STEAM Lab: Building a Battery

Grade Level:	Time Frame:
8th Grade	50 Minutes

Standards (ALCOS Science):

Energy 14) Use models to construct an explanation of how a system of objects may contain varying types and amounts of potential energy (e.g., observing the movement of a roller coaster cart at various inclines, changing the tension in a rubber band, varying the number of batteries connected in a series, observing a balloon with static electrical charge being brought closer to a classmate's hair).

Objectives:

Students will develop a model of a battery to produce enough potential energy in the form of voltage to power a small LED light bulb.

Students will construct an explanation of how they used a system of objects in the experimental procedure to convert chemical energy into potential energy and build a battery.

Background Information:

Having the ability to store energy is important and often undervalued. The storage of energy (**batteries**) is integrated into daily life from your cell phone to your laptop to even electric vehicles. Solar panels also use lithium-ion batteries to store the abundance of **solar energy** for later use when the sun may not be shining. Lithium is a lightweight metal that an electric current can easily pass through. Lithium ions make a battery rechargeable because their chemical reactions are reversible, allowing them to absorb power and discharge it later.

Although we use them everyday, most people do not understand how batteries work or what they represent. A battery is a device that is able to store electrical energy in the form of chemical energy, and convert that energy into electricity. A battery is made up of two terminals which are typically two different metals, along with an electrolyte solution. The electrolyte solution allows the flow of electrical charge which creates **potential energy**, or **voltage**, for powering a device.

In this activity, the saltwater solution serves as the electrolyte and activates the chemical reaction with the metals. This reaction starts the process. Since there are two different kinds of metals - the two different coins - one metal reacts more strongly than the other, which creates a voltage difference which creates an imbalance of electrons. That difference results in a force - a power source - and the force makes an electrical current through the closed circuit created by

the voltmeter connected to each end of the stack. As a result, chemical energy is converted to potential energy that can be used for turning on the LED light bulb if enough voltage from the reaction is produced.

Materials:

- ONE PER CLASS
  - Voltmeter
  - Small LED light (about 1.4V-1.8V) current-compatible with coin battery with insulations stripped from ends of wires
  - Additional wiring to make connections easier
- FOR EACH GROUP OF 3-4 STUDENTS:
  - One set of "Building a Battery Matching Cards"
    - they are matched correctly on the handout but should be cut apart and shuffled before giving to students
  - 8 pennies
  - 8 nickels
  - Pencil for tracing
  - A mild soap to clean your coins
  - Salt water solution (Add a small amount of water in the glass or bowl - about ¼ cup. Mix in enough salt such that a few grains no longer dissolve after stirring.)
  - 1 small bowl for salt water solution
  - 1 large paper towel
  - Scissors
- FOR EACH STUDENT:
  - a copy of the "Lab Guide: Building a Battery" handout

Engage (10 minutes):

1. Match it up! Students will use the "Building a Battery Matching Cards" to understand terminology used in the experiment and how the experiment should work.
   a. Students will first match the 8 term cards to the correct 8 definition cards.
   b. Teacher should check each groups' answers or discuss correct answers.
   c. Students will then organize the 6 experiment cards to correctly display the steps of the experiment.
   d. Teacher should check each groups' answers or discuss correct answers.

Explore (35 minutes):

1. Build it! Students will complete the "Essential Question" and "Hypothesis" sections of their Lab Report.
   a. Teacher can guide students in deciding these as a class or allowing students to decide of their own.

   b. It is suggested that the Teacher at least guides the class in forming the "Essential Question."
2. Build it! Students will use the Lab Guide to follow each step of the experiment procedures to build to a battery.
   a. Students will record each step of their experiment in the "Procedures or Observations" section of the Lab Report.
3. Students will completely build and test their battery!

Evaluate (5 minutes):

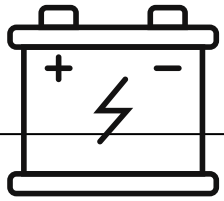
1. Make Conclusions! Students will use the "Discussion/Conclusions" section to refer back to their hypothesis and list any final thoughts about their experiment.
   a. Students can discuss these thoughts out loud with their group or as a class.

References:

https://www.energy.gov/eere/solar/articles/solar-plus-storage-101
https://engineering.mit.edu/engage/ask-an-engineer/how-does-a-battery-work/
http://www.pbslearningmedia.org/resource/phy03.sci.phys.mfw.zlemon/experimenting-with-a-lemon-battery/

Additional Content:
https://archive.org/details/NasaWhyFiles-TheCaseOfTheElectricalMystery

Lab Guide



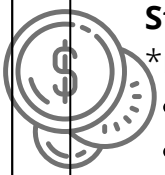
Lab: Building a Battery **Grade: 4th**

Step 1:
materials: 8 pennies, 8 nickels, soap, paper towel
- Use the soap to clean the dirt and grime off the coins.
- Use the paper towel to dry them.

Step 2:
materials: pencil, a penny, paper towel, scissors
- Use the pencil to trace 10 circles a little bit bigger than the size of a penny out of the paper towel.
- Use the scissors to cut out each circle.

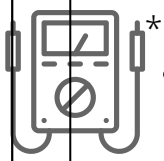
Step 3:
materials: 10 paper towel circles, salt water solution, bowl
- Soak the paper towel circles in the saltwater solution one at a time and then set to the side.

⚠ Circles should be wet but not dripping. Dripping electrolyte can create a short circuit. If necessary, press out excess liquid from the paper towel circles by placing them between your thumb and a finger.



Step 4:
materials: 8 pennies, 8 nickels, soaked paper towel circles
- Lay out 8 nickels and place one piece of the salt water soaked paper on each.
- Lay a penny on top of each paper.
- Each of the penny-paper-nickel stacks becomes an individual coin battery cell.

⚠ Be sure the penny touches only the paper and not the nickel. This will create a short circuit and prevent your battery from working.



Step 5:
materials: coin battery cells, voltmeter
- Use the voltmeter to test one of your battery cells before you start stacking them.

<u>Ask your teacher to:</u>

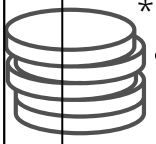
- Turn the voltmeter on to a DC Voltage setting that shows at least one, and if possible, two or more decimal points.
- Test one the battery cells to make sure it is working as a small battery by putting one lead on the nickel and the other on the penny. You should see somewhere between .25 and .50 volts DC depending on how well that cell is working.

Lab Guide

Lab: Building a Battery **Grade: 4th**

Step 6:

materials: coin battery cells



- Stack all of your small battery cells together to make one big battery using the same penny-paper-nickel pattern.

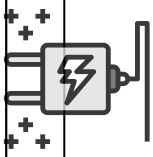
Ask your teacher to:

- Use the voltmeter to test the total voltage of your big battery.
- Is the voltage higher?

Are you ready to **GLOW** to the next step?

Step 7:

materials: big coin battery from each group, extra wire, tape, LED light



- Place one end of the wire on the bottom coin and one end of the wire on the top coin. You can use tape to hold the ends in place.
- Place each end of your battery wire on each end of your LED light wire.

Did your light glow?

⚠ Work with other groups to build a battery strong enough to power an LED light by carefully stacking your big coin batteries together.

Ask your teacher to:

- help you if needed!
- Use the voltmeter to measure the voltage as you add on other groups batteries.

Lab Report

Scientist Name: **Date:**

Essential Question: (What do you want to learn from your experiment?)

Hypothesis: (What do you think will happen in your experiment and why?)

Procedures:
(Use pictures and notes to describe each step of your experiment.)

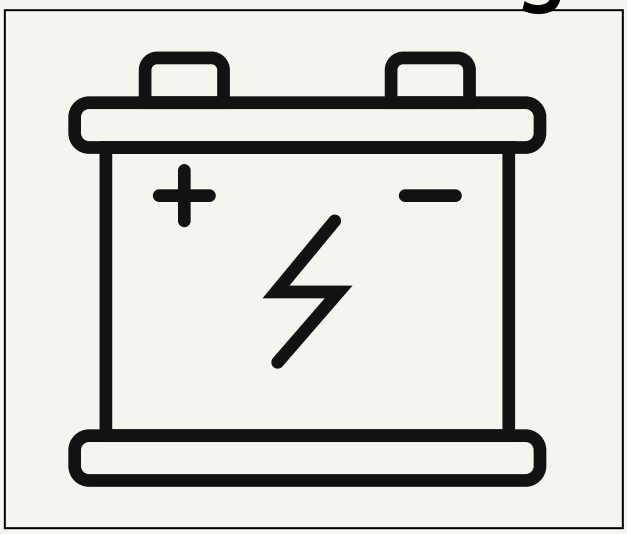
Observations: (What worked in the experiment? What didn't work?)

Lab Report

Scientist Name: **Date:**

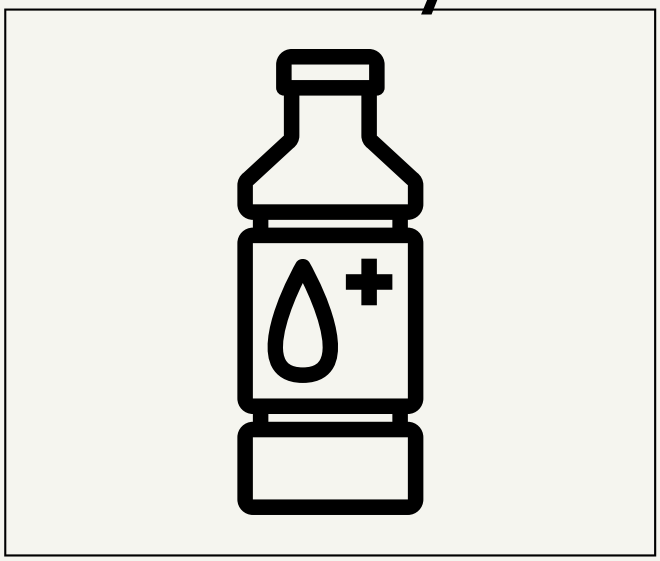
Discussion/Conclusion: (This should include: restating and reflecting on your original hypothesis, constructing an explanation of how the system of objects contained potential energy, describing how your experiment provided evidence to support your claims, and suggesting any changes you would make next time.)

electric charge



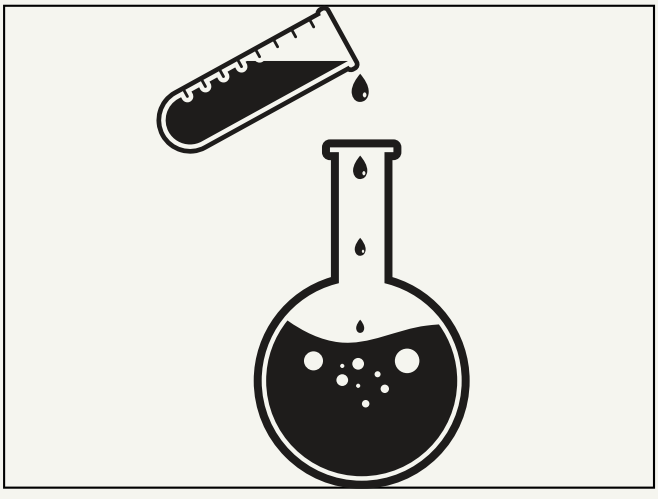
the basic physical property of matter that causes it to experience a force in an electromagnetic field; can be positive, negative, or zero

