ADVANCED

Lesson 4

KIRCHOFF'S LAW

ACMA Syllabus February 2024 Chapter 1.1

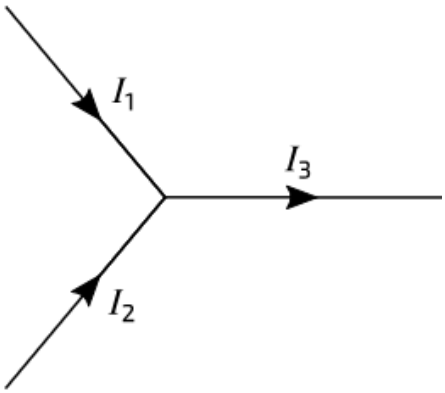
Contents

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.

Kirchhoff's First Law

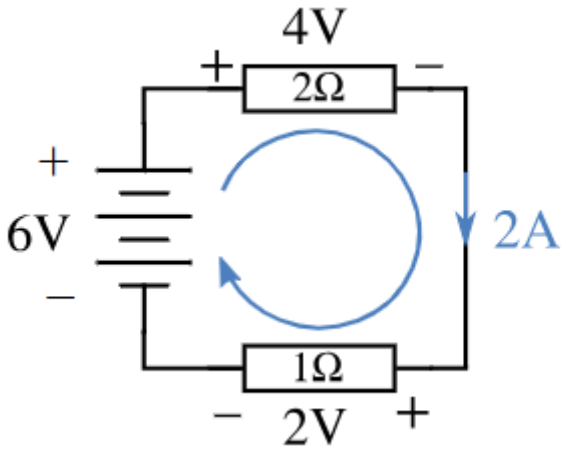
Kirchhoff's current law (1st Law) states that the current flowing into a node (or a junction) must be equal to the current flowing out of it.



$I_1 + I_2 = I_3$

Kirchhoff's Second Law

Kirchhoff's voltage law (2nd Law) states that in any complete loop within a circuit, the sum of all voltages across components which supply electrical energy (such as cells or generators) must equal the sum of all voltages across the other components in the same loop.

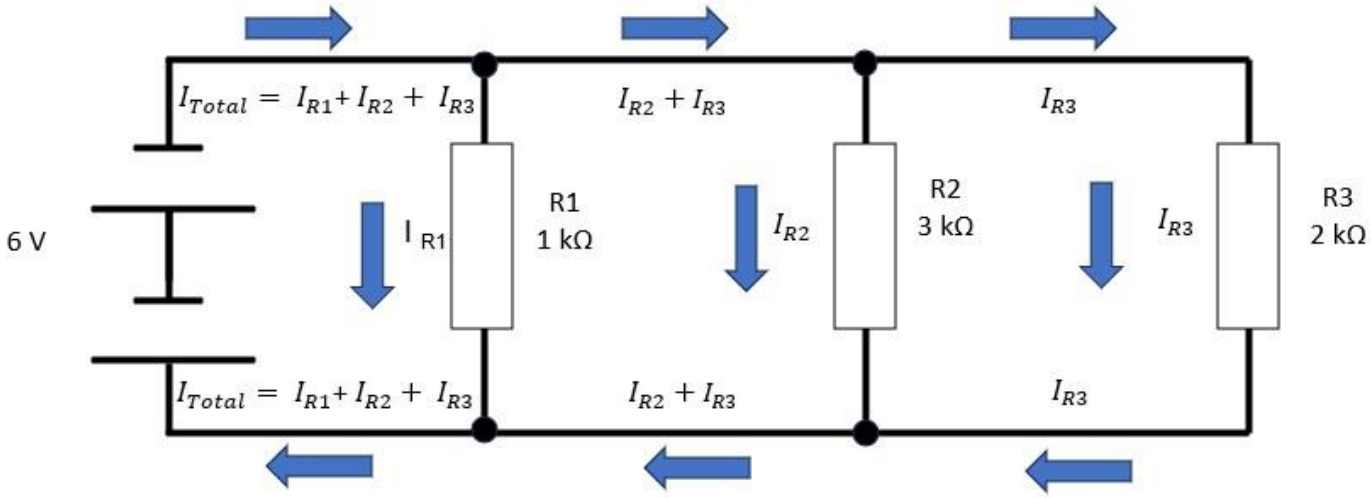


First Law

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.

