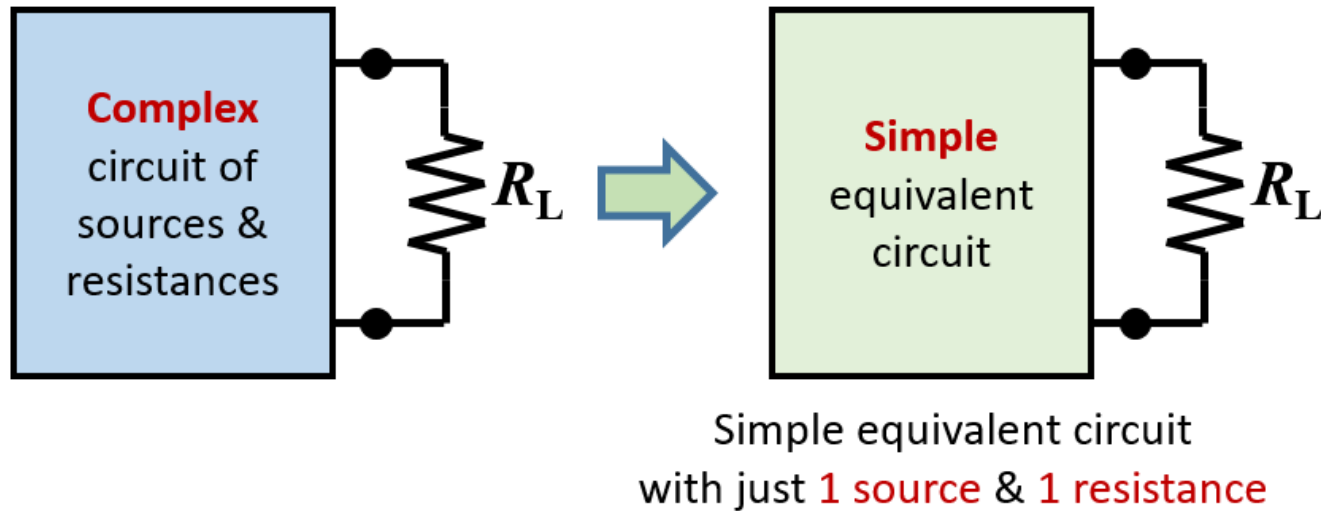


CG1111: Engineering Principles and Practice I

DC Circuit Principles:
Thevenin Equivalent Circuit

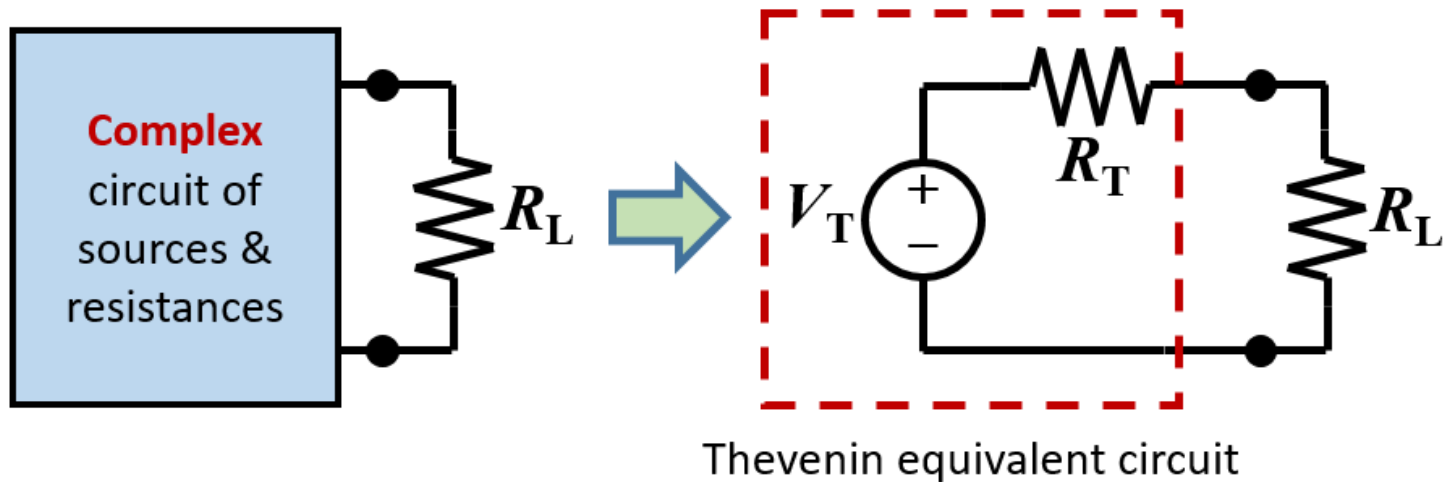


Concept of Equivalent Circuit



- Sometimes, we have a load that is connected to a complex circuit via only **two** terminals
