Specific Objectives

By the end of this lesson, you should understand;

- ✓ Simple electrical circuits using a source, resistance (load) and path
- ✓ Circuit analysis using Ohm's Law
- ✓ Circuit analysis using the Power Rule

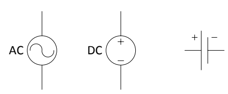
By the end of this lesson, you should be able to;

- ✓ Apply Ohm's Law to analyze simple circuits
- ✓ Manipulate linear equations
- ✓ Solve linear equations

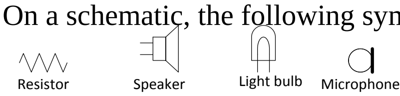
Notes:

Electrical Engineers and technicians model circuits in a schematic which is simply a sketch of the circuit. Think of a schematic as a recipe for building the circuit.
A circuit must have;

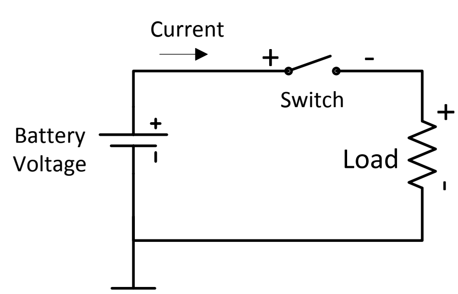
- The **voltage source** that pushes the electrons along. Think of the voltage source as the pump that forces water (current) through a pipe. Voltage is measured in volts and current is measured in amperes or amps. Throughout this program you will use conventional flow of current, which means that the current is always pushed out the positive terminal of the voltage source and into the positive terminal of devices. It is important that the direction of the current flow is indicated.
    - ⇒ On a schematic voltage is represented with the following symbols



- The **load** which consumes power and impedes or resists the flow of electrons. A functioning load requires voltage and current. Often the load is represented with a resistor and is measured in Ohms.
    - ⇒ On a schematic, the following symbols are frequently used.



- **Ground** is required for a circuit to operate. Ground is always at zero voltage, called zero potential. It is not necessary to always show the ground symbol because it is assumed that the ground is on the negative side of the voltage source.
    - ⇒ On a schematic, the ground is represented with the following symbol 
- A **closed path** connected from the voltage source through the load to ground. This path depicts the conductive wire that connects all the components within the circuit.
    - ⇒ Represented with a line on a schematic



The figure to the right is a schematic of a simple electronic circuit.
This circuit consists of;

- a battery voltage source which pushes the current along
- an arrow that indicates the direction of the current
- a switch to complete the electrical path
- a load which provides resistance to the current and consumes energy and produces work. So if the load is a light bulb, the light will illuminate when the flow of electrons starts.
- a ground which is required for a circuit to operate.

The natural physical laws are responsible for the responses within the circuit and we use mathematics to predict how the circuit will behave.

Problem Situation 2.1 – Ohm's Law

We know that in a circuit there is a minimum of voltage, current and resistance. The units are defined in the following table.

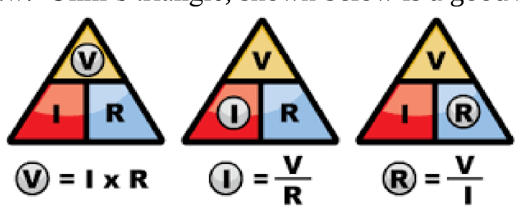
Quantity	Unit Name	Unit Symbol
Electric current (I)	Ampere (amp)	A
Voltage (V, E) Electromotive force (E)	Volt	V, E
Resistance (R)	Ohm	Ω
Electric power (P)	Watt	W

The German physicist Georg Ohm discovered and quantified the relationship between voltage, current and resistance in an electrical circuit.

Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points.

$Voltage = Current * Resistance$ (Quantity)
$Volts = Amperes * Ohms$ (Unit Name)
$V = IR$ (Unit Symbol)

By knowing any two values of the Voltage, Current or Resistance quantities we can use Ohms Law to find the third missing value. Ohms Law is used extensively in electronics. Almost every analysis of a circuit begins with Ohm's Law. Ohm's triangle, shown below is a good memory tool.

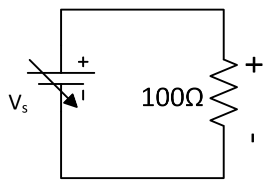


Ohm's Law is a linear equation. A linear equation is an equation for a straight line when plotted on a graph. Each term is a first degree constant or variable. .

1) Suppose you have a car radio that you want to install in your car. This radio is 3 Ω and it is powered from your 12 V car battery. How much current will this radio draw? Sketch the circuit.

