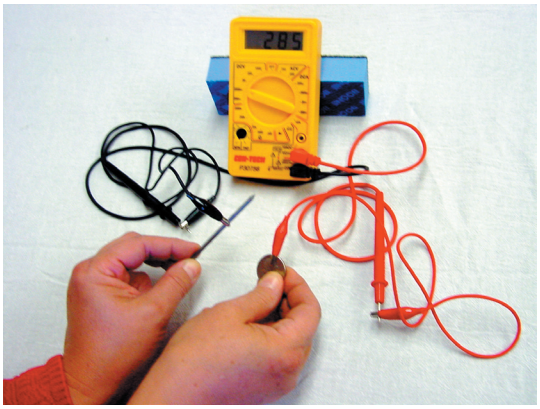
Batteries 'R' Us

Students actually become a part of a battery as they serve as the conducting medium between zinc nails and copper pennies.



Grade Level

- 4th - 8th

Science Focus

- circuit
- voltage
- current

Time Required

- 15 minutes

Supplies

There are enough materials in the kit to run up to ten cooperative groups.

Per Cooperative Group

1 digital multimeter
1 set (a red and a black) of multimeter connections or leads
2 alligator clip leads
1 penny and 1 zinc nail (really galvanized - steel with a zinc coating) for each student in the group

Doing the Activity

- Have students plug the red multimeter connection into the lower right corner of the multimeter. It's marked with a red circle. Then have students plug the black multimeter connection into the lower right corner of the multimeter. It's marked with a black circle.
- Students should take one alligator clip and attach it to the end of the red lead. They should take another alligator clip and attach it to the end of the black lead.
- Have students attach a penny to the free end of one of the alligator clips and a zinc nail to the free end of the other alligator clip.
- Tell your students to turn the dial to the area marked Hand Battery on the multimeter. It is labeled 2000m. (This means "2000 mV": 2000 millivolts. This is the highest reading the meter will read on this scale. 2000 millivolts is 2.000 volts. The students will be reading voltages that range between 0.5 and 1.5 volts or so - so this is just right. If you want to use your meter to measure other things, you can change the scale. In fact, you can just change the scale until you get a decent reading, no matter what you are doing. This usually works pretty well.)
- Have them check the readout. Are they getting any numerical readings yet? (With nothing connected, they should not be getting any reading. You might see some small fluctuations, but they should be minimal.)

- Now have one student from each group hold the penny in one hand and the zinc nail in the other. The student holding the penny and the nail is now hooked up to the meter as in the picture at the top. What type of readout does the student get now? (Tell them that they will get a higher reading if they don't touch the ends of the alligator clips with their fingers, but rather grip the ends of the nail and the penny.) Have all the students try it individually and compare readouts. (You should find that most students have about the same voltage reading. The voltage reading depends mainly on the metals, not the person.)
- Now have the groups add more people, nails, and pennies to their batteries. What do they think will happen? (Remind them that they must make a complete circuit in order for it to work. Each participant in the chain will need a penny in one hand and a zinc nail in the other hand. They'll need to touch penny to nail all around the circle.) It might be interesting to make this a challenge - to see how high a reading the students can get. Adding another person (holding a nail and a penny) to the circuit is - if done correctly - just like adding another battery to the system, so adding additional people should lead to a higher voltage.

Active Questioning, Explanation, and Discussion

Depending on your students' background with electricity, you may wish to question and probe their knowledge or provide more of an explanation of what is happening in this experiment.

1. What surprised you most about this activity? (Open-ended)
2. Why do you think this experiment uses two different types of metal? (If the zinc nail and the penny are put in contact with each other, they will develop a voltage between them. This is called a contact potential and it can make a current flow. In fact, this is how real batteries work.)
3. Did the experiment work by just touching the two metal parts together? (No. You can demonstrate this by connecting a third alligator clip to the hand battery set-up connecting the penny to the zinc nail. Even though you've made a complete circle, you shouldn't get a readout at all. When you hold the metals in your hands, weak acids in your hands cause electrochemical reactions that allow the current to flow. In a later experiment, students will do this with another weak acid - salt water!)
4. Were you an important part of the experiment? (Yes. Each person in the experiment not only completed the circuit between the two metals, but also served as a conducting medium. The current was really flowing through your body as you touched both metals. The current also flowed through the multimeter which measured it. If you open up a heavy-duty battery, it has a zinc can on the outside and a carbon rod in the center. There is a contact potential between these two substances that produces the voltage of the battery. In between the two is a conducting paste. In this experiment, the students make the battery by holding a nail in one hand and a penny in the other. The students serve the role of the conducting paste in the battery! The current really flows through their bodies, but it is such a small voltage and a small current that there is no danger.)
5. What happened when you added more people and metal to the circuit of your battery? (The multimeter had a higher reading. It's like connecting more batteries together to get a brighter light bulb.)

Other Experiment Extensions To Try

1. Experiment with different kinds of metals. What happens if you use the same kind of metal? (You can try different coins, but most American coins are made of mostly zinc, with the exception of the penny. Washers, nails and screws are nice; they are made mostly of iron. Where else can you find different kinds of metal?)
2. Do you get a different reading from the hand battery when your hands are dry, cold, warm, or moist? (Think about why this would be - how this would affect your conductivity. Can you see why most household electrical accidents occur in the bathroom or the kitchen?)
3. Does it matter which connection of the multimeter is hooked to the penny and which is hooked to the zinc nail? (When the copper penny is hooked to the red connection, you get a positive readout. When it is hooked to the black connection, you get a negative readout.) Why do you get a negative number? (This has to do with the contact potential mentioned above. One metal will be electron hungry and will pull them from the other metal. The zinc nail is the "electron hungry" one in this battery.)

Trouble Shooting

If you aren't getting a readout on the multimeter, make sure that your multimeter connections are pushed snugly into their sockets. You also may have an alligator clip that isn't making a good connection any more. You could try another lead, or you could measure the conductivity of the lead. Test the clip by turning your multimeter to the 200 ohms setting which is directly opposite from the OFF switch on your multimeter. (Ohms is the unit of electrical resistance: high resistannce means very little current flows; bad conductors have high resistance. Low resistance means a lot of current can flow; good conductors have a low resistance.) Connect one end of the alligator clip to the black lead and the other end to the red lead. If you get a reading of zero or near that, your alligator clip is functioning properly. (It's a good conductor, which is what you want.) If you get a readout with a number one way to the left and there aren't any other numbers, your alligator clip isn't working properly. (This means your reading is off the scale - lots of resistance. Your clip is no longer a good conductor. Get rid of it!)