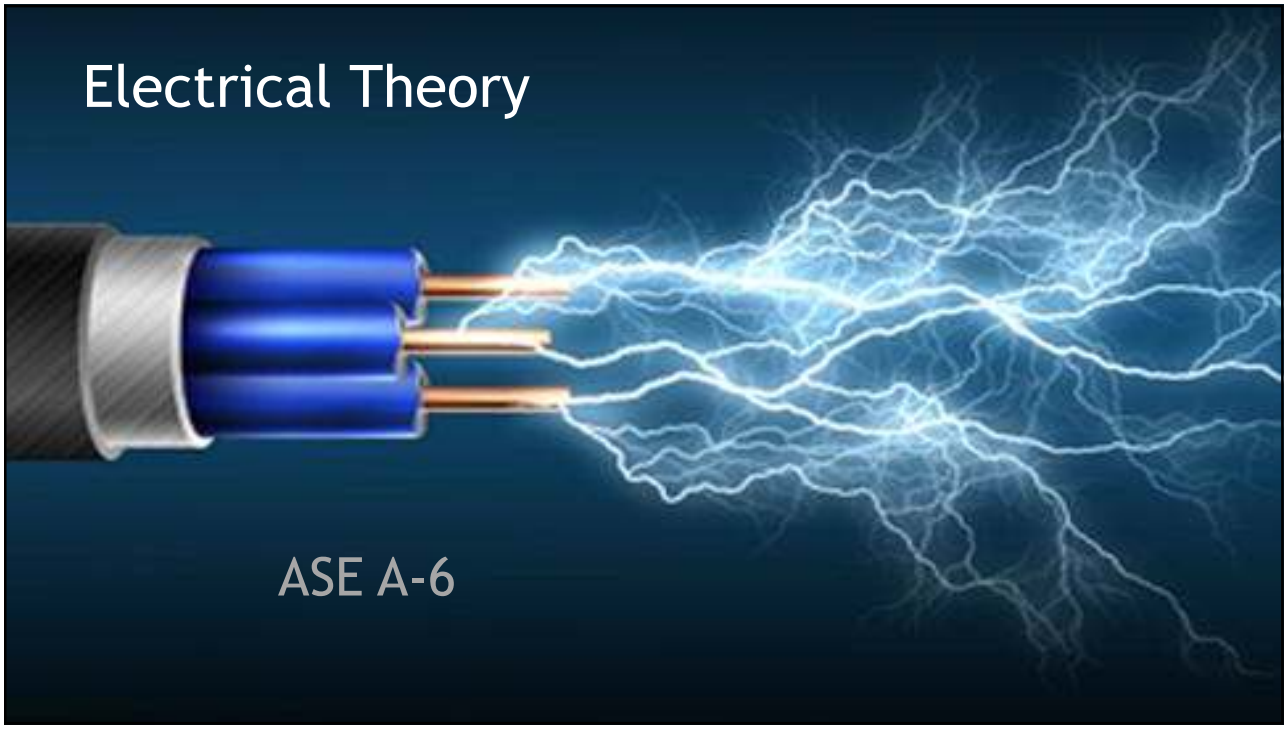

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Objectives

- Explain electricity
- Explain the properties of conductors and insulators.
- Explain how electricity can be used to produce heat, light, and motion.
- Explain the effects of magnetism on ferrous materials

2

Atoms

- Every element is made up of atoms
- For example: Copper is a chemical element
- Atoms are smallest part of an element that still retain the chemical properties of the element

3

3

Parts of an Atom

- Nucleus:
  - Central core of the atom
  - Contains protons and neutrons
  - Protons are positively charged
  - Neutrons have no charge
- Electrons
  - Orbit the nucleus in layers known as shells
  - Have a negative charge

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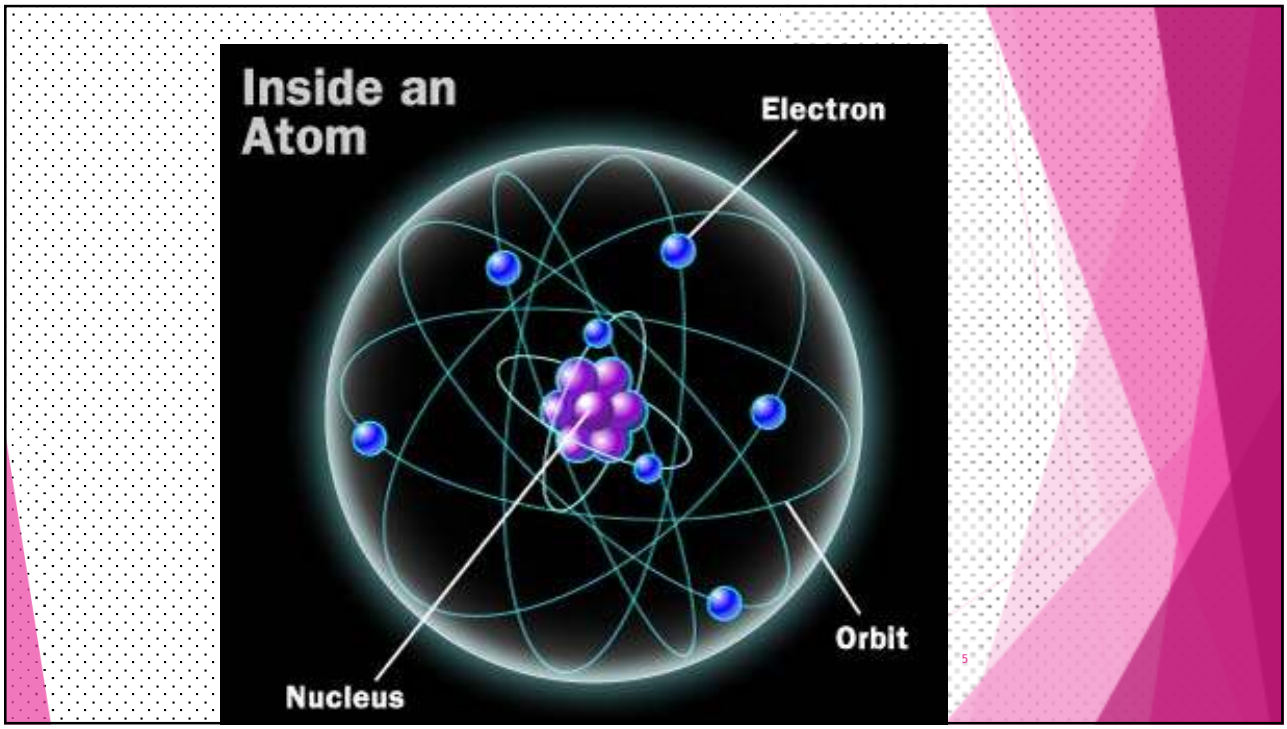

