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# Introduction to Kirchhoff's Voltage Law

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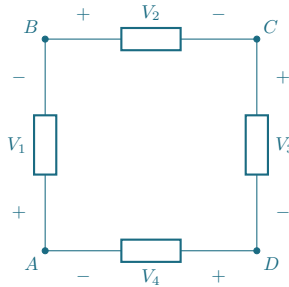
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This lesson provides an overview of Kirchhoff's Voltage Law as it applies to the study of electric circuits. When you complete this lesson, you should know the following:

1. The definition and basic meaning of Kirchhoff's Voltage Law (KVL).
2. How to apply KCL for an electric circuit loop.
3. How to apply KCL to simple electric circuits to solve for all voltages, currents and powers.

## Kirchhoff's Voltage Law

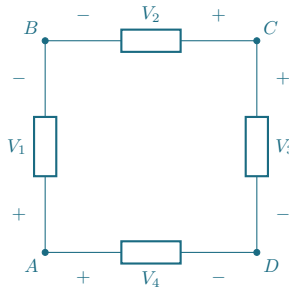
Simply stated, Kirchhoff's Voltage Law (KVL) requires that the sum of all voltage drops (or gains) around a loop in an electric circuit must be equal to zero.



Applying KVL around the loop shown above, for instance, requires that the sum of the voltage drops be zero:

$$V_1 + V_2 + V_3 + V_4 = 0.$$

To obtain this equation, we start at node  $A$  and move clockwise around the circuit adding all the voltage drops that we encounter. When applying KVL to other circuits, we need to pay careful attention to the direction of the polarity for the voltages. If, for instance, the voltages were defined as shown below:

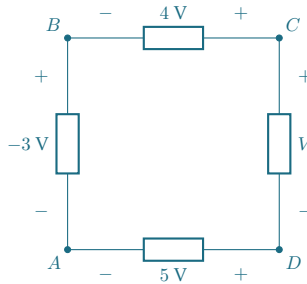


then the application of KVL would require that:

$$V_1 - V_2 + V_3 - V_4 = 0.$$

Note that the voltages that move from their negative to positive reference as we move clockwise around the loop—like  $V_2$  and  $V_4$ —are subtracted from, rather than added to, the KVL sum.

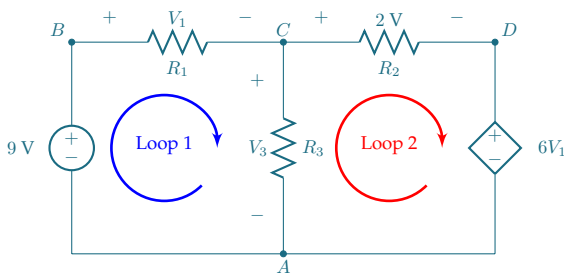
**Example 1.** Suppose we have the following voltages specified for a single-loop circuit:



Applying KVL to this loop (clockwise from node A), we require

$$-(-3) - 4 + V + 5 = 0 \implies V = -4 \text{ V.}$$

**Example 2.** Suppose we have the circuit shown below:



If we apply KVL about Loop 1 (from node A to node B to node C back to node A), then we will require the following equation to be satisfied:

$$-9 + V_1 + V_3 = 0. \quad (\text{Loop 1})$$

Likewise, if we apply KVL about Loop 2 (from node A to node C to node D back to node A), then we will require the following equation to be satisfied:

$$-V_3 + 2 + 6V_1 = 0. \quad (\text{Loop 2})$$

Then, if we solve these two equations for  $V_1$  and  $V_3$ , we obtain

$$V_1 = 1 \text{ V},$$

and

$$V_3 = 8 \text{ V}.$$