

# Copper Wars!

## Objective

Students will investigate the conductivity of copper as they join the “Dark Side” of a popular science fiction universe. They will learn how copper tape can be used to create a circuit, and how switches can be used to open and close a circuit. Using this knowledge, students will build an LED “lightsaber” out of popsicle or craft sticks, copper tape, LED lights, a simple switch, and a battery. They can choose the color of LED light to symbolize their allegiance, and use “force” from copper to illuminate their lightsaber!

## Materials (per student or per lightsaber made)

- 3 jumbo popsicle or craft sticks
- Copper tape
- 1 CR2032 battery
- 1 colored LED light (10mm)
- Electrical tape
- Scotch tape
- Clear mini glue sticks
- Glue gun
- 1 Lilypad button board switch
- Optional: markers, paint, patterned tape to decorate the finished lightsaber

## How-to

1. Spark curiosity by showing students a completed lightsaber and demonstrating how it turns on and off by pushing the switch. Ask them a series of questions (you can add in your own if you'd like!):
  - a. What is making the lightsaber light up?
  - b. What is happening to cause it to turn on and off?
  - c. How do you think the stored energy in the battery is moving to the light?
2. Explain that building a successful lightsaber requires knowledge of a few basic principles of electronic circuits: a circuit, a conductor, electricity, and electrons.
  - a. Provide a quick definition for each:
    - i. A circuit is a roughly circular line, route, or movement that starts and finishes at the same place.
    - ii. A conductor is a material or device that transmits heat, electricity, or sound.
    - iii. Electricity is the transfer of energy resulting from the flow of charged particles (such as electrons).

- iv. Iv. Electrons are negatively charged subatomic particles found in all atoms and act as the primary carrier of electricity in solids.
3. Reveal to students that copper is the key to making these lightsabers work! Ask students to brainstorm about why copper is considered an excellent conductor of electricity. Let's look at how the properties of copper help it move energy to light up the lightsaber:
- The copper tape is made up of copper atoms packed tightly together. Copper is a great conductor because the electrons in each copper atom can move freely and easily between other copper atoms without much energy. As the electrons move through positively-charged copper ions, they now can be called free electrons, or conduction electrons.
  - When the copper tape is connected to a battery and a switch, turning the switch "on" completes the circuit and changes the random movement of the electrons, causing them to flow through the metal. Because electrons have a negative charge, they will move towards the positive terminal in the battery, creating an electric current flowing through the copper tape.
  - The electric current reaches the LED (light-emitting diode) bulb and passes through the diode. As the moving electrons pass from the copper tape through the diode, the diode emits bright colored light for the lightsaber! When the lightsaber switch is turned "off," it breaks the circuit, preventing the electrons in the copper to flow.
  - Because copper is a great conductor of electricity, it is used in all kinds of electrical wires and is helping to power many of the things we rely on every day, such as laptops, TVs, kitchen appliances, and cell phones!
4. Now, it's time to get hands-on!
- Provide each student with the materials listed. If you have a variety of colored LED lights, students can choose a light color to represent a side of their choosing—will they choose the dark side or fight evil and join the "good guys?"
  - First, have students take one of the jumbo craft sticks and cut a piece of copper tape so it is the same length of the craft stick. They should stick the copper tape lengthwise on the craft stick. This will be craft stick A.
  - Next, have students cut two short pieces of copper tape and place them horizontally near the middle of another craft stick (B), leaving a small gap between them. This will look like an equal sign (=), but the copper tape should wrap all the way around the width of the stick. **IMPORTANT**—the button board switch should fit vertically between these two pieces of copper tape, so that the copper tape can be seen through the holes on either side of the switch, but the copper tape strips should not touch each other.
  - When the copper tape strips and switch are in place and the copper tape is visible through the switch holes, use copper or scotch tape to secure the switch to craft stick B in this position. Then, have students cut and stick a piece of copper tape that will reach from each small horizontal piece of tape vertically to the tip of each end of the craft stick. This is done on the opposite side of the switch on craft stick B.
  - For the final craft stick (C), students should use scissors to cut off the bottom of the craft stick to make it roughly the size of the battery. No copper tape is applied to this stick.
  - Take the LED light and use a small piece of copper tape to attach each of the light's electrodes to the copper tape at the end of craft sticks A and B. The strips of copper tape on A and B should

- be facing each other on the inside of the lightsaber. The switch should be on the outside of the lightsaber.
- g.** Slide craft stick C in between A and B all the way to the top where the LED light is and press the three sticks together. Next, slide the battery into the bottom gap created between craft sticks A and B, so that it is touching the cut portion of craft stick C. Push down on the switch to turn on the LED light to ensure the battery is in the proper place and position. The battery may have to be flipped if the light does not come on. Wrap electrical tape around the bottom of the craft sticks and battery to hold the battery in place.
  - h.** Next, have students press the nozzle of a hot glue gun into the end of a clear mini glue stick to make a hole in the glue stick that the LED light will fit into. Press the LED light into the end of the glue stick and add extra glue to secure the glue stick onto the light. This creates the light “beam” for the lightsaber. Students should test the switch to ensure the LED light is on when the switch is pushed.
  - i.** With any time remaining, students can decorate their lightsabers, adding colored tape, or designs and graphics with markers or paint.
- 5.** When everyone has completed their lightsabers, let the intergalactic copper wars begin!
  - 6.** When the copper wars have finished, synthesize learning by asking students the following reflection questions:

    - a.** How do you think you could change the circuit in your lightsaber? Could you place the copper tape differently and still get it to light up? What would be important to remember about electrical circuits when doing this?
    - b.** Copper tape, batteries, and switches also are used in light-up greeting cards! Can you think of how you might be able to use these materials to construct one on your own?
    - c.** Copper is also a good conductor of heat, heating quickly when energy is passed through it. Can you think of where this power of copper might be helpful in your home?