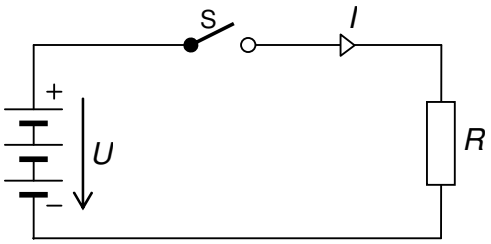
Electric circuit



An **electrical network** is an interconnection of electrical components such as resistors (*R*), inductors, capacitors, or their combinations, voltage sources (*U*), current sources, and switches (S) with transmission lines.

An **electrical circuit** is a network that has a closed loop, giving a return path for the current. A network is a connection of two or more components.
A network that also contains active electronic components is known as an **electronic circuit**.

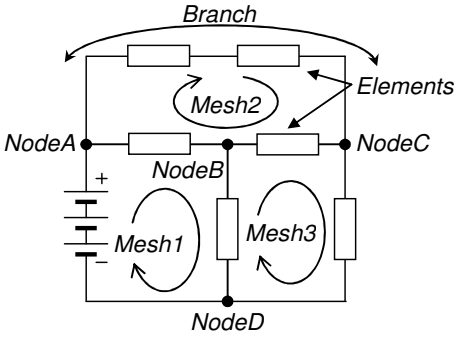
Definitions

Node A point in which terminals of more than two components are joined. A conductor with a substantially zero resistance is considered to be a node for the purpose of analysis. (In the picture are 4 nodes: node A ÷ D)

Branch The component(s) joining two nodes. (In the picture are 6 branches: between nodes A-B; B-C; A-D; A-C; B-D; C-D)

Mesh A group of branches within a network joined so they form a complete loop. (In the picture are 3 meshes.)

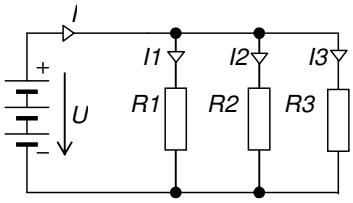
Element The individual circuit components which form the meshes are called elements. (In the picture are 9 elements: 3×DC sources and 6×resistors.)



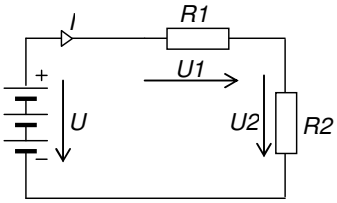
Port Two terminals where the current into one is identical to the current out of the other.

Circuit A current from one terminal of a generator, through load component(s) and back into the other terminal. A circuit is, in this sense, a one-port network and is a trivial case to analyze. If there is any connection to any other circuits then a non-trivial network has been formed and at least two ports must exist. Often, "circuit" and "network" are used interchangeably, but many analysts reserve "network" to mean an idealized model consisting of ideal components.

In electronics, components of an electronic circuit can be connected in **series** or in **parallel**. Components connected in series are connected along a single path, so the same current flows through all of the components. Components connected in parallel have the same voltage is applied to each component.



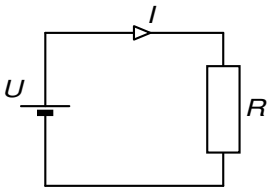
A circuit composed only of components connected in series is known us **serial circuit**; likewise, one connected completely in parallel is known as a **parallel circuit.**



In a series circuit, the current through each of the components is the same, and the voltage across the components is the sum of the voltages across all the components. In a parallel circuit, the voltage across each of the components is the same, and the total current is the sum of the currents through all the components.

Ohm‘s law

Ohm‘s law is a physical law describing the relationship among current, voltage and resistance. The law was named after the German physicist Georg Ohm, who in 1827 published a treatise describing the measurements of applied voltage and current through simple electrical circuits containing various lengths of wire.



Electric circuit illustrating the relationship among voltage (U), resistance (R) and current (I).

In electrical circuits, Ohm's law states that the current through a conductor between two points is directly proportional to the potential difference or voltage across the two points, and inversely proportional to the resistance between them.

The mathematical equation that describes this relationship is: $I = \frac{U}{R}$, where *I* is the current going through the conductor measured in Amperes, *U* is the potential difference measured across the conductor in units of Volts and *R* is the resistance of the conductor measured in Ohms.

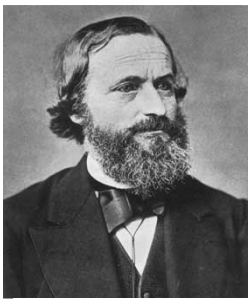
In circuit analysis, three equivalent expressions of Ohm's law are used interchangeably:

$$I = \frac{U}{R} \text{ or } R = \frac{U}{I} \text{ or } U = R \cdot I$$

The law applies to circuits composed of linear elements through which direct current flows in ideal conditions – such as constant temperature and constant resistance.

