Basic Electrical

PRESENTED BY

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Objectives

- Define basic components of electricity
- Recognize the 3 electrical classifications of materials
- Compare and contrast AC vs. DC
- Use Ohm’s law and Watt’s law to express the relationship between current, voltage, and resistance

Electricity can be broken down into:

- Electric Charge
- Voltage
- Current
- Resistance

Negative & Positive Charges

- What do the effects of electricity in TV, radio, a battery, and lightening all have in common?

- Basic particles of electric charge with opposite polarities.

Electrons

- The smallest amount of electrical charge having the quality called negative polarity.

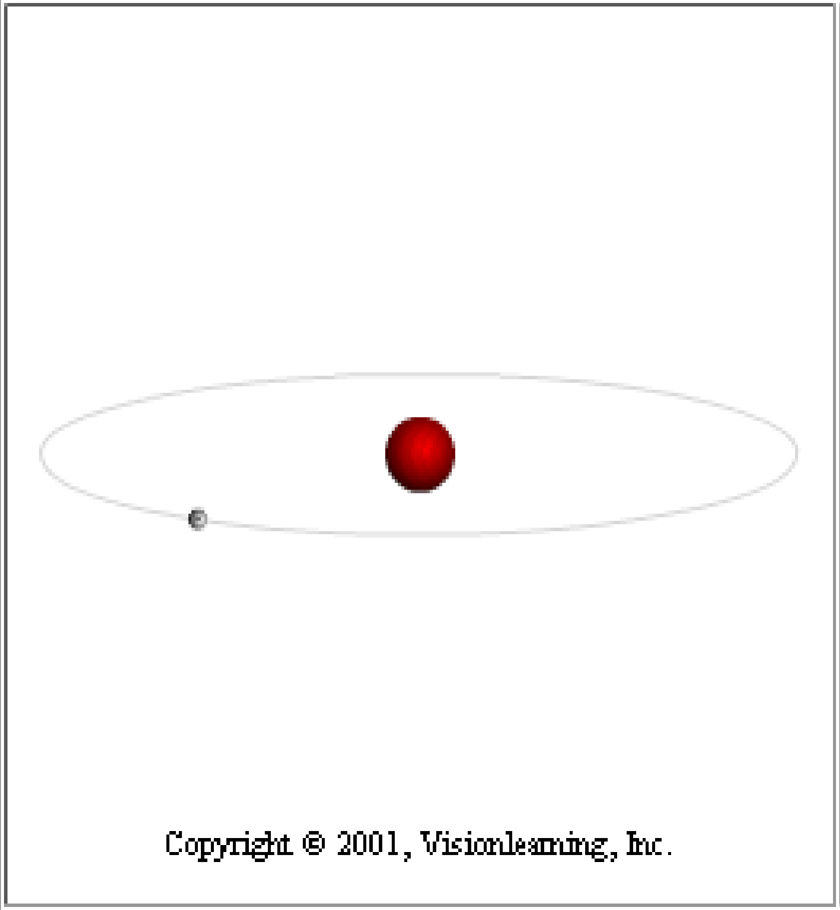
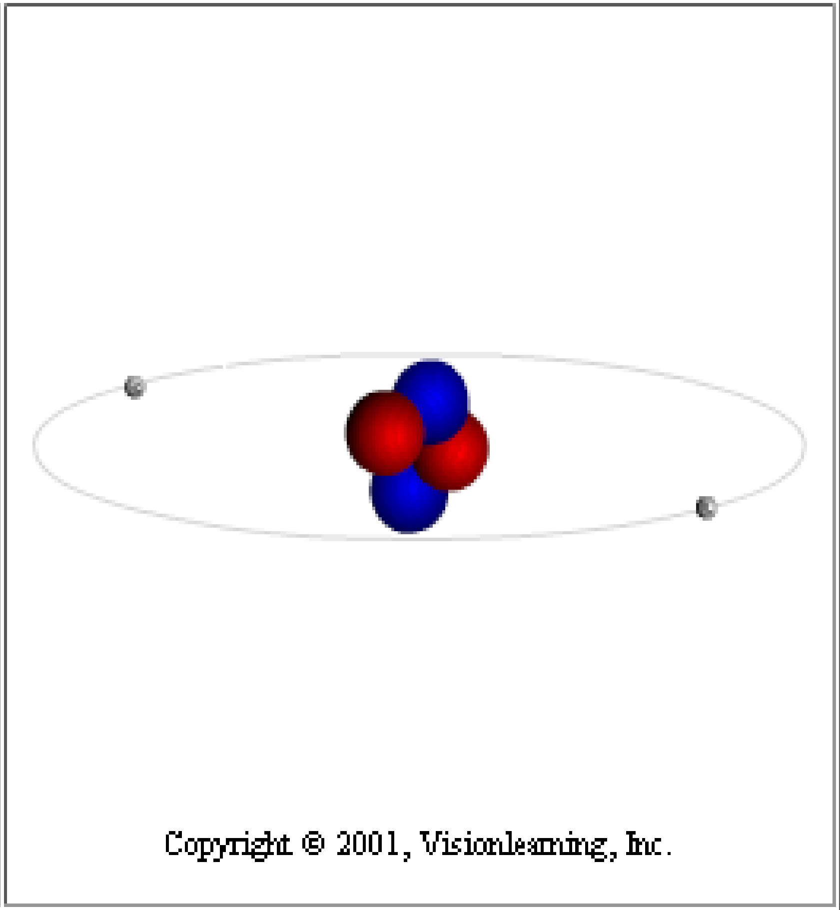
- Electrons orbit is around the center of atoms.

Protons

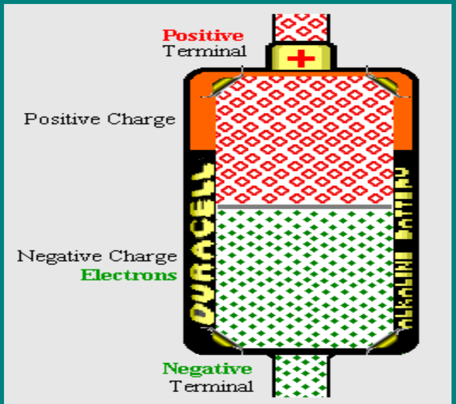
- The proton is a basic particle with positive polarity.
- Protons are located in the nucleus of atoms along with neutrons, particles which have neutral polarity.

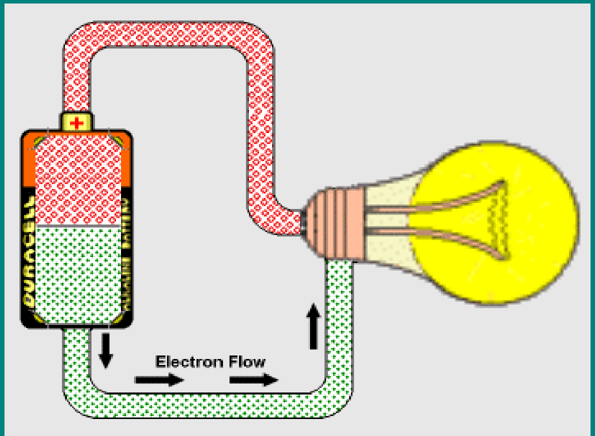
Illustration of the Atomic Structures of Hydrogen and Helium

Key: **electrons** ( ), **protons** ( ) and **neutrons** ( )

	
Hydrogen z = 1, mass = 1	**Helium** z = 2, mass = 4

- Surplus of electrons is called a negative charge (-). A shortage of electrons is called a positive charge (+).
- A battery provides a surplus of electrons by chemical reaction.
- By connecting a conductor from the positive terminal to negative terminal electrons will flow.





