STEM CLUB
BY AKA SCIENCE

Tech Club
Class 1: Circuit Basics

VOCABULARY:

- **Circuit:** A pathway to transmit electricity.
- **Conductive:** To have the ability to transmit light, heat, sound, or electricity.
- **Current:** Rate of flow of electric charge.
- **Electricity:** The flow of tiny particles called electrons. It can also mean the energy you get when electrons flow from place to place.
- **Hypothesis:** A prediction of the outcome of a test. A hypothesis must be testable through experimentation or observation.
- **Negative (pole):** The side of the battery that releases electrons. This side also collects the current, which flows in the opposite direction of the electrons.
- **Positive (pole):** The side of the battery that electrons flow into, and the side that the electric charge flows from.
- **Resistor**: An electrical component that limits or regulates the flow of electrical current in an electronic circuit.
- **Schematic:** A drawing or plan that uses symbols to show how something operates or is put together.
- **Technology:** The use of knowledge to invent new devices or tools.
- **Voltage**: The difference in charge between two points

Tech Vocabulary

C O N D U C T I V E R S C H E M A T I C
T E C H N O L O G Y Y E C P E J V Z E X
M Y R W F U G U A E W Y S V O L T A G E
L I N E L W B W N E G A T I V E G Z K E
C I R C U I T H Y P O T H E S I S V B U
V D H F C U R R E N T T G X M T V D A X
E P O S I T I V E S W I T C H H O S U U
E L E C T R I C I T Y K R E P E Y R E W

1. CIRCUIT **2.** CONDUCTIVE **3.** CURRENT **4.** ELECTRICITY **5.** HYPOTHESIS **6.** NEGATIVE **7.** POSITIVE
8. RESISTOR **9.** SCHEMATIC **10.** SWITCH **11.** TECHNOLOGY **12.** VOLTAGE

GO WITH THE FLOW (OF ELECTRICITY)

BACKGROUND:

Many times we don't even think about how we use electricity in our homes and lives. The items we power with electricity are connected through circuits, usually made of wires that transmit electricity to the motors, lights, heating elements, etc, that we use to cook, clean, light our homes, and charge our portable devices.

In the simplest terms, electricity in a circuit flows from the positive end of the power source, such as a battery, to the negative end. This can be visualized as a loop or circle. Sometimes electricity is compared to flowing water - if you turn off a hose the water stops flowing, similar to disconnecting a battery from a wire. This is not an exact explanation of how electricity works, but it helps us visualize current moving through wires.

The circuit is closed if there are no breaks in the path from the positive end to the negative end of the battery. If there is a break in the path, the circuit does not make a complete "circle" all the way around and it is considered an open circuit. You need a closed circuit to power your device. This first activity will replace the wires usually used with a special tape called maker tape. You will get first-hand experience powering an LED with a battery in a simple circuit.

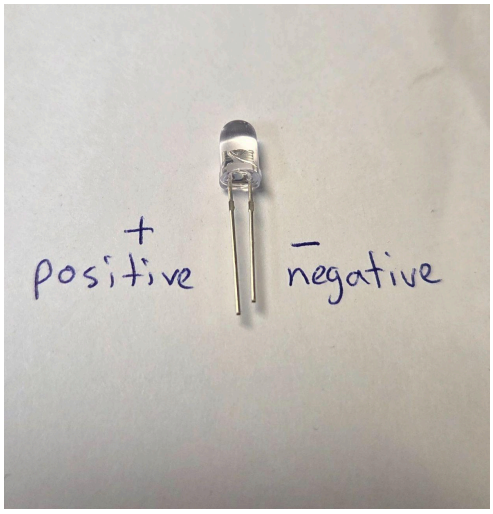
ENGINEER SPOTLIGHT:
Dr. Joseph Bull, Portland State University

Joseph Bull is an enrolled member of the Delaware Tribe of Indians and Dean of the Maseeh College of Engineering and Computer Science at Portland State University. Dr. Bull has worked on various engineering and computer modeling projects and is the first Native American Dean of an engineering school in the US. Let's learn how to be engineers like Dr. Bull, starting with simple circuits.

