What to Bring

- Non Programmable Calculator
- No larger than 8.5 X 11 Sheet with Notes, Equations, Conversions, What ever you want. Can have information on both sides.

Important Web sites

#1 – National Web Site

http://soinc.org/shock_value_b   "http://soinc.org/shock_value_b"

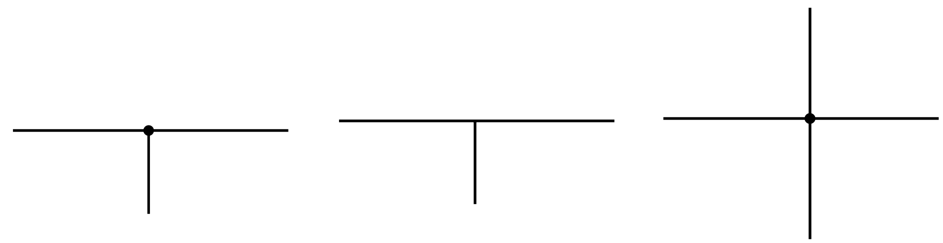
- Other possible Web Sites Many
  - http://www.electronicstheory.com/html/e101-6.htm

Shock Value 2010

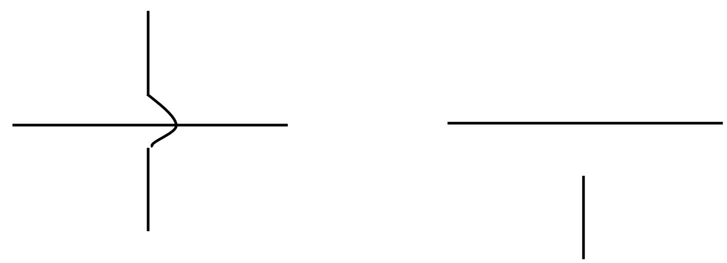
- Students expected to know
  - Voltage, current, direction, pathways, units
  - Series and parallel
  - Connection
  - Analog and digital style meters
  - Electricity
  - Magnetism
    - North / south pole, electromagnetic principles, magnetic versus no magnetic materials
    - Sound and or magnetic forces
    - Magnetic operation within a motor, electro magnet
- Electrical Devices
  - Batteries and polarity; wet cell versus dry cell; kitchen built batteries
  - Light bulb
  - Resistors
  - Switches, power supplies
  - Motors
- Thermal energy
- Light

