Electricity is but yet a new agent for the arts and manufactures, and, doubtless, generations unborn will regard with interest this century, in which it has been first applied to the wants of mankind.

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Energy in Everyday Life

Resistance and Power

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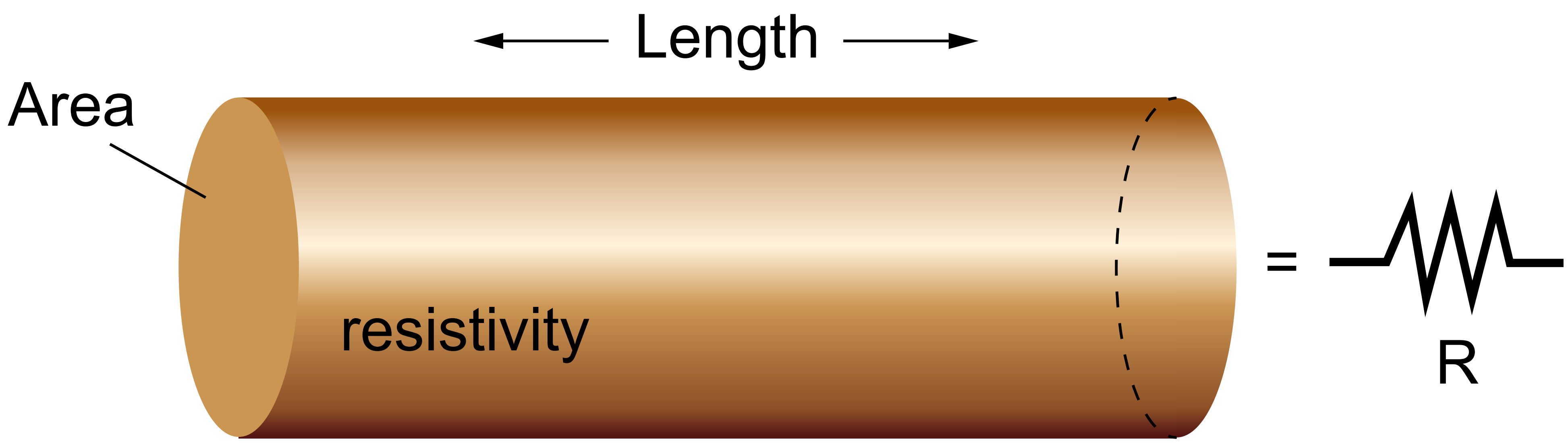
Various materials resist the flow of electrons, an electrical current, by different amounts.

Materials such as silver, copper or aluminum offer less obstacle to the movement of electrons are are said to have low electrical resistance.

Other materials, such as rubber or carbon, offer a great deal of electrical resistance.

Resistance depends on the size and shape as well as the material. Resistivity characterizes the resistive properties such that it depends only on the material.



$$\text{Resistance} = \text{resistivity}\ \frac{\text{Area}}{\text{Length}}$$

All copper has the same resistivity, but a 2m copper wire has twice the resistance of a 1 m cooper wire of the same diameter.

The current, a flow of charge, depends on the electron's mean speed through a (resistive) wire.

In common household AC wiring and currents, the speed of the electrons as they wiggle back and forth is ~ 0.2 mm/s or ~ 1 yard/hour.

Yet we know from everyday experience that electrical energy travels very quickly. Flip a switch and the device is on.

Since the electrons are just wiggling back and forth at low speeds for AC, or just moving at low speeds for DC, the electrons cannot be what's transporting the energy.

In electronic circuits it is useful to define a resistance between the voltage and the current. If we use the symbol I for the current and the symbol R for the resistance

$$V = IR$$

The unit of resistance is the ohm, symbolized by Ω, in honor of Georg Ohm for his work on circuits in the 19th century.

The resistance seen by 1 A of current over 1 V of potential is defined at 1 ohm (1 Ω= 1 V/A).

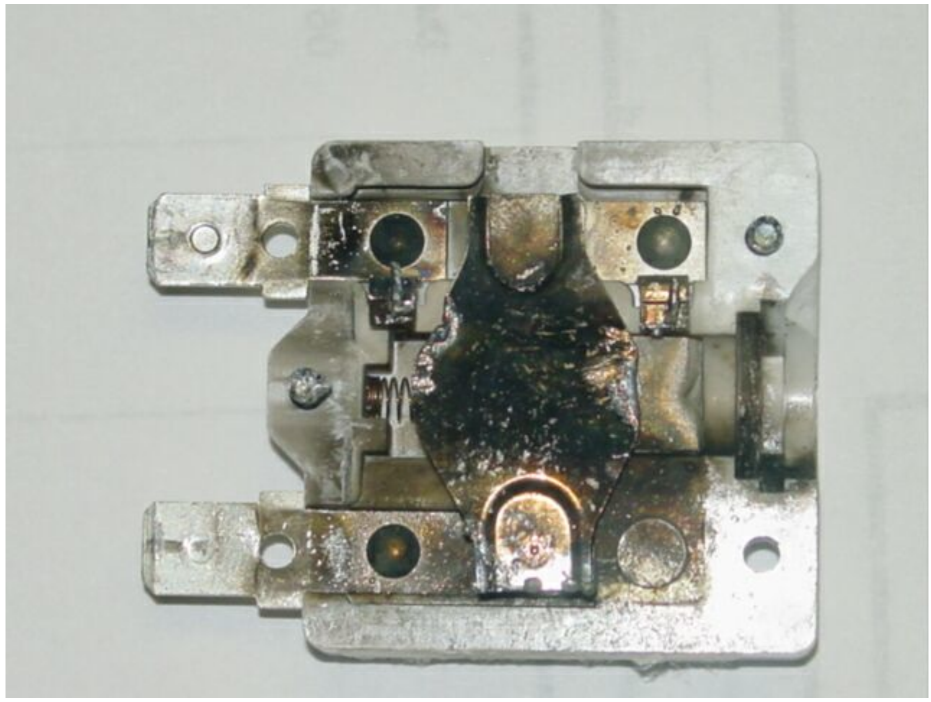
Power is energy per unit time. Since the potential V is the energy/charge and the current is the charge/time, the power used by a circuit is

$$P = IV$$

An electric drill connected to a household 120 V source draws 2 A of current.
The power being supplied to the drill bit is $120V \times 2\ A = 240\ W$.

If Ohm's law holds, then V = IR and

$$P = I^2R$$



This is the power lost, usually to thermal energy.
It heats your toast and limits the energy lost by transporting energy over long distances by keeping the current small.

Fuses or circuit breakers use this heating to prevent circuits from drawing too much current for the wiring. If too big a current travels through the device, a metal melts from heating inside the fuse, breaking the circuit.