electrolyte



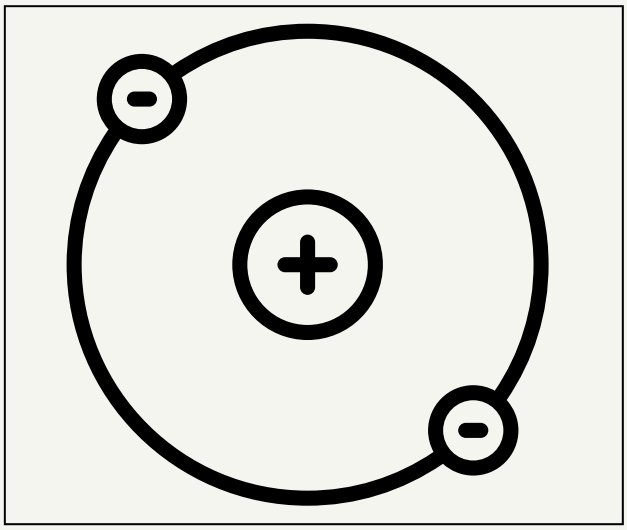
a liquid that contains particles carrying charge

electrochemical reaction



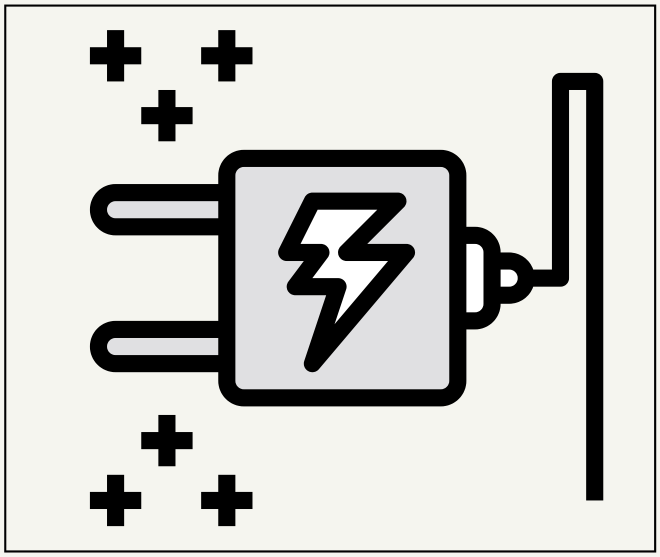
a type of chemical reaction that creates electrons

electrons



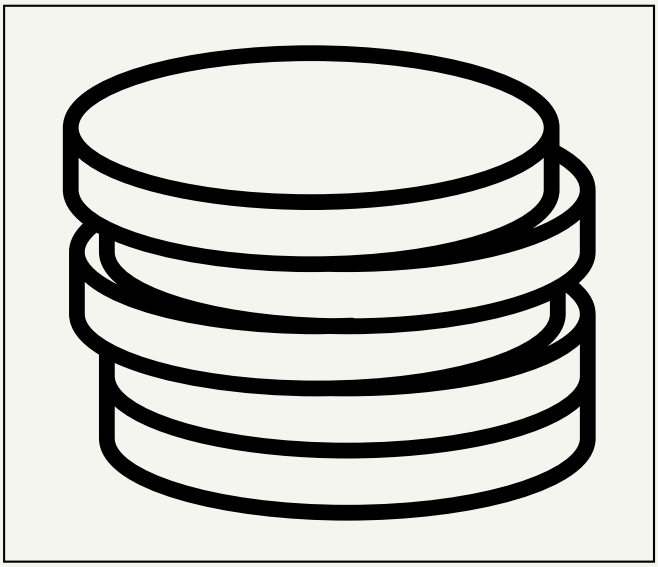
a particle with a charge of negative electricity

