Lesson: Why is this so important?

Unit Question: Why do cell phone batteries overheat?

Lesson: Penny Lab Instructions

Electrochemical cells

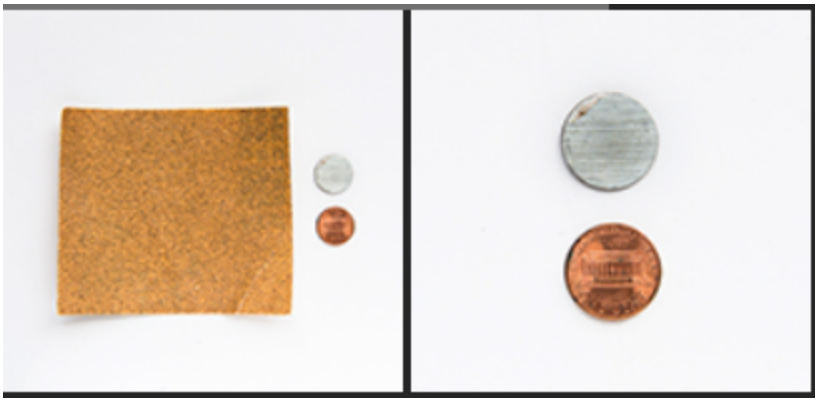
Materials:



Five or more post-1982 U.S. pennies
Piece of 100-grit sandpaper
Matboard or thick cardboard
Salt
Vinegar
A red LED; high-intensity ones are easier to see
Electrical tape
A voltmeter
Scissors (not shown)
Cup with water (not shown)
Paper towel (not shown)
Optional: other LEDs of different colors, such as yellow and blue

Procedure:

- ☐ Make a saturated salt solution by adding salt to water and stirring until it doesn't dissolve anymore.
- ☐ Add a splash of vinegar to this solution.
- ☐ Cut your matboard into four 1/2-inch squares, each about the size of a penny.
- ☐ Soak the pieces in the salt-and-vinegar solution. Once the pieces are thoroughly wet, take them out and place them on a paper towel so they are still damp, but not dripping.
- ☐ Use sandpaper to remove the copper from ONE side of each of four pennies. ONLY USE PENNIES MADE AFTER 1982. This is because Pennies that were made after 1982 have zinc cores that are plated with copper. Sand until you see zinc (shiny silver color) covering the entire face of the coin.



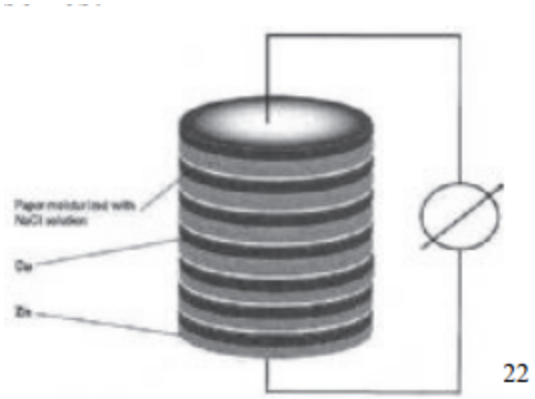
- ☐ Leave the fifth penny intact.

  This takes some time and effort, so be patient. Try placing the sandpaper on a hard surface and moving the penny instead of the sandpaper. The "tails" side may be easier to sand because the Lincoln Memorial (or Union Shield) doesn't protrude as far as Lincoln's head. When you're done, the sanded coins should have a bronze-colored copper side and a silver-colored zinc side.

- ☐ Take one of your sanded pennies with the zinc side facing up (copper side down), and place a damp piece of matboard on it. Then stack another sanded penny (again, zinc side facing up) on top of this.

Take your next piece of matboard and place it on top, and continue stacking pennies and matboard on top of each other to make a neat pile. Finally, place the unsanded penny at the very top.

Note: When you're done, you should have alternating layers of pennies and matboard with all the zinc sides facing up, and both the very top and the very bottom of your stack (facing down) should be copper. Make sure the pennies aren't directly touching each other and, likewise, that the pieces of matboard aren't touching each other.



- ☐ Test your battery by connecting your LED. Touch the longer lead to the intact penny on the top and the shorter lead to the bottom of the stack.
  Make sure that the leads don't touch any other layer.

Did the LED turn on? _____
If not, make sure the LED leads are oriented correctly and use a paper towel to wipe off any excess water from the penny-matboard stack.

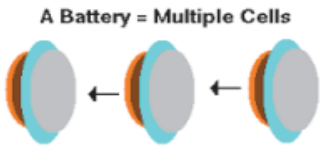
What's Going On?

1) Batteries are devices that convert chemical energy into electrical energy. Can you explain how this might happen? Explain the conversion process

2) We have also learned that the battery system is made up of 2 electrodes and one electrolyte. Identify the electrodes and electrolyte in your system

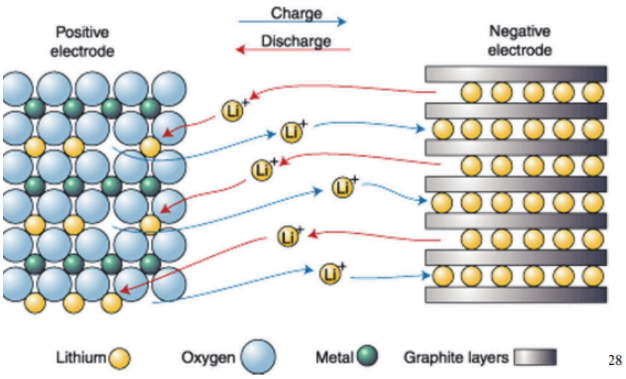
   Electrode 1 _____
   Electrode 2: _____
   Electrolyte: _____

3) A battery is a set of cells connected in series. Each zinc-matboard-copper stack represents one individual cell. Using a voltmeter, test one zinc-matboard-copper stack to see how much voltage each cell can generate.



   Write the number here: _____V
   How many cell stacks did you make? _____cells
   Calculate total voltage (volts of one cell x number of cells) = _____

4) Consider the image (to the right) depicting what is happening at the atomic level.
Using that picture, observations from your experiment and any other resources we have used in class for this exploration to explain, IN YOUR OWN WORDS,
   a) How the electric current is created in the battery system
   b) How the REDOX reaction happens in the battery cells



5) A 12-volt car battery is composed of six lead/lead oxide cells, each with a voltage of approximately 2 volts. On the basis of your voltage measurements, how many of your homemade copper/iron cells would you need to generate 12 volts?