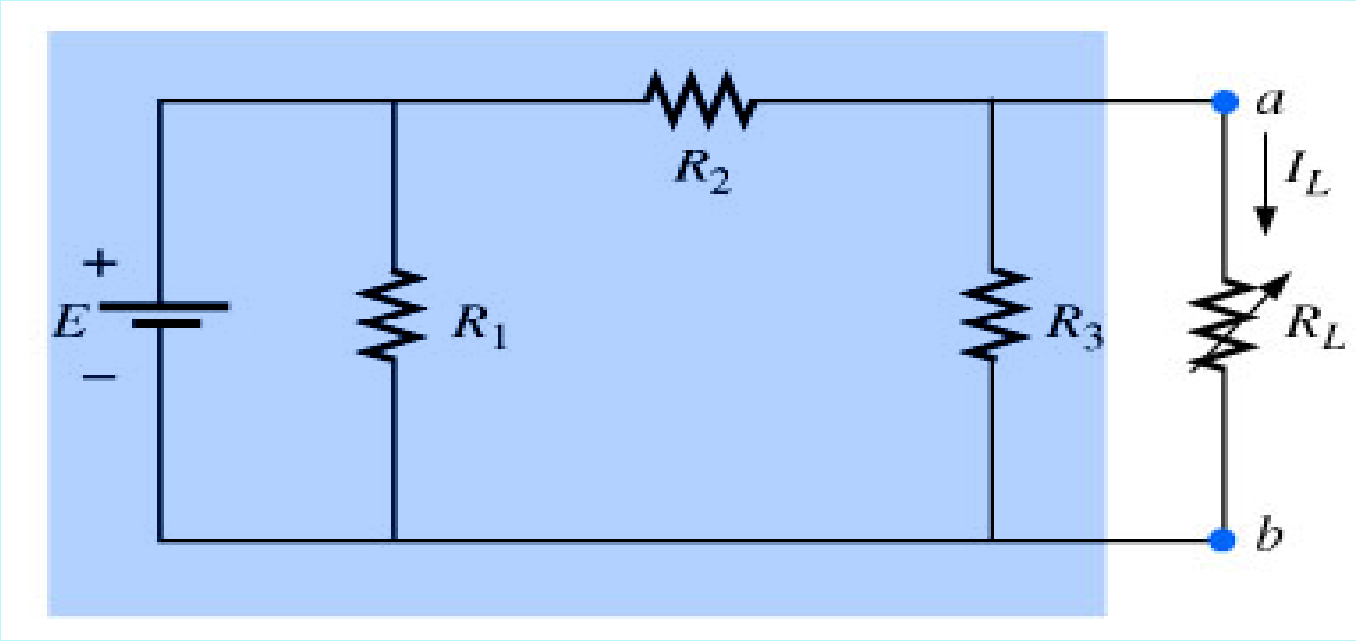
Thévenin's Theorem

- Thévenin's theorem can be used to:
  - Analyze networks with sources that are not in series or parallel.
  - Reduce the number of components required to establish the same characteristics at the output terminals.
  - Investigate the effect of changing a particular component on the behavior of a network without having to analyze the entire network after each change.

Thévenin's Theorem

- Procedure to determine the proper values of R_{Th} and E_{Th}
- Preliminary

1. Remove that portion of the network across which the Thévenin equation circuit is to be found. In the figure below, this requires that the load resistor R_L be temporarily removed from the network.



Thévenin's Theorem

2. Mark the terminals of the remaining two-terminal network. (The importance of this step will become obvious as we progress through some complex networks.)

R_{Th}:

3. Calculate R_{Th} by first setting all sources to zero (voltage sources are replaced by short circuits, and current sources by open circuits) and then finding the resultant resistance between the two marked terminals. (If the internal resistance of the voltage and/or current sources is included in the original network, it must remain when the sources are set to zero.)

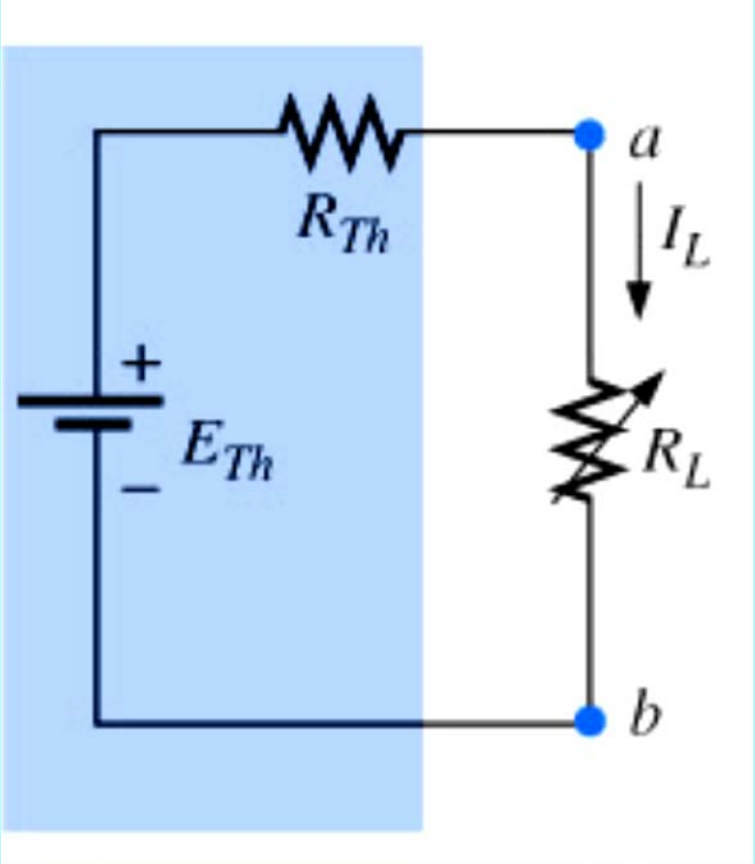
Thévenin's Theorem

E_{Th}:

4. Calculate E_{Th} by first returning all sources to their original position and finding the open-circuit voltage between the marked terminals. (This step is invariably the one that will lead to the most confusion and errors. In all cases, keep in mind that it is the open-circuit potential between the two terminals marked in step 2.)

