Be Battery Smart: A Battery Safety Lesson

Aligned to the S.C. College- and Career-Ready Science Standards 2021

GRADE 4

CCC:

Learning Objectives

Students will:

- **Identify uses and characteristics of different types of batteries**;
- **Describe and analyze safe handling procedures for battery storage and disposal**; and
- **Have a working understanding of energy and how energy is produced.**

LESSON VOCABULARY

- **Energy** – usable power (such as heat or electricity)
- **Insulator** – a material that is a poor conductor (as of electricity or heat)
- **Conductor** – a material capable of transmitting another form of energy (such as heat or sound)

BACKGROUND

If it makes sounds, lights up, moves and more without being plugged in – it has a battery.

Batteries are everyday essentials, but they also contain toxic metals such as lead, cadmium, lithium and silver and if not properly managed at the end of their useful life can cause harm to human health and the environment.

How do you properly manage? The first thing to know is to never place ANY batteries in the household recycling container. Batteries require specific management. In addition, certain batteries – particularly lithium-based – should never go in the household garbage. These types of batteries can start fires threatening worker and first responder safety as well as damage equipment and facilities.

Generally, there are two categories of batteries: 1) **single-use** or **non-rechargeable**; and 2) **rechargeable**.

ENGAGE

Ask the students to generate a list of household items that require the use of a battery (e.g., flashlight, cell phone, computer, tablet, gas powered car, electric cars, scooter, electric bike, watch, game controller, TV remote, remote control vehicle or hover board, power tools).

Ask the students to name the types of batteries those items might use (e.g., AA, AAA, C, D, 9-volt, cell phone batteries, lithium-ion). Use the ***Examples of Common Electronic Devices Containing Lithium Cells or Batteries*** chart on the following page to generate a discussion on which type of battery is found in each type of device.

Discuss with the students the difference between single-use batteries and rechargeable batteries. (Walkie Talkies, camera, some remote-controlled toys may have single-use batteries that need to be replaced when the charge is lost, while smartphone, shavers, tablets are rechargeable.) Take this online quiz as a pre-assessment – **britannica.com/quiz/electricity-short-circuits-direct-currents**. This pre-assessment can be done individually or as a whole group. Discuss the items that were missed as a whole group.

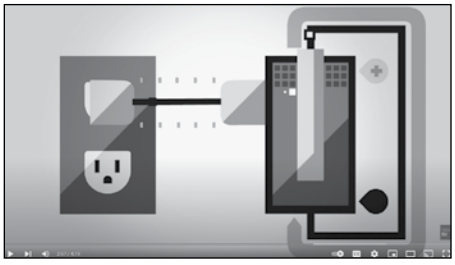
Examples of Common Electronic Device Containing Lithium Cells or Batteries

Video Cameras	**Walkie Talkies** (two-way radios)	**GPS Devices**	**Radio-Controlled Toys**
Cameras	**Scanners**	**Cordless Phones**	**MP3 Players**
Bluetooth Headsets	**Cell & Smart Phones**	**Laptops**	**Handheld Games**
Power Drills	**Tablets**	**Portable DVD Players**	**Drones**

EXPLORE

The students will make a coin battery to investigate the question "What is a battery?"

Before the investigation, show the video ***How Batteries Work – Adam Jacobson***. For a direct link to this video, visit **takeactionsc.org/curriculum**. Batteries are a triumph of science. They allow smartphones and other technologies to exist without anchoring us to an infernal tangle of power cables. Yet even the best batteries will diminish daily, slowly losing capacity until they finally die. Why does this happen and how do our batteries even store so much charge in the first place? In this video, Adam Jacobson gives the basics on batteries.



How Batteries Work – Adam Jacobson

Next, conduct the investigation ***Charge from Change: Make a Coin Battery | STEM Activity*** at **sciencebuddies.org** and follow the instructions provided. Teachers, please note that there is a video demonstration of this investigation if time or resources are not available.

After the students work through creating a battery, have students create a student-friendly definition and explanation of “What is a battery?” (**Definition:** A battery is a device that holds electrical energy in the form of chemicals. With the help of an electrochemical reaction, it converts stored chemical energy into direct current (DC) electrical energy.)

EXPERIMENT – Charge from Change: Make a Coin Battery

From ***Science Buddies****,* ***sciencebuddies.org/stem-activities/charge-from-change-make-a-coin-battery***

Electricity is the presence of an electric charge, which can be either positive or negative. An electric current is generated by moving charges, usually in the form of electrons or ions. In batteries, these moving charges are created from chemical reactions, meaning that electrical energy is derived from chemical energy.

The main components of a battery are two electrodes, typically made from carbon or two different metals, and the electrolyte, which is a liquid or paste that is in contact with both electrodes. The electrodes and electrolyte need to be electrically conductive to allow electrons and ions to flow from one electrode to the other. The question now is where do the electrons come from? Here is where chemistry comes into play.

Electrons are generated through electrochemical reactions, called redox (reduction-oxidation) reactions, where negative charges (in the form of electrons) are transferred from one chemical (or metal) to another. The electrons and ions that are released during these reactions travel through the electrolyte from one electrode to the other.

During that process, one electrode releases electrons while the other accepts electrons to complete the electric circuit. There are many different battery types that use different chemical reactions to generate electrons. Two common examples are the lithium ion battery and the nickel cadmium battery.

In this activity, you will make a copper zinc battery using a vinegar/salt solution as the electrolyte. Do you think your battery will generate enough electricity to power an LED?

PREPARATION

1. Trace a coin 20 times on the construction paper with a pencil.
2. Cut out all the coin-sized paper pieces.
3. Pour some vinegar into a bowl and add enough salt to create a saturated solution, which means that not all of the salt is able to dissolve. Mix with a spoon.
4. Put 15 of the coin-sized paper pieces in the bowl and let them soak in the vinegar/salt solution for five minutes.

NOTE: In this activity, you will make a very low-voltage battery. The amount of electricity generated by this homemade battery is safe; higher voltages of electricity, however, can be very dangerous and even deadly, and you should never experiment with commercial batteries or wall outlets!

INSTRUCTIONS

1. Take one washer and place it on your work area. What material is the washer made of?
2. Take a soaked construction paper piece and place it on top of the washer. Why do you think the construction paper needs to be soaked in the vinegar/salt solution?
3. Next, place another washer on top of the soaked paper piece.

SUPPLY LIST

- 20 Metal Washers (galvanized), size of a penny
- 20 Pennies (preferably shiny)
- Pencil
- Construction Paper
- Scissors
- Bowl
- Vinegar
- Table Salt
- Spoon
- Small LED (white or red)
- Paper Towels
- Work Area (one that can tolerate vinegar spills)
- OPTIONAL: Calculator
- OPTIONAL: Aluminum Foil

Charge from Change: Make a Coin Battery

4. Then place another washer on top of that washer. Add another piece of soaked construction paper and then add two more washers on top of that.
5. Repeat alternating the soaked paper and two washers until you have used nine washers in total. You should finish with two washers on top of a soaked piece of paper.
6. With a paper towel dry off the sides of your stack. You want to make sure that the washers are dry on the side.
7. Also, make sure that the soaked paper is not touching more than one washer on each side.
8. Take the LED and spread the two pins apart. Then, push the long pin of the LED underneath the stack so that it makes firm contact with the washer on the bottom. Place the short pin on top of the washer on the stack and press it down. Watch the LED. Does the light turn on when you connect the pins to the top and bottom of the washer pile?
9. Make a second stack, but this time, use pennies instead of washers. What material are the coins made of?
10. Once the stack is complete, dry it off on the sides and ensure that the soaked paper only touches one penny on each side.
11. Then take the LED again and connect the long pin to the bottom coin and the short pin to the top coin. Do you see the LED light up when you make contact with the coins?
12. Make a third stack, but this time, start with a penny on the bottom, place a soaked paper piece on top of the coin and then add a washer on top of the paper. Repeat, adding a coin, soaked paper and washer, until you have used five coins in total. You should end up with a coin placed on top of a washer.
13. Again, make sure to dry off any excess liquid from the soaked paper on the side of the coins and washers, and check that the soaked paper only touches one washer and coin on each side.
14. Then connect the long end of the LED pins to the coin at the bottom of the pile and the short end to the washer on top of the stack. What happens to the LED this time?
15. Finally, use the dry construction paper pieces and make a fourth stack, alternating coin, a dry paper piece, washer, coin, a dry paper piece, washer until you have used five coins in total. Do you think it makes a difference if the construction paper is wet or dry?
16. Take the LED one more time and connect the long pin to the bottom of the stack and the short pin to the top of the stack. Does the LED light up this time? Why or why not?

EXTRA: How many coins and washers do you need to light up the LED? Does the amount matter at all? Try lowering the number of coins and washers that you stack. What is the minimum number of coins and washers that you need to light up the LED?

EXTRA: Could you power other devices with your self-made coin battery? Test this by connecting other devices, such as a calculator or a little clock, to your battery! (You might need the help of an adult to figure out which wires inside the device you have to connect to the battery.)

EXTRA: What would happen if you exchanged the washers with another type of material, like aluminum foil? Would you still get a functional battery? Cut coin-sized pieces of aluminum foil and create a stack of coins and aluminum foil to find out!

EXTRA: If you have a multimeter at home, you can measure the voltage of your battery and how much current it produces. How does the voltage and current change as you add more coins to your battery?

Recycle Right – and Safely!

- **Collect and sort your batteries by type.** If the batteries have a white or rusty colored powder on the terminals, use latex or nitrile gloves since this powder can burn.
- **Remember, single-use (alkaline) batteries (e.g., as AA, AAA, C, D) do not have to be recycled.** They can be safely placed in the trash.
- **Prepare batteries for the drop-off facility.** Place batteries in a clear plastic bag OR place clear tape on both the positive (+) and negative (-) terminals of batteries (except alkaline) to prevent fires.
- **Bring the entire device if you cannot remove the battery.**
- **Tape these, too.** Tape all button or coin shaped batteries and all lithium batteries whether rechargeable or single-use.

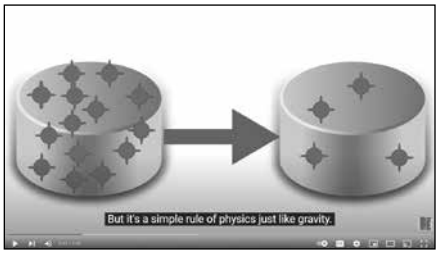
- **Safely store!** After you tape your batteries, place them in a container until you take them to a participating take-back retailer or your county program. The container should not be airtight.
- **Timing is everything.** Aim to drop batteries to recycle within six months, ensuring they are bagged or taped.

EXPLAIN

How does a battery work? Now that the students have a better understanding of the history of batteries, lead a discussion on how batteries work.

Watch ***How Does a Battery Work? Electricity and Batteries Explained***. This video gives the students a brief review of insulators and conductors and electricity. Then, have the students read the ***Britannica Battery Summary*** at britannica.com/summary/battery-electronics.

Ask the students to share 1 to 3 interesting facts they have learned from these two sources. Ask students if all batteries the same? The answer is no. There are single-use batteries and rechargeable-batteries. Read and discuss the handout ***Identifying Different Types of Batteries***.



How Does a Battery Work? YouTube

ELABORATE

Batteries require proper safe handling. Review and discuss the ***Be Battery Smart*** Web page – scdhec.gov/be-battery-smart-dispose-or-recycle.

Afterward, have students create a ***Be Battery Smart*** awareness poster for hallways or flyers to spread the word about battery safety. The students must include the proper ways to store, recycle or dispose of different types of batteries.

Britannica Battery Summary

EVALUATE

As a post-assessment have students re-take the quiz at britannica.com/quiz/electricity-short-circuits-direct-currents. Then have the students answer these questions.

1. **What is a battery?**
2. **What are some examples of items that require batteries?**
3. **Why should batteries be stored properly?**
4. **What steps could you take at home to ensure batteries are stored properly?**
5. **Why is it important to properly dispose of or recycle batteries?**

DHEC's Be Battery Smart Web Page

Extension Activities

1. Have the students research battery recycling in their county.
2. Have the students research their own home with the help of parents to make sure batteries are stored safely. See ***More Safe Battery Handling Resources*** at call2recycle.org.

Call2Recycle Website

Identifying Different Types of Batteries

STUDENT HANDOUT

Every year in the United States, millions of single use and rechargeable batteries are bought, used and recycled or disposed of in the trash. Batteries come in various chemistries, types and sizes to fit their use. Rechargeable batteries may be removable or permanently attached to the device.

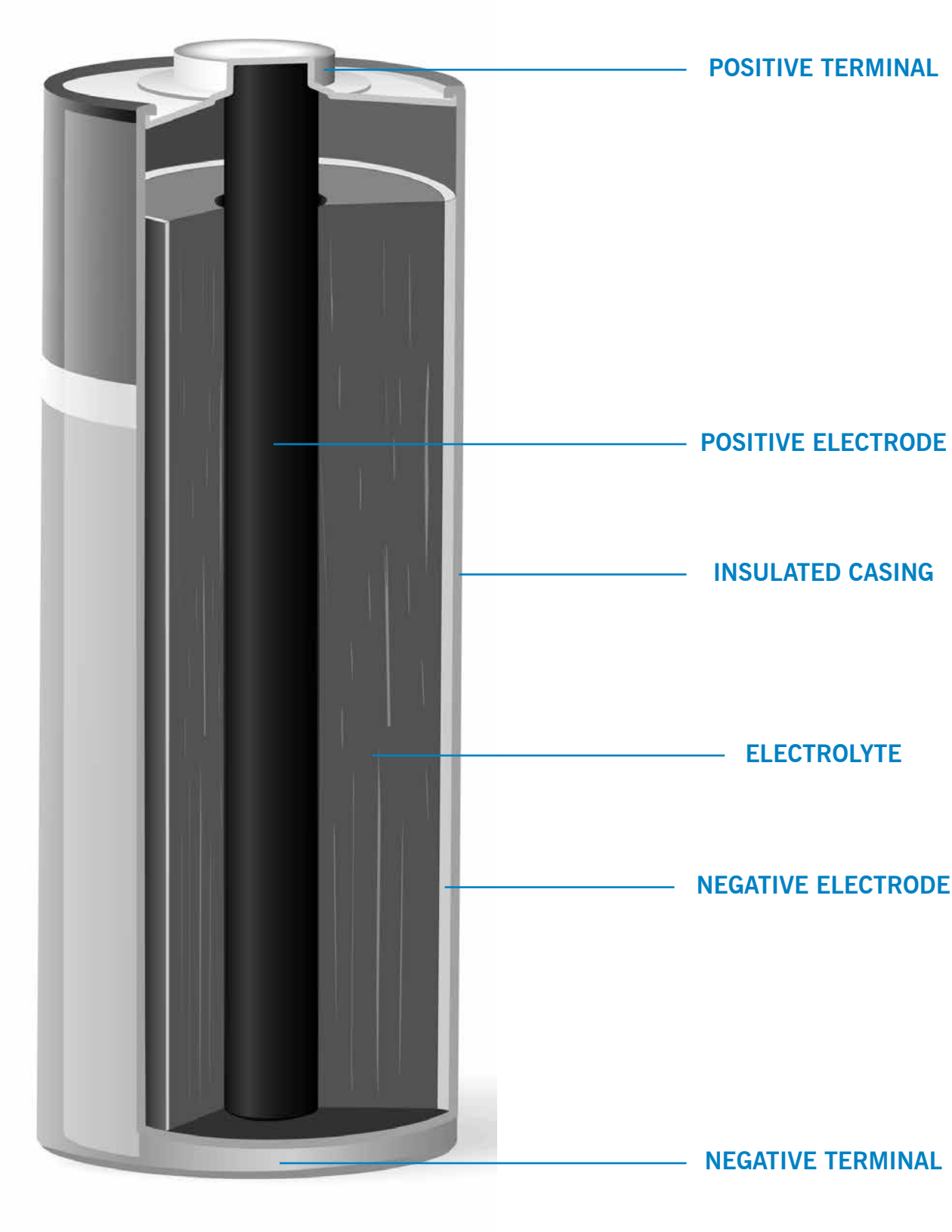
RECHARGEABLE BATTERIES

TYPE	EXAMPLE	USES AND DESCRIPTION
Nickel Cadmium (Ni-Cd)		• These batteries are typically used in cordless power tools, cordless phones, digital and video cameras, two-way radios and bio-medical equipment. • Ni-Cd batteries may look like single-use AA, AAA or other alkaline batteries or a battery pack shaped for specific tools.
Lithium-Ion (Li-ion)		• Commonly found in older cellphones, power tools, digital cameras, laptops, toys, e-cigarettes, appliances, tablets and e-readers. • Some Li-ion batteries are not easily removed from the product and can become problematic as a fire hazard if they are broken, bent or crushed.
Lithium Polymer (LiPo)		• A rechargeable battery of Li-ion technology using a polymer electrolyte instead of a liquid electrolyte. • LiPo batteries provide higher specific energy than other lithium battery types and are used where weight is a critical feature – such as mobile devices.
Nickel Metal Hydride (Ni-MH)		• Commonly found in cellphones, cordless power tools, digital cameras and two-way radios. • These batteries are not as common as they once were.
Nickel-Zinc (Ni-Zn)		• Commonly found in digital cameras, wireless keyboards and small electronics.
Small-Sealed Lead Acid (Pb)		• Commonly found in mobility scooters, children's toy cars, emergency lighting and hospital equipment. Also used for backup power in residential landline phones and uninterruptable power supplies for computers.

SINGLE-USE BATTERIES

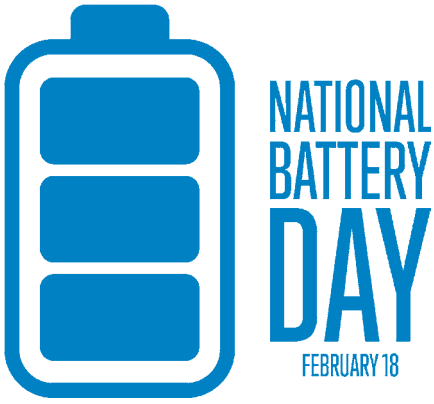
TYPE	EXAMPLE	USES AND DESCRIPTION
Alkaline & Zinc-Carbon		• These common everyday batteries can be used in products such as alarm clocks, calculators, flashlights, TV remote controls, radios, remote-control products, children's toys and other items. • For example, some common alkaline and zinc-carbon batteries include 9 Volt, AA, AAA, C, D and some button cells.
Button-Cell or Coin		• These small, round batteries have historically contained silver, cadmium, mercury or other heavy metals as their main component. • Today, the majority are made of lithium metal. These batteries are commonly used in products such as watches, hearing aids, car keyless entry remotes, medical devices and calculators.
