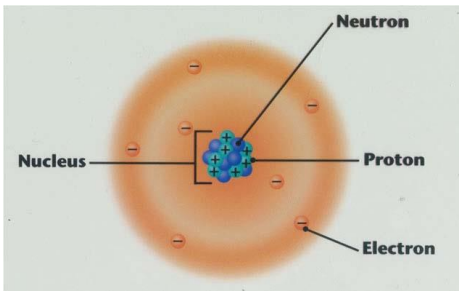
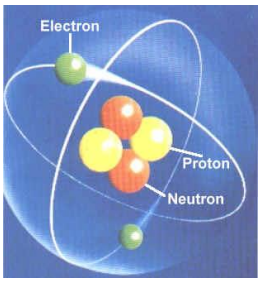
Electric Charges & Current

Chapter 12

Types of electric charge

- **Protons w/ '+' charge "stuck" in the nucleus**
- **Electrons w/ '-' charge freely moving around the nucleus in orbits**





Conductors

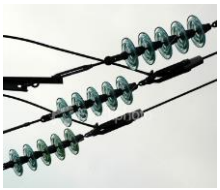
- Allow the easy flow of electricity
- loosely bound electrons that are free to move from atom to atom
- metals like aluminum, gold, copper and silver




Insulators

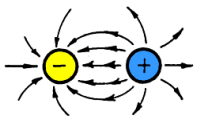
- **Insulators – resists the flow of electrons**
  - **hold more tightly to their valence electrons:**
  - **plastic, rubber, glass**

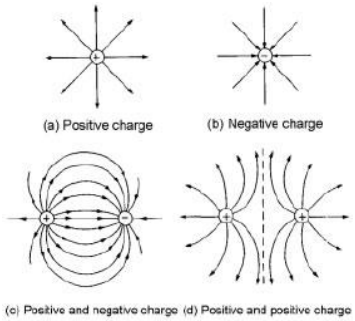




Interactions between charges

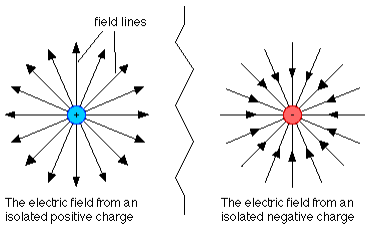
- same as in magnetism
  - Unlike magnetism where on a magnet there is always a + on one end and a – on the other end of the magnet
  - electrical charges can **exist alone**
- Like charge repel
- Opposite charges attract

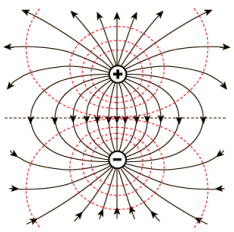




Electric Fields

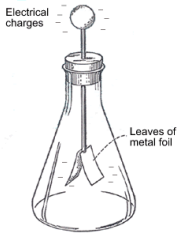
- Exert a force through the force field in all directions from the charged particle
- When a charged particle enters the force field of another particle it is either attracted or repelled
  - The diagram represents stronger force as the lines get closer & closer together





Static Charge

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

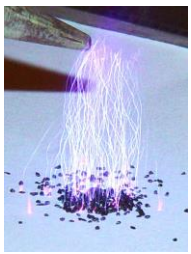


Transferring Static Charge

- **Friction – transferred from rubbing i.e. get shocked after walking on the** carpet
- **Conduction – transferred by direct contact w/ another object – hair** standing on end w/ **Van de Graff machine**
- **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

Static Discharge

- Objects don't hold a static charge forever – **objects tend toward equilibrium –** they "want" to be neutral
- When electrons move toward this equilibrium – static discharge occurs
  - **Humidity –** water (a polar molecule) vapor in the air pulls electrons off negatively charged objects, preventing static charges to build up
  - **Sparks & Lightning -** objects reaching static equilibrium

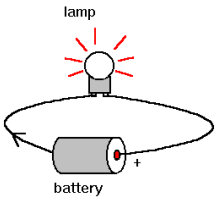


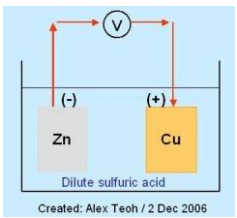


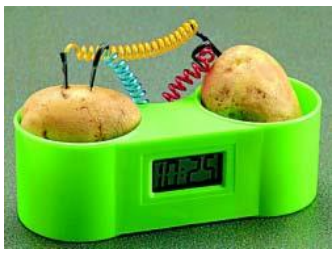


Circuit Measurements

- **Electric Current -** Flow of electrons through a material
- **Electrical Potential –**
  - 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
  - Electrical potential is related to their electrical fields and not to height – **as electrons build up on one side they "want" to flow to an area w/ less potential**

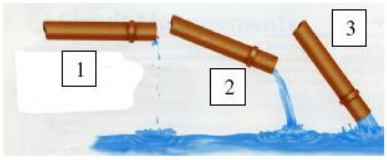




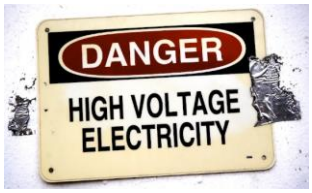


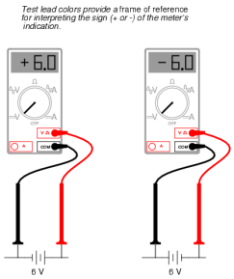
Voltage

- **Voltage** – causes current to flow through an electrical circuit
- **Volt** – unit of measure to measure this potential
- A **Voltage Source** (**battery** or **generator**) is required to maintain the electrical potential in a circuit.