Basic Electrical Components And Symbols

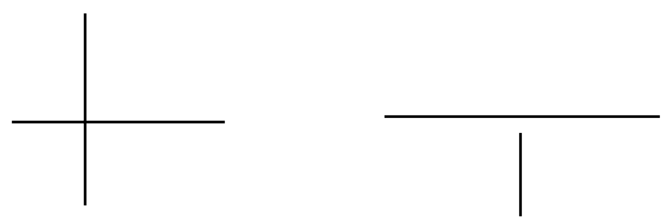
Wire / Connection



Wire / No Connection

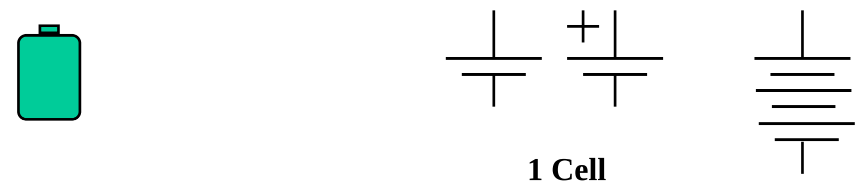


Normally means no connection
Unsure -> Ask



Basic Electrical Components And Symbols

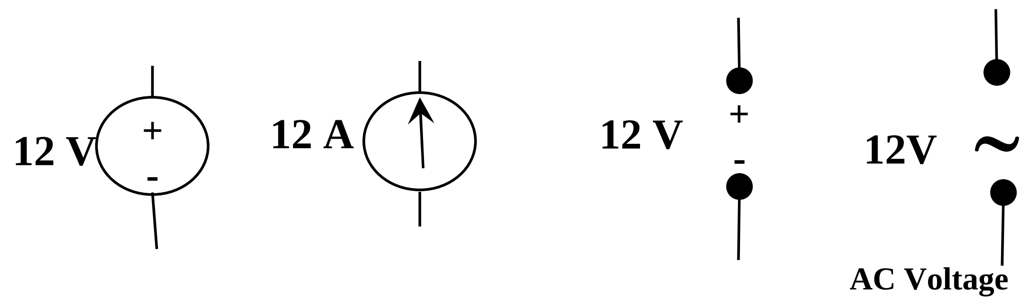
Battery



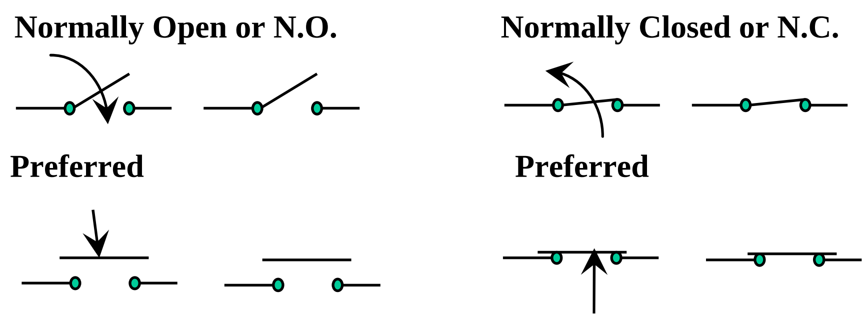
Picture Symbols **Schematic Symbols**

Light Bulb

Power Supply



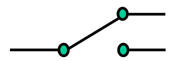
Switch



Basic Electrical Components And Symbols

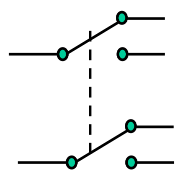
Switch - Complex

Single Pole Double Throw
SPDT



Normally Closed or N.C.
Normally Open or N.O.

Double Pole Double Throw
SPDT



Normally Closed or N.C.
Normally Open or N.O.
Normally Closed or N.C.
Normally Open or N.O.

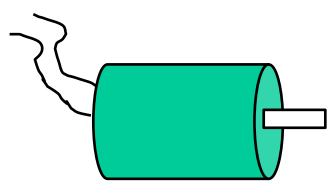
Ammeter

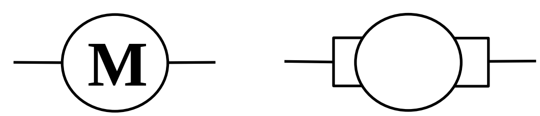
Voltmeter

Ground

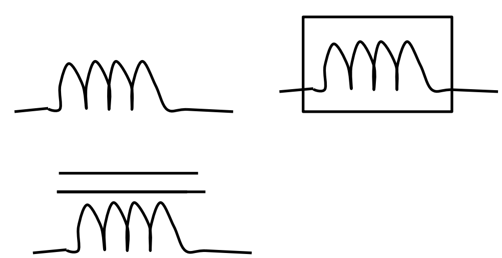
Indicates a zero voltage point or connected to the earth

Motor



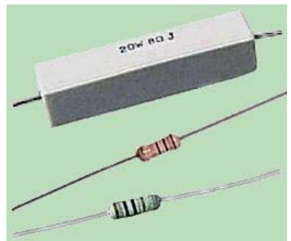


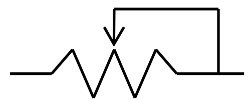
Electro Magnet



Basic Electrical Components And Symbols

Resistor

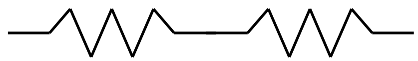




Variable resistor or potentiometer

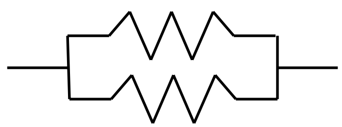
Basic Electrical Concepts

Series Circuit



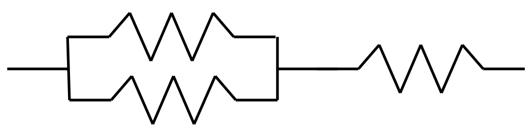
Electrons must flow through both components

