Electric Current

(Chapter 15 - Page 694)

In an electric conductor, current (I), is described as a quantity of charge (q) passing a point during an interval of time (t).

$$I = \frac{q}{t}$$

I -> C/s
q -> C
t -> s

$1\,\frac{C}{s} = 1\,A$

amp
ampere

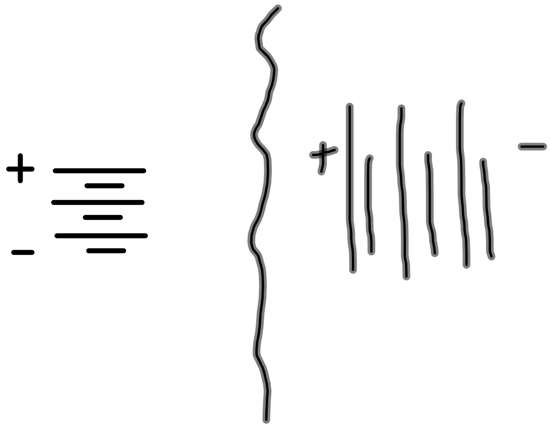
Textbook: Page 696, #4-10

★ $V = \frac{W}{q_t}$

#4. 4.00 V (text: 40.0 V)
#8. 75 s (text: 57 s)

Symbol - Battery

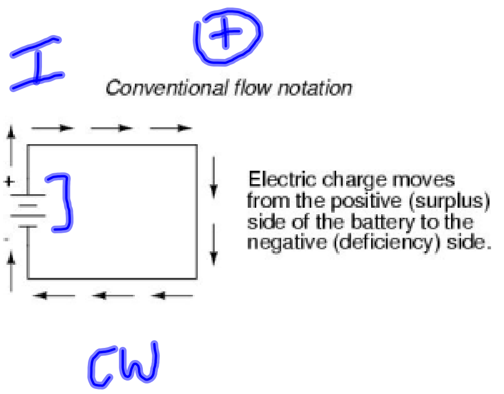
postive terminal

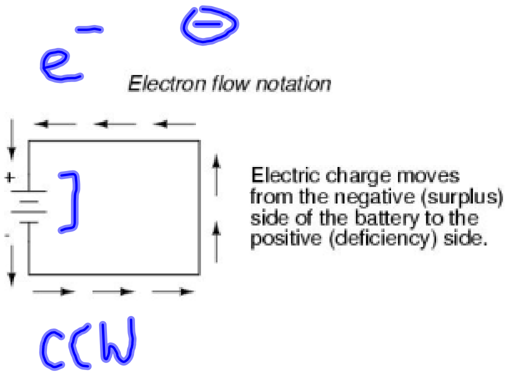


negative terminal

Conventional Current vs. Electron Flow

Conventional current means the flow of positive charge in a circuit. The flow of negative charge is called electron flow.





Website

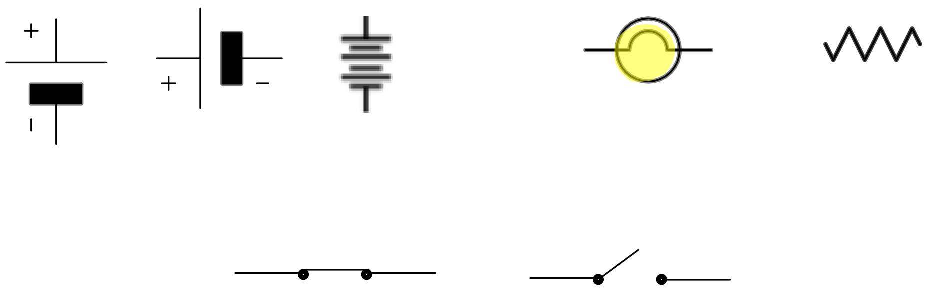
The *anode* of a device is the terminal where current flows in. The *cathode* of a device is the terminal where current flows out.

★

<u>More Circuit Symbols</u>

Imagine a power supply such as a battery is connected to a load such as a light bulb. A switch allows you to open and close the circuit.

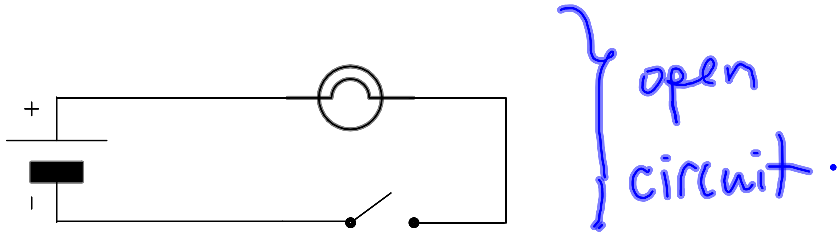
Symbols are used to represent the **elements of a circuit**.