Electrically, all materials fall into 1 of 3 classifications:

- Conductors
- Insulators
- Semi-Conductors

Conductors

- Have 1 valence electron
- Materials in which electrons can move freely from atom to atom are called conductors.
- In general all metals are good conductors.
- The purpose of conductors is to allow electrical current to flow with minimum resistance.

Insulators

- Have 8 valence electrons
- Materials in which electrons tend to stay put and do not flow easily from atom to atom are termed insulators.
- Insulators are used to prevent the flow of electricity.
- Insulating materials such as glass, rubber, or plastic are also called **dielectrics**, meaning they can store charges.
- Dielectric materials are used in components like capacitors which must store electric charges.

Semi-Conductors

- Have 4 valence electrons
- Materials which are neither conductors nor insulators
- Common semi conductor materials are carbon, germanium and silicone.
- Used in components like transistors

The Symbol for Charge

- The symbol for charge is Q which stands for quantity.
- The practical unit of charge is called the coulomb (C).
- One coulomb is equal to the amount of charge of 6.25×10^{18} electrons or protons stored in a dielectric.

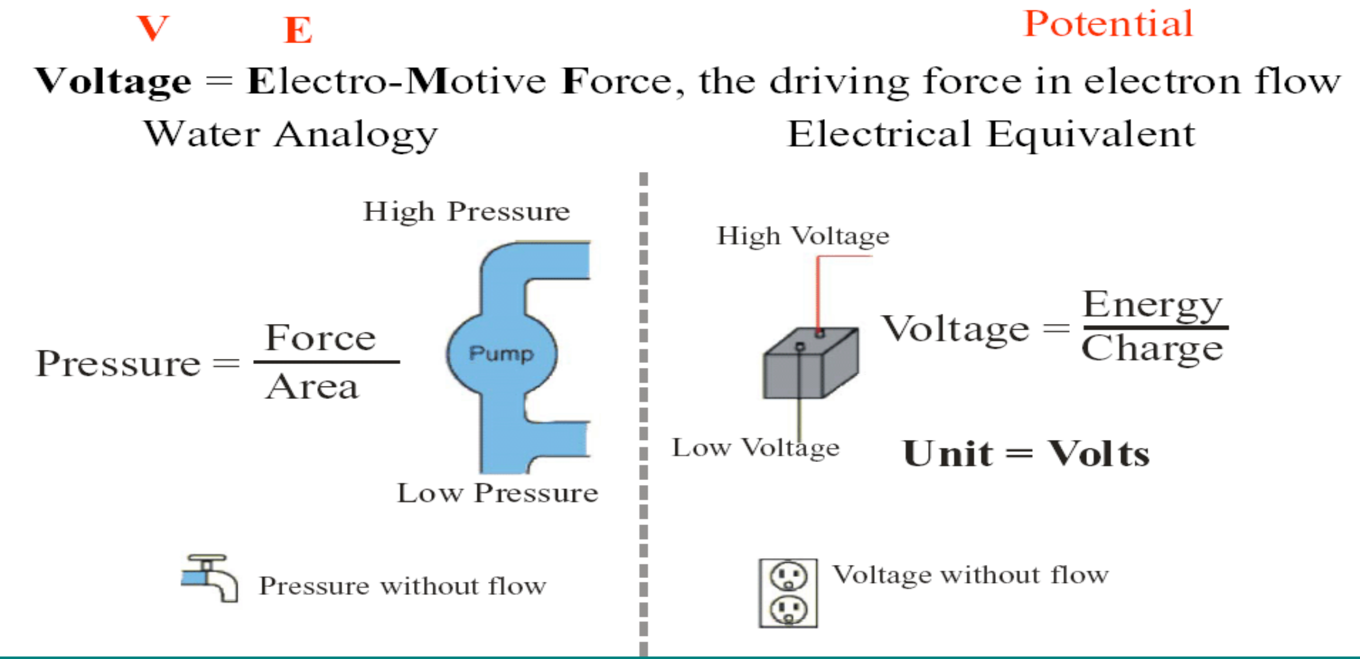
Voltage

- Potential refers to the the possibility of doing work.
- Any charge has the potential to do the work of attracting a similar charge or repulsing an opposite charge.
- The symbol for potential difference is E (for electromotive force)
- The practical unit of potential difference is the volt (V)
- 1 volt is a measure of the amount of work required to move 1C of charge

Voltage

- A battery positive terminal (+) and a negative terminal (-). The difference in charge between each terminal is the potential energy the battery can provide. This is labeled in units of volts.

Water Analogy

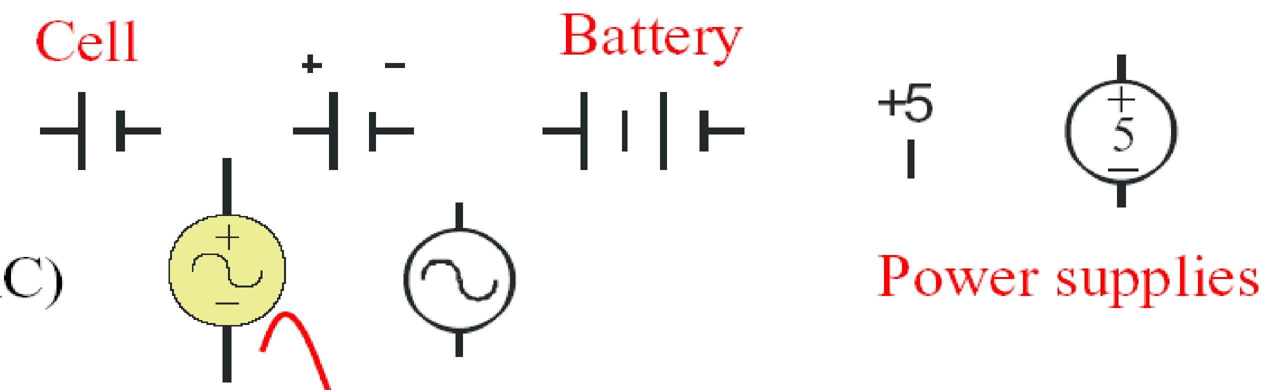


Voltage Sources:

Symbols

UniPolar

BiPolar (AC)



