

Lesson 4

Kirchhoff's Laws

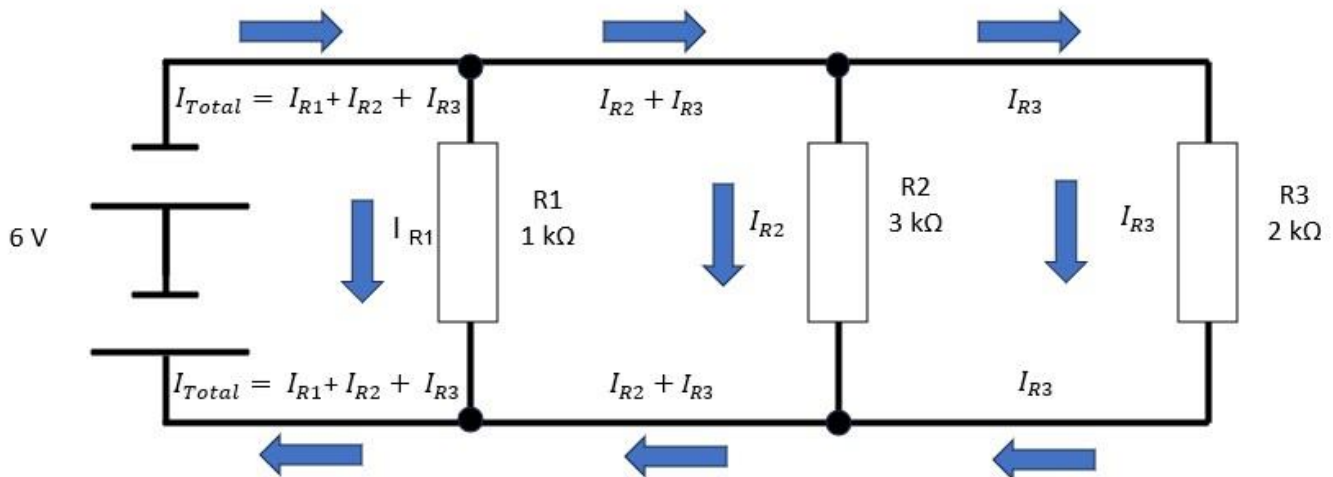
Gustav Robert Kirchhoff was a German physicist who contributed to the fundamental understanding of electrical circuits. His two laws for current and voltage define how current flows through a circuit and how voltage varies around a loop in a circuit.

First Law

The sum of all currents entering and exiting a node must equal zero.

The current entering a node is $+$ and current exiting a node is $-$. In the circuit below, the black circles are nodes. R1 and R2 are on a branch.

$$I_{\text{Entering}} + (- I_{\text{Exiting}}) = 0$$



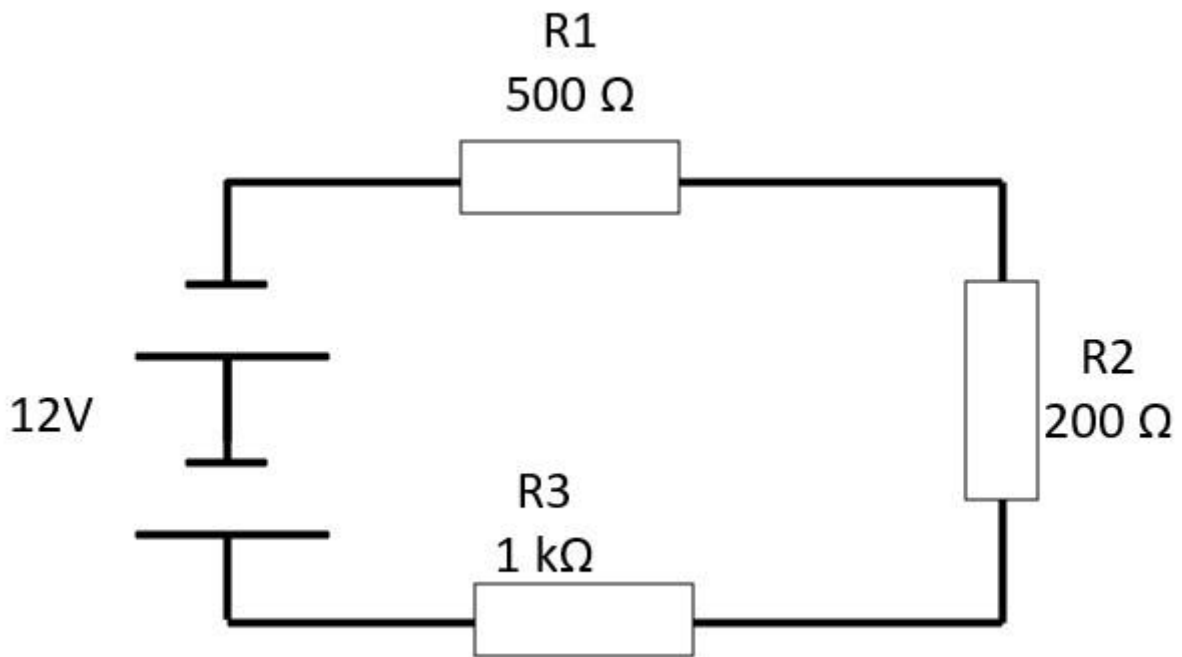
	R1	R2	R3	Total
Volts (E) across Rs	6	6	6	6
Current through Rs	6 mA	2 mA	3 mA	11 mA
Resistance of Rs	1 kΩ	3 kΩ	2 kΩ	545.45 Ω

