



Safety Science Tools

Power to the Electron

Open your students' eyes to the importance of scientific literacy. As a Science Educator, you can help them draw connections between science, engineering, math, and language. These lessons can help build their confidence, strengthen their interest, and apply their knowledge to solve new problems.

Can I control the power of electrons? Experimenting with electrical safety!

THE SAFETY LESSON

We use electricity in some form practically all day, every day. It's pure energy. We use electricity to run computers, lights, televisions, and dishwashers, all kinds of stuff. Electricity is invisible and it's powerful. We have to be careful with it.

Electrons are the very small particles that flow through wires and circuits, creating currents of electricity. Electrons move from negatively charged parts to positively charged ones. The negatively charged parts of a circuit have extra electrons, while the positively charged parts want more electrons. The electrons jump from one area to the other. When the electrons move, a current of electricity is flowing through the circuit. Electricity can go through metals and other materials called "conductors." Conductors carry electricity. But electricity can't go through things like rubber, wood or plastic. These materials are called "insulators" because they stop electricity from passing through them.

To see how electricity works and test the conductivity of certain materials we are going to build a simple electrical circuit (Experiment #1). Then we will investigate the importance of insulators in electrical safety (Experiment #2).

MATERIALS

2 – 3 each AA, AAA and C Batteries

EXPERIMENT #1

- 2 D Batteries
- Masking tape
- Working flashlight that you can unscrew and take apart (incandescent, two-battery)
- Conductors and insulators:
- 12" (30 cm) strip of heavy-duty aluminum foil
- 12" (30 cm) wire
- 12" (30 cm) strip of paper
- Shoelace
- Pipe cleaner
- Rubber band
- Large paper clip

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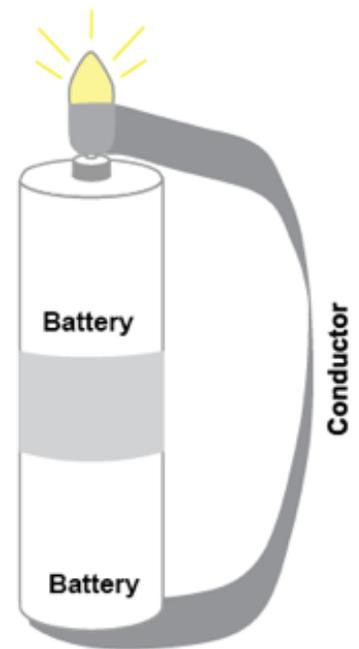
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EXPERIMENT #2

- 3 – 4 Batteries (9 volt, not rechargeable)
- Penny
- Thick rubber band
- Extension cord cut in half

EXPERIMENT #1

- We can make our own electrical circuit safely because the batteries have very low current. Even though we can touch this electrical current without danger, you should never touch the electrical socket of a real lamp.
- Ask for 2 -3 volunteers. Divide up the following steps:
- Unscrew the flashlight and remove the light bulb.
- Tape the two D batteries together, putting the positive and negative ends together.
- Starting with the strip of aluminum foil. Wrap one end around the metal screw threads on the light bulb. Secure with tape. Do not cover the tip of the light bulb.
- Tape the other end of the foil to the flat (negative) end of the stacked batteries.
- Touch the metal tip of the light bulb to the post (positive) end of the battery stack.



WHAT'S GOING ON?

- Ask the children if they can explain how the electricity (current) is flowing from the battery to the light bulb.
- The aluminum foil strip provides a pathway for the current. The foil is a conductor of electricity. The light bulb will glow only if there is an electrical current flowing through it in a complete and uninterrupted path. The conductor connects the electricity from the batteries to the light bulb so the current can flow through and light

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RE-RUN EXPERIMENT #1

- Ask for 2 – 3 different volunteers. Repeat the experiment with the other materials (wire, paper, shoe lace, pipe cleaner, rubber band, and paper clip) asking students to predict which material will be a conductor and which will be an insulator.

EXPERIMENT #2

- Now that we've learned about the benefit of electricity, let's try this experiment to get a sense of the possible danger of electricity.
- Ask for 2 volunteers. Divide up the following steps:
- Compare the 9 volt battery to the D battery, note the difference of where the negative and positive terminal ends are located for both batteries. Ask what the volunteers think will happen if they lay a penny across the terminals of the 9 volt.
- Lay the penny across the battery terminals of the 9 volt. Hold in place for about 15 seconds. Ask the volunteer to describe what they feel? Can they explain why they feel the penny heating up?
- (Note: the 9 volt battery will drain of power very quickly. Don't leave the penny on for more than a few seconds – just long enough to feel the heat.)
- Explain that they are creating a simple closed circuit by connecting the two terminals with a conductor. The penny is made mostly of copper and copper is a very good conductor of electricity. Ask your students if they can think of something in their homes that is made of copper. (Answer: Household wiring and electrical cords!)
- Now lay the rubber band across the terminals.
- Hold the penny over the rubber band. Ask the volunteer to describe what they feel – any heat?
- Remind the students that rubber is an insulator. So when the rubber band is put between the battery and the penny, the circuit is broken and no circuit, no heat!
- Ask your students if they can think of a product in their home that has an insulator on it. Electrical cords! In order to protect surroundings from the heat of the electricity and to keep the electricity inside, electrical cords are wrapped in an insulating material.
- Show students the damaged extension cord and point out the copper wiring and plastic wrapping. Ask them if they know what to do with damaged extension cords in their homes. Throw them away, and replace with new ones.



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THE SCIENCE

It's important to know the difference between voltage and current. A volt is a measure of electromotive force (the voltage created by a source of electrical energy like a battery). Here's a simple way to think about electricity: voltage can be compared to the pressure that pushes water through a hose, where the water is the current of electricity and the hose is the conductor. Earlier in history, people thought electricity really was a fluid, like water, but we now know electricity is not a fluid.

Current is the flow of electrons through a circuit. Current, not voltage, does the work in an electrical circuit. For example, the flow of water through a turbine is what makes the turbine spin. The flow of current through an electrical circuit is what lights the light bulb, heats a stove, or runs a motor. Batteries come in different sizes, A, AA, C, D. But notice that no matter the size of the battery the labels indicate each one measures 1.5 volts – that's the power of the battery. So all alkaline batteries have an electrical force of 1.5 volts. How can that be?

The amount of current an alkaline battery can deliver is roughly proportional to its physical size. This is a result of decreasing internal resistance as the internal surface area of the cell increases. A general rule of thumb is that an AA alkaline battery can deliver 700 mA without any significant heating. Larger batteries, such as C and D's, can deliver more current.

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