- If we are **only interested in the I-V characteristics across the load**, it is **useful** to model the complex circuit using a very simple “**equivalent circuit**” that gives the **same I-V characteristics**

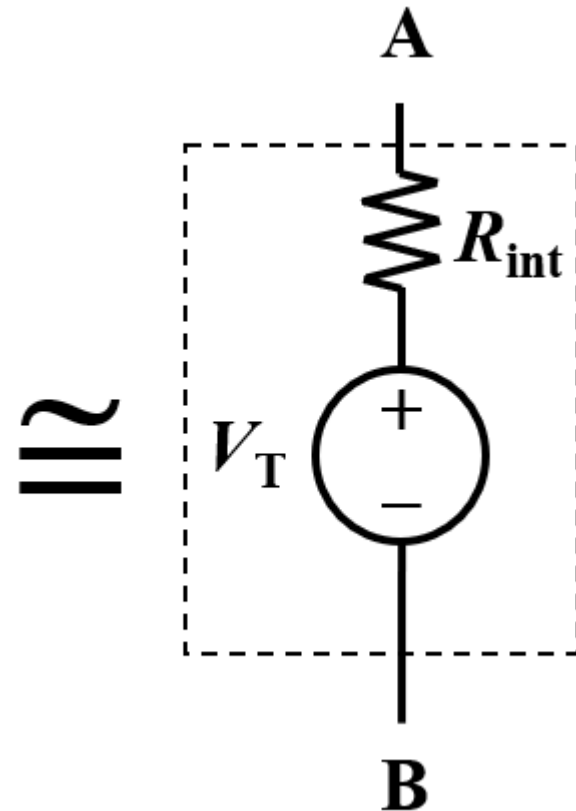
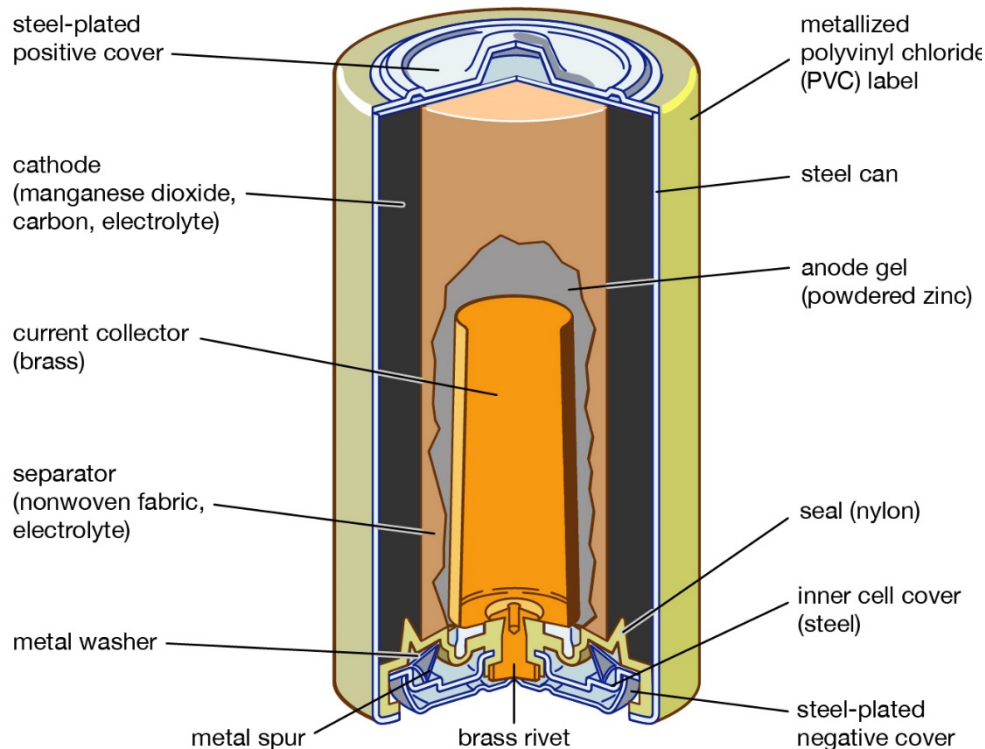
Thevenin Equivalent Circuit



- The equivalent circuit is called a “**Thevenin equivalent circuit**” if it consists of just an **ideal voltage source** and a **series resistance**
 - Ideal voltage source called “**Thevenin voltage**” (V_T)
 - Series resistance called “**Thevenin resistance**” (R_T)

Recall:

Battery's Equivalent Circuit



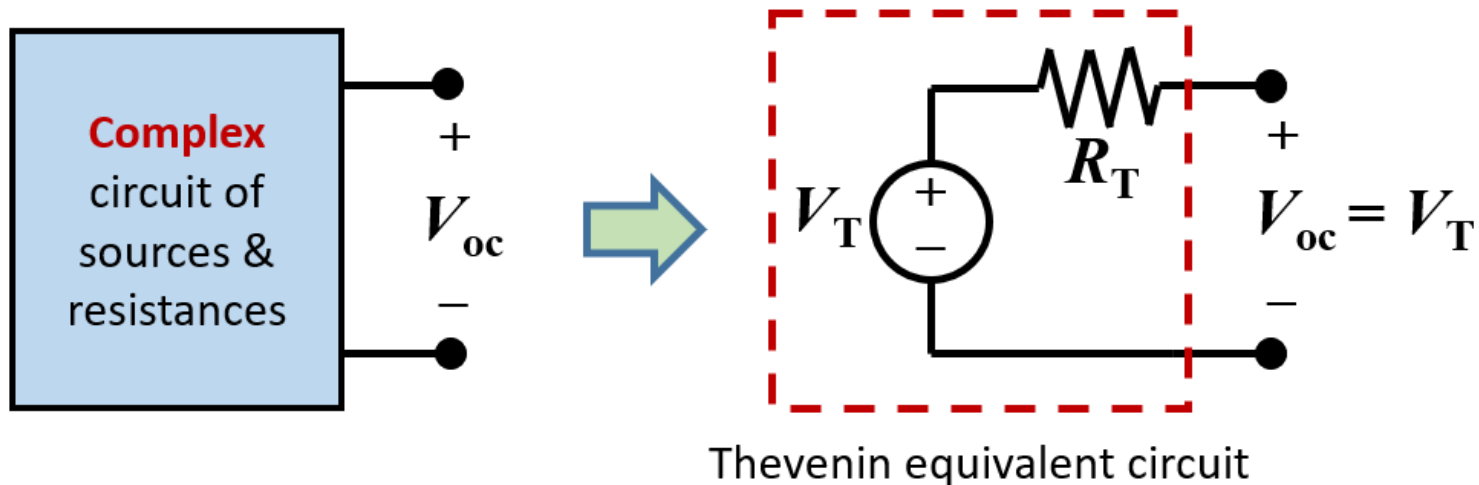
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- Battery's equivalent circuit is actually a Thevenin equivalent circuit!

