Lesson: Fruit Battery Lab

Unit Question:Why do cell phone batteries sometimes overheat?

NAME: _____

PERIOD: _____ DATE: _____

Fruit Battery Lab

Student Handout

Introduction:

Concepts to Investigate:
Batteries,
oxidation-reduction,
electrochemical cells (voltaic cells,
galvanic cells),
parallel circuits, series circuits,
instrumentation,
current detection,
magnetism.

All batteries have a "+" and "-" terminal and require three things to conduct electricity: 2 electrodes and one electrolyte solution.

Electric current is a flow of atomic particles called electrons.

Certain materials , called **conductors**, allow electrons to flow through them. Most metals (copper, iron) are good conductors of electricity. Electrons will flow from the "-" electrode of a battery, through a conductor, towards the "+" electrode of a battery.

Volts (voltage) is a measure of the force moving the electrons. (High voltage is dangerous!).

If the two metal strips are connected with an external copper wire, electrons flow through the wire from the zinc (the reducing agent) to copper (the oxidizing agent). The combination is an electrochemical cell (also known as a galvanic or voltaic cell), and the metal strips at which the transfer of electrons occur are called electrodes.

In this reaction, the zinc strip/nail and the copper penny are called electrodes. The lemon juice is called electrolyte. The zinc electrode at which oxidation occurs (electrons are lost) is called the anode, while the copper electrode at which reduction occurs (electrons are gained) is called the cathode.

Investigation question: Do different combinations of metals produce voltages? We'll perform the following experiments to answer this question.

Lesson: Fruit Battery Lab

Unit Question:Why do cell phone batteries sometimes overheat?

NAME: _____

PERIOD: _____ DATE: _____

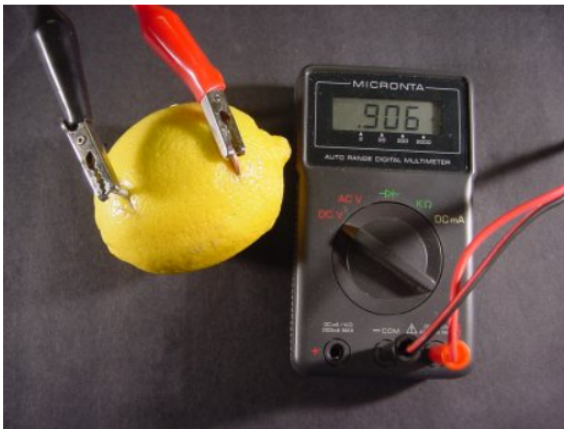
Materials:

- lemon (or other citrus fruit),
- strips of 5 metals -
- magnesium, aluminum, zinc, iron, nickel, tin and copper
- multimeter (analog multimeter or digital multimeter which consumes less current)
- Steel wool

Note: Galvanized nails are coated with zinc. This will work well if you can't find a strip of zinc.

Procedure:

Procedure:



- ☐ Obtain similar sized strips of a variety of metals, such as copper, iron, magnesium, tin, lead, nickel, aluminum, carbon, and zinc.
- ☐ Rub the metal strips with steel wool to remove oil and oxide coats.
- ☐ Make two slits in the lemon (any citrus fruit will suffice) a few centimeters apart (far apart so that the two strips of metal do not touch when inserted in the lemon).
- ☐ Place a piece of copper in one slit and a piece of iron in the other slit. Connect the leads of a voltmeter (multimeter) to both strips as shown in the diagram.
- ☐ Reverse the leads if necessary to obtain a positive voltage reading
- ☐ Record the voltage in the table below (For **Iron** ONLY)
- ☐ **Leave the copper strip in the lemon**.
- ☐ **Remove the iron strip** and test the potential difference between copper and each of the following: magnesium, tin, nickel, aluminum, zinc.
- ☐ With each metal strip, remember to record the voltage in the chart below (See RESULTS section below)
- ☐ Use the voltages to rank the metals in terms of ease with which electrons are lost to copper. The more easily electrons are transferred to copper, the higher the voltage of the galvanic cell.

- ☐ **Extension:** Repeat the procedure using tomatoes, oranges, potatoes or apples for the electrolyte source. Does the type of fruit used for wet cells affect the ranking of potential differences?

Lesson: Fruit Battery Lab

Unit Question:Why do cell phone batteries sometimes overheat?

NAME: _____

PERIOD: _____ DATE: _____

Results/Data:

Record the voltage in the following table: remember to record every reading in Volts (V)

Voltages for Cells with Copper Cathodes. Cathode will always be Copper

FRUIT - Lemon

Anode			**Anode**		
Iron			Tin		
Zinc			Nickel		
Magnesium			Aluminum		

FRUIT - Orange

Anode			**Anode**		
Iron			Tin		
Zinc			Nickel		
Magnesium			Aluminum		

FRUIT - Tomato

Anode			**Anode**		
Iron			Tin		
Zinc			Nickel		
Magnesium			Aluminum		

FRUIT - Potato

Anode			**Anode**		
Iron			Tin		
Zinc			Nickel		
Magnesium			Aluminum		

Lesson: Fruit Battery Lab

Unit Question:Why do cell phone batteries sometimes overheat?

NAME: _____

PERIOD: _____ DATE: _____

Analysis Questions:

1. **Rank** the cell voltage of the anodes tested (iron, magnesium, tin, nickel, aluminum, zinc) when using copper as the cathode (reference electrode).

Anode	**Lemon**	**Orange**	**Tomato**	**Potato**	**Apple**
Iron					
Zinc					
Magnesium					
Tin					
Nickel					
Aluminum					

2. Why was copper a good choice for the cathode in this activity?

3. Compare the voltages of the following combinations of metals:
magnesium-copper,
zinc-copper,
tin-copper.

What might this suggest about the ability of magnesium, zinc and tin to give up electrons?

4. Does the type of fruit affect the rank-order of electrode potential?

Lesson: Fruit Battery Lab

Unit Question:Why do cell phone batteries sometimes overheat?

NAME: _____

PERIOD: _____ DATE: _____

5. It takes at least 12V to light up a bulb. Is there any anode -cathode combination that yields this much energy?

6. How many fruits can you combine (think series or parallel circuits) to be able to produce a 12-volt battery to light up a bulb?

Note: The more easily electrons are transferred to copper, the higher the voltage of the galvanic cell.