Energy & power

Know the difference between energy and power. (Too many people don't!)

Energy E is a quantity that indicates the ability or capacity to do work.

- gravitational
- mechanical
- thermal
- electrical
- chemical

Energy is perfectly conserved.
It can change forms, but the total energy will always be conserved.

- joules (J) = $kg \cdot m^{-2} \cdot s^{-2}$
- calorie = 4.184 J
- erg = 10^{-7} J
- BTU = 1055.056 J (British Thermal Unit)

Power is the rate at which energy is used (converted).

$$P = \frac{dE}{dt} \qquad\qquad \Delta E = \int P dt$$

- watt (W) = J/s
- horsepower (hp) = 746 W
- BTU/hr
- “ton” = 12,000 BTU/hr (refrigeration)

Power is related to energy in the same way the speed is related to distance.

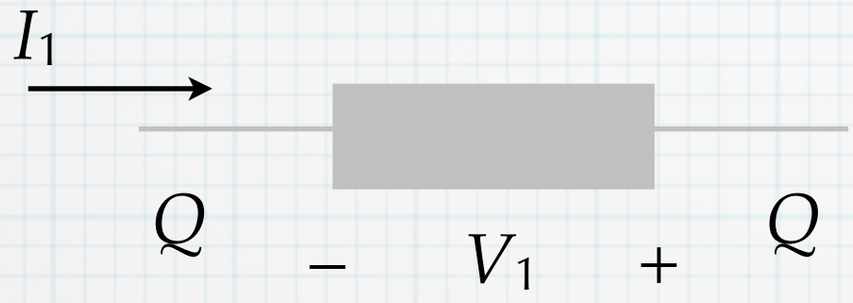
Don’t confuse them!

Another unit of energy: kilowatt-hour (kW-hr) = 3.6×10^6 J

Electrical energy is described in terms of voltage

$$E = QV$$

Electrical power



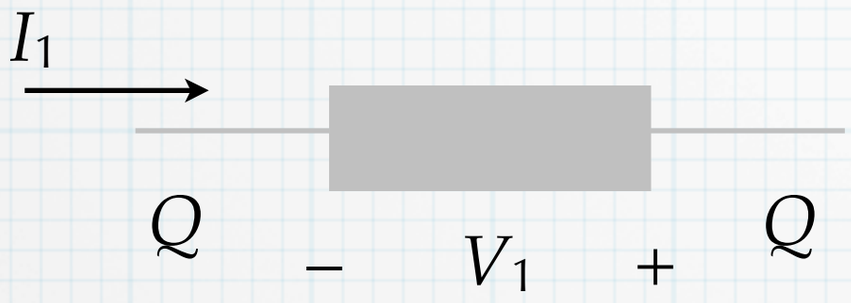
Current flows through a device with a voltage difference across it.

The charge has gained energy: $E = QV_1$

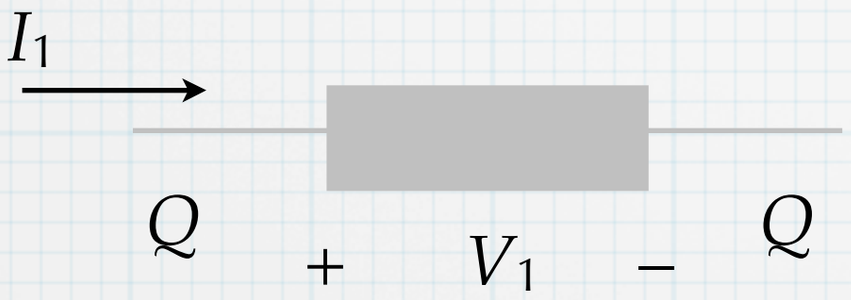
Take the time rate-of-change:

$$\frac{dE}{dt} = \frac{dQ}{dt}V_1 \qquad P = I_1 V_1 \qquad P = V \cdot I$$

Polarities and directions matter – components can add or remove energy from the charge flowing through



Energy is being added (charge goes to higher voltage as it moves through). This is a *source* of electrical energy. (e.g. battery)



Energy is removed (charge goes to lower voltage as it moves through). This component dissipates electrical energy (e.g. resistor)

Some components are only dissipative: resistors

Others can both source energy and absorb energy – charging a battery