Lithium Single-Use		• These common batteries are made with lithium (Li) metal and are single-use and non-rechargeable • They are used in products such as cameras, watches, remote controls, handheld games and smoke detectors. • These batteries may be difficult to distinguish from common alkaline batteries, but may also have specialized shapes for specific equipment, such as some types of cameras and calculators.

Single-Use Battery Diagram



Celebrate National Battery Day

To commemorate their contribution that all types of batteries make to our lives, **National Battery Day is celebrated each year in the United States on February 18**.



Batteries are important accessories for all the electronic devices that are part of our day-to-day routine. Cell phones, tablets, radios, watches and even a growing number of cars are battery-powered.

Batteries convert chemical energy to become electrical energy. When different chemicals are combined in a designated order, electrons (negatively charged ions in the battery) travel from one substance to another. This action leads to the creation of an electrical current.

Because of advances in technology and the need for portable power, batteries make it possible to communicate, learn, travel and be entertained.

To learn more about National Battery Day and way to celebrate, visit nationaltoday.com/national-battery-day/.

S.C. Science Standards for Grade 4

GRADE 4	
4-PS3-4.	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
DISCIPLINARY CORE IDEA (DCI):	
PS3.D: Energy in Chemical Processes and Everyday Life	The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.
CROSSCUTTING CONCEPTS (CCC):	
Energy and Matter:	Energy can be transferred in various ways and between objects.

MORE RESOURCES

- **Test Your Battery Smarts!** Take a short quiz at blog.savvas.com/national-battery-day/. Scroll to the middle of the page and click the link.
- **Charge It!** Learn more about rechargeable batteries at epa.gov/recycle/used-lithium-ion-batteries.
- **Bring It Home!** Learn more about single-use batteries at epa.gov/recycle/used-household-batteries.
- **A Battery History Lesson!** See the History of National Battery Day and the Battery Timeline at nationaltoday.com/national-battery-day/.
- **History of the Battery: Part 2** – For more information about the early history and development of batteries, visit batteryguy.com/kb/knowledge-base/a-history-of-the-battery/.
- **Picture Perfect!** Watch ***Timeline: History of the Battery Slide Show*** at batteryguy.com/kb/knowledge-base/timeline-history-of-the-battery/.

Timeline: History of the Battery