# Google “PhET Circuits” and RUN the AC-DC Circuit Construction Kit.

# Adding Resistors to a Series Circuit (Pay attention to the brightness of the bulbs)

Construct Circuit A, using a single bulb and a single battery. (a) Use the ammeter to measure the current that flows into Bulb 1, and the voltmeter to measure the voltage across the Bulb 1, and record the values in the table below. (b) Then, add an additional bulb (Bulb 2) to create Circuit B, and measure and record the current through and the voltage across each bulb and the battery. (c) Finally, add an additional bulb (Bulb 3) to created Circuit C, and measure and record the current through and voltage across each.

**1**

**1**

**2**

**1**

**2**

**3**

|  |  |  |  |
| --- | --- | --- | --- |
| Circuit A | Current  | Voltage | Power |
| Bulb 1 |  |  |  |
| Battery |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Circuit B | Current  | Voltage | Power |
| Bulb 1 |  |  |  |
| Bulb 2 |  |  |  |
| Battery |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Circuit C | Current  | Voltage | Power |
| Bulb 1 |  |  |  |
| Bulb 2 |  |  |  |
| Bulb 3 |  |  |  |
| Battery |  |  |  |

1. Adding additional bulbs in series to a circuit decreases the current the circuit. Explain why this is true (your answer should involve Ohm’s Law):
2. Look at the voltages across each of the bulbs in each of the three circuits. The sum of the voltages for each of the three bulbs is \_\_\_\_\_\_\_ the voltage across the battery. Express this in equation form:
3. Predict what would happen Circuit C if a fourth bulb were added in series (using the words, “**increase”, “decrease”, or “stays the same”**):
* Req of the circuit would \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Ibatt would\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Current in bulbs 1 – 3 would \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Brightness in bulbs 1 – 3 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The ΔV across bulbs 1 – 3 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
1. What is the equivalent resistance of five 10-Ω bulbs connected in series?

# You’re So Bright

**Adding Resistors to a Parallel Circuit (Note: Pay attention to the brightness of the bulbs)**

Copy your data from Circuit A into the table below. Then, (a) construct Circuit D as shown, using two bulbs and a single battery. Measure and record the current flowing into EACH bulb and the battery, and the voltage across each. (b) Then, add a bulb to create Circuit E, and again, collect measurements to complete the table below:

**1**

**2**

**1**

**2**

**3**

|  |  |  |  |
| --- | --- | --- | --- |
| Circuit A | Current  | Voltage | Power |
| Bulb 1 |  |  |  |
| Battery |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Circuit D | Current  | Voltage | Power |
| Bulb 1 |  |  |  |
| Bulb 2 |  |  |  |
| Battery |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Circuit E | Current  | Voltage | Power |
| Bulb 1 |  |  |  |
| Bulb 2 |  |  |  |
| Bulb 3 |  |  |  |
| Battery |  |  |  |

1. Which bulbs glowed the brightest of ALL the circuits (A - E)? Which bulb(s) were the most dim? Explain why this is so:
2. Predict what would happen Circuit E if a fourth bulb were added in parallel (using the words, “**increase”, “decrease”, or “stays the same”**):
* Req of the circuit would \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Ibatt would\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Current in bulbs 1 – 3 would \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* Brightness in bulbs 1 – 3 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
* The ΔV across bulbs 1 – 3 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
1. **Power:** Look back over the power (joules per second) provided by the battery for each circuit. For example, compare the power output of Circuit B’s battery to the power used by bulbs. How does the battery power output compare to the power used by the bulbs, in a given circuit?
2. Of Circuits A, D, and E, which battery is working the hardest (i.e., which has the greatest power output)? Which battery will likely “die” first?

**Combination Circuits:**

1. Look at Circuit F below.

 **Circuit F**

**2**

**1**

**3**

Which of the three light bulbs do you believe will glow the brightest? Defend your answer:

Now, construct the circuit, and collect data to complete the table:

|  |  |  |  |
| --- | --- | --- | --- |
| Circuit F | Current  | Voltage | Power |
| Bulb 1 |  |  |  |
| Bulb 2 |  |  |  |
| Bulb 3 |  |  |  |
| Battery |  |  |  |

1. How does the current in bulb 1 (I1) compare to that of bulbs 2 and 3 (I2 and I3) ? Write an equation that relates these currents:
2. Some students would incorrectly expect the voltage across bulbs 2 and 3 to be 9.0 V. Look carefully at the voltages across ALL the bulbs. Why isn’t the voltage across bulbs 2 and 3 9.0 V? Remember, the voltage across a bulb is the energy lost *per charge*, as charges pass through.

Now, look at Circuit G, which is similar to Circuit F, except that we’ve added an additional bulb in parallel with 2 and 3.

 **Circuit G**

**2**

**1**

**3**

**4**

1. Before constructing this circuit, **predict** what will happen to the resistance of the circuit when bulb 4 is added:
2. Predict what will happen to the brightness of the bulb 1 when bulb 4 is added:

Now, construct the circuit, and collect data to complete the table:

|  |  |  |  |
| --- | --- | --- | --- |
| Circuit G | Current  | Voltage | Power |
| Bulb 1 |  |  |  |
| Bulb 2 |  |  |  |
| Bulb 3 |  |  |  |
| Bulb 4 |  |  |  |
| Battery |  |  |  |

# You’re So Bright (Page 2)

1. Compare the data from circuits F and G: What happened to the current through bulb 1 when bulb 4 was added? Did it glow brighter? (You can disconnect 4, and then reconnect it to compare brightness easily)
2. Explain why the brightness of the bulbs changed. You should reference Ohm’s Law in your answer.

Look at Circuit H.

 **Circuit H**

**1**

**2**

**4**

**3**

1. Rank the bulbs, 1 – 4, according to brightness, greatest first, and defend your answer.
2. Build the circuit. Was your prediction correct? If not, where did your reasoning lead you astray?

**BIG IDEAS:** Write a big idea about each of the following in a circuit.

**Series Circuits:**

Resistance:

Current:

Voltage:

Power:

**Parallel Circuits:**

Resistance:

Current:

Voltage:

Power: