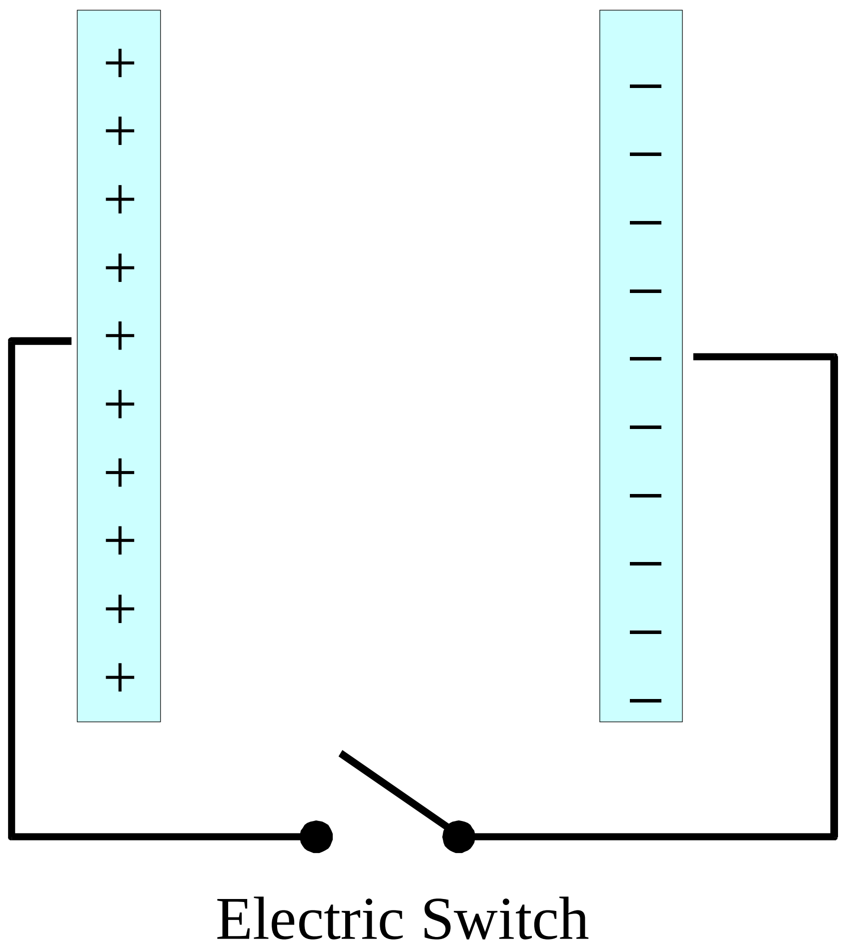
Chapter 20

Electric Circuits

Electric Circuits



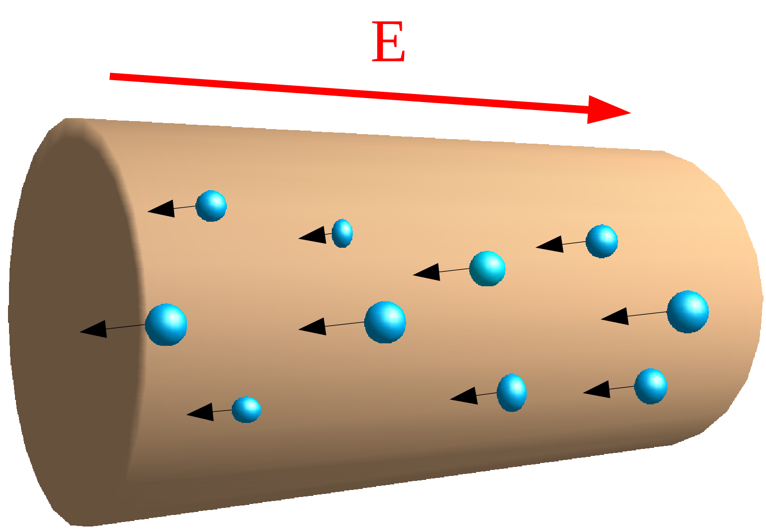
We start with a charged capacitor. There is a wire attached to each plate on one end and attached to an open switch on the other.

Why does the charge stay on each plate with the switch open?

If the switch is closed, what happens?

This is a simple example of an electric circuit.

Electric Current



Look inside the wire (and pretend electrons were visible).