Thévenin's Theorem

- Conclusion:
  5. Draw the Thévenin equivalent circuit with the portion of the circuit previously removed replaced between the terminals of the equivalent circuit. This step is indicated by the placement of the resistor R_L between the terminals of the Thévenin equivalent circuit.



Thévenin's Theorem

Experimental Procedures

- Two popular experimental procedures for determining the parameters of the Thévenin equivalent network:
  - Direct Measurement of E_{Th} and R_{Th}
    - For any physical network, the value of E_{Th} can be determined experimentally by measuring the open-circuit voltage across the load terminals.
    - The value of R_{Th} can then be determined by completing the network with a variable resistance R_L.

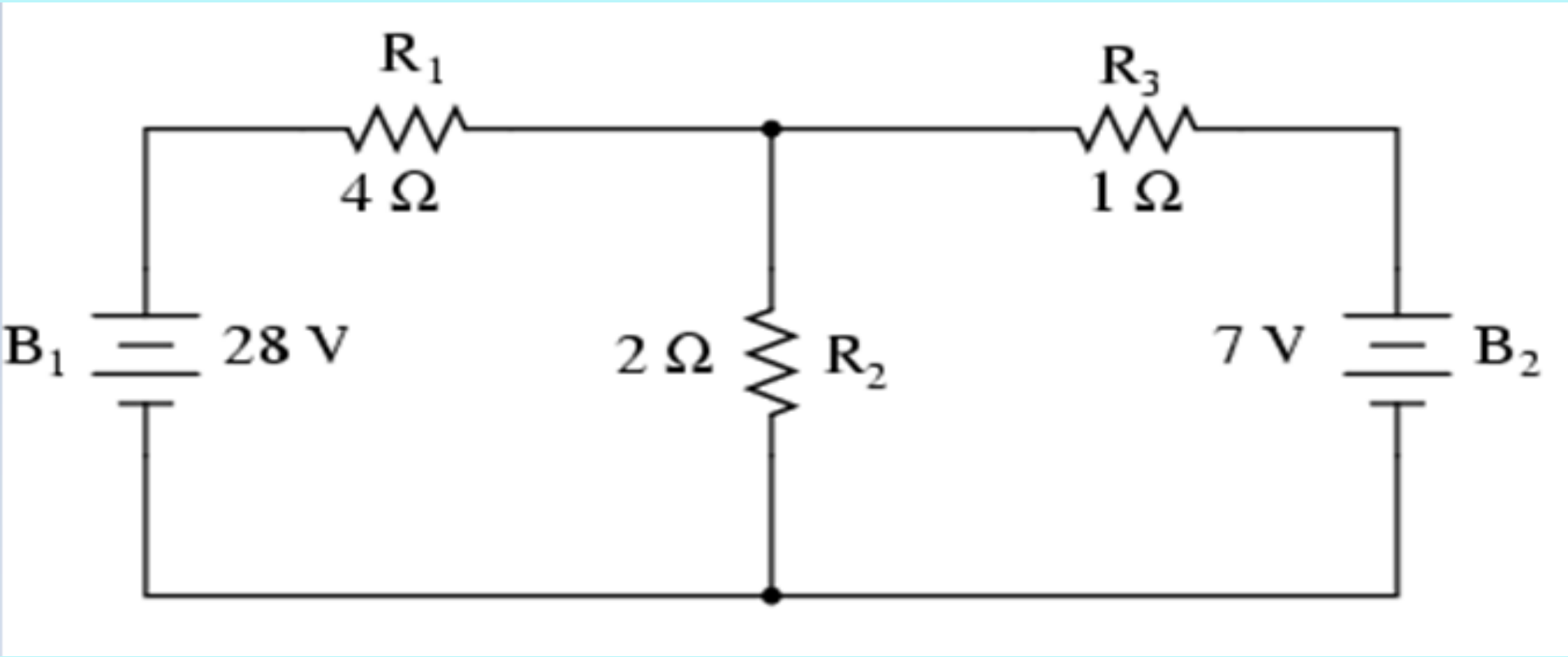
Thévenin's Theorem

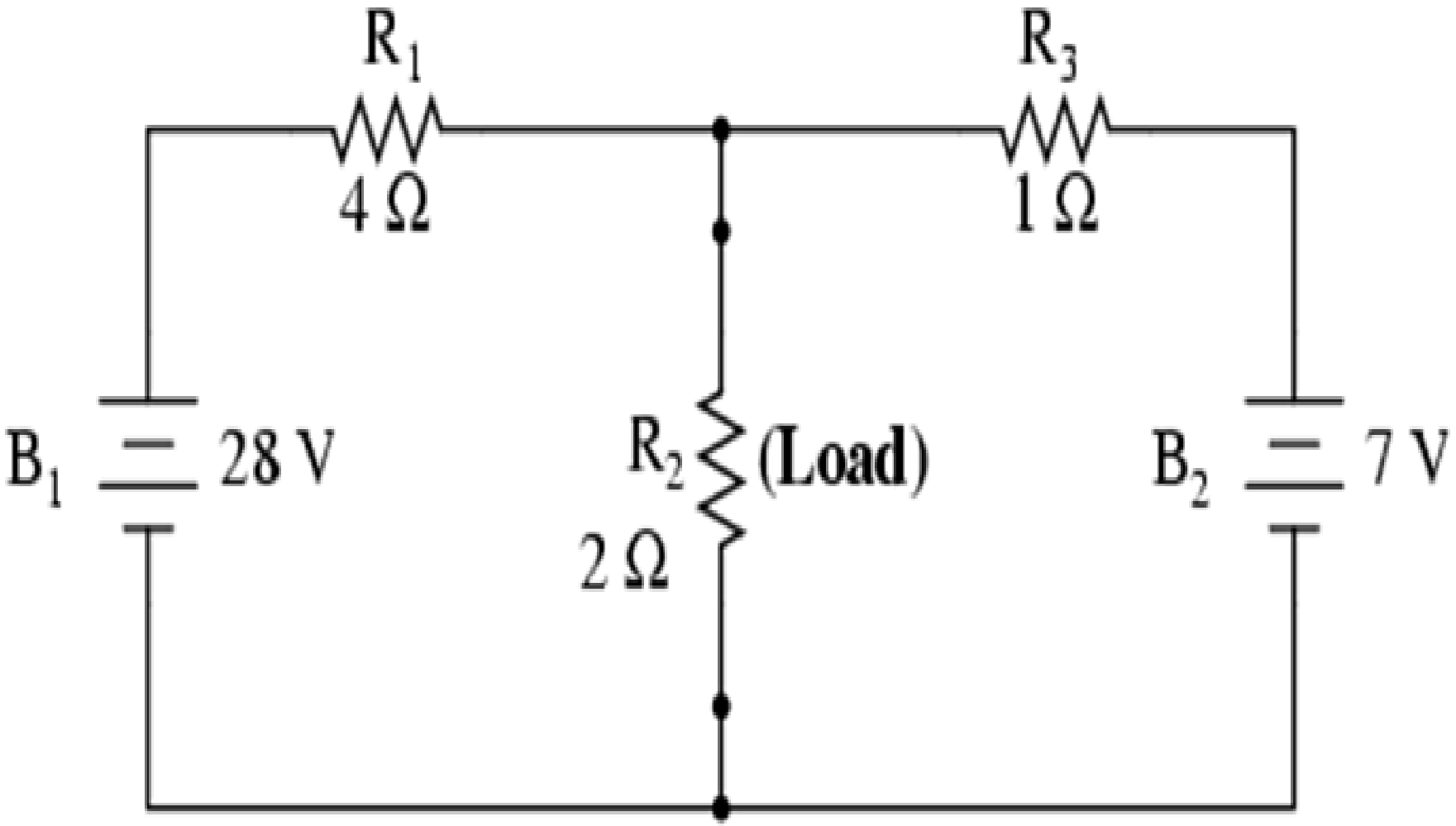
- Measuring V_{OC} and I_{SC}
  - The Thévenin voltage is again determined by measuring the open-circuit voltage across the terminals of interest; that is, $E_{Th} = V_{OC}$. To determine R_{Th}, a short-circuit condition is established across the terminals of interest and the current through the short circuit (I_{sc}) is measured with an ammeter.
  - Using Ohm's law:

