Battery Builders

Primary Curriculum	Grade 5
Supplemental Curriculum	Grades 3–5+
Notes	Standard unit/refill kit comes with enough materials for 30 students.

Description

How can the properties of objects affect how we use them?

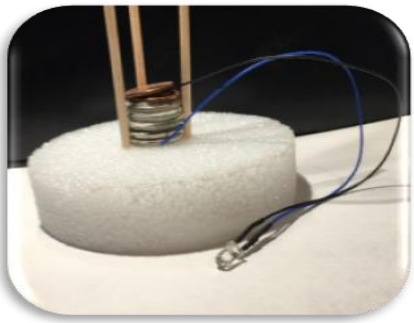
Are you tired of your tablets, phones, and toys losing power when you're in the middle of using them? Join Fernando as he talks about his drive to understand how things work and design a better battery.

Using the overarching goal of designing improved devices, students explore properties of materials and engineering as they ask themselves: *"How can we make a better battery?"*

Main Investigations

Materials Investigation with Coin Cell Batteries

Battery – LED Design Challenge



Supplies for battery holder included

Number of Lessons*

Full unit – 25 lessons

Supplemental program – minimum 5 lessons

**Lesson = 30–40 min. block, 50% of full unit lessons can be delivered in non-science classes*

Best Suited For

- Classroom science instruction

Overarching Enduring Understanding

How can the properties of objects affect how we use them?

Number of Lessons*

Full unit – 18-20 lessons

Supplemental program – minimum 5 lessons

**Lesson = 30 – 40 min block, 50% of full unit lessons can be delivered in non-science classes*

FLOW OF INSTRUCTION

Introductory Investigation: Materials Mix-Up (hands-on investigation, occurs during week 1)

Note: This introductory investigation serves two purposes—it generates student excitement and student wonderings for the unit ahead and also enables the teacher to assess student foundational knowledge and understanding about observable properties.

In this investigation students start with a bag of objects and must organize them in a number of different ways. For the initial sorting cycles groups can use any criteria to sort their objects (color, feel, etc.). As you progress through various cycles of sorting, students must categorize objects based on their assumed electrical conductivity (insulators vs. conductors) and on their ability to absorb water. Students will revisit this activity when they begin to build their batteries.

Investigation: Building a Basic Battery (hands-on investigations, occurs during week 2)

In this investigation students become familiar with the different parts of a battery through the creation of coin cell batteries. For this part of the investigation their materials set is limited to pennies, nickels, paper towels, and lemon juice. Once they have gained some experience with generating coin cell batteries of various strengths from this limited set of materials, they will move on to a more detailed exploration of material properties in **Building a Better Battery**.

Investigation: Building a Better Battery (hands-on investigations, occurs during week 3–5

In this follow-up investigation to **Building a Basic Battery** students explore using different materials as electrodes, separators, and electrolyte to assess battery performance. While students will be given the opportunity to explore a variety of materials of their choosing the following comparisons will be made:

- As part of the electrode investigation they will evaluate materials that are either conductors or insulators.
- As part of the separator investigation they will evaluate materials that absorb liquid or don't absorb liquid.
- As part of the electrolyte investigation they will make up a number of solutions with more and more salt added to determine both the requirements for the electrolyte and the properties that result from mixing the salt and the water. The electrolyte will also provide the opportunity for students to create a model of the dissolved salt in the water.

Part A: Materials Matter

Students will be able to choose from a variety of alternative materials, which they can test out as electrodes, separators, and electrolyte.

Part B: The Solution Solution

Students will complete a quantitative series of tests of increasing salt content in the saltwater and determine the correlation between salt content and battery voltage.

Investigation: I Can See the Light! (design challenge, occurs during weeks 5–7)

In this design challenge students must take what they've learned from Building a Basic Battery and Building a Better Battery to put together a powerful enough battery to turn on an LED. It is likely students will need to design a battery holder to help keep their battery in place while still being able to connect the copper tape and LED wires.

Investigation: Why We Should Build a Better Battery (summative challenge, occurs during weeks 7–8

Building off the knowledge they have amassed during the unit students must complete the following summative challenge.