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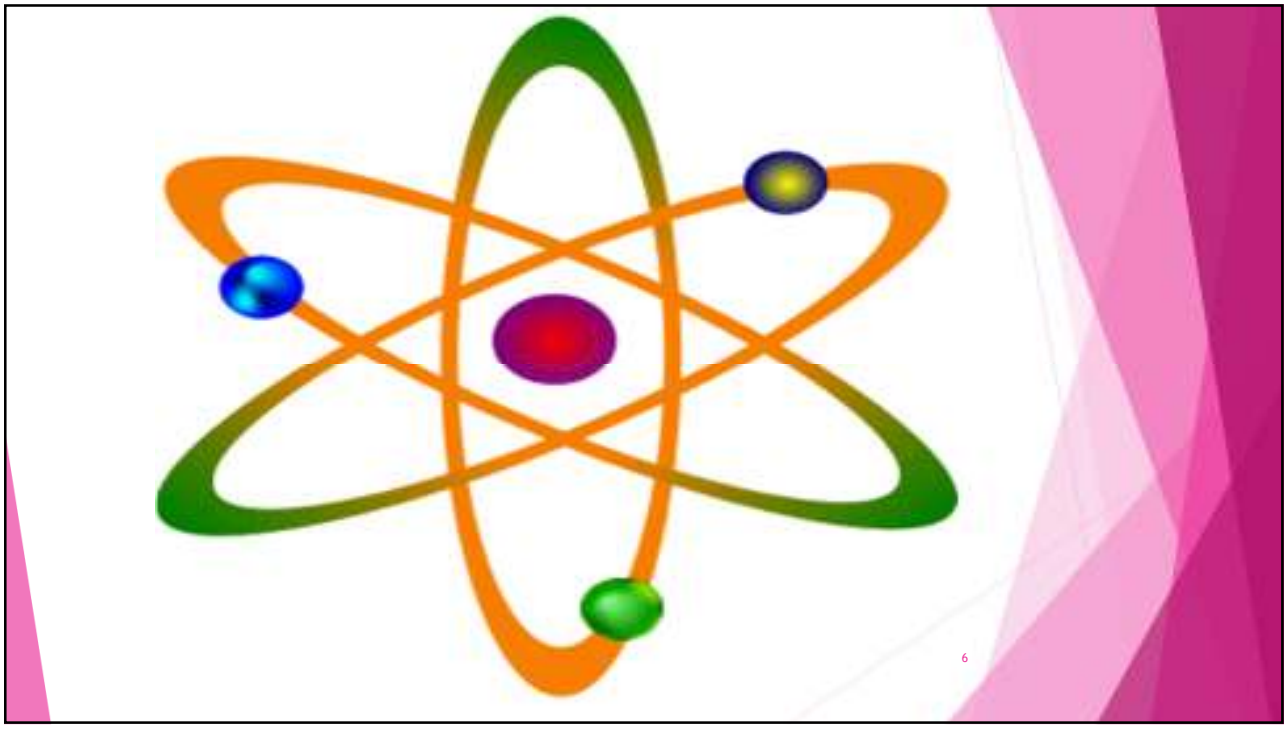

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Electrons

- Make electrical current possible
- Negatively charged subatomic particle
- Orbits the nucleus of an atom in rings or shell
- Held in orbit by the positive attraction of the protons
- Set number of electrons orbiting in each shell
- Outermost shell is the “VALANCE RING”

7

7

VALANCE RING

- The valence ring is the most important to the study of electricity
- It is what determines how well an element conducts electricity
- The number of electrons in this shell determines the valence of the atom
- The valence determines the capacity of the electrons to move (jump) to the valance ring of an adjoining atom