Finding Thevenin Voltage

- Notice that the **open-circuit voltage** V_{oc} of a Thevenin equivalent circuit is **equal to its** V_T ?
- Recall that the **I-V behaviour** of the Thevenin equivalent circuit must be the **same** as the I-V behaviour of the complex circuit

Hence, V_T can be obtained by finding V_{oc} across the 2 terminals of the complex circuit

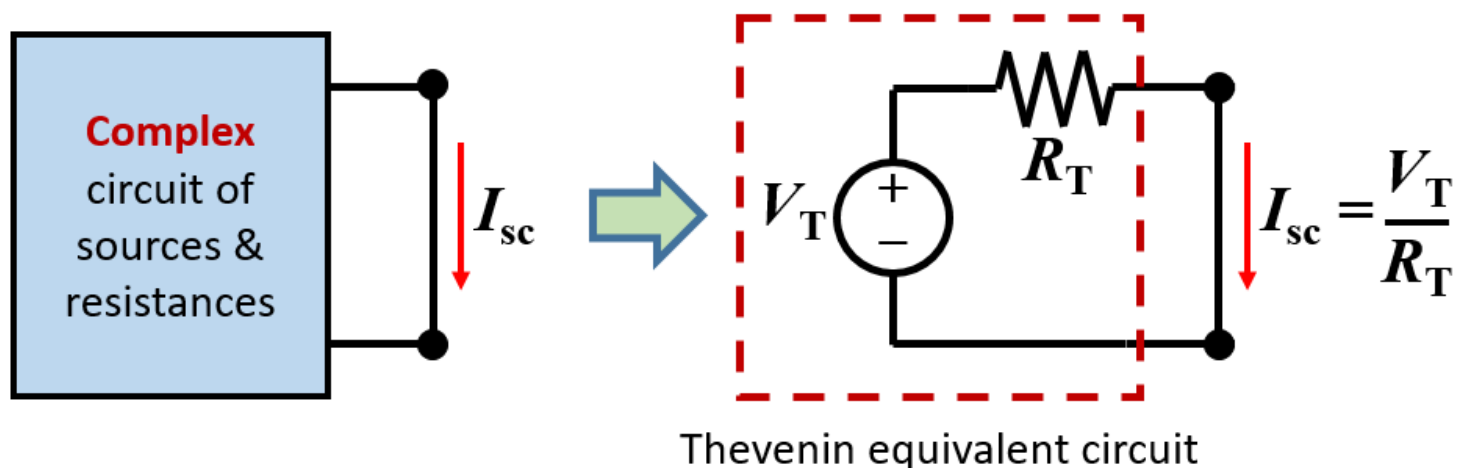


Finding Thevenin Resistance

- Notice that we can find R_T using Ohm's Law if we know its short-circuit current I_{sc} ?
- To be an equivalent circuit, the I_{sc} of our Thevenin equivalent circuit must be equal to the I_{sc} of the complex circuit

