

IPC: Science Course Module—Goes to the Movies! University of Houston

Growing Crystals

Type of Lesson:	<u>Content with Process:</u> Focus on constructing knowledge through active learning.	
IPC Content TEKS:	9A 9D 9E	<ol style="list-style-type: none"> 1. Relate the structure of water to its function as the universal solvent. 2. Demonstrate how various factors influence solubility including temperature, pressure and the nature of the solute and solvent. 3. Demonstrate how factors such as particle size influence the rate of dissolving.
Learning Goal/ Instructional Objective:	<p>General Objective Students investigate solution chemistry and learn that the rate of dissolving and amount of a solute dissolved by a solvent depends on the nature of each, the temperature and particle size. They gain this knowledge by growing crystals that are of high personal interest.</p> <p>Instructional Objectives</p> <p>While participating in a crystal growing project students:</p> <ol style="list-style-type: none"> 1. Explain the function of a solute and solvent in forming a solution. 2. Point out that for many solute/solvent combinations, as the temperature increases, the solubility of solute increases, as does the dissolving rate. Also, to identify the solubility of rate of a solute/solvent from a line graph. 3. Discuss that as the surface area of solutes increases and the particle size exposed to the solvent decreases, the dissolving rate increases. 4. Observe and describe that different solutes, such as potassium aluminum sulfate and copper sulfate have different solubilities. 5. Construct and interpret graphs showing how the change in mass and size of crystals result over time. 6. From daily observations of crystal growth, describe how as a crystal solution cools, the solvent drops extra solute to form crystals. Also, as the solvent evaporates how this contributes to the formation of crystals. 7. Identify solutions that are unsaturated, saturated, and supersaturated. 8. Grow large, well-formed crystals. 	
Key Question:	Why do crystals grow? What factors affect the growth of the crystal?	
Related Process TEKS:	<p>(1) Scientific processes. The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices</p>	<p>The student is expected to:</p> <p>(A) demonstrate safe practices during field and laboratory investigations; and</p> <p>(B) make wise choices in the use and conservation of resources and the disposal or recycling of materials.</p>
	(2) Scientific	The student is expected to:



	<p>processes. The student uses scientific methods during field and laboratory investigations.</p>	<p>(A) plan and implement experimental procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology;</p> <p>(B) collect data and make measurements with precision;</p> <p>(C) organize, analyze, evaluate, make inferences, and predict trends from data; and</p> <p>(D) communicate valid conclusions.</p>
	<p>(3) Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.</p>	<p>The student is expected to:</p> <p>(A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;</p> <p>(B) draw inferences based on data related to promotional materials for products and services;</p> <p>(C) evaluate the impact of research on scientific thought, society, and the environment;</p> <p>(D) describe connections between physics and chemistry and future careers; and</p> <p>(E) Research and describe the history of physics, chemistry, and contributions of scientists.</p>
<p>To the Teacher:</p>	<ul style="list-style-type: none"> • Potassium Aluminum Sulfate can be found in pharmacies and in chemical catalogs for a reasonable price. Its nickname is Alum. • Copper Sulfate can be found in hardware stores and chemical catalogs. Its nickname is Blue Stone. In large amounts it can be poisonous, but it tastes so bad (like chewing on a tin can) that students are very careful. Do not use a metal nail file to file down bumps on this crystal. It will cause a yellow residue and cause the crystal to discolor. • Students must wash their hands completely after touching their crystals. Wearing goggles and aprons during the heating of the solutions is required. • This project should be done in teams due to the cost of supplies and the amount of work that must be done in a short amount of time on Day 1. • Students should not ignore deformities in their crystal shapes. Holes will fill in over time but bumps on the crystal shape will get larger over time. • Coffee cans work well for holding the water bath water, but any waterproof container with a flat bottom will work. Make sure that the beaker of solution does not float in the water bath. If the beaker falls over, the crystal will dissolve. • On Day 2, some students will find that their crystals have grown nicely. Some teams will find an empty loop. This is usually caused by a solution temperature above 40 degrees at the time that the crystal was added, water bath at a higher temperature than 40 degrees, too much water added to the solution or too little chemical. Sometimes, the students have tied the seed crystal too loosely and it fell to the bottom of the beaker. • If there is solute on the bottom of the solution, the saturated solution is safe to hang another seed crystal. Notching the crystal to give the string a place to settle will often prevent the crystal from slipping out. This new crystal will grow slowly by evaporation and has missed the cooling part of crystal growing until next time the solution is changed. Hang the crystal low in the solution. If there is no solute on the bottom of the beaker, this unsaturated solution is unsafe for a seed crystal. If the teacher has extra solution from the demonstration day, some can be added to an empty beaker. If not, students may need to come on their own time to repeat the experiment. • After the first day, the water bath can be spilled out unless the room where it is stored gets very hot. The water bath will keep the solution at a constant temperature and prevent the 	



	<p>dissolving of the crystal by heated water molecules.</p> <ul style="list-style-type: none"> Teacher can show students atomic structures of different mineral crystals. At the end of the crystal growing, a "beauty contest" can occur. Students can vote for "Most Beautiful", "Best Shape", "Most Sympathetic" crystal awards. Prizes (such as rock candy) and certificates can be given out. If there is a yellow residue on the crystal, wash it off. This is due to a reaction to metal such as metal stirring rod or metallic ions in the water. If the solution is contaminated, pour it out and clean the beaker completely. Change the solution at least once during this project. Five days between new solutions is best. Students should give the teacher the seed crystals so they can be used next year. The last recommendation is for the teacher to try this project ahead of time. In this way, sample crystals will be available for students to see and there will be a supply of seed crystals for students to use. Good Copper sulfate crystals look like parallelograms and good Alum crystals look like flat diamonds. The teacher can also anticipate problems so that all students will be prepared to complete this project successfully. 	
Multiple Intelligences:	<i>Logical-Mathematical Intelligence</i>	Consists of the ability to detect patterns, reason deductively and think logically. This intelligence is most often associated with scientific and mathematical thinking.
	<i>Linguistic Intelligence</i>	Involves having a mastery of language. This intelligence includes the ability to effectively manipulate language to express oneself rhetorically or poetically. It also allows one to use language as a means to remember information.
	<i>Interpersonal Intelligence</i>	Includes interpersonal feelings and intentions of others.
	<i>Intrapersonal Intelligence</i>	Intrapersonal intelligence--the ability to understand one's own feelings and motivations.

Materials:

- two beakers,
- paper to hold the chemical, balance
- two burners or one hot plate
- thermometer
- water
- chemical for the crystal
- thread
- splint (or popsicle stick)
- sandpaper (or emery board)
- empty metal coffee can
- graduated cylinder
- goggles
- apron
- wooden stirring stick for solution



SAFETY NOTE:

Be careful using chemicals. Make sure students wash hands thoroughly. Students must wear safety goggles and aprons. Students must not taste chemicals or rub their eyes with their unwashed hands. See Texas Science Safety Manual for lab and investigation guidelines:

http://www.tenet.edu/teks/science/safety/safety_manual.html

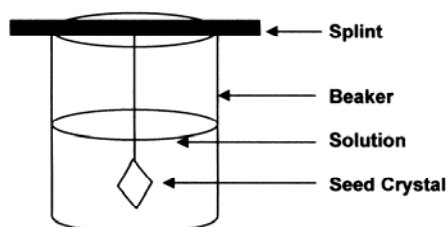
Engagement: Show students pictures of mineral crystals or bring in real samples. Another motivation could be showing students large examples of the crystals being grown



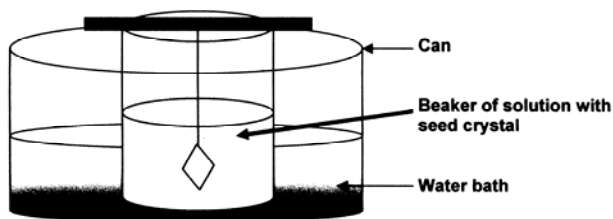
Explore:

Procedure: Split up the following jobs:

1. Mass out your chemical. Remember to find the mass of your paper to hold the chemical. The amount of chemical needed is: 50 grams of Copper Sulfate OR 22 grams of Potassium Aluminum Sulfate.
2. Measure out 100 ml of water with the graduated cylinder and pour it into a beaker.
3. Add the chemical to the water and heat the mixture until it reaches 50 degrees Celsius. Stir with a non-metal stick as the mixture is being heated.
4. Make sure that the seed crystal is tied securely on a piece of thread using a slip-knot. Attach the other end to the wooden splint. Find the mass of the seed crystal and measure its length. Begin to write about the crystal and what you did today in your journal. This should be at least 2 sentences.
5. Prepare a warm water bath by heating water in the second beaker to 40 degrees Celsius. Use about 150 ml of water for the water bath.
6. When the chemical and water in step 3 have been heated to 50 degrees Celsius, take the beaker off of the heat and let the solution cool on your lab table until it reaches 40 degrees Celsius. Only then, put your crystal into the beaker as shown below:



7. Pour the water for your water bath into the coffee can. Check to make sure that its temperature is 40 degrees Celsius or less. **MAKE SURE THAT YOUR WATER BATH IS COOLER THAN YOUR SOLUTION.**
8. Put your crystal with its beaker of solution carefully into your water bath as shown below:



9. On Day 2, remove the crystal from the beaker and dry it off. If there are bumps on it, file them off with your emery board (or sandpaper). Remember that the bumps will get larger but holes will fill in over time. Measure the mass and length of your crystal. Give your crystal a name.
10. Record in your journal and write two or more sentences about what happened today. Spill out the water bath water and put the crystal back into the solution until the next day it is checked.
11. Every day (or when your teacher directs), check your crystal. Measure its length and find its mass. Write at least two sentences about your observations in your journal. Keep a chart of the date, size and mass of your crystal. Sketch the shape and size of the crystal.
12. When it is time to change the solution (about 5 days), pour out the solution and donate the seed crystals on the bottom of your beaker for future crystal growers. Do steps 1-3 and 5-8 again.

Explain:

1. Draw a graph showing how the mass of the crystal has changed during time
2. Draw a second graph showing how the size has changed during time.
3. Make sure that your data table is complete.
4. Your journal must have the diary entries for each day and sketches of your crystal.
5. You must discuss the following questions at the end of your journal entries:
 - A. What problems did you have during the project? How did you solve them?
 - B. Why was the water bath in the coffee can needed only on the day the solution was heated? *The water bath slowly cooled down the solution so that the solute had time to arrange onto the seed crystals. The slower a crystal grows, the better its shape. If the water bath had not been used, the seed crystal would have grown too quickly and the shape would have been poor. After it cooled to room temperature, the crystal was growing by the evaporation of the solute.*
 - C. How did the solubility of your chemical change as the water was heated and then cooled? *As the solvent was heated, its solubility increased as more solute was dissolved by the solvent. When the solvent was cooled, its solubility decreased and solute starts to fall out of the solution.*
 - D. Under which conditions could your crystal become smaller while in the beaker of solution? Explain why each would happen and how you could "fix" each problem. *My crystal can become smaller if I put it into a solution that is too hot and the solvent dissolves the solute (crystal) because the solution is unsaturated. It can also dissolve if there is too much solvent and the solution is unsaturated. In both cases, adding additional solute until the solution becomes saturated will keep more of the crystal from dissolving.*
 - E. Do all chemicals have crystals of the same shape? Suggest reasons to explain why. *Not all crystals have the same shape. In this project, the Alum crystals look like diamonds while the Copper sulfate crystals look like parallelograms with slanted sides. The molecules must fit differently in each solute crystal. It must depend on the atoms of the different elements that make up each solute compound and the bonding involved.*
 - F. How would you improve what you have done in this project to produce a better crystal?
6. Write a conclusion by writing your final answer to the problem using what you have observed in this project.

Elaborate:

Investigate different minerals and their crystal shapes and colors.
 Research different crystal shapes and find examples of minerals with those shapes.
 Visit a local museum that features minerals.
 Investigate other crystal growing chemicals besides Copper II sulfate and Aluminum Potassium sulfate.
 Create solubility graphs by using other chemicals besides KNO_3 .
 Conduct the Magic Garden Elaboration Activity found in this unit's materials.
 Use solubility graph question sheet to practice reading and interpreting graphs.

Evaluate:

Explain how your students demonstrate their new understandings and skills. What is the learning product for this lesson? Is the experimental conclusion, a picture, a Power Point presentation, a story, a solved problem? Be explicit here. And then prepare a rubric to evaluate student learning. Be extra sure that your assessment measures exactly what the target TEKS says it should measure.

Grading Rubric:

1. There was a diary entry for each day that students checked their crystals. ____
2. Each day, student measured the mass and size of the crystal. _____
3. There were data tables and graphs. _____
4. Sketches of the crystal over time were included. _____
5. The analysis questions (Student lab instructions #13 E 1-6) were discussed fully. ____
6. A conclusion was written that showed that the student analyzed the factors that affect crystal growth and how crystals grow. _____



POINTS	Scientific Accuracy of data and graphs	Reasoning	Communication in written crystal diary	Collaboration during crystal growing	
4	All graphs and data tables are correctly set up	All questions on crystal growing are answered correctly using observations	Crystal diary was well organized with all requirements met. All questions answered clearly and completely	Team of students worked very well together and shared all responsibilities and input	
3	Graphs and data tables set up with some mistakes	Most questions on crystal growing are answered correctly using observations	Crystal diary was organized adequately with most requirements met. Most questions answered fully	Team of students worked well together and shared most responsibilities and input	
2	Graphs and data tables set up with many mistakes.	Some questions on crystal growing are answered correctly using observations	Crystal diary was slightly disorganized with some requirements met. Some questions answered	Team worked somewhat well together. Each person had some responsibilities and some input.	
1	Graphs and data tables not set up or set up incorrectly	Questions on crystal growing are unanswered or not based on valid observations	Crystal diary was disorganized with few requirements met. Very few questions answered and most is unclear and incomplete	Team did not work together. The team did not share responsibilities or value the input of team members	
	Subtotal: ____	Subtotal: ____	Subtotal: ____	Subtotal: ____	TOTAL: ____/16pts

References/Resources/Websites:

- http://www.chemistry.co.nz/crystals_defined.htm
- http://uk.geocities.com/magoos_universe/crystals.htm
- <http://www.sdnhm.org/kids/minerals/grow-crystal.html> (San Diego Natural History Museum)
- <http://webphysics.davidson.edu/alumni/MiLee/JLab/crystallography>
- http://www.phschool.com/science/science_news/chemistry/properties_matter.html

The following site contains teacher resource lessons:

<http://visualclutter.com/Links/Science>

The following sites contain information about growing crystals in unusual gravity conditions:

- http://science.nasa.gov/headlines/y2001/ast11dec_1.htm (crystals in outer space)
- <http://www.mos.org/cst/article/77/3.html> (growing crystals in near zero gravity)

The following sites contain information about many I.P.C. topics including chemistry and crystals:

- http://www.thinkquest.org/library/cat_show.html?cat_id=36
- <http://www.sciencenews.org> (This web site has advertisements.)
- http://www.phschool.com/science/science_news/chemistry/properties_matter.html

Properties of Matter:

The following sites contain information about chemistry especially matter and crystals:

- http://www.phschool.com/science/science_news/chemistry/properties_matter.html
- <http://www.chem4kids.com>
- <http://www.school-for-champions.com/science.htm>
- http://www.thinkquest.org/library/cat_show.html?cat_id=36
- <http://school.discovery.com/lessonplans/physci.html>

