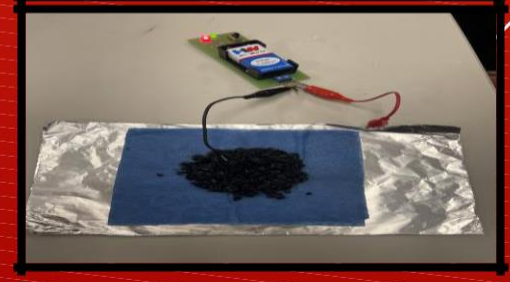
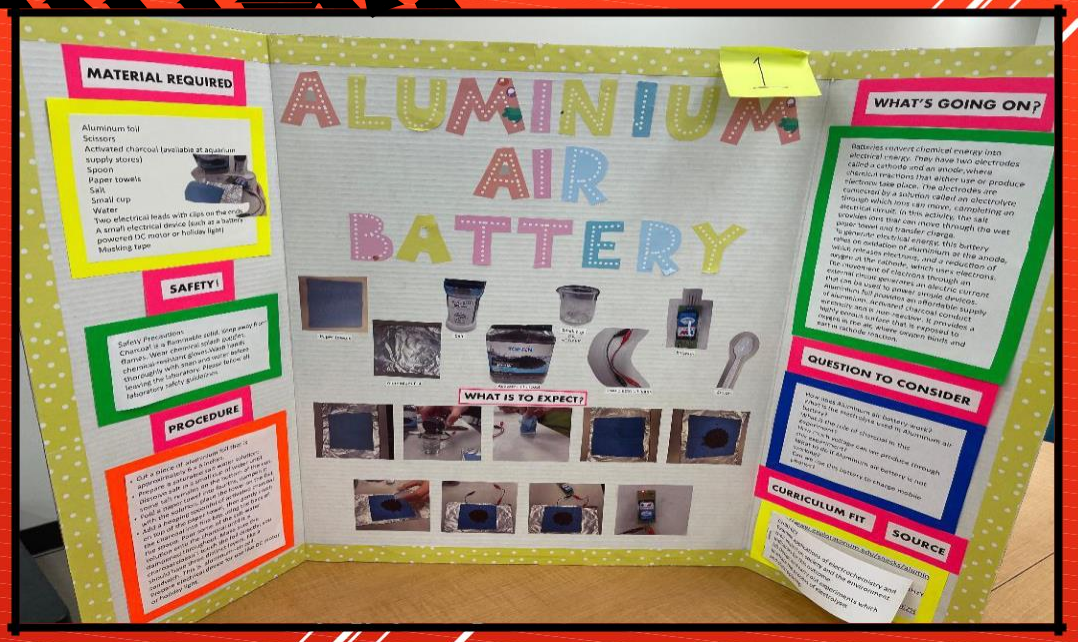
ALUMINUM AIR BATTERY

MATERIAL REQUIRED

- Aluminum foil
- Scissors
- Activated charcoal
- Spoon and Paper towels
- Salt
- Small cup and Water
- Two electrical leads with clips on the ends ,small electrical device (such as a battery-powered DC motor or holiday light), Masking tape





PEOCEDURE

1. Cut a piece of aluminum foil that is approximately 6 x 6 inches.
2. Prepare a saturated salt-water solution: Dissolve salt in a small cup of water until some salt remains on the bottom of the cup.
3. Fold a paper towel into fourths, dampen it with the solution, then place the towel on the foil.
4. Add a heaping spoonful of activated charcoal on top of the paper towel, then gently crush the charcoal into fine bits using the back of the spoon. Pour some of the salt-water solution onto the charcoal until it is dampened throughout.
5. Prepare your electrical device for use.

WHAT IS GOING ON?

Batteries convert chemical energy into electrical energy. It has two electrodes cathode and anode, where chemical reactions that either use or produce electrons. The electrodes are connected salt solution called an electrolyte, through which ions can move, completing an electrical circuit. Aluminum foil provides an affordable supply of aluminum which works as charcoal provides a large number of sites to which oxygen can bind and participate in the cathode reaction.

SOURCE: https://www.exploratorium.edu/snacks/aluminum-air-battery

Tools and Materials

Aluminum foil Scissors
Activated charcoal (available at aquarium supply stores)
Spoon
Paper towels
Salt
Small cup
Water
Two electrical leads with clips on the ends
A small electrical device (such as a battery-powered DC motor or holiday light)
Masking tape

Assembly

Cut a piece of aluminum foil that is approximately 6 x 6 inches (15 × 15 centimeters).
Prepare a saturated salt-water solution: Dissolve salt in a small cup of water until some salt remains on the bottom of the cup.
Fold a paper towel into fourths, dampen it with the solution, then place the towel on the foil.
Add a heaping spoonful of activated charcoal on top of the paper towel, then gently crush the charcoal into fine bits using the back of the spoon.
Pour some of the salt-water solution onto the charcoal until it is dampened throughout. Make sure the charcoal doesn't touch the foil directly; you should have three distinct layers, like a sandwich. This is your aluminum–air cell.
Prepare your electrical device for use. If you are using a DC motor, attach a small piece of tape to the end of the motor shaft to serve as a “flag” so you can easily see when the motor is moving. If you are using a holiday light, strip the ends of the wires so that you can attach the leads.

