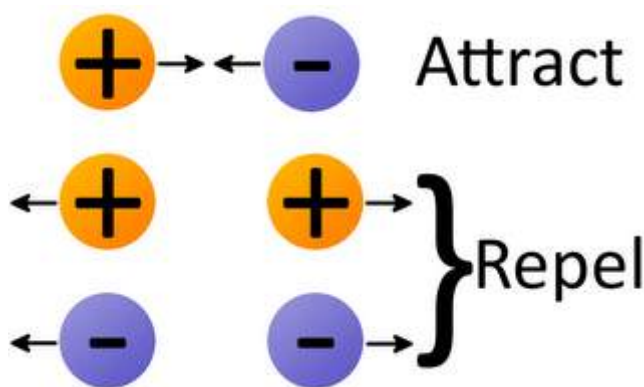# Electricity

Current and Voltage

Atomic Structure

- An atom has a positively charged nucleus and negatively charged electrons revolving around it.
- Valence electrons in metals are free to move within the conductor and constitute an electric current.

Charge

The charge is an intrinsic property of matter by virtue of which it can exert electromagnetic force.

Interaction between charges

Conductors and Insulators

A substance which offers comparatively less opposition to the flow of current is known as conductors and substances which offer larger opposition are insulators.

Electric Potential and Potential Difference

The electric potential at a point is defined as work done in bringing a unit positive charge from infinity to that point. The potential difference between two points is defined as the difference in electric potentials at the two given points.
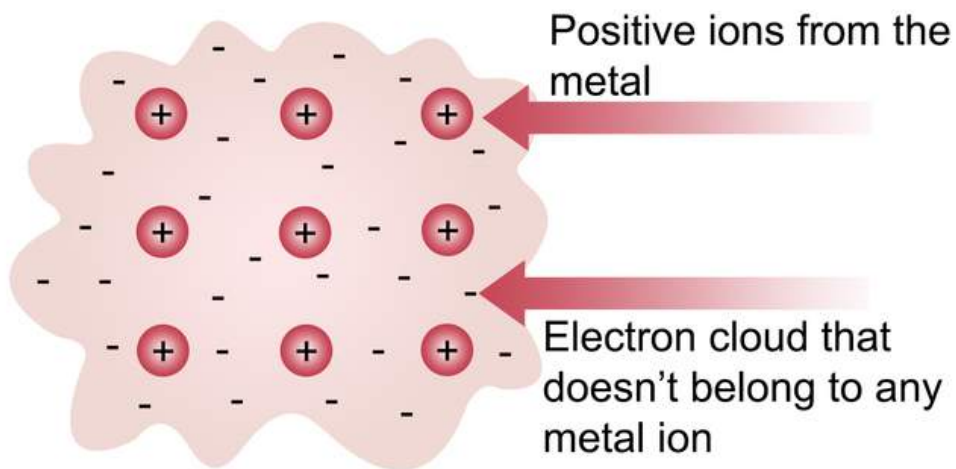
Models of Electric Current

Electric Current(I)

Flow of electric charges is called electric current, i.e, $I = \frac{Q}{t}$.

Electron sea model

Electric current in a solid conductor is due to drift of a 'sea' of free electrons, which are free to jump onto any neighbouring atom.

Positive ions from the metal

Electron cloud that doesn't belong to any metal ion

Electron sea model

Drift velocity of Electron

Average velocity which an electron attains inside a metallic conductor due to the application of an electric field due to the potential difference.

Voltage Applied

V_{drift}

I
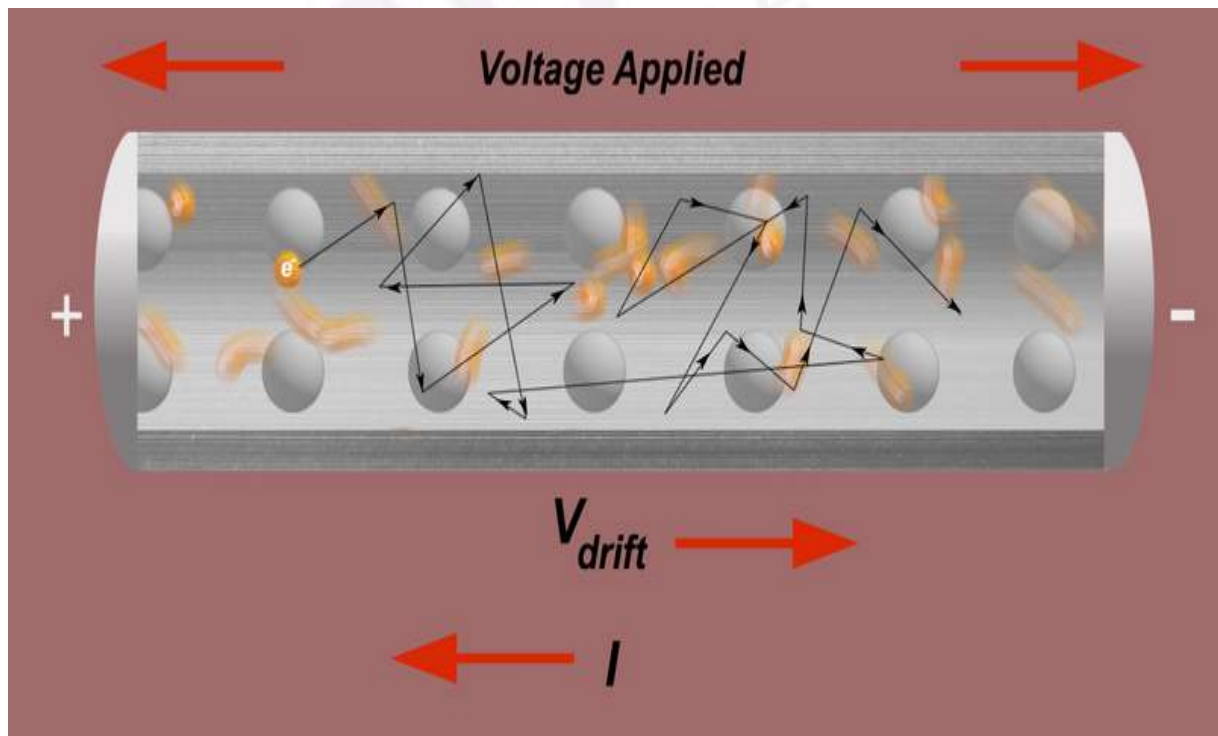
Drift velocity of an electron

Battery and its working

A cell is a source of potential difference, which is created inside it due to internal chemical reactions.

At anode: $\qquad\qquad\qquad\qquad Cu(s) \rightleftharpoons Cu^{2+}(aq) + 2e-$
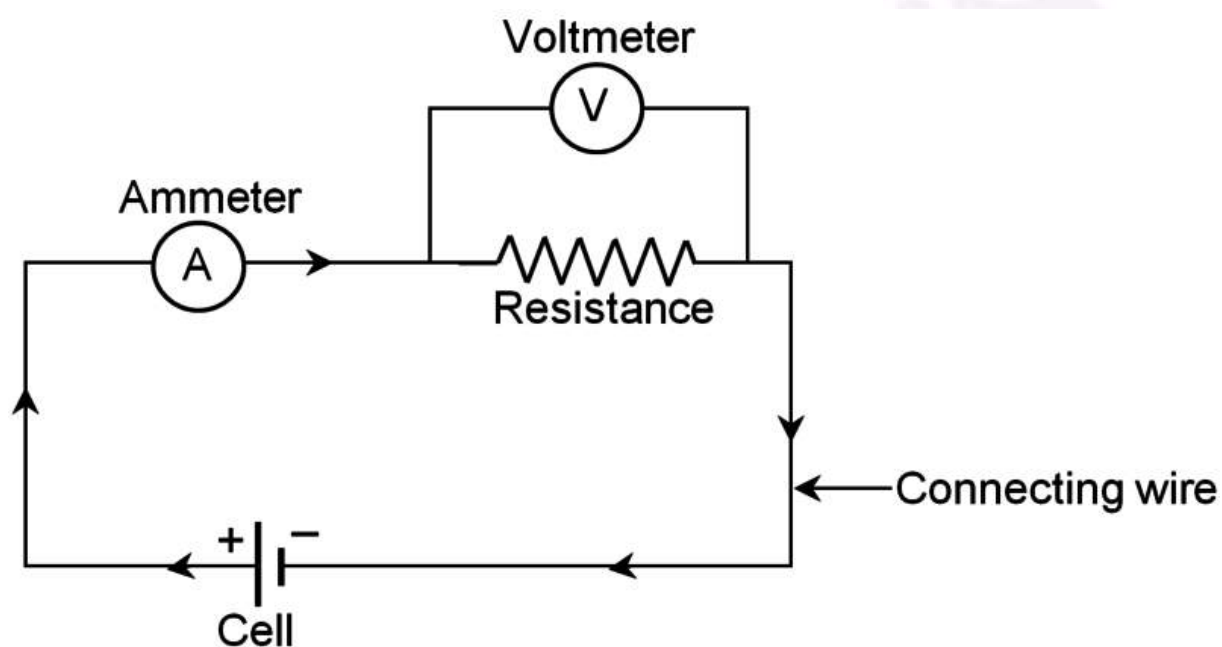
At cathode: $\qquad\qquad\qquad\quad Ag(aq) + 2e- \rightleftharpoons 2Ag(s)$