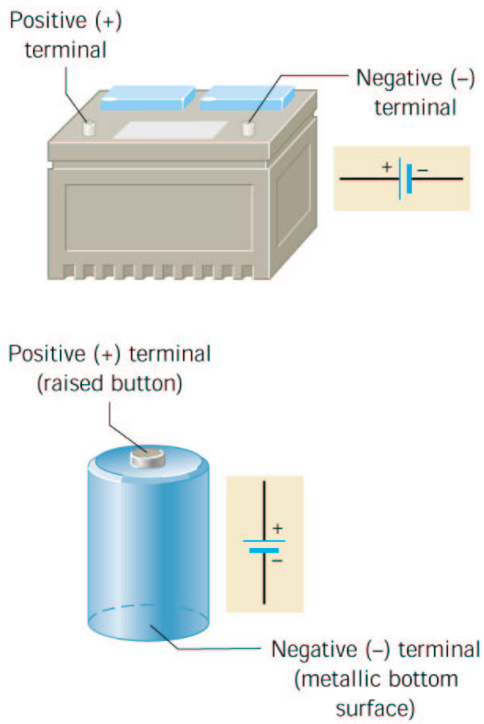
Once you closed the switch, there would be a path the electrons could follow between the negative plate and the positive plate.

If you could count how many electrons passed a given point in a given time, you would be able to define a current.

$$\text{Current} = I = \frac{\Delta q}{\Delta t}$$

SI Unit is the Ampere: $1\,A = \frac{1\,\text{Coulomb}}{1\,\text{sec.}}$

EMF: ElectroMotive Force



Cutnell & Johnson
Wiley Publishing
Physics 5th Ed.
Figure 20.02 (W747)
C M Y K

A device which has the ability to transfer charge from one place to another is said to provide an electromotive force (emf). Anything which provides a voltage provides an emf.

The word force is used for historical reasons but there is no force, only a potential difference measured in energy per unit charge which is not a unit of force.

A common example of an emf is a battery. A chemical reaction within the battery provides a potential difference between the pos. and neg. terminals of the battery. The maximum voltage the battery produces is the emf of the battery.

Resistors

Anything which hinders the flow of electrons is said to provide a resistance to the current or simply provide resistance.

In a circuit, the following symbols are commonly found:

This is a resistor

This is an "Ideal" wire which is defined to have no resistance.

SI unit is the Ohm

Resistivity

This relates the resistance of a material to its physical dimensions.

$$R = \rho \frac{L}{A} \quad \text{or} \quad \rho = R\frac{A}{L}$$

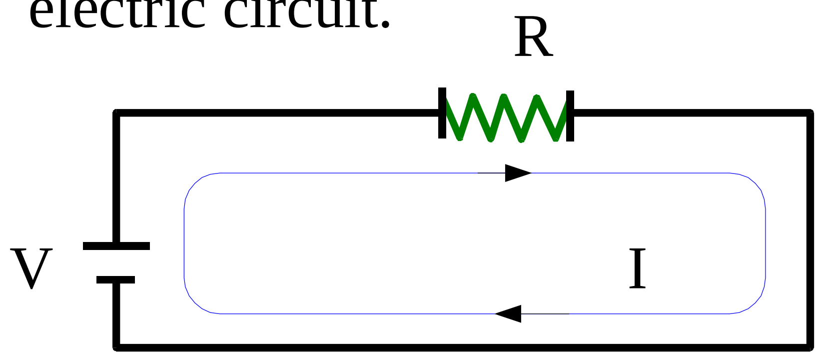
where A is the cross-section area of the wire and L is the wires length.

The SI unit is Ohm · m. Below are listed some common resistivities:

material	ρ ($\Omega \cdot m$)	material	ρ ($\Omega \cdot m$)
Aluminum	2.82×10^{-8}	Mica	10^{11} - 10^{15}
Copper	1.72×10^{-8}	Rubber	10^{13} - 10^{16}
Gold	2.44×10^{-8}	Teflon	10^{16}
Tungsten	5.6×10^{-8}	Wood	3×10^{10}

Ohm's Law

Relates the voltage, current, and resistance to each other in a electric circuit.



V = voltage
I = current
R = resistance

$$V = IR$$

or

$$I = \frac{V}{R}$$

or

$$R = \frac{V}{I}$$