Properties

Constant Voltage, independent of the amount of current

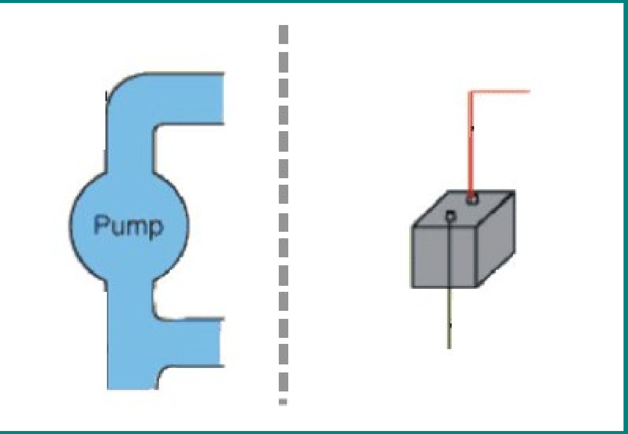
Usually ideal

Examples

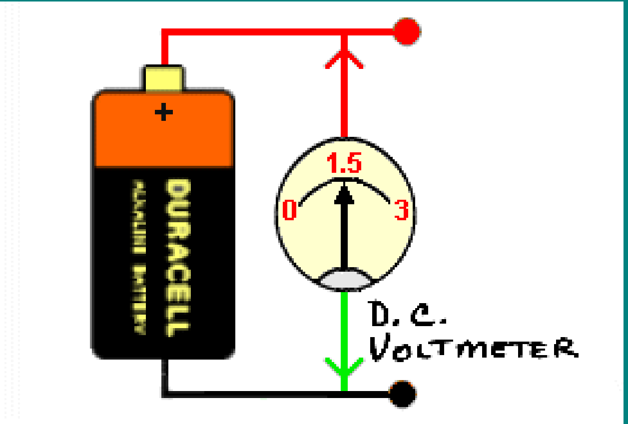
Batteries

Power Supplies

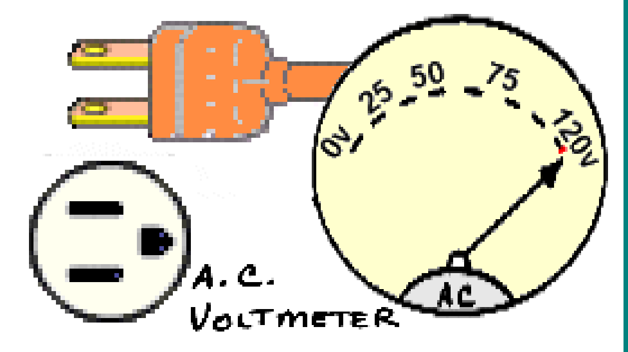
Signal Generators



- Voltage is like differential pressure, always measure between two points.
- Measure voltage between two points or across a component in a circuit.



- When measuring DC voltage make sure polarity of meter is correct ,positive (+) red, negative (-) black.

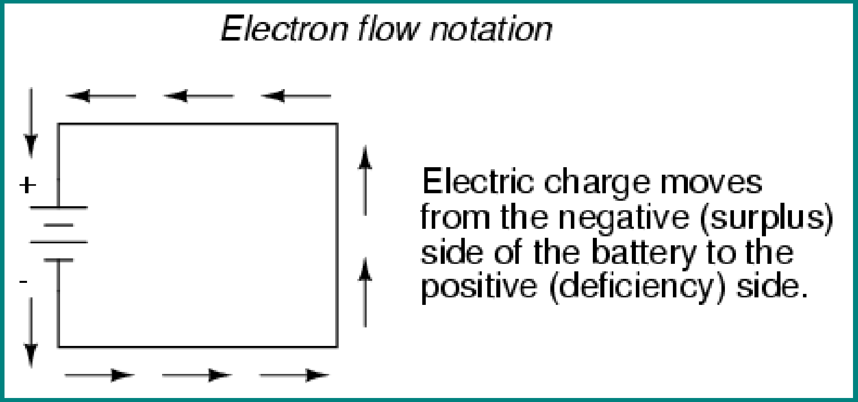


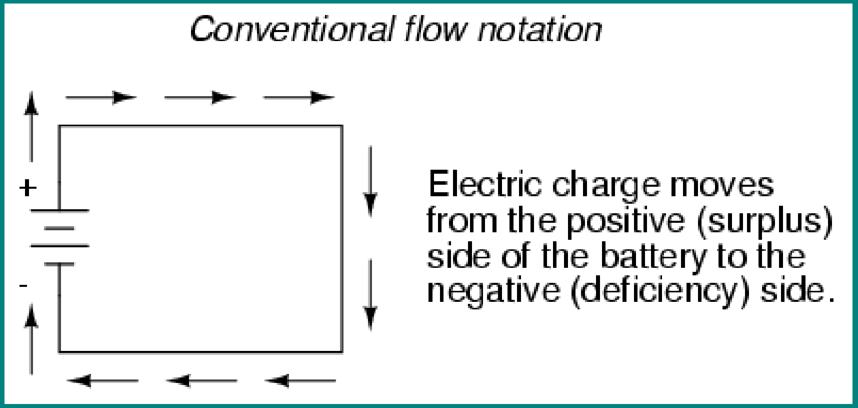
Current

- When a charge is forced to move because of a potential difference (voltage) current is produced.
- In conductors - free electrons can be forced to move with relative ease, since they require little work to be moved.
- So current is charge in motion.
- The more electrons in motion the greater the current.

Current

Uniform flow of electrons thru a circuit is called *current*.

