The Road Ahead

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A New Road

Grades 6-8

Introduction

In this three-part lesson, students take a deeper dive into battery technology and its potential effect on transportation and energy resources. Students identify true and false statements about batteries and battery technology; act out the process behind battery science; research the chemistry, advantages, and limitations of a specific battery; and consider the personal and global impact of batteries that could power electric cars.

Time Frame

2-3 class periods

Objectives

Students will:

- Explain the science behind how batteries work.
- Research and present the chemical elements, chemical reactions, advantages, limitations, and applications of a specific battery technology.
- Draw conclusions about how advanced battery technology could provide sustainable energy options.

Materials

- 8 small signs (see note in "procedure")
- Tape
- "Anatomy of a Battery" student activity sheet – one per student
- Access to Internet

For extension activity:

- A 400-1,000 milliliter clear beaker
- Tap water
- Two 20-centimeter or longer test leads (wires) with double-ended alligator clips
- A 6-Volt lantern battery
- A strip of cardboard, about three inches wide and two inches longer than the top of the beaker
- Two electric-conducting tin strips

Procedures

Part 1

Note: Before students enter, place 8 signs around the room, each with one of the following facts written on it:

1. Batteries work because of a chemical reaction.

2. Batteries do not create energy. They store it.
3. No battery lasts forever.
4. When you recharge a battery, you are reversing the chemical reaction using electrical energy.
5. A regular household outlet could charge a battery big enough to power a car.
6. Advanced battery technology will be at the heart of the transformation from cars powered by petroleum to cars powered by electricity.
7. All batteries have a negative electrode and a positive electrode.
8. Lithium ion batteries can store more energy than alkaline batteries.

2. Ask students to get out a sheet of paper and list every technology, appliance or object they have used in the last 24 hours that was powered by a battery. See who can come up with the longest list! Have students share their answers, encouraging them to think about objects like store scanners, cell phones, cordless phones, computers, remote controls, gaming controls, etc.

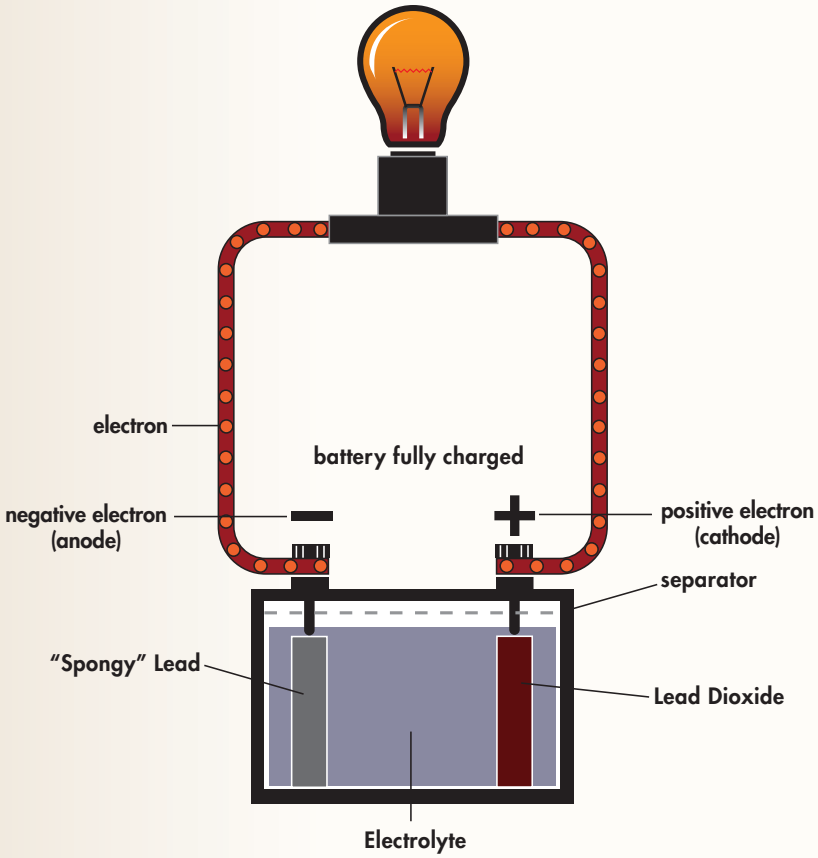
3. Lead a discussion using the following questions:
   a. Based on their lists, would students agree or disagree that battery power is important in their lives?
   b. Which battery-powered objects would they be willing to live without?
   c. Do they think they could exist without battery power for a day? A week? A year?
   d. Given the fact that battery power is so important to modern society, how much do students know about how batteries work?

4. Divide students into small groups and have each group name themselves. Point out the 10 signs around the room and tell students that each sign includes a fact about batteries that is either true or false. Direct each group to get up and write their group name on every sign that they believe states a "true" fact about batteries. After all groups have had ample time to complete the activity, read and discuss each sign. Groups that wrote their name on all 10 signs should give themselves a "powerful" applause. They are all true! Do any of these facts surprise students? Which would they like to learn more about?

5. Have students identify the signs that relate to how batteries work. Ask students to share what they already know about the science behind battery technology. Then read the following passage aloud. Tell student groups that, after reading, they will be challenged to act out a particular step in the process.

A battery can be any device that stores energy for later use. Batteries do not make energy. They store it. A battery is like a small power plant that converts chemical reactions into useful electricity. Even though different batteries look different, they all contain four main parts: a positive electrode: a negative electrode; an electrolyte; and a separator. If you look at a battery, you will see that it has two ends – a positive terminal and a negative terminal. Electrons, which have a negative charge, want to move to the positive point of the battery since opposite charges attract one other. They do that through a copper wire or other conductor. The path that goes from the negative point to the positive

one is called a circuit. You can attach anything to the middle of that circuit that needs power, such as a light bulb or motor. The electrons have one goal – to get to the positive point. Inside the battery, a reaction between the chemicals causes electrons to flow from the negative terminal to the positive terminal. As they move and travel around the circuit, they create energy and power. Some batteries have different chemical makeup than others but all store power and convert chemical reactions into useful electricity. Energy is stored in a battery until the electrons are flowing from the negative to the positive terminal. When they are flowing, the energy is released. But until that happens, the energy is stored.



6. Assign each group one step in the process to act out. Challenge other students to guess what is being acted out. If students have trouble guessing, encourage the group to explain the thought process behind their acting.

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Part 2

1. Put the words, "disposable" and "rechargeable" on the board. Ask students what happens when the batteries in their flashlights, portable gaming systems, or toys run out of power. They probably ask their parents for new batteries, which they insert. Explain that these batteries are called disposable batteries because they are disposed of after they are used. A battery only contains a fixed amount of chemical reactants, and, once these have been used up and the chemical reactions stop – the battery is dead! Ask students which objects from the beginning of the lesson use disposable batteries?

2. Ask students what they or their parents actually do with disposable batteries when they run out of charge? For those who answer, "throw them away," ask what they think happens to batteries that are thrown away and what impact throwing them in the trash has on the environment. Sealed inside the alkaline cells of a battery are harmful materials which are not encountered during normal use. However, when the batteries end up in a landfill, the casings can degrade or get crushed. This causes mercury and other toxins that are dangerous to humans and animals to leak into the environment. These materials can seep into the ground and become hazardous to our ground water. The average American discards around eight batteries a year. That totals three billion per year just in the U.S. – enough to cause considerable mercury and toxic metal contamination.

3. Ask students if they know the best way to reduce this environmental threat. The best solution is to use rechargeable batteries! Rechargeable batteries are not thrown away when they run out of charge. They are plugged in to a power source and recharged. Ask students what objects from the beginning of the lesson (or which objects in their lives) use rechargeable batteries. Examples include cell phones, computers, cameras, and remote control cars. Explain to students that, with rechargeable batteries, the chemical process is reversed and the electrical current is carried from the cathode (the positive terminal) back to the anode (negative terminal). Ask students the advantages of using rechargeable batteries. Encourage them to think about advantages to them personally (cost over time, not running out) and to the environment (renewing rather than using new energy, gentler on the environment).

4. Explain that in addition to batteries being disposable or rechargeable, different batteries use different chemistries to power objects. For example, the battery that powers their laptop or cell phone likely uses a different chemistry than the battery that powers their flashlight. The science is the same, but the chemicals are different. Given our reliance on portable technology and the limits of non-renewable resources, battery technology is constantly evolving. Learning the chemistries, advantages, and challenges of different battery types can help students understand how battery technology can provide sustainable options for the future.

5. Have students get back into their groups and distribute the "Anatomy of a Battery" activity sheet. Review the directions and assign or have each group select one of the following batteries to research: alkaline, lead acid, lithium, lithium ion, nickel cadmium, or nickel metal hydride.

Give students ample time to complete their research. Suggested research sites include:

a. Duracell Battery Guide: http://www1.duracell.com/oem/comparisons/default.asp
b. Energizer Battery Handbook: http://data.energizer.com/Static.aspx?Name=AppManuals
c. The Energy Story: http://www.energyquest.ca.gov/story/chapter05.html
d. Electric Tool Guide- http://www.electrictoolguide.com/types-of-batteries/
e. Green Batteries- http://www.electrictoolguide.com/types-of-batteries/

6. Challenge each group to come up with a way to teach the rest of the class about their battery. Ideas include a Power Point presentation, commercial, poster, talk show interviewing their battery, or rap song! Have students prepare and present their information.

Part 3

1. Share with students that scientists and some companies are developing battery technologies to power cars electrically without the need for petroleum. This battery could be recharged, allowing cars to be powered by renewable resources instead of petroleum. Lithium ion batteries in particular have high energy capacity and a low mass, which makes them ideal for many types of mobile devices and for electric automobiles. Lead a discussion with students and have them consider:

a. Which of the battery technologies they researched could power a car? Lithium ion, nickel metal hydride, and lead acid.
b. How do students think that this technology would work? When would they recharge the battery? What would happen when the battery ran out of charge?
c. If electric cars became more prevalent, how might that change the following:
    - Our reliance on petroleum and other non-renewable resources.
    - Our reliance on other countries.
    - Our current energy situation.
    - The current transportation system.
    - Our way of life.
    - Current service stations.
    - What else might change?
d. How do small, portable, energy dense batteries help support our modern way of life?

2. Finally, have students imagine that they have been asked to be a guest contributor for an Internet blog called, "Power to the Battery." Have them write a blog entry that supports one of the statements below. Their blog should consider the questions above and additional research, be informative and fun to read!

a. Batteries have an important role in creating a sustainable energy future.
b. Advanced battery technology can help support our modern way of life.
c. Advanced battery technology that leads to electric cars is important.

Note: Think your students' blogs are ready to be published?! Submit them to "Teach Green" on the General Motors Education Site, and they just may be selected to appear! Submit student

blogs to educationeditor@gmblogs.com. Then visit the blog at http://teachgreen.gmblogs.com/to see if your students have been published.

Extension

Fuel cells are a type of advanced battery technology that could dramatically reduce our reliance on non-renewable energy sources. With a fuel cell, chemicals constantly flow into the cell so it never goes dead -- as long as there is a flow of chemicals into the cell, the electricity flows out of the cell. Most fuel cells in use today use hydrogen and oxygen as the chemicals. Using the materials listed in the "materials section," have students conduct the following experiment to see how a fuel cell works:

1. Fill the beaker one-quarter full with tap water.
2. Cut two small slits in the cardboard, which will serve as a holder and insulator for the strips.
3. Slide the tin strips into the cardboard so the tips of the strips dip into the water.
4. Attach the double-ended alligator clipped wires to the battery.
5. Connect the opposite end of the wires to the tin strips.
6. Observe what happens.

Additional Resources

Power of the Plug- This digital magazine explains the science behind batteries and how the portable power of batteries, specifically lithium-ion batteries, can power a car!
http://www.gm.com/corporate/responsibility/education/teachers/electricity.jsp

VoltageU/Battery 101- Learn the science behind the portable power packs known as batteries!
http://www.chevroletvoltage.com/index.php/Content/voltage-u-start.html

Blogging? It's Elementary, My Dear Watson-Learn ideas to help students complete the final activity where they are asked to create a blog about batteries.
http://www.educationworld.com/a_tech/tech/tech217.shtml

Vocabulary

anode
Definition: The negative terminal of a voltaic cell or battery.
Context: The electrons collect at the anode and move to the cathode.

cathode
Definition: The positive terminal of a voltaic cell or battery.
Context: The electrons collect at the anode and move to the cathode.

charge
Definition: The conversion of electrical energy – provided in the form of a current from an

external source – into chemical energy within a cell or battery.
Context: Some batteries take longer to charge than others.

circuit
Definition: The complete path of an electric current.
Context: When an electric circuit is broken, the current stops flowing.

disposable
Definition: Capable of being thrown away after being used.
Context: I used a disposable battery to power my flashlight.

electron
Definition: A chemical particle that carries a charge. Collects on the negative terminal of the battery and flows to the positive terminal when the circuit is connected.
Context: Batteries do not release energy until electrons move.

electrolyte
Definition: A paste-like substance or solution that contains charged particles that can move or conduct an electric current.
Context: The electrolytes are needed to cause a chemical reaction in a battery.

Rechargeable
Definition: Capable of being charged repeatedly.
Context: Rechargeable batteries are more environmentally-friendly than disposable batteries.

National Science Education Standards (5-8)

- Science as Inquiry: Abilities necessary to do scientific inquiry
- Science as Inquiry: Understanding about scientific inquiry
- Physical Science: Properties and changes of properties and matter
- Physical Science: Transfer of energy
- Science and Technology: Abilities of technological design.
- Science and Technology: Understanding about science and technology
- Science in Personal and Social Perspectives: Populations, resources and environments
- Science in Personal and Social Perspectives: Science and technology in society.

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Student Activity Sheet: Anatomy of a Battery

Many different types of batteries have been produced for many different applications -- for powering heart pacemakers, flashlights and radios, handheld games, laptops, cell phones, and even automobiles! As our need for portable technology grows and our supply of natural resources decreases, advanced battery technology can help provide sustainable solutions.

Choose one battery type from the following list to learn more about: alkaline, lead acid, lithium, lithium ion, nickel cadmium, or nickel metal hydride.

1. Conduct research to complete the following information about your battery.

Battery Type	
Chemical Elements/Components	
Chemical Reactions That Produce Power	
What It Powers	
Advantages	
Challenges/Limitations	
Ideas on Sustainability	

2. Come up with a creative way to teach the rest of the class about your battery technology. Ideas include a commercial, song, presentation, or lesson plan.