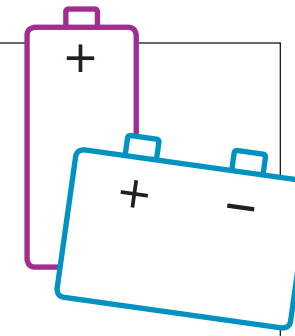
BATTERIES OF YESTERDAY AND TODAY



Give your students a "jolt" with a fun innovation challenge inspired by Alessandro Volta's original battery!

Objective

Students will explore the oxidation/reduction chemical reaction firsthand and design an engineering solution for a real-world problem.

NGSS Standards

HS. Chemical Reactions
HS-PS1 Matter and Its Interactions
HS-ETS1-2 Engineering Design

Materials

Session 1

- The Power of Batteries reading passage
- Build a Battery activity sheet

To build a voltaic pile:

- Pennies minted prior to 1982
- Nickels
- Scissors
- Thick paper towels
- Pickle juice
- Plastic clamps
- Auto-ranging voltmeter with 200 mV DV measurement capabilities

Session 2

- Engineering Innovative Materials lesson and Drive Progress activity sheet (**bit.ly/2ytc6t1**)

Session 3

- Innovators of Tomorrow Contest entry forms
- Contest Entry Planner

Session 1: 75 minutes

1 **Kick off** the lesson with a discussion. What kinds of technology make a cell phone portable? Welcome all responses and narrow focus on the cell phone's battery. What kinds of engineering innovations and advanced manufacturing techniques might have taken place to create a battery that is compact, lightweight, and long-lasting enough to carry around in your pocket? What are some of the other places batteries are used? Think large and small.

2 **Distribute** The Power of Batteries reading passage and Build a Battery activity sheet. Have students read the passage and complete the questions on the activity sheet.

3 **Supply** groups of students with the materials required to create their own voltaic pile. Troubleshoot as needed.

4 **Wrap up** with a discussion. What are some of the limitations of the voltaic pile? What are some of the obvious reasons it isn't a suitable choice for powering a cell phone or using in place of a car's battery? Prompt for ideas like: *requiring human intervention to keep the electrolyte moistened, voltage, doesn't recharge itself, size, shape, etc.* Ask students to consider how the needs and constraints of a design problem are important to solve for when engineering and how these same needs and constraints can be used to drive innovation forward.

Session 2: 75 minutes

1 **Ask** students to recall the reading passage from the first session. Once the battery had been invented, other innovators began to wonder about how basic battery principles could be built and improved upon. Have your students examine some of the ways scientists are innovating new materials and power sources.

2 **Download** and deliver the Engineering Innovative Materials lesson.

3 Have students **complete** the accompanying Drive Progress activity sheet and consider some of the real-world constraints associated with innovation.

Session 3: 60–120 minutes

1 **Encourage** students to see themselves in the role of inventor and innovator. What kind of advanced manufacturing solution could they develop to address a real-world problem?

2 **Distribute** the Innovators of Tomorrow Contest entry forms and Contest Entry Planner. Support students as they create and submit their entries.

MORE LESSONS AND ACTIVITIES

For more innovation inspiration, introduce students to an invention designed to rid the world's oceans of plastic (**bit.ly/2SZ7XXx**) and robotics technology that allows humans and robots to work together in new ways (**bit.ly/331urvn**).

Name _____

BUILD A BATTERY

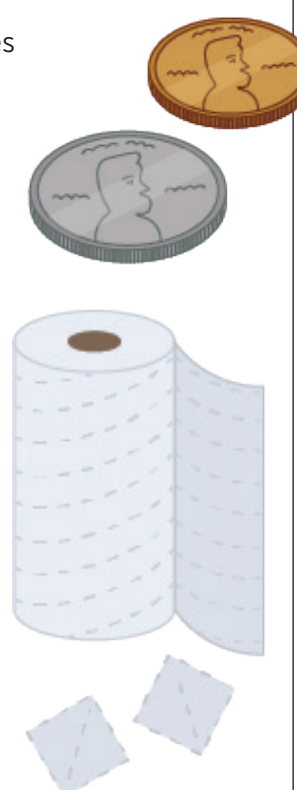
Read The Power of Batteries passage and answer the questions below on a separate sheet. Then, work in groups to build a simple battery of your own.

Respond to the reading

1. **Choose three of the bolded terms** in the passage. Use plain language to explain their meaning.
2. In your opinion, **what was the most important innovation** in batteries? Explain your thinking.

Build and test

3. Assemble your materials and follow the steps below. **Materials:** four pennies (minted prior to 1982), four nickels, paper towel, pickle juice, plastic clamp, scissors, voltmeter.



a) **Cut** paper towel into squares roughly the size of a penny and dip in brine (paper towel should be damp, not dripping).

b) **Create** one voltaic cell by stacking a nickel, a layer of brine-soaked paper towel, and a penny. Clamp your cell and use the voltmeter to measure its voltage.

c) **Unclamp** and continue adding cells to your pile following the towel-nickel-towel-penny-towel-nickel pattern. Re-clamp and test with the voltmeter as you add more cells.

d) **What are your findings?** Roughly how much voltage does each cell contribute to your battery? About how many cells would it take to send current to a 19-volt laptop?

Create a diagram

4. Now that you have seen it in action, **draw a diagram** of a voltaic pile powering an electronic device of your choice. Use the images and the information in the reading passage to help you. Be sure to:

a) Label the following: voltaic pile, one voltaic cell, electrolyte, cathode, anode, wire, electronic device, positive terminal, negative terminal.

b) Use arrows to demonstrate the flow of electrons.