Simulation: Series and Parallel Circuits

Purpose: To discover how the design of a circuit- series vs. parallel- compare.

Theory: A circuit is any path through which current will flow. Circuit diagrams are the way we represent these circuits, see the common symbols used in the table shown.
When a switch is open (also shown on the right), we call that circuit an 'open circuit' and no current will flow. When the circuit forms a complete loop, it is a closed circuit, and current will flow from high potential (voltage) to low potential. We draw current from the positive terminal of the battery to the negative terminal (high to low potential, like electric field lines).

	Battery		Resistor
	Switch (Open)		Capacitor
	Switch (Closed)	A	Ammeter
	Wire	V	Voltmeter
OR	Light bulb		

Instructions:

1. Go to Circuit Construction Kit: DC (click this link) and click the "**Lab**" simulation.
2. Check the boxes on the right to show the conventional current, labels, and values of the components in the circuit.
3. Build each circuit shown with the provided equipment in the simulation.
4. Record your observations about the qualitative brightness of the bulbs.
5. Repeat steps 1-2 until all circuits have been analyzed.

Part 1: Getting Ready

In the simulation, create a simple circuit using 1 battery, 1 switch, 1 light bulb and wires.
Explore the controls and tools to answer the following.

1. Fill out the table below with the devices and units.

	Unit	Device used to Measure
Electrical Current		
Electrical Potential Difference		

2. Exploring the switch and current.
   a. Connect Ammeter to any wire in your circuit. Keep the switch open. What is the reading on the ammeter? _____A
   b. Close the switch by clicking the switch in your circuit. What is the reading on the ammeter? _____ A
      i. Move the Ammeter to at least 5 different locations in the circuit, how does the currents compare?

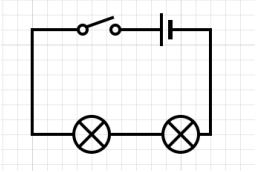
   c. Why is the reading value different when switch is open and closed? (Hint: read theory again.)

3. Optional Extra Challenge (skip ahead if you don't want the challenge)
   What is the quantitative relationship between voltage, current, and resistance?

   a. What is the resistance of the light bulb? _____ Ω
   b. Click on the battery to change the voltage. Collect at least 5 data points with voltage, and resulting current, between 5-100 volts. Input these into an excel sheet with Voltage (V) and Current (A) columns.
   c. Create a scatterplot graph of the voltage (x-axis) vs. current (y-axis) and input a linear trendline. Paste a screenshot of the graph on the right of this page in OneNote.
   d. What does the slope represent? Use unit analysis and the known values to determine an equation relating voltage, current, and resistance.

Part 2: Series Circuits

Create the circuit pictured right consisting of 1 battery, 1 switch, and 2 light bulbs (and wires).

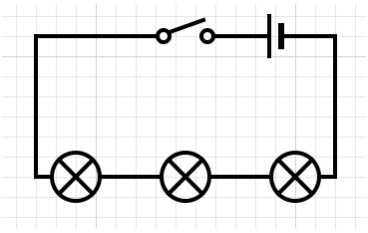


1. Close the switch by clicking the switch in your circuit and connect ammeter to any wire in the circuit. What is the reading on the ammeter? _____ A

2. Connect Voltmeter to both end of your battery. What is the voltage across the battery? _____V

3. Count number of light streaks around each light bulb, the relative brightness, and record the numbers in the table below. Click "**Values**" on the top right corner of the simulation. Compare the values of your light bulbs by connecting ammeter to each bulb. Connect the voltmeter across the light bulb (one lead on each side) to measure the voltage, or electric potential difference, across each bulb.

Light Bulb	Relative Brightness	Current	Voltage
A			
B			



Add another light bulb, so now you have a circuit with 3 light bulbs in series.

4. Close the switch by clicking the switch in your circuit and connect ammeter to any wire in the circuit. What is the reading on the ammeter? _____ A

5. Connect Voltmeter to both end of your battery. What is the voltage across the battery? _____V

6. Count number of light streaks around each light bulb (brightness) and record the numbers in the table below. Click "**Values**" on the top right corner of the simulation. Compare the values of your light bulbs by connecting ammeter to each bulb. Connect voltmeter across your light bulbs one at a time.

Light Bulb	Relative Brightness	Current	Voltage
A			
B			
C			

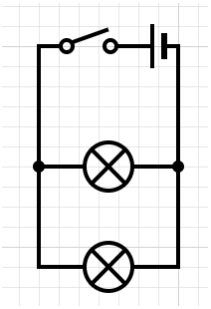
Analyze your data above to answer the following questions with respect to series circuits.

7. How did the brightness of the bulbs change as more bulbs were added to the circuit?

8. How did the current of the series circuit change as more bulbs were added to the circuit?

9. How did the voltages across the bulbs change as more bulbs were added to the circuit?

Part 2: Parallel Circuits



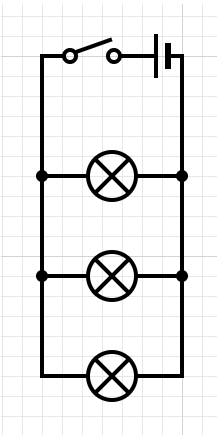
Create the circuit pictured left consisting of 1 battery, 1 switch, and 2 light bulbs (and wires).

1. Close the switch by clicking the switch in your circuit and connect ammeter near the battery. What is the reading on the ammeter? _____ A

2. Connect Voltmeter to both end of your battery. What is the voltage across the battery? _____V

3. Count number of light streaks around each light bulb, the relative brightness, and record the numbers in the table below. Click "**Values**" on the top right corner of the simulation. Compare the values of your light bulbs by connecting ammeter to each bulb. Connect voltmeter across your light bulbs one at a time.

Light Bulb	Relative Brightness	Current	Voltage
A			
B			



Add another light bulb, so now you have a circuit with 3 light bulbs in parallel.

4. Close the switch by clicking the switch in your circuit and connect ammeter to a wire near the battery in the circuit. What is the reading on the ammeter? _____ A

5. Connect Voltmeter to both end of your battery. What is the voltage across the battery? _____V

6. Count number of light streaks around each light bulb, the relative brightness, and record the numbers in the table below. Measure the current through your light bulbs by connecting ammeter to each bulb. Connect voltmeter across your light bulbs one at a time.

Light Bulb	Relative Brightness	Current	Voltage
A			
B			
C			

Analyze your data above to answer the following questions with respect to parallel circuits.

5. How did the brightness of the bulbs change as more bulbs were added to the circuit?

6. How did the total current in the circuit change as more bulbs were added to the circuit? How did the current across each bulb change?

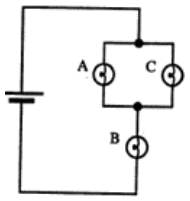
7. How did the voltages across the bulbs change as more bulbs were added to the circuit?

Part 3: Putting it all together

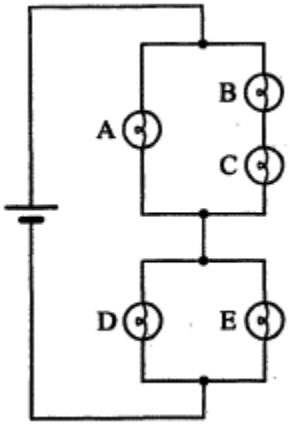
1. Compare and contrast series and parallel circuits in terms of how current and voltage change.

2. What variable seems to influence the relative brightness of bulbs? (ie. Current, Voltage, Resistance). There may be more than one correct answer.

3. Without using the simulation, rank the bulbs in the 'combined circuit' shown in order of brightness. Explain your reasoning. You may create it in the simulation to check after you have ranked them.



4. Different combined circuit! Make predictions based on your observations above. You are welcome to use Ohm's Law to support your answer.



   a. How would the brightness of bulb B compare to bulb C? Explain.

   b. How would the brightness of bulb A compare to bulb B? Explain.

   c. How would the brightness of bulb D compare to bulb E? Explain.

   d. How would the brightness of bulb D compare to bulb A? Explain.

Optional Extra Challenges!

Using the motor, battery pack, and LED bulb, create a series circuit and a parallel circuit. In which circuit will the motor spin faster? In which circuit will the LED light and/or be brighter? Why?
Insert a picture of your circuits below.
***hint- you may need to research LEDs to help create and understand the circuit- here's a link to the LED's I bought for your kits! https://www.amazon.com/gp/product/B07N1Y965C/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1*

Try this game that challenges you to draw a series or parallel circuit diagram based on the relative brightness of bulbs and behavior of switches! https://universeandmore.com/crack-the-circuit/ Send me a screenshot of the highest level you achieve!