Parallel Circuit



Electron will flow through one or the other component

Series Parallel Circuit



Combination of Series and Parallel
Many forms

Basic Electrical Concepts

Voltage

Measured in Volts
Symbol for Volts = V
Potential to do work
Volt = Joule Per Coulomb
Higher Voltage => higher pressure to push electrons

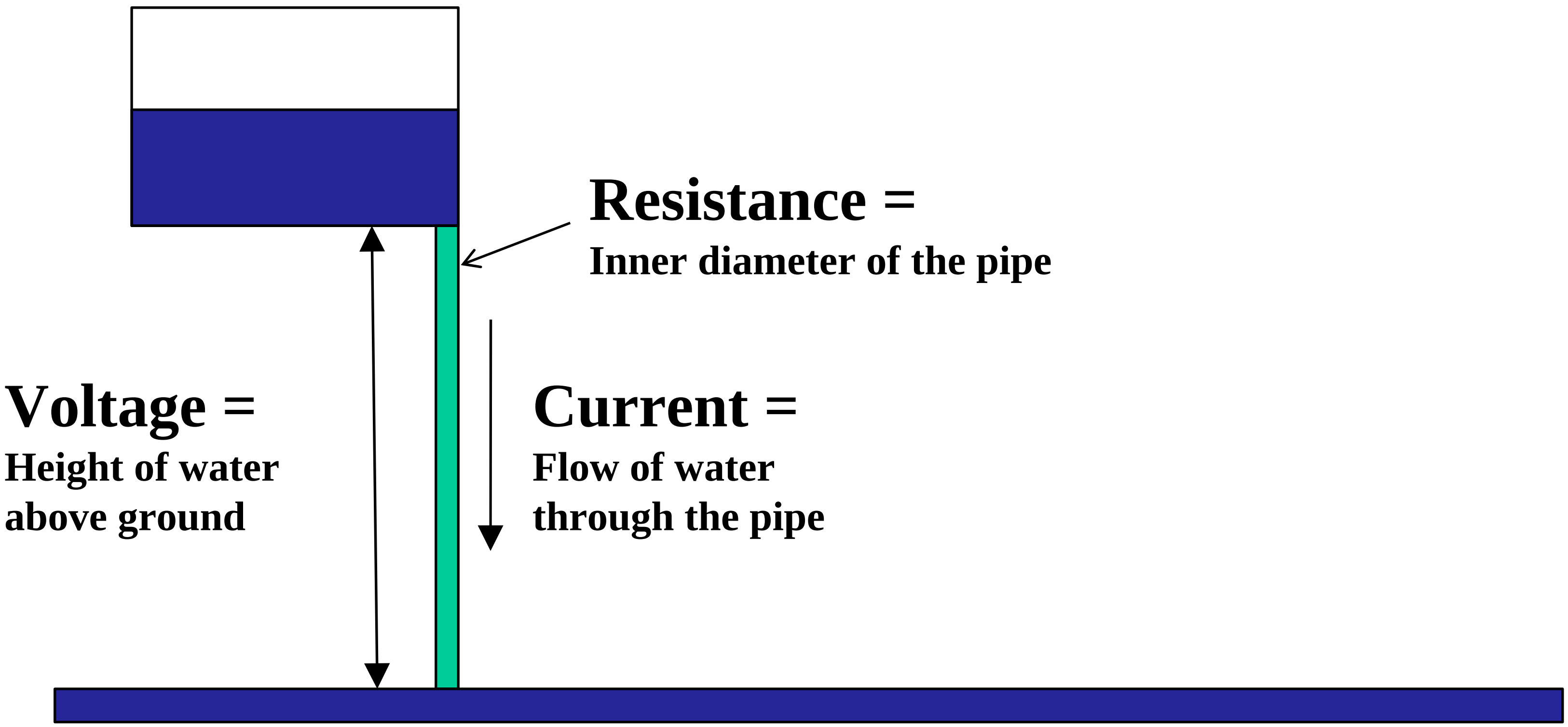
Current

Measured in Amps
Symbol for Amps = A
Rate of flow of electrons
Amps = Coulomb per second
Higher Current => more electrons flowing