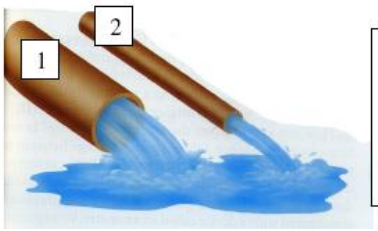
In #1- the pipe is nearly level, very little potential (difference) & water dribbles out
In #2- a greater angle allows more water to potentially pour out
In #3- the greater angle between top & bottom, the faster the water flows





Electrical Current

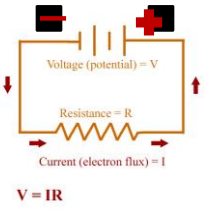
- Water flowing thru a pipe depends on more than the angle of the pipe. It also depends on the length of the pipe, diameter of the pipe and if the pipe is clogged or open.
- **Electrical Current** is measured in **Amperes**
- **Amount of Electrical Current** (**amps**) depends on more than just Voltage, it depends on the Resistance found in the circuit.



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

Electrical Resistance

- the **opposition** to the flow of electricity –
- measured in **Ohms** – symbol is the **Greek letter Omega** - Ω
- 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.
- **Electricity will take the path of least resistance**
- The **greater the resistance, the less current** there is for a given voltage.
  - a. **Longer wires** have **greater resistance** than short wire
  - b. **Thin wires** have **more resistance** than thick wire
  - c. High conductors have less resistance than insulators



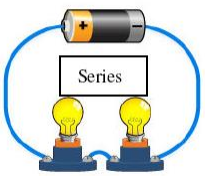
Ohm's law

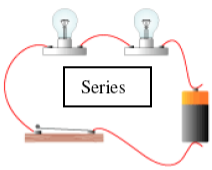
1. **Resistance = Voltage / Current**
2. **Ohms = Volts /Amps**
3. **Volts = Amps x Ohms**
4. **Amps = Volts / Ohms**

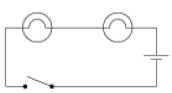
V = Voltage = volts
I = Current = Amps
R = Resistance = Ohms

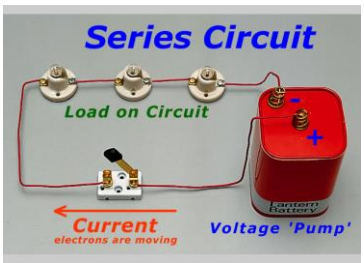
Series Circuits

- **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**



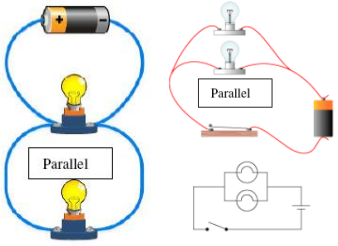


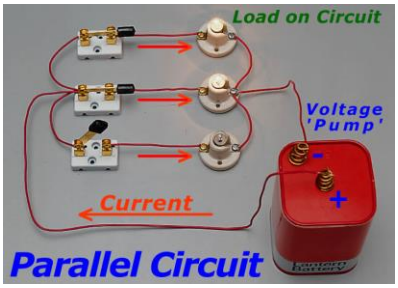




Parallel Circuits

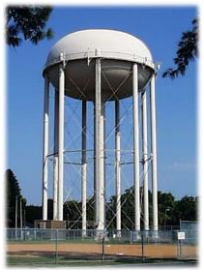
- Parallel circuits – the different parts of the circuit are on separate branches
- A break (burn out light bulb) in the circuit doesn't stop the flow to the remaining devices
- Multiple light bulbs will remain the same brightness since the resistance is not decreasing as it does in a series circuit.
- Each pathway can be separately switched off w/out affecting the others
- Household circuits – Wired in parallel, with a standard of 120 volts
- Voltmeters are wired in parallel





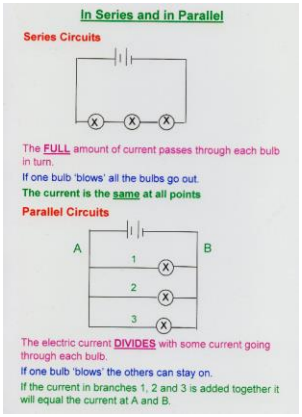
Parallel Circuits

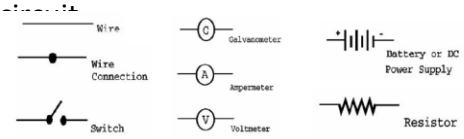
- The **more paths the LESS the resistance**
  - Water example again: added pipes coming from a large tank will allow more water to flow out that a single pipe.
  - Therefore **as resistance decreases, current increases; they are inversely proportional**

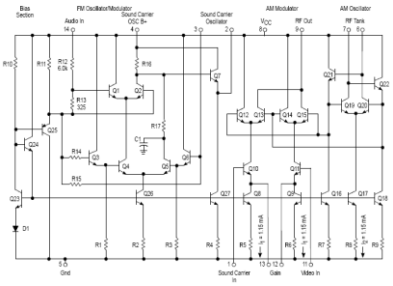


Schematic Diagrams

- All circuits need at least the following
  - Power supply, wire, resistors, other items include switches, connectors, meters, etc.
- There is a set of standard symbols used to represent these items in a diagram of the circuit







That's all for Chapter 12