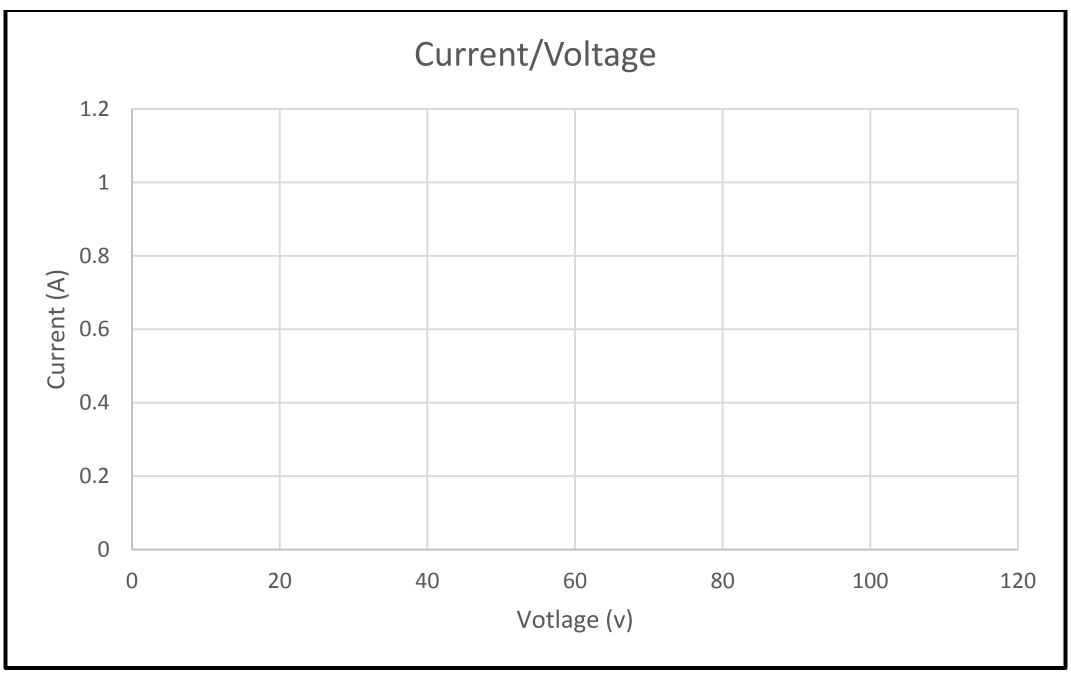
2) Based on Ohm's Law if you were to use a 6 V source with the same radio what would change and how much would it change?

3) For the following circuit; hold the resistance constant at 100 Ω; calculate the current as the voltage changes as indicated in the chart. Use no more than 3 significant digits.



Voltage (v)	Current (A)	Resistance (Ω)
10		100
20		100
30		100
40		100
50		100
60		100
70		100
80		100
90		100
100		100

4) Graph the current and resistance on the following chart.

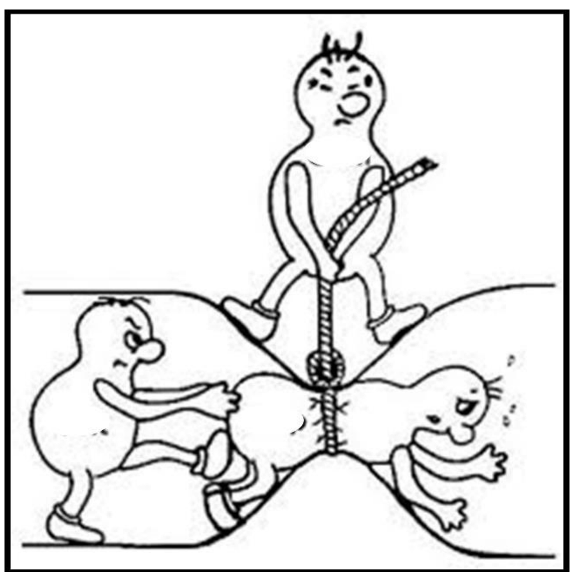


5) What is the shape of the graph?

6) Can you predict what the current would be if you held the voltage constant at 12 V and the resistance is 100Ω? What equation would you use?

7) Can you predict the voltage required if you changed the load to 80Ω that required 1.2 Amps? What equation would you use and what would the required voltage?

8) Can you label which character depicted; Voltage in volts, Current in Amps and Resistance in Ohms.



Problem Situation 2.2 – Power Rule

Every electrical component consumes power. Power is represented with the letter P and is measured in Watts. Often these components consume power to convert electrical energy into heat. Electrical components are physically limited to the amount of power they can consume without burning up. Overloading electrical components destroys the components and can cause fires.

Power Rule

$Power = Current * Voltage$ (Quantity)

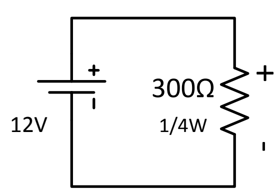
$Watts = Amperes * Volts$ (Unit Name)

$P = IV$ (Unit Symbol)

1) What equation would you use if you wanted to calculate the current and knew the power and the voltage?

2) What equation would you use if you wanted to calculate the voltage and had the power and the current?

3) In the following circuit, the load is 300Ω and has a rating of $^{1}/_{4}$ Watt. 12V is applied to the load.
    a. What current is the load is drawing?



    b. Will this component fail?

c. What would you recommend changing in this circuit?

4) The following chart lists some common household appliances and devices. You need to determine the missing information for a complete analysis.

Device	**Voltage (V)**	**Resistance (Ω)**	**Current (A)**	**Power (W)**
Refrigerator	120			1200
Heater	120	9.6		
TV	120		2.5	
Hair Dryer	120	9		
Phone Charger	120			15
Light bulb	120		1	