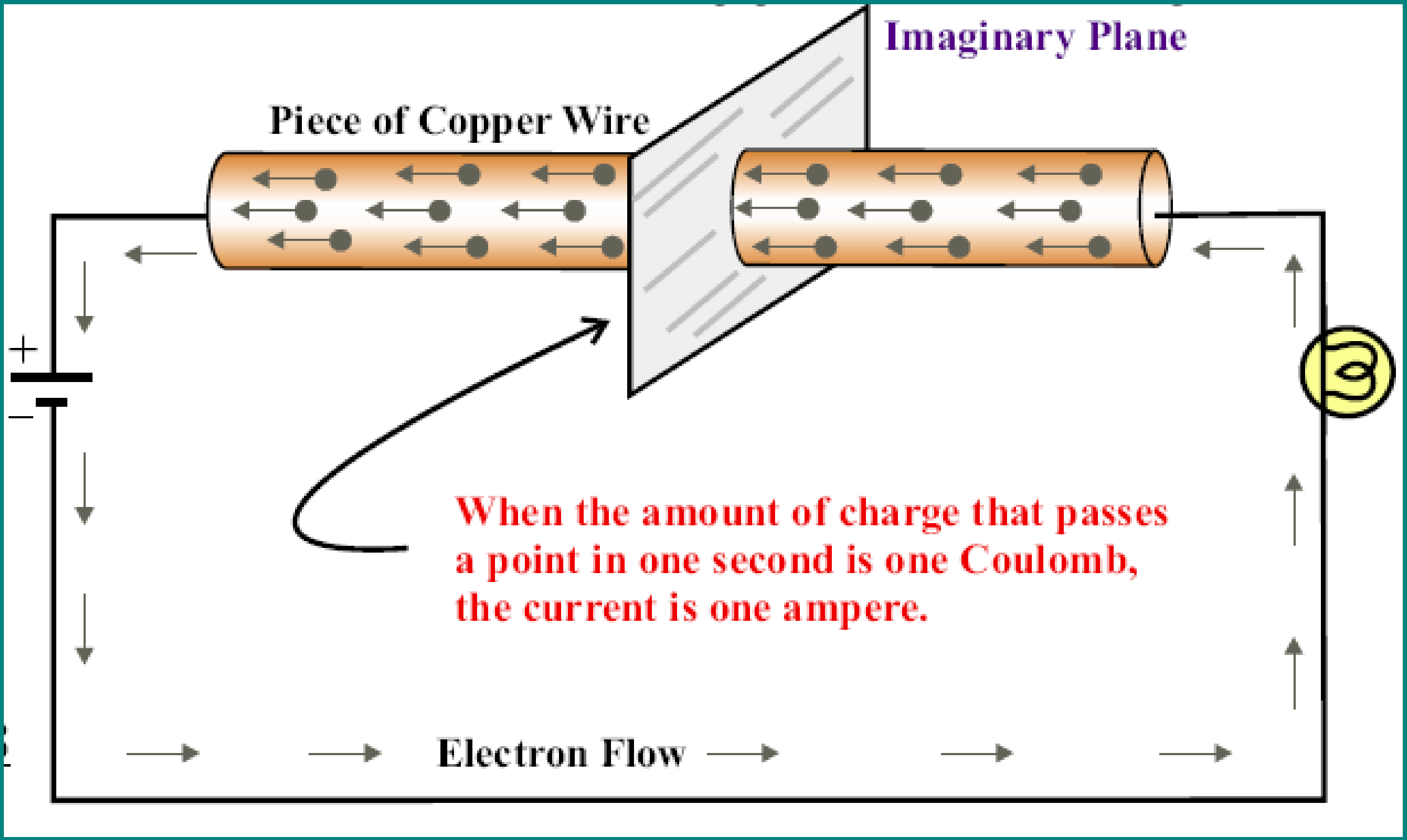




Amperes

- Current indicates the intensity of the electricity in motion. The symbol for current is I (for intensity) and is measured in **amperes.**
- The definition of current is: $I = Q/T$
- Where I is current in amperes, Q is charge in coulombs, and T is time in seconds.

1 ampere = 1 coulomb per second



Resistance

- Opposition to the flow of current is termed resistance.
- The fact that a wire can become hot from the flow of current is evidence of resistance.
- Conductors have very little resistance.
- Insulators have large amounts of resistance.

relation

- $R = \rho L/A$

- Where R= resistance of conductor
- L = Length of conductor
- A= cross sectional area of
- conductor
- **ρ= resistivity** of conductor

Ohms

- The practical unit of resistance is the **ohm** designated by the Greek letter omega: Ω

- A resistor is an electronic /electrical component designed specifically to provide resistance.

Closed Circuits

- In applications requiring the use of current, electrical components are arranged in the form of a circuit.
- A circuit is defined as a path for current flow.

Open Circuits

An Open Circuit

Current can only exist where there is a conductive path (e.g. A length of wire). In the circuit shown in Figure 4- 6, I= 0 since there is no conductor between points a & b. We referred to this is an *open circuit*.

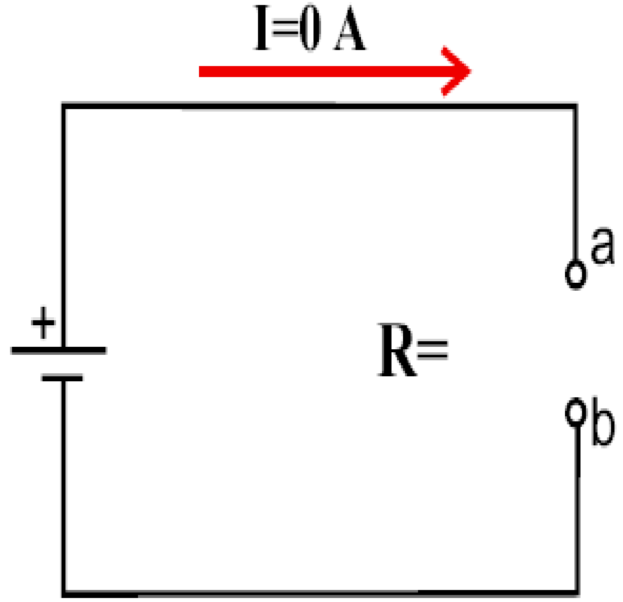


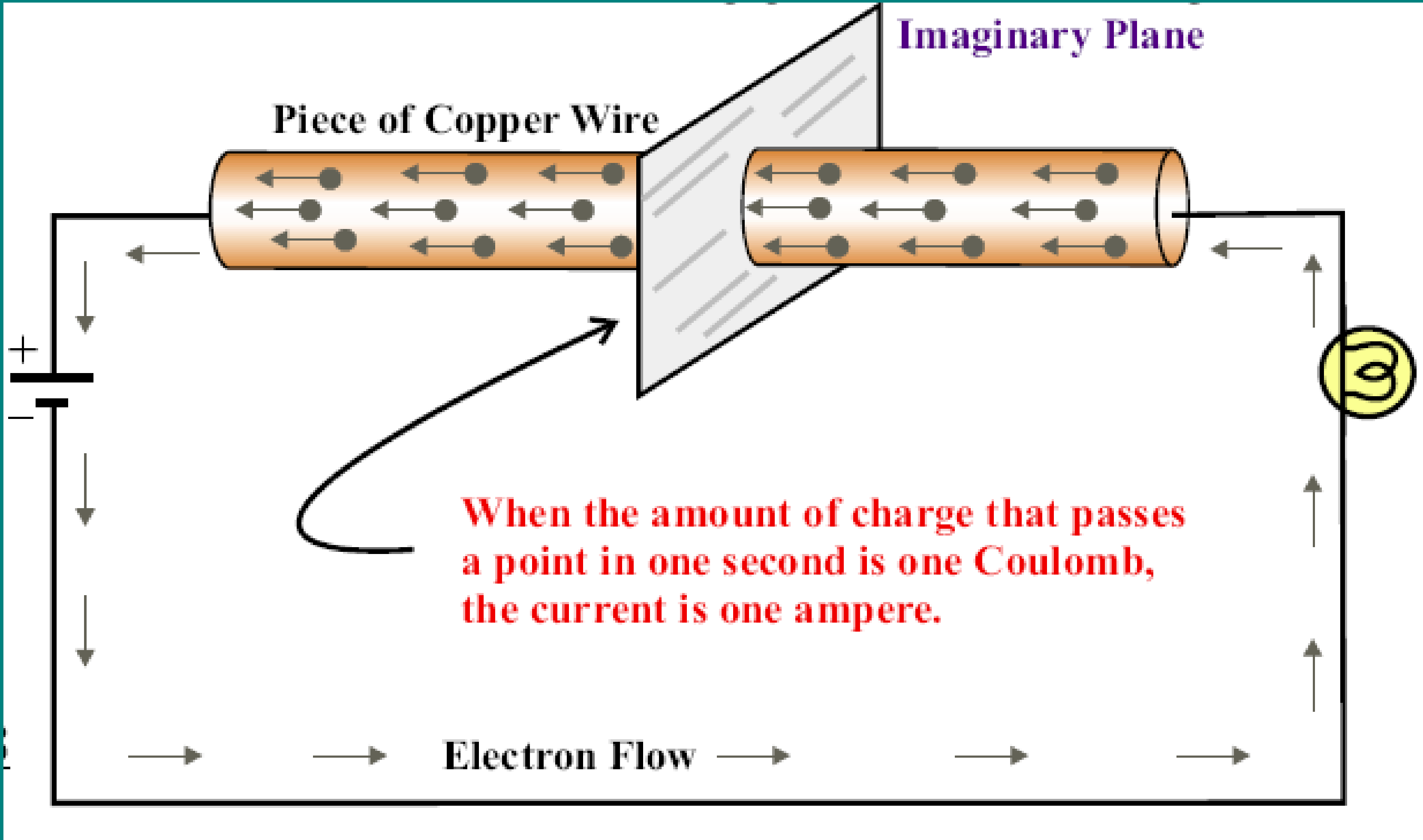
Fig 4-6 An open circuit has infinite resistance

Direction of Electron Flow

- The direction of electron flow in our circuit is from the negative side of the battery, through the load resistance, back to the positive side of the battery.

