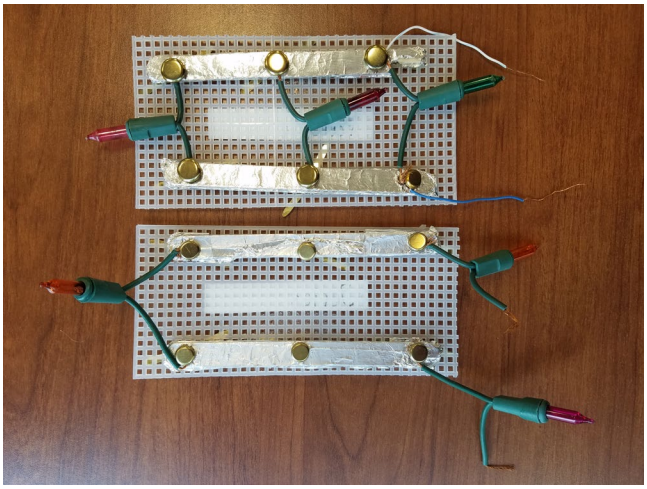
STEM ON A DIME

BASIC BREAD BOARD CIRCUITS

Activity Adapted from 4-H Junk Drawer Robotics: Mechatronics

Activity Updated August 2021



SKILL LEVEL

Age 8 - 18

KEY TERMS

Circuits, Series, Parallel, Conductor, Insulator

EDUCATION STANDARDS

South Dakota Science:
- 4-PS3-2

TIME NEEDED

60 minutes

MATERIAL LIST

Materials needed per circuit:
- One 9V or AA battery
- Four to Six Incandescent or Christmas Lights
- Two 8-inch Copper Wires (18-22 gauge)
- Four Craft Sticks
- Four Aluminum Foil Pieces (1.5 inches x 5 inches)
- Two Plastic Canvas or Cardboard Pieces (2.75 inches x 5 inches)

Materials to be shared by group:
- Wire Strippers
- Hole Punch or Crop-a-dile or Drill

EXPECTED LEARNER OUTCOMES

OBJECTIVE 1 – Youth will be able to identify a conductor and an insulator.

OBJECTIVE 2 – Youth will be able to describe how energy flows in a series and parallel circuits.

OBJECTIVE 3 – Youth will construct simple operating series and parallel circuits.

BACKGROUND

Electricity is all around us, and as a society we are highly dependent on it. However, most of us have very little understanding of how it works since we cannot physically see the electricity. Electricity is a form of energy resulting in charged particles, called electrons. The movement of these electrons through a substance, known as a conductor, creates electrical current which is what powers our lights and many other things.

In this activity, youth will build and explore two different types of electrical circuits: series and parallel. Additionally they will be introduced to a variety of electrical terms to enhance their understanding.

Series circuits allow the electrical current to flow in a straight path through the circuit. In the circuits in this activity, the current passes

through each incandescent light one at a time. Incandescent lights are resistors and each time the current passes through a resistors, the voltage drops slightly. This means that a single power source will only be able to power a circuit with a certain amount of resistance. For example, a AA battery has a voltage of 1.5, so the total voltage drop of all resistors in the series circuit will need to be less than 1.5 V for the circuit to be complete (Figure 1). If it is not, then it will be an open circuit and the lights will not light up.

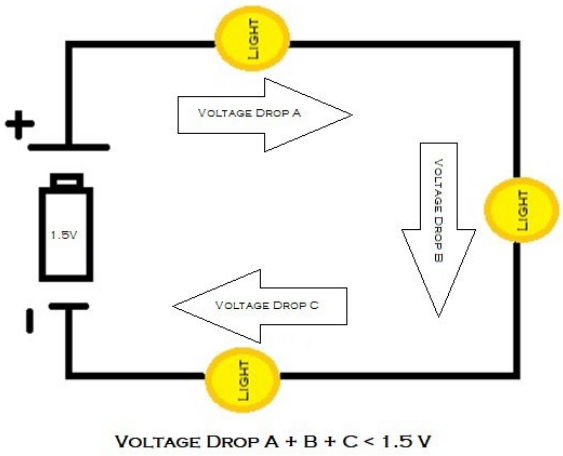


Figure 1: Diagram of Series Circuit Voltage Drop

Parallel circuits allow the electrical current to flow through more than one path simultaneously. In these scenarios the voltage drop of each resistor, light, can be equal to or less than that of the battery voltage (Figure 2).