$$R_{Th} = V_{oc} / I_{sc}$$

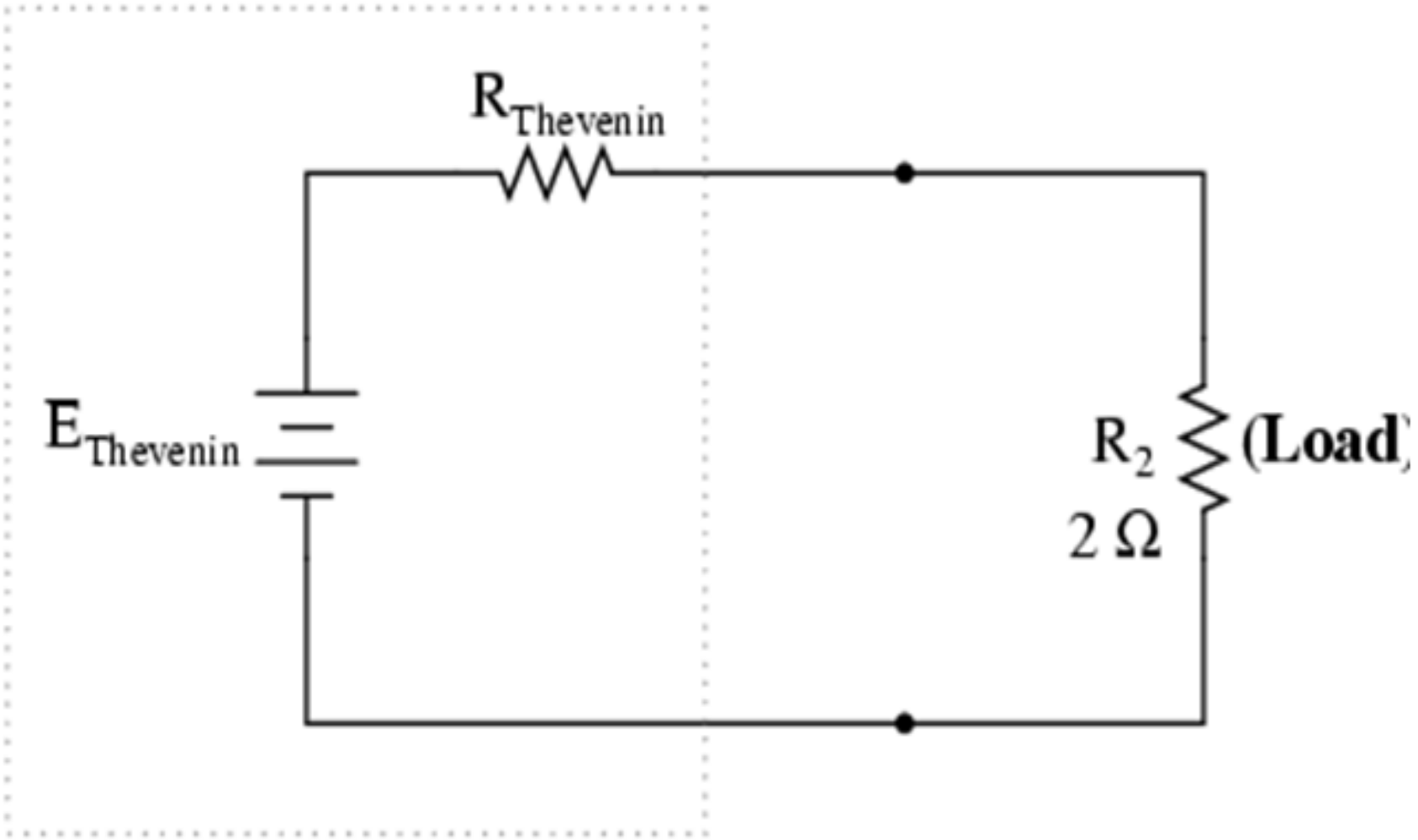
Ex Thevenin's Theorem

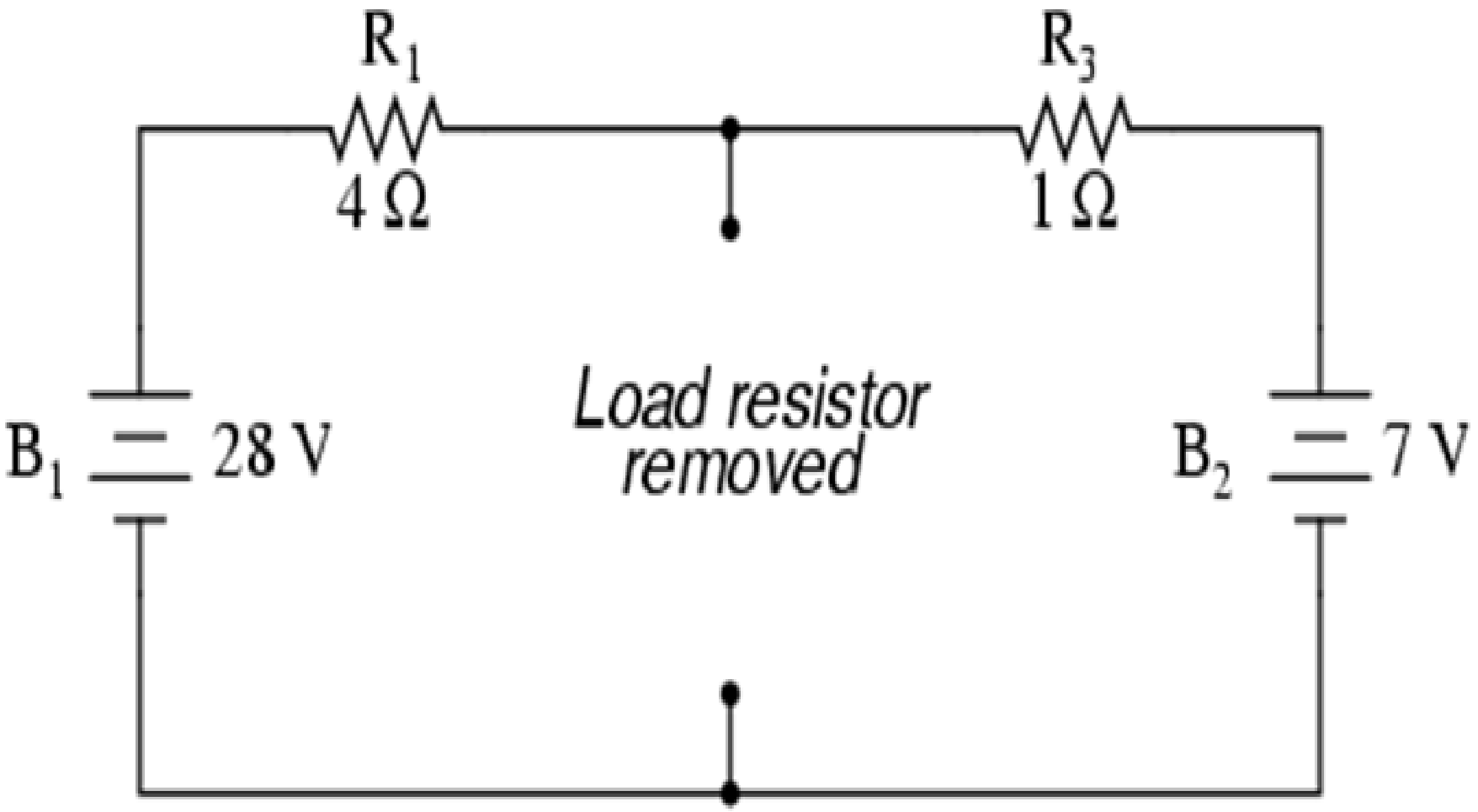
- To calculate voltage across 2Ω resistance .
- Step 1 : Remove 2Ω resistance



