

ELECTRIC GEL CELL

PRE LAB DISCUSSION

An electric current is a flow of electrons. In electric cells [commonly called "batteries"] electrons move from the cathode to the anode in a redox reaction. The modern operational definition of oxidation is *the loss of electrons*. Oxidation takes place at the anode [+]. The modern operational definition of reduction is *the gain of electrons*. Reduction occurs at the cathode [-].

Voltage is the electrical PRESSURE that is causing the electrons to flow. It is commonly called *electro motive force [EMF]*. Amperage is the NUMBER of electrons that move past a given point per second. Electric energy is measured in Watts, which is defined as *voltage X amperage*. A 9-volt battery has more electrical pressure than a "D" cell, but it does not have as much amperage.

A series circuit is when the anode of one cell is connected to the cathode of the next cell. This adds the voltage of the first cell to that of the second cell. Most common electrical cells [such as "D" cells] are 1.5 volts. If the cover is removed from a 9-volt battery, one will discover that it is made up of six AAA cells connected in a series¹. Each AAA cell produces 1.5 volts, which is added to next cell, which is added to the next cell etc. The combined pressure of the six 1.5 volt cells is 9 volts.

Electrical cells can produce direct current [D.C.], that is, a current of electrons that flows only in one direction. The electricity that is used in our homes is alternating current [A.C.], in which the flow of electrons reverses 60 times per second. Thomas Edison was an advocate of direct current and wanted to build electric supply systems based on this type of electric current. Nikola Tesla and George Westinghouse were advocates of A.C. electrical systems. The conflict between these great scientists is very interesting technological history.

¹ A battery is a grouping or series of individual units. The term "**battery**" is correct when applied to the 9-volt unit of 6 individual units. The term "**cell**" is the correct term to describe a "D" cell although the term battery is often incorrectly applied to them.

Electricity can be produced in a number of ways. The electricity that powers our homes is produced by induction. This is done by moving a metal conductor through a strong magnetic field using mechanical energy. Electrons are displaced by the force of the field. Photovoltaic cells use light energy to displace electrons. In this laboratory we are using chemical energy to displace electrons. Two metals will react in an ionic solution. This reaction will occur when an electrical circuit provides a way for the electrons to move from one metal to the other.

Each partition of the egg carton can be made to function as an electrical cell. If the students want to increase the electrical voltage, the cells must be connected in series. The metals used for the cell determine the voltage of the cell. To increase the amperage of a cell, the students must increase the amount of reactive surface of the metals or connect the cells in parallel circuits.

Students should be aware of the importance of cleaning all metal surfaces with sand paper or emery cloth to insure good electrical conductivity. Students will need to connect alligator clips to bell wire in order to connect the electrical cells in a series or to motors, lights, and galvanometers.

OBJECTIVE: To make functional electrical cells and determine the relative strength of each type of cell.

CHEMICALS/EQUIPMENT: Styrofoam egg carton, Gelatin dessert such as Jell-O [lemon, lime or orange flavored], copper [pennies, tubing or strips], aluminum [nails or strips of can and foil], magnesium, iron [nails], lead [weights, wall anchors, strips], zinc [hot dipped galvanized nails], bell wire, alligator clips, galvanometer or 1.5 volt DC motors and plastic coffee stirrers. filter paper, phenolphthalein solution

PROCEDURE:

1. Make the Jell-O with only 1/2 half of the water that is normally used in the directions on the box.
2. Fill the individual partitions of an Styrofoam egg carton with the

Jell-O and allow it to gel.

3. Attach alligator clips to both ends of four pieces of bell wire.
4. If you are using 1.5 volt electric motors, poke a hole in the center of a plastic coffee stirrer and place it on the shaft of the motor.
5. Make the following cells and test them by connecting them to the galvanometer or the electric motor. If there is no reaction, then make a second cell and connect it in series to the first. Then connect it to the motor or galvanometer. For each type of cell, rate its voltage *relative* to the other cells. If two or more cells in series were needed to obtain a measurable voltage, divide the reaction by the number of cells used in the series.

Cu---Zn cell

Al --Cu cell

Fe--Zn cell

Cu--Mg cell

Pb--Al cell

Pb--Mg cell

6. For each of the cells above that you were able to make, record the reading on the galvanometer or the *relative* speed of the electric motor. You need to be able to rate the cells from the highest voltage to the lowest voltage.

<i>DATA</i>		
CELL	GALVANOMETER READING	OR RELATIVE SPEED OF MOTOR
Cu--Zn	_____	_____
Cu--Al	_____	_____
Fe--Zn	_____	_____
Cu--Mg	_____	_____
Pb--Al	_____	_____
Pb--Mg	_____	_____

PART II
[optional]

OBJECTIVE: To make a paper galvanometer.

PROCEDURE:

1. Saturate a piece of filter paper in a solution of concentrated salt water and phenolphthalein.
2. Attach opposite sides of the filter paper to one of the working electrical cells using the alligator clips. Observe for several minutes until there is a definite color change at one clip.
3. Reverse the position of the alligator clips and observe for several minutes until color changes are seen at both clips.

PART III THE TEN-CENT BATTERY

OBJECTIVE: To make a voltaic pile.

PROCEDURE:

1. Place a small piece of aluminum foil on the table, then place a small piece of filter paper saturated with salt water on the foil. Now place a penny on the filter paper.
2. Cover the penny with another piece of filter paper soaked with salt water.
3. Repeat this procedure until you have a stack of ten pennies and aluminum foil, separated by moist salty filter paper.
4. Attach wire to the bottom piece of aluminum foil and another wire to the top penny. Now test this Voltaic pile with the motor or galvanometer.

THINKING SCIENTIFICALLY

1. List the cells in the relative strength beginning with the cell that produced the highest voltage.
2. Determine which metal was the anode and which metal was the cathode in each of the cells tested.

3. Using a table of reduction potentials, calculate the theoretical voltage for each of the experimental cells.

4. Compare the relative strength of the theoretical voltages to the relative strength of the experiment cells. Are they the same or not? How can you explain any differences?

5. This experiment specified the flavors of gelatin to be used. What would have happened if cherry or strawberry gelatin were used instead? Why?

6. How many cells were in the Voltaic pile? Theoretically, what voltage could this battery of cells produce?

7. What is the same about a "D" cell and a "AAA" cell?

8. What is difference between a "D" cell and a "AAA" cell?

[The following questions are related to PART II]

9. Phenolphthalein turns pink in a basic solution. Did the anode or the cathode side of the filter paper turn pink?

10. Write the two half reactions for the electrolysis of NaCl.

11. Write an equation for the reaction of metallic sodium with water.