Batteries do more than just power our cell phones and tablets. For a number of people batteries make a huge difference in how they live. Some examples include a hearing aid worn by someone who is older or has trouble hearing or an electric wheelchair that helps someone who can't walk get around. For this challenge you need to create a poster, brochure, or public service announcement that does the following things:

- Explains what the different parts of the battery are and how they work. (A)
- Explains how batteries are used in everyday life with at least two examples. (B)
- Some scientists and engineers think the biggest obstacle to replacing fossil fuel usage with sources of renewable energy is that battery technology, and energy storage technology in general, isn't good enough. Do you agree or disagree? Justify your opinion with at least three pieces of evidence from various sources. (C)

Parts List

Full Unit

Printed Materials

- Educator Guide
- Individual *My STEM Stories™ notebooks*
- Individual *My STEM Explorer Notes™ notebooks*
- Timeline sheets
- Introductory investigation sheets

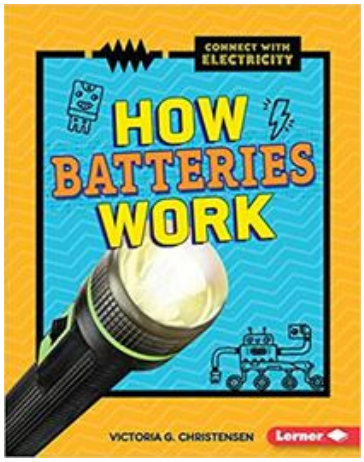
Provided Equipment & Materials

- Multimeters (4) w/batteries for testing
- Alternative electrode materials
- Copper tape1
- Wired LEDs (15)
- Scale
- Electrolyte components (salt, scoops, containers)
- Battery holder starter kit (insulated wire, pipe cleaners, tape, foam blocks, craft sticks)

Common Equipment & Materials Needed but NOT Provided

- Pennies (2 rolls of 50)
- Nickels (2 rolls of 40)
- Lemon Juice
- Water

Trade Books



- *How Batteries Work (Connect with Electricity) Victoria G. Christensen*

Digital Resources

- Electronic copies of printed materials1
- How-To videos for investigations1
- Easy-to-use links to publicly available videos and other information.

Supplemental Unit

Printed Materials

- Educator Guide
- Individual *My STEM Stories™ notebooks*
- Individual *My STEM Explorer Notes™ notebooks*
- Timeline sheets
- Introductory investigation sheets

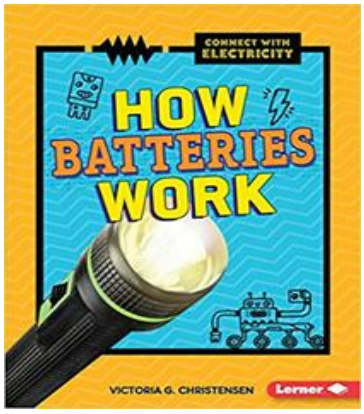
Provided Equipment & Materials

- Multimeters (4) w/batteries for testing
- Alternative electrode materials
- Copper tape1
- Wired LEDs (15)
- Scale
- Electrolyte components (salt, scoops, containers)
- Battery holder starter kit (insulated wire, pipe cleaners, tape, foam blocks, craft sticks)

Common Equipment & Materials Needed but NOT Provided

- Pennies (2 rolls of 50)
- Nickels (2 rolls of 40)
- Lemon Juice
- Water

Trade Books



- *How Batteries Work (Connect with Electricity) Victoria G. Christensen*

Digital Resources

- Electronic copies of printed materials1
- How-To videos for investigations1
- Easy-to-use links to publicly available videos and other information.

Refill Kit

Printed Materials

- Educator Guide
- Individual *My STEM Stories™ notebooks*
- Individual *My STEM Explorer Notes™ notebooks*
- Timeline sheets
- Introductory investigation sheets

Provided Equipment & Materials

- Alternative electrode materials
- Copper tape1
- Wired LEDs (15)
- Electrolyte components (salt, scoops, containers)
- Battery holder starter kit (insulated wire, pipe cleaners, tape, foam blocks, craft sticks)

Digital Resources

- Electronic copies of printed materials1
- How-To videos for investigations1
- Easy-to-use links to publicly available videos and other information.

