Build a Cleaner Battery

MATERIALS

For the activity (per pair or team)

- warm water
- 3 tablespoons salt
- plastic cup
- 1 strip of copper plumber's strap, about 1 inch taller than your cup
- 1 zinc (plated or galvanized) screw, at least 2 inches long
- 6 inches of insulated wire, with ends stripped to expose wire
- 1 large alligator clip
- 1.5-volt buzzer
- activity sheet

For the group

- AA battery
- 1.5-volt LED light (optional)
- multimeter (optional)
- wire strippers
- paper towels
- video clip available at pbs.org/nova/education/makingstuff
- video display equipment

Note: Copper strip and zinc screws are available at hardware stores. Wire, alligator clips, buzzers, LED lights, and a multimeter can be found at electronics stores.

Time: Prep: 15 minutes; Activity: 45 minutes

Activity Description

Kids build environmentally cleaner batteries from saltwater, a zinc screw, and a copper strip, and then connect them all in a series circuit to increase the voltage and power small electrical devices.

Learning Goal

Kids learn about batteries, circuits, environmental problems with battery disposal, and the efforts of materials scientists to build cleaner batteries.

Introduction

Batteries are devices that store and convert chemical energy to electrical energy. They are used in many household electrical devices and personal electronics. They are cleaner than petroleum-based energy, but many batteries contain chemicals that are hazardous if they are not disposed of properly and get into the air, water, or soil. Powerful batteries are also very big and heavy. Small and light batteries do not have much power. Materials scientists are working to design new kinds of batteries, including smaller and more powerful ones that will provide clean energy for a new generation of electric vehicles. For example, materials scientists have developed rechargeable molten (hot) salt batteries that are more efficient than current batteries and could one day be used to power electric cars.

Advance Preparation

- Gather the materials.
- Bend the copper strip back and forth to break it into strips that are about an inch taller than the cup. File any rough edges.
- Cut the 6-inch lengths of wire and use the wire cutters to strip the ends to expose half an inch of metal wire.
- You can mix pitchers of saltwater, using 3 tablespoons of salt per cup of water, or have kids mix up their own.

Procedure

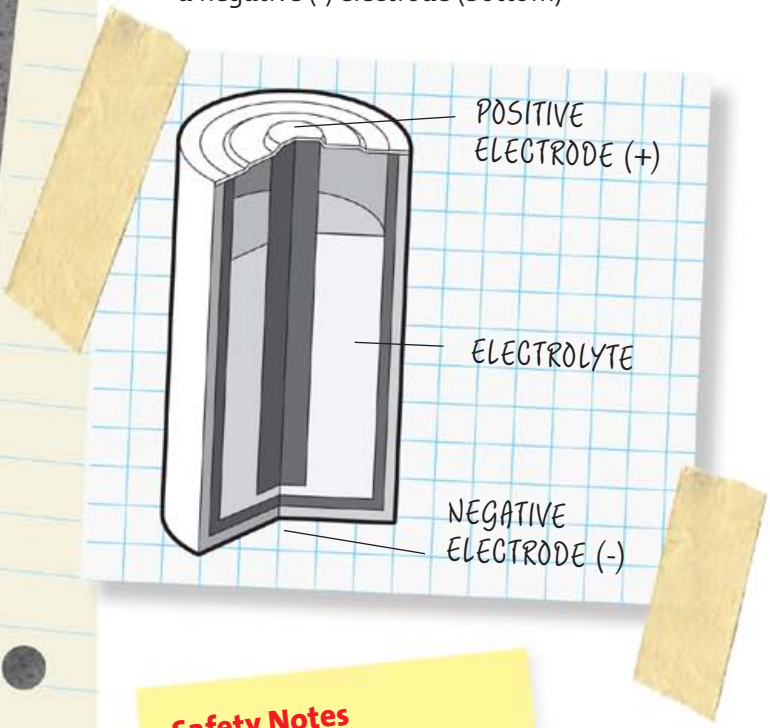
1. Introduce the topic.

Ask kids: *What are some things that we use batteries for?* (Accept all answers.) *What happens to batteries after they are used up?* (Some can be recharged, and some are recycled, but many are thrown away.) Explain that batteries are an environmental problem because they contain chemicals that can be hazardous if they get into the air, water, or soil, which can happen when batteries are thrown away improperly or burned in waste incinerators.

2. Define a battery.

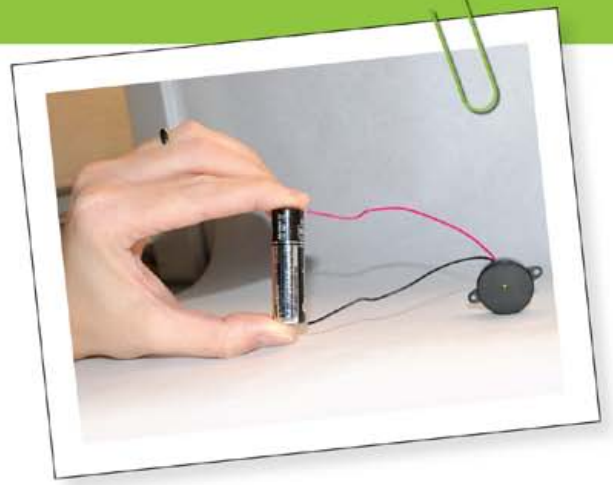
Hold up a AA battery and ask: *What is a battery?* (Answers will vary.) Explain that a battery is a device that stores and converts chemical energy into electrical energy. A battery is made up of an electrolyte, which is a chemical solution or paste inside the battery, and two electrodes, or connectors:

- a positive (+) electrode (top)
- a negative (-) electrode (bottom)



Safety Notes

- Break the copper strip cleanly. Do not leave sharp edges.
- Caution kids not to drink the saltwater.



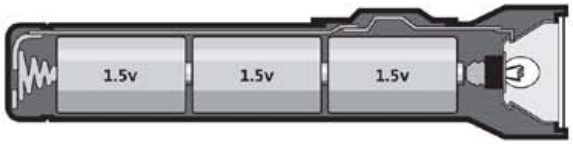
3. Show how batteries work.

Ask: *How does a battery work?* (Accept all answers.) With your thumb and forefinger, hold the red buzzer wire against the positive electrode on top of the battery and the black wire against the negative electrode on the bottom of the battery. The buzzer will sound.

When a battery's electrodes are connected, for example by the buzzer, a chemical reaction inside the battery causes positive and negative charges to separate and build up at the electrodes. The difference in the amount of charge built up in each area is called the electric potential difference, or voltage. Charge flows from areas with more charge to areas with less. So the greater the voltage, the greater the energy a battery provides to the charges. The AA battery has a voltage of 1.5 volts.

4. Discuss circuits.

Tell the kids that when you touched the buzzer wires to the battery electrodes above, you created a circuit. When the parts of a circuit are all connected one after another in a line, it is called a series circuit. The battery and buzzer are a series circuit. Another example of a series circuit is a flashlight in which the batteries are stacked on top of each other. When batteries are connected in series, the voltage adds together. Three 1.5-volt batteries connected in series have a total voltage of 4.5 volts.



5. Facilitate the activity.

Distribute the activity sheet and the materials. Explain that each team or pair of kids will make a battery. Review the activity sheet, including the illustration, and help kids follow the steps as needed. When they've completed assembling their batteries, ask: *Can anyone identify the parts of this battery?* (The copper strip is the positive electrode, the zinc screw is the negative electrode, and the saltwater is the electrolyte.)

6. Test the saltwater batteries.

Have the kids use the buzzers to test the battery (touch the buzzer's red wire to the copper strip and the black wire to the zinc screw). They may hear a faint buzz or no buzz at all due to the battery's low voltage. If you have a multimeter, set it to the lowest setting for DCV (Direct Current Voltage) and have each pair or team use it to test their battery (touch the red probe to the copper strip and the black probe to the zinc screw). It should detect a very low voltage (less than 1 volt), but the movement of the needle will be apparent.

7. Power up.

When all the kids have tested their batteries, ask: *Did you get your buzzer to work?* (Some kids will say no, some will say a little bit.) Ask: *Why do you think that happened?* (The individual saltwater batteries have very low voltage.) Ask: *How can we get more power from our batteries?* (By connecting the batteries together in series.) Have the kids bring their batteries to one area and arrange them in a circle. Use the 6-inch lengths of wire to connect the batteries in a series circuit. Attach the zinc screw in one cup to the copper in the next (see activity sheet illustration).

After connecting the first two or three cups, check the voltage using the multimeter or a buzzer (touch the red wire or probe to the copper in the first cup and the black wire or probe to the zinc screw in the last cup). Connect the rest of the cups. When the cups are all connected, close the loop with a buzzer.

If the buzzer doesn't work, see the Troubleshooting tips. When the battery works, try to light a small LED light (touch the longer wire to the copper strip and the shorter wire to the zinc screw.) LEDs use very low voltage, so it should light if all the connections are working.

8. Discuss the results.

Ask:

- *How is the saltwater battery better than the AA battery?* (no toxic chemicals, environmentally friendly, easy to make)
- *What are the drawbacks?* (The saltwater battery is bigger than a AA battery and not easy to carry around.)
- *How many saltwater batteries do you think it would take to power a computer or an electric car? Why?* (Accept all responses.) *Do you think that would be a practical power source?* Explain that, in addition to the danger of chemicals, size is another big problem for batteries. Powerful batteries are also very big and heavy. Small and light batteries do not have much power. Materials scientists are working to solve these problems and to make small, powerful batteries that are safe for the environment.

9. Conclude the activity.

Ask: *How could you increase the power of your saltwater battery without increasing its size?* Some answers are: add more salt or use warmer water —both increase the rate of the chemical reaction.) If time permits, have kids try these variations. Then, show the clip from NOVA *Making Stuff: Cleaner* about smaller more powerful batteries that may soon power electric cars. The clip is available at pbs.org/nova/education/makingstuff.

TROUBLESHOOTING

After the batteries (cups) are linked, there should be a significant increase in voltage and a sharp, clear buzz. If not, make sure:

- the wires are securely attached to each electrode (copper strip is positive electrode and zinc screw is negative electrode) and wrapped in a way that touches exposed metal
- the ends of the wire are out of the water
- the zinc and copper are not touching each other in the cups
- the wires connect the copper strip in one battery to the zinc screw in the next

MAKING STUFF

Build a Cleaner Battery

NOVA PBS

MATERIALS

(per simple battery)*

- warm water
- 3 tablespoons salt
- plastic cup
- 1 strip of copper (plumber's strap), about 1 inch taller than your cup
- 1 zinc (plated or galvanized) screw, at least 2 inches long
- 6 inches of insulated wire, to attach batteries together
- 1 large alligator clip
- 1.5-volt buzzer

Batteries are all around us. They are cleaner than some forms of energy, such as petroleum, but they can be hazardous to the environment if not disposed of properly. Materials scientists are working to make smaller, more powerful, and environmentally friendly batteries. **Build simple batteries. Connect them together to make a super battery with more power!**

1. Build a saltwater battery.

Use the saltwater provided, or put 3 tablespoons of salt in the cup and fill it with warm salt water, to about an inch from the top. Put a copper strip and a zinc screw in the saltwater solution, using an alligator clip to secure the screw to the cup.

2. Connect a buzzer to your battery.

Touch the RED wire to the copper strip and the BLACK wire to the screw. How loud was the buzzer?

If you have a multimeter, measure and record the voltage. Set the multimeter to DCV and touch the RED probe to the copper strip and the BLACK probe to the screw.

Record the voltage: _____ volts

Most electrical devices use more than one battery and their voltages add up. How could you increase the voltage of your battery and get the buzzer to buzz louder?

3. Make more power.*

Connect two batteries together by wiring one of your electrodes to the opposite electrode in another battery. Wrap one end of a wire around the copper strip in your battery. Wrap the other end around the zinc screw (or clip it under the alligator clip) on another.

Test the buzzer again by touching the wires to the remaining unattached electrodes (the RED wire to the copper strip and the BLACK wire to the screw).

- How loud was it?

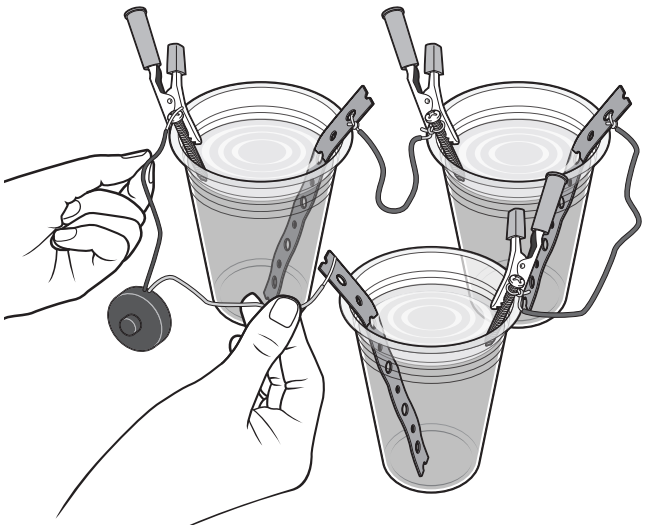
If you have a multimeter, use it again and record the voltage:

_____ volts

- What do you think happened?
- How could you increase the voltage of your battery even more?

4. Build a super battery.*

Gather all the batteries in a circle and connect them into a series circuit—a circuit in which all the parts follow one another (see illustration). After each connection, measure the voltage or test the buzzer. Make sure your wires are securely attached and out of the water, and that the electrodes are hooked up in opposite pairs.



5. Test the super battery.

Touch a buzzer to the unattached electrode in the first battery and the unattached electrode in the last battery. (If you're using an LED, connect the longer wire to a copper strip and the shorter wire to the zinc screw.) What happened?

If you have a multimeter, use it again and record the voltage:

_____ volts

Why did the voltage increase as you added batteries?

6. Think like a materials scientist.

- How is the saltwater battery better than the AA battery? How is it worse?
- How could you increase the power of your saltwater battery without increasing its size?
- How many saltwater batteries do you think it would take to power a computer or an electric car? Why?

*If doing this activity at home, make several more simple batteries.

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