Circuit Wizardry Event Study Guide

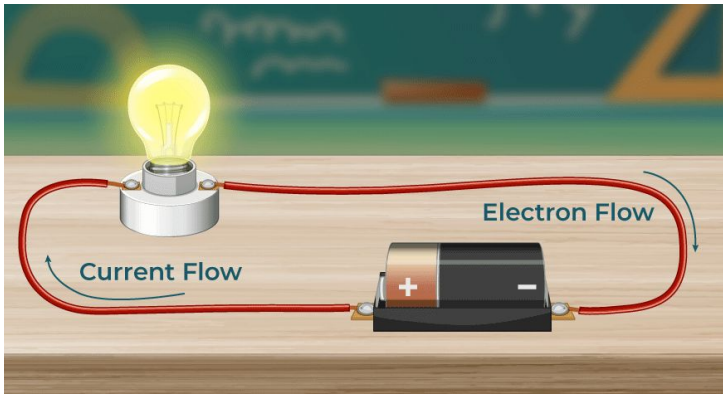
Basic Units of Measurement + Concepts

Basic SI Units

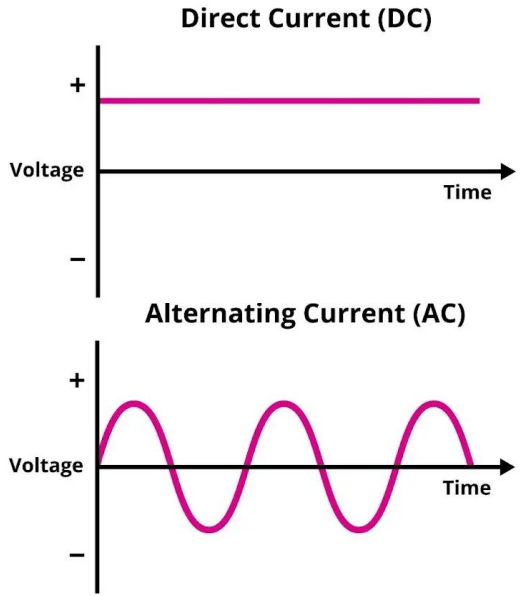
- Charge - Coulombs
  - Measure of the number of Positive(+) or Negative charges(-)
- Current - Ampere = Coulomb/second (A)
  - Rate, measure of charge / time
- Voltage - Volt (V), Joule/Coulomb
  - Potential Difference between two points, positive minus negative or negative minus positive

Current

- Defined as the flow of positive charges from the positive end to the negative end of a power source
  - Electrons flow in the opposite direction
- Can be Direct or Alternating



Alternating vs Direct Current



DC: Constant and direct flow of current in one direction(+ -> -). Commonly seen in batteries.

AC: Alternating flow of current that periodically changes. Can take different shapes (sin wave, square, etc.) Seen in wall outlets.

WESO only uses DC Current.

Voltage

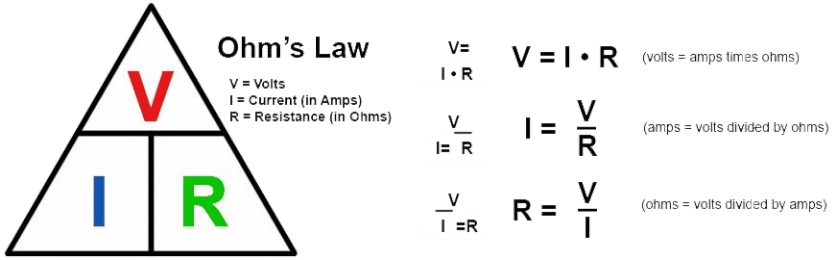
- Electrons only move when there is a difference in charge between two different locations
  - This difference in charge is called the “potential difference”
- Heavily dependent on location, measuring from positive to negative or negative to positive will change the sign from positive to negative voltage

Conductors Vs. Insulators

Conductors allow electricity to move through them easily, while insulators hinder or completely stop the flow of electricity.