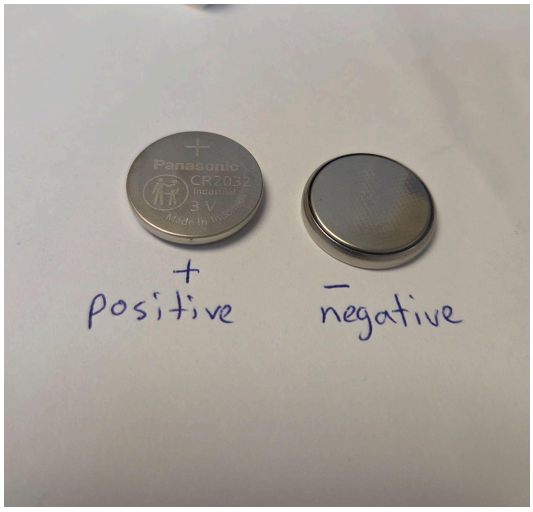
STEPS:

1. Electric current flows from a power source through wires to different parts of circuits, like light bulbs, switches and motors. Electricity is produced by batteries or generators - the bigger the battery the more electricity produced, and wires must be made of materials that conduct electricity, like metal.
2. Your Class Leader will pass out an LED bulb. What do you notice about it?

3. The longer leg is the positive or plus side and the shorter leg is the negative or minus side. Batteries also have positive and negative sides, the positive side is usually marked with a plus sign (+).