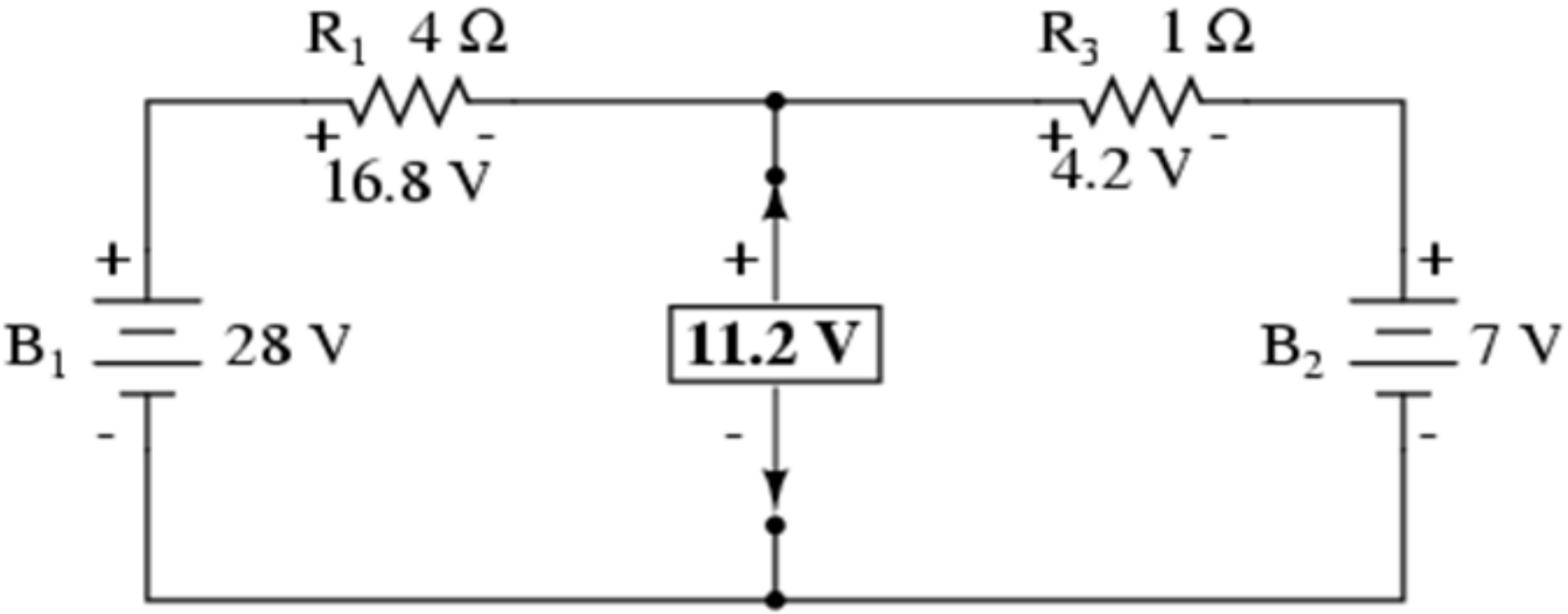

R1
4 Ω
R3
1 Ω
B1
28 V
R2 (Load)
2 Ω
B2
7 V

Thevenin Equivalent Circuit



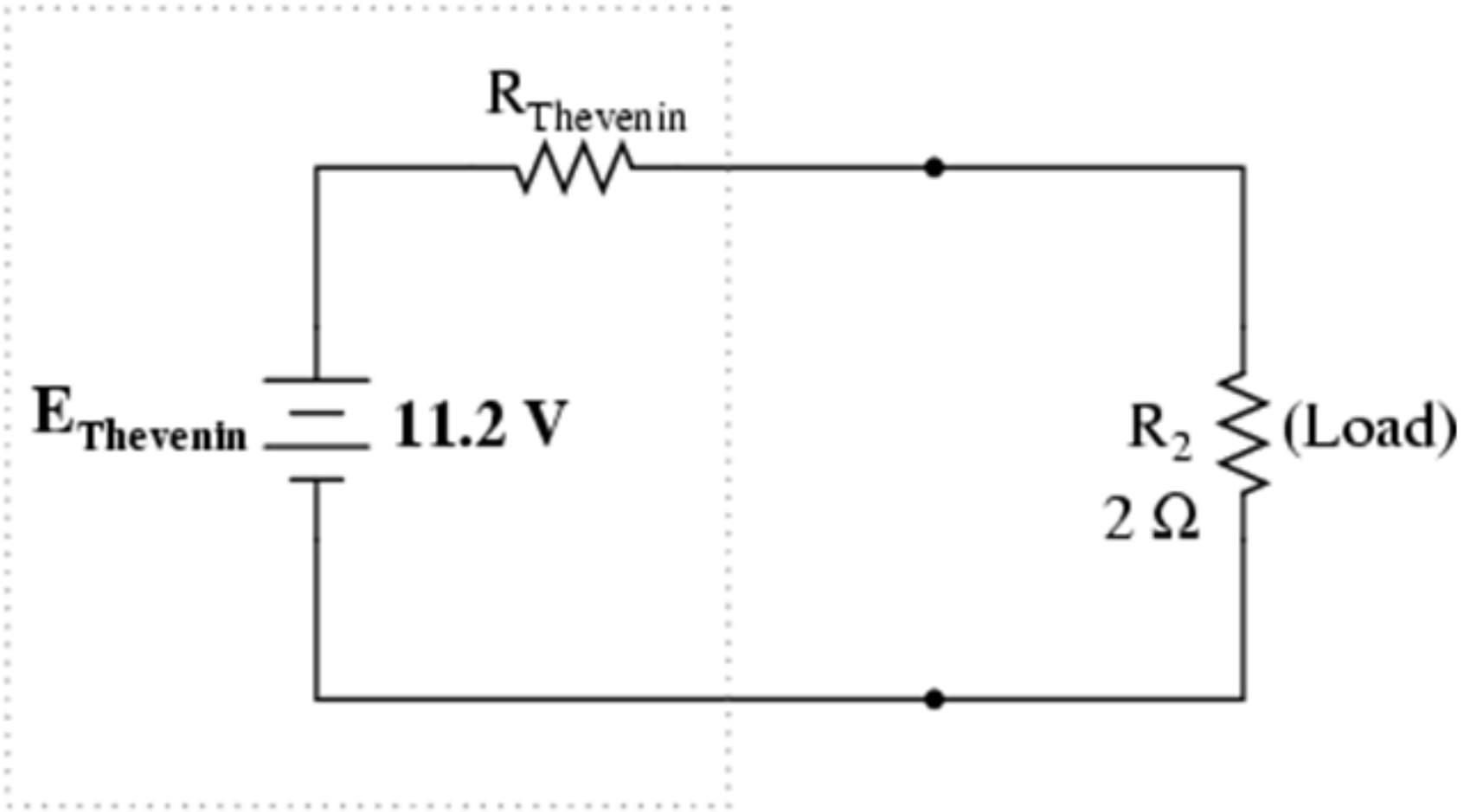

R1
4 Ω
R3
1 Ω
B1
28 V
Load resistor
removed
