Science Unit: ***The Electron: Conductivity and Chemistry***

Lesson 4: ***Making a Food Battery***

School Year:	2011/2012
Developed for:	Trafalgar Elementary School, Vancouver School District
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Grade level:	Presented to grades 6 and 7; appropriate for grades 5 – 7 with age appropriate modifications
Duration of lesson:	1 hour and 20 minutes
Notes:	This lesson plan assumes that students have completed Lesson 3, How Batteries Work, in this science unit (The Electron: Conductivity and Chemistry).

Objectives

1. Demonstrate their conceptual understanding of how batteries work.
2. Gain experience building simple circuits and using a voltmeter.
3. Practice the scientific method when confronted with an optimization challenge.

Background Information

Batteries use a chemical reaction to do work on charge and produce a voltage between their output terminals. The basic element of a battery is called an electrochemical cell. The electrochemical cell makes use of an oxidation/reduction reaction. If the electrochemical cell produces an external current it is called a voltaic cell. Using some common household items and foods, students can build their own batteries with measurable and functional voltages.

Vocabulary

Voltage:	The electrical potential difference between two points. It is equal to the total energy required to move a small electric charge from one point to another, divided by the value of the charge being moved.
Current:	The flow of electric charge through a medium. The charge is typically carried by moving electrons in a conductor (such as wire), but can also be carried by ions in an electrolyte (as in a battery).
Resistance:	A measure of how much an object opposes an electric current through it.

Materials

- pennies
- nickels
- galvanized nails
- copper wire
- lemons
- oranges
- potatoes
- apples
- connecting wires
- alligator clips
- voltmeter
- low-powered LEDs

In the Classroom

Introductory Discussion

1. Have students consider whether a battery can be made out of some regular household items. Recalling what they learned in the previous lesson, ask what sort of items might be required to build their own battery. Also ask if a homemade battery could somehow be made strong enough to power a device?

2. Have students briefly review the previous lesson on how batteries work. Drawing a cartoon on the blackboard of the anatomy of a battery might help students to remember the main components of a battery and why each is important. Having students label this diagram will further aid to solidify the associated vocabulary.

3. Briefly describe science experiment/activity. Groups of students will select the materials (e.g., specific foods and metal electrodes), from a variety of materials, to build their own battery. Once the materials have been chosen, the groups will use their knowledge of how batteries work to build an electrochemical cell (i.e. a battery). Once a battery has been constructed, the voltage of their battery can be measured using a digital voltmeter. For a bit of fun and extra incentive, the teacher can record the "voltage high score," so that the groups can compete to create the strongest food battery. If any group is capable of building a battery with near to 2V voltage, they may attempt to light a low-powered LED.

4. Briefly describe the processes of science that the students will focus on. For this lesson, students will rely on hypothesis testing (they will use what they have learned to make as strong a battery as possible), observations (they will note what works and what doesn't when it comes to increasing the voltage of their food battery), and recording results (a schematic diagram of their food battery should be recorded into their notebook once they have an operational one.

5. Briefly describe safety guidelines. In particular, students should be very careful with the knives (used to cut fruit into pieces or to make slots for their electrodes). Students should also be aware that the juice from their fruit (lemons in particular) is somewhat acidic and can sting if it gets into their eyes or whatever cuts they may have on their hands.

Science Activity

Activity Title: Building a food battery.

Purpose of Activity: To demonstrate and put into practice a conceptual understanding of how batteries work.

Experimental Observations: The effects of electrolyte and electrodes used will be observed separately.

Prediction or Hypothesis: Before making your hypothesis, it helps to start with a question, or make observations and then ask a question. Use your prior knowledge of batteries to predict what you think will happen when you use different foods or electrodes to build your own battery. Record your prediction based on, for example, the following question: What do you think will happen to the output voltage of a battery when a lemon is exchanged for a potato and all other materials are left the same?

Methods and Instructions:

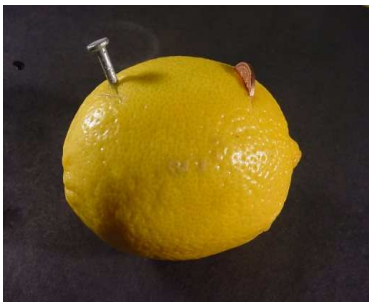
Set-up prior to experiment: Give the students a few days notice about this lesson and ask them to bring fruit from home to try to make into a food battery (lemons, oranges, potatoes, apples, etc.). On the day of the activity, students will build batteries in groups of two or three.

1. For the groups using citrus, it is recommended that they gentle squeeze the lemon by rolling it gently on the table before doing anything else.

2. Groups should then select two electrode materials for their initial battery. Common items are a small piece of copper wire, pennies, nickels, and galvanized nails (galvanized nails have a coating of zinc on their exterior, and are different than regular iron nails.)

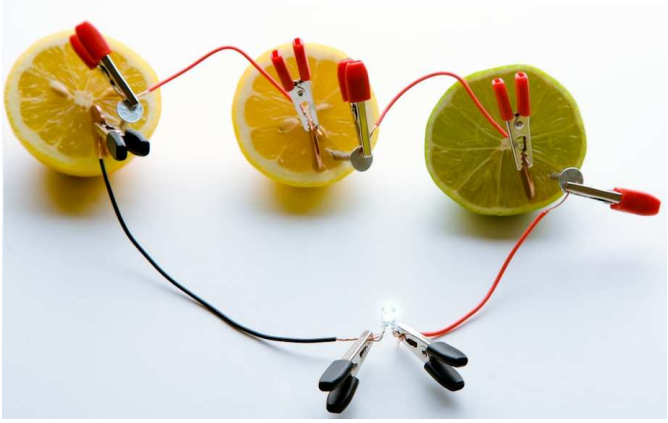
3. Cut two small slits on either side of the chosen food item.

4. Insert the two different electrodes into the slits, as shown below.



5. Using the alligator clip-ended wires, connect each electrode to one input of the voltmeter, to measure the voltage by the generated battery. Using different electrode materials demonstrates the differences in reduction potentials for various metals.

6. A series of cells can be constructed by using multiple lemons (or other food item) and *connecting the cathode on one to the anode on the other*. If enough of the foods are connected together, a voltage large enough to power an electronic device can be produced (e.g., illuminate an LED).



7. Students should be recording their choice of materials and drawing schematics of their batteries along the way. Every time a voltage output is measured, this number should be written into the notebook.

Closure Discussion

1. Which food items seemed to generate the greatest voltages? Which pairs of electrodes seemed to generate the greatest voltages?

2. Once one food battery had been constructed, how did your group generate a greater voltage?

3. Would it be possible to power something bigger than an LED? What about an incandescent light bulb? Or an alarm clock?

References

1. <http://en.wikipedia.org/wiki/Lemon_battery > 'Lemon battery' entry on Wikipedia [Simple description of how a lemon battery works.]

2. <http://hilaroad.com/camp/projects/lemon/lemon_battery.html > 'Lemon Battery' Step-by-step instructions on how to construct a lemon battery. Webpage also includes links to other battery-related experiments.

3. <http://www.youtube.com/watch?v=CJK2kwF6Am4> A short youTube video, titled “Create a lemon battery” providing a thorough demonstration of how to make a lemon battery to light an LED and operate a calculator.