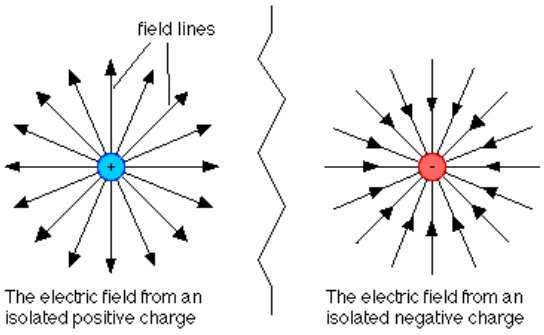
Physical Science
Lecture Notes
Chapter 12

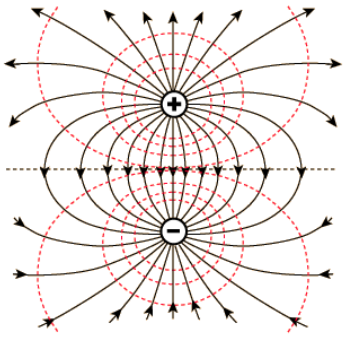
I. Chapter 12 Section 1 – Electric Charge & Static Electricity:

A. Types of electric charge
   1. Found at the atomic level:
      a. **Protons** w/ '**+**' charge "stuck" in the nucleus – bound tightly in the center
      b. **Electrons** w/ '**-**' charge freely moving around the nucleus in orbits;
         i. **Conductors** – metals like aluminum, gold, copper and silver have loosely bound electrons that are free to move from atom to atom
         ii. **Insulators** – hold more tightly to their electrons
      c. Charges were given the name negative & positive by **Ben Franklin**!

B. Interactions between charges
   1. **Like charge repel**, **opposite charges attract** (same as in magnetism)
   2. Unlike magnetism were on a magnet there is always a + on one end and a – on the other end of the magnet, electrical charges can exist alone

C. Electric fields
   1. Electric charges exert a force through the force field in all directions from the charged particle
   2. When a charged particle enters the force field of another particle it is either attracted or repelled
   3. Just as in magnets you can draw the force field lines around individual charged particles
      a. The diagram represents stronger force as the lines get closer & closer together





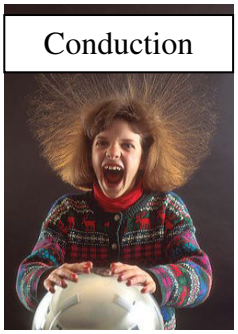
      b. When multiple charges are placed near each other their fields are altered

D. Static charge
   1. Static from the Latin word "**Stasis**" which means "**Stays**"
   2. Objects are typically "Neutral" w/ the same # of protons and electrons
   3. They can become "charged" by gaining or losing electrons –
      a. NOT PROTONS! – They stay in the nucleus!
   4. The buildup of these charges is "**Static Electricity**"
   5. In **Static Electricity** the charges build up and ***STAY***; they don't flow as they do in electric currents

6. Transferring Static Charge – 3 ways: **Friction, Conduction & Induction**
    a. **Friction** – transferred from rubbing i.e. get shocked after walking on the carpet
    b. **Conduction** – transferred by direct contact w/ another object – hair standing on end w/ **Van de Graff machine**
    c. **Induction** – the force field of a highly negatively charged object pushes the electrons away from nearby objects causing them to become + charged, they then are attracted to each other. i.e. statically charged balloon attracts small pieces of torn up paper

Friction

Conduction

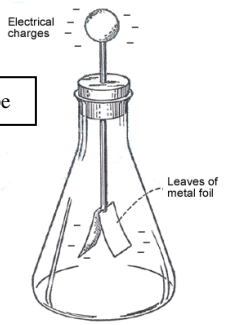


Induction

Small strips of torn paper are attached to the negative charge on the balloon

E. Static discharge
    1. Objects don't hold a static charge forever – **objects tend toward equilibrium** – they "want" to be neutral
    2. When electrons move toward this equilibrium – static discharge occurs
    3. **Humidity** – water (a polar molecule) vapor in the air pulls electrons off negatively charged objects, preventing static charges to build up
    4. **Sparks & Lightning** –
        a. Rubbing your feet on the carpet pulls electron off you and you become + charged. When you touch the door knob electrons jump off and shock you.
        b. In thunder clouds the bottoms of the clouds become negatively charged while the upper parts of the clouds become positively charged
            i. Most lightning is a giant "spark" between or within the clouds to reach equilibrium.
            ii. The land below the clouds is positively charged and sometimes the spark jumps from the clouds to a "high" point on the ground – lightning bolt occurs

F. Detecting charges
    1. Electric charge detected w/ an **electroscope**



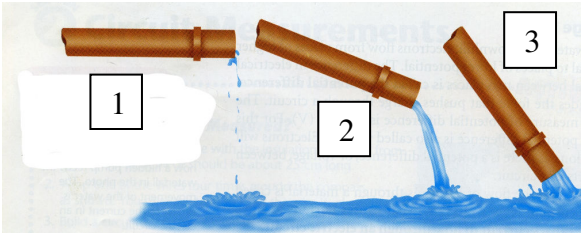
electroscope

II. Chapter 12 Section 2 – Circuit Measurements
A. Flow of electrons through a material is an **electric current**
B. **Electrical Potential** –
    1. Similar to potential energy (lifting something higher against the force of gravity gives it greater potential to do work, increasing its potential energy.) When given the opportunity, objects will move from higher potential energy to an area of lower potential energy
    2. In a similar way electrons in a circuit have potential energy. This potential is related to their electrical fields and not o height – Electrical Potential
    3. Electrons want to travel from areas of **high Electrical Potential to areas of low Electrical Potential**. This provides the energy to push a charge through a circuit and light a light bulb.

C. Voltage
    1. **Volt** – unit of measure to measure this potential –
    2. **Voltage** – causes current to flow through an electrical circuit

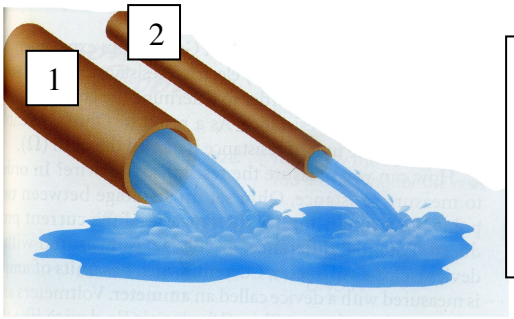
D. Voltage sources

1. The potential for water to flow through a pipe depends on the difference in height:



In #1- the pipe is nearly level, very little potential (difference) & water dribbles out
In #2- a greater angle allows more water to potentially pour out
In #3- the greater angle between top & bottom, the faster the water flows

2. **A Voltage Source** (battery or generator) is required to maintain the electrical potential in a circuit.
3. Just as a greater difference in height allows a greater flow of water, an increase in voltage causes a greater flow of electrical current.



In #1- the pipe has a large diameter and allows a large current to flow with very low resistance
In #2- the smaller diameter offers greater resistance and less current can flow through it.
greater the resistance, the less current
greater the current, the less resistance

E. **Resistance** – the opposition to the flow of electricity – measured in **Ohms**

1. Water flowing thru a pipe depends on more than the angle of the pipe. It also depends on the length of the pipe, diameter of the pipe and if the pipe is clogged or open.
2. **Electrical current** is measured in **Amperes**
3. Amount of Electrical Current (amps) depends on more than just Voltage, it depends on the Resistance found in the circuit.
4. The **greater the resistance, the less current** there is for a given voltage.
   a. Longer wires have greater resistance than short wires
   b. Thin wires have more resistance than thick wire
   c. High conductors have less resistance than insulators
5. Electricity will take the **path of least resistance**

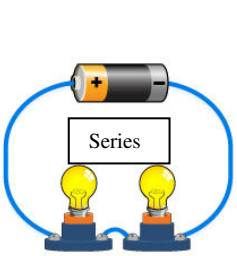
F. Ohm's law

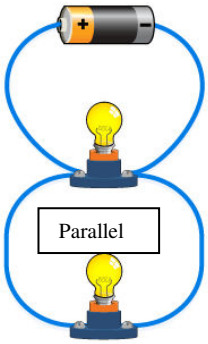
1. **Resistance = Voltage / Current**
2. **Ohms = Volts /Amps**
3. **Volts = Amps x Ohms**
4. **Amps = Volts / Ohms**

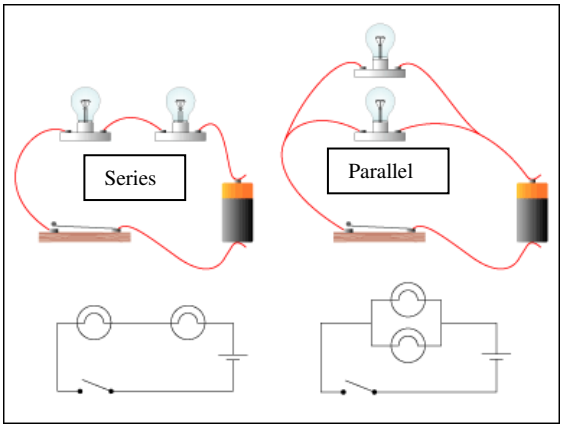
Ohm's Triangle

Cover the variable you want to find and perform the resulting calculation (Multiplication/Division) as indicated.

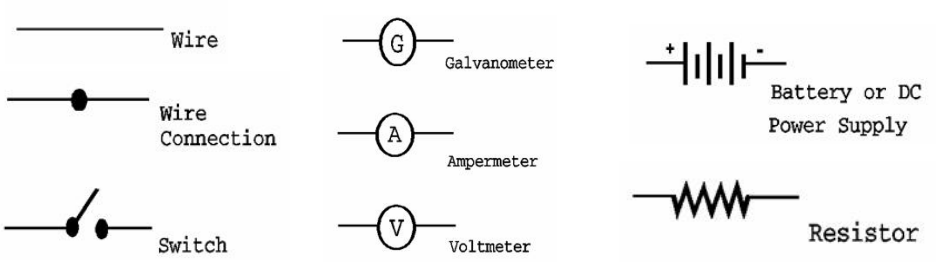
V = Voltage = volts
I = Current = Amps
R = Resistance = Ohms







III. Standard symbols of an electrical diagram



IV. Chapter 12 Section 3- Series & Parallel Circuits

A. **Series circuits** – provides only one path for the electrons to follow
    1. A break in the circuit stops the flow of electricity to all other parts of the circuit
    2. With multiple light bulbs (more resistance) the current reduces & the dimmer the lights become
    3. **Ammeters** should be wired in series

B. **Parallel circuits** – the different parts of the circuit are on separate branches
    1. A break (burn out light bulb) in the circuit doesn't stop the flow to the remaining devices
    2. The **more paths the LESS the resistance**
        a. Water example again: added pipes coming from a large tank will allow more water to flow out that a single pipe.
        b. Therefore as resistance decreases, current increases; they are inversely proportional
    3. Multiple light bulbs will remain the same brightness since the resistance is not decreasing as it does in a series circuit.
    4. Each pathway can be separately switched off w/out affecting the others
    5. Voltmeters are wired in parallel

C. Household circuits – Wired in parallel, with a standard of 120 volts