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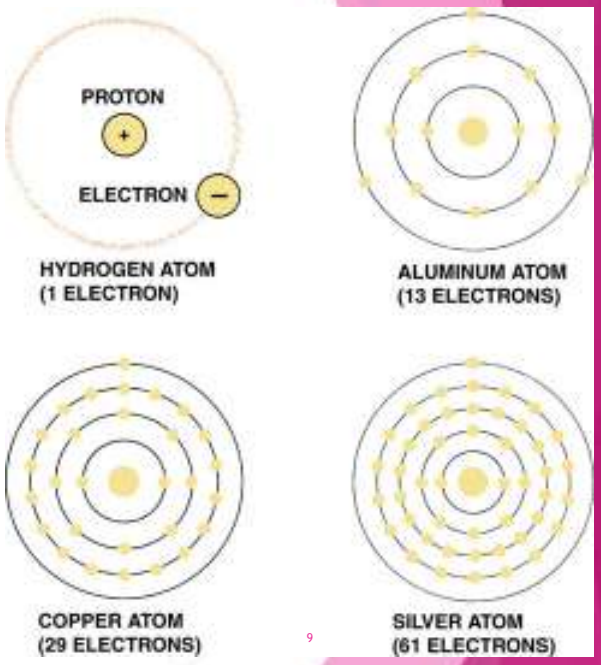
Valance Shells

- Electrons orbit around the nucleus in definite rings (shell)
- Only a specific number of electrons can orbit within each shell.



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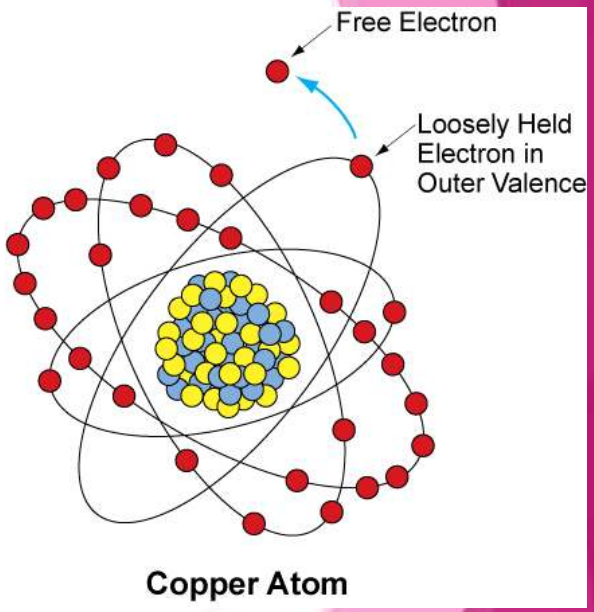
Atomic Balance

- Atoms normally have balance of forces
- Imbalance results in free electrons



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Free Valance Electrons

- If the valence ring of an atom has three or fewer electrons, the electrons are held very loosely.
- It is easy for a drifting electron to join the ring and push another electron away.
- These loosely held electrons are called free electrons
- The movement of these drifting electrons is called current.

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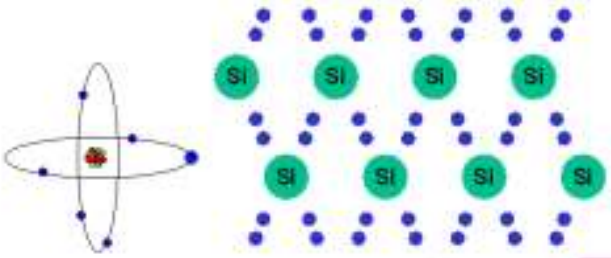
What is electricity?

- The movement of electrons from one atom to another
- Electric current is the controlled, directed movement of electrons from atom to atom within a conductor.



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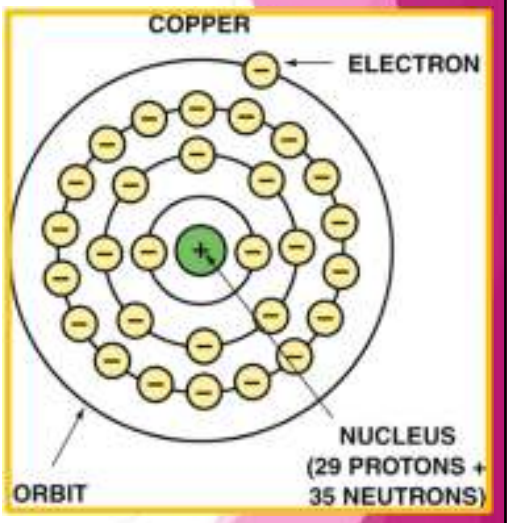
Conductors

- Materials with fewer than four electrons in their atom's valence ring
- Copper is excellent as a conductor because it has only one electron in its valence ring.



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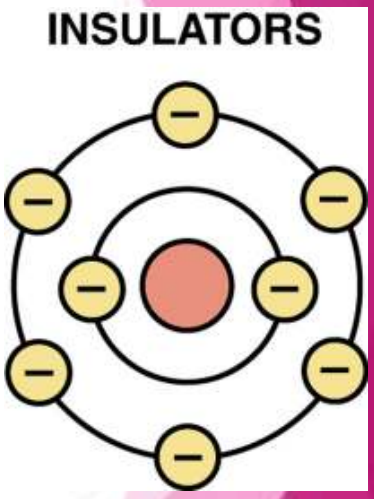
Insulators

- Materials with more than four electrons in their atom's outer orbit
- Easier for these materials to acquire (gain) electrons than to release electrons.
- Insulators include plastics, wood, glass, rubber and ceramic



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Electron flow

- If a power source (battery) is connected to the ends of a conductor, a positive charge (lack of electrons) is placed on one end of the conductor and a negative charge is placed on the opposite end of the conductor
- The negative charge will repel the free electrons from the atoms of conductor, and the positive charge on the opposite end of the conductor will attract these electrons