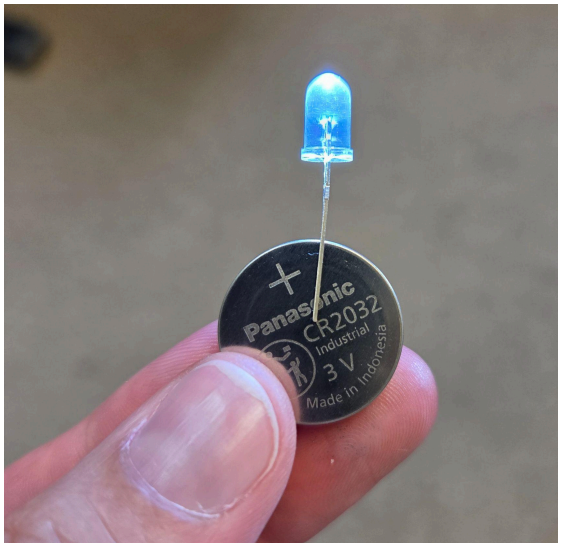
LED



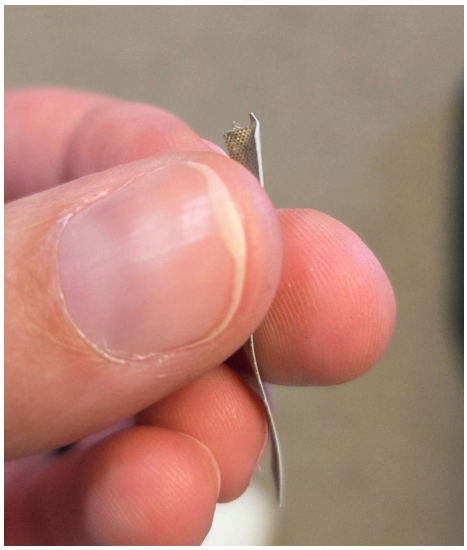
Battery

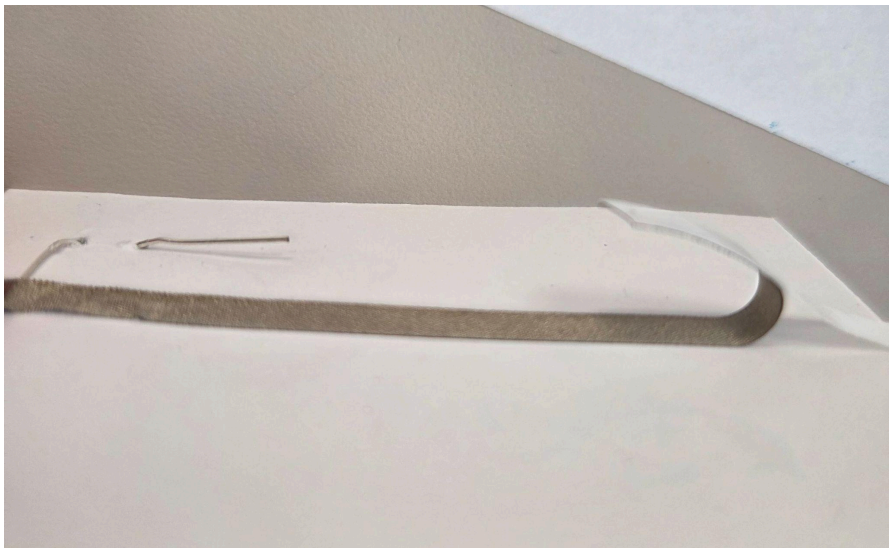
TIP: One way to remember which leg of the LED is positive and which is negative is to think of the letters p and n. Letter p has a long "leg" and letter n has a short "leg" - just like the positive and negative legs of an LED!

4. Gently fit the legs of the LED on either side of the battery. Make sure the positive and negative sides match! What happens?

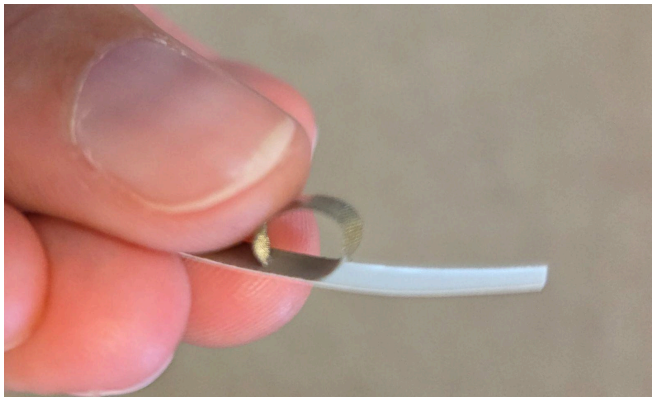


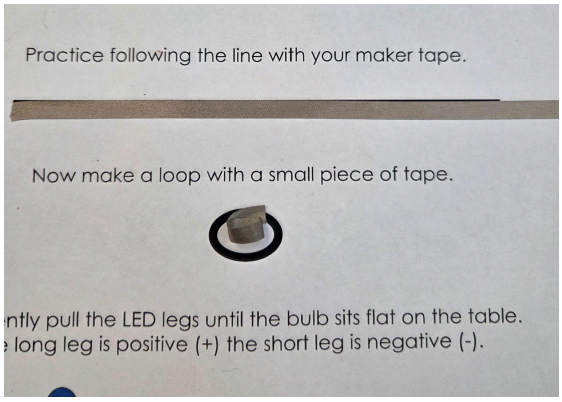
5. This is your first circuit! Now remove the LED from the battery so you can make a different circuit with maker tape.
    - Maker tape is made of metal, just like the legs of the LED. You will use maker tape because it is flexible, safe, and easy to use with a little practice.
6. First you need to practice using maker tape. Using a long piece of tape, follow the line at the top of your maker tape practice worksheet. If you are having trouble removing the backing, roll your thumb along the edge of the tape or ask for help.



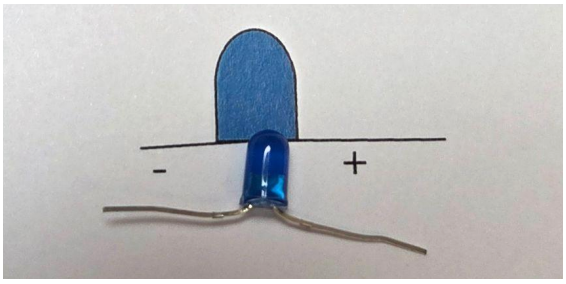


7. Now practice making a loop with the short piece of maker tape.

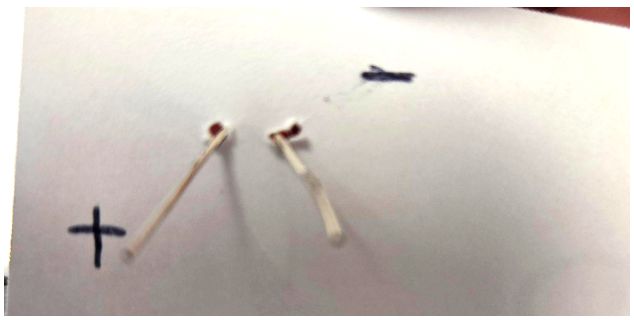




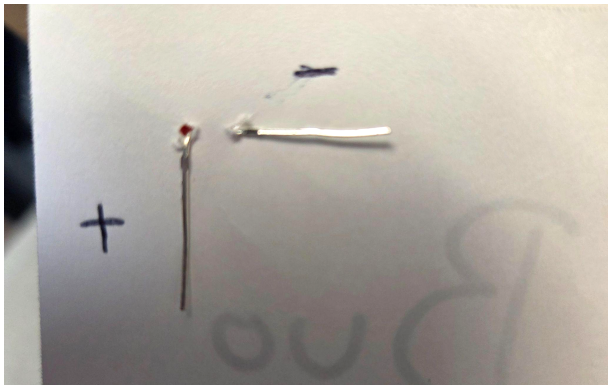
8. Look at your LED again and follow the instructions on the worksheet to bend the legs. Your bulb will look like it's doing the splits.



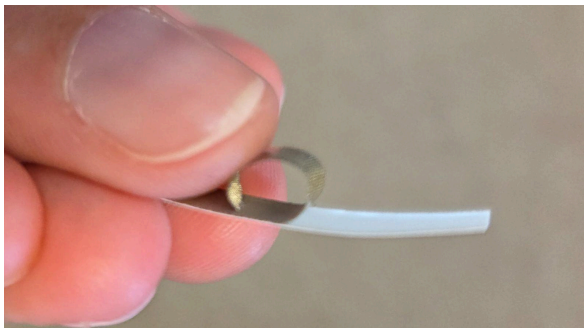
9. Your Class Leader will pass out an **index card** to use as a name tag. Write your name on the name tag and decorate it using **crayons**. Your Class Leader will also poke two holes in your index card with a pin.
10. Look at the **large LED** when you receive one. Do you remember which leg of an LED is the positive (+) one?
11. Stick the LED legs through the two holes poked into the name tag. The positive leg should be closest to the right edge of the index card.

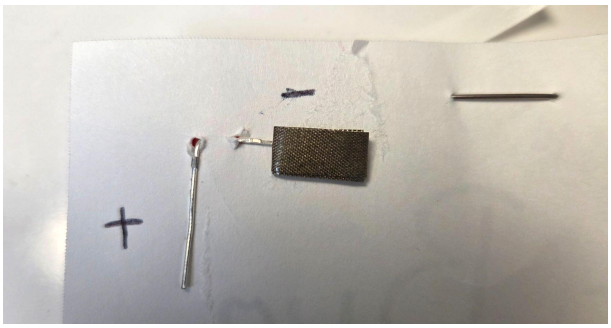


12. Bend the LED legs so that the positive leg is pointing down, parallel to the right edge of the index card. The negative leg should be bent pointing toward the opposite side of the index card, parallel to the top of the index card.

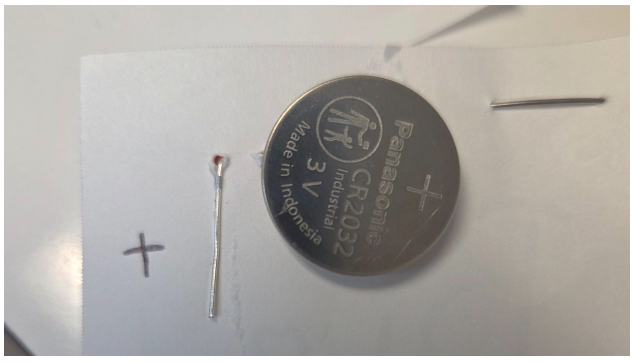


13. Make a loop with one of the short pieces of maker tape. Place the tape loop on top of the negative (-) LED leg.

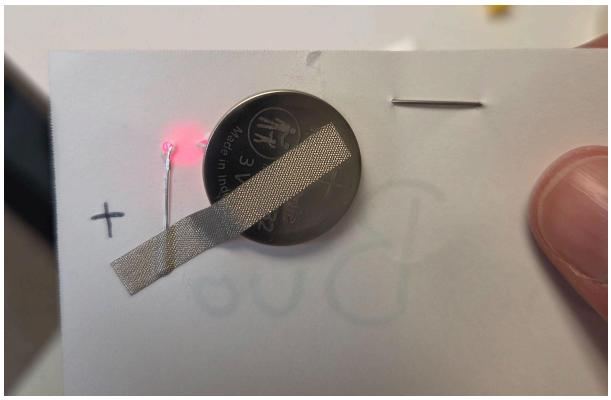




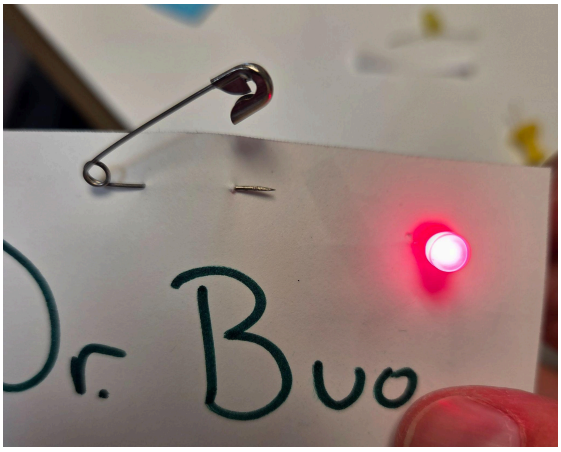
14. Place the battery with the negative side down on top of the tape loop.

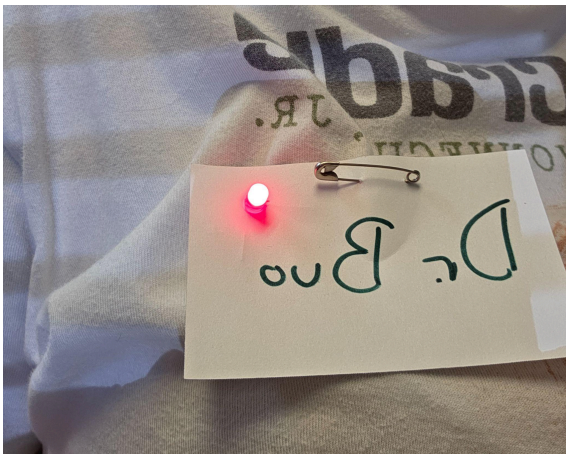


15. Remove the backing from the second piece of maker tape and connect the circuit by placing the tape over the positive leg and the positive side of the battery. Make sure to press down on the maker tape to secure the connections.



16. Use the **safety pin** to attach the name tag to your shirt or bookbag.





17. How is this circuit like the first one? How is it different?

HYPOTHESIS TIME!

WHAT IS A HYPOTHESIS?

A hypothesis is a testable question used in science and engineering. You will be making hypotheses throughout the AKA Science program.

Hypotheses are sometimes in the form of an If-then statement, such as "If (I do this), then this (will happen)."

- "If my battery is producing too much power, then I can add a resistor to the circuit to prevent it from overloading" is a hypothesis you can test.

They can also sound more like a statement. Either way, they must contain wording about something you can test!

- "Resistors made of metal will lower voltage more than resistors made of graphite" is a hypothesis statement you can test.

