Lesson 5
Electric Current and Ohm's Law

How does a police Taser gun work?
Why don't birds on wires get electrocuted?
Why do some plugs have two prongs while others have three?

Electric Current:
The flow of charge, or the movement of charged particles (electrons) along a path.

$$Current = \frac{charge}{time}$$

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

Where
I = current (amperes)
q = charge (C)
t = time (s)

Since current is measured in amperes, then

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

Electron current – flow of negative charges.
Conventional current – flow of positive charges.

Example:
How much charge passes through a light bulb that draws about 6.0×10^{-2} A of current in 8.0 hours?

To measure electric current we use a device called an ammeter.

Recall:

Electric potential difference = voltage

$V = \frac{E}{q}$ 1 volt = 1 J/C

An electric charge has a certain amount of electric potential energy because of the electric field set up by the power supply in a circuit. Work is done by the power supply to increase the electric potential energy of each Coulomb of charge from a low to a high value. As the charge flows through the load its energy decreases.

Example:
What is the energy of a proton accelerated through a potential difference of 500.0 kV?

Potential difference or voltage is measured using a voltmeter.

Recall:

$I = \frac{q}{t}$ *and* $V = \frac{E}{q}$

$q = It$ $\quad\quad$ $E = Vq$

So,

$E = Vq$

$E = V(It)$

or,

$E = VIt$

Example:
A current of 10.0 A flows through the element of an electric kettle for 2.5 min. The kettle is plugged into a 120 V outlet. Assuming that all electrical energy is transformed into heat, how much heat energy is absorbed by the water?

Example:
A current of 2.5 A flows for 5.0 s through a conductor. Calculate the number of electrons that pass through a point in the conductor in this time?

Summary:

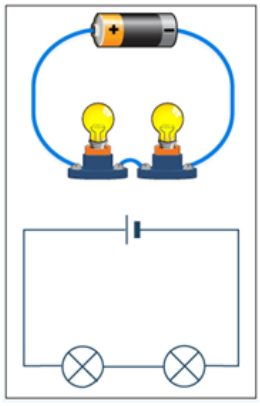
1. Electric current is the flow of charge.
2. Voltage is the electric potential energy for each Coulomb of charge in a circuit. A greater voltage causes a greater electric current flow.

The energy delivered to a circuit load depends on the voltage and the current.

Energy Transfer in a circuit:

An electric circuit typically consists of a voltage source that supplies the energy and a load that draws energy from the source (eg. a bulb).

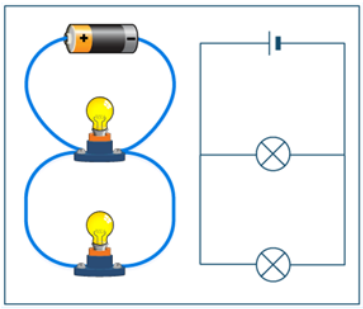
Series Circuit:



In a series circuit:

- Energy from the source is given to everything in its path.
- Electrons are given electric potential energy in the source.
- As the electrons travel through the circuit, most of their energy is given to the light bulb in the form of heat and light.
- Small amounts of energy are lost due to heating in the wires and sound vibration. Some energy is lost in the source itself.

Parallel Circuit: (more on this later)



For both types of circuits we refer to a voltage "rise" across the source and a voltage "drop" across the circuit elements using the energy.

The electrical energy supplied to electric circuits can come from many sources (see handout and p. 598).

- Voltaic cell (a cell used to convert chemical energy into electrical energy)
- Piezo-electricity (mechanical force is used to produce electrical energy)
- Thermoelectricity (thermal energy is transferred to electric potential energy by means of a thermocouple)
- Photoelectricity (light energy is transferred to electrical energy)
- Generators (mechanical energy of rotation converted to electrical energy through electromagnetic induction – more on this next section)