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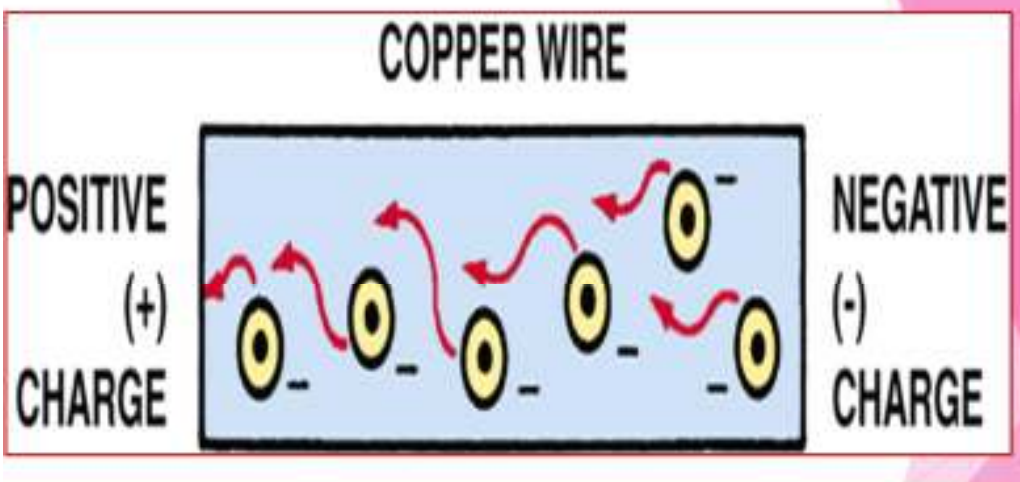

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Conventional Theory / Electron Theory

- Conventional theory: current flowed from positive to negative
- Discovery of electrons in the atom led to electron theory
  - Current flows from negative to positive
  - This is what actually happens
- Automotive electrical schematics use conventional theory

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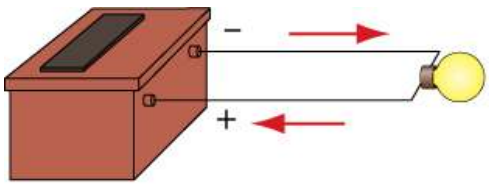
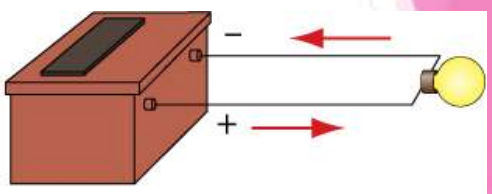
Current Flow Theories



Conventional Flow Theory
(Positive to Negative)



Electron Flow Theory
(Negative to Positive)

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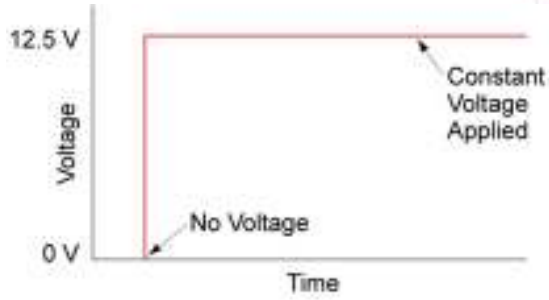
Direct Current (DC)

- Electrons flow in one direction only
- Used in most automotive circuits



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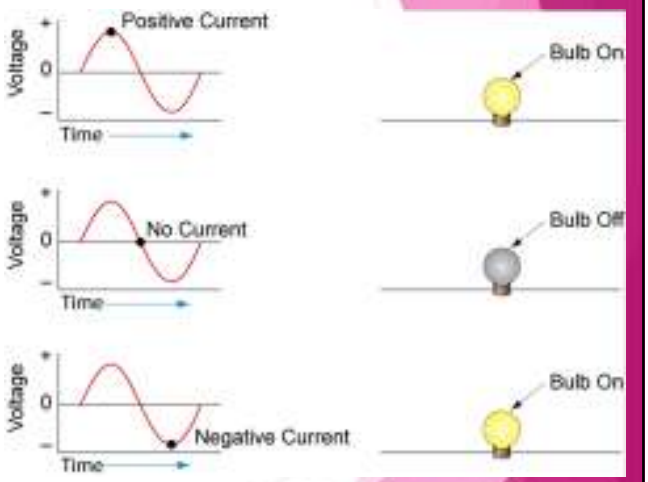
Alternating Current (AC)

- Electrons flow in both directions
- Voltage follows sine wave curve
- Frequency = cycles per second



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Current

- The flow of electrons through a circuit
- The unit used to measure current flow is ampere
  - French electrician André Marie Ampère (1775–1836)
- 1 amp of current = 6.28 billion electrons (a coulomb) moving from atoms to atoms in 1 second
- Abbreviations for amperes are A, amps, and I (intensity)
- Measured by an ammeter connected in series

