

**Topics:** Electricity,  
Parallel & Series Circuits,  
Conductors

## Materials List

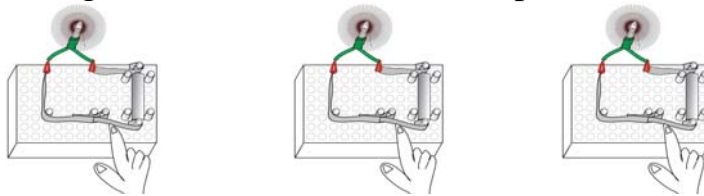
- ✓ Pipette tip box, empty (the “base”)
- ✓ Straws, regular size
- ✓ Aluminum foil sections, about 30 cm x 7 cm (12”x 3”)
- ✓ Thin cardboard, pressboard, or equal
- ✓ AA battery
- ✓ Straws, coffee stirrer size (narrow)
- ✓ Bulbs from holiday mini lights, clear (best) or colored
- ✓ Scissors with pointed tips
- ✓ Wire strippers

This Activity can be used to teach:

- Series and Parallel Circuits (CA Science Standards: Grade 4, 1.a)
- Electrical energy can be converted to heat, light, & motion. (CA Science Standards: Grade 4, 1.g)

# Breadboard Circuits

Creating electrical circuits with inexpensive materials



Some pipette tips come in boxes that can be turned into bases for creating a variety of electrical circuits; just add straws, a battery, foil wires, and a clear holiday mini-bulb!

## Assembly (Wash hands after handling bulbs!)

1. **To prepare the straws:** Cut a slit lengthwise through 3 regular straws using pointed scissors See figure 1. A slit makes the straws smaller in diameter so they will fit into the holes in the pipette tip “base.”
2. Cut the straws in 1/3’s to make sections about 6 cm (~2½”) long. See figure 1.
3. **To make a battery holder:** insert six straw sections into the holes in the pipette tip base as shown in figure 2. This configuration of straws can be put in other locations as well.
4. **For a basic circuit:** insert 3 of the straw sections into the holes as shown in figure 3. Coordinate math could be used to indicate the straw placements (3,3; 7,3; 8,3). Other locations for the straws are possible. Other circuits may require different straw locations or more straws sections.
5. **To make folded foil wires:** cut foil into 30 cm x 7 cm (12” x 3”) pieces. Fold the foil to make a narrow ribbon ~1 cm (½”) wide. Folding the foil around a thin cardboard strip, ~1 cm x 30 cm (~½” x 12”), makes the folding the foil much easier. If the strips are less than 30 cm (12”) long then add tape tabs to the ends of the strip. Remove the cardboard strip and reuse as needed. See figure 4. See the RAFT idea sheet *Folded Foil Wires* for details.
6. Cut a folded foil wire into 2 sections about 6 cm (2½”) long. Wrap each piece around the straws at the ends of the battery holder, (A) and (B), and bring the foil wires over to the left. See figure 5.
7. Insert the AA battery, as shown. The battery can be reversed and the circuit still will work. See figure 5. **Do not let the foil wires from the battery touch each other!** That would create a short circuit.

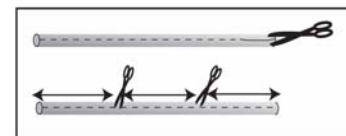


Figure 1

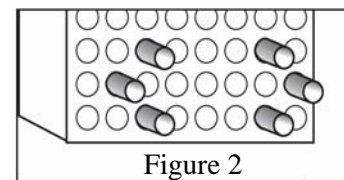


Figure 2

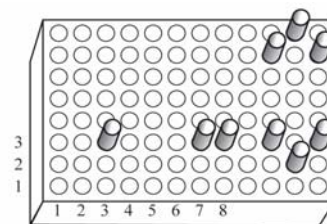


Figure 3



Figure 4

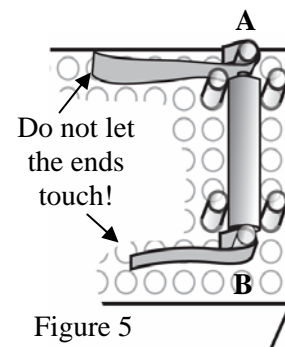


Figure 5

8. Cut a thin coffee stirrer straw in half to make sections about ~9 cm (~3½") long. Fold each section in half.
9. Strip ~2 cm (~¾") of insulation from each of the 2 wire leads of a holiday mini bulb (for details on using mini bulbs, see the RAFT idea sheet *Light up your life!*). Gently twist the thin wire strands of a bulb's lead together. Repeat for the other wire lead of the mini bulb. (Optional: To protect the fingers from being poked during twisting, place the wire strands in a folded piece of cardstock or business card.)
10. Put a bulb lead in the fold created by bending over 1 cm (~½") of the foil wire coming from (A). See figure 6 & 7. Bend the end of the wire lead over the bottom edge of the foil to hold the wire in place.
11. Place each end of a folded coffee stirrer straw on either side of the foil wire, close to the fold. Press the straw down firmly into a hole in the base at (F).
12. Repeat steps 10 & 11 for the second lead, but use a 15cm (6") section of foil wire. Secure and anchor the connection by using another folded coffee straw section into a hole at (E). See figure 6 and 7.
13. Create a switch by positioning the foil wire from the mini bulb lead as shown in figure 8. The foil wire at "C" should not touch the foil wire at "D".

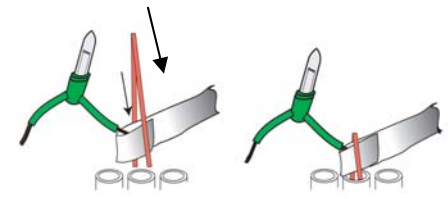


Figure 6

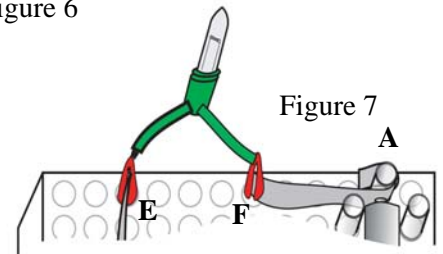


Figure 7

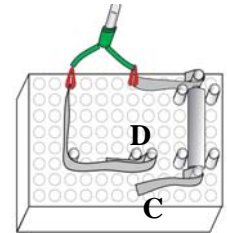
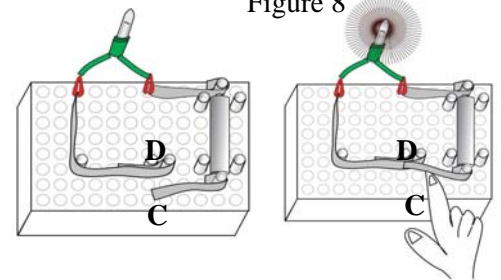


Figure 8



### To Do and Notice

1. Close the switch by moving the end of the foil wire at "C" to "D", the "on" position. The bulb should light.
2. If the bulb does not light, check the connections, battery, and bulb.
3. Let go of the foil wire at "D". The bulb should go out. If the bulb stays lit then move and/or straighten the foil wire coming from the battery, as needed, to keep the two wires from touching.

**Note** If a bulb will not light up then remove the bulb from the socket, clean the leads with an easer and reseal the bulb.

### The Science Behind the Activity

The process of making experimental circuits is called **breadboarding** and originally used a breadboard! Most homes had a board for cutting bread and early experimenters found this breadboard an ideal nonconductive base for building electrical circuits. Nails could be hammered in to creating connection points for electrical and electronic components. This is why the term "breadboarding" came to mean the easy and rapid creation of electrical circuits. (For additional details and explanations of the science involved in circuits, see **RAFT Idea Sheets: Circuits – An Electron Maze, Folded Foil Wires, and Light up your life!**).

### Taking it Further

- Draw a circuit using electrical symbols. See the RAFT idea sheet *Make a Circuit Symbolically* for symbols.
- Use the same circuit creating techniques to make more complex circuits:
  - Circuits with 2 batteries (connected in series or parallel) or larger batteries
  - Circuits with 2 bulbs (connected in series or parallel). (Note: Two bulbs connected in a series will glow dimly even with a fresh single battery.)
  - Circuits with 2 batteries & 2 bulbs (Using 2 batteries in series will make bulbs in a series glow brighter.)
  - Circuits that model a hall light that is controlled by two switches (called "three-way" switches).
  - Create non-functioning circuits that students can test to find the reason(s) the light(s) do not glow such as a burnt bulb, dead battery, loose connection, and/or an incomplete circuit.

**Web Resources** (Visit [www.raft.net/more](http://www.raft.net/more) for how-to videos and more ideas!)

See these websites for more information on the following topics:

- **Breadboards** – <http://en.wikipedia.org/wiki/Breadboard>
- **Bulbs** – <http://home.howstuffworks.com/light-bulb.htm/printable>
- **Batteries** – <http://electronics.howstuffworks.com/battery.htm/printable>
- **Three-way switch** - <http://home.howstuffworks.com/three-way.htm/printable>