- Inside the battery, electrons move to the negative terminal due to chemical action, maintaining the potential across the leads.

Electron Flow in a Simple Circuit

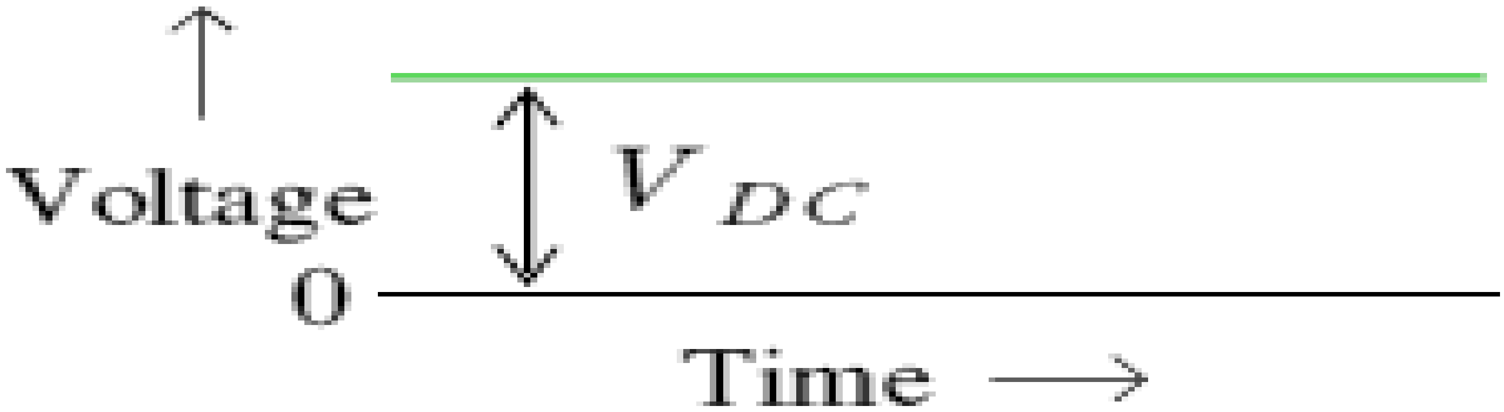


DC

- Circuits that are powered by battery sources are termed **direct current** circuits.

- This is because the battery maintains the same polarity of output voltage. The plus and minus sides remain constant.

Waveform of DC Voltage



4.1a Steady Voltage

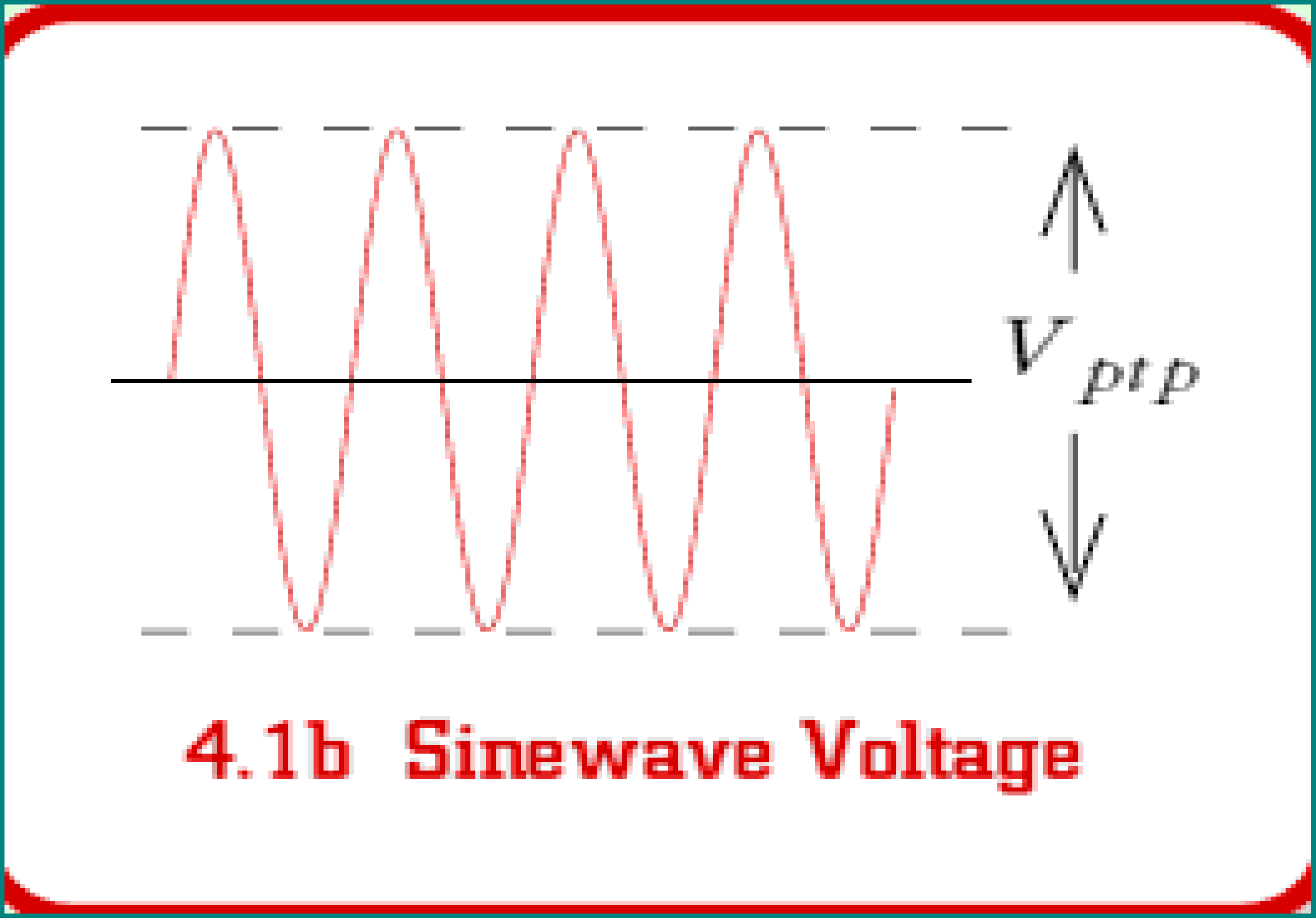
Characteristics of DC

- It is the flow of charges in just one direction and...
- The fixed polarity of the applied voltage which are characteristics of DC circuits

