



Power It Up!

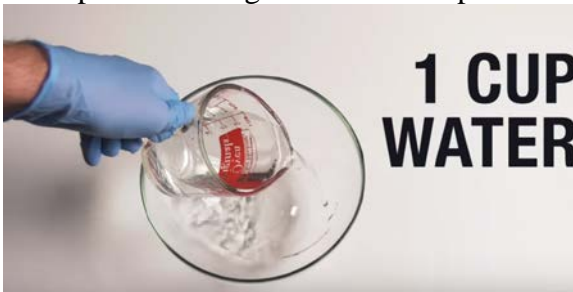
Suggested Grades: 4-8

Activity Overview

In this activity, you will build a basic battery from pennies and a salt-vinegar solution, and test battery voltage using LED lights and a voltmeter.

Steps

1. Fill a plastic mixing bowl with a cup of water.



2. Add 4 tablespoons of salt and stir until dissolved.



3. Add 2 tablespoons of vinegar, and then stir the solution until well mixed.



Time: 45 minutes

Materials

- Five-10 pennies made after 1982
- Sandpaper (medium grit)
- Mat board or cardboard
- Vinegar
- Salt
- LED Light (red)
- Electrical tape
- Voltmeter
- Scissors
- Paper towels
- Mixing cup

4. Cut the cardboard or mat board into four squares measuring approximately $\frac{1}{2}$ inch on each side.



5. Soak them thoroughly in the saltwater solution. Once they are fully soaked, take them out and set them on the paper towel. They will need to be damp but not dripping with liquid.



6. Sand off the copper from one side of four of the pennies until all that is seen is the silver-colored zinc. An easy way to do this is to lay the sandpaper flat on the table, gritty side up, and energetically rub the tails-side of the pennies on the sandpaper. Do this carefully so you don't hurt your fingers. The goal is to have four pennies that are copper on one side and zinc on the other, and a fifth penny that is copper on both sides.



7. Start assembling the battery. Place a sanded penny, copper side down, and then place a piece of damp cardboard on top of it. Repeat three times until all that is left is the unsanded penny. Place it on the top of the stack. You will have a stack of pennies and damp cardboard with all copper sides facing down and all zinc sides facing up, except that the top penny will have copper on both sides. No pennies should touch, and no damp cardboard should touch.



8. Next, you will test your battery. Pick up the red LED and look at the leads (wires) coming out of it. One is longer than the other. Touch the longer lead to the top of the penny stack and the shorter lead to the bottom of the stack. Don't let the leads touch each other.



9. The LED should light up! If it doesn't, make sure all pennies are facing in the correct direction but not touching each other, and that the cardboard squares are damp but not dripping. Then, try again. When the LED lights up, the battery is working. It sometimes takes a few minutes to reach maximum power.
10. How can you tell how much voltage your battery is producing? Take the voltmeter and touch its leads to the top and bottom of the coin battery. Record the measurement. Then, use the electrical tape to attach the LED to the battery. You can watch as the light gets fainter over time as the cardboard dries out. Take a second measurement if the LED is still lit after one day.



11. To recharge the battery, simply soak the cardboard squares in the liquid again and put the battery back together.

You Can Also Try...

- Try making the battery with more than five pennies.
- Try a liquid solution using other liquids like lemon-lime soft drink.
- A blue LED requires more electricity. Try making a battery that will light up a blue LED.

Background Information about Batteries

Batteries are devices that convert chemical energy into electrical energy. When two different metals are connected by an electrolyte, a chemical reaction occurs at each metal surface, called electrodes, that either releases or uses electrons. When these electrodes are connected by a wire, electrons will move from one surface to the other, creating an electric current.

Pennies that were made after 1982 have zinc cores that are plated with copper. By sanding off one face of a penny, you create a zinc electrode that can pair with the copper electrode on the face of the next penny. The cardboard soaked in salty vinegar water serves as the electrolyte between the two terminals.

Each zinc-cardboard-copper stack represents one individual cell. By stacking additional cardboards and sanded pennies, you've created a battery, which is a series of electrochemical cells. This is also called a voltaic pile, which is named after Alessandro Volta, who created the first battery in 1800 by alternating zinc and copper electrodes with sulfuric acid between them. In Volta's battery and the penny battery, an oxidation reaction occurs at the zinc electrode that releases electrons, and a reduction reaction occurs at the copper electrode that uses them.

How Does NASA Use Batteries to Fly?

NASA is always working to make flight safer, more convenient and more environmentally friendly. Airplanes powered by electricity rather than by burning fuel produce much fewer harmful emissions, which helps protect the environment. This type of propulsion is known as electrified aircraft propulsion.



Figure 1. NASA's X-57 is powered completely by batteries in order to reduce harmful emissions.

One of NASA's newest experimental airplanes, or X-planes, is the X-57 (Maxwell). This airplane is completely powered by batteries. This airplane was built to learn more about electrified aircraft propulsion. But, it is just the start! Using what it learns from the X-57, NASA is working to build larger passenger carrying airplanes that are at least partially powered by electricity. The goal is to help reduce emissions drastically over the next 20 years.