THE VOLTAIC PILE

TOPIC:

Current Electricity

SCIENTIST:

Alessandro Volta 1745–1827

INTRODUCTION:

Alessandro Volta's greatest discovery was to produce the first reliable and convenient source of electric current. Volta's contemporary, the anatomist Luigi Galvani (1737–1798), had shown that if two different metals were brought into contact with an animal's muscle they produced a violent contraction. Galvani concluded that the contraction was caused by a current of "animal electricity" stored in the tissues and released when touched by the two metals. When Volta heard about Galvani's work he criticized his conclusions. He suggested that a current could be produced not from the animal tissue but instead from the two metals. He used two different metals separated by a "moist conductor" and succeeded in producing a small current. To multiply the effect he made a pile, consisting of pairs of silver and zinc disks separated by pieces of moist cardboard soaked in brine. The voltaic pile, as it came to be known, was made public in 1800. In this experiment you will construct a voltaic pile and show that it produces a current, creating what Volta called an "artificial electric organ, fundamentally the same" as the natural electrical apparatus found in the electric eel.

TIME NEEDED:

45 minutes

MATERIALS:

strip of zinc 4 cm x 25 cm
strip of copper 4 cm x 25 cm
piece of cardboard 4 cm x 25 cm (not corrugated)
common salt (sodium chloride)
teaspoon
250-ml beaker
2 pieces of bell wire, each 30 cm long
wire strippers
small metal shears
scissors
strip of cloth 2 cm x 30 cm
metric ruler
multimeter

Original Materials:

Volta used silver, which is too expensive to use now. In the original experiment, he placed the disks of his pile inside a wooden frame; in this experiment the "disks" are squares and are simply bound together with a piece of cloth. He used an electrometer to detect current flow; this is beyond the scope of this duplicate experiment, hence the use of the multimeter.

Safety Precautions

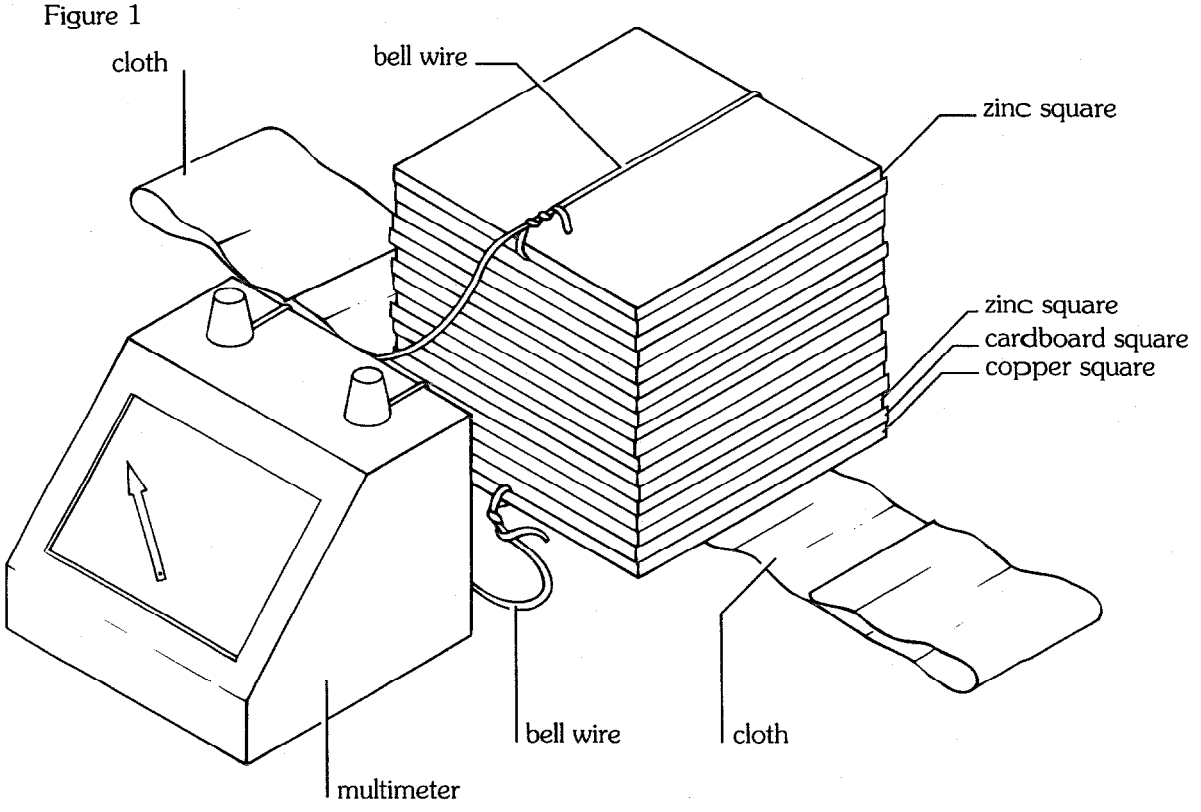
Please read and copy the safety precautions at the beginning of this book. Be careful when cutting metal with the metal shears.

