Lemon Battery: Using a Lemon to Create a Voltaic Cell

Project Overview:

Middle and high school teachers will earn 10 TEC points upon the completion of this activity. This activity focuses on making a voltaic cell using a lemon. This activity can be done with your class either before or after you complete the Voltaic Cell activity in this kit. With the exception of pennies, paper clips, and lemons, all of the materials needed to complete the activity are included in the box. There are components to the project.

- There is a reading component for the teacher to complete, along with a set of questions that covers the reading.
- There is a lab component for this activity. The lab will take one class period.
- There are follow-up reports that must be completed by the teacher and students.

Background Information:

The lemon battery acts as a voltaic cell. Oxidation and reduction reactions occur when the metals are placed in the lemon. Electrons are lost (oxidation) at the iron paper clip electrode. Electrons are gained (reduction) at the copper penny electrode. The electron flow, from iron to copper is channeled through the wire and voltmeter. This flow of electrons is electricity. The voltage created by this flow is less than one volt, but will be measurable on the voltmeter.

Instructions:

1. Contact your school district's staff development office for pre-approval before beginning the project.
2. Read pages 83-84 in *Chemistry Made Simple* up to "Balancing Redox Equations," and pages 90-93 up to "Dry Cells."
3. Prepare the materials for the Lemon Battery lab according to the lab preparation section in this packet.
4. Complete the lab by yourself by following the instructions in this packet.
5. Have your students complete the lab according to the instructions.
6. Have your students complete the Student Assessment Form after their lab reports have been handed in. These forms must be submitted. They will be used to evaluate the project, but will not be a contributing factor in earning recertification points.

7. Complete the Teacher Reading Assessment Form, and the Teacher Project Assessment Form.
8. Contact your school district's staff development office for instructions on where to send the forms. If you have any questions about the project, please email Rich McHenry at *mchenryr@mail.leon.leon.k12.fl.us*, or Dave Rodriguez at *rodriguezd@mail.raa.leon.k12.fl.us*

Materials Needed:

Each group of four students will need the following materials. Lemons, pennies and paper clips are not provided.

Voltmeter
Lemon
Penny
Paper clip
Small strip of zinc
Aluminum nail
Two wires with alligator clips on each end

Lab Instructions:

1. Have the students roll the lemons on a flat surface while applying pressure. This is important to soften the inside of the lemon for better results.
2. Push the penny and the paper clip into the lemon. Be sure each is inserted into the fruit of the lemon below the skin. The penny and paper clip should be on the same side of the lemon. This will make handling the wires and clips much easier.
3. Connect the red wire from the voltmeter to the penny. Connect the black wire from the voltmeter to the paper clip. Set the voltmeter to the 20V setting within the DCV portion of the voltmeter face.
4. Observe and record voltage reading.
5. Substitute a piece of zinc for the paper clip and repeat step four.
6. Substitute a piece of pure copper for the penny and repeat step four.
7. Substitute an aluminum nail for the paper clip and repeat step four.

* You may want to test the effect of different materials in place of the penny and paper clip as an extension.

Lemon Battery: Using A Lemon To Create A Voltaic Cell
Student Assessment Form

1. How did this activity increase your knowledge of the relationship between chemical reactions and electricity?

2. Describe what happens in the lemon to generate electricity.

3. Draw and label the main features of the lemon battery.

4. Describe one way you can apply this knowledge to a real-life situation.

Lemon Battery: Using A Lemon Battery To Create A Voltaic Cell
Teacher Reading Assessment Form

1. Why does a redox reaction occur?

2. How does the law of conservation of mass apply to redox reactions?

3. Explain what happens if an iron nail is put into a solution of copper sulfate. What would you be able to observe?

4. Make a drawing of a voltaic cell using aluminum and silver as the two metal electrodes (anode and cathode). Show the direction of the electron flow and calculate the total emf of the cell.

Lemon Battery: Using A Lemon To Create A Voltaic Cell
Teacher Project Assessment Form

1. Describe the learning process for your students in this activity.

2. How did your students react when they saw the lemon producing electricity?

3. What areas of student performance are at or above expectations?

4. Does this activity represent improvements in students work as a result of the work done and knowledge gained from this experiment?

5. How did various sub-populations of students perform? Consider factors such as gender, race, socio-economic status, etc.

6. How will your students transfer this knowledge to their everyday lives?

7. How does this activity align with your IPDP?

8. If your school improvement plan has addressed science, how will this training module be an integral part of the process?

9. Were the instructions in this activity complete and easy to understand? If they were not, please make suggestions as to how they can be improved.

Lemon Battery
Sunshine State Standards

Middle School:

- The student understands that all matter has observable, measurable properties. (SC.A.1.3)
- The student recognizes that energy may be changed in form with varying efficiency. (SC.B.1.3)
- The student understands the interaction of matter and energy. (SC.B.2.3)
- The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.3)
- The student understands that science, technology, and society are interwoven and interdependent. (SC.H.3.3)

High School:

- The student understands that all matter has observable, measurable properties. (SC.A.1.4)
- The student recognizes that energy may be changed in form with varying efficiency. (SC.B.1.4)
- The student understands the basic principles of atomic theory. (SC.A.2.4)
- The student understands the interaction of matter and energy. (SC.B.2.4)
- The student uses the scientific processes and habits of mind to solve problems. (SC.H.1.4)
- The student understands that most natural events occur in comprehensible, consistent patterns. (SC.H.2.4)
- The student understands that science, technology, and society are interwoven and interdependent. (SC.H.3.4)

Lemon Battery: Using a Lemon to Create a Voltaic Cell
National Education Science Standards

Middle School:

Content Standard A: Science as Inquiry
- As a result of activities in grades 5-8, all students should develop abilities necessary to do scientific inquiry.
- Understanding about scientific inquiry

Content Standard B: Physical Science
- As a result of activities in grades 5-8, all students should develop an understanding of properties and changes of properties in matter.
- Transfer of energy

Content Standard E: Science and Technology
- As a result of activities in grades 5-8, all students should develop abilities of technological design.
- Understanding about science and technology

Content Standard F: Science in Personal and Social Perspectives
- As a result of activities in grades 5-8, all students should develop understanding of personal health.
- Science and technology in society

Content Standard G: History and Nature of Science
- As a result of activities in grades 5-8, all students should develop understanding of science as a human endeavor.
- Nature of science
- History of science

High School:

Content Standard A: Science as Inquiry
- As a result of activities in grades 9-12, all students should develop abilities to do scientific inquiry.
- Understandings about scientific inquiry

Content Standard B: Physical Science
- As a result of activities in grades 9-12, all students should develop an understanding of structure and properties of matter.
- Chemical reactions
- Conservation of energy and the increase in disorder

Content Standard E: Science and Technology

- As a result of activities in grades 9-12, all students should develop abilities of technological design.
- Understanding about science and technology

Content Standard F: Science in Personal and Social Perspectives

- As a result of activities in grades 9-12, all students should develop understanding of personal and community health.
- Science and technology in local, national, and global challenges

Content Standard G: History and Nature of Science

- As a result of activities in grades 9-12, all students should develop understanding of science as a human endeavor.
- Nature of scientific knowledge
- Historical perspectives