CLEAN ENERGY INSTITUTE
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"A Battery From Household Chemicals" Demo Instructions

Last Modified by: Dion Hubble, 1/28/16

Supplies

Saturated salt (NaCl) solution

6% acetic acid (vinegar) solution

3% hydrogen peroxide solution

1 – Magnesium metal strip

1 – Conductive carbon rod

1 – Galvanic cell cup with attached clips for metal/carbon

1 – Microporous cup, pre-soaked in salt solution

1 – Small red LED (must be red, most other colors will not work)

1 – Set of red/black wires with alligator clip leads

Steps

1. **Unpack the supplies. Gloves are suggested but not required.**

   Suggested discussion:

   - What does a battery do?
   - Where can batteries be found in everyday life?
   - Batteries are made up of chemicals that exchange electricity. What are some chemicals that can be found around your home?
   - (*advanced)* Why do we need to separate the chemicals? (answer: because if they were in direct contact, they would transfer electricity directly, instead of through a wire like we want.)

2. **Take the microporous cup out of its salt soak and place it in the center of the galvanic cell cup. If not already full, fill the microporous cup to within 1-2 cm of its top with salt solution.**

   Suggested discussion:

   - (*advanced)* Why do we need salt in the water? (answer: because charge must be balanced, so for every electron that flows across the battery, a positively charged atom, or ion, must flow across also. Salt has Na^+ which is a positive ion that moves through water easily.)

3. **Place the magnesium strip into the salt solution. Use one of the clips on the galvanic cell cup to secure it.**

Suggested discussion:

- Magnesium can be found in flint firestarters for camping.
- (advanced) Magnesium is used in flints because it is more reactive than other metals like aluminum. Why does this make it good for use in batteries? (answer: more negative redox potential, which gives us higher voltage)
- (*advanced)* Why do we need salt in the water? (answer: because charge must be balanced, so for every electron that flows across the battery, a positively charged atom, or ion, must flow across also. Salt has Na^+ which is a positive ion that moves through water easily.)

4. **Insert the carbon rod into the outer cup. Secure it with the other clip.**

Suggested discussion:

- The carbon rod isn't part of the chemical reaction. The reason we need it is because it will carry electrons.

5. **Fill the outer cup to about 1/3 with vinegar.**

Suggested discussion:

- Vinegar is commonly used for cooking.
- (*advanced*) Vinegar is a type of acid. Acids and bases are often important to reactions in batteries because they have excess charge that they can give up.

6. **Continue to fill the outer cup with hydrogen peroxide until it is 2/3 full (equal volumes vinegar and hydrogen peroxide solution). Try to avoid splashing any peroxide on the magnesium.**

Suggested discussion:

- Hydrogen peroxide is commonly used to disinfect minor cuts and scrapes.
- We need both the hydrogen peroxide and vinegar because they will work together to accept electricity from the magnesium.
- (*advanced*) Hydrogen peroxide is used for first aid because it is also very reactive and can kill bacteria and viruses. Why does this make it good for us to use? (answer: more positive redox potential, which gives us higher voltage)

7. **Attach the red wire to the clip holding the carbon rod, and the black wire to the clip holding the magnesium.**

Suggested discussion:

- The red wire is clipped to the positive side of the battery, which is called the "cathode." The black wire is clipped to the negative side of the battery, which is called the "anode."

- (*advanced*) The magnesium is the anode because gives up electricity easily, and the hydrogen peroxide/vinegar is the cathode because it accepts electricity easily. The more eager one or both of the sides are to exchange electricity, the higher the voltage of the battery will be.

8. **Clip the red wire onto the LED's positive terminal (usually longer) and the black wire onto the LED's negative terminal. The LED should light up.**

Suggested discussion:

- When we connect the wires, the magnesium gives up electricity, which flows through the black wire, then through the LED, lighting it up. It then flows through the red wire and into the carbon rod, where it is given to the hydrogen peroxide and vinegar. They react to make water.
- (*advanced*) If we left this battery connected for a long time, the light would eventually go out as the chemicals get used up. This type of battery isn't rechargeable, because once the chemicals are reacted, they can't be unreacted (much like how eggs can't be unscrambled). Some types of batteries have chemicals that can unreact if we pull on the electricity hard enough. This is what you're doing when you charge your phone or laptop.
- (*advanced*) At the CEI, we're trying to make better rechargeable batteries. This will make electric cars cheaper and better, and it will also make green energy like solar and wind cheaper.

<u>Cleanup</u>

- Unclip all wires and the LED.
- Unclip the magnesium strip and remove it from the salt solution. Rinse it off with water and pat dry. Store it in a sealed plastic bag.
- Unclip the carbon rod and remove it from the peroxide/vinegar solution. Rinse it off with water and pat dry. Store it in a sealed plastic bag.
- All solutions can be poured down the sink.
- Lightly rinse the porous cup before placing it back into its salt soaking solution. Top off the soak with enough salt solution to keep the liquid level above the top of the cup.
- Lightly rinse the galvanic cell cup and pat dry.

