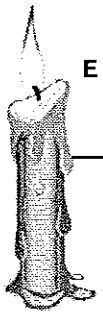
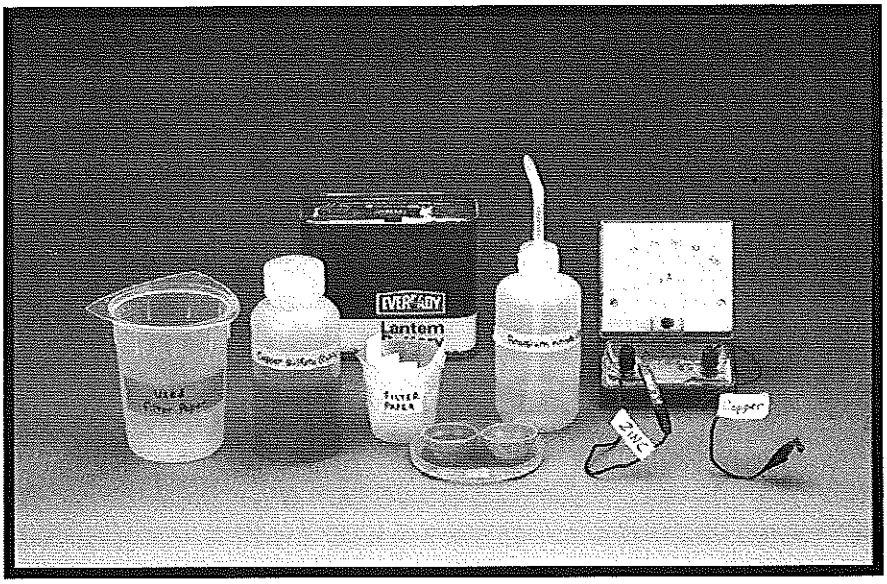


EXPERIMENT

Build a Battery!

Visitors use an ammeter to test a battery. They then build their own battery. Visitors add solutions of potassium nitrate and copper sulfate to separate bowls. They connect the solutions in the bowls with a "bridge" made from filter paper. They place leads of copper and zinc into the appropriate solutions and observe the ammeter registering the electric current.



OBJECTIVES:

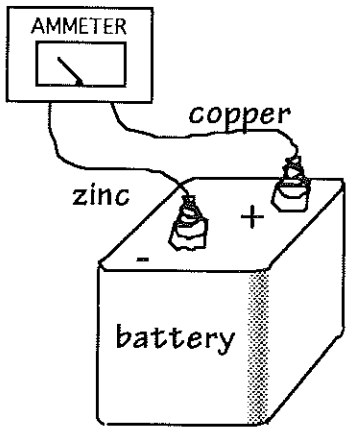
Visitors observe that chemical reactions can produce electricity. Visitors make a connection between chemistry and ordinary batteries.

SCIENCE TOPICS	PROCESS SKILLS	VOCABULARY
Electrochemistry	Observing	Atom
Electricity	Measuring	Electron
Atomic Structure	Investigating	Nucleus
Chemical Reactions	Making Models	Solution
Properties of Electrons		

Build a Battery!

Procedure:

1. Always wear safety goggles.

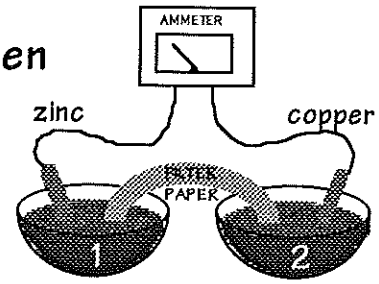


2. Rinse the two small blue bowls attached to the plastic dish.

3. An ammeter measures electric current. Test the ammeter by touching the "copper" wire to the positive (+) terminal on the battery and the "zinc" wire to the negative (-) terminal.

4. Add potassium nitrate (KNO_3) solution up to the black line on bowl 1. Add blue copper sulfate ($CuSO_4$) solution up to the black line on bowl 2

5. Squeeze about 4 drops of potassium nitrate (KNO_3) solution onto a strip of filter paper until it is soaked.



6. Use the wet filter paper to make a "bridge" between bowl 1 and bowl 2. Make sure one end of the filter paper is below the black line in each bowl.