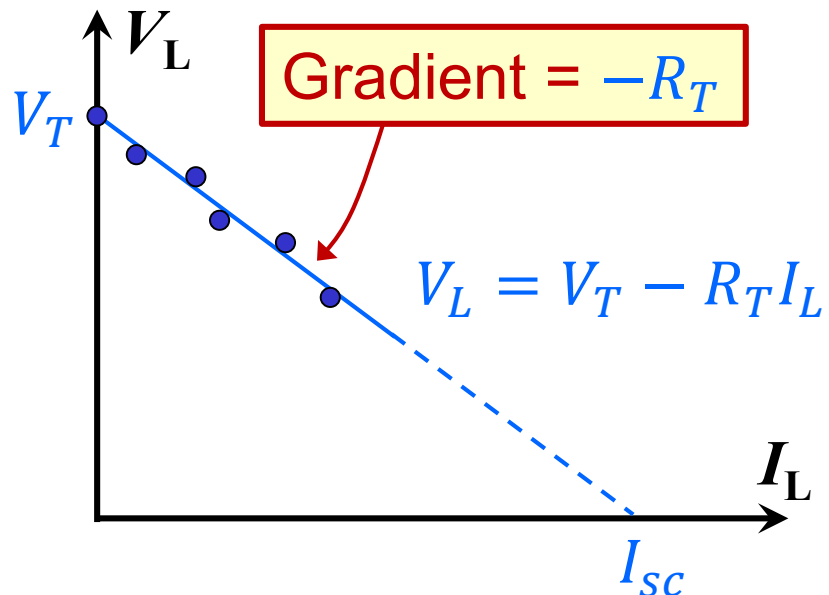
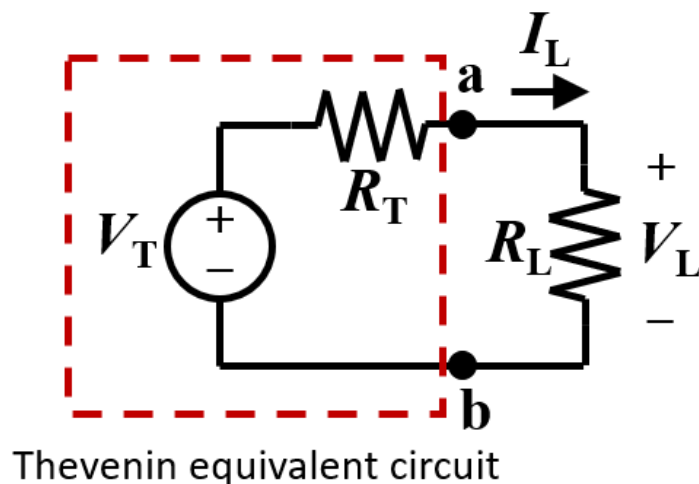
$$R_T = \frac{V_T}{I_{sc}}$$

Hence, R_T can be obtained using Ohm's Law after finding I_{sc} across the 2 terminals of the complex circuit



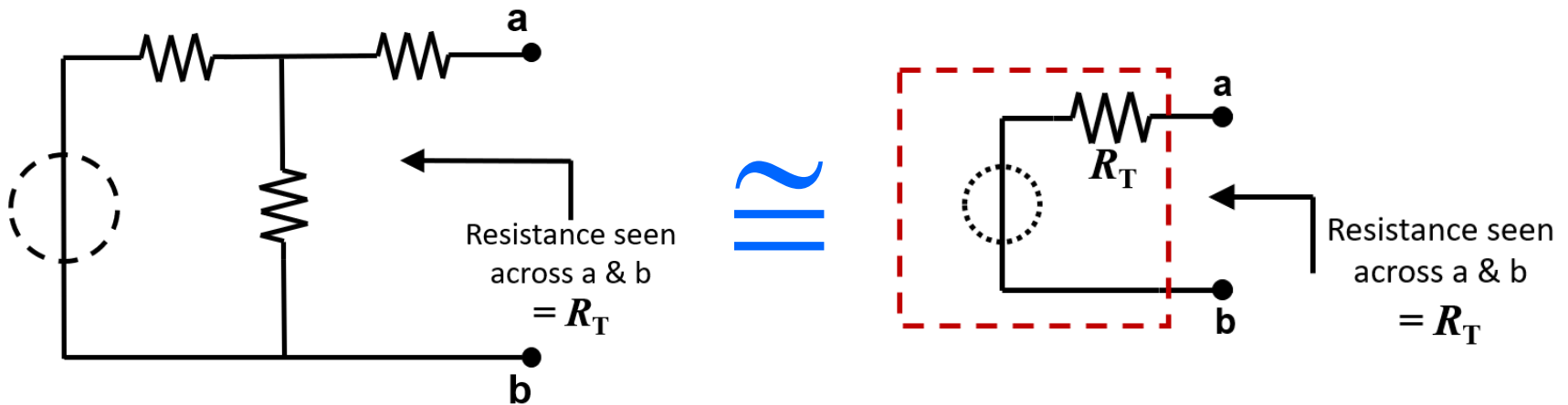
Experimental Method to Find R_T

- If we were to determine R_T experimentally using the previous approach, there is a risk that I_{sc} may be large
- It is safer to connect the circuit to multiple resistive loads and then use an alternative graphical approach