Resistance

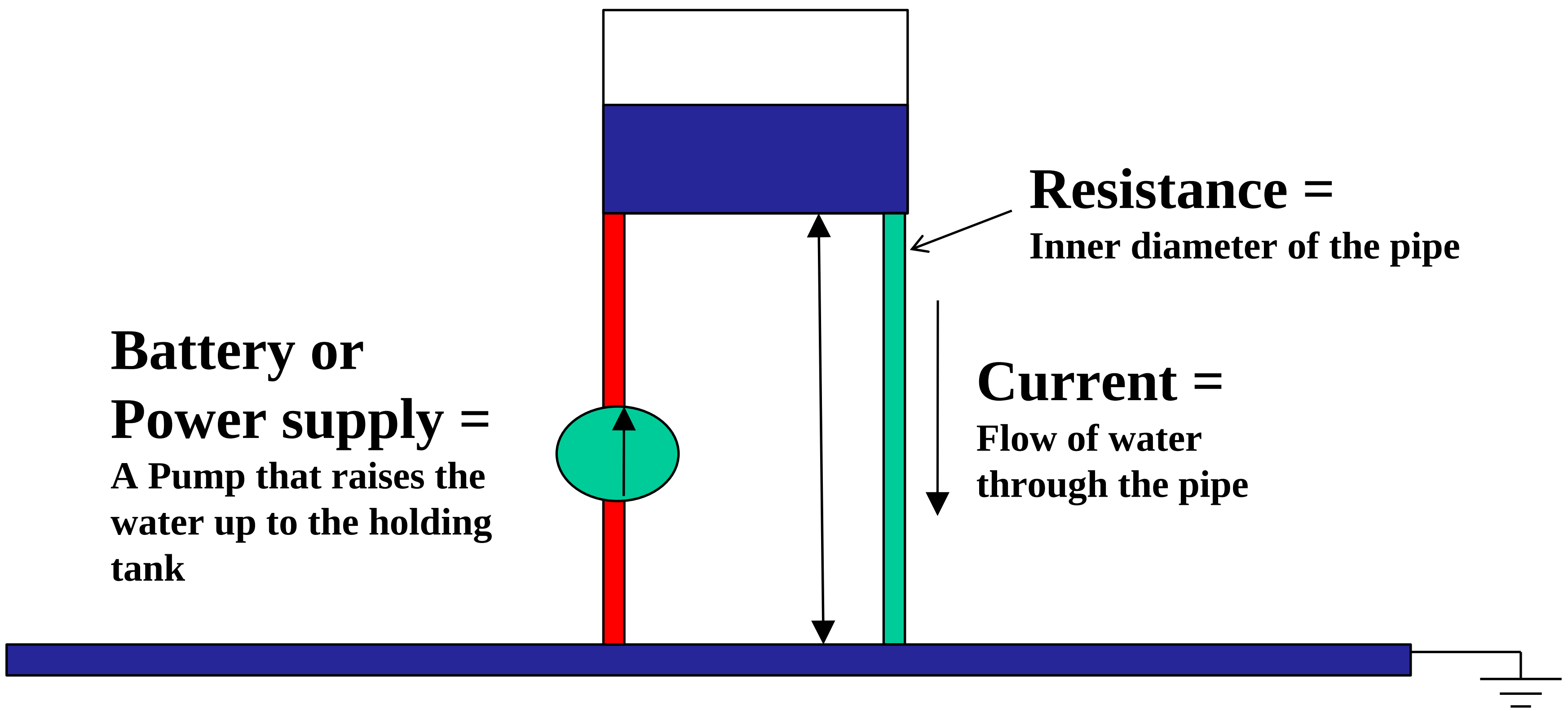
Measured in Ohms
Symbol for Ohms = Ω
Limits / resists the flow of electrons
Resistance – opposition to flow of charge or electrons
Higher resistance => smaller current for a given voltage or larger voltage for a given current

Basic Electrical Concepts – Water Analogy



In the water analogy – electrons are symbolized by water molecules. The height that the water molecules are above ground symbolizes the voltage. The higher the water is above ground the more potential energy the water has; or the more pressure that is exerted by the water.
The resistance is the size of pipe or hole that allows the water to flow out of the tank.
As the pressure increases (voltage increases), more water will flow through a give size of pipe.
As the size of pipe increases (resistance decreases) , more water will flow through a give size of pipe.

