

Salty Battery

Overview: In the last experiment (Fruit Batteries), we experimented with different electrolyte solutions for the electrodes. This time, we're keeping the solution the same, but changing the electrodes.

What to Learn: The basic idea of electrochemistry is that charged atoms (ions) can be electrically directed from one place to the other. If we have a glass of water and dump in a handful of salt, the NaCl (salt) molecule dissociates into the ions Na⁺ and Cl⁻. When we plunk in one positive electrode and one negative electrode and add electricity, we find that opposites attract: Na⁺ zooms over to the negative electrode and Cl⁻ zips over to the positive. The ions are attracted (directed) to the opposite electrode and there is current in the solution.

Materials

- water
- salt
- distilled white vinegar
- Goggles and gloves if you have an adult to handle bleach (do not handle this yourself – your adult will do this part for you)
- Disposable cup
- Popsicle stick

Electrodes to experiment may include:

- real silverware (not stainless)
- shiny nail (galvanized)
- dull nail (iron)
- wood screw (brass)
- large paper clip
- copper penny or copper pipe
- graphite from inside a pencil
- 2 alligator wires
- digital multimeter (DMM)

Lab Time

1. Fill your cup partway with water.
2. Add a teaspoon of vinegar.
3. Add a teaspoon of salt.
4. Optional: add a couple of drops of bleach, cap it and put it away out of reach of kids. If you are using bleach, make sure every kid is wearing a pair of goggles.
5. Connect the nail with one alligator clip lead.
6. Connect the penny with another alligator clip lead.
7. Dip both nail and penny in the water, and make sure they are not touching each other.
8. Connect the other ends of alligator clip leads to the probes on the DMM, one alligator wire to each probe.
9. Turn on the DMM to 20 VDC. What do you read? Write it here: _____
10. What happens if you pull the two electrodes as far apart from each other as possible? What happens to your voltage? Write it here:

11. Replace the penny with a paperclip, and dip it in the solution. What do you read? Write it in your data table.
12. What about a brass screw? What other things can you try? What different combinations are there to test?
Fill in the data table with your measurements.

Reading

Using ocean water (or make your own with salt and water), you can generate enough power to light up your LEDs, sound your buzzers, and turn a motor shaft. We'll be testing out a number of different materials such as copper, aluminum, brass, iron, silver, zinc, and graphite in a small sample of salt water to find out which works best for your solution.

Electrochemistry studies chemical reactions that generate a voltage and vice versa (when a voltage drives a chemical reaction), called oxidation and reduction (abbreviated "redox") reactions. When electrons are transferred between molecules, it's a redox process.

Electrolytes (a solution containing free ions, like salt water or lemon juice) can be used to generate a voltage. Think of electrolytes as a material that dissolves in water to make a solution that conducts electricity. Did you notice how in *Lesson #23: Fruit Batteries*, we also needed electrodes made of conductive material, like metal? Metals are conductors not because electricity passes through them, but because they contain electrons that can move. Think of the metal wire like a hose full of water. The water can move through the hose. An insulator would be like a hose full of cement – no charge can move through it. You need two different metals in this experiment that are close, but not touching inside the solution. If the two metals are the same, the chemical reaction doesn't start and no ions flow, no voltage is generated... nothing happens. But don't take my word for it – try it for yourself!

Exercises

1. Which combination gives the highest voltage?
2. What happens if you use two strips of the same material?
3. What would happen if we used non-metal strips?

Salty Battery Data Table

Trial #	Electrode #1	Electrode #2	Voltage (V)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Answers to Exercises: Salty Battery

1. Which combination gives the highest voltage? (Check data for result.)
2. What happens if you use two strips of the same material? (You won't have a difference. These copper ions interact with the zinc electrode to form zinc ions. The copper electrons are chemically reacting with the lemon juice to form copper ions. The difference in electrical charge (potential) on these two plates causes a voltage.)
3. What would happen if we used non-metal strips? (They don't break into ions, and don't work.)