B2
7 V

Calculations for $V_{Thevenin}$

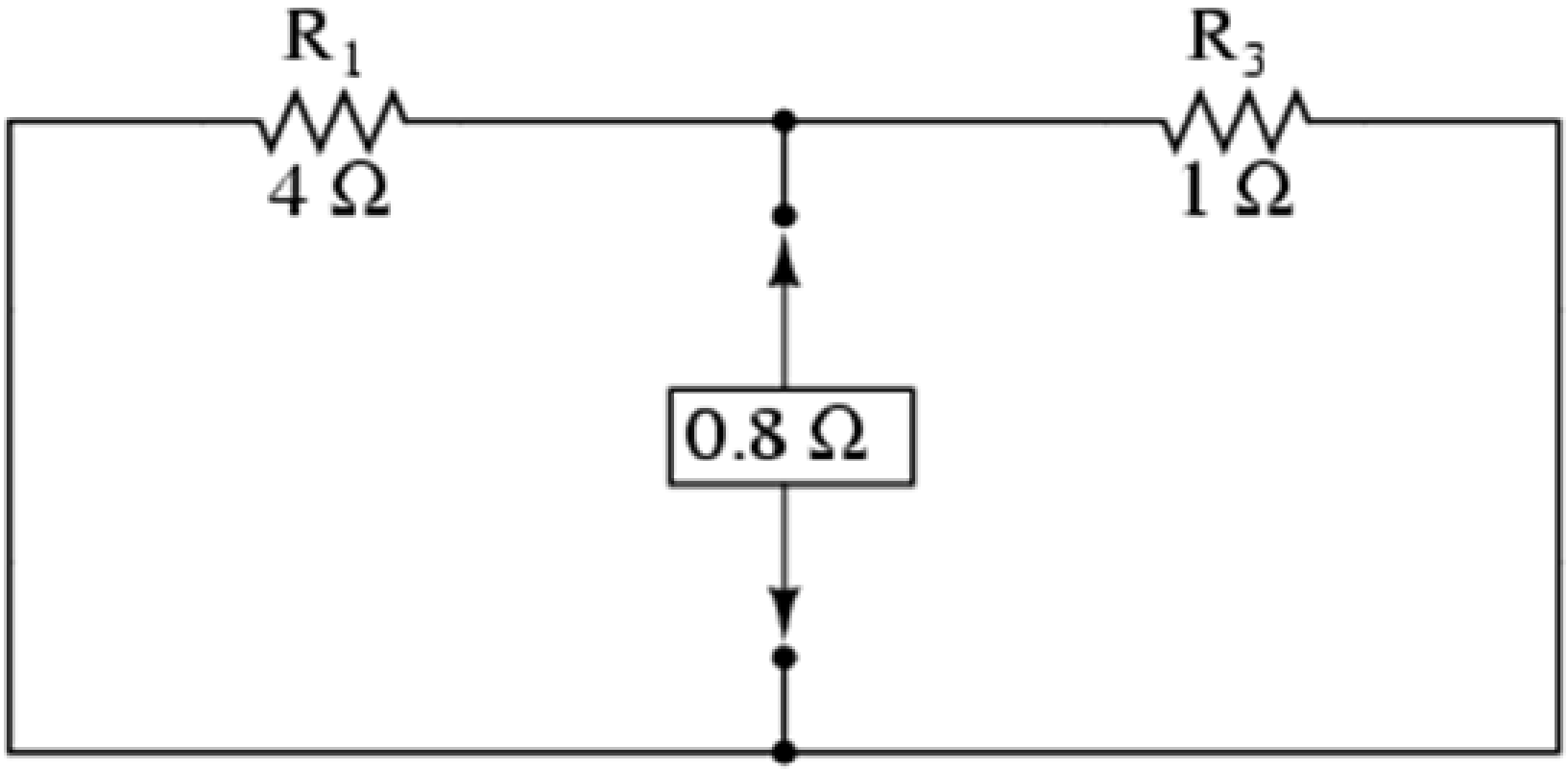


$V_{Theveni'n}$ is the open circuit voltage from where load is removed

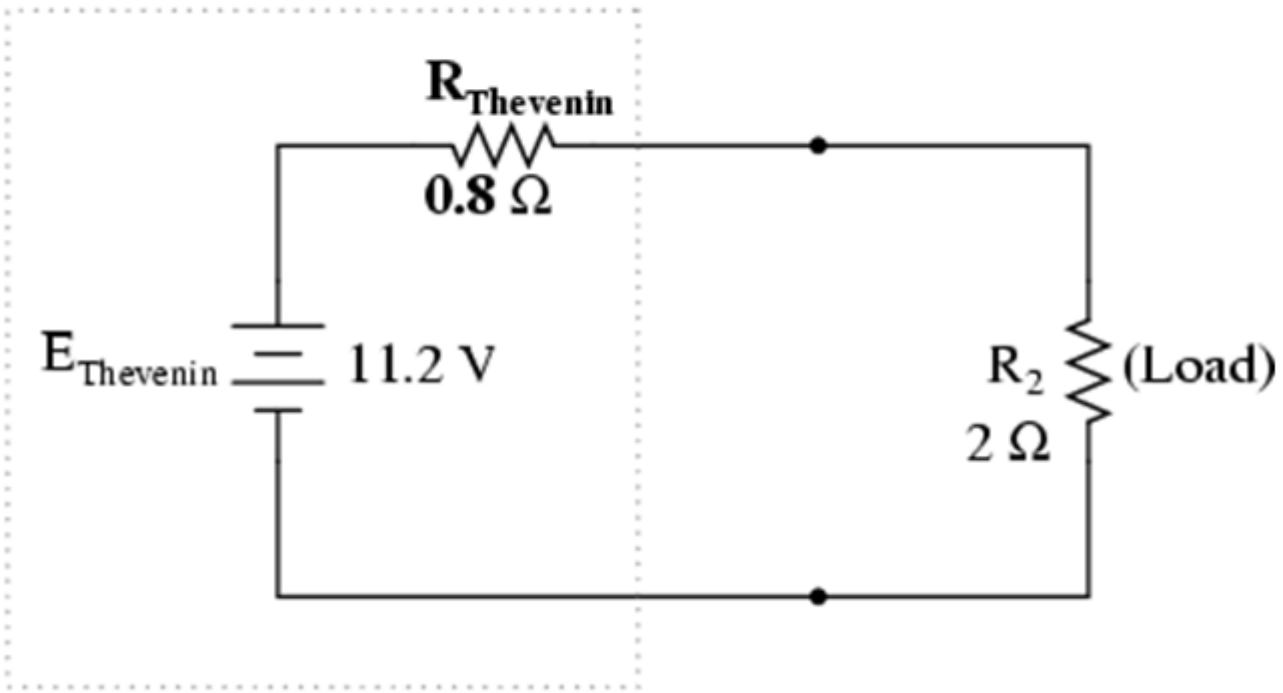