An opinion statement is NOT a hypothesis.

- "I think button batteries are better for paper circuits" is an opinion.

A question is NOT a hypothesis.

- "Will a resistor lower the current?" is a question.

If you have any questions about hypotheses, make sure to ask your Class Leader!

VIVA LA RESISTOR

BACKGROUND:

Now that you have learned how to make a basic circuit, it's time to start building on that knowledge. You will add more components to your circuits, starting with resistors. Resistors are items that reduce the voltage, or amount of current, flowing through a circuit. They do this by forcing the circuit to flow through less conductive materials like carbon (graphite) or metal films. The resistors you are using are made of carbon film coated in plastic, which is less conductive than metal. This means the electricity can still travel along the circuit, but the current is limited by the resistor. While resistors aren't necessary for paper circuits, you will need them in later class projects (bit.ly/4ngqTxU).

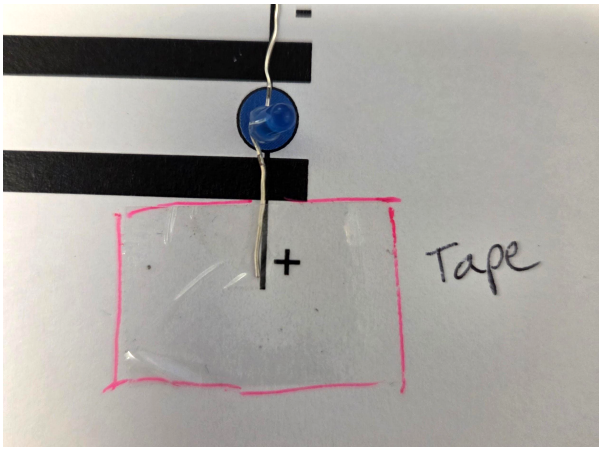
STEPS:

1. Sometimes we have a power source that is too strong for the items we want to power. For instance, if you were to use a battery pack with 2 AA batteries to light up a single LED, the LED would burn out because there would be too much power.
2. In many circuits, the resistor looks like this item, a cylinder with wires sticking out, similar to the LED bulb.

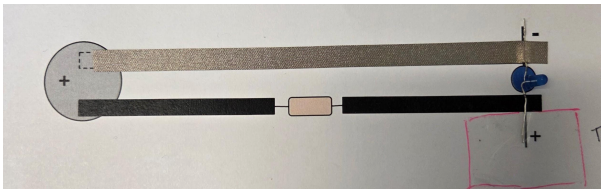
Resistor

3. Things to know about resistors:
    - Resistors lower the voltage passing through the circuit, saving the circuit from overloading and burning out.
    - Resistors make it harder for current to flow.
    - Resistors can be made of metal films or nonmetals like carbon.
4. You will be making another circuit, this time with a resistor. Make a hypothesis about whether the resistor will control the current enough to change the brightness of the LED. Write your hypothesis here:

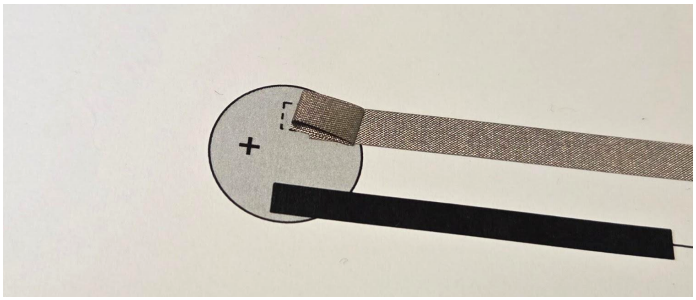
5. Look at the **resistor worksheet**. Where will the resistor go in the circuit?
6. Your Class Leader will give you **a resistor, an LED, one 5" piece of maker tape, and one 1" piece of maker tape**. Bend the LED legs the same as you did in the previous activity.
7. If you need help keeping the LED in place on the worksheet, try using a small piece of tape on one of the LED legs. Do not cover the entire leg!



