BREADBOARD CIRCUITS

Creating electrical circuits with simple materials

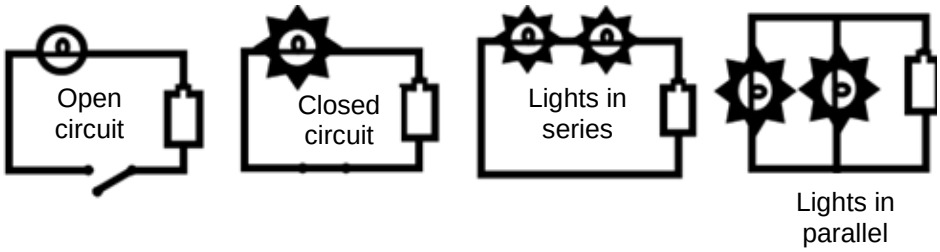
Curriculum topics:

- Electricity
- Conductors
- Parallel and Series Circuits

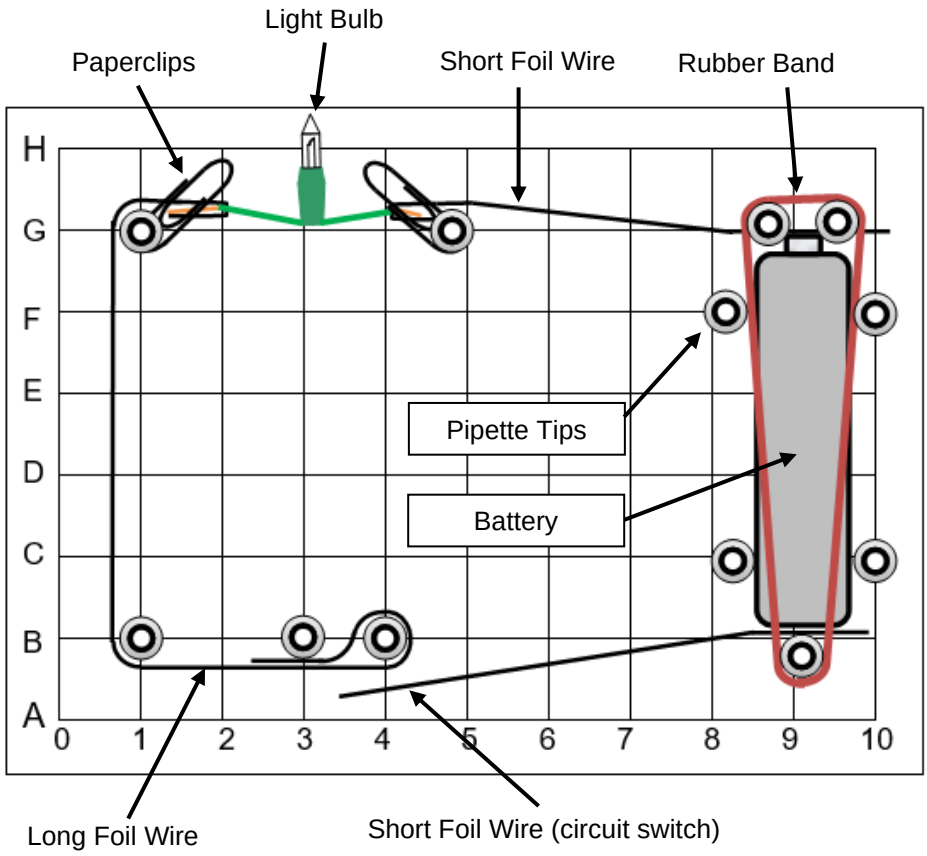
Subject:

Physical Science, Engineering

Grade range: 4 – 12



Provide students with opportunities to create a basic circuit, build a portable version, and explore parallel and series circuits! This is a great way to teach and learn about energy being transferred to different places by electric currents, light, and heat.



Who we are:

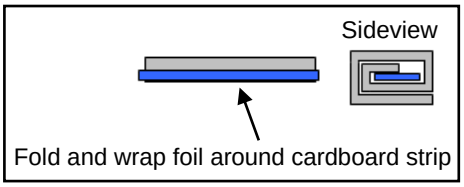
Resource Area for Teaching (RAFT) helps educators transform the learning experience by inspiring joy through hands-on learning.

For more ideas visit
https://raft.net

Materials required per student or group

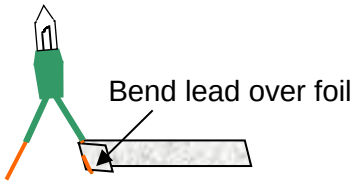
- Foam base (x1)
- Plastic pipette tips (x16)
- Aluminum foil sheet (x1)
- Cardboard strip, ½“ x 12” (x1)
- Paperclips, regular size (x4)
- Rubber bands (x2)
- Paper circuit template (x1), more copies accessible online at https://bit.ly/34tPZBZ
- Light bulbs, clear (x2)
- Battery (x1), AA, AAA, C, or D (not included)
- Optional: Scissors, ruler (not included)

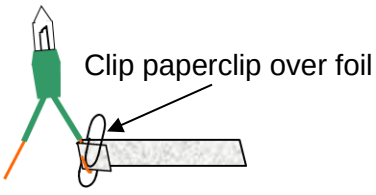
Note: There will be left over pipette tips, foil strip and a bulb in a wired socket.



