65 Chemical Batteries

One way of transforming potential energy into electricity is by battery. Batteries do not provide the large amounts of electricity that power plants do, and they don't serve communities in the same way as power plants. They are, however, a source of electricity that is important to everyday life, whether in a car, a phone, a wristwatch, or a hearing aid.

Batteries contain metals and other chemicals that store potential energy. When the chemicals in the battery are connected to a device and allowed to react, they release electrical energy. Once the reactants are used up, the battery no longer can produce electricity and is "dead." In rechargeable batteries, the battery regains potential energy when it is charged—by another source of electricity.

CHALLENGE

What combination of metals makes the best battery to power a small motor?

MATERIALS

For each group of four students

- 1 dropper bottle of 3% hydrogen peroxide solution
- 1 small piece of sandpaper

For each pair of students

- SEPUP wet cell chamber
- strip of each of the following metals:
  - copper
  - iron
  - magnesium
  - zinc
- 5 packages of table salt
- 1 plastic spoon
- 1 50-mL graduated cylinder
- 2 wire leads—one red and one black, with clips
- 1 clear plastic cup
- 1 electric motor
- masking tape
- paper towel

For each student

- 1 pair of safety goggles

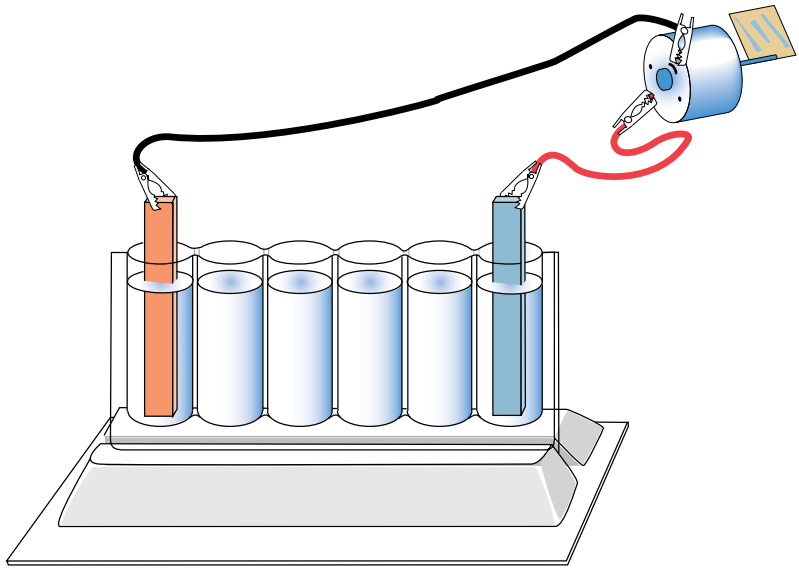
SAFETY

Wear safety goggles at all times during this lab. Do not allow the solutions to touch your skin or clothing. Clean up any spills immediately. If accidental contact occurs, tell your teacher and rinse exposed areas. Wash your hands after completing the activity.

PROCEDURE

Part A: Testing the Motor

1. Put 25 ml of water into the plastic cup. Add 5 packages of salt. Add 25 drops of hydrogen peroxide. Stir until all of the salt is dissolved. Carefully pour the mixture into the SEPUP wet cell. This is the battery's **electrolyte**—the material that makes the liquid electrically conductive.
2. Attach a small piece of masking tape to the motor shaft to make a flag. This will allow you to see when the spindle on the motor is turning.
3. Clip one wire lead onto the copper strip and another wire lead onto the magnesium strip. Clip the other ends to the motor.



4. Lower the copper and magnesium strips into the outside slots of the SEPUP wet cell as shown. **There should be a small amount of metal sticking out of the cells.**

5. Observe the motor spinning.

   Hint: If the motor doesn't spin, try giving the flag a small push with your finger to start it. If it still does not spin, let your teacher know.

6. Once the motor spins, disconnect the wire leads. Remove the two metal pieces. Dry them, and then shine them with a piece of sandpaper. It is extremely important to completely dry the metals on a paper towel and clean both sides with the sandpaper!

Part B: The Effects of Different Metals

7. You just tested two metals, copper and magnesium, that, along with the electrolyte, transformed chemical energy into electrical energy. The motor transformed the electrical energy into the mechanical energy that caused the shaft to turn. Design an investigation to test other combinations of metals. While you're designing the investigation, think about the following questions:

   What is the purpose of your investigation?

   What will you observe or test?

   What materials will you need to conduct your investigation?

   How will you record your observations?

   How will you use the results to make a conclusion?

8. Obtain your teacher's approval for your investigation.
9. Conduct your investigation, and record the results in your science notebook.

Part C: Other Effects

10. Investigate what happens when you place the metals closer together. Use two strips that caused the motor to turn slowly. Place them in the slots at opposite ends of the SEPUP wet cell. In steps, move one strip from slot to slot so that it gets closer to the other strip. Observe what happens to the motor during each step. Make a table in your science notebook to record the results.
11. Investigate what happens to the direction the shaft turns when you reverse the connections. Use the zinc and copper combination of metals to explore this. Record your observations in your science notebook.
12. Investigate what happens to the motor as you gradually remove both of the metal strips from the electrolyte. Use a combination that caused the motor to spin rapidly to explore this. Record your observation in your science notebook.

ANALYSIS

1. Was there a chemical change when you inserted the strips into the electrolyte? Describe any evidence that supports your answer.
2. Use your results from Part B to rank the metal combinations from 1 to 6, with 1 as the highest-releasing electrical energy rate, and 6 as the least. Describe any evidence that determined the ranking.

   Magnesium/copper

   Magnesium/iron

   Zinc/copper

   Zinc/magnesium

   Zinc/iron

   Copper/iron

3. Look at the table below that describes the reactivity of the metals used in this activity. Compare the table to your response in Analysis Question 2.

   Based on the comparison:

   a. Does reactivity alone indicate what combinations of metals will release the most energy?

   b. What patterns do you see that could indicate why the most and least energy combinations occurred?

   c. Gold is the least reactive metal known and tends not to give up electrons. Which metal from the table would you pair it with to make a strong battery? Explain your choice.

4. Make a table that summarizes your investigation in Part C. It should identify each effect, summarize the results, and include a brief explanation of why you think each result happened.

Reactivity of Common Metals

Metal	Reactivity	Tendency to Give Up Electrons
Magnesium	Most	Most
Zinc	↓	↓
Iron	↓	↓
Copper	Least	Least

5. From the materials in this activity, draw and label a battery that would produce the most energy.

EXTENSION

Design and conduct an investigation that tests the effect of changing the concentration of the electrolyte.