UOP: Molecules in a Solution

State Math Standards Addressed:

- *8.4. Additional Key Content (Numbers, Operations)*
- *8.4.A Represent numbers in scientific notation, and translate numbers written in scientific notation into standard form.*
- *8.4.B Solve problems involving operations with numbers in scientific notation and verify solutions.*
- *8.4.C Evaluate numerical expressions involving nonnegative integer exponents using the laws of exponents and the order of operations.*
- *G.6.E Use measurements with degrees of precision in measurement, explain the reasons for using a certain degree of precision, and apply estimation strategies to obtain reasonable measurements with appropriate precision for a given purpose.*
- *G.7 Core processes: Reasoning, Problem Solving, and Communication*
- *G.7.A Analyze a problem situation and represent it mathematically.*
- *G.7.B Select and apply strategies to solve problems.*

Goal: Find the number of molecules in a solution of Alum and Water.

Step 1: Estimate the number of molecules in 50grams of solution containing 6 grams of Alum ($KAl(SO4)_2$ and 30 ml of water (12(H2O)). Turn your answers into the teacher before doing step 2.

Step 2: Organize your data in a spreadsheet. Remember to label each of the units. Example: Chemical formula of the solution ($KAl(SO_4)_2 \bullet 12H_2O$), name of each element, atomic mass of one atom of the element (remember one atomic unit is equal to one gram), number of atoms in the solution formula, total mass of all the elements which equals one mole of solution in grams. LABEL ALL UNITS.

Step 3: Write a detailed paragraph explaining how you'd solve the problem. Use Microsoft Word to type it.

> **Sample: In order to complete this lab activity, you will need to find the molecular mass – a mole of your water and a mole of Alum. To find the mole of the solution you will use Avogadro's number and the molecular mass of each**

element in the molecule of solution. You will need to use the periodic table to find the mass of the atoms of each element and then multiply by the number of atoms in the solution. Once you know the mass of a mole of solution you divide it into the mass of your total solution - you have been given 50 grams. Look up Avogadro's number on your constants chart and multiply Avogadro's number times your number of moles of solution. You now know the number of molecules of solution in your sample! HINT: Remember to write your paragraph using your own words to explain the process. Use the vocabulary words for this unit but explain them so the YOU can understand them.

Step 3: Carry out the activity. Directions are found on the next page.

Step 4: Describe the final results of your project. What does it look like? Does it glow in the dark? What color is it? Is it fragile? Did you wrap it in tissue paper to take home? Did you need a box to protect it in your backpack? What are you going to do with your project?

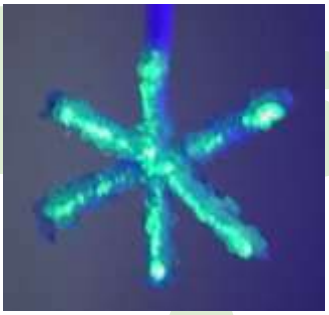
Step 5: Answer the following in your final write-up and label it Evaluation:

What would have made finding the number of molecules easier for you? Would you like to complete projects like this in the future? What did you learn in this activity? What should you do differently? Did you have to use Scientific Notation in your answers? Why was it necessary or why not?

When revising your Microsoft Word write-up, make sure your description contains all of your steps, any necessary diagrams or pictures from the internet and appropriate labels. Show all your work and label your answers. Remember to add pictures of your supplies and/or diagrams. The final write-ups will be displayed in the classroom.

Glow-in-the-Dark Crystal Snowflake

By Anne Marie Helmenstine, Ph.D. Revised by Loretta Davidson M.S.



Let the paint dry before dipping your ornament in the solution or you could get non-glowing spots, as shown here.

Anne Helmenstine

Materials for a Glowing Ornament

- **alum**
- water at 50^0C
- glow-in-the-dark paint
- pipe cleaners
- scissors or wire cutters (optional)
- popsicle sticks
- coffee filters
- glass or jar big enough for your ornament
- measuring cup or larger glass for making the solution
- paintbrush or cotton swab (optional)

Make a Glowing Ornament Day 1:

1. Shape your ornament. To make a snowflake, cut a pipe cleaner into thirds (doesn't have to be exact). Line up the pieces and twist them in the center. Bend the arms out to make the snowflake shape. Trim the arms to make them even, except the longest arm, which you can bend over a popsicle stick to suspend the ornament in the crystal-growing solution. You can make other shapes, of course, like trees, stars, bells, etc.
2. Coat the pipe cleaner shape with the glowing paint. You can use a paintbrush or a swab or your fingers. It's all good. Let your ornament dry over night. This sets up the paint to ensure good coverage.

Make a Glowing Ornament Day 2:

3. Prepare your solution. Pour hot water into your graduated cylinder to fill it to 30ml. Dump this hot water into a larger glass or cup (where you will prepare the actual solution).
4. Stir in 6.0 g of alum until the solid stops dissolving. The reason you are using separate containers for making the solution and growing the crystals is because you want a saturated solution for quick crystal growth, but no solids, which would compete with your ornament for crystal growth.

5. Pour the clear solution into your crystal-growing jar. Rinse out your other container so no one accidentally drinks crystal solution.
6. If your pipe cleaner has a long arm, attach the ornament directly to a popsicle stick (otherwise you will have to tie the ornament or use a second pipe cleaner, twisted onto the ornament and the popsicle stick). Rest the popsicle stick on top of the jar, being sure the ornament is completely immersed in solution and not touching the sides or bottom of the container. Cover the jar with a coffee filter to prevent dust from contaminating the solution.
7. Allow crystals to grow 1 to 2 hours or overnight (until you like the way they look).
8. Remove the ornament from the solution and allow it to dry. You can hang it over an empty glass or set it on a paper towel. Do not eat the ornament crystals as alum is used to pickle cucumbers and make them crisp. It is very bitter.
9. You can store the ornaments wrapped in tissue paper.

Tips and Safety

- I pretty much covered the safety. Don't drink crystal-growing solution; don't eat the ornaments, etc. If you used alum (found in food), the ornaments are very safe to handle. Even though the glowing paint is non-toxic, ornaments aren't food.
- If you used borax or epsom salts, rinse the dishes before putting them in the dishwasher. It's safe to wash any of these materials down the drain.
- You can vary the size of the crystals by using a less saturated solution (like 2 grams of alum per 30 ml of 50^{o}C water) and by controlling the cooling rate of the solution. If you are up for some experimentation, try refrigerating your warm solution and see what happens. What do you get if you keep the solution warm? What happens if you cool the solution quickly? Are you up for trying an experiment?

Evaluation Questions:

Does the number of molecules in your solution make sense? Could you have guessed the number of molecules without calculating the number? Do you have any suggestions to improve the activity? Would it help you understand scientific notation better? Justify all of your answers in your project write-up.

UOP

Molecules in a Solution Activity

Name: _____ Teacher: Mrs. Davidson_____

Date : _____ Title of Work: _____

	Criteria				Points
	1	2	3	4	
Paragraph Explanation	Misses key points. Grammar rules not followed	Explanation is unclear. Grammar rules followed somewhat.	Good solid response with clear explanation. Very few grammar errors.	A complete response with a detailed explanation. No grammar errors.	____
Appropriate Presentation of data. Use of Microsoft Excel.	No chart. Work not organized. Wrong measurements.	Inappropriate or unclear chart.	Clear diagrams.	Clear diagram with measurements correctly written.	____
Mechanics and labels	Major math errors or serious flaws in reasoning.	May be some serious math errors of flaws in reasoning	No major math errors or serious flaws in reasoning.	No math errors.	____
Group behavior	Didn't contribute to group	Minimal help with group activity.	Helped with group activity but interrupted other classmates	Exceptional behavior and work.	____
Follow up activities	Way off on answer.	Off a little from actual answer. Labels not correct.	Close to true answer and can offer answer to why you are	Little difference between lab answer and true answer	____
				Total---->	____

Teacher Comments:

Rubric adapted from: Connie Gretschmann

Username: Loretta Davidson

UOP Title: Using Scientific Notation

Subjects: Applied Math 1, Applied Math 2, Science, and English/Language

Level: High School

- **Content Standards:**
- ***8.4. Additional Key Content*** *(Numbers, Operations)*
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Content Objectives:

1) Write large and small numbers in power-of-ten notation.
2) Read and write numbers in scientific notation.
3) Enter numbers written in scientific notation into a calculator and read answers in scientific notation displayed by a calculator.
4) Combine numbers written in scientific notation to solve problems.

Author: Loretta Davidson

Abstract: The students will learn how to write extremely large and extremely small numbers in scientific notation. They will understand why a much more simply written number in scientific notation is preferable to using a large unwieldy number. They will become competent in using calculators and excel spread sheets to find answers when using numbers in scientific notation. Students will understand the significance of using scientific notation on the job.

Anticipatory Set:

Most of the time people work with numbers between 0.1 and 100. Once in a while you work with numbers over 10,000. We may read about people who are worth billions of dollars but we seldom write them at home. However, many people do use *very large* and *very small* numbers everyday on the job. For example people who work in the space industry, banking or national defense. They use *very large* numbers. Doctors, nurses, and people who work for disease control work with cells and viruses. These numbers are *very small*.

Situations:

The students will be in both our computer lab and the classroom for this 14-day unit. The activity itself will probably take only 4 or 5 days, but I plan on using it in conjunction with the unit I teach on Scientific Notation. Each day is based on a 50-minute class period.

Tasks:

The students will watch a video introducing scientific notation.

The students will complete study guides, scientific notation worksheets, and a unit test.

The students will work individually on assigned story problems with class discussion to follow on the more difficult problems.

The students will learn how to convert from standard notation to scientific notation through interactive web sites.

The students will work in groups of 2 or 3 to complete a given lab activity.

The students will use word processing to write a paragraph explaining how to solve the number of molecules in a solution problem, carry out the activity of organizing their data using a spreadsheet, and answer questions about the lab.

Interactions:

Students will work on some projects individually.

The lab activities will be completed in groups of 2 or 3.

Questions over assigned problems will be answered as a class.

The teacher will act as a facilitator making sure students can read the scales and graduated cylinders and supervise their lab activities.

Assessment:

Lab Activities: Participation and behavior in group

How precise their answer is to number of molecules and crystal growing problem.

Measuring correctly and showing their work solving problems.

Labeling their answers correctly as part of their solutions to problems.

Teacher Graded Activities: Study guides, assigned problems, worksheets, laboratory write-ups and unit test.

Tools:

1) Microsoft PowerPoint presentations, video introducing unit, Microsoft Excel to record, and organize, data, Microsoft Word to type explanation paragraph.

2) Other tools: Cord Mathematics textbook & resource materials, mass scales, graduated cylinders, scientific calculators, empty jars, pipe cleaners, fishing line, popsicle sticks, tempera paint, and heat sources.

Project:

Completion of the following activities: (Based on 50 minute class periods)

Day 1: Watch video and start study guides.

Day 2: Complete studies guides and answer any questions.

Day 3: Discuss scientific notation. Give handout with constants listed. Complete practice worksheet.

Day 4: View PowerPoint presentation on converting standard to scientific notation. Assign textbook problems. (Problem set # 1)

Day 5: Complete a computer internet activity.

Day 6: Group discussion over problem set #1. Assign problem set # 2.

Day 7: Microsoft PowerPoint tutorial on the multiplication of numbers in scientific notation. Complete activities in groups of 2.

Day 8: Introduce crystal lab. Work with partner to write out detailed process. Hand in estimate.

Day 9: Complete activity. Use Microsoft Excel to record and organize data.

Day 10: Turn in excel data.

Days 11 and 12. Word process you write up including pictures, diagrams, labeling of units to explain your process and results. Turn in with this packet for grading.

Day 13: Discuss problem set # 2. Explain division using numbers in scientific notation. Assign problem # 3.

Day 14: Complete skill drill worksheet. Work on problem set # 3.

Day 15: Discuss problem set #3. Review for test.

Day 16: Unit test.

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