Thevenin Equivalent Circuit



Calculations for $R_{Thevenin}$

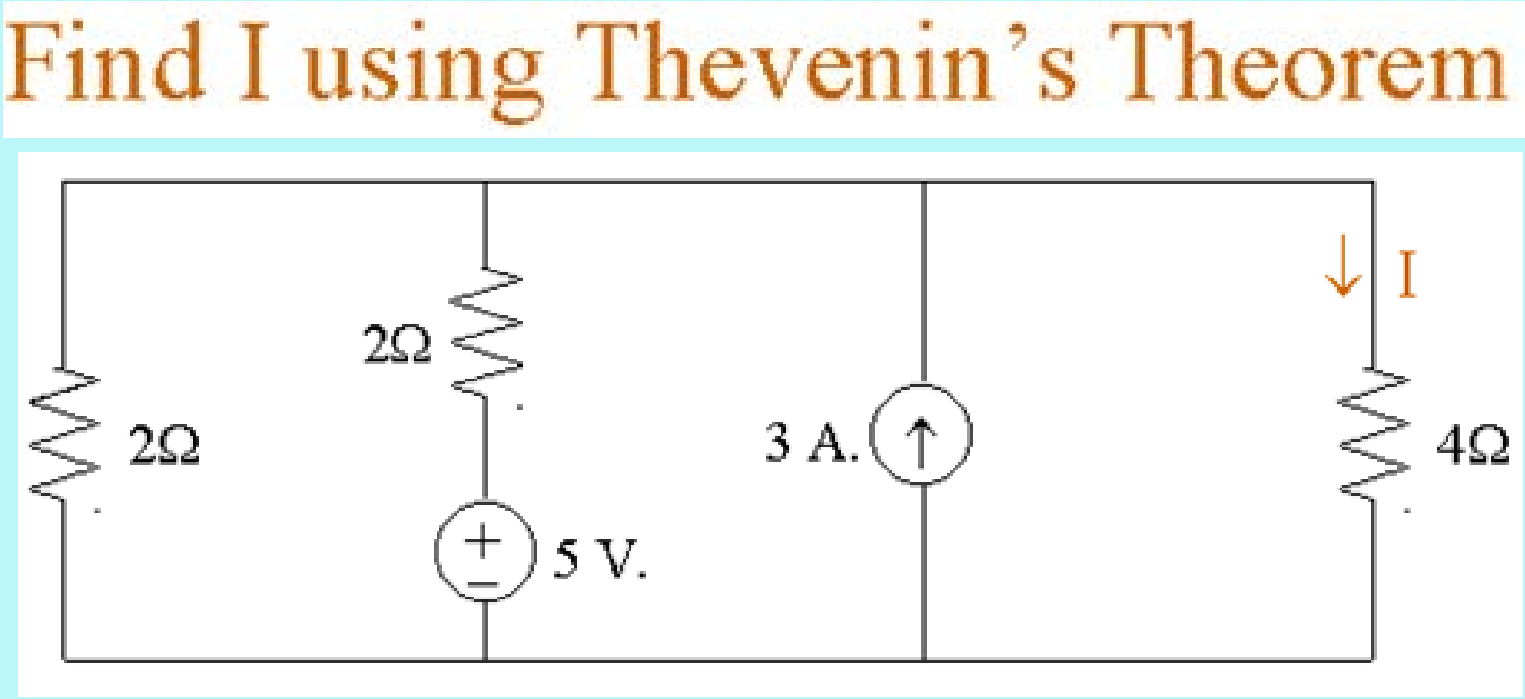


Thevenin Equivalent Circuit

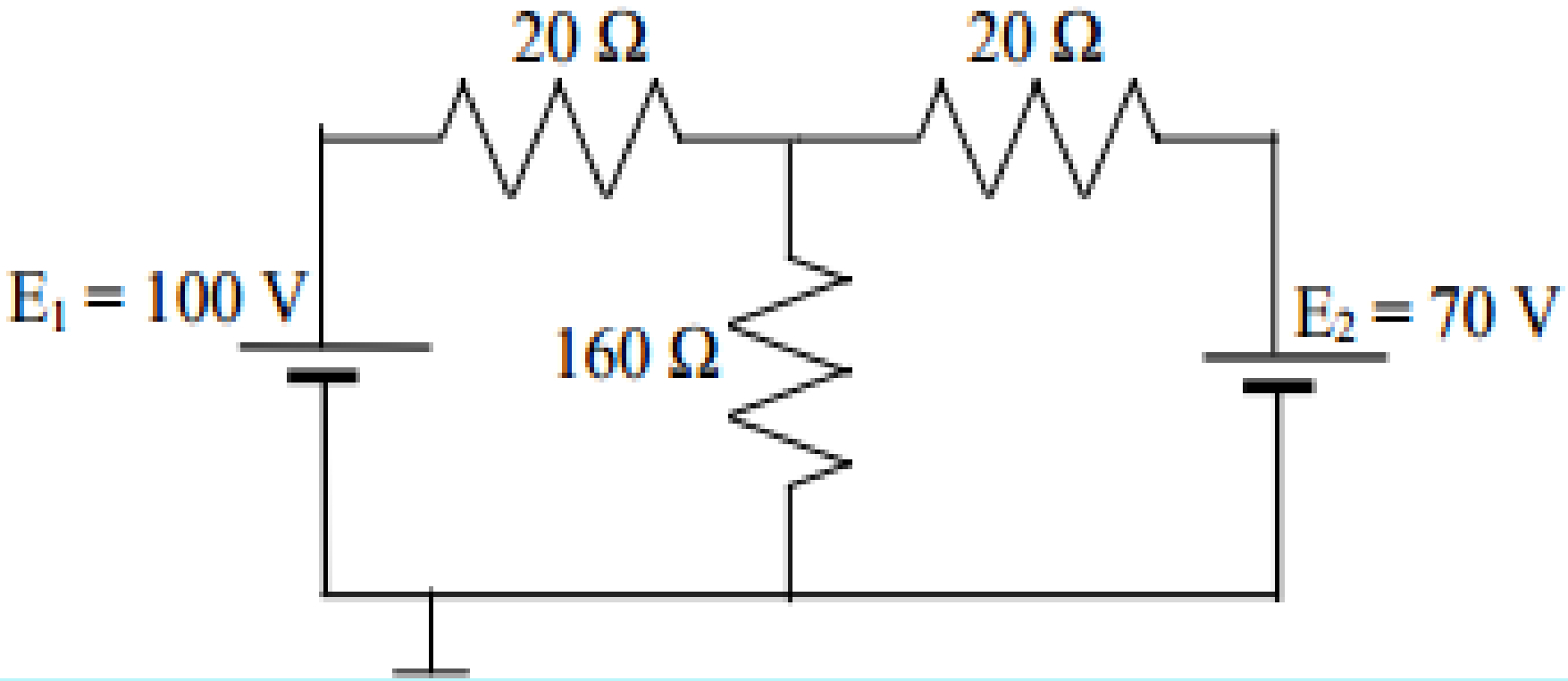


Test Yourself