Set Up

1. Cut the foil sheet lengthwise to make strips approx. 3” x 12”.
2. **Folded foil wire:** Put the cardboard strip near a long edge of one foil strip. Fold the edge of the foil over the cardboard strip and then fold and roll the cardboard upward to wrap the foil around it, making a narrow ribbon-like foil wire about 3/8" wide (see above right). Pull the cardboard strip out.
3. Tear or cut the folded foil wire in the middle to make two equal sections. Take one section and tear it in half, resulting in 1 longer and 2 shorter foil wires.
4. Twist and pull the insulation off the light bulb wire leads, if present. Gently twist the thin strands together giving the wires a “rope” like appearance.
5. Cut and center the paper circuit template on the foam base. Poke 1/3 of a pipette tip through the paper and into the foam at points 10F and 10C.
6. Place the battery against the 2 pipette tips as shown on the template and add 2 more tips on the other side of the battery, near 8C and 8F, thus securing the battery from rolling.
7. Insert 2 tips on either side of the bump at the positive end of the battery at 8.5G and 9.5G, and one tip against the negative (flat) end, near 9B. Insert tips into 1B, 3B, and 4B.
8. Put a light bulb lead in a fold created by bending over ½” of a short foil wire (shown below). Bend the end of the copper wire lead over the bottom edge of foil to hold the wire in place. Place a paperclip over the folded foil wire and the light bulb lead.
9. Insert a pipette tip into the bottom loop of the paperclip. Insert tip into the foam base at 5G.
10. Repeat steps 8 for the second light bulb lead using the long foil wire but insert the tip into 1G. Loop the rest of the long foil wire around the tips in row “B” (see title page).
11. Insert the other end of the short foil wire between the battery’s top end and the 2 tips (see title page). Double wrap a rubber band around the 3 tips at the ends of the battery. The rubber band presses the foil wires onto the ends of the battery to ensure a good electrical connection.





Content Standards:

NGSS

Definitions and Transfer of Energy:
4-PS3-2
4-PS3-4
HS-PS3-3

Engineering:
3-5-ETS1-3

To do and notice

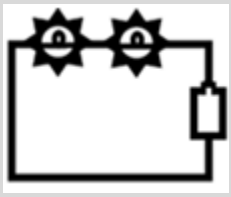
1 To close the circuit, insert the second short foil wire starting from the battery at 10B to touch the wire at 4B. The foil wires at 4B become the switch to open/close the circuit. When closed the bulb should light up.

2 Let go of the foil wire from the battery at 4B. 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 separate the wires so they are not in contact.

3 To explore the effect of removing a bulb from a circuit, disconnect the bulb from the foil wires, rather than pulling directly on the bulb.

The science behind the activity

Metals are **conductors** because some electrons in the metal can move about easily, unlike **non-conductors** (insulators) such as plastic and glass. Metals will vary in how easily electrons can move. Aluminum and copper are both metals with a low resistance to the movement of electrons. Copper is commonly used inside the wires found in homes and cars. Aluminum is used in some wires.



Bulbs in **series**

An **incandescent bulb** produces light when the wire filament inside becomes hot enough to glow. The filament contains the metal tungsten which has a relatively high resistance to the movement of electrons. When the bulb is connected to the battery, the electron movement occurs easily in the aluminum wires but is resisted in the coiled filament of the bulb and causing it to heat up and give off light.

When batteries are positioned with the positive end of one connected to the negative end of another, the batteries are said to be in **series**. Batteries in series will provide more electrical push/pull, called **voltage**, than a single battery. Two 1.5-volt batteries in series can provide 3 volts to a circuit. Bulbs can be connected in series (shown at left).

Bulbs in **parallel**

Batteries connected with the positive ends together and, separately, the negative ends together are said to be in **parallel**. The voltage remains unchanged but more potential chemical energy is available from the battery so the circuit can be powered longer. Bulbs can be connected in parallel as well.

Learn more

- Use additional lights and/or batteries to make more complex circuits
- Model a hall light that is controlled by two switches (3-way switches)
- Create a circuit where closing a switch turns the bulb off

Visit https://raft.net to view the following related activities!

Light Up Your Life
Circuits – An Electron Maze
Folded Foil Wires

Resources

- YouTube video (8:36), Electricity and Circuits - https://bit.ly/3cJhJGb
- YouTube video (9:43), Voltage and Current - https://bit.ly/2WIh9CY