Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Resistors Simulation Lab**

**Procedure:**
***SINGLE BULB***

1. Go to phet.colorado.edu and open the simulation labeled “Circuit Construction Kit (DC Only).”
2. Connect a single light bulb to a battery.
3. Measure the voltage across the battery by touching one of the leads of the voltmeter to one terminal of the battery and the other lead to the other terminal.
4. Record the voltage in the data table.
5. Measure the voltage across the light bulb using the same technique and record in the data table.
6. Measure and record the current through the light bulb by inserting the ammeter into the circuit in series with the light bulb, i.e. by removing the wire from the light bulb, inserting it into one terminal of the ammeter, and connecting the ammeter back to the light bulb with an additional wire record the current on the data table.
7. Remove the ammeter and reconnect it on the other side of the light bulb and record the current in the data table.

Battery Voltage = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across one light bulb = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Current through light bulb: Before bulb \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ After bulb \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What do you notice about the current before and after the light bulb?

# **SERIES CONNECTIONS**

 **2 bulbs**

1. Place an additional light bulb into the circuit in series.
2. Measure and record the new reading of the ammeter.
3. Use the voltmeter to read the voltage across both of the light bulbs and record.

Current through light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3 bulbs**

1. Add an additional light bulb in series with the first. Record the new ammeter reading.
2. Measure and record the voltage across each light bulb.

Current through light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through circuit: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**3 bulbs and 1 resistor**

1. Add a resistor to the circuit in series with the other two light bulbs. Record the new ammeter reading through the circuit.
2. Measure and record the voltage across each item in the circuit, including the battery.

Current through light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through resistor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across resistor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Observation Questions**

What did you notice about the total current in the circuit when you add light bulbs or resistors to the circuit?

What happened to the brightness of each light bulb as you added additional light bulbs and the resistor in series?

## PARALLEL CONNECTIONS

 **2 bulbs**

1. Connect two light bulbs in parallel with the battery.
2. Measure and record the voltage across each light bulb using the voltmeter.
3. Measure and record the current through each bulb in the circuit using the ammeter.

Current through light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How does the current through each light bulb in parallel compare with the current through the single light bulb?

What do you notice about the current through each bulb?

What do you notice about the voltage across each light bulb?

Increase the resistance of one of the two light bulbs. What effect does that have on the current through the other light bulb?

What effect does it have on the current through the increased resistance light bulb?

What effect does it have on the voltage across the increased resistance light bulb?

What effect does it have on the voltage across the unaffected light bulb?

Decrease the resistance of the same bulb to a value below the original value. What effect does that have on the current through the other light bulb?

What effect does it have on the current through the newly decreased light bulb?

What effect does it have on the voltage across the decreased resistance light bulb?

What effect does it have on the voltage across the unaffected light bulb?

**3 bulbs**

1. Add an additional bulb in parallel.
2. Measure and record the voltage across each light bulb using the voltmeter.
3. Measure and record the current through each bulb in the circuit.

Current out of battery: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What happened to the total current out of the battery when you added the third light bulb to the circuit?

**3 bulbs and 1 resistor**

1. Add the resistor in parallel with the light bulbs.
2. Measure and record the voltage across each light bulb and the resistor.
3. Measure and record the current through each bulb and the resistor in the circuit.

Current out of battery: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across light bulb 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across resistor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 1: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 2: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through light bulb 3: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through resistor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What happened to the total current out of the battery when you added the resistor to the circuit?

# **COMBINATION SERIES AND PARALLEL CIRCUIT:**

1. Reset the simulation.
2. Assemble a circuit that has two light bulbs in series that are together in parallel with one light bulb, i.e. two light bulbs are in series and that series branch is in parallel with one light bulb.
3. Measure and record the voltage across each light bulb.
4. Measure and record the current out of the battery and through each bulb.

Current out of battery: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through single bulb: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through branch with two bulbs: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across single bulb: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across branch with two bulbs: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across each of the two bulbs: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

### How does the current through the two bulbs in series compare to the current through the single bulb?

1. Reset the simulation.
2. Assemble a circuit that has two light bulbs in parallel that are together in series with one light bulb, i.e. two light bulbs are in parallel and that parallel arrangement branch is in series with one light bulb.
3. Measure and record the voltage across each light bulb.
4. Measure and record the current out of the battery and through each bulb.

Current out of battery: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through single bulb: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Current through each bulb: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across single bulb: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across two bulbs: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Voltage across each of the two bulbs: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How does the current through the two bulbs in parallel compare to the current through the single bulb?

### Analysis Questions

1. As you added light bulbs in series, what happened to the brightness of the bulbs?

Increased Decreased No Change
2. As you added light bulbs in parallel, what happened to the brightness of the bulbs?

Increased Decreased No Change
3. As you added light bulbs in series, what happened to the current through each bulb?

Increased Decreased No Change
4. As you added light bulbs in parallel, what happened to the current through each bulb?

Increased Decreased No Change
5. As you added light bulbs in series, what happened to the total current from the battery?

Increased Decreased No Change
6. As you added light bulbs in parallel, what happened to the total current from the battery?

Increased Decreased No Change
7. As you added light bulbs in series, what happened to the voltage across each bulb?

Increased Decreased No Change
8. As you added light bulbs in parallel, what happened to the voltage across each bulb?

Increased Decreased No Change
9. How does the brightness of the bulbs when in series compare with the brightness of the bulb when in parallel? (i.e. compare the brightness of two bulbs connected in series to two bulbs connected in parallel)
10. In the combination circuit, how did the brightness of the single bulb compare to the brightness of the two bulbs in series? Explain this result for both of the arrangements.