# A Battery That Makes Cents

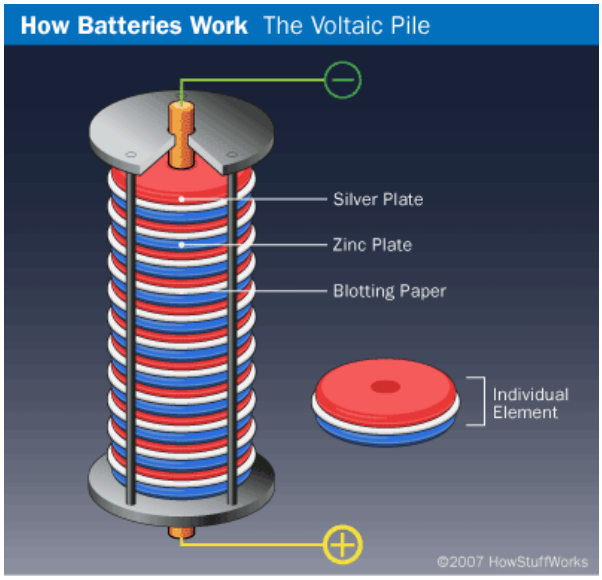


## Objective

In this experiment, you will make a simple battery out of coins and test if the number of coins in the pile will affect the amount of electricity produced.

## Introduction

You might think that batteries are a modern invention, but batteries were one of the first ways of making electricity. Alessandro Volta discovered the first electric battery in 1800. He made a giant stack of alternating layers of zinc, blotting paper soaked in salt water, and silver. This early design for a battery became known as the *voltaic pile*.




This image shows the structure of a voltaic pile, which is the first design of a battery that's used to make electricity. It was discovered by Alessandro Volta in 1800. (HowStuffWorks.com, 2007.)

How does a voltaic pile make electricity? The key to electricity is the movement of **electrons**. In a voltaic pile, electrons move from one metal to the other through the saltwater solution. The saltwater solution is called an **electrolyte**, and it contains **ions** in solution from the dissolved salts. An ion is a group of atoms that carries a positive or negative electric charge. The ions react with the metals, causing an **electrochemical reaction**, a special kind of chemical reaction that makes electrons.

The two types of metals in a voltaic pile are called **electrodes**. Since there are two kinds of metals, one metal reacts more strongly than the other, which leaves an electrical potential difference, also called (**voltage,**) between the two types of metals. One metal becomes positively charged (the positive electrode) and the other becomes negatively charged (the negative electrode). This causes electrons to move, creating an electrical **current** (which is measured in amperes), and then you have electricity!

In this experiment, you will make your own version of the voltaic pile using two different types of coins and a salt-vinegar solution. How does a voltaic pile made of money work? Since each coin is made up of a different metal, one metal reacts more strongly than the other, which leaves an electrical potential difference (voltage) between the two types of metals. The question is, how will different numbers of coins affect the amount of electricity produced? By making piles with different numbers of coins and measuring the voltage and current produced, you can test the effect of changing the number of coins in the piles

## Terms, Concepts and Questions to Start Background Research

To do this type of experiment, you should know what the following terms mean. Have an adult help you search the Internet or take you to your local library to find out more!

- Electron
- Electrolyte
- Ions
- Electrochemical reaction
- Electrode
- Voltage
- Current

### *Questions*



### Project Summary

| | |
|---|---|
| Difficulty | 1 – 2 |
| Time required | Very Short (a day or less) |
| Prerequisites | None |
| Material Availability | Readily available |
| Cost | Very Low (under $20) |
| Safety | No issues |

- What materials can a battery be made out of?
- Why is it important for the materials to be arranged in alternating layers?
- What does the electrolyte solution do?
- Will more layers make a more or less powerful homemade battery?