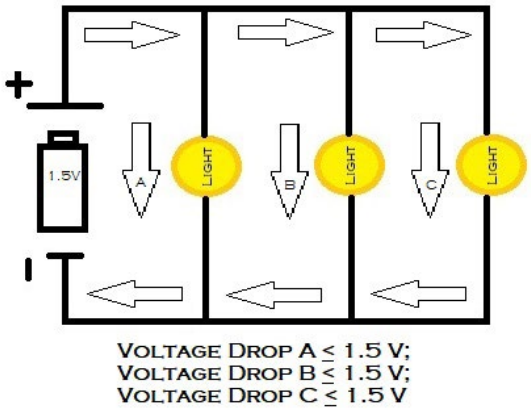


Figure 2: Diagram of Parallel Circuit Voltage Drop

VOCABULARY

Circuit – The pathway that allows electricity to flow from the power source (out of the + side) to the item being powered (light, motor, etc.) and then back to the power source (into the – side).

Current – The rate at which electricity flows through a circuit.

Voltage – The electrical force that drives the electrical current through the circuit.

Conductor – A material that allows electricity to flow easily through it (metals, graphite, etc.)

Insulator – A material that stops electricity from flowing through it (plastic, glass, rubber, etc.)

Series Circuit – A circuit in which the electricity flows in a straight line from the battery, through the item utilizing the power, one after the other, and then back to the battery. See Figure 1 in the Appendix.

Parallel Circuit – A circuit in which the electricity flows from the battery, into the items using the power simultaneously, and then back to the battery. See Figure 2 in the Appendix.

Resistor – A material that resists the flow of electrical current in a circuit. They generally convert the electrical energy into heat or light energy.

ACTIVITY PREPARATION

1. Gather the following materials for each youth or group of two youth:
   a. 9V Battery – If you chose to utilize AA batteries instead of 9V batteries, you will most likely only be able to place two lights per circuit rather than three lights.
   b. Six Incandescent or Christmas Lights – A non-working strand of incandescent lights is perfect for this. Most of the lights on the strand will still function on their own and so you can recycle the lights. You will want to cut the lights from the strand leaving the largest lead possible.
   c. Copper Wire (8 inches) – 18- to 22-gauge insulated copper wire works well for this. If you have CAT 5 wire, you could strip it down to the individual strands to utilize them.
   d. Craft Sticks – Either the standard or jumbo size will work.
   e. Aluminum Foil – The foil will be utilized to cover the craft sticks. You may choose to pre-cut the foil into rectangles approximately 1.5 inches x 5 inches for covering small craft sticks. They will need to be slightly larger for the jumbo craft sticks.
   f. Plastic Canvas / Cardboard / Foam Board – This material creates the base for the circuit to be built upon. It needs to be sturdy and at least 2.75 inches x 5 inches if you are using small craft sticks. If you have jumbo craft sticks it should be a bit larger. This material should also allow for you to either push a brass brad through it or punch a hole to allow the brad to pass through it.
   g. Wire Stripper – Make sure that the wire stripper can easily strip the wire without cutting through it. If you are short on time, or your youth don't have the hand eye coordination, you may want to strip your wires in advance.
   h. Hole punch / Crop-a-dile / Drill – This will be used to put holes in the craft sticks. If you utilize an electric or hand drill, you may want to consider placing masking tape over the craft stick before drilling to keep them from splitting.

2. Consider the age and capabilities of your youth as well as the amount of time you have for this activity.
   a. If you don't feel wire stripping is appropriate for the youth in your group or you are limited on time, consider stripping the wires ahead of time.
   b. If you are limited on time, consider wrapping the craft sticks with aluminum foil ahead of time.
   c. If you don't feel that your youth are capable of punching or drilling holes in the craft sticks, determine if you will have adequate adult assistance during the activity. If not, punch these holes ahead of time.

