Molarity: Making Solutions For Use In Voltaic Cells

Project Overview:

Middle and high school science teachers will earn 10 recertification points upon the completion of this activity. All of the materials needed to complete the activity are included in the box. The project focuses on making solutions with various molarities. There are three components to this activity.

- 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:

Moles and molarity are two scientific terms that often confuse science teachers. The two terms are actually quite easy to understand. The mole is a counting unit just like a dozen. Where a dozen indicates 12, a mole indicates 6.02×10^{23}. We use this large number to count very small things like atoms, ions, molecules, etc. A nice fact that doesn't occur by chance is that a mole of atoms of any element has a mass equal to its atomic mass in grams. If you weigh out one mole of particles (molecules, formula units, atoms) and add enough water to make one liter of solution, the solution will have a molarity of one. To make a .1 molar (M) solution you will weigh out .1moles of particles and add enough water to make 1 liter of solution. If you want to make a smaller amount of solution you will use a proportionally smaller amount of salt. For example to make a 1 molar solution you could weigh out .1 moles of salt and add enough water to make .1 liters (100 ml) of solution. Many crystals have water molecules locked in the structure. The cupric sulfate crystal has 5 water molecules in it so it is called a pentahydrate. The proper name for these crystals is cupric sulfate pentahydrate.

Another way to make a particular molarity of solution is to dilute an existing solution. When making a dilution the following formula is useful.
$\text{Molarity}_1 \times \text{Volume}_1 = \text{Molarity}_2 \times \text{Volume}_2$

Instructions:

1. Contact your school district's staff development office for pre-approval before beginning the project.
2. Read Chapter 4 page 29 Formula or Molecular weight and answer question 10 on page 30. Most chemistry books describe a mole of a substance as the gram atomic mass (the mass of an atom or a molecule or an ion which is gotten from the periodic table) measured in grams.

3. Read Chapter 8 pages 58-60. Make sure that you understand molarity. The other measurements of concentration are needed in order to understand other chemistry concepts. Answer questions 1 & 6 on page 61.
4. Prepare the solutions according to the lab instructions included in this packet.
5. Have your students complete the lab according to the instructions.
6. Have your students complete the Student Assessment Forms. These forms should be distributed after the students have turned in their lab reports. These forms must be submitted. They will be used for project evaluation but will not be a contributing factor in earning recertification points.
7. Complete the Teacher Reading Assignment 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:

Cupric sulfate
Zinc sulfate
Balance
Graduated cylinder
6 one-liter bottles
24 vials

Lab Preparation:

Prepare a 1M solution by stirring 250.7 grams of Cupric Sulfate pentahydrate into 1 liter of water. One-liter beverage bottles work well for this. Put the measured amount of cupric sulfate into the bottle and add water to almost the top. Leave a little room so that you can speed up dissolving by capping and then shaking the bottle. If you use a .5-liter bottle mass out ½ the amount of cupric sulfate. Take .5 liters of this solution and dilute it to 1liter to make a .5M solution. In another bottle measure .1 liters and dilute it to 1 liter to make a .1liter solution. Compare the colors of the 3 samples.

To prepare 1 liter of 1M Zinc Sulfate solution, stir 287.6 g of Zinc Sulfate Heptahydrate into 1 liter of water. Follow the same procedure you used to make Cupric Sulfate solutions to make Zinc Sulfate solutions. Zinc Sulfate is a clear solution, so you will not be able to compare the solutions by color like you did with the Cupric Sulfate. **Save these solutions for the other activities in this kit.**

Lab Instructions:

It will take a lot of Cupric Sulfate and Zinc sulfate to have the students make 1 liter of 1 M solutions. An alternative would be to have students take a sample of each of your 3 cupric sulfate solutions in a vial and compare their color. Another alternative would be to

have students make more diluted solutions of smaller volumes. A third alternative would be having students using your original 1M cupric sulfate solution to make dilutions and then compare the colors.

Safety Precautions:

Cupric Sulfate and Zinc Sulfate are toxic. Safety glasses should be worn. Material Safety Data Sheets (MSDS) for each chemical are provided.

Disposal Of Solutions:

Cupric Sulfate and Zinc Sulfate may be disposed of with copious amounts of water added and then poured down a drain with more water.

Molarity: Student Assessment Form

1. How did this lab increase your knowledge of solutions and molarity?

2. Describe how a scientist could apply this knowledge to his or her work.

3. Describe how you can apply this knowledge to your everyday life.

4. Identify the technical terms that are used in making solutions and identify them in your solution.

5. Describe how a solution with a particular molarity is made.

6. Explain how you would make a .1 molar solution if you had a 1.0 molar solution to start with.

Molarity: Teacher Reading Assessment Form

1. How do you calculate the formula weight of a compound?

2. What is the relationship between a mole of a compound and its formula weight?

3. Explain how you would calculate the formula weight of water (H_2O).

4. Explain how you would make 50ml of a .25 molar solution of Cupric Sulfate using a balance and a 50ml volumetric flask.

5. Explain how you would make a .1 molar solution from a 1.0 molar solution.

Molarity: Teacher Project Assessment Form

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

2. What explanation did your students give for the difference in color of the solutions?

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

4. How did this activity improve student's knowledge of the molarity concept?

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

6. How will students be able to transfer the knowledge gained from doing this activity to their everyday life experience.

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 not, please make suggestions as to how they can be improved.

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Sunshine State Standards

Middle School:

- The student understands that all matter has observable, measurable properties. (SC.A.1.3)
- The student understands the basic principles of atomic theory. (SC.A.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 understands the basic principles of atomic theory. (SC.A.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

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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

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

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.
- Understanding 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
- 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