## Bibliography

- Here are some resources for making batteries out of money:
  - Instructables, 2007. "Penny and Nickel Battery," Instructables.com [accessed June 6, 2007] http://www.instructables.com/id/E60SQ467J1EZBF8S7J/
  - U.S. Mint, 1999. "Coin Battery," *H.I.P. Pocket Change.* The United States Mint. [accessed June 6, 2007] http://www.usmint.gov/kids/teachers/lessonPlans/viewLP.cfm?lessonPlanId=138
  - Iggulden, G. and Iggulden, H., 2007. *The Dangerous Book for Boys*, New York, NY: Harper Collins Publishers Inc., pp. 16-17.
- Here is a description of how batteries work:
  Brain, M., Bryant, C.W., 2007. "How Batteries Work," HowStuffWorks.com [accessed June 6, 2007] http://electronics.howstuffworks.com/battery2.htm
- Read this article to learn about the battery based on the voltaic pile design by Alessandro Volta:
  Wikipedia contributors, n.d. "Voltaic pile," Wikipedia, The Free Encyclopedia. [accessed June 6, 2007] http://en.wikipedia.org/w/index.php?title=Voltaic_pile&oldid=165511439
- Read this article to learn about what a multimeter is and how it works:
  Wikipedia contributors, n.d. "Multimeter," Wikipedia, The Free Encyclopedia. [accessed June 6, 2007] http://en.wikipedia.org/w/index.php?title=Multimeter&oldid=166392721

## Materials and Equipment

- Pennies (4)
- Nickels (4)
- Mild dish soap
- Vinegar (any kind, 1/4 C.)
- Salt (1 Tbsp.)
- Small bowl
- Small plate (ceramic, plastic, or Styrofoam™; not paper or metal)
- Digital multimeter (any kind that reads mA and mV)
  - Radio Shack carries a variety of multimeters. You can get a basic one for about $20 or borrow one from a friend.
  - You can also purchase a basic, inexpensive multimeter online from Jameco Electronics, part number 318781 (about $10 plus shipping, May, 2007).
- Paper towels (2)
- Scissors

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## Experimental Procedure

1. In a small bowl, mix together 1/4 C. of vinegar (electrolyte) and 1 Tbsp. of salt (ions).
2. Using scissors, cut up a paper towel into small squares, each approximately 1 cm x 1 cm.
3. Place the small squares to soak in the bowl of salt-vinegar solution, and set them aside.
4. Gather some pennies and nickels, wash with a mild detergent (like dish soap), and dry. This is just a preliminary step to remove dirt and grime.
5. Start building your stack on a dry paper towel on your plate. Put down a penny first, then place a square of vinegar-soaked paper towel on top, and then add a nickel. Keep repeating the layers until you have a stack of four coins (alternating pennies, wet paper towel pieces, and nickels), making sure you end with a nickel on top.
6. Attach the leads of the multimeter to the two ends of the battery by touching one lead to the penny on the bottom and the other to the nickel on the top. Measure the voltage produced by your battery (in millivolts, mV). You can also measure the current produced (in milliamps, mA).
7. Repeat the experiment, each time building a battery with a different number of coins. One important rule is to always start with a penny and end in a nickel, so the number of layers of pennies and nickels will always match. Why do you think this is necessary?
8. Record your data in a data table like the one below:

| Number of pennies | Number of nickels | Voltage (mV) | Current (mA) |
|---|---|---|---|
| | | | |
| | | | |

9. Make a graph of your data. What trends do you observe?

## Variations

- Try connecting an LED to your battery with copper wire. Be sure the wire is NOT enameled, or it will not work! How many coins do you need to light the light? You can test different LEDs to see if they need the same number of coins to light up. (LEDs only pass current in one direction, so be sure you have it oriented correctly.)
- Compare different coin combinations to see which ones work and which ones don't:

- Penny - Dime
- Nickel - Dime
- Nickel - Quarter
- Penny - Quarter

- Try other electrolyte solutions to see which ones work and which ones don't:
  - Plain water
  - Salt water
  - Lemon juice
  - Soda water
- Try making batteries out of other things, like potatoes or fruits. Try the Science Buddies experiment Veggie Power! Making Batteries from Fruits and Vegetables for more ideas!
- For more science project ideas in this area of science, see Energy & Power Project Ideas.

## Credits

Sara Agee, Ph.D., Science Buddies

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