Fundamentals of Electricity

- Electrical charge can be positive or negative.
    - Opposite charges attract each other
- Electrical current is the flow of *electrons*.
    - Electrons are negatively-charged atomic particles, usually surrounding an atom's positively-charged nucleus of protons (positive) and neutrons (neutral – no charge)
    - Electrons move in response to an *electromotive force* and can move independently of atoms
- Current: the movement of electrons, measured in *amperes* (A) by an *ammeter*, and represented by *I* in formulas
- Voltage: the amount of electromotive force (emf), also called *electrical potential*, measured in *volts* (V) by a *voltmeter,* represented by *E* or *V* in formulas
- Resistance: the opposition to the movement of electrons, measured in *ohms* (Ω) by an *ohmmeter* and represented by R in formulas.
- Resistance is like friction and turns electrical energy into heat when current flows.
- *Conductors* permit current flow (low resistance) and *insulators* block current flow (high resistance).

Current that flows in only one direction, is called direct current (dc).

Batteries are a common source of dc.

Current that flows in one direction then in the opposite direction is called alternating current (ac).

- Household current is ac

AC current reverses direction on a regular basis

Each process of reversing is a cycle.

The number of cycles per second is frequency, measured in hertz (Hz).

1 Hz = 1 cycle per second

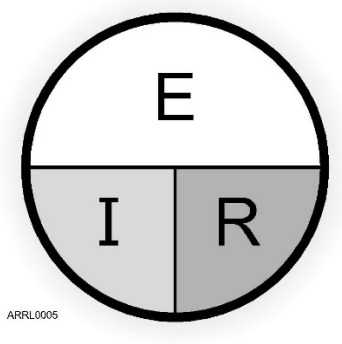
- For current to flow, there must be a path from one side of the energy source to the other side of the source – this path is called a *circuit*.
    - There must be a pipe (conductive path) through which the water (current) can flow.
- There are two types of electric circuits.
- Series circuits provide one and only one path for current flow.
- Parallel circuits provide multiple paths for current flow.

- Ohm’s Law
    - E represents voltage Units – volts (V)
- I represents current
    - Units – amperes (A)
- R represents resistance
    - Units – ohms (Ω)

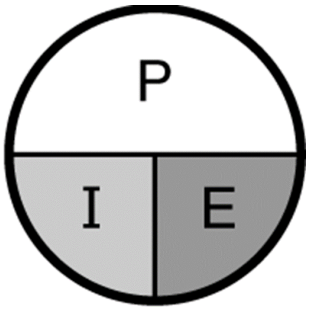
R = E / I

I = E / R

E = I x R



- Any time energy is expended, power is consumed.
- Electrons moving through resistance expend electrical energy and consume power.
- Power is the rate at which energy is consumed.
- Power is measured in units of watts (W).



P = I x E

I = P / E

E = P / R

Electrical Units and Their Namesakes

Unit	*Measures*	*Named for*
Ampere	Current	Andree Marie Ampere (1775 – 1836)
Coulomb	Charge	Charles Augustin Coulomb (1736 – 1806)
Farad	Capacitance	Michael Faraday (1791 – 1867)
Henry	Inductance	Joseph Henry (1797 – 1878)
Hertz	Frequency	Heinrich Hertz (1857 – 1894)
Ohm	Resistance	George Simon Ohm (1787 – 1854)
Watt	Power	James Watt (1736 – 1819)
Volt	Voltage	Alessandro Giuseppe Antonio Anastasio Volta (1745 – 1827)

Table 2-1
International System of Units (SI)—Metric Units

Prefix	*Symbol*	*Multiplication Factor*
Tera	T	$10^{12} = 1{,}000{,}000{,}000{,}000$
Giga	G	$10^{9} = 1{,}000{,}000{,}000$
Mega	M	$10^{6} = 1{,}000{,}000$
Kilo	k	$10^{3} = 1000$
Hecto	h	$10^{2} = 100$
Deca	da	$10^{1} = 10$
Deci	d	$10^{-1} = 0.1$
Centi	c	$10^{-2} = 0.01$
Milli	m	$10^{-3} = 0.001$
Micro	μ	$10^{-6} = 0.000001$
Nano	n	$10^{-9} = 0.000000001$
Pico	p	$10^{-12} = 0.000000000001$