

# Potato Battery

Lesson Plan by Amber Caicedo

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**Overview:** This lesson provides students with a basic introduction to circuits, and explains how batteries work.

**Suggested grade level(s):** 6 – 8 grades

**Concepts covered:** energy transformation, energy sources, and circuits

**Standards:** 6-8 & 9-12 Algebra:

6-5.1 Sources of Energy

6-5.2 Energy Transformation

6-5.4 Circuits

**Length of lesson:** 50 minutes

**Materials required:**  
(Per Group)

1 potato

3 pieces of wire

2 copper pennies

2 zinc coated (galvanized) nails

1 battery powered clock / stopwatch

## Lesson Format

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### Phase I. Engage

How does a battery power something? What happens inside the battery that allows electricity to come out of it? Why does a battery eventually stop working? What is it that gets used up?

In this lesson we will explore what types of reactions are going on in a real battery by making “an exploded version” from the acid contained in a potato and elements that cause a chemical reaction to occur. From this chemical energy, electrical energy is created.

### Phase II. Explore

**Teachers Note:** Keep the wires long enough to handle (12” – 18”) and try to encourage the students to not wrap the nails excessively with the wires. You can put a slit in advance in the potatoes for the pennies, but they should be able to push them in without it. Try and get the students to put the penny and nail on opposite sides of the potato. It won’t affect the reaction but it makes it easier to visualize what is happening and apply it to a real battery.



**Step 1:** Cut the potato in half and label one half “#1” and the other half “#2”.

**Step 2:** Make a slit on the outside of both half #1 and half #2.

*These do not necessarily need to be labeled but hopefully it will help the students follow along with the directions to construct the battery*

**Step 3:** Take one of the pennies and wrap an end of a piece of wire around the middle of the penny and twist it closed.

**Step 4:** Stick the penny that is wrapped in the wire inside the slit of half #1.

**Step 5:** Do the same for the other penny with a different piece of wire and stick it in the slit of half #2.



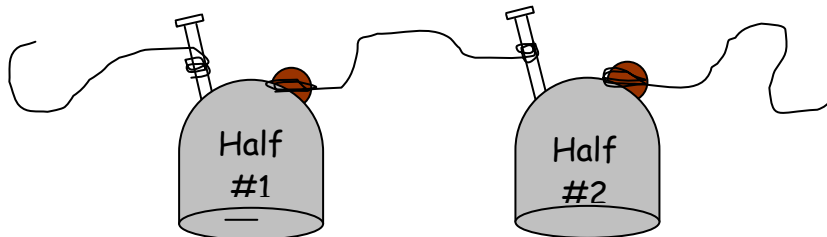
*There should now be one penny with a wire stuck into half #1 and one penny with a wire stuck into half #2.*

**Step 6:** Take the free end of the wire sticking out of half #1 and wrap it around one of the nails.

**Step 7:** Stick the nail into half #2.

**Step 8:** Take the other nail and stick it into half #1.

**Step 9:** Wrap a wire around the nail.



*In half #1, you will now have a penny with a wire that is connected to a nail that is stuck into half #2. In half #1 you will also have a nail with a free wire. In half #2, you will have a penny with a free wire.*

**Step 10:** Take the free wire connected to half #2 and stick it to the + side of the battery place in the clock.

**Step 11:** Take the free wire connected to half #1 and stick it to the – side of the battery place in the clock.

**Step 12:** Observe what happens to the digital screen.



**Teacher's Note:** This will only work with the correct wire attached to the plus side of the battery holster and the correct wire attached to the negative side of the battery holster. If a student's battery is not working, he/she may need to switch the locations of the wires.

**What happened when you attached the free ends of the wires to the stopwatch?**

When I closed the circuit the stopwatch turned on.

Maybe an incredibly enthusiastic student will identify the chemical energy stored in the potato that reacts with the copper in the penny and the zinc in the nail to cause a chemical reaction that creates electrical energy, but more than likely, some more questions will help them along.

**What type of energy do the potato and metals contain? What type do they convert into?**

Stored or potential energy in the form of chemical energy. It converts into electrical energy which is how the clock turns on.

**Describe what is happening to power the clock.**

Some summary of the energy transformation from chemical to electrical.

### Phase III. Explain

**Why does this work?**

Does a potato actually power a clock?

Not really. The acid in the potato combined with the elements zinc and copper permit a chemical reaction to occur that allows chemical energy to transform into electrical energy. **There is no electricity contained in food.**

The chemistry behind the reaction:

The zinc and copper act as electrodes to interact with hydrogen ions in the acid. Zinc is an active metal and will react readily with acid; acid's active ingredient is a positively-charged hydrogen. So a transfer of electrons takes place between the zinc and the acid; the zinc ( $Zn^0$ ) is **oxidized** to  $Zn^{++}$  and the acid ( $H^+$ ) is **reduced** to hydrogen gas ( $H_2$ ).

Of course, this will happen whether or not you have a copper electrode present, but you need the copper electrode to draw power from the potato; the copper helps channel the electrons through the external circuit. This sort of cell will work for any fruit or vegetable with some acid content; lemons are best simply because they're more acidic than any other food.

A battery works much the same way; it contains a strong acid that undergoes a chemical reaction with the chemicals on either end of the battery. The battery's life lasts until either the chemicals are no longer present in sufficient quantities as to continue the chemical reaction. A rechargeable battery is designed so that when it is being "recharged" the chemical reaction is actually running in the reverse, moving hydrogen



ions back to their original location. The used electrons (H+) are then replaced and the oxidation-reduction can continue.

Most of this is well beyond necessary for your students but it can't hurt for you to have all the answers!

#### Phase IV. Elaborate

**Do you think this would work with a baseball? A lemon? Lettuce? Coca-cola?**

Baseball, no. Lettuce, no. Lemon, definitely. Coca-cola? Probably, although I didn't try it. The reaction occurs between an acid and the chemical elements so as long as there is a liquid acid present, it should work.

**So why do you get tired when you are hungry? What makes a battery stop working?**

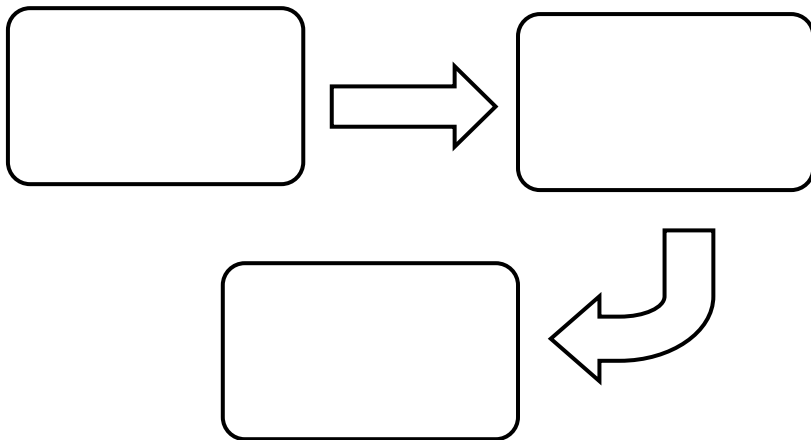
You get tired when your body runs out of stored (chemical) energy so that you can produce mechanical energy. You need to feed the body so that it can continue making the chemical – mechanical transformation. A battery stops working when there is no longer stored (chemical) energy to produce electricity.

**Do you think a potato is a good alternate energy source? Why or why not?**

Definitely, no. A substantial amount of energy goes into making a potato and the amount of electrical output you can draw from a potato is about 0.5 Volts. Not very economical. Most normal batteries are 12 Volts and you don't have the storage issues that you do with potatoes (shelf life, space). There is a great picture on the web of someone that built a potato battery large enough to power a stereo system (<http://www.latteier.com/potato/>).

**Draw a flowchart to describe the energy transformation.**

Two are obvious, chemical energy to electrical energy. There are always tons of energy transformations going on in every process, so having them think one beyond that shouldn't be too hard. Mechanical (putting it together), Light energy (the display), even mechanical (growing potatoes) would work.



## Phase V. Evaluate

Have the students summarize the process. Make sure they understand that potatoes do not contain electricity and can not be used to power anything without the chemical reaction between the copper, zinc, and the *acid contained* in the potato (or strong acid in any other food). Additionally, they should understand that the process works only with the circuit closed.