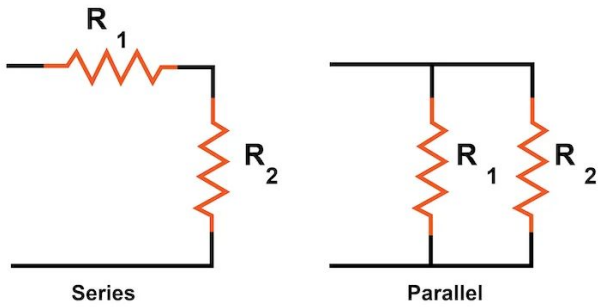
Wires used in circuits are often made with conductive material and surrounded by insulative material so electricity to prevent injury

Ohm’s Law



Ohm’s law is the fundamental relationship between voltage, current, and resistance. As long as you know ⅔, you can calculate the other.

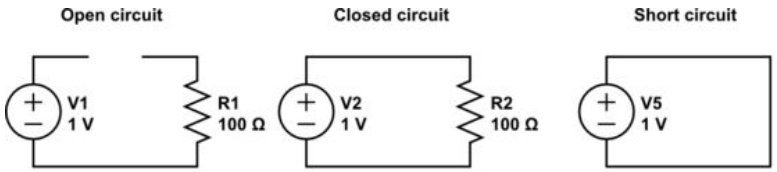
Parallel vs Series Components



Series: Components connected by one end. Current is the same between all components, however voltage is split amongst them depending on resistance

Parallel: Components are connected at both ends, voltage is the same but current is split

Open Vs Closed Vs Short Circuits



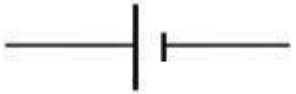
Open Circuit: Portion of wire in the circuit is disconnected, not allowing current to flow from + to - end.

Closed Circuit: No breaks in wire, current is flowing through from + to -

Short Circuit: Circuit with low/no resistance. Can create a surge in energy and extreme heat (not good)

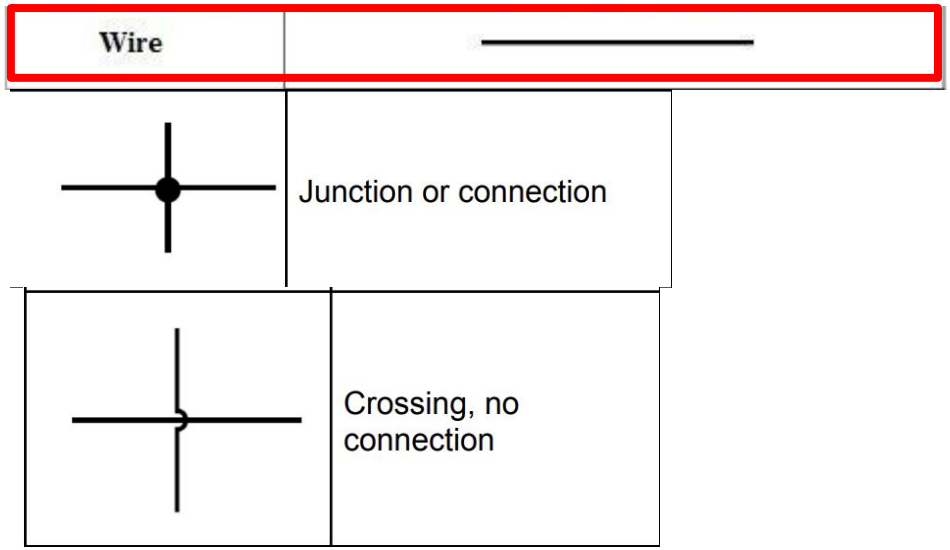
Circuit Components

General Overview

Component	Circuit Diagram Symbol
Wire	
Resistor	
Light bulb	
Cell	
Battery	
Switch	