Grade 5

(NGSS Standards:5-PS1-1,2,3,4; 5-ESS3-1; 3-5-ETS1-1,2,3)

Overarching Enduring Understanding
How can the properties of objects affect how we use them?

Number of Lessons*

Full unit – 18-20 lessons
Supplemental program – minimum 5 lessons
**Lesson = 30 – 40 min block, 50% of full unit lessons can be delivered in non-science classes*

FLOW OF INSTRUCTION

5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen**.**

5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances the total amount of matter is conserved.

5-PS1-3. Make observations and measurements to identify materials based on their properties.

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect Earth's resources and environment.

3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved. Tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Introductory Investigation: Materials Mix-Up (hands-on investigation, occurs during week 1)

Note: This introductory investigation serves two purposes—it generates student excitement and student wonderings for the unit ahead and also enables the teacher to assess student foundational knowledge and understanding about observable properties.

In this investigation students start with a bag of objects and must organize them in a number of different ways. For the initial sorting cycles groups can use any criteria to sort their objects (color, feel, etc.). As you progress through various cycles of sorting, students must categorize objects based on their assumed electrical conductivity (insulators vs. conductors) and on their ability to absorb water. Students will revisit this activity when they begin to build their batteries. (5-PS1-3)

Investigation: Building a Basic Battery (hands-on investigations, occurs during week 2) (5-PS1-1,3)

In this investigation students become familiar with the different parts of a battery through the creation of coin cell batteries. For this part of the investigation their materials set is limited to pennies, nickels, paper towels, and lemon juice. Once they have gained some experience with generating coin cell batteries of various strengths from this limited set of materials, they will move on to a more detailed exploration of material properties in **Building a Better Battery**.

Investigation: Building a Better Battery (hands-on investigations, occurs during week 3–5) (5-PS1-1,2,3,4)

In this follow-up investigation to **Building a Basic Battery** students explore using different materials as electrodes, separators, and electrolyte to assess battery performance. While students will be given the opportunity to explore a variety of materials of their choosing the following comparisons will be made:

- As part of the electrode investigation they will evaluate materials that are either conductors or insulators. (5-PS1-3)
- As part of the separator investigation they will evaluate materials that absorb liquid or don't absorb liquid. (5-PS1-3)
- As part of the electrolyte investigation they will make up a number of solutions with more and more salt added to determine both the requirements for the electrolyte and the properties that result from mixing the salt and the water. The electrolyte will also provide the opportunity for students to create a model of the dissolved salt in the water. (5-PS1-1, 2, 4)

Part A: Materials Matter
Students will be able to choose from a variety of alternative materials, which they can test out as electrodes, separators, and electrolyte.

Part B: The Solution Solution
Students will complete a quantitative series of tests of increasing salt content in the saltwater and determine the correlation between salt content and battery voltage.

Investigation: I Can See the Light! (design challenge, occurs during weeks 5–7) (5-PS1-1,3, 3-5-ETS1-1,2,3)

In this design challenge students must take what they've learned from Building a Basic Battery and Building a Better Battery to put together a powerful enough battery to turn on an LED. It is likely students will need to design a battery holder to help keep their battery in place while still being able to connect the copper tape and LED wires.

Investigation: Why We Should Build a Better Battery (summative challenge, occurs during weeks 7–8+) (5-PS1-1, 5-ESS3-1, 3-5-ETS1-1)

Building off the knowledge they have amassed during the unit students must complete the following summative challenge.
Batteries do more than just power our cell phones and tablets. For a number of people batteries make a huge difference in how they live. Some examples include a hearing aid worn by someone who is older or has trouble hearing or an electric wheelchair that helps someone who can't walk get around. For this challenge you need to create a poster, brochure, or public service announcement that does the following things:

- Explains what the different parts of the battery are and how they work. (A) (5-PS1-1)
- Explains how batteries are used in everyday life with at least two examples. (B)
- Some scientists and engineers think the biggest obstacle to replacing fossil fuel usage with sources of renewable energy is that battery technology, and energy storage technology in general, isn't good enough. Do you agree or disagree? Justify your opinion with at least three pieces of evidence from various sources. (C) (ESS3-1, 3-5-ETS1-1)