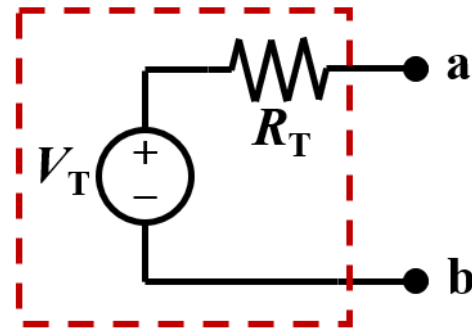
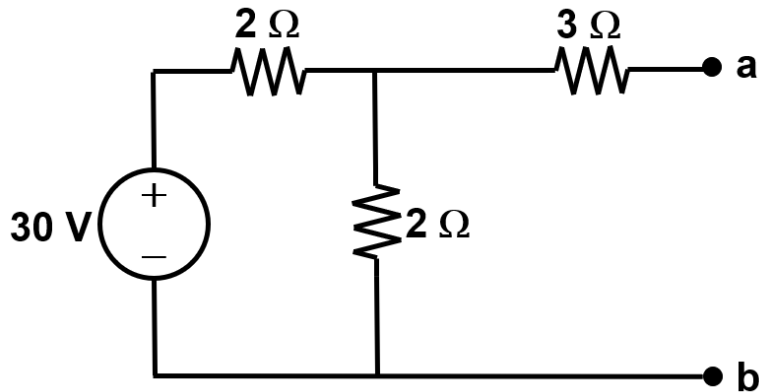
Another Analytical Method to Find R_T

- If the original electrical circuit consists of independent voltage sources only,
 1. Replace all voltage sources with a short-circuit (0 V); this results in a purely resistive network
 2. Find the equivalent resistance between the two terminals



Example

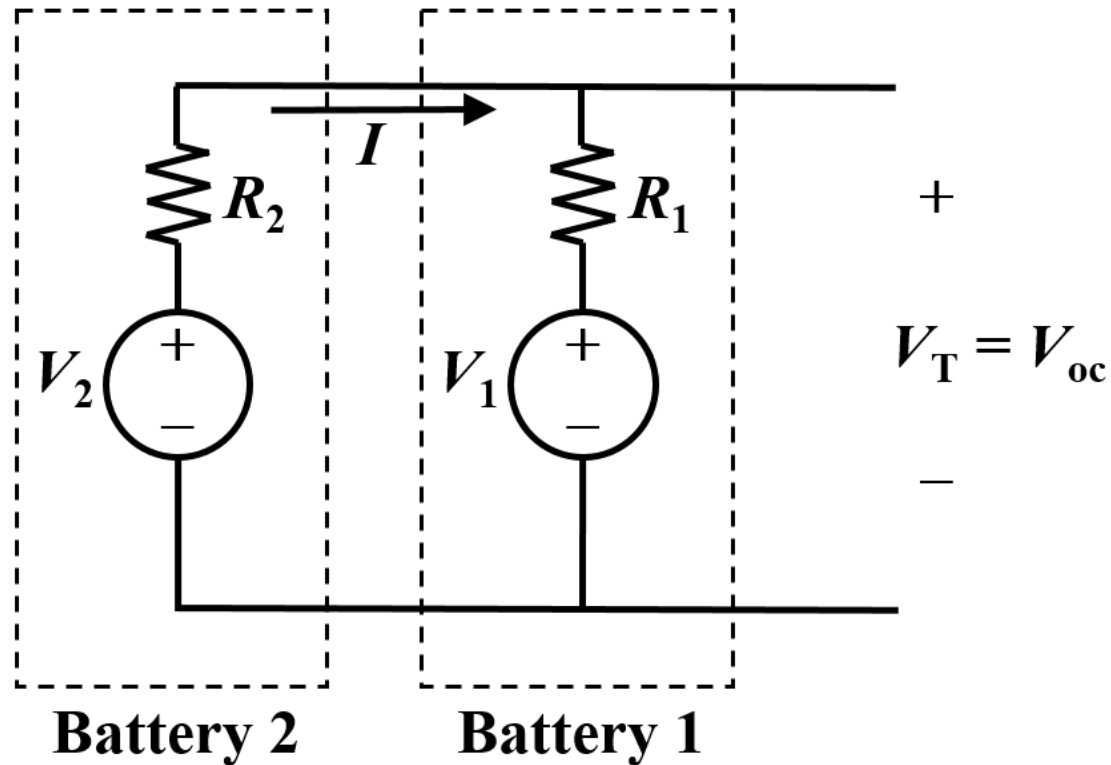
Find the Thevenin equivalent circuit across nodes **a** & **b**