What to Do and Notice

Clip one end of each electrical lead to each terminal of the electrical device. Clip the other end of one of the leads to the aluminum foil. Firmly press the final clip on the pile of charcoal, then watch what happens.

If the battery doesn’t seem to be working after a few seconds, you may need to reduce its internal resistance. Try increasing the contact area between the clip and the charcoal by folding the entire battery over the clip—like a taco—and pressing down hard. Make sure that the clip stays buried in the charcoal. If you are using a motor, you can also try kickstarting it by briefly spinning the flag.

What’s Going On?

Batteries convert chemical energy into electrical energy. They have two electrodes—called a cathode and an anode—where chemical reactions that either use or produce electrons take place. The electrodes are connected by a solution—called an electrolyte—through which ions can move, completing an electrical circuit. In this activity, the salt provides ions that can move through the wet paper towel and transfer charge.

To generate electrical energy, this battery relies on oxidation of aluminum at the anode, which releases electrons, and a reduction of oxygen at the cathode, which uses electrons. The movement of electrons through an external circuit generates an electric current that can be used to power simple devices. A diagram of the battery and equations for the half and overall reactions are given below:

Equations for the Half and Overall Reactions:

anode: $Al(s) + 3OH^-(aq) \rightarrow Al(OH)3(s) + 3e^-$
cathode: $O2(g) + 2H2O(l) + 4e^- \rightarrow 4OH^-(aq)$
overall: $4Al(s) + 3O2(g) + 6H2O(l) \rightarrow 4Al(OH)3(s)$

Aluminum foil provides an affordable supply of aluminum. Activated charcoal, which is mostly made of carbon, can conduct electricity and is non-reactive. It provides a highly porous surface that is exposed to oxygen in the air. One gram of activated charcoal can have more internal surface area than an entire basketball court! This surface provides a large number of sites to which oxygen can bind and participate in the cathode reaction.

This large reaction area makes it possible for the simple aluminum–air battery to generate 1 volt (1 V) and 100 milliamps (100 mA). This is enough power to run a small electrical device and provides a safe and easy way to make a powerful battery at home or in school.

GOING FURTHER

The first modern electric battery was made up of a series of electrochemical cells, called a voltaic pile. To make a voltaic pile, repeat Assembly steps 1–4 to construct additional aluminum–air cells. Stack two or three aluminum–air cells on top of each other to see if you can make a more powerful battery. Clip one lead to the bottom piece of foil and place the other lead in the top charcoal pile. Press down firmly on the pile to reduce the internal resistance of the battery, but make sure that the foil pieces don't touch each other. If the foil from one cell is in contact with the foil from the cell above it, the electrons will bypass the paper towel and activated charcoal and move directly into the second piece of foil, which has a lower resistance than the charcoal layer. This effectively shorts out the lower cell, which no longer contributes to the overall power output.

You can compare the power qualitatively by looking at the intensity of the electrical device or quantitatively by taking measurements on a multimeter. Use a multimeter to measure the voltage and current generated by your battery. What changes to the battery design result in a larger voltage or current?

Calculate the power output from your battery by calculating the product of its voltage and current. Try to power other devices that require higher voltage or current, such as a string of LEDs (make sure they're connected in the right orientation), a piezo buzzer, or a more powerful light.

SAFETY PRECAUTIONS

Charcoal is a flammable solid. Keep away from flames. Wear chemical splash goggles, chemical – resistant gloves. wash hands thoroughly with soap and water before leaving laboratory. please follow all laboratory guidelines.

TIPS

Small electrical devices are available at electronic stores. Make sure the chosen electrical device will produce a noticeable change when connected to a one-volt power supply.
This activity demonstrates oxidation and reduction reactions—integral parts of battery chemistry. The use of atmospheric oxygen as the oxidizing agent has extensions to other redox reactions that occur in corrosion, metabolism, and combustion. In addition, the participation of oxygen as a reactant in the aluminum–air battery can be used to introduce the concepts of fuel cells and alternative energy sources.

QUESTIONS TO CONSIDER

How does Aluminum air battery work?
What is the electrolyte used in Aluminum air battery?
What is the role of charcoal in this experiment?
How much voltage can we produce through this experiment?
What to do if Aluminum air battery is not working?
Can we use this battery to charge mobile phones?

CURRICULUM FIT

CH30-EC2
Examine applications of electrochemistry and their impact on society and the environment.
Indicators for this outcome
(d) Design and carry out experiments which illustrate the process of electrolysis and electroplating.

RESOURCES

This activity is based on a demonstration by teachers from the Galileo Workshop in Japan.
https://www.exploratorium.edu/snacks/aluminum-air-battery