PROCEDURE:

1. Cut six 4 cm x 4 cm squares from the strip of cardboard using the scissors.
2. Repeat step 1 with the strip of zinc, using metal shears instead of scissors. Take care not to cut yourself on the sharp edges of the cut metal.
3. Repeat step 2 with the strip of copper.

4. Half fill the beaker with *warm* water from the faucet. Add 4 teaspoons of salt to the water and stir.
5. Put the cardboard squares into the salt solution for 10 minutes.
6. Take one piece of bell wire. Strip 10 cm insulation from one end with wire strippers and wrap the bare wire once around one of the copper squares, securing it with a twist. Strip 3 cm of insulation from the other end of the wire and attach it to one of the multimeter terminals.
7. Take the second piece of bell wire. Strip 10 cm insulation from one end with wire strippers and wrap the bare wire once around one of the zinc squares, securing it with a twist. Strip 3 cm of insulation from the other end of the wire.
8. Remove the cardboard squares from the salt solution. Carefully squeeze them between your palms to remove excess fluid.
9. Put the strip of cloth flat on the table.
10. Put the copper square with the wire wrapped around it flat in the center of the cloth.
11. Put one of the pieces of soaked cardboard on the copper square.
12. Put a zinc square on the cardboard, then a copper square on the zinc.
13. Repeat this "sandwich" arrangement of copper, cardboard, and zinc until all the squares are used up. The last addition should be the zinc square with bell wire attached (see figure 1).

Figure 1



14. Tie the cloth strip around the pile to secure the squares in position.
15. Touch the end of the top bell wire (attached to the zinc square) to the terminal of the multimeter not attached to bell wire. Record your observations.
16. Repeat step 15 reversing the contacts. Record your observations.

ANALYSIS:

1. What happened when you touched the top wire to the multimeter as described in step 15?
2. What happened when you reversed the contacts as described in step 16?
3. Do some research. What do you think would happen if more squares were added to the pile?

OUR FINDINGS:

Click on above link to see what we found.

SPECIAL SAFETY NOTE TO EXPERIMENTERS

Each experiment includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific experiment. For this reason, it is absolutely necessary that you read, copy, and remain mindful of the General Safety Precautions that follow this note.

Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly while you are performing an experiment. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the *entire* time you are performing the experiment, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual experiments. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each experiment you are preparing to perform, and that you will *remember* them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say BE CAREFUL WITH HOT LIQUIDS or DON'T CUT YOURSELF WITH THE KNIFE does not mean that you should be careless when simmering water or stripping an electrical wire. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it.

If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while conducting experiments. Be sure to check the experiments in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:
—Clear all surfaces before beginning experiments
—Read the instructions before you start
—Know the hazards of the experiments and anticipate dangers

PROTECTING YOURSELF:
—Follow the directions step-by-step; do only one experiment at a time
—Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eye wash, and first-aid kit
—Make sure there is adequate ventilation
—Do not horseplay
—Wear an apron and goggles
—Do not wear contact lenses, open shoes, loose clothing, or loose hair
—Keep floor and work space neat, clean, and dry
—Clean up spills immediately
—Never eat, drink, or smoke in laboratory or work space
—Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:
—Set up apparatus far from the edge of the desk
—Use knives and other sharp or pointed instruments with caution
—Pull plugs, not cords, when removing electrical plugs
—Don't use your mouth to pipette; use a suction bulb
—Clean glassware before and after use
—Check glassware for scratches, cracks, and sharp edges
—Clean up broken glassware immediately
—Do not use reflected sunlight to illuminate your microscope
—Do not touch metal conductors
—Use only low voltage and current materials such as lantern batteries
—Be careful when using stepstools, chairs, and ladders

USING CHEMICALS:
—Never taste or inhale chemicals
—Label all bottles and apparatus containing chemicals
—Read labels carefully
—Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves)
—Do not touch chemical solutions
—Wash hands before and after using solutions
—Wipe up spills thoroughly

HEATING SUBSTANCES:
—Use goggles, apron, and gloves when boiling water
—Keep your face away from test tubes and beakers
—Never leave apparatus unattended
—Use safety tongs and heat-resistant mittens
—Turn off hot plates, bunsen burners, and gas when you are done
—Keep flammable substances away from heat
—Have fire extinguisher on hand

FINISHING UP:
—Thoroughly clean your work area and glassware
—Be careful not to return chemicals or contaminated reagents to the wrong containers
—Don't dispose of materials in the sink unless instructed to do so
—Wash your hands
—Clean up all residue and put in proper containers for disposal
—Dispose of all chemicals according to all local, state, and federal laws

BE SAFETY CONSCIOUS AT ALL TIMES