Electric Current Notes

I. Electricity refers to the flow of an electric current.

A. Electric current - is the flow of charged particles, usually electrons inside a conductor

1) conductor - a material that conducts electricity, lets electrons flow.

a) Metals are careless with their electrons-electricity flows easily - good conductors

b) Nonmetals hold electrons tightly - do not allow electricity to flow- i.e. good insulators

2. Current is measured in units called amperes, or amps (A)

a) one amp = 6.2×10^{18} electrons flowing through the wire per second.

b) Current is often measured in mA which is 1/1000 or .001 A

3. Current is measured with an ammeter or the ammeter part of a multimeter.

II. Electrical Circuits - The conducting paths through which electricity can flow. Must be continuous or have continuity.

A. Electricity flows like water in a pipe, except the same water flows over and over through the circuit.

B. Symbols in a circuit

wire switch battery lamp resistor

C. Open circuits - open switch or break in the wire keeps current from flowing

D. Closed circuit - complete circuit that allows electricity to flow

E. Short circuit - is a path that allows electricity to flow without flowing through any devices or resistors.

1. Can cause overheating and/or fires.

III. Voltage - Pump is needed to keep water flowing, a battery is needed to keep electrons flowing.

A. Voltage - is the electrical pressure that causes the circuit to flow

- voltage is also known as the electrical potential difference b/w 2 points

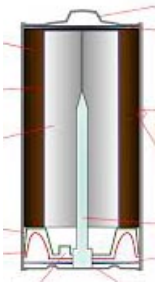
B. Voltage tells how much power (watts) is carried by 1 amp of current

-measured by voltmeter

C. Batteries convert chemical energy → electrical power

1. Chemicals store joules of energy
   - D cell has 1.5 volts and uses 1.5 J/s and has 70,000J
   - AAA cell also has 1.5 V - uses 1.5 J/s - only has 5,000 J

D. Batteries are composed of 2 or more cells



ZnO_2
Carbon + MnO_2
both are immersed in KOH electrolyte causing reaction
electrons accumulate at anode Zinc oxide

IV. Batteries in Series and in Parallel

A. Batteries attached in series (positive to negative), have double the voltage but the same current as a single battery.

B. Batteries attached in parallel (positive to positive, neg. to neg.), have double the current & the same voltage as a single battery.

V. Resistance - how much the object opposes the flow of electricity or how easily current can flow through a material.

A. Measured in units known as ohms (Ω)

B. Factors that affect a conductor's resistance:

1. Diameter of the wire -
   narrow has more resistance, bigger has less resistance
2. Length of the wire -
   longer the wire is, the more resistance it has
3. Material it is made of
   a. metals have low resistance, (Au, Ag, Cu)
   b. nonmetals have high resistance
   c. metalloids - Silicon, germanium
      - make semiconductors - that can be turned on/off, or only conduct current in one direction (diodes, transistors, other electronics)
      - low resistance when:

at higher temps
or "doped" with impurities

4. Temperature - the higher the temperature the greater the resistance
   a. Superconductors - at low temperatures (0-70 K) have zero resistance

VI. Ohm's Law

I=V/R

where I = current (A), V = voltage (V), and R = resistance (Ω)

A. If voltage increases, the amount of current increases.

B. If resistance increases, the amount of current decreases and vice versa.

C. If a wire has a resistance of 1 Ω, that means that if 1 V is applied 1A of current will flow.

*How much electricity will kill you?

The damaging effects of shock result from current through the body, which depends on voltage and resistance.

Human body - Soaked in salt water - resistance = 100 Ω
Very dry skin - resistance = 500,000 Ω
Touch with your fingers = 100,000 Ω

Current	**Current(mA)**	**Effect**
.001 A	1mA	Can be felt
.005 A	5mA	Is painful
.070A	70mA	Goes thru heart is painful. For > 1 second may be deadly
>.2 A	>200mA	Heart clamps up - may be able to resuscitate.

VI. Direct Current and Alternating Current

A. Direct current (dc) is current made up of electrons that flow in one direction.
   1. Batteries - Electrons move from the - terminal toward the + terminal, always moving through the circuit in one direction.

B. Alternating current (ac) - current flows initially in one direction and

then in the opposite direction.

1. AC changes directions about 60 times a second
   - frequency is 60 hertz (cycles/second)

VII. Electric Power

A. Moving charges in an electric current can do work.

1. Usually they heat a circuit or turn a motor.

B. In electrical terms, power is equal to current multiplied by voltage.

Power = current x voltage

In units: **watts = amperes x volts**

VIII. Electric Circuits

A. Devices in a circuit can be connected in series or parallel.

1. Series circuits

a. The devices and the wires connecting them form a single path for electrons to flow.

b. The same current exists immediately in all three light bulbs.

c. The total resistance is found by adding the resistance of all the parts of the circuit.

$$R_{Total} = R_1 + R_2 + R_3 \ldots + R_{wire}$$

d. The sum of the voltage drops across each device is equal to the total voltage supplied by the power source.

e. Disadvantage - If one device fails, the rest will not work either.

2. **Parallel circuits**

a. Form branches, each providing **separate paths** for electrons to flow.

b. Electrons leaving the (-) terminal only need to travel **through one light bulb** before returning to the (+) terminal.

c. The **voltage** is therefore the **same** across each device and is equal to the voltage of the power source.

d. How much current is in each branch depends on the resistance in that branch.

e. The total current in the circuit equals the sum of the currents in its parallel branches.

f. As the number of **parallel branches is increased,** the **overall resistance of the circuit is lowered.**

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \ldots\ldots + \frac{1}{R_{wire}}$$

-This means the overall resistance of the circuit is less than the resistance of any one of the branches.

g. Therefore, the **overall current increases.**

3. Home circuits are parallel circuits
   a. the more devices plugged into a circuit the greater the amount of current flowing through the circuit
   b. wires heat up as the circuit is overloaded - causing a fire unless the circuit contains a fuse or has a circuit breaker.
   c. **Fuse** - has a metal piece that melts when too much current flows through it.
   d. **Circuit breaker** - too much current creates a magnetic force that flips the switch.
   e. **Ground fault circuit interrupter (GFCI)** - measures current leaving and current returning. If not the same, it shuts off flow of electricity (current)
   f. Cause, such as a short circuit, must be fixed.