

## Bulb A Versus Bulb B

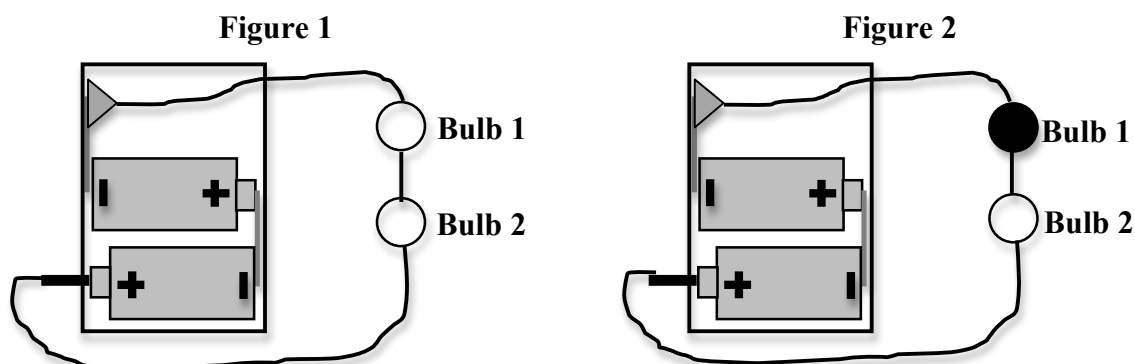
Two students are investigating the resistance of light bulbs. Their materials include two different types of light bulbs - a type **A** and a type **B** bulb. They conduct the following experiments.

### Experiment 1

In **Experiment 1**, the students use two D-cells and two **Type A** light bulbs to construct the electric circuit shown in **Figure 1**. When they make the final connection to the *battery*, they observe that both bulb 1 and bulb 2 are lit.

### Experiment 2

In **Experiment 2**, the students use two D-cells and both types of light bulbs. They construct the electric circuit shown in **Figure 2**. When they make the final connection of a wire to the *battery*, they observe that bulb 1 is lit and bulb 2 appears to not be lit. Bulb 1 is a **Type B** bulb and bulb 2 is a **Type A** bulb.

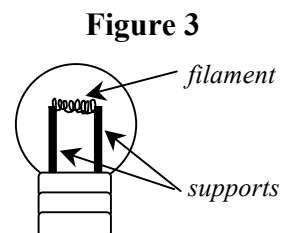


### Experiment 3

In **Experiment 3**, the students use the same circuit used in **Experiment 2** except that they switch the positions of the two light bulbs. Bulb 1 is now a **Type A** bulb and bulb 2 is a **Type B** bulb. They observe that bulb 2 is lit and bulb 1 appears to not be lit.

### Experiment 4

In **Experiment 4**, the students use a dissecting microscope to compare the diameter of the filaments and the support posts of the two types of bulbs. See **Figure 3**. They observe that the support posts of both types of bulbs have equal diameters. They observe that the filaments are significantly narrower than the support posts. And they observe that **Type A** bulbs consist of a larger diameter wire than **Type B** bulbs.



### Experiment 5

In **Experiment 5**, the students model the flow of charge through wires using straws of varying diameter. They take a deep breath and exhale the air in their lungs through a coffee stirrer, a drinking straw and a milkshake straw. The straw diameters and the times to exhale a full breath of air are listed in **Table 1**.

**Table 1: Exhale Times for Straws**

Straw Type	Diameter (mm)	Time (s)
Coffee Stirrer	1 mm	34
Drinking Straw	6 mm	12
Milkshake Straw	12 mm	5



### Questions:

1. What is the control in **Experiment 1** and **Experiment 2** and why?
  - a. Bulb **1** is the control. It is a **Type A** bulb in **Experiment 1** and a **Type B** bulb in **Experiment 2**.
  - b. Bulb **1** is the control. It is a **Type A** bulb in both experiments while bulb **2** changes from a **Type A** to a **Type B** bulb.
  - c. Bulb **2** is the control. It is a **Type A** bulb in **Experiment 1** and a **Type B** bulb in **Experiment 2**.
  - d. Bulb **2** is the control. It is a **Type A** bulb in both experiments while bulb **2** changes from a **Type A** to a **Type B** bulb.
2. What is the most critical observation that is made in **Experiment 2**?
  - a. Both light bulbs light.
  - b. The circuit seems to work.
  - c. Only the **Type B** bulb lights.
  - d. The bulbs are connected to the battery.
3. Bulb **1** and bulb **2** are said to be arranged *in series*. When in series, the current (rate of charge flow) is the same in each bulb. Also when in series, bulbs act together to offer a total resistance to the charge flow in a circuit. The more resistance, the less current there will be and the dimmer that an individual bulb will be. In which circuit is there less total resistance?
  - a. The circuit in **Figure 1**.
  - b. The circuit in **Figure 2**.
  - c. The current is the same in the two circuits shown in **Figure 1** and **Figure 2**.
  - d. The answer depends on which bulb one is considering - bulb **1** or bulb **2**.
4. Bulb **1** and bulb **2** are said to be arranged *in series*. When in series, the current (rate of charge flow) is the same in each bulb. Also when in series, bulbs act together to offer a total resistance to the charge flow in a circuit. The more resistance, the less current there will be and the dimmer that an individual bulb will be. Through which bulb does charge flow at the greatest rate in the circuit in **Figure 2**?
  - a. Charge flows at a greater rate through bulb **1** (the **Type B** bulb).
  - a. Charge flows at a greater rate through bulb **2** (the **Type A** bulb).
  - c. Charge flows at the same rate through both bulbs..
  - d. Charge only flows through bulb **1** (the **Type B** bulb); it doesn't even flow through bulb **2**.
5. Which statement describes the purpose of **Experiment 3**?
  - a. To determine if one of the wires is not working.
  - b. To determine which bulb has the most electricity.
  - c. To determine which one of the bulbs is not working.
  - d. To determine if the location of a bulb will affect whether it lights or not.
6. Which statement accurately summarizes the findings of **Experiment 1** and **Experiment 2**?
  - a. Light bulbs that are of a different type should never be placed in the same circuit together.
  - b. The bulb **1** location is the preferred location within a circuit; bulbs placed at this location will always be lit.
  - c. When with a **Type B** bulb, a **Type A** bulb does not light; a **Type A** bulb does light when combined with another **Type A** bulb.
  - d. Bulb **2** *burns out* when placed with a **Type B** bulb. That is why bulb **2** appeared not to light; the charged stopped flowing once it got past bulb **1**.

7. Which type of light bulb – **Type A** or **Type B** – has the greatest resistance and what is the evidence that supports such a conclusion?
- Type A** bulbs have a greater resistance. The evidence is that **Type A** bulbs do not light and **Type B** bulbs do light when placed together in the same circuit in **Experiment 2**.
  - Type A** bulbs have a greater resistance. The evidence is found in **Experiment 4** and **Experiment 5**. **Type A** bulbs are wider and wider straws offered greater resistance.
  - Type B** bulbs have a greater resistance. The evidence is that in **Experiment 2**, the **Type B** bulb used up all the energy, thus preventing the **Type A** bulb from even lighting.
  - Type B** bulbs have a greater resistance. The evidence is that in **Experiment 1**, Bulb 2 lights when placed with a **Type A** bulb; yet in **Experiment 2**, bulb 2 doesn't light when placed with a **Type B** bulb.
8. Suppose that a third type of bulb with a less resistance than a **Type A** bulb were used in place of the **Type B** bulb in **Figure 2**. What observation could be expected?
- Bulb 2 would still not light.
  - Bulb 2 would light, but not as brightly as in **Figure 1**.
  - Bulb 2 would light more brightly than it did in **Figure 1**.
  - A prediction cannot be made since actual resistance values must be known.
9. After conducting **Experiments 1, 2, and 3**, one of the students hypothesized that a high resistance bulb has a narrower filament. Do the results of **Experiment 1, Experiment 2, Experiment 4** confirm or not confirm this hypothesis and why?

	<b>Experiment 4</b> _____ this hypothesis ...	... for the following reason:
a.	confirms	The <b>Type B</b> bulb had a wider filament than the <b>Type A</b> bulb; the <b>Type B</b> bulb also had the greater resistance.
b.	confirms	The <b>Type A</b> bulb had a wider filament than the <b>Type B</b> bulb; the <b>Type A</b> bulb also had the greater resistance.
c.	does not confirm	The <b>Type B</b> bulb had a wider filament than the <b>Type A</b> bulb; yet the <b>Type B</b> bulb had the lower resistance.
d.	does not confirm	The <b>Type A</b> bulb had a wider filament than the <b>Type B</b> bulb; yet the <b>Type A</b> bulb had the greater resistance.

10. What major assumption must be made in order to consider the results of **Experiment 5** to provide reasonable evidence regarding the relationship between electrical resistance and the diameter of electrical wires?
- Type A** bulbs have a different diameter than **Type B** bulbs.
  - The lungs of a person serve a similar role as the battery of an electric circuit.
  - The time it takes to exhale air from the lungs is inversely proportional to flow rate.
  - The flow of air through straws follows the same laws as the flow of charge through wires.
11. If the flow of air through straws is an effective model of the flow of charge through wires, then which one of the following conclusions is supported by **Experiment 5**?
- Charge flows at the greatest rate through the longest wires.
  - Charge flows at the greatest rate through the shortest wires.
  - Charge flows at the greatest rate through the narrowest wires.
  - Charge flows at the greatest rate through the narrowest wires.