**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Block:\_\_\_\_\_Date:\_\_\_\_\_\_\_\_\_\_\_\_**

**Electric Circuits Lab (part 1)**

**Purpose:** To construct series and parallel circuits

 To compare the current, voltage, and resistance in series and parallel circuits

To draw schematic (circuit) diagrams of various circuits

**Materials:** Computer with internet access and Java/Flash for simulated circuit kit

**Go to:** <https://phet.colorado.edu/sims/html/circuit-construction-kit-dc/latest/circuit-construction-kit-dc_en.html> Or you can google “Phet circuits” and choose DC virtual lab. **Choose the lab part**

**You must read this to understand how to work with the program!**

**Simulation basics:**

1. maximize the window so you have more room to work
2. the simulation labels a cell as a battery, this lab properly calls it a cell. They should **both be 9 volts** and if you need 2 of them, they should be placed **side by side** in the circuits, not separated by other components.
3. all you need to do for part 1 of the lab to make circuits is to click and drag items from the left side onto the blue workspace, click on items and click the trash can at the bottom if you need to delete and click on the circle of the connection and the scissors if you need to disconnect them.
4. do not connect bulbs directly to anything, use wires and put the cells together in the circuit.

Here are the symbols you should use for your sketches. Notice, the wires are connected as straight lines or at right angles.

**Draw them the same on your sketches**

If you notice, the light bulb has 2 places where a wire can connect. You must be sure to connect a wire to each place and not both on the same spot. This could result in no power to your circuit or the batteries catching fire.

Also, if you click on the bulb, you will see a siding tab on the bottom of the screen where you can change the resistance of the bulb. It is automatically set at 10 ohms of resistance but you will be asked to change it to other values throughout this lab.

**Part 1:**

You will construct 4 different electric circuits using various combinations of cells, light bulbs and wires as indicated in the table below. **Be careful when using multiple cells to always connect (+) to (-).** Be sure to complete the following for each circuit: ***(read each first)***

Describe the brightness of each bulb when your circuit is complete.

Draw a circuit diagram for each setup. Use the **symbols** provided in **Fig A**.

 (remember a light bulb is a resistor)

Identify each circuit as series or parallel. I realize you might be guessing at this, but make an educated guess.

|  |  |
| --- | --- |
| **One cell and one bulb**a) Very Brightb)c) Series | **One cell and two bulbs**a) Bright b)c) Series  |
| **Two cells and one bulb**a) Very Brightb)c) Series | **Two cells and two bulbs**a) Bright b)c) Series  |

**Have your teacher approve your work up to this point.**

**Electric Circuits Lab (part 2)**

**Series Circuits**

R= 5Ω

**Part 2: Single bulb series circuit**

**#1**

* 1. Use bulb #1 and click on it. Notice there is a resistance scale at the bottom of the screen. Set the resistance of bulb 1 to 5.0 ohms **always** throughout this lab and construct the circuit shown in **Figure B** . Measure the voltage provided by the battery (**2 cells**) by touching the red led on the voltmeter to the (+) end of one battery and the black led to the (-) end of the other battery. Notice that the leds are placed **“ACROSS”** the battery, this is how you measure voltage. **Record this value (ignore +/-) on the right side of the page as a whole number.**
	2. Now measure the voltage across the light bulb in the same manner. This means red on left side of light and black on the other side of the light. **Record this value as the voltage “ACROSS”.** **(ignore +/-) on the right side of the page as a whole number.**

**+**

**-**

* 1. This is also known as the “**voltage drop**” due to the electrical energy being converted into heat and light by the bulb. **Record this value as the voltage “DROP” on the right side of the page as a whole number.** *Note that this is the same value as the voltage “across” from the previous step.*
	2. Measure the current in the circuit by connecting the ammeter “in-line” between the (+) end of one cell and the light bulb. Basically you are adding the ammeter to the circuit just like you would another piece of wire. **Record this value (ignore +/-) on the right side of the page with one decimal.**

R= 10Ω

**#1**

* 1. Calculate **(G-U-E-S-S)** the resistance of the light bulb in the space provided on the right, using the bulb’s voltage drop and the current measured.

**#2**

* 1. Repeat steps 1-5 using bulb #2 but change the resistance of bulb #2 to 10.0 ohms. You will **always** set bulb #2 to 10.0 ohms throughout the lab.

**The directions are on the left side of the page for these questions. Please read and follow them before trying to create your circuits.**

**Part 2: Single bulb series**

**LIGHT BULB #1**

1. What is the voltage
2. Voltage provided by the battery (both cells) \_\_\_\_18 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2) Voltage “ACROSS” light bulb #1 \_\_\_\_\_\_\_\_\_18 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3) Voltage “DROP” for light bulb #1 \_\_\_\_\_\_\_\_\_\_18 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4) Current in the circuit with light bulb #1 \_\_\_\_\_3.6 Amps\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5) Calculate the Resistance of light bulb #1 (Show G-U-E-S-S)

R=V/I 18V/3.6A = 5 ohms

Work approved \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**LIGHT BULB #2**

6) Voltage provided by the battery (both cells) \_\_\_18 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Voltage “ACROSS” light bulb #2 \_\_\_\_\_\_\_\_\_\_\_\_18 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Voltage “DROP” for light bulb #2 \_\_\_\_\_\_\_\_\_\_18 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Current in the circuit with light bulb #2 \_\_\_\_\_\_\_\_1.8 Amps\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Calculate the Resistance of light bulb #2 (Show G-U-E-S-S)

R = V/I

R = 18V/1.8A = 10 ohms

Work approved \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Electric Circuits Lab (part 3)**

**Two bulb series circuit**

* 1. Use both bulbs, #1 and #2, to construct a circuit like **Figure C**. This is a series circuit because there is only one pathway for the current to flow. Remember the resistors are the bulbs.
	2. Disconnect one of the bulbs and complete the circuit with the other one in it. What happens to the bulb in the circuit when you have only one compared with two? Write your answer on the right then reconnect the bulb. Brighter
	3. Measure the voltage provided by the battery by touching the red led to the (+) end of one battery and the black led to the (-) end of the other battery. **Record this value.** **(ignore +/-) on the right side of the page as a whole number.**
	4. Measure the voltage drops across**each** light bulb (if you forgot what a voltage drop is, look back at part 2). **Record this value on the right side of the page as a whole number.**
	5. Add the voltage drops of each bulb together. This should equal the voltage provided by the battery, however, some electrical energy might be lost in the wires and you may notice a very small difference. **Record this on the right side as the total voltage drop across the bulbs.**
	6. (a) Measure the current in the circuit by connecting the ammeter *in-line* between the (+) end of one battery and one of the light bulbs. **Record this value on the right side of the page with one decimal.**

 (b) Measure the current again, this time between the bulbs. **Record this value on the right side of the page with one decimal.**

(c) Measure the current once more, this time between the (-) end of the battery and the other light bulb. **Record this value on the right side of the page.** How are these three currents related? **Answer on the right side of the page.**

* 1. Calculate **(G-U-E-S-S)** the equivalent (total) resistance of both light bulbs by using the total voltage drop across both bulbs and the current measured at any point in the circuit. How does the equivalent resistance relate to the resistance of total resistance of both bulbs you found in Part 2? **Answer on the right side of the page.**

**The directions are on the left side of the page for these questions. Please read and follow them before trying to create your circuits.**

**Part 3: Two bulb series circuit**

Answer to step #2

**#1**

3) Voltage provided by battery \_\_\_\_18 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4) Voltage drop across light bulb #1 \_\_\_\_\_6 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage drop across light bulb #2 \_\_\_\_\_\_12 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**#2**

5) Total Voltage drop across both bulbs \_\_\_\_18 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6) a. Current between (+) of battery and light bulb #1\_\_1.2 Amps\_\_\_\_\_\_\_

b. Current between bulb #1 and bulb #2 \_\_\_\_\_\_\_\_1.2 Amps \_\_\_\_\_\_\_\_

c. Current between (-) of battery and light bulb #2\_\_1.2 Amps \_\_\_\_\_\_\_\_

 How are these three currents related? (same, one larger/smaller)

7) Calculate the TOTAL or EQUIVALENT Resistance of the circuit: (Show K-U-E-S)

R = V/I

R = 18V/1.2Amps = 15 ohms

How does the total resistance of the two bulb series compare to total resistance of both of the two bulbs from Part 2?