3. To simplify the facilitation of the activity, consider packaging the materials for each group together in a small container or Ziploc bag.

ACTIVITY INSTRUCTIONS

Part 1

1. Find out what youth already know about electricity by asking:
   a. What allows our lights to work?
   b. What is electricity?
   c. How does the electricity get to the lights? (wires)
   d. What are the wires made from? (copper) Let them know that this type of material is called a conductor as it allows electricity to flow readily.
   e. What are some other conductive materials? (other metals) (Use caution with answers related to water. Pure distilled water should not conduct electricity. However, if water is contaminated with salts and other inorganic materials charged particles form in the water allowing electricity to move through it.)
   f. What keeps the electricity from moving from the copper wires to other things around them? (plastic coating on the wires) Let them know that this type of material is called an insulator and keeps the electricity from flowing beyond the wires to other conductive surfaces.
   g. What are other insulators? (glass, plastic, rubber, etc.)
   h. What is an electric circuit?

2. Ask students to form a circle with you. Explain to them that the circle represents an electrical circuit with you serving as the battery. As the battery provides power to the circuit electricity flows around it – give the student next to you a high five and instruct them to do the same, passing the high five all the way around the circle. Tell them that electrons repel one another, so as one hand (electron) hits the other it sends it down the path where it bumps into another electron (the next person's hand). The electricity (high fives) will continue to flow as long as there are electrons to continue the flow. This is a closed circuit.

3. Create a large gap in the circle, large enough that youth cannot high five across it. What happens to the energy flow if that high five doesn't occur? The energy stops and this is considered an open circuit.

Part 2.

1. Group youth into teams of two.

2. Pass each group a Christmas tree light and battery.

3. Ask youth to identify what portions of the battery and light are conductors and which are insulators.

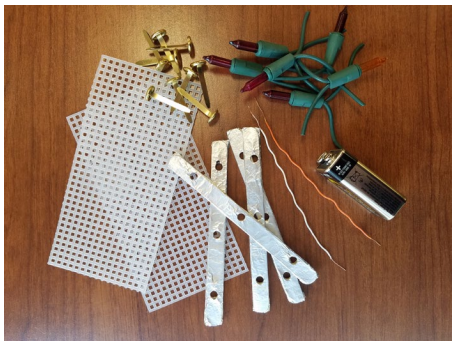
4. Ask youth what they think they need to do to create a circuit with the two objects in front of them. If you haven't already done so, have youth strip a small portion of each lead of the Christmas tree light.

5. Have them place one lead on each terminal of the battery. Their light should light up indicating they have created their first closed circuit.

Part 3.

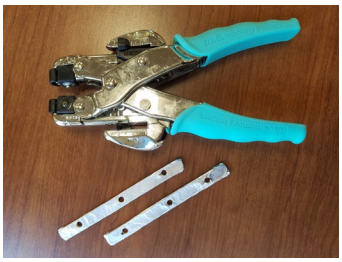
1. Keep youth in their existing teams of two and hand each team a supply bag.

2. Have youth examine the contents of the bag.
   a. What is conductive?
      i. Wire in lights
      ii. Tin foil
      iii. Brass brads
   b. What materials would be insulators?
      i. Plastic coating on wires
      ii. Plastic canvas
      iii. Craft sticks

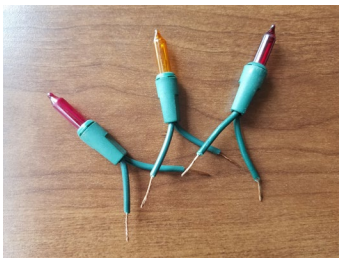


3. Explain that you will be using the materials in the bag to build two different types of circuits, series (Appendix A, Figure 1) and parallel (Appendix A, Figure 2)

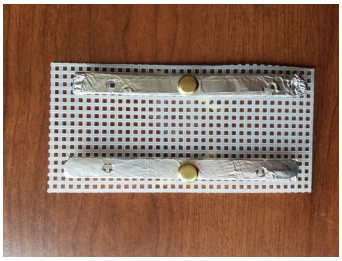
4. Series Circuit (skip to c. if you have already prepared craft sticks and lights)



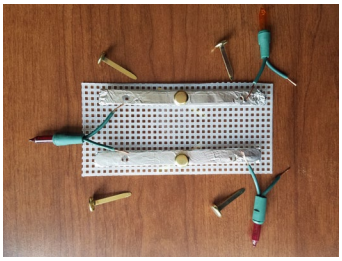
a. Have youth cover their craft sticks in tin foil and punch holes at each end and in the middle.