7. Place the end of the "zinc" bar into bowl 1 (KNO_3). Place the end of the "copper" wire into bowl 2 ($CuSO_4$).

   What happens on the ammeter?
   What happens if you remove the filter paper? Try it!

8. Rinse the end of the copper wire, the end of the zinc bar, and the two blue bowls. Throw away the wet filter paper in the waste beaker.

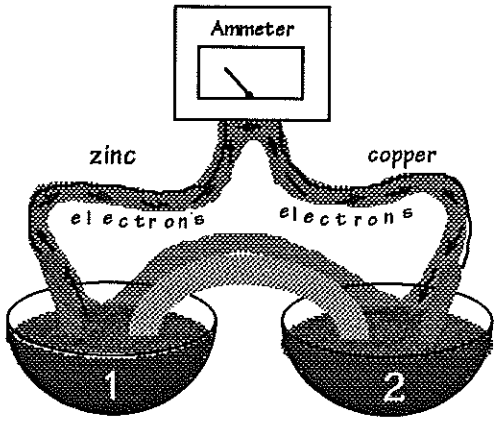
Where did the electricity come from?

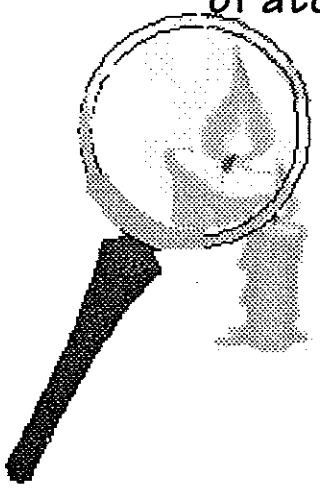
What do you think would happen if you left the "battery" hooked up for a long time?

A Closer Look:

Electricity involves the flow of small charged particles, usually electrons.

Electrons are tiny particles with negative (-) charges. They travel around the nucleus or center of atoms.





In this experiment, the zinc metal loses electrons and dissolves in the potassium nitrate solution. The electrons flow through the wire, and charged copper particles in the copper sulfate solution pick them up.

The filter paper bridge completes the electrical circuit.

Eventually the chemicals needed in the reaction will be used up, and the "battery" will die.

MATERIALS

See Materials Prep for more details

(with amounts to have on hand)

- One package of circular filter paper
- One battery (6V lantern cell works well)
- $CuSO_4 \cdot 5H_2O$(copper sulfate) (keep 200 g on hand)
- KNO_3 (potassium nitrate) (keep 500 g on hand)
- Two 500-ml plastic bottles
- Two 250-ml plastic squirt bottles
- Zinc bar (0.75 to 1.75 in. long)
- Electrical tape
- One metal electrical clip
- One plastic petri dish
- Two plastic measuring spoons (1-tbsp size)
- Hot-glue gun
- One small plastic beaker
- One medium plastic beaker
- Steel wool (two or three pieces)
- Microammeter (0-500 mA)
- Two-ft copper wire with insulation
- One quart-size, resealable plastic storage bag

Setup/Takedown Procedures

ORIGINAL SETUP

- ❑ Label the battery terminals "+" and "-."
- ❑ Label the plastic squirt bottles "Copper Sulfate ($CuSO_4$)" and "Potassium Nitrate (KNO_3)."
- ❑ Label the small plastic beaker "Filter Paper."
- ❑ Label the medium plastic beaker "Used Filter Paper."
- ❑ Label the plastic bag "Spare Filter Paper Strips."
- ❑ Cut two 1-ft lengths of insulated copper wire.
- ❑ Strip 1 in. of insulation from each end of the wires. Label the right wire "Copper"; label the left wire "Zinc."

- ❑ Attach the copper wire to the right-hand terminal of the ammeter.
- ❑ Attach the second wire to the left-hand terminal of the ammeter.
- ❑ Attach a metal clip that holds a bar of zinc to the opposite end of the left-hand wire.

