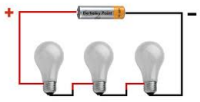
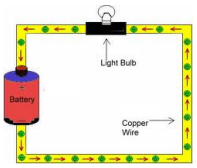
Chapter 20 - Current Electricity

Demo - light bulb gray/ white demo



Statics- charge moves all at once...either charged or discharged

Current - charges continue to move



To create current you need:

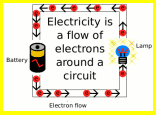
1) Conductor = wire = supplies e-

2) Potential difference = moves e-

3) Resistor = device ...otherwise current will move BUT it will move too fast and overheat

Current

- I
- Coulombs per sec
- Like water moving down a river
- Current and charge are ALWAYS conserved
- Conventional current = + charges****



I = q/t

units = amperes = A = C/s

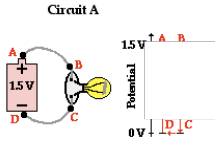
Potential Difference

- Voltage
- Supplied by

  - > outlet
    - « creates Alternating Current (AC)

OR.....

- > battery
  - « creates Direct Current (DC)
  - « + side of battery = top of hill
  - « - side of battery = bottom of hill



Check questions??

1) How many electrons does PG&E provide for you every day?

a) 1,000,000

b) 1,000,000

c) too many to count

d) none

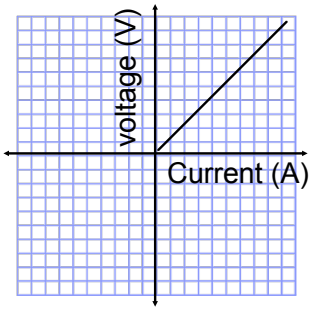
Soldier line up demo

Resistance

- resists the flow of electrons/current
- due to devices and wires
- units = ohms = Ω

Ohm Jokes.....

Ohm measured the current through a resistor by varying V and found....



This relationship is known as Ohm's Law

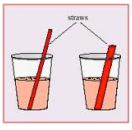
He named the slope resistance

R = V/I

V = IR

Resistance is like drinking a milkshake through a straw

- **Big** straw gives **less** resistance
- **Small** straw gives **high** resistance
- **Long** straw gives **high** resistance
- **Short** straw gives **less** resistance



$R = \rho L/A$

where

ρ = resistivity

L = length of wire

A = area of end of wire

According to Ohm's Law resistance stays constant....BUT...really it changes with temperature

$\rho = \rho_o(1 + \alpha(T - T_o))$

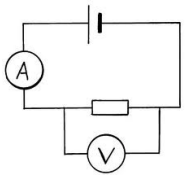
$R = R_o(1 + \alpha(T - T_o))$

Most materials have a +α so R increases with temperature

Note: That is why bulbs burn out most offen when you first turn them on...explain....

Measurements in circuits

Current	Voltage
Uses an ammeter	Uses a voltmeter
Needs current to go **through**	Needs current to stay in circuit so measures **across**
Needs **low** resistance	Needs **high** resistance
Connected in **series**	Connected in **parallel**

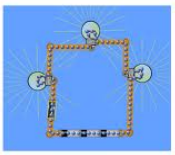


Demo - Phet Circuits

http://phet.colorado.edu/en/simulation/circuit-construction-kit-dc

Series Circuits

1. Series= current goes from one resistor/device to the next in a "series"
2. ONE path
3. SAME current
4. SPLITS voltage



Equations for Series:

$I_t = I_1 = I_2 = I_3 \ldots$

$V_t = \Sigma V_i$

Since V= IR

$IR_t = \Sigma IR_i$

so...I's cancel and

$R_t = \Sigma R_i$

Since q = CV and q = I/t

V = q/C

$q/C_t = \Sigma q/C_i$

so....the q's cancel and

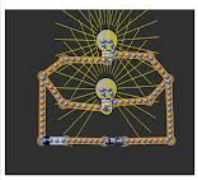
$1/C_t = \Sigma 1/C_i$

Check question??

What happens to the resistance as you put in more and more resistors? Why?

Parallel Circuits

1. Parallel= current splits between resistors so it move "parallel" to each other
2. Multiple paths
3. SAME voltage
4. SPLITS current



Equations for Parallel:

$V_t = V_1 = V_2 = V_3....$

$I_t = \Sigma I_i$

Since I= V/R
$V/R_t = \Sigma V/R_i$
so...V's cancel and

$1/R_t = \Sigma 1/R_i$

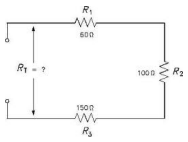
Since q = CV and q = I/t
$C_tV = \Sigma C_iV$
so....the V's cancel and

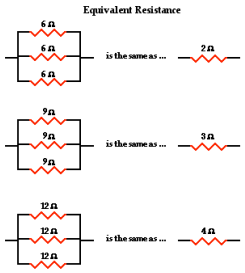
$C_t = \Sigma C_i$

Check Q???

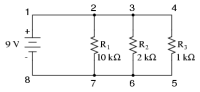
1. What happens to the resistance of a circuit as more devices are connected in parallel?
2. Why would you use a series circuit?
3. Why would you use a parallel circuit?

Sample circuits....find the total/effective resistance for.....

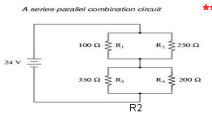




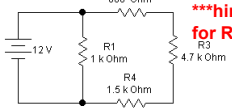
For these figure out R_t, I_t, and I and V through/across each!!!



hint: all connected across SAME battery



hint: current splits opposite ratio of R



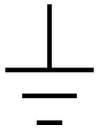
hint: current splits at point AND you know V for R_t by looking

Fuse - a device that "burns out" when too much current flows to protect the circuit

Circuit breaker = as switch that "flips" to off when too much current flows

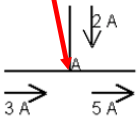
Grounding - provides a path to the "ground" so there is not a build up of charge that can "spark" if there is a large potential difference

ex. 3rd prong in plug (other two flip between + and - since it's AC)



Kirchoff Rules - rules based on **conservation of charge** and **conservation of energy**

Point or Junction Rule -- The sum of all the currents going into a point/junction must equal the sum of all the currents leaving the point/junction



$\sum I_A = 3\text{A} + 2\text{A} - 5\text{A} = 0$

$\Sigma I_{in} = \Sigma I_{out}$

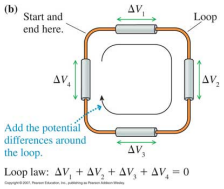
or

$\Sigma I = 0$

I_{in} = +

I_{out} = -

Loop Rule: The sum of the energy drops and rises is always ZERO (or the voltage drops = the voltage rises)



$\Sigma V_{rises} = \Sigma V_{drops}$

or

$\Sigma V = 0$

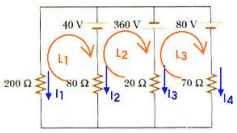
V_{rises} = +

V_{drops} = -

Determining if potential differences is + or -

If current goes "right way"	If current goes "wrong way"
batteries = +V	batteries = -V
resistors = - V	resistors = + V

Ex.



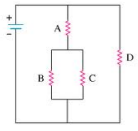
L1: $\Sigma V = -40 - 80I_1 + 200I_1$

L2: $\Sigma V = 360 - 20I_2 + 80I_1 + 40$

L3: $\Sigma V = -80 - 70I_3 + 20I_2 + 360$

Things to remember:

- Once you make I go a certain direction it needs to go that direction ALWAYS
- The direction must make logical sense
- If you get a - value for I you chose a backwards direction



For this one...determine loops and set up equations

A series-parallel combination circuit