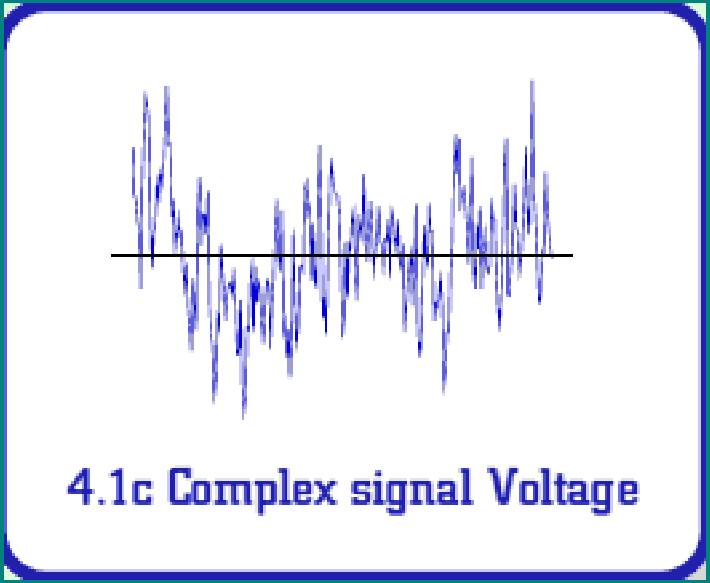
AC

- An alternating voltage source periodically alternates or reverses in polarity.
- The resulting current, therefore, periodically reverses in direction.
- The power outlet in your home is 50 cycle ac - meaning the voltage polarity and current direction go through 50 cycles of reversal per second.
- All audio signals are AC also.

Waveform of AC Voltage



Complex Voltage



This is a more realistic view of what an audio signal's voltage would look like

Comparison of DC & AC

DC Voltage	AC Voltage
Fixed polarity	Reverses polarity
Can be steady or vary in magnitude	Varies in magnitude between reversals in polarity
Steady value cannot be stepped up or down by a transformer	Used for electrical power distribution
Easier to measure	Easier to amplify

Heating Effects the same for both AC and DC current

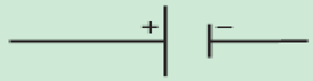
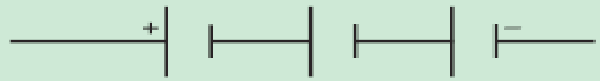
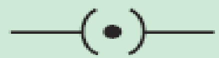
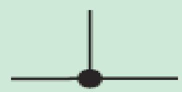
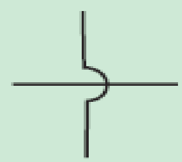
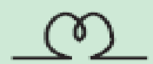
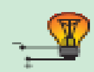
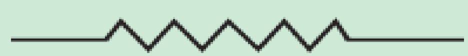
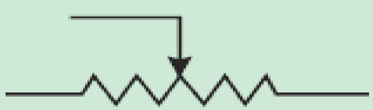
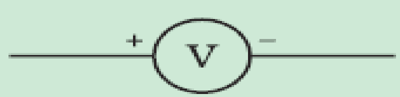
Many Circuits Include both AC & DC Voltages

- DC circuits are usually simpler than AC circuits.
- However, the principles of DC circuits also apply to AC circuits.

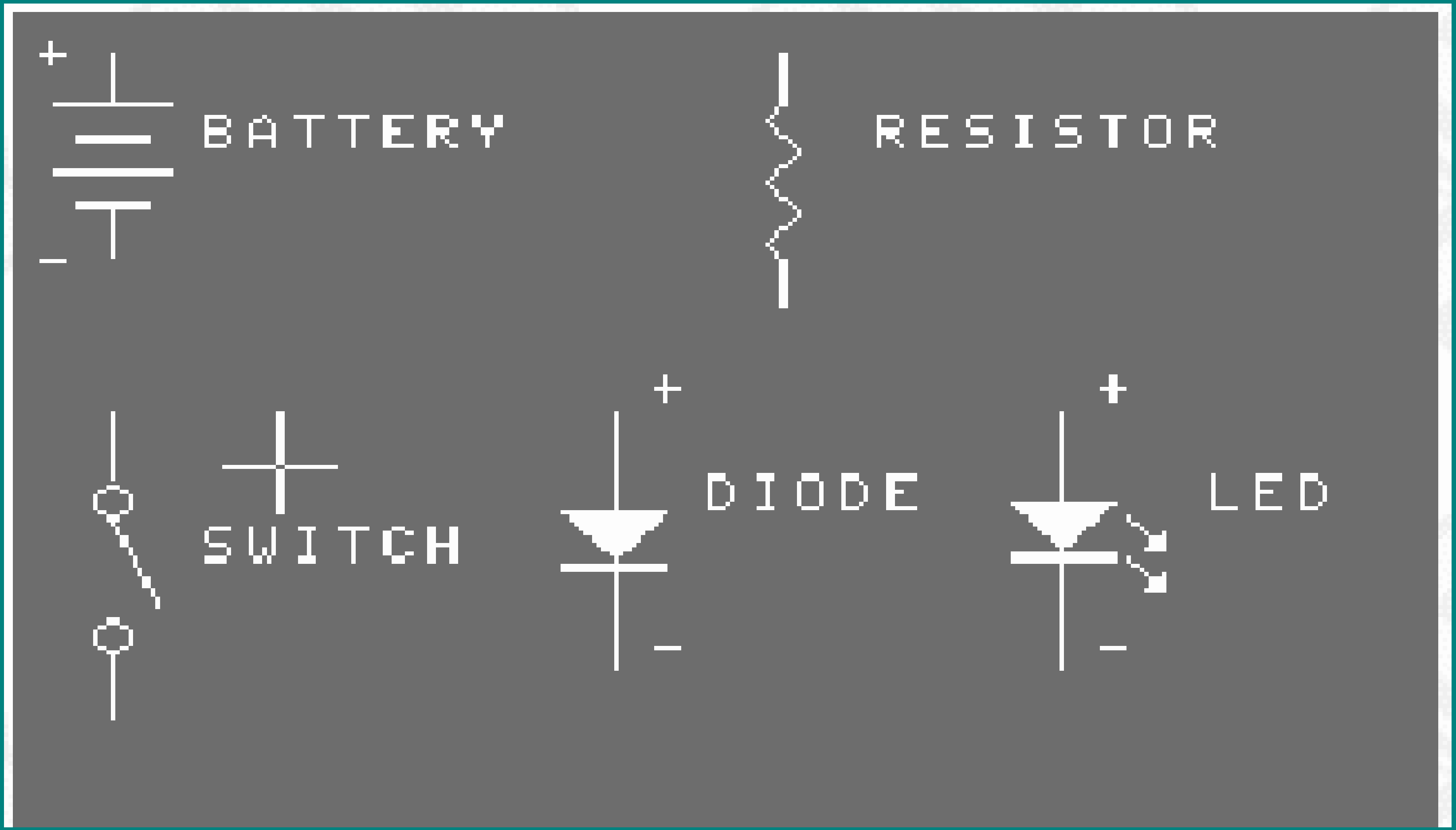
Impedance

- Impedance is resistance to current flow in AC circuits and its symbol is [illegible].
- Impedance is also measured in ohms.

