Electrical Conductivity of Solutions

Project Overview:

Middle and high school teachers will earn 10 recertification points upon the completion of this activity. The project focuses on the electrical conductivity of various solutions. All of the materials you need to complete the activity are included in the kit, except for salt, sugar and distilled water. There are three 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 that will take one class period to complete.
- There are follow-up reports that must be completed by the teacher and students.

Instructions:

1. Contact your school district's staff development office for pre-approval before beginning the project.
2. Read pages 68-72, up to "Sample Ionic Reactions" in *Chemistry Made Simple.*
3. Prepare the materials for the Electrical Conductivity Of Solutions lab according to the lab preparation section in this packet.
4. Complete the lab 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*

Background Information:

Electrolytes are compounds that conduct electricity in water-based solutions. Ionic compounds are electrolytes in which the electrolytes form positively and negatively charged ions in solution. Electrolytes are divided into three substances: Acids, Bases, and Salts. Not all electrolytes conduct electricity to the same degree. Nonelectrolytes

are compounds that do not conduct electric currents in water based solutions. Most molecular (covalent) compounds are nonelectrolytes. They are non electrolytes because they are nonionic, which means there are no positively and negatively charged ions in solution to conduct the electrical charges. A circuit can be created to test the conductivity of various solutions. In this activity, you will use a simple circuit with a battery and a voltmeter to compare the conductivity of several solutions. The different settings on the voltmeter will give you different numbers of significant figures.

Materials:

Voltmeter
Battery
Battery holder
Wire with clips
Beaker
Iron rods
Sugar
Salt
Tap water
Distilled water
Soft drink
Spoon

Lab Preparation:

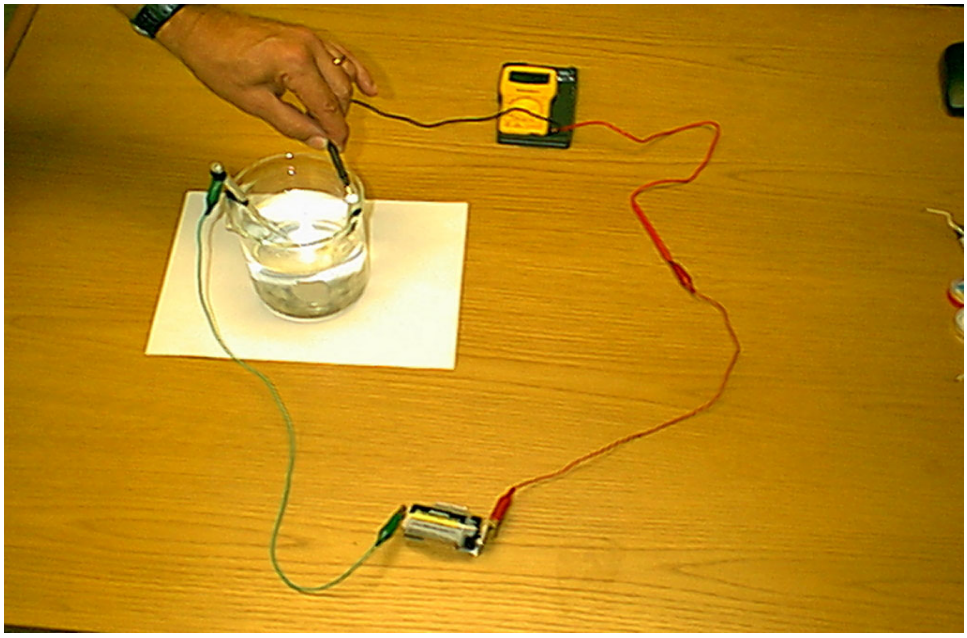
1. Place the following items at each lab station:
    - Voltmeter: Set these at the 20V or 2V setting within the DCV section of the voltmeter face.
    - Batter and battery holder
    - Wires and clips
    - Iron rods
    - Beaker
    - Spoon
    - Consumable materials: You can either set up the other materials needed (sugar, salt, distilled water, tap water, etc.) at each station, or have one of the group members responsible for measuring and collecting these supplies from a central location in the room.

Lab Instructions:

1. Fill the plastic beaker half way with distilled water.

2. Place two metal rods into the water. It is important that they do not touch each other. You may need to tape them to the sides of the beaker to keep them from touching. Any kind of tape will do.
3. Connect the battery, wires, and voltmeter as shown in the photo in the instructions. *The positive terminal of the battery must connect to the red probe of the voltmeter.*
4. Touch the black voltmeter probe to the top of the metal rod as shown in the photo.
5. Observe and record the voltage from the voltmeter.
6. Now add one spoonful of salt to the beaker and stir.
7. Repeat steps 4 and 5.
8. Empty and rinse the beaker.
9. Repeat steps 1-8 but use sugar instead of salt.
10. Have students test the conductivity of tap water

    Note: You can test a number of different substances. Students may want to compare soft drinks, milk, etc.



Electrical Conductivity Of Solutions
Student Assessment Form

1. How did this activity increase your knowledge of ionic and covalent bonding and the conduction of electricity?

2. Describe on way you can apply this knowledge to a real-life situation.

3. Explain why distilled water and tap water do not conduct electricity to the same degree.

4. Explain why there are differences in the conductivity for sugar water and salt water.

Electrical Conductivity Of Solutions
Teacher Reading Assessment Form

1. What is an electrolyte?

2. Describe two major differences between the properties of electrolytes and nonelectrolytes.

3. Why are most covalent compounds nonelectrolytes?

4. Why does tap water conduct electricity while distilled water does not?

5. Complete the following equations which show the dissociation of electrolytes into their ions:

   HCl =

   NaCl =

   $CaCl_2$ =

Electrical Conductivity Of Solutions
Teacher Project Assessment Form

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

2. How did your students react when they realized that pure water (distilled) and tap water do not conduct electricity the same?

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

Electrical Conductivity of Solutions
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 most natural events occur in comprehensible, consistent patterns. (SC.H.2.3)
- 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 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)

Electrical Conductivity of Solutions
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.
- Understandings 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 of atoms.
- Structure and properties of matter
- Interactions of energy and matter

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