Thevenin equivalent circuit

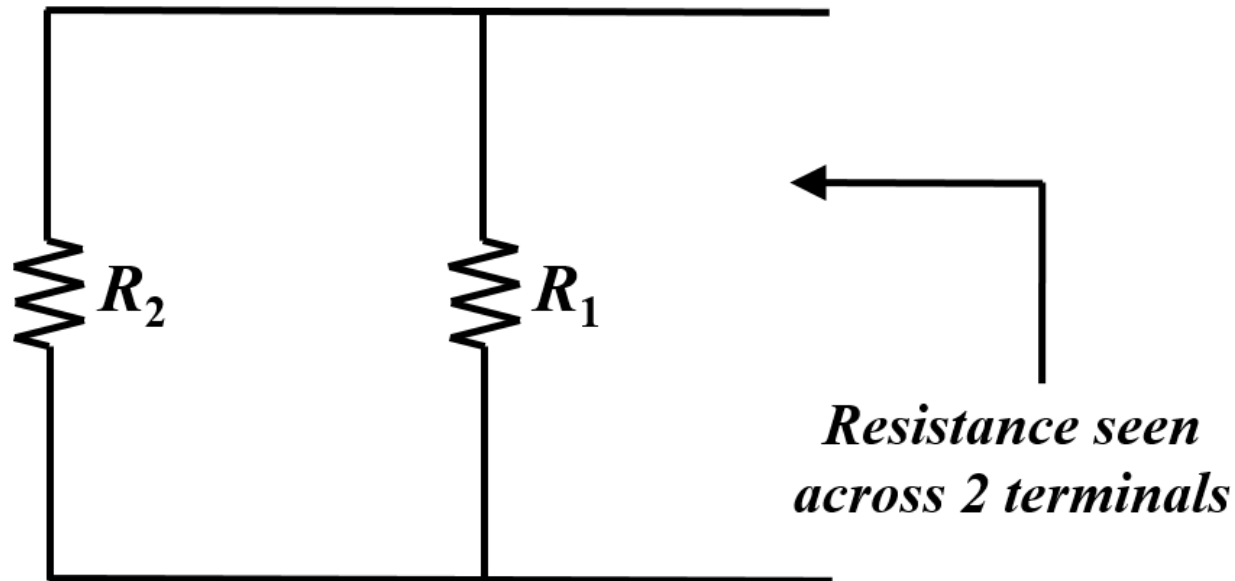
[Answer: $V_T = 15\text{ V}$, $R_T = 4\ \Omega$]

Thevenin Equivalent Circuit of Two Parallel Batteries



Finding Thevenin Voltage V_T

Thevenin Equivalent Circuit of Two Parallel Batteries



Finding Thevenin Resistance R_T

THANK YOU