A combination of cells is called a battery.

Electric Circuit

Electric circuit and circuit diagram

- A closed-loop path which a current take is called an electric circuit.
- Representation of an electric circuit through symbols is called a circuit diagram.
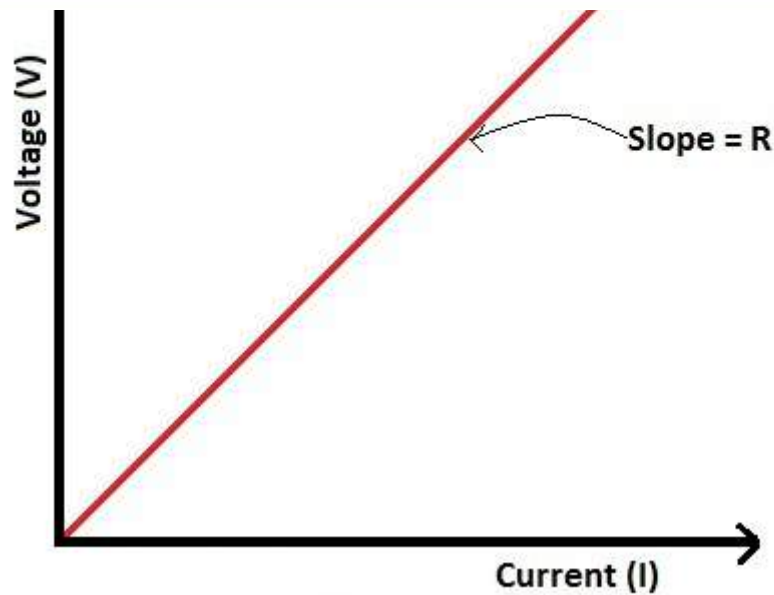

Circuit Diagram

Resistance and Ohm's Law

Ohm's law

The current flowing through an ohmic conductor is directly proportional to the applied potential difference between the two ends of the conductor.

Voltage-Current Characteristics - Ohm's Law Graph

Ohm's law

Resistance

Resistance is a measure of the opposition offered to the current flow in an electric circuit.

## Factors affecting Resistance & How they affect

Resistance is:

- directly proportional to the length of the conductor.
- directly proportional to nature of the conductor.
- directly proportional to the temperature of the conductor.
- inversely proportional to the cross-sectional area of the conductor.

Resistivity

The electrical resistance offered by a substance of unit length and unit cross-sectional area is called resistivity.

Ohmic and Non-Ohmic resistors

Resistors which follow Ohm's Law are called Ohmic resistors, and those which do not follow it are called Non-Ohmic resistors.
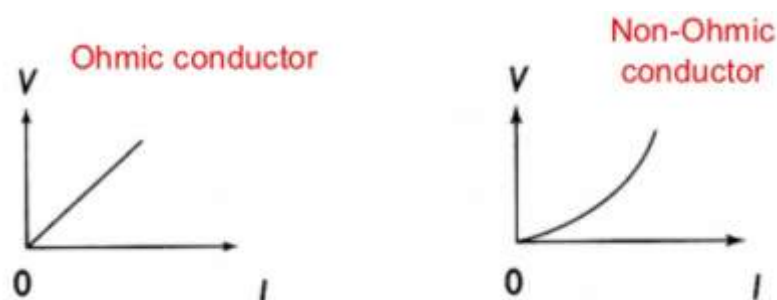
Ohmic vs Non-Ohmic conductors

Superconductors

Conductors which offer zero resistance to the flow of current are called superconductors.

Combination of Resistors

Combination of resistors

- Two resistors are said to be combined in series if they carry the same current.
- Two resistors are said to be combined in parallel if the same potential difference is applied to them.

Equivalent Resistance of a system of resistors

The equivalent resistance of two resistors is given as:

- In series, $R_{eq} = R_1 + R_2$
- In parallel, $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$

EMF and Terminal Voltage

- EMF: The potential difference between the two terminals of a cell, when there is no current flowing through the circuit.
- Terminal voltage: The potential difference between the two terminals of a cell, when current is flowing through the circuit.
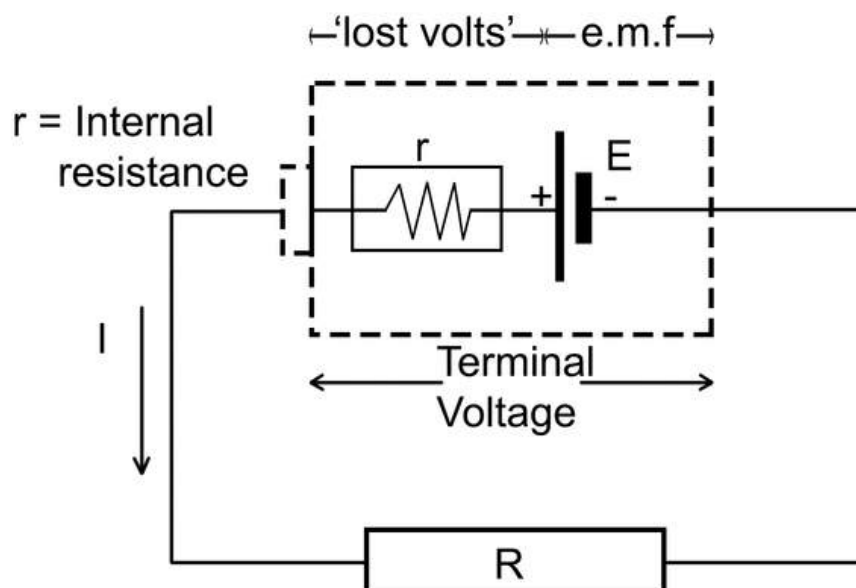
EMF and Terminal voltage

Electric Power and AC

Heating Effect of Current

Joule's Law:

- Heat (H) $\propto$ square of the current (I).
- H $\propto$ Resistance of the given circuit.
- H $\propto$ Time (t) for which current flows through the conductor.

When a potential difference is established, it causes electrons to move i.e. flow of current.

Electric Power

- The rate of doing work or rate of consumption of electrical energy is called Electric Power. If W is work done in time t, then $P = \frac{W}{t}$.
- S.I unit is Watt(W). One watt of power is consumed when 1 A of current flows at a potential difference of 1 V.
- The commercial unit of electrical energy is kilowatt-hour (kWh).
- $1 kWh = 3,600,000 J = 3.6 \times 10^6 J$
- Represented as $P = I^2 R$ and $P = \frac{V^2}{R}$
- One kilowatt-hour is defined as the amount of energy consumed when 1kW of power is used for 1 hour.