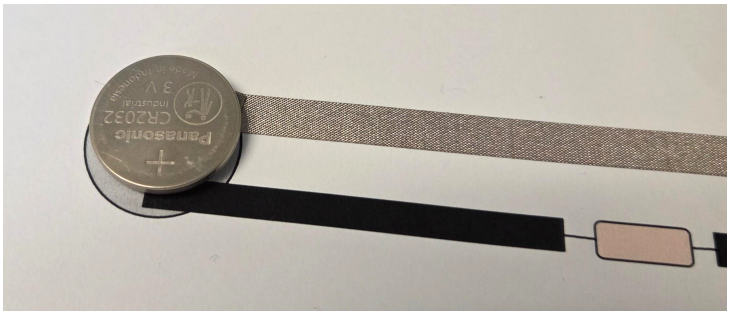
8. Cover the top line of the circuit with the 5" piece of maker tape. The maker tape should go over the negative leg of the LED and reach the circle that represents the battery.



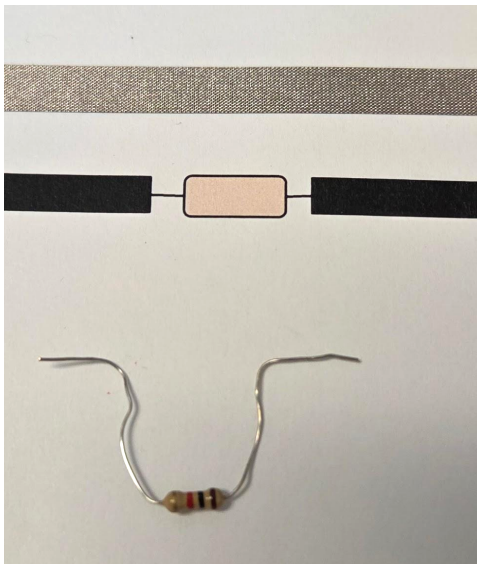
9. Make a tape loop with the 1" piece of maker tape and place it on the end of the long maker tape that is in the battery circle.

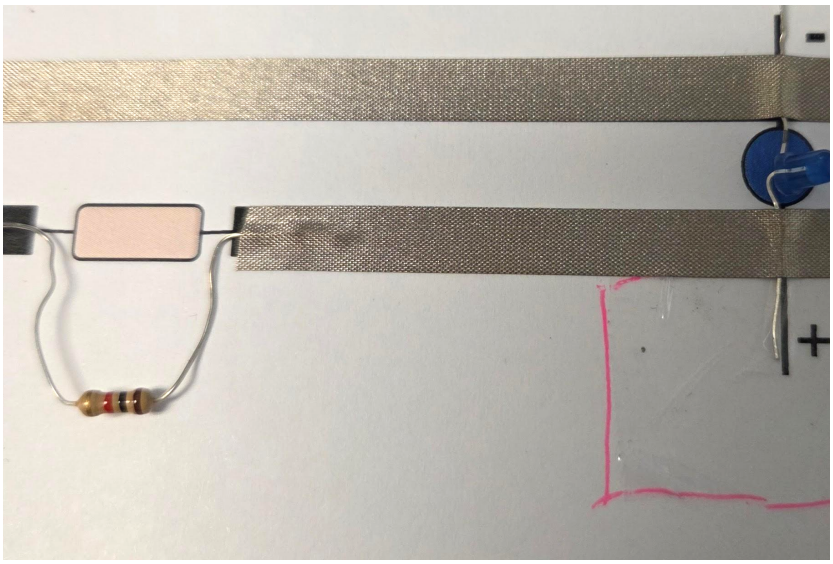


10. You will now receive **two pieces of 2" maker tape.** You will also need the **button battery** from your name tag.
11. Place the battery negative side down on top of the loop of maker tape.