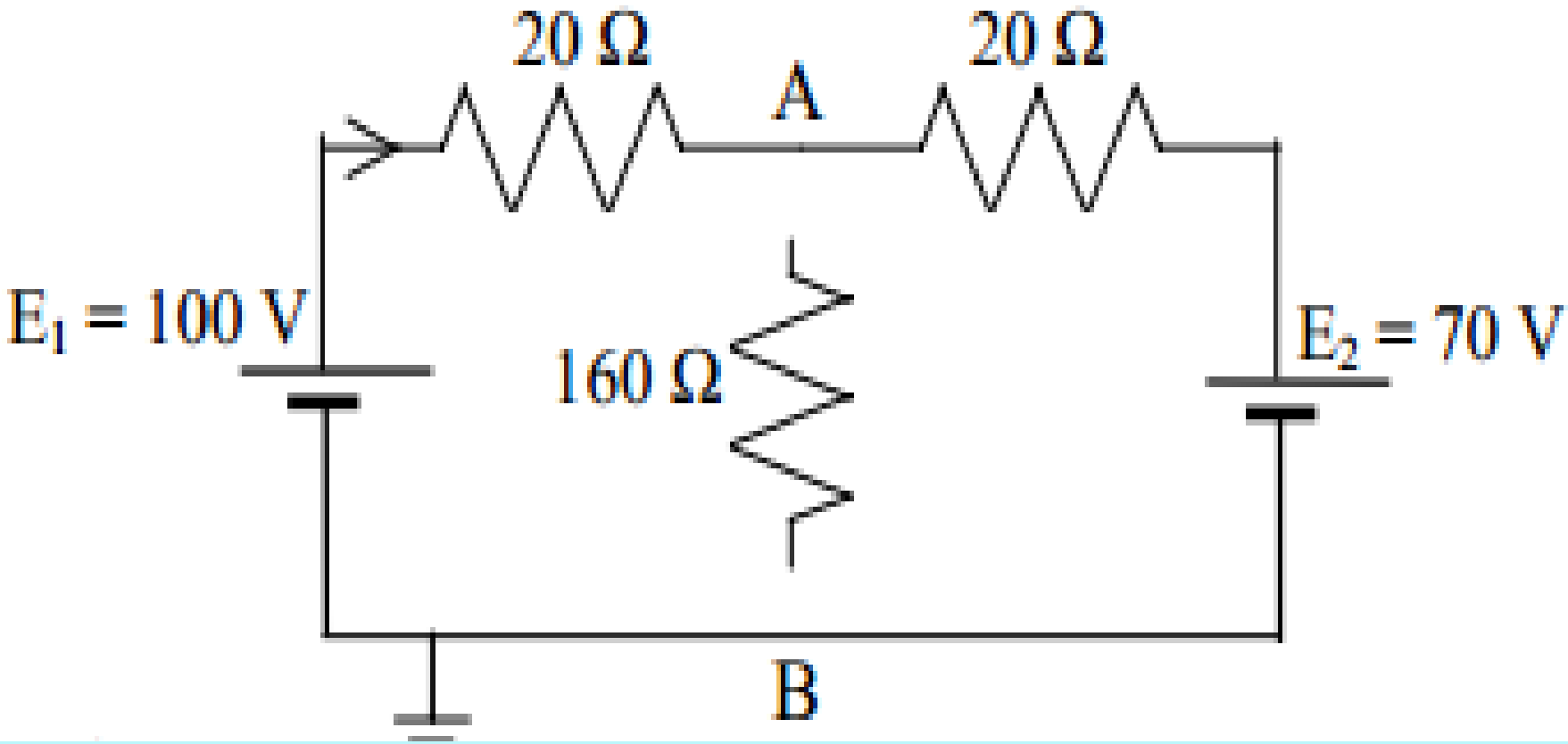
Q1. Find out Thevenin's Equivalent Circuit &



Q2. Find out Thevenin's Equivalent Circuit



Solution: To find out Thevenin's Equivalent Circuit



Thevenin's Equivalent Circuit