Example: Calculate the resistance of 3.5 V light bulb through which 200 mA of current is flowing.	$R = \frac{U}{I} = \frac{3,5}{0,2} = 17,5\ \Omega$

Kirchhoff‘s circuit laws

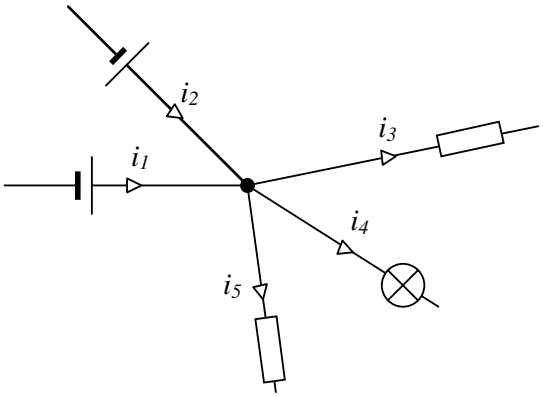


Kirchhoff’s circuit laws are two equalities that deal with the conservation of charge and energy in electrical circuits, and were first described in 1845 by Gustav Robert Kirchhoff. Widely used in electrical engineering, they are also called Kirchhoff’s rules or simply Kirchhoff’s laws.

1. Kirchhoff‘s current law

1. The algebraic sum of current at any node (junction) in electric circuit must be zero (the current flowing towards the node is positive and that every current flowing away is negative).

2. The sum of currents flowing into that node is equal to the sum of currents flowing out of that node.



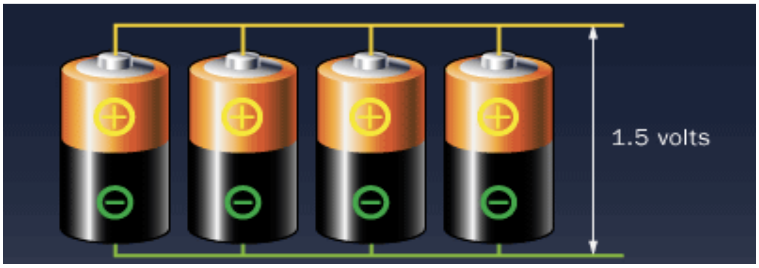
The formula: $\sum_{k=1}^{n} i_k = 0$

1. $i_1 + i_2 + i_3 + i_4 + i_5 = 0$

because currents i_1 and i_2 have reversed direction of flow towards the common junction, currents i_3, i_4 and i_5 have an opposite sign and therefore we can state that:

$$i_1 + i_2 - i_3 - i_4 - i_5 = 0$$

2. $i_1 + i_2 = i_3 + i_4 + i_5$



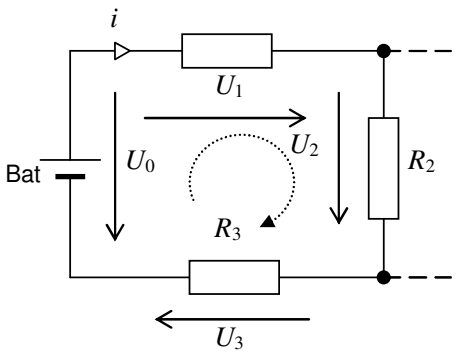
parallel arrangement

If you assume that each cell produces 1,5 Volts, then four batteries in parallel arrangement will also produce 1,5 Volts, but the current supplied will be four times that of a single cell.

2. Kirchhoff’s voltage law

1. The directed sum of the potential differences around any closed circuit must be zero.

2. The sum of dissipated voltages in a closed circuit must be equal to the sum of source voltages.



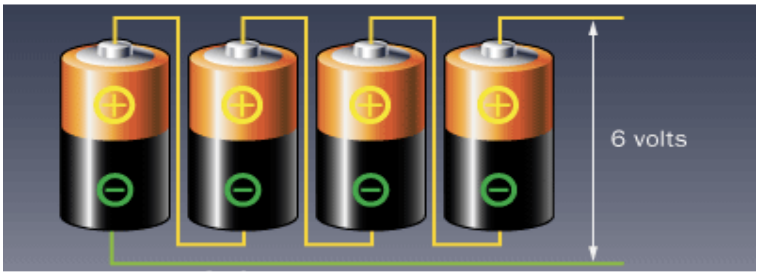
The formula: $\sum U = 0$

1. $U_0 + U_1 + U_2 + U_3 = 0$

the voltage vector U_0 has reversed orientation when compared to the other vectors and therefore U_1, U_2 and U_3 have opposite signs and so we can state that:

$U_0 - U_1 - U_2 - U_3 = 0$

2. $U_0 = U_1 + U_2 + U_3 = i.R_1 + i.R_2 + i.R_3$



serial arrangement

The four voltages add together to produce 6 Volts.

VOCABULARY

wire – drôt
circuit – obvod (elektrický)
directly proportional – priamo úmerný
direct current – jednosmerný prúd
alternating current – striedavy prud
opposite sign – opačné znamienko
source – zdroj
switch – spínač
path – cesta
treatise – pojednanie, stať, článok,spis
dissipated voltages – úbytky napätí

conductor – vodič (elektrický)
interchangeable – vy(za)meniteľný
inversely proportional – nepriamo úmerný
node – uzol
junction – spoj (spojenie)
element – súčiastka
branch – vetva
mesh – slučka
loop – slučka
equality – rovnosť, zhoda
assume – predpoklad

Note:
A mesh is a loop, but a loop is not necessarily a mesh. Mesh cannot have inner-meshes or loops, but a loop can have meshes inside it.