electric current



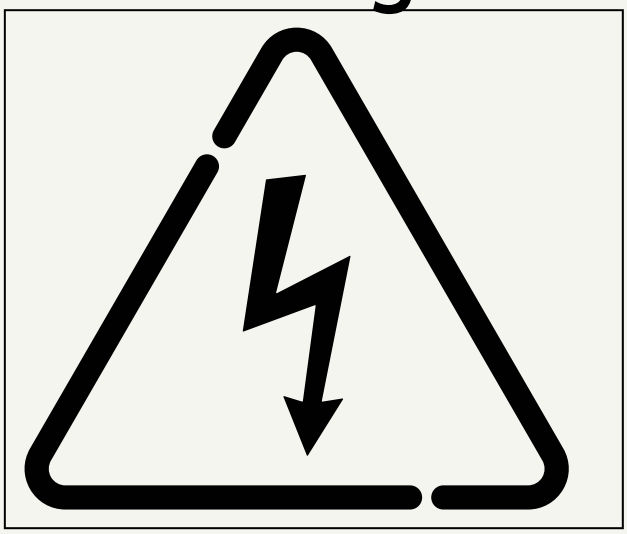
a stream of charged particales all moving in the same direction

electrode



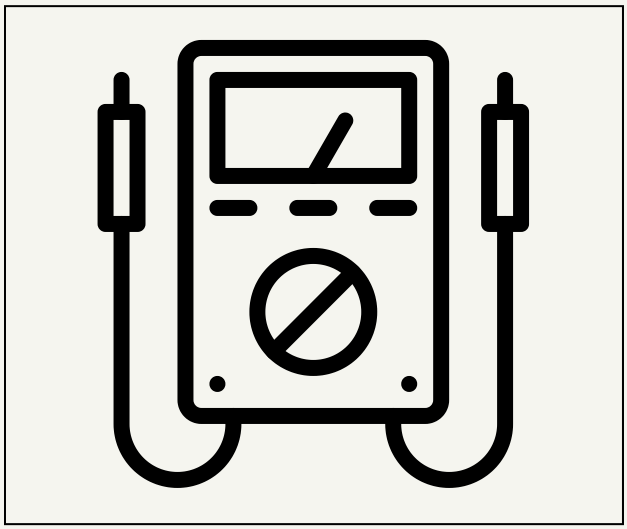
a solid metal conductor that carries electric current into non-metallic substabces such as a liquid

voltage



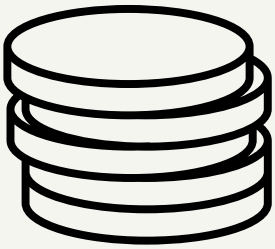
the amount of electrical force (or potential energy) between two units in a circuit

voltmeter

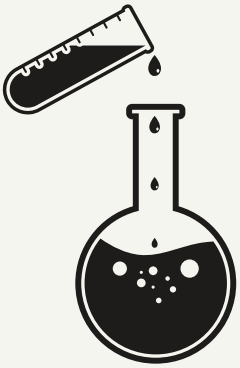


an instrument that measures electic potenial in volts

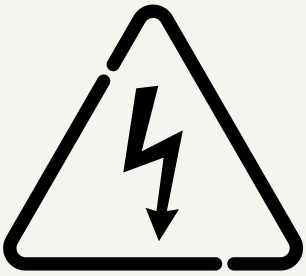
saltwater solution + different metals



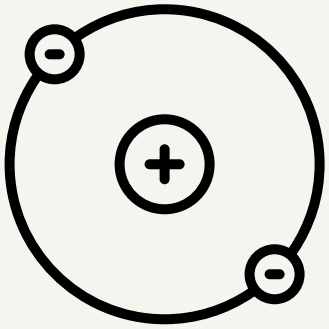
causes chemical reaction



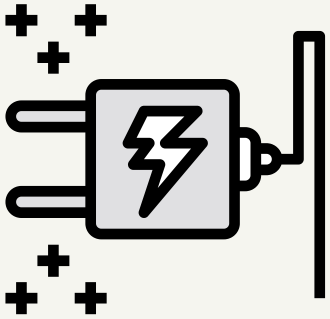
produces voltage difference

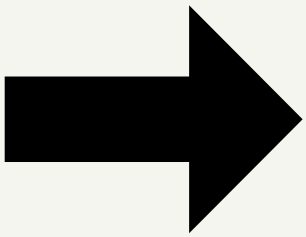


electrons move through closed circuit



electrical current is produced





electricical potential can be measured