- ❑ Tape the connection with electrical tape so that the zinc bar is well secured.
- ❑ Cut the handles from the bowls of the two 1-tbsp plastic spoons.
- ❑ Use a hot-glue gun to attach the two "bowls" to the lid of a plastic petri dish.
- ❑ Label the right bowl "1" and "Potassium Nitrate (KNO_3)." Label the left bowl "2" and "Copper Sulfate ($CuSO_4$)."

WEEKLY SETUP

- ❑ Cut 100 filter paper strips (about 3 in. by 1/2 in.) from filter paper sheets.
- ❑ Place about 25 cut filter paper strips in labeled cup. Place remainder in the labeled plastic bag and seal the bag.
- ❑ Prepare the KNO_3 (potassium nitrate) solution and the $CuSO_4$ (copper sulfate) solution if needed (see Materials Prep).

DAILY SETUP

- ❑ Set out the visitor instructions in a Plexiglas holder.
- ❑ On a tray, set out the following:
  - Two labeled squirt bottles of KNO_3 (potassium nitrate) and $CuSO_4$ (copper sulfate) solutions
  - Labeled battery
  - Ammeter with attached wires
  - Labeled plastic beaker with 25 filter paper strips
  - Labeled waste beaker
  - Labeled petri dish with two attached blue bowls
- ❑ Refill the solution bottles as necessary.
- ❑ Prepare more KNO_3 (potassium nitrate) solution or $CuSO_4$ (copper sulfate) solution if needed (keep 500 ml on hand) (see Materials Prep).
- ❑ Polish the ends of both wires and the battery connectors with a piece of steel wool.
- ❑ To test the battery and ammeter, do the steps of the experiment:

  Step 3. The needle on the ammeter should go off the scale. If the needle does not respond, check the wire connections, and polish the copper, zinc, and battery terminals with steel wool.

  Step 7. The ammeter should show significant movement. It will not respond unless the filter paper bridge is in place.

  Step 7. The metal pieces need to be held in place in the solutions. If the ammeter is not responding, check to be sure the metal pieces are well submerged.

DAILY TAKEDOWN

- ❑ Clean the tray and petri dish.
- ❑ Empty waste filter papers from waste beaker. (They can be dried and reused.)
- ❑ Place all supplies under counter, storing tightly capped squirt bottles in an upright position.

WEEKLY TAKEDOWN

- ❑ Sponge out the tub.
- ❑ Empty and clean the squeeze bottles.
- ❑ Store left over solutions in plastic bottles with caps tightly sealed.
- ❑ Place extra filter paper pieces in the labeled plastic storage bag.

RUNNING SUGGESTIONS

- ◊ Keep the back of the ammeter and the battery as dry as possible.

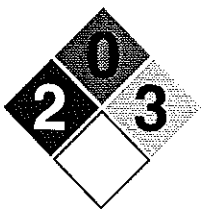
EXTENSIONS

Relate the electrochemical cell to everyday batteries. Comment on the difference between a dry cell (solid inside like a flashlight battery) and a wet cell (liquid inside like a car battery).

Try getting power from different solutions. What works? What doesn't? Can the two solutions be the same solution?

Try attaching wires from the battery to the metal pieces in the solutions–what happens? (electrolysis, electroplating)

SAFETY & DISPOSAL



KNO_3 (potassium nitrate) and $CuSO_4$ (copper sulfate) are hazardous substances. Consult the Material Safety Data Sheets (MSDS) for handling information.

MATERIALS PREP

To prepare 0.1M $CuSO_4$ (copper sulfate) solution:

- ❑ Weigh 12.5 g of $CuSO_4 \cdot 5H_2O$ (copper sulfate).
- ❑ Add 500 ml of dH_2O (deionized water).
- ❑ Mix solution to dissolve.
- ❑ Store solution in a labeled/dated bottle.

To prepare 0.5M KNO_3 (potassium nitrate):

- ❑ Weigh 27.5 g of KNO_3 (potassium nitrate).
- ❑ Add 500 ml of dH_2O (deionized water).
- ❑ Mix to solution dissolve.
- ❑ Store solution in a labeled and dated bottle.