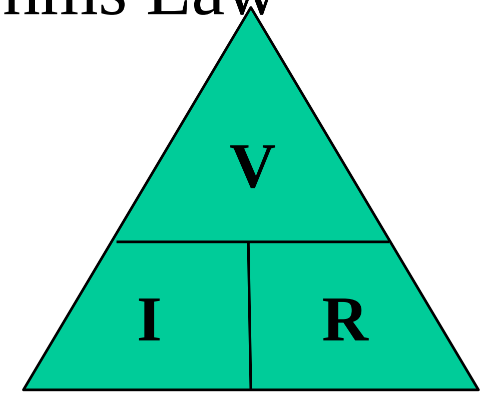
Basic Electrical Concepts – Water Analogy



A battery or power supply works like a pump to replenish the water (electrons) that flow out of the holding tank.
Under their own power, water molecules / electrons only flow from high to low.
It takes an external force to move them from Low to high (Pump; Battery or Power supply)

System only works in an equilibrium – if more water is pushed up than flows through the pipe, the water level in the holding tank increases and overflows. If the current flow out is too large, the tank drains and stops the current flow.

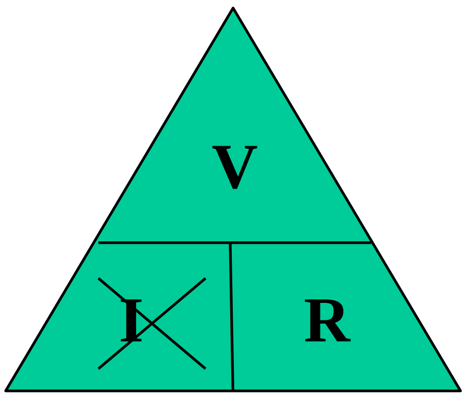
Basic Electrical Concepts – Ohms Law



V = I * R
Voltage = Current * Resistance
Volts = Amps * Ohms

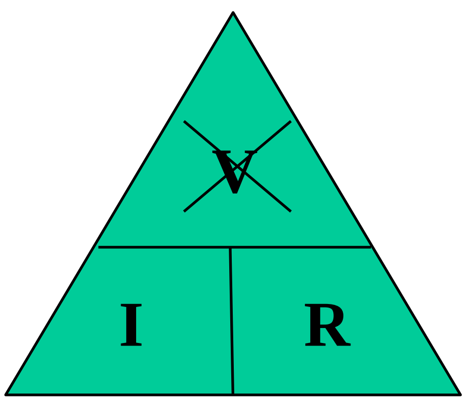
If you know any 2 you can find the other one

I =



= V / R

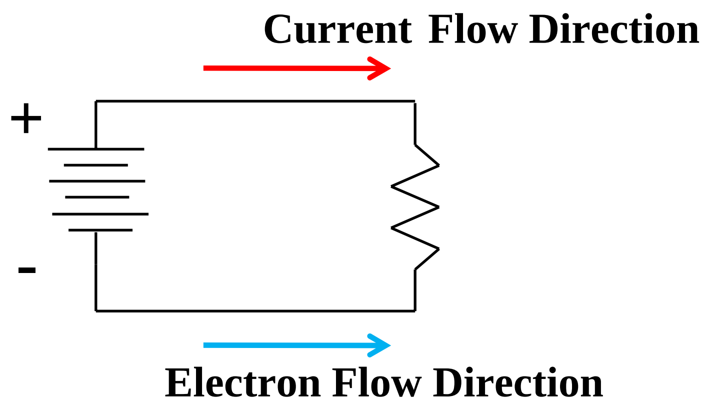
V =



= I * R

Basic Electrical Concepts – The Confusing Part

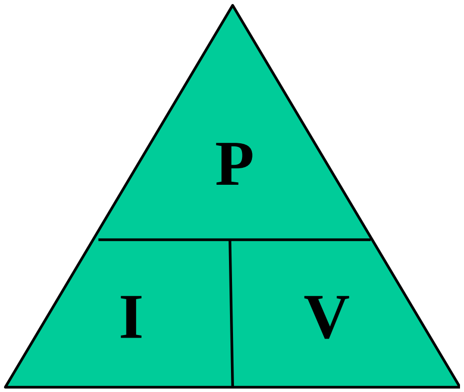
Electron Flow



Because Electrons are negative charged particles, the flow direction of electrons is in the opposite direction of the current flow.

A negative charge * Opposite direction (negative) = Positive current flow

Basic Electrical Concepts – Power and Energy



The Power Triangle

Power = Voltage * Current
Measured in Watts
Symbol for Watts = W
Power is the rate that work is being performed
Higher Power => Higher rate of performing work

Energy = Power * Time = Voltage * Current * Time
Measured in Watts * Seconds or Joules
Symbol for Energy = J
Energy is the amount of work that is / was done
Higher Energy=> Higher amount of work

The watt (W) is the unit of power, the rate at which energy is supplied.

1 kilowatt (kW) *equals* **One thousand watts**
1 megawatt (MW) *equals* **One million watts**
1 gigawatt (GW) *equals* **One thousand million watts**
1 terawatt (TW) *equals* **One million million watts**

The kilowatt hour (kWh) is the unit of total energy supplied, as registered by domestic electricity meters.
1 kilowatt-hour *equals* **One thousand watts supplied for one hour**

MWh, GWh, TWh *equals* **Multiples of a thousand, as above**

(a kilowatt-hour is equivalent to 3,600,000 joules, the SI unit)

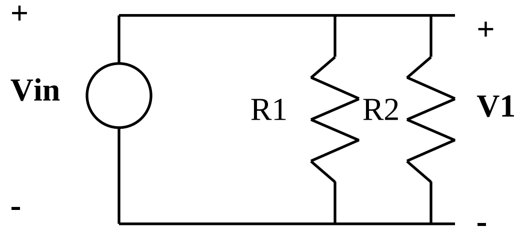
Basic Electrical Concepts – Power and Energy

Light bulbs typically give a power rating 60, 75, 100, 150 Watts. This rating is the rate at which the light bulb consumes power. Typical outlet voltage is 120 VAC, therefore a 60 watt light bulb draws 0.5 amps at 120VAC.

If the light bulb stays on for 1 hour, the light bulb will consume 60 W * 3600 s = 216,000 J of Energy.

A 120 watt light bulb is twice as much power and therefore will consume twice as much energy as a 60 watt light bulb over the same amount of time.

For a conventional style light bulb, the rating of the bulb is the power that is put into the bulb. This power produces two things – Light and Heat. The efficiency of the bulb is the ratio of the Amount of Light Generated / Power Consumed. The heat generated is wasted energy. Florescent bulbs generate less waste heat and therefore more light per watt of power consumed.



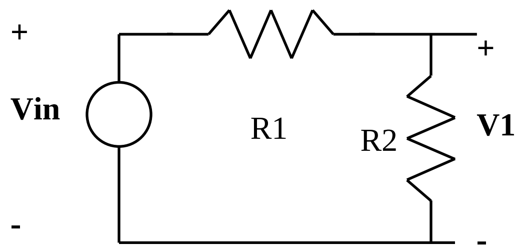
Simple Parallel Circuit

Vout = Vin - The voltage is the same across both resistors.

To find Req – Req = R1 * R2 / (R1 +R2)

To find current through one of the resistor, use Vin = I*R1 or I = Vin/R1

To find the current from the supply use Vin = I* Req or I = Vin / Req



Simple Series Circuit

$I_{R1} = I_{R2}$ - The current is the same through both resistors.

