1) Electrical Conductor:

In electricity, a conductor is a material that contains electric charge carriers able to move around easily. When this conductor is subjected to an electric field, the movement of load carriers becomes globally orderly, resulting in a electric current.

By extension, a conductor is an electrical or electronic component of low resistance, used to carry current from one point to another.

Conductive materials include metals, electrolytes (or ionic solution) and plasmas.

Since there is no such thing as a perfect conductor, ohmic conductors are used, the best of which are are silver, gold, and aluminum.

2) Electric Current:

2-1 definition

Electric current is a collective and organized movement of charge carriers (electrons or ions). This flow of charges can occur in a vacuum (electron beam in cathode ray tubes, etc.), or in conductive matter (electrons in metals, or ions in electrolytes). An electric current appears in a conductor when a difference is established between the terminals of the latter.

2-2 Amperage

The electric current is a number describing the flow rate of electric charge at through a given surface, such as the section of an electrical wire

$$I(t) = \frac{dq}{dt}$$

Where

I: is the magnitude of the current.

q: is the electrical charge.

t: time

In the International System of Units, the amperage of the current is measured in amperes, a base unit with a standard symbol of A. One ampere corresponds to a charge rate of one coulomb per second.

The current is measured using an ammeter that must be connected in series to the circuit.

2-3 Current Density:

Current density is a vector describing the electric current at the local scale. His direction indicates the direction of the movement of the load carriers (but its direction may be opposite to the direction of the negative carriers) and its magnitude is the magnitude of the current per unit area. It is connected to the electric current by:

$$I = \iint_S \vec{J} \cdot \vec{dS}$$

where: I is the magnitude of the current; S is a surface, j is the current density; dS the surface vector elementary.

In the International System of Units, current density is measured in amperes per square meter (A•m-2).

3) Ohm's Law:

The potential or voltage difference U (in volts) across a resistor R (in ohms) is proportional to the magnitude of the electric current I (in amperes) flowing through it.

Resistance is the opposition exerted by a body to the passage of an electric current. The resistance is measured in ohms.

4) Joule effect

The Joule effect is a heat-producing effect that occurs when current passes through in a conductor with resistance. It is manifested by an increase in the thermal energy of the conductor and its temperature. In fact, this type of conductor transforms electrical energy in the form of heat energy (energy dissipated in the form of heat). Power dissipated by this conductor is equal to:

$$P=RI^2$$

The unit of power is watt (W).

A: The resistance of the conductor.

I: the magnitude of the current flowing through the conductor.

According to the definition of energy, it is deduced that, the energy consumed by a resistor over time t is equal to:

$$E=U.I.t = RI^2 .t = \frac{U^2}{R}.t$$

The unit of energy is joule (J).

5) Resistance grouping:

There are two cases for resistance grouping:

5-1) Serial Grouping:

All the resistors Ri are traversed by the same electric current I, and each of them has no than a common end with another resistor. The voltage UAB = U is equal to the sum of Resistor Voltages.

$U = U_1 + U_2 + U_3 + \ldots\ldots U_n$

$U = R_1 . I + R_2 . I + R_3 . I \ldots\ldots + R_n . I = R.I$

$$R = \sum_{i=1}^{n} R_i$$

5-2) Parallel grouping:

This grouping is characterized by the fact that all resistors have their common bounds two to two. The voltage is the same between the ends of any resistor laugh.

The electric current that supplies the portion of the circuit is distributed among the resistors, such as:

$$I = I_1 + I_2 + I_3 + \ldots\ldots I_n$$

$$I = \frac{U}{R} = \frac{U}{R_1} = \frac{U}{R_2} = \frac{U}{R_3} = \cdots \ldots.. = \frac{U}{R_n} \qquad \frac{1}{R} = \sum_{i=1}^{n} \frac{1}{R_i}$$

6) Electrical circuits:

An electrical circuit is a collection of electrical conductors (wires) and electrical components (sockets, switch,...) or electronic (household appliances, etc.) with an electric current running through them.

The electrokinetic study of an electrical circuit consists of determining, at each location, the intensity of the Current & Voltage

Elements of the electrical circuit:

The electrical circuit is essentially composed of the following elements:

1- The knot: this is a point where more than two conductors end.

2 - The branch: this is a portion of the circuit that is interspersed between two nodes.

3- Mesh: any closed outline, formed by a series of branches.

Generators

To obtain a direct electric current in a closed circuit, it is essential to power the energy circuit. This is done by devices, which are called generators. It can be said that this are sources of electromotive forces to carry charges.

There are 2 types of generators:

Voltage generators or sources:

The voltage source, or voltage generator, is a dipole characterized by a voltage between these terminals, regardless of the variable intensity it flows. In the following, we will we are particularly interested in DC voltage generators. This type of generator is characterized by an electromotive force E, and a low internal resistance (r)

It is possible to replace a voltage generator, whose characteristics are (e,r) with a ideal source of electromotive force E, connected in series with ohmic conductor, of resistance r.

The electromotive force of a voltage generator is equal to the potential difference between its terminals when it does not discharge any current

I=0 → e = UAB

Generators or power sources:

The current source, or current generator, is a dipole characterized by the flow of a constant current, regardless of the variable potential difference between its terminals. In the following, we're going to focus on DC generators.

A current generator can be replaced by an ideal power source, which delivers a constant current, and mounted in parallel with an ohmic conductor, resistor.

7) Kirchhoff's Laws:

7-1) First Law (Law of Knots):

At one node of a circuit, the sum of the incoming currents is equal to the sum of the intensities outgoing:

$$\sum I_S = I_E$$

This means that the charges do not accumulate, they flow into a node in the network, it obey the rule of conservation of energy.

7-2)Second Law (Law of Meshes):

In a mesh of an electrical circuit, the algebraic sum of the resistance products by Amperage $\sum_{k=1}^{n} R_k I_k$ is equal to the algebraic sum of the electromotive forces

$\sum_{k=1}^{n} e_k = \sum_{k=1}^{n} R_k I_k$.

When applying this law, one must choose a positive meaning around the mesh: all the electromotive forces and currents which have the same direction will be counted positively, those which are in the opposite direction will be counted negatively. We consider the meaning of e positive when we enters, according to the positive direction chosen, through the negative pole, and one leaves through the positive pole (which is leads to an increase in potential) , and vice versa if it does not.