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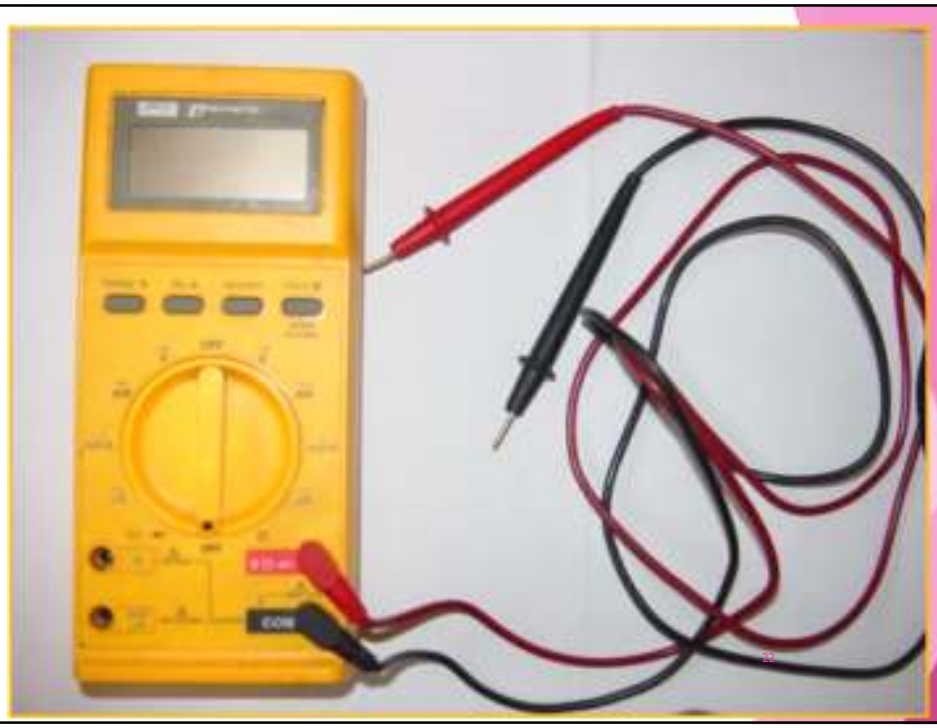

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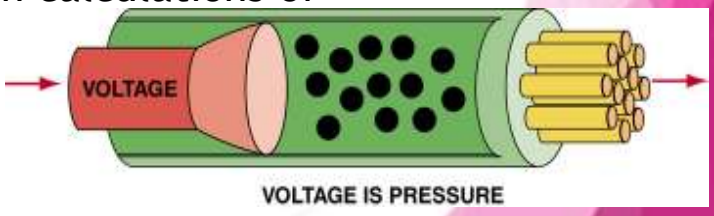
Voltage

- Electromotive force that causes the electrons to move
- Volt is the unit of measurement for voltage
  - named for Alessandro Volta (1745–1827), an Italian physicist.
- The letter *V* is the abbreviation volts
- The letter E is used in calculations of *electromotive force*



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Ohm

- The unit of measurement for resistance to current flow
  - Named after the German physicist Georg Simon Ohm (1787–1854)
- The symbol for ohms is Ω (Greek letter omega)
- The symbol used in calculations is R, for resistance

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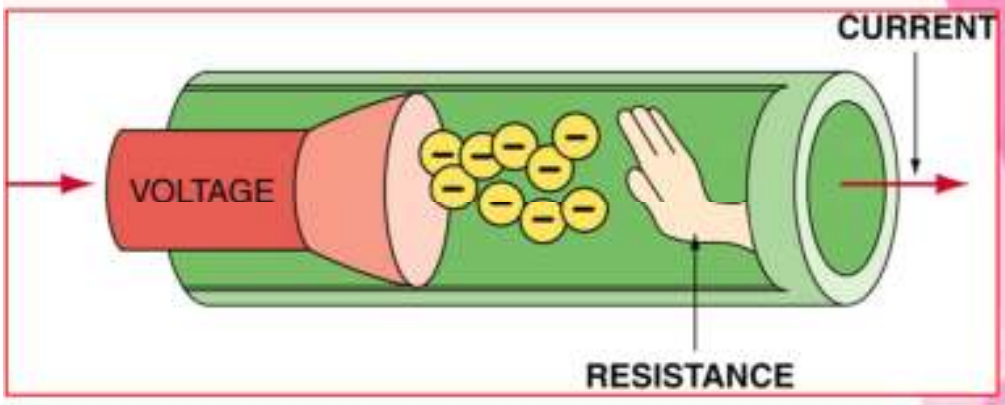

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Watt

- Electrical unit of measure for power
  - Capacity to do work
- Represented by a current of 1 ampere through a circuit with a potential difference of 1 volt
- The symbol for power is *P*

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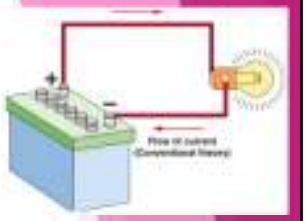
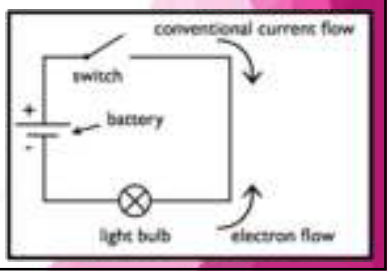
Electric Circuit



- For electron flow to occur there must be a path for the electrons; this is known as a circuit.
- For *any* circuit to work, it must be continuous from the battery through all



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Parts of a circuit

- A power source, vehicle battery
- An insulated path for current flow from the power source to the load
  - The electrical load converts electrical energy into heat, light, or motion
- A path from the load back to the power source
- There must be a complete circuit for current flow
- Continuity