To find Req – Req = R1 + R2

To find current through one of the resistor (either of the resistors since the current is the same), use Vin = I*Req or I = Vin/Req

To find the current from the supply use I = Vin / Req (Same current as the current through the resistors)

To find the voltage across a resistor use the voltage divider rule

$$V1 = \frac{Vin * R2}{R1+R2}$$

Ohms Law

$V = I * R$

$I = V / R$

$R = V / I$

Power

$P = V * I$

$P = V * V / R$

$P = I * I * R$

Resistor Equations

Resistors in Series

$Req = R1 + R2 + R3 \ldots$

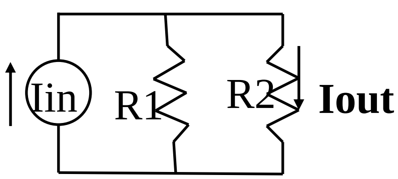
Resistors in parallel

$$Req = \frac{1}{1/R1 + 1/R2 + 1/R3 \ldots}$$

For only 2 Resistors

$$Req = \frac{R1 * R2}{R1 + R2}$$

Current Divider Rule

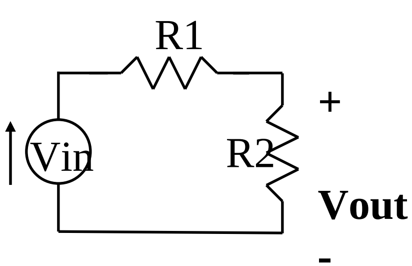


$$Iout = \frac{Iin * R1}{R1+R2}$$

For example if R1 = 1K, R2 = 4 K, and Iin = 5 Amps

Iout = 5* 1 / (1+4) = 1 Amps

Voltage Divider Rule

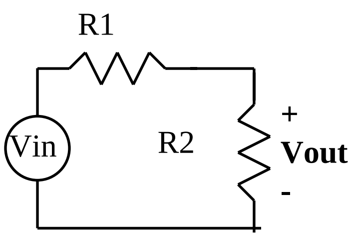


$$Vout = \frac{Vin * R2}{R1+R2}$$

For example if R1 = 1K, R2 = 4 K, and Vin = 5 Amps

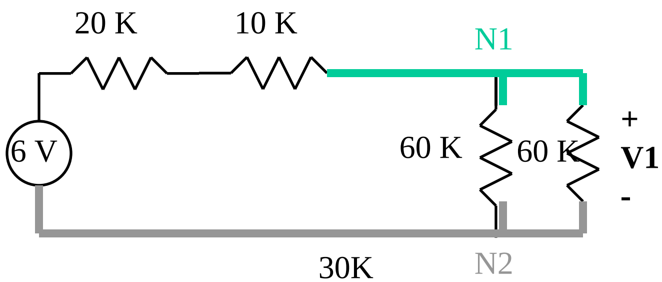
Vout = 5* 4 / (1+4) = 4 Volts

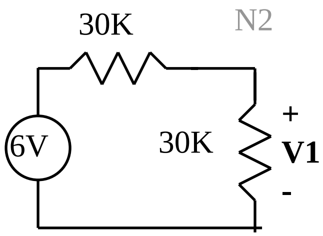
Voltage Divider Rule



$$Vout = \frac{Vin * R2}{R1+R2}$$

For example if R1 = 1K, R2 = 4 K, and Vin = 5 Volts
Vout = 5* 4 / (1+4) = 4 Volts





Steps to find V1

Simplify resistor values using parallel and series rules.

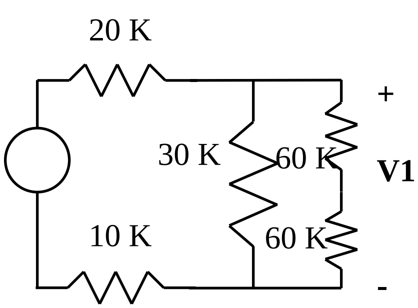
The two series 10K's can be combined to a single 20K.

The two parallel 60K's can be combined to a single 30K

You can not combine the 60K's and the 10K's because you will change the value of V1

V1 is the voltage between the two wires N2 and N2.

Anything that is between the nodes can be combined together, and anything that is outside of the nodes can be combined together without changing the result.



For example you can combine the 20K and the 10K as series resistors (30K) in either leg of the power supply circuit without changing the value of V1.

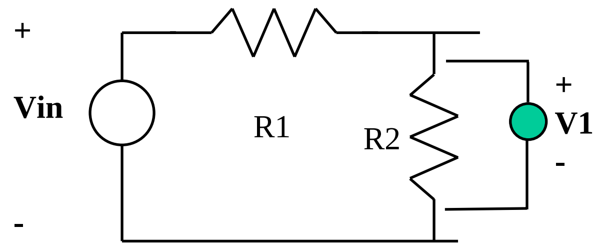
You can also combine the two 60K's and the 30K without changing V1

After simplification, the problem becomes an easy application of the voltage divider rule

Multimeter Basics

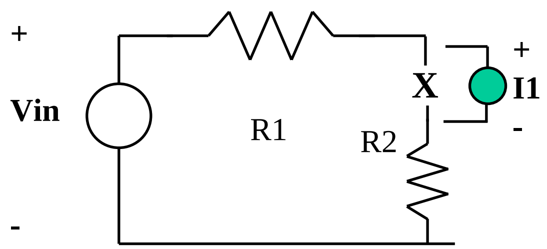
- A Multimeter is used to measure:
  - Voltage
  - Resistance
  - Continuity (level of resistance)
- When using a Multimeter, you must properly set it to either AC or DC, depending on the voltage you’re trying to measure.

Using Meters



Measure Voltage

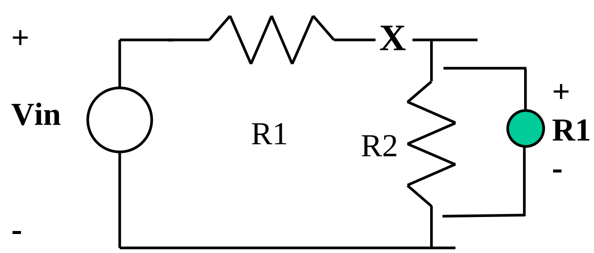
Voltage is measured across a component. Otherwise known as a voltage drop across the component. The meter is connected in parallel with the component to be measured.



Measure Current

Current is measured as a flow through a component. In order to measure current through a component, you will have to disconnect the circuit and hook the meter in series with the component to measure the current through.

Watch for Short Circuit



Measure Resistance

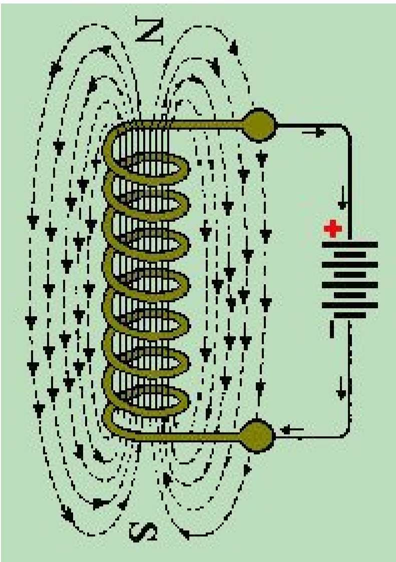
Resistance is measured across a component. The meter is connected in parallel with the component to be measured. In order to accurately measure the resistance, you should disconnect other components to prevent them from interfering with your reading.

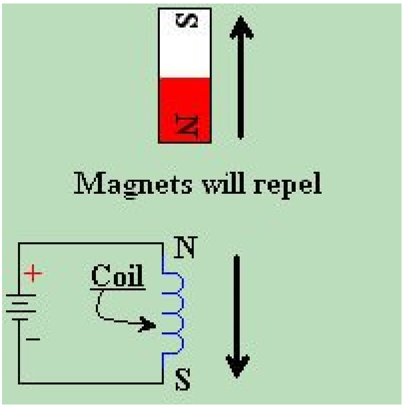
Basic Electrical Concepts – Electro Magnetism

Forcing electrons to travel in a circle causes a magnetic field.

North and south poles form because of the circulation of the electrons

Right Hand Rule





Links

- http://www.electronicstheory.com/html/e101-6.htm
  - Many Pages on electronics and magnetism
  - (www.electronicstheory. Com/html/e101-6.html)