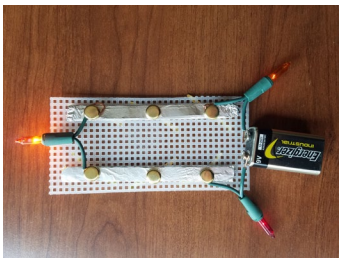
b. Strip the plastic off the ends of the Christmas lights



c. Use brass brads to secure the craft sticks to the board (pegboard, plastic canvas, cardboard or other).

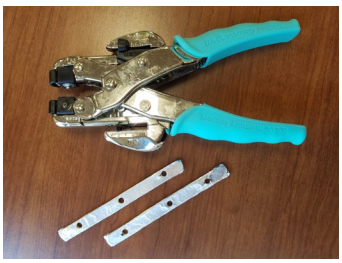


d. Then connect three Christmas lights in line with each other.

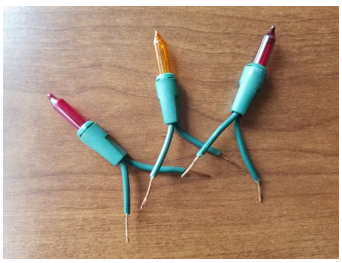


e. Have youth test their circuit with the 9V battery.

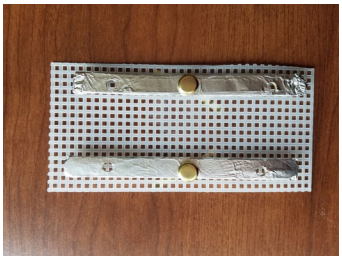
5. Parallel Circuit (skip to c. if you have already prepared craft sticks and lights)



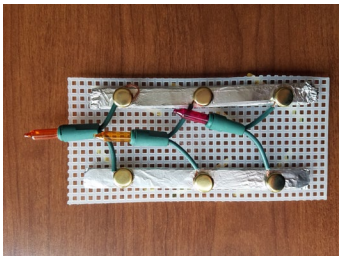
a. Have youth cover their craft sticks in tin foil and punch holes at each end and in the middle.



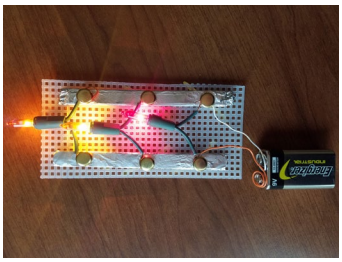
b. Strip the plastic off the ends of the Christmas lights



c. Use brass brads to secure the craft sticks to the board (pegboard, plastic canvas, cardboard or other).



d. Then connect three Christmas lights parallel to each other across the two sticks.



e. Have youth test their circuit with the 9V battery.

6. Ask youth what observations they make about the two types of circuits.
   a. Is one set of lights brighter than the other? With a 9V battery this may not be noticeable depending on your lights; however, it would be with an AA if you have one available.
   b. What happens if you disconnect a light from each circuit? (The series does not work, but parallel still does). This occurs because the electricity can still enter the other lights in the parallel circuit, however the electrons cannot continue to flow in the series once it is opened.

7. Have youth reflect upon the activity. Can they summarize what they learned/did?

EXTENDED LEARNING

This activity was adopted from the 4-H Junk Drawer Robotics Mechatronics Activity A. Youth can continue exploring this content and learn about creating on and off switches for their circuits in Activity B. Activities C, D and E also further explore circuits. The Junk Drawer curriculum can be found at the 4-H mall at https://shop4-h.org/.