$I_{Total\ In}$	I_{R1}	I_{R2}	I_{R3}	$I_{Total\ Out}$
11 mA	6 mA	2 mA	3 mA	11 mA

Second Law

Kirchhoff's voltage law states that in any complete loop within a circuit, the sum of all voltages across components which supply electrical energy must equal the sum of all voltages across the other components in the same loop.

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$$\begin{aligned} R_t &= R_1 + R_2 + R_3 \\ &= 500 + 200 + 1000 \\ &= 1700 \Omega \end{aligned}$$

$$\begin{aligned} I &= E / R \\ &= 12 / 1700 \\ &= 0.007 \text{ mA} \end{aligned}$$

V in	V R1	V R2	V R3	V Total
12 V	3.53 V	1.41 V	7.05 V	12 V

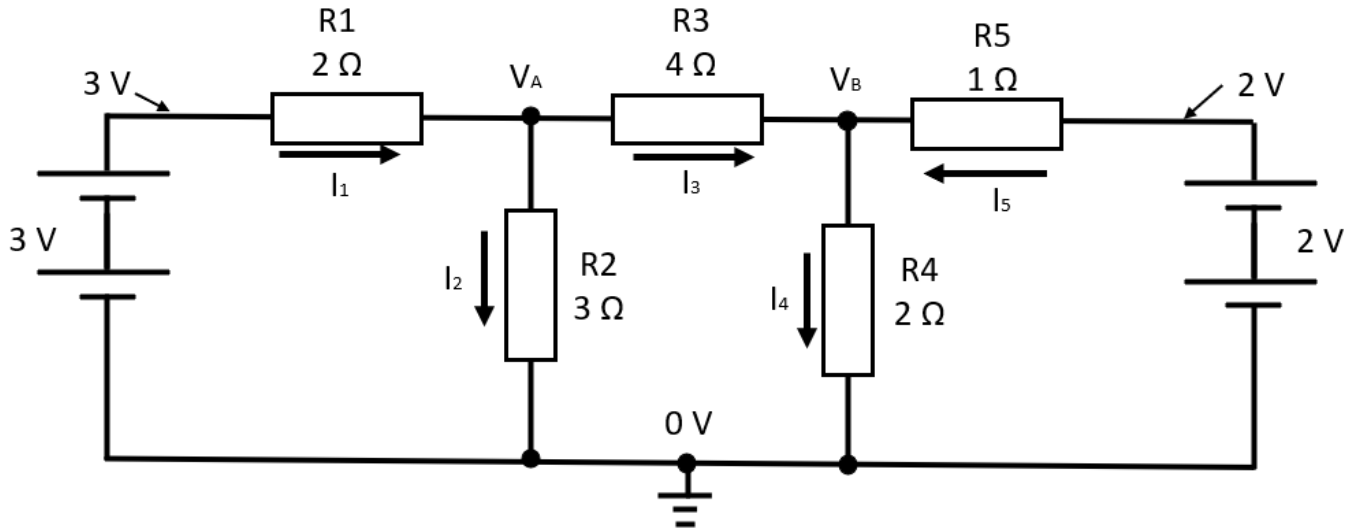


Nodal Analysis

Print off the nodal analysis sheet to follow along.

Calculate the following.

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VA	V R1	V R2	V R3
VB	I1	I2	I3

1. The nodes we focus on are V_A and V_B
2. Assume a point on the circuit is at 0V and conventional current flow applies.
3. Indicate any voltages we know currently.
4. Mark in the currents through the resistors and assume the direction the current will travel.
If the assumed direction is wrong, the result will be negative and can be changed.
5. Current flowing into a node is considered **Positive** and current flowing out of a node is considered **Negative**. (+ in and – out)
6. Using Kirchhoff's Current Law (KCL) for V_A and V_B

Go to Lesson 4 questions.

Have fun and stay safe.