Part 1: 5 ohms + 10 ohms = 15 ohms

Part 2: 15 ohms

Part 1 = Part 2

Work Approved \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Electric Circuits Lab (part 4)**

**Two bulb parallel circuit**

* 1. Construct a circuit like **the figure below**. Use enough wires so that the circuit is structured like the figure below. This is a parallel circuit due to the two pathways for the current to flow. Disconnect one of the bulbs. What happens to the other bulb? What might be an advantage of parallel circuits over series circuits based on this observation? Reconnect the light bulb.

**A**

**B**

**C**

**Bulb 1**

**Bulb 2**

* 1. Use a red pen or pencil and sketch the 2 ways that the current flows through the light bulbs when it leaves the battery.
	2. Measure the voltage provided by the battery by touching the red lead to the (+) end of one battery and the black lead to the (-) end of the other battery. **Record this value.**
	3. Measure the voltage drop across each light bulb. **Record these values.** How do these voltages compare to the voltage provided by the battery?
	4. Measure the current in the circuit by connecting the meter *in-line* at point A (where the dot is). **Record this value.** Measure the current again…this time connect the meter *in-line* at point B (where the dot is). **Record this value.** Measure the current one more time…this time connect the meter *in-line* at point C (where the dot is). **Record this value.** How does the current through both point B and point C relate to the current through point A?
	5. Calculate **(K-U-E-S)** the equivalent (total) resistance of the light bulbs using the voltage provided by the battery and the current when **measured nearest the battery at point A**. How does the equivalent resistance relate to the resistance of both bulbs you found in Part 2?

**The directions are on the left side of the page for these questions. Please read and follow them before trying to create your circuits.**

**Part 4: Two bulb parallel circuit**

Answer to step #1

3) Voltage provided by the battery \_\_\_\_\_\_18 V\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4) Voltage drop across light bulb #1 \_\_\_\_\_\_18 V \_\_\_\_\_\_\_\_\_\_\_\_\_

 Voltage drop across light bulb #2 \_\_\_\_\_18 V \_\_\_\_\_\_\_\_\_\_\_\_\_

How do these voltages compare to the voltage provided by the battery?

5) Current at Point A \_\_\_\_\_5.4 Amps\_\_\_\_\_\_\_\_\_\_\_

 Current at Point B \_\_\_\_3.6 Amps\_\_\_\_\_\_\_\_\_\_\_\_

 Current at Point C \_\_\_1.8 Amps\_\_\_\_\_\_\_\_\_\_\_\_\_

How does the sum of the currents at B and C relate to the current at A? (same, one larger/smaller) A = B + C

Which current from question 5) is the current for the whole circuit?

Current at point A = 5.4 Amps

6) Calculate the Total or Equivalent Resistance (Show G-U-E-S-S)

R = V/I

R= 18V/5.4Amps = 3.3 ohms

How does the total resistance of the two bulb parallel circuit compare to total resistance of the two bulbs from Part 2? (same, one larger/smaller)

Work Approved \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Electric Circuits Lab**

**Lab Conclusions:**

1. Describe the path of the flow of charge in the series circuit.

1 path, so same everywhere

1. Describe the path of the flow of charge in the parallel circuit.

2 paths, different in each path

1. What happens to the equivalent resistance when light bulbs are

 connected in series? To answer you need to compare Parts

 2 and 3.

Resistance increases in series

1. What happens to the equivalent resistance when light bulbs are

 connected in parallel? To answer you need to compare Parts 2

 and 4.

Resistance decreases in parallel

1. Which circuit draws more current from the cells…series or parallel? Explain why this is so.

Parallel: running multiple circuits (branches)

1. How is the voltage from the battery distributed in a series circuit? (how does the voltage compare from bulb to bulb)

Shared between all resistors

V1+V2…. = Vtotal

1. How does the voltage of each part in a parallel circuit compare to the battery voltage?

Each parallel branch has same voltage as the source

1. Draw a circuit diagram of a parallel circuit with three light bulbs and an open switch. The switch should only turn off one of the light bulbs. You can try it on the simulation first…it might help. Here is the symbol for an open switch