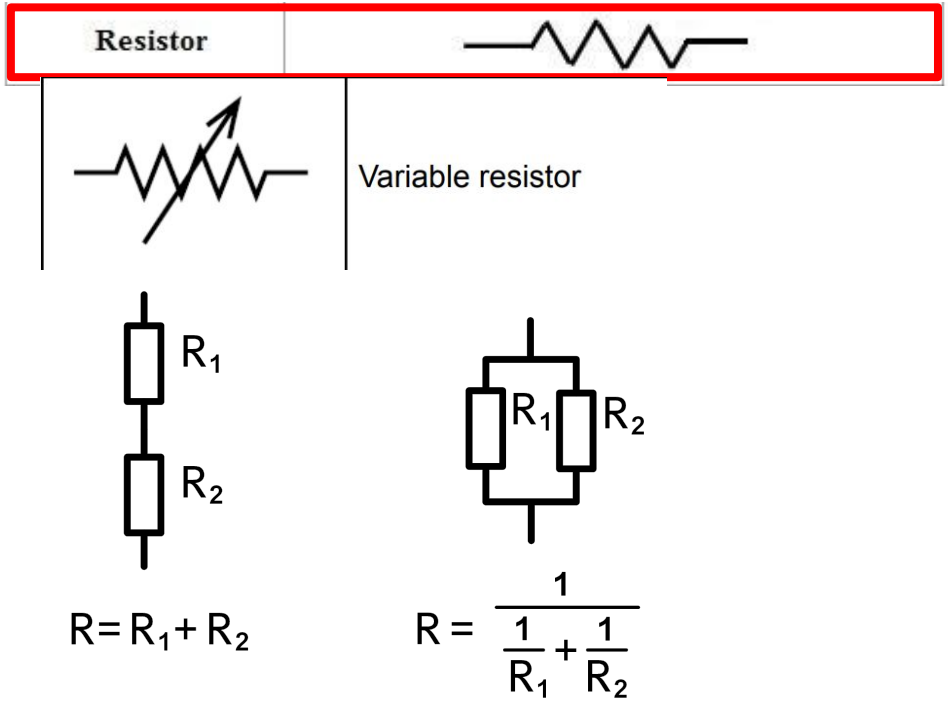
Most common Circuit Components you will see and use

Wire



A Conductor that connects circuit components together. May or may not be connected to a component.

Resistor

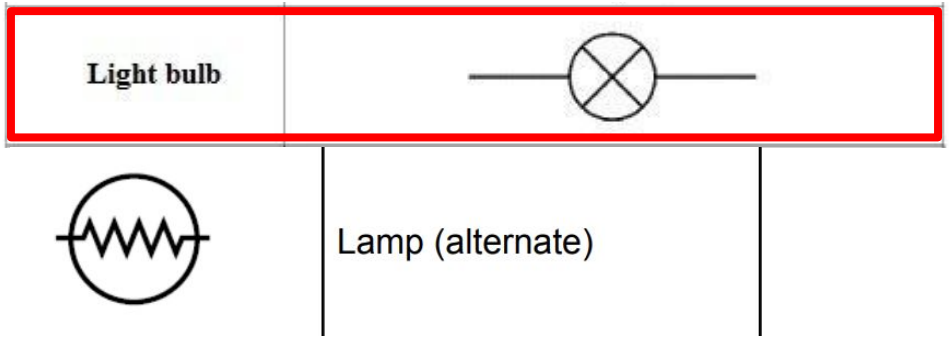


A resistor slows down the current, dissipating heat in the process. This results in a voltage drop across the resistor (can be measured with a multimeter).

Strength is measured in Ohms(Ω)

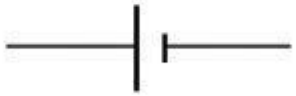
Series resistors add together, parallel add inversely