Once youth have the basics of building a simple circuit mastered, they can begin creating various works of art with built-in circuits. Consider some of the ideas shared by the following sources:

Maker Ed (http://makereducation.weebly.com/circuits--led-projects.html)

Makerspaces.com Simple Circuit Projects (https://www.makerspaces.com/25-makerspace-projects-for-kids/).

These ideas and skills can be further developed through the exploration of other electricity-based STEM on a Dime lessons like Robo Art, Circuit Bugs and Glowing Chromatography Flowers; as well as through exploring the South Dakota 4-H Electricity Project (https://extension.sdstate.edu/4-h-electricity-project).

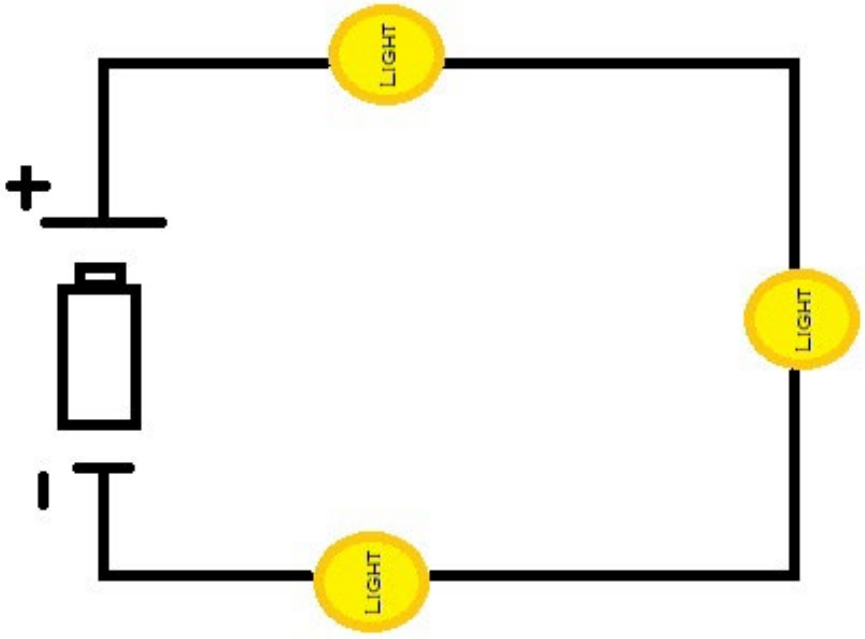


FIGURE 1: Series Circuit

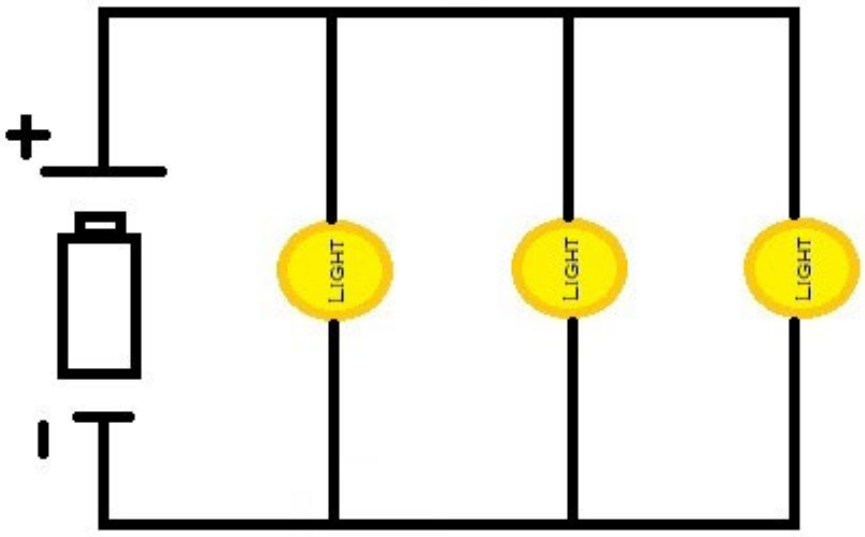


FIGURE 2: Parallel Circuit