# Ohm's Law

## A. OHM'S LAW

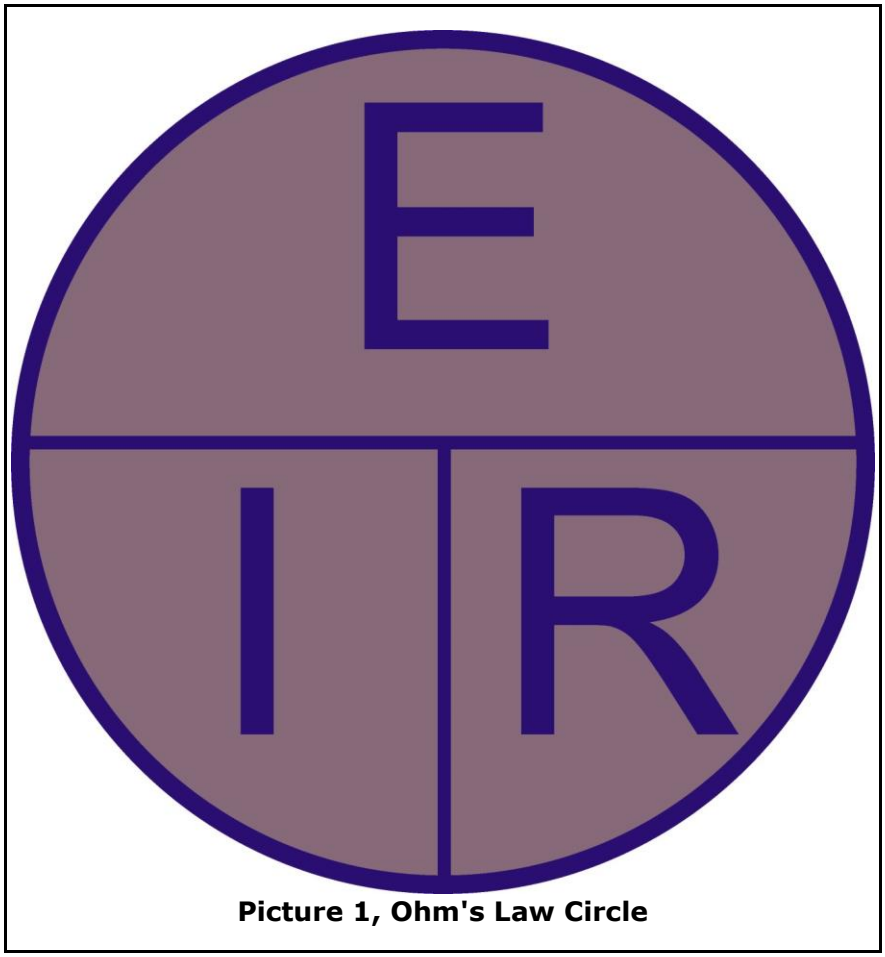
1. A need to express each concept, voltage, resistance, and current, in terms of the others caused George Simon Ohm, (1789-1854), a German physicist, to develop this relationship:

$$\text{resistance (ohms)} = \frac{\text{potential difference (volts)}}{\text{current (amperes)}}$$

2. The resistance (R) of a circuit is directly proportional to the potential difference (E) and inversely proportional to the current (I). Using shorthand symbols, this statement is written as:

$$R = \frac{E}{I}$$

3. A simple way to remember Ohm's Law is by using the Ohms Law circle, shown in the illustration below.




**Picture 1, Ohm's Law Circle**

4. To utilize the Ohm's Law circle, place your thumb over the unknown term in the circuit. The orientations of the uncovered letters will provide the terms and the mathematical operation to be used. The result of this calculation will be the value of the unknown term.

   Example: Suppose, in an electrical circuit, there is a 120 volt battery and a circuit resistance of 30 ohms. Using Ohm's law, what is the expected current flow?

   **Answer:** $I = E/R = 120/30 = 4\,\text{amps}$

   Example: If a battery is needed for a 10 amp load through a resistance of 4 ohms, what must the battery voltage be?

**Answer**: The equation is changed to $E = IR$. Therefore,

$$E = 10 \text{ x } 4 = 40 \text{ volts.}$$

## B. In Review

a. Ohm's law, shows how voltage, current, and resistance interrelate. Thus, by controlling one parameter, one or both of the others can be changed..

b. In review, the electron is the basic component of electricity. The proton and electron have the same charge but opposite polarities. The charge of 6.25 x 1018 electrons equals one coulomb. Charges of the same polarity repel each other. Types of negative charges include electrons and negative ions, atoms which have gained electrons. Types of positive charge include protons and positive ions, atoms missing one or more electrons.

c. All charged particles have an electrostatic field around them. This field is represented by electrostatic field lines. Electrostatic field lines are drawn to always leave a positive charge and always enter a negative charge. The magnitude of this attraction (or repulsion) can be determined by using Coulomb's law.

d. Electricity is based on outer electrons of certain atoms being easily freed. These electrons can be freed in one of six ways: friction, pressure, heat, light, chemical, or magnetic interaction. Free electrons flow to the source, creating a difference of potential (voltage) between the source's terminals. If a material (conductor) which easily releases its outer electrons is connected between terminals, electrons will flow through the conductor from the negative to the positive terminal. This will continue until no difference in potential exists between the two terminals.

e. Electric current is the rate of electron flow in a closed path. A potential difference must exist to produce current. In the external circuit outside

the voltage source, electrons flow from the negative terminal to the positive terminal.

f. In all electrical circuits the electrons must overcome the opposition to electron flow (resistance) which all matter exhibits. Conductors have very little resistance to electron flow. Insulators have a large resistance to electron flow.

g. The following table summarizes the main features of electric circuits.

# Ohm's Law

| Term | Symbol | Unit | Description |
|---|---|---|---|
| Charge | Q | Coulomb | Quantity of electrons |
| Current | I | Ampere (A or a) | Charge in motion $I = \frac{Q}{t}$ |
| Voltage | E | Volt (V or v) | Potential difference that makes charges move to produce current (I) $E = IR$ |
| Resistance Current | R | Ohm($\Omega$) | Opposition to current Flow $R = \frac{E}{I}$ |

## PRACTICE:

1 How much current flows through a 360 Ω watt light bulb when connected to 120 volts?

2. 120 amps flows through a car starter as it cranks the engine. The battery voltage is 13.3 volts. What is the resistance of the starter?