Curiosity Guide #310
Electric Batteries

Accompanies Curious Crew, Season 3, Episode 10 (#310)

Design a Better Battery

STEM Challenge

Description

Design and test two batteries made of different materials. Which design is more cost-effective? Which design works better?

Materials from which to choose

- Different kinds of metals, such as:
  - Copper
  - Zinc
  - Aluminum
  - Steel
- Different kinds of liquids, which will act as electrolytes:
  - Water
  - Saltwater
  - Lemon juice
  - Grapefruit juice
  - Any kind of soda
  - Toilet bowl cleaner
  - Vinegar
  - Sports drinks
  - Pickling brine, from a jar of pickles

Materials per team

- Gloves
- Goggles

- 3 plastic cups
- Voltmeter
- Graduated cylinder
- 2 alligator clip cables
- LED test bulbs
- Tape
- Item cost sheet

Teams will choose from the available materials to make two different battery cells. Each team will determine which combination of materials is more cost effective and has the higher output.

Procedure 1: Choose materials

1) As a team, choose different materials for two separate battery-cell tests. Select two metals and a liquid for each test.
2) Note the materials selections on your cost sheet.

Procedure 2: Set up the test

1) You will perform this test twice with the two different sets of materials you chose.
2) Place 150 milliliters of the selected liquid in a plastic cup.
3) Place one pair of selected metals in the liquid so that half of each piece of metal is sticking above the liquid.
4) Use a strip of tape across the cup to separate the two metals on either side of the cup.
5) Attach an alligator clip cable to each piece of metal. Attach the other ends of the alligator clip cables to the voltmeter.

Procedure 3: Test, record, and evaluate

1) Measure and record the voltage reading on the team's cost sheet.
2) If you got a negative number, switch the lead wires from your voltmeter to the alligator clips.

3) Repeat Procedures 2 and the first two steps of Procedure 3 with the second set of materials.
4) What combination of materials makes the better battery?
5) What is the cost to make the single-cell battery?
6) How many cells would you need to produce 12 volts, which would be enough to start a car?

My Results

Explanation

Batteries are used to change chemical energy into electrical energy through a redistribution of electrons between different metals and a solution. Every battery has three components: an electrolyte, an anode, and a cathode. A chemical reaction happens when two different metals are connected by an electrolyte, which provides a path for electrons to move from one metal to the next. At the point of contact, there is a chemical reaction where the anode loses electrons and a cathode receives them. Because the two metals have different voltages, the electrons move from the concentrated negative terminal, or anode, toward the lower concentrated positive terminal, the cathode. Placing a device that requires electrons between the two terminals powers that device. For example, an LED light, when connected to the positive and negative terminals, will turn on.

Two of the most common metals used in the development of a battery are copper as the cathode, because copper carries electricity so well, and zinc as the anode. What you built is an example of a "wet cell" battery because the liquid solution has a chemical reaction with the different metals and converts the chemical energy into electrical energy. If the wet cell can produce a reading of 1.0 milli-volts or higher, that is quite efficient.

Explore further: You may want to find a diagram of a car battery in a book or on the internet. Then think about this: The Crew discovered how to make a wet cell battery with two electrodes and an electrolyte and do it pretty efficiently. But have you ever seen a car battery? Each car battery is a wet cell battery that is made of 6 cells. Each cell has 2 electrodes. The electrodes are large metal grids covered in lead oxide and lead. These electrodes carry electrons in and out to the next cell. The grids sit in a bath of water and sulfuric acid. Each little cell produces 2 volts of electricity. However, when you put all the cells together, that 12 volts is enough to start your car! Vroom, vroom!

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