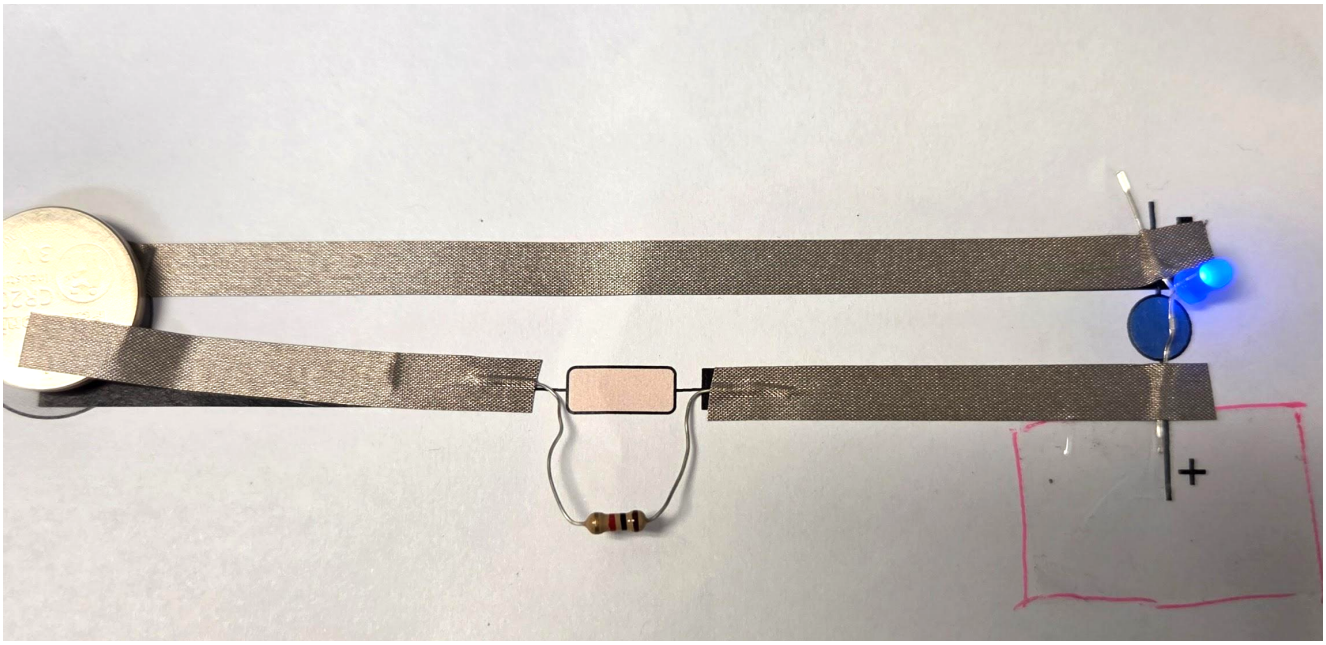


12. Bend the legs of the resistor as shown. Place the resistor on the circuit. Using one piece of 2" maker tape, cover the positive leg of the LED and one end of the resistor.





13. Complete the circuit by connecting the other end of the resistor to the top of the battery with the second piece of maker tape.



14. Compare this circuit to the one you had on your name tag - is the light different? Was your hypothesis correct?

15. When would a resistor be useful in a circuit?

CIRCUIT SKETCHBOOK

BACKGROUND:

An important part of making circuits is making schematics to show the components of a circuit. This schematic is called a circuit diagram and is useful because it can show others how to make the same circuit. Many times electricians and engineers draw circuit diagrams to design new circuits, showing how all the components connect to each other. You will complete a short activity drawing a circuit diagram for the first circuit activity using some basic symbols.

STEPS:

16. Imagine you want to show someone how to make the same circuit you created in AKA Science class. What is the best way to show someone how to make the same circuit we made in class?

17. There is a system of symbols that engineers use to draw circuit diagrams. How would that be useful?

18. Look at your worksheet and practice drawing the circuit you made in the first activity.
19. Use the space below to make a new circuit, one you have never built! Use the same symbols shown on the worksheet.

20. If there is time, exchange circuit drawing with a partner. Did you both use the same circuit parts?

FOR FUN! Match the technology types!

TECHNOLOGY CHANGES

Draw a line to match the olden day item to its modern day item: