



## Saturated Solutions!

<b>Type of Lesson:</b>	<u>Content with Process:</u> Focus on constructing knowledge through active learning.	
<b>IPC Content TEKS:</b>	8B 9D	Analyze energy changes. Demonstrate how various factors influence solubility including temperature, (pressure), and nature of the solute and solvent.
	9E	Demonstrate how factors (such as particle size) influence the rate of dissolving.
<b>Learning Goal/ Instructional Objectives:</b>	<p>In this investigation, students learn that unsaturated solutions have solvents that have not dissolved all of the solute possible at that temperature. They learn that solutions become saturated when the solvent has dissolved all of the solute possible at that temperature. Supersaturated solutions occur when the solvent cools and is still holding more solute than it normally holds at that temperature. Students will observe that supersaturated solutions can drop the extra solute with help (like shaking) and the solute drops until the solution becomes saturated.</p> <p><b>Instructional Objectives:</b></p> <ul style="list-style-type: none"> <li>• When observing solutions, students can distinguish between unsaturated, saturated and supersaturated solutions.</li> <li>• When observing solutions, students can determine the effect of the temperature on the rate of dissolving and solubility of solute.</li> <li>• When observing crystallization, students explain the temperature changes.</li> </ul>	
<b>Key Question:</b>	What are the differences between unsaturated, saturated and supersaturated solutions?	
<b>Related Process TEKS:</b>	<b>(1) Scientific processes.</b> The student, for at least 40% of instructional time, conducts field and laboratory investigations using safe, environmentally appropriate, and ethical practices	The student is expected to: (A) demonstrate safe practices during field and laboratory investigations; and (B) make wise choices in the use and conservation of <a href="#">resources</a> and the disposal or recycling of <a href="#">materials</a> .
	<b>(2) Scientific processes.</b> The student uses scientific methods during field and laboratory investigations.	The student is expected to: (A) plan and implement experimental procedures including asking questions, formulating testable hypotheses, and selecting equipment and technology; (B) collect data and make measurements with precision; (C) organize, analyze, evaluate, make inferences, and predict trends from data; and (D) communicate valid conclusions.
	<b>(3) Scientific processes.</b> The student uses critical thinking and scientific problem solving to make informed decisions.	The student is expected to: (A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information;

<p><b>To the Teacher:</b></p>	<ol style="list-style-type: none"> <li>1. The chemical Sodium thiosulfate (Hypo) can be purchased from chemical catalogs.</li> <li>2. Use a disposable container to collect the Hypo solution after the experiment is completed.</li> <li>3. If students are observant, they will notice that the test tube gets colder as the Hypo is dissolved in the water and after the Hypo falls out of the supersaturated solution, the test tube will get warmer.</li> <li>4. To see the supersaturated solution "snow", the solution should be clear when lifted out of the cold water beaker and as the crystals are dropped in, the test tube must be shaken sideways. Be careful that the solution does not splash out.</li> <li>5. The supersaturated solution will stop dropping Hypo crystals until it becomes saturated.</li> </ol> <p>6. Make sure that the students re-heat the test tubes to completely dissolve the chemical. If not, the test tubes are very difficult to clean out.</p>	
<p><b>Multiple Intelligences:</b></p>	<p><i>Logical-Mathematical Intelligence—</i></p>	<p>Consists of the ability to detect patterns, reason deductively and think logically. This intelligence is most often associated with scientific and mathematical thinking.</p>
	<p><i>Linguistic Intelligence—</i></p>	<p>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.</p>
	<p><i>Spatial Intelligence—</i></p>	<p>Gives one the ability to manipulate and create mental images in order to solve problems. This intelligence is not limited to visual domains--Gardner notes that spatial intelligence is also formed in blind children.</p>

**Materials:**

- 15 grams of Hypo (Sodium thiosulfate),
- test tube
- test tube rack
- 10 ml graduated cylinder
- beaker of water
- burner
- stirring rod
- test tube holder
- balance, funnel
- paper to hold chemical
- small spoon
- goggles
- apron



**SAFETY NOTE:** Remind students how to heat a test tube filled with chemical over a flame. Test tube must be pointed away from students and kept in constant aback and forth motion. Sodium thiosulfate (Hypo) is used in film developing and students should be careful to wash hands after using this chemical. Due to the solubility of this chemical (15 grams per 2 ml of water), do not let students pour the hot solution down the drain. It will clog the drain pipes as the solution cools and the sodium thiosulfate crystallizes. A large beaker in the front of the room should be used. To clean up, students should re-heat the test tube to dissolve the chemical and pour the hot solution into the large collection beaker. If the budget is tight, the chemical can be used over again if water is removed and Hypo is allowed to dry out. See Texas Science Safety Manual for lab and investigation guidelines: [http://www.tenet.edu/teks/science/safety/safety\\_manual.html](http://www.tenet.edu/teks/science/safety/safety_manual.html)

**Engagement:**

Since students are already growing crystals, this lab will answer many questions that they will have:

1. Why do some crystals dissolve when placed into hot solutions?
2. Does it matter what temperature the solution is heated to or how cool the solution should be before the crystal is hung in the beaker?
3. How can I grow the best crystal?
4. Show several crystals and explain that what students learn in this lab will help them become better crystal growers.



**Explore:**

1. Measure 2 ml of water and pour into a clean test tube.
2. Measure out 15 grams of Hypo for use in this lab.
3. Place a few crystals of Hypo into the test tube using the spoon and funnel.
4. Stir. When the crystals have completely dissolved, this is an unsaturated solution.
5. Continue to add hypo and stir. When no more can dissolve, the solution has become saturated. Touch the test tube and note any temperature changes.
6. Gently heat the solution, adding Hypo until all 15 grams has dissolved. Do not let the solution boil because this will remove some of the water in the solution.
7. Place the test tube carefully in a beaker of cold water and allow it to cool for at least two minutes. The test tube should be clear when you remove it from the cold water.
8. At this point the solution is supersaturated. Touch the bottom of the test tube and note the temperature.
9. Drop a few crystals of Hypo into the test tube and shake sideways. Record all observations and include any temperature changes.
10. Reheat the solution to re-dissolve the Hypo and pour it into a container as directed by your teacher.

**Facilitation Questions:**

1. What changes did you observe in this lab? Record in your journal.
2. What are the differences between saturated, unsaturated and supersaturated solutions?

**Explain:**

Answer the following questions in your journal.

1. What temperature changes did you observe in this experiment? Why did they happen? *The solution cooled down as I added the Hypo but became very warm when the Hypo dropped to the bottom of the test tube. Energy must be needed to dissolve the Hypo but was released when the Hypo crystallized.*
3. How did the heating of the water affect the solubility of the chemical Hypo? *As the water was heated, more and more Hypo dissolved because the heated water had more energy and dissolved the chemical quickly.*
3. Why was the solution called unsaturated at step 4? *The solvent (water) had not dissolved all of the solute (Hypo) that it could at that temperature. More Hypo could be added and would dissolve.*
4. Why was the solution called saturated at step 5? *At that point, the water had dissolved all of the Hypo that it could at that temperature.*
5. Why was the solution called supersaturated at step 8? *At that point, the water had cooled down and should have "dropped" some of the solute. The solute did not drop to the bottom of the test tube. Since the water is holding more solute than it should at that temperature, it is supersaturated.*
6. Why did the supersaturated solution begin to drop small crystals when the additional Hypo was added and the test tube was shaken? *I think that the additional solute bumped into the water molecules and the solvent could finally let go of the extra solute that would not let go until that point.*
7. At what point will the crystallization of the supersaturated solution stop? (When will it stop "snowing"?) *I think that it will stop snowing when the solution is saturated.*
8. In your own words, define the terms: Unsaturated, Saturated, Supersaturated and Solubility. *Unsaturated happens when a solvent has not dissolved all of the solute that it can at that temperature. Saturated happens when the solvent has dissolved all of the solute that it can at that temperature. Supersaturated happens when the solvent dissolves all of the solute that it can at a high temperature but cools down. The extra solute that should drop off at the cooler temperature does not crystallize. The solvent is holding more solute that it usually can hold at that temperature. Solubility **means how much solute dissolves in a certain amount of solvent at a certain temperature.***

**Conclusion:** *This lab showed the different types of solutions. At the beginning of the lab, the solution was unsaturated because the water could dissolve more chemical. At