PENNY POWER

A **battery** is a chemically operated pump for electricity. It can move a stream of electrons through a system of wires called a circuit. Batteries come in many sizes and forms but they are all made up of one basic unit called a **galvanic cell**. All galvanic cells contain three necessary parts, an **anode**, a **cathode**, and an **electrolyte.** An anode is a strip or piece of a chemically active metal. The cathode is a strip or plate of a less active substance. The electrolyte is ususally an aqueous solution of an acid, base, or a salt. This solution conducts electricity. The anode and cathode must both be in contact with the electrolyte. Each group of anode, cathode, and electrolyte unit comprise what we call a galvanic cell. A battery is two or more of these galvanic cells connected together. When cathode and anode are connected together through a circuit (both ends of the battery joined by a wire)
extra electrons that have collected on the anode move through the circuit. While moving through the circuit, these electrons are capable of doing work (lighting a bulb, moving a wheel, cooking your dinner, etc.)

With a few simple materials we will make a simple battery called a voltaic pile. We will use our EA-100 data collector and voltage probes to Asee@ how much electricity we can generate. This movement of electrons will be measured in volts (v) or millivolts (mv).

Materials: Copper coins (at least 10 the same size); Cup; Salt; Water; Aluminum foil or zinc washers; Kitchen paper towels; Two pieces of insulated Cu wire (~6 in. long); Adhesive tape; Scissors; Pencil; EA-100 data analyzer; voltage probe.

Procedure:

1. Use one of your coins as a pattern to trace its shape at least 10 times on both the foil and the paper towel.

2. Cut out these paper and foil coin shapes.

3. Measure 5 teaspoons of salt into your cup. Add 4oz of warm water to the salt and stir until most of the salt has dissolved.

4. Wet the paper disks in this very salty water.

5. Pile the disks in groups of three--foil, moistened paper, copper coin--one on top of the other until you have completed a pile using ten copper coins. Record the number of coins in the data table. Each group of three disks equals one cell. All the cells combined (the whole pile of disks) make a battery.

6. Strip approximately one inch of the insulation from each end of both pieces of copper wire. Tape an end of one wire to the top of the pile of disks. Tape an end of the other wire to the bottom.

7. Plug the voltage probe into *Channel* 1 of the EA-100 and push the red A**ON**@ button. If you do not see the word Amultimeter@ in the lower left hand corner, push the **MODE** button one time and it should appear. The words Asampling@ and Adone@ should be flashing above the word multimeter. *Channel* 1 and the Av@ symbol should also be visible on your screen. A meaningless voltage of ~2.00v will be on the screen at this point. Just ignore this reading.

8. Pull back on the red spring cap at the end of one of the probe wires exposing the copper hook at its end. Attach this hook to the end of one of the exposed copper wires attached to the battery. Repeat this procedure with the black hook and the exposed end of the other piece of wire.

9. When the voltage reading stabilizes, write down this value next to the number of coins you recorded earlier. If the reading is A-@ switch the position of the red and black clamps on the voltage probes. You should now get a positive reading. (See question #4.)

10. What happens if you remove the voltage clamps and carefully touch the two free ends of copper wire together? Why?

DATA TABLE

# of cells	voltage reading

Questions:

1. What material serves as the anode in this battery?

2. What material serves as the cathode in this battery?

3. What material serves as the electrolyte in this battery?

4. When a positive voltage reading was displayed on the EA-100, was the red voltage clamp attached to the anode or to the cathode?

5. What did you see when you touched the two free ends of Cu wire? Why?

6. What is electricity?

7. Name three ways you use electricity every day.

8. Suggest another way to design this experiment and explain what you think will happen.

9. Batteries are only one source of electricity. Name another way electricity can be generated.

Extensions:

1. Using your EA-100 and voltage probe, record the individual voltage readings for several 9 volt batteries. Connect two batteries in series by connecting the (-) terminal of one battery to the (+) terminal of the next battery. Place a voltmeter in the circuit and connect the (+) terminal of the second battery to the (+) terminal of the voltmeter. Next, connect the two negative terminals in the same manner. Read and record this voltage reading in the second column of your data table. Repeat this step with 3 batteries connected in series, and then four, five, and six batteries connected in series. Note and record the voltage in each case. Compare the sum of the voltages of the individual batteries with the total voltage for each series combination of cells. Is there an inverse or direct relationship between number of cells connected and total voltage? Does varying the length of the wires connecting the batteries affect your results? Why? Does this demonstrate an inverse or direct relationship. Write an equation relating **I, E,** and **R** for a series

circuit. How do you think your results would be affected by doubling the cross-sectional area of the resistance wire?

2. Research modern sources of power. Based on the information you find discuss what you think our major source of energy will be in 20 years. Why?

1

[C]*asio Workshop @ Gloucester High School, June 1997*
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