

Current Electricity

A flow of charged particles is called an electric current. This flow stops when there is an open circuit or when there is no potential difference.

Electric current is generated by batteries (chemical energy to electrical energy), photovoltaic cells (light energy to elec. energy) or by a generator (kinetic energy to elec. energy).

No conversion from one form of energy to another is perfect. In other words, energy is always lost as heat when energy is transformed.

Current

The electric current is a measure of the amount of flow of electric charge (C) in a second, or

$$1 \text{ A} = 1 \text{ C/s}$$

This is different from power, because power measures the amount of energy per second, or

$$P = E/t$$

As a result, electrical power can also be determined by:

$$P = VI$$

Ohm's Law

As you have discovered, there is a direct relation between the amount of current through a circuit and the corresponding voltage. This relation is:

$$V = IR$$

Resistors are devices which obstruct the flow of electricity or current through the device.

In summary, you can change the current in a circuit by two different ways, change the voltage, or change the resistance.

Power & Energy

We have seen that power is the energy per unit time produced by a form of energy. We can then change the formula for power to:

$$P = I^2R$$

And since power is the energy per unit time, we can find the electric energy produced in a resistor through:

$$E = I^2Rt$$

Kilowatt Hours

Electric companies charge you on the amount of energy used. They do this by charging you by the amount of energy used (kW) in one hour (h).

$$1 \text{ kWh} = 1000 \text{ J/s (3600 s)} = 3.6 \times 10^6 \text{ J}$$

Energy Loss

One problem experienced by power companies is "Joule heating", or the thermal energy produced by current running through electrical lines. This results in a loss of power and thermal energy through the electrical lines. What are two ways to solve this problem?

- 1) Reduce resistance - expensive because you have to use a very large wire. Although, when we do this, current increases which heats up the wire too.
- 2) Reduce current, increase voltage - decreases heat produced by line, power remains the same.

Once the electricity reaches your house, do you think the individual plugs are connected in series or in parallel? What is a fuse?

Voltage and Resistance in Series

When batteries are placed in series, the voltage of each battery adds on to the original voltage.

$$V = V_1 + V_2 + V_3 + \dots$$

When resistors are placed in series, the equivalent resistance can be determined by adding the resistance of resistors in series.

$$R = R_1 + R_2 + R_3 + \dots$$

Voltage Dividers

When a battery produces a 9V potential difference, but a device only needs 5V, a voltage divider can be used.

It is possible to put a resistor before the device to reduce some of the voltage.

By doing this, the voltage that reaches the device is less.

The voltage then through the device can be calculated through the following equation:

$$V_{\text{dev}} = V \frac{R_{\text{dev}}}{(R_1 + R_{\text{dev}})}$$

Resistance in Parallel Circuits

When resistors are parallel to one another, the total resistance on the battery is different than with just one resistor.

Total resistance by all the resistors in parallel can be calculated by the following equation:

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$