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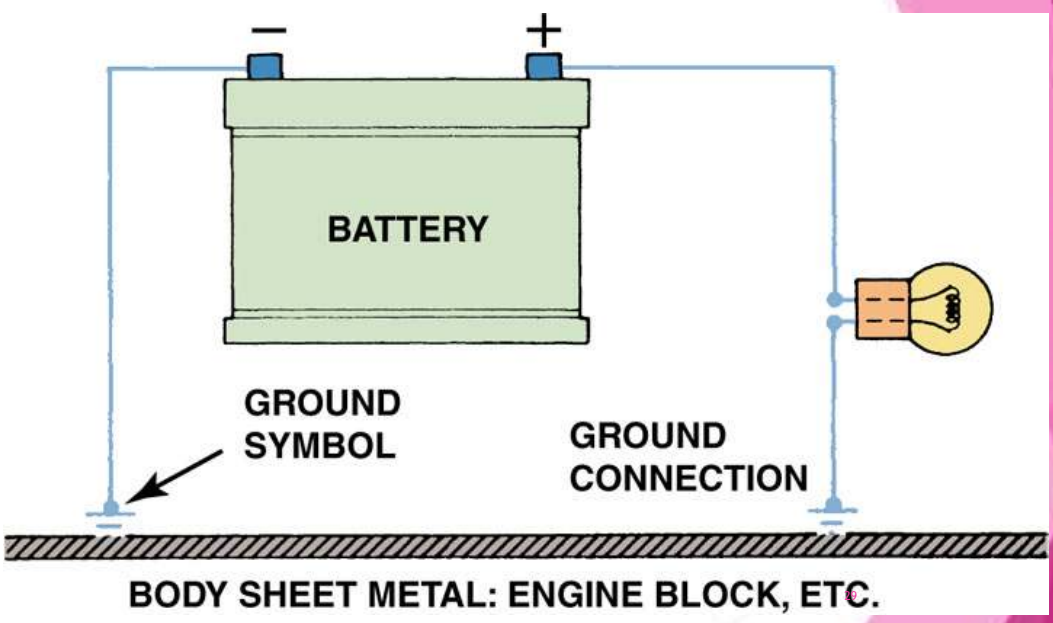

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Ohm's Law

- Relationship between volts, amperes, and resistance
- It requires 1 volt of electrical force to push 1 ampere of current through 1 ohm of resistance

Ohms Law:

Volts (E) =Current (I) x Resistance (R)

E=IR

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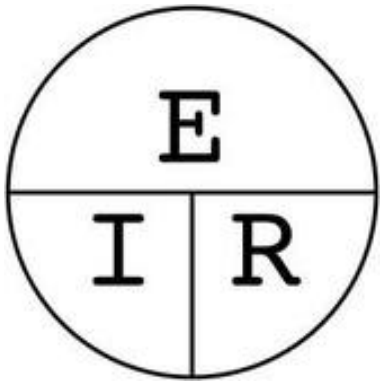

If any two values are known the remaining factor can be calculated using Ohm's law.

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Voltage (E) = Current (I) x Resistance(R)

- Example: You know the voltage is 12 V, and the current is 5 amps.

- Divide both sides by the unknown
- $\frac{\text{Voltage}}{\text{Current}} = \frac{\text{~~Current~~} \times \text{Resistance}}{\text{~~Current~~}}$
- Cancel the currents
- Result: Voltage / Current = Resistance

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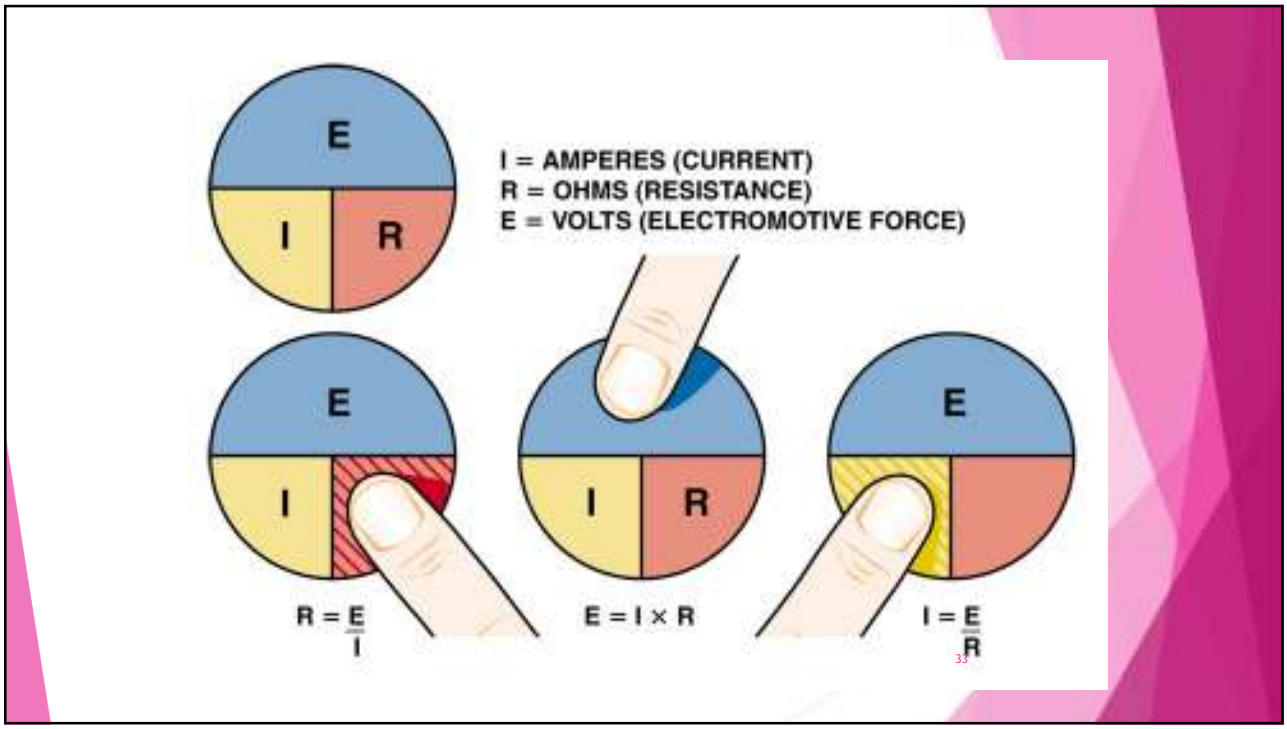