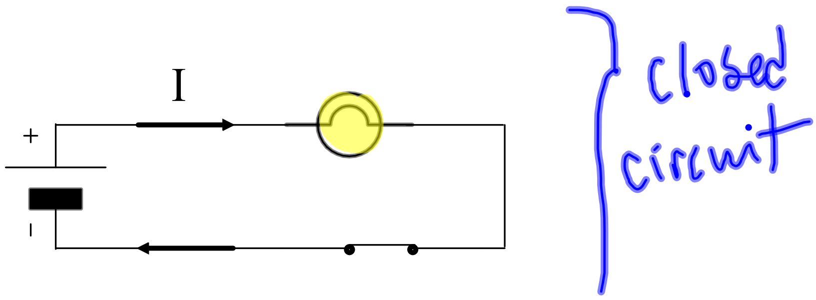
See Page 701 for more symbols.

Open and Closed Circuits

An **open circuit** means there is a break in the circuit that prevents current from flowing.



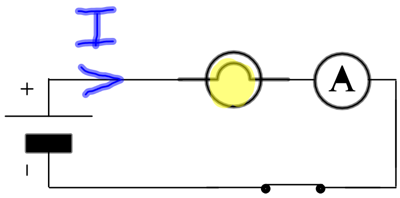
A **closed circuit** means that all connections are complete. A closed or continuous path exists allowing current to move around the circuit.



Ammeters vs Voltmeters

An **ammeter** measures the **electric current** through a circuit element. It is connected in what is called a series connection since the current moves through the circuit element and the ammeter one after the other.

ammeter 



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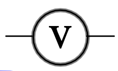
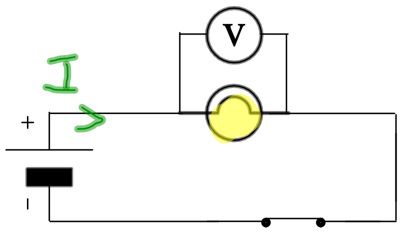
A **voltmeter** measures the **electric potential difference** across a circuit element. It is connected in what is called a parallel connection since the voltmeter presents a path that runs beside the circuit element.

voltmeter 

electrical pot. diff. } voltage



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Resistance to Flow of Charge

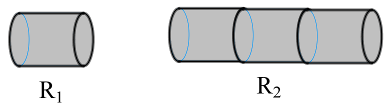
Frictional effects in conductors offer resistance to the current passing through them.

Factors Affecting Resistance in a Wire

1. Resistance and Length

   Resistance increases proportionately with the length of a conductor. Assume a fixed diameter.

$$R \propto L$$

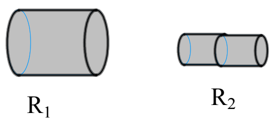


$R_1 < R_2$

2. Resistance and Cross-Sectional Area

   Resistance is inversely proportional to the cross-sectional area of a conductor. Assume equal length.

$$R \propto \frac{1}{A}$$



$R_1 < R_2$

Greek rho [ρ]

3. Temperature

$$R \propto T$$

We will assume temperature is constant.

The result of combining the first two relationships above is:

$$R \propto \frac{L}{A}$$

This proportionality can be written as an equality if a proportionality constant is included. In the case of resistance, the symbol used for the proportionality constant is the Greek letter rho (ρ) and it is called **resistivity**. It is a property of the material from which the conductor is made.

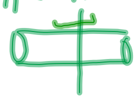
$$R = \frac{\rho L}{A}$$

rho ρ

R -> resistance (Ω) — ohm
ρ -> resistivity (Ωm)
L -> length (m)
A -> area (m^2)

constant

$A = \pi r^2$



$A = x^2$

PHYSICS FILE

The thickness of wire is called its "gauge." As the gauge of a wire increases, the wire becomes thinner. When electricians wire the circuits of a house, they usually use 14 gauge wire, while the lighter wire in the cord of a small appliance might be 18 gauge wire.

Diameters/Resistances of Some Gauges of Copper Wire

Gauge	Diameter (mm)	Resistance ($\times 10^{-3}\Omega$/m)
0	9.35	0.31
10	2.59	2.20
14	1.63	8.54
18	1.02	21.90
22	0.64	51.70

The resistance of a conductor with a particular length and cross-sectional area depends on the *material* from which it is made. At room temperature, copper is one of the best conducting (lowest resistance) metals. Table 15.1 includes resistivity values for carbon and germanium, which are semiconductors, and for glass, which is an insulator. Insulators are sometimes thought of as conductors with extremely high resistances. By examining Table 15.1, you can see that glass has about 10^{18} to 10^{22} times the resistance of copper.

Table 15.1 Resistivity of Some Conductor Materials

Material	*Resistivity, ρ ($\Omega \cdot$ m)
silver	1.6×10^{-8}
copper	1.7×10^{-8}
aluminum	2.7×10^{-8}
tungsten	5.6×10^{-8}
Nichrome™	100×10^{-8}
carbon	3500×10^{-8}
germanium	0.46
glass	10^{10} to 10^{14}

*Values given for a temperature of 20°C

Textbook: Page 708, #16-20

$$V = \frac{W}{q}$$

$$I = \frac{q}{t}$$

Attachments

Inverse Square Love.jpg

Physics 122 - Practice Coulomb's Law.doc

Ohm Pictures.jpg