Light Bulb



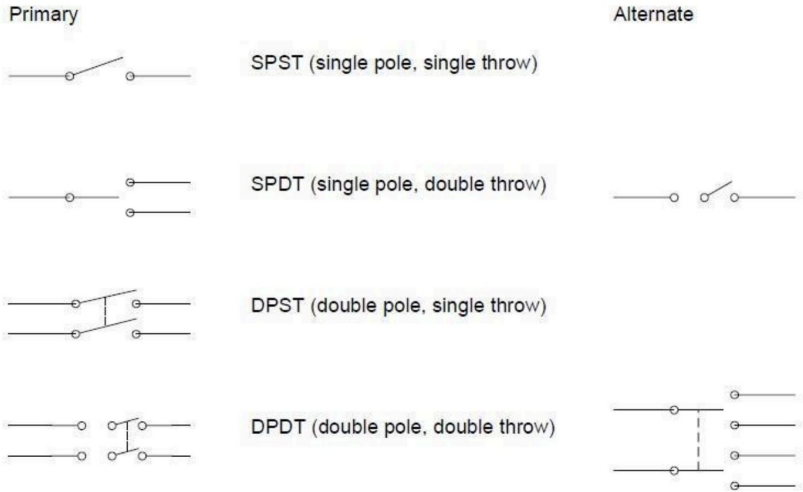
Light that releases energy as light and heat. As with resistors, it has a voltage drop across it.

DC & AC Power Sources

Cell	
Battery	

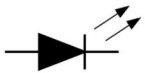
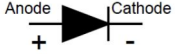
Cells and Batteries provide DC current to your circuit. These will be the main power sources you will be using.

Switches



When open, the circuit does not allow current to flow through. When closed current is allowed to flow through like a normal wire with no gap. Can be single/double poles, single/double throws

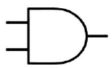
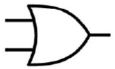
Diodes

	Diode		LED (light emitting diode)
	Diode terminals and polarity		

Highly dependent on orientation: + and - end labeled. Only allows current from + to - end. Acts as an insulator if polarity is reversed. + end is normally longer

LED diodes emit light when current flows through

Logic Gates

Logic Gate Symbol	Truth Table
NOT 	Input | Output 0 | 1 1 | 0
AND 	Input1 | Input2 | Output 0 | 0 | 0 0 | 1 | 0 1 | 0 | 0 1 | 1 | 1
OR 	Input1 | Input2 | Output 0 | 0 | 0 0 | 1 | 1 1 | 0 | 1 1 | 1 | 1
XOR 	Input1 | Input2 | Output 0 | 0 | 0 0 | 1 | 1 1 | 0 | 1 1 | 1 | 0

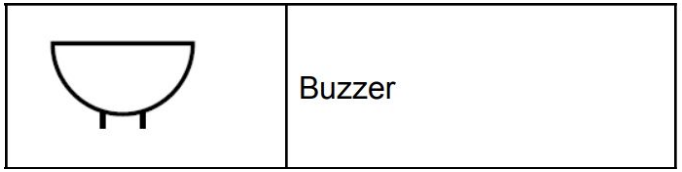
Not: Inverts signal

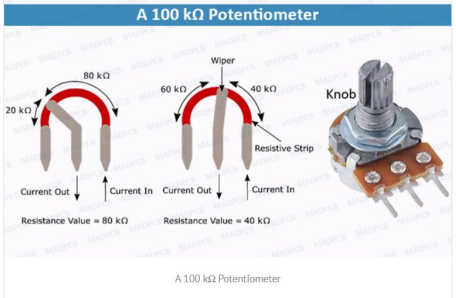
And: Requires both signal as 1/active for an output signal

Or: Requires either or both signals as 1/active for an output signal

Xor: Requires either signal as 1/active for an output signal, won't accept two signals

Miscellaneous Components



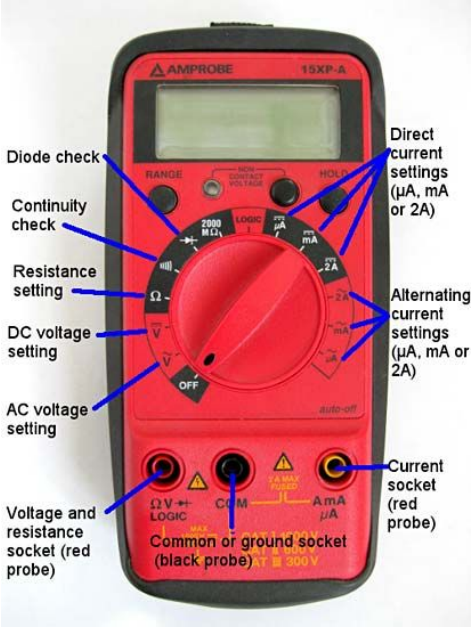


Buzzer: Can be orientation based like diode, current needs to flow from + to -. Creates sound when current flows through.

Potentiometer: Similar to variable resistor. 3 terminal knob that acts as a voltage divider. Changes resistance as knob turns

Measurement Tools

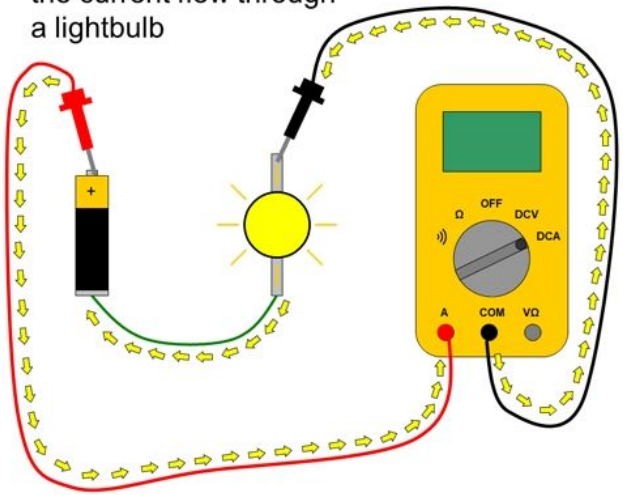
Multimeter



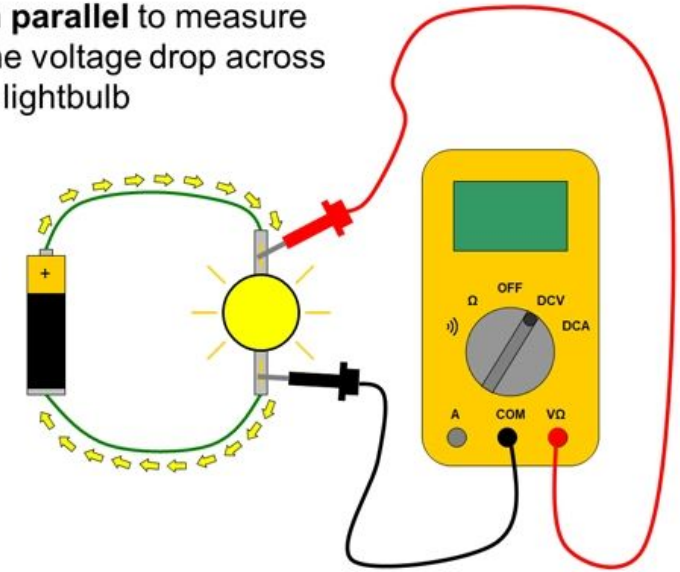
A digital multimeter is able to display the voltage across circuit components and the current going through them. Students should only need the DC Voltage setting. Ensure probes are placed in Com (Black probe) and V (Red Probe) slot. Convention has red on + end and black on - end

Using the Test Probes

Connect a multimeter in **series** to measure the current flow through a lightbulb



Connect a multimeter in **parallel** to measure the voltage drop across a lightbulb



Practice Problems

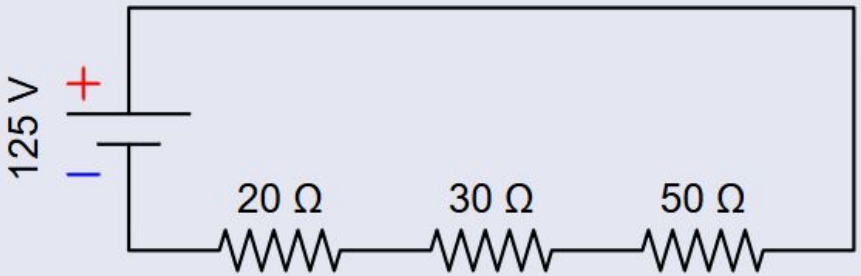
Determine the following quantities for the given circuit…

i. the equivalent resistance

ii. the current from the power supply

iii. the current through each resistor

iv. the voltage drop across each resistor



Determine the following quantities for the given circuit…

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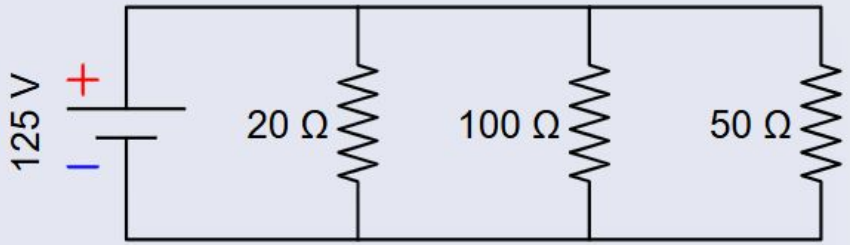
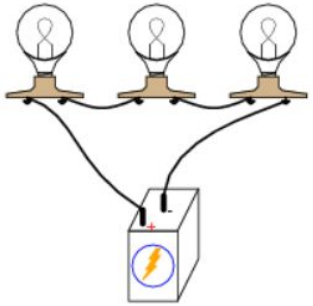
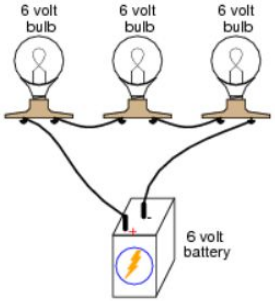
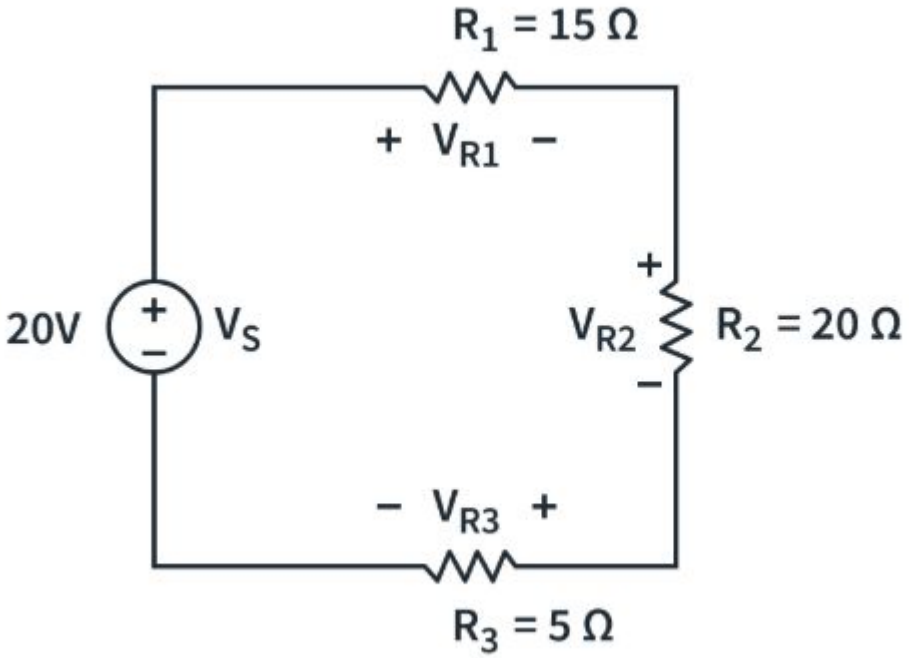


Re-draw this circuit in the form of a schematic diagram:



What would happen if three 6-volt light bulbs were connected as shown to a 6-volt battery? How would their brightnesses compare to just having a single 6-volt light bulb connected to a 6-volt battery?





Find the voltage across R1, R2, and R3

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