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

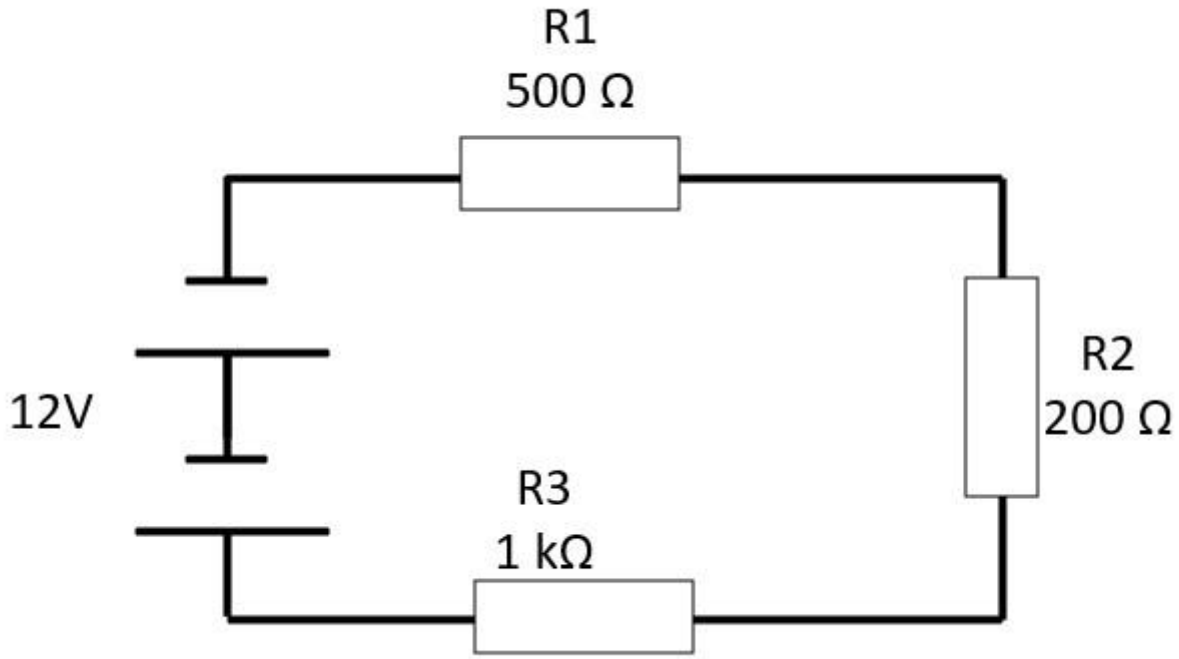


	R1	R2	R3	Total
Volts (E) across Rs	6	6	6	6
Current through Rs	6 mA	2 mA	3 mA	11 mA
Resistance of Rs	1 kΩ	3 kΩ	2 kΩ	545.45 Ω

$I_{Total}\ In$	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.



Rt = R1 + R2 + R3
= 500 + 200 + 1000
=1700 Ω

I = E / R
= 12 / 1700
=0.007 mA

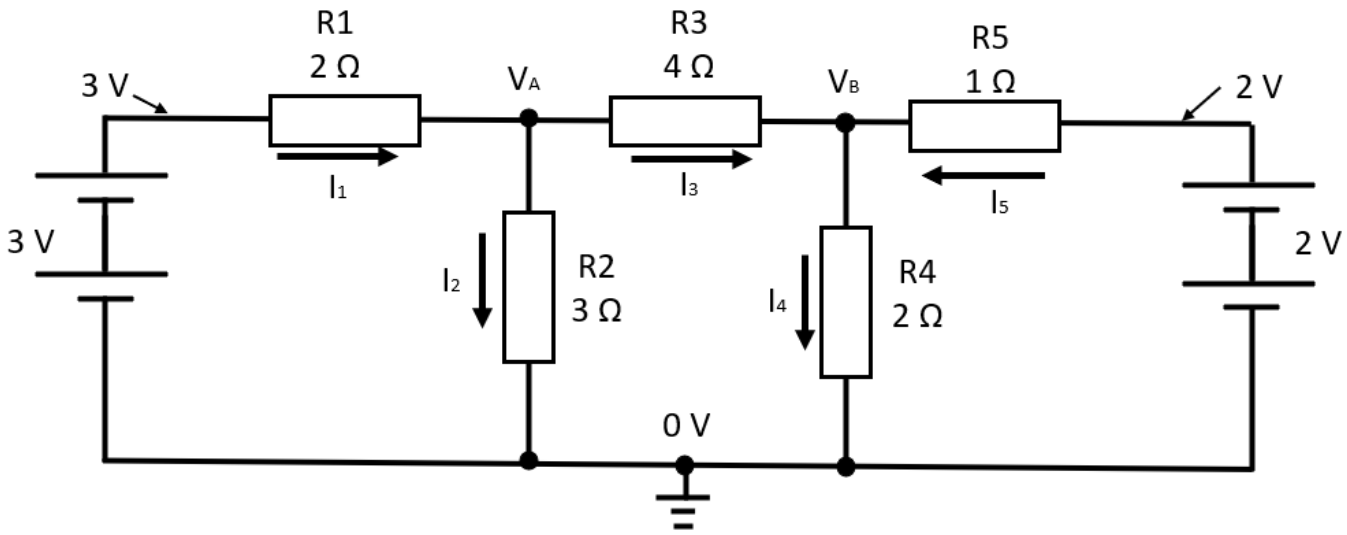
V in	V R1	V R2	V R3	V Total
12 V	3.53 V	1.41 V	7.05 V	12 V

Nodal Analysis (Not required for the exam)

Not required for the Advanced amateur licence. This material is intended to help the candidate better understand the splitting of currents and voltage drops across resistors and re-enforces Kirchoff's law.

Print off the nodal analysis sheet to follow along.

Calculate the following.



VA	V R1	V R2	V R3
VB	I1	I2	I3

1. The nodes we focus on are VA and VB
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 VA and VB

Go to Lesson 4 Questions.