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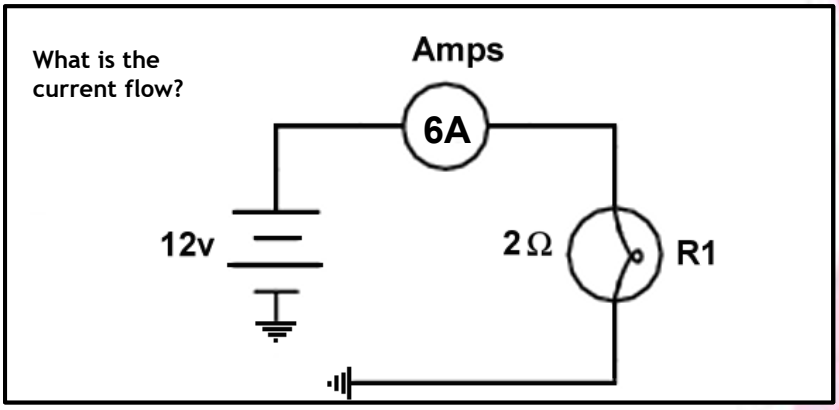
Automotive Electrical Theory



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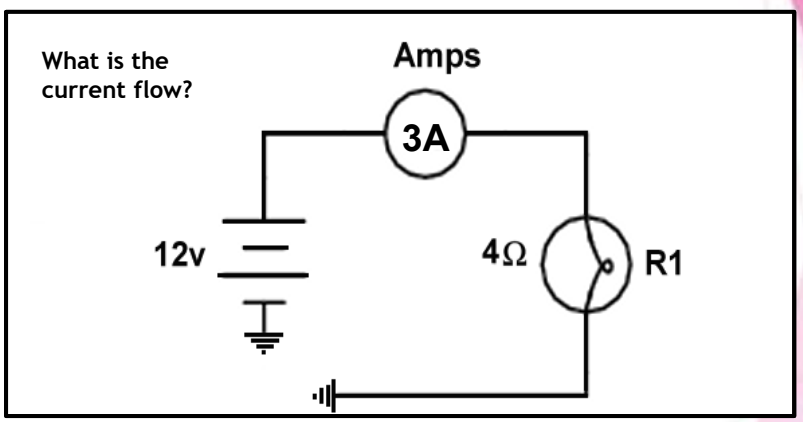
Automotive Electrical Theory

What is the current flow?



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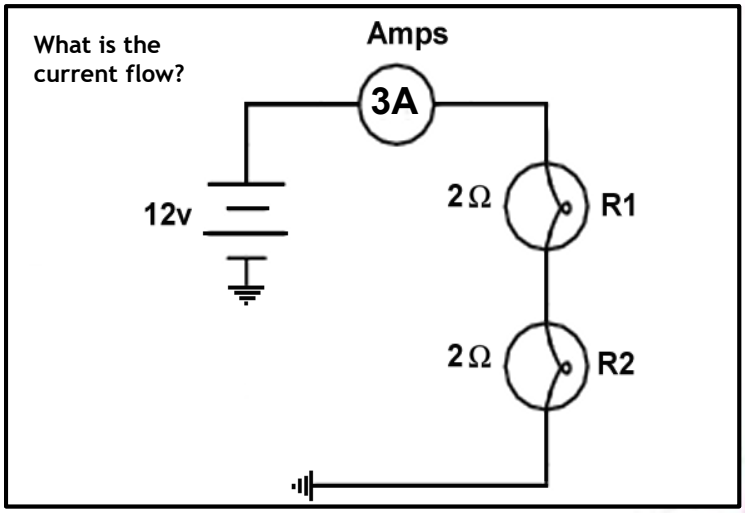
Automotive Electrical Theory

What is the current flow?



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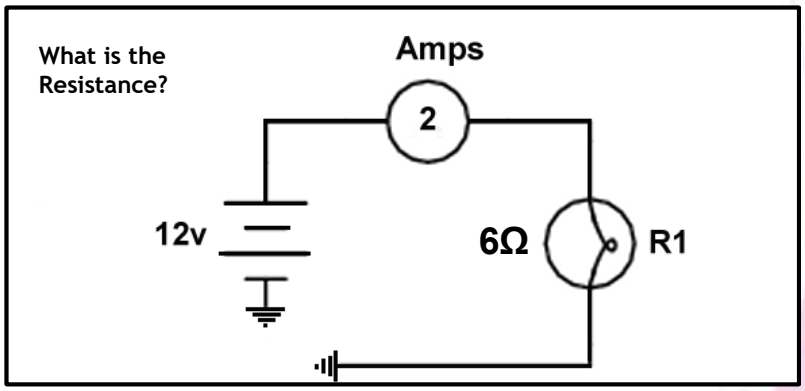

Do you see a Pattern?

37

#1 rule of electricity

- It will always follow the path of least resistance to ground

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Open Circuit

- An open circuit is any circuit that lacks continuity
- Any break in the circuit that prevents current flow is an open
- Amps decrease to zero instantly!

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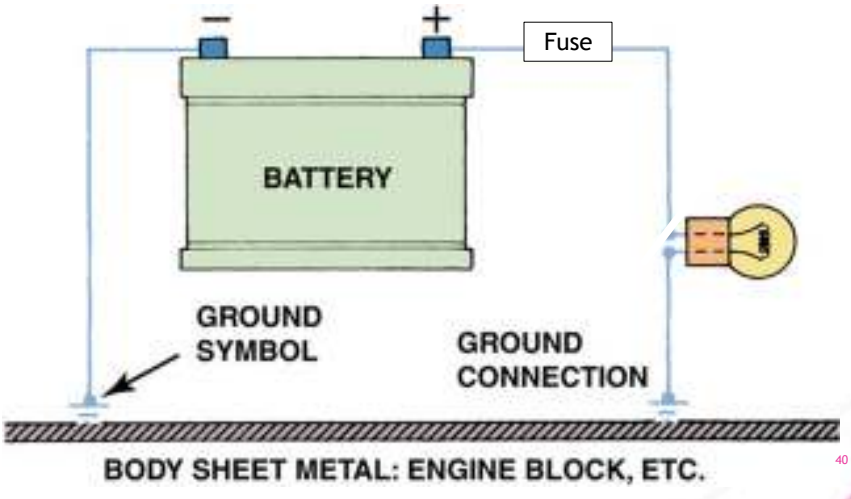
Open Circuit

What happens to current if a circuit opens?



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Short Circuits

- Electricity always takes the path of least resistance to ground
- A circuit can short to ground or to voltage
- What happens to current flow if a circuit shorts to ground?

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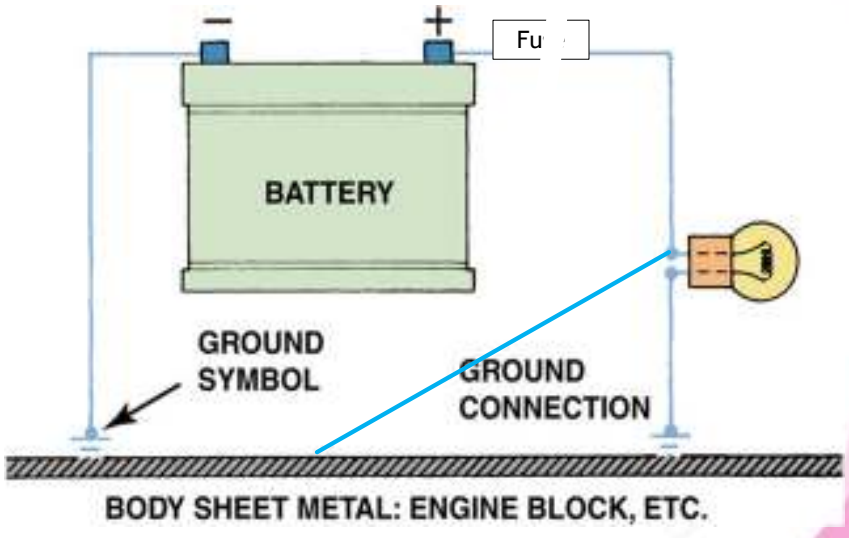
Short Circuit



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Open vs Short Circuit

- Open Circuit: path for current flow is interrupted
- Short Circuit: current finds a path to ground around the load on the circuit

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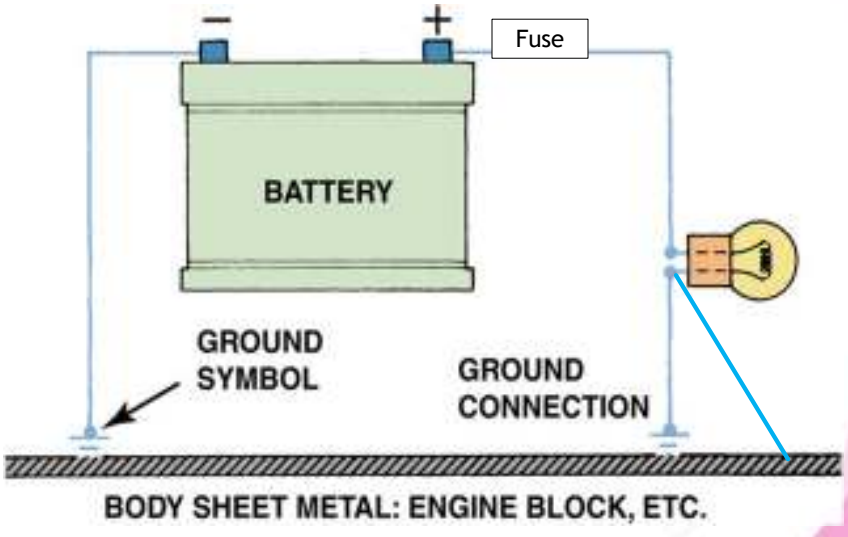
Short Circuit



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Types of Circuits

- Series Circuit
- Parallel Circuit
- Series Parallel Circuit