Table 12.2 Symbols of some commonly used components in circuit diagrams

Sl. No.	Components	Symbols
1	An electric cell	
2	A battery or a combination of cells	
3	Plug key or switch (open)	
4	Plug key or switch (closed)	
5	A wire joint	
6	Wires crossing without joining	
7	Electric bulb	 or 
8	A resistor of resistance R	
9	Variable resistance or rheostat	 or 
10	Ammeter	
11	Voltmeter	

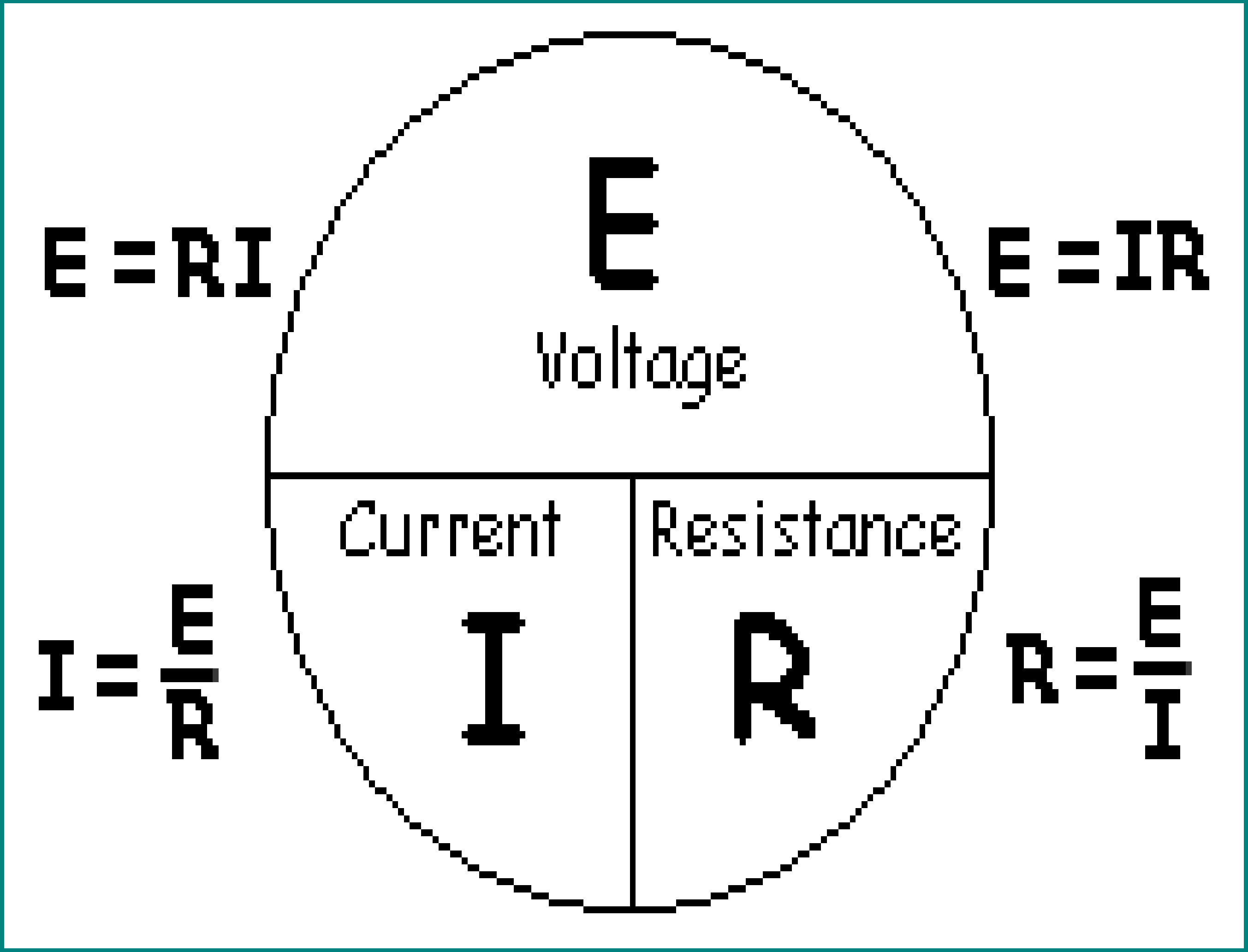
Common Electronic Component Symbols



Ohm's Law

- The amount of current flow(I) between two points in a circuit is directly proportional to the applied voltage (V) between those two points.
- Specifically I = V/R, R= Resistance of the wire
- If you know any two of the factors V, I, and R you can calculate the third.
- Current I = V/R
- Voltage V = IR
- Resistance R = V/I

Ohm's Law



FORMULAE

SI unit

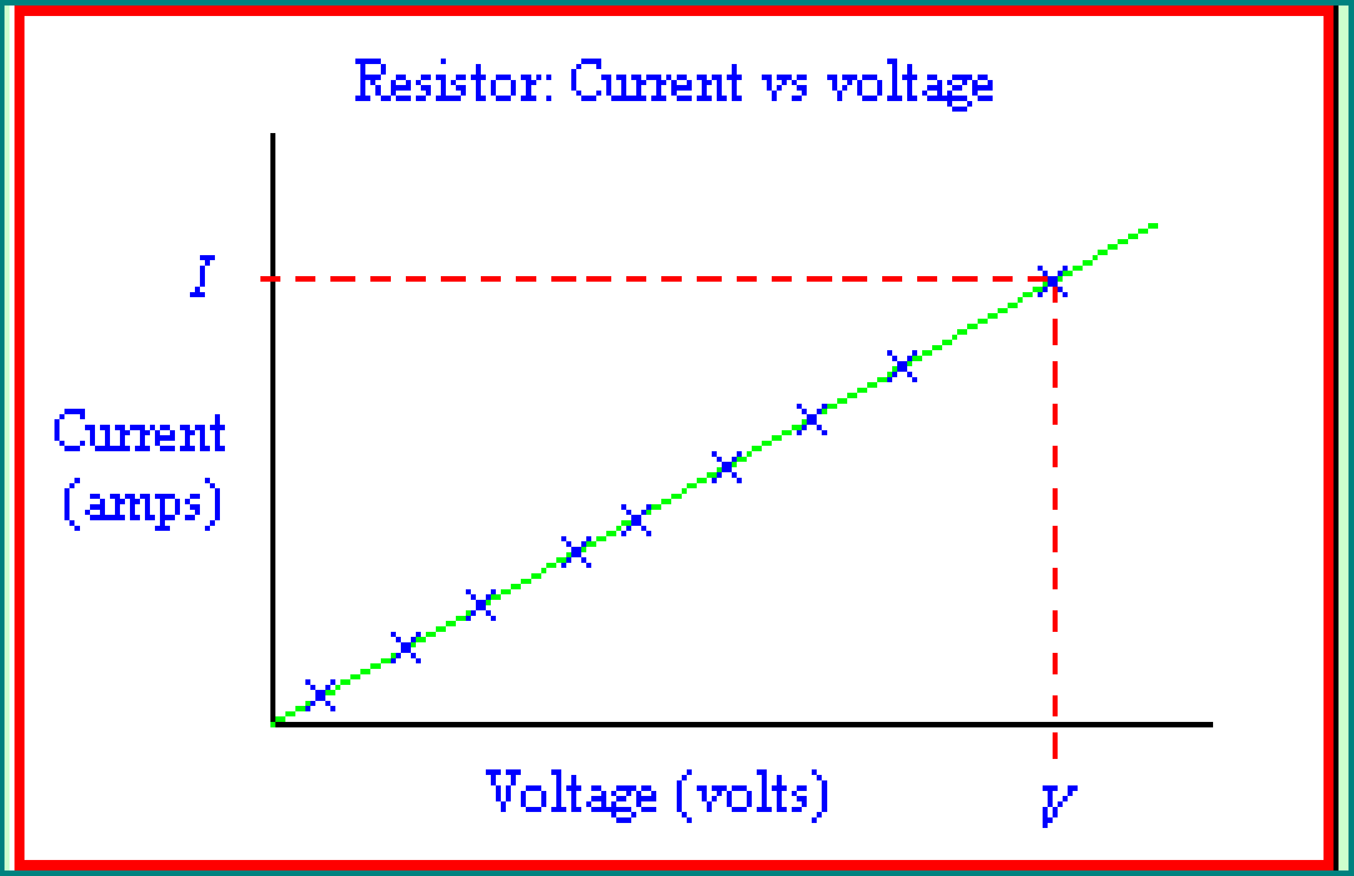
- **I = Q/T Ampere** (Calculation of current)
- **V = W/Q Volt** (Calculation of potential difference)
- **V = IR Volt** (Ohm's law, R resistance)
- R= **ρ** L/A **Ohm** (Calculation of Resistance)
- **ρ = RA/L Ohm metre (**Calculation of resistivity**)**

FORMULAE

- **$R = R_1 + R_2 + R_3$** (Resistance in series) **Ohm**
- **$R = 1/R_1 + 1/R_2 + 1/R_3$** (Resistance in parallel) **Ohm**
- **$H = I^2RT$** (Joules law of heating) **Joule**
- **$P = VI = I^2 R = V^2R$** (Calculation of power) **Watt**
- **$E = P \times t$** (Electric energy)**Watt second (Joule)**

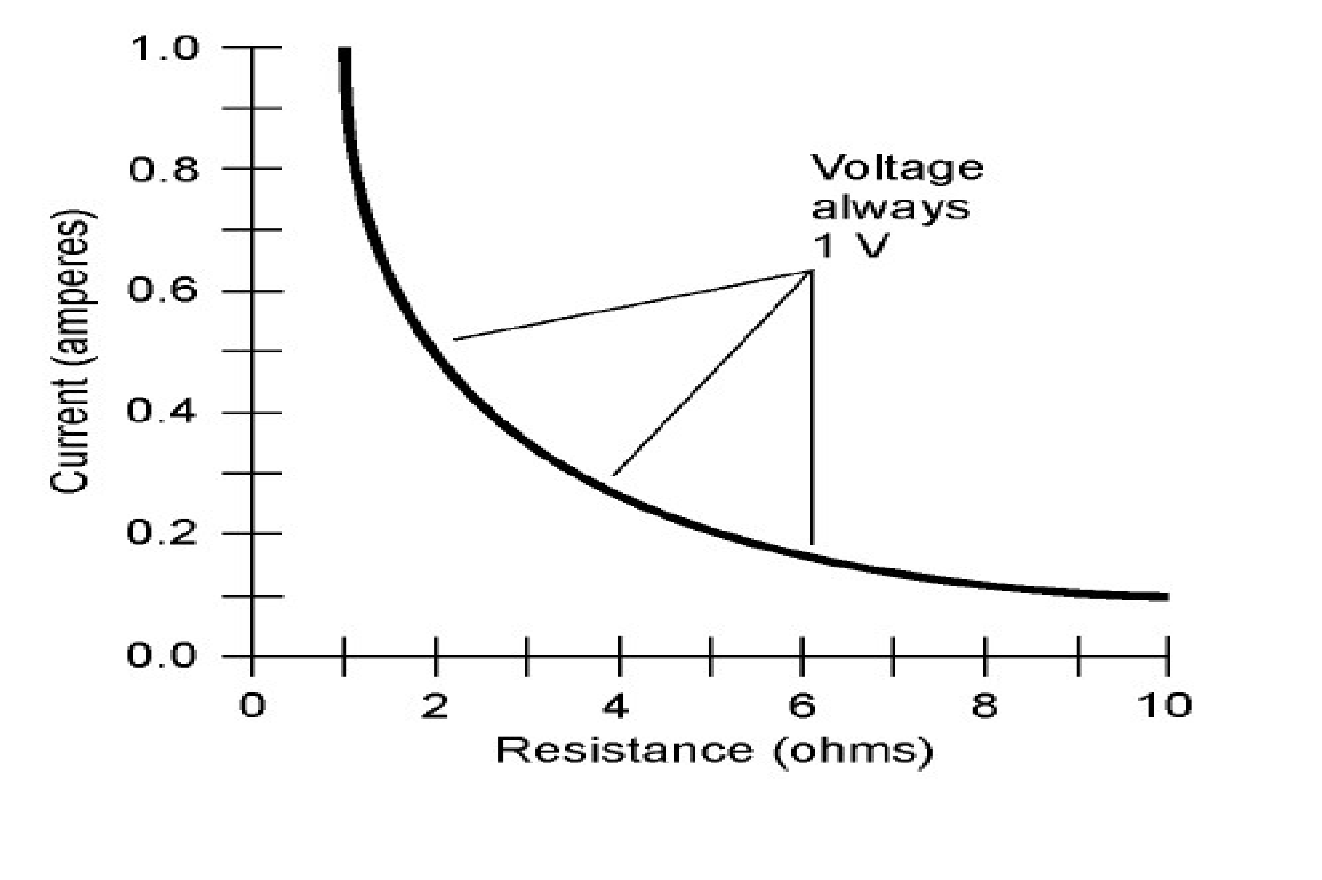
Current is Directly Proportional to Voltage for a Constant Resistance

OHM's LAW



Current is Inversely Proportional to Resistance for a Constant Voltage

OHM's LAW



Power

- The unit of electrical power is the watt.
- Power is how much work is done over time.
- One watt of power is equal to the work done in one second by one volt moving one coulomb of charge. Since one coulomb a second is an ampere:
- Power in watts = volts x amperes
- $P = E \times I$

Conversion Factors

Prefix	Symbol	Relation to basic unit	Examples
Mega	M	1,000,000 or $1x10^{6}$	5MΩ = $5x10^{6}$ Ω
Kilo	k	1,000 or $1x10^{3}$	18kV = $18x10^{3}$ V
Milli	m	.001 or $1x10^{-3}$	48 mA = $48x10^{-3}$A
Micro	˪	.000001 or $1x10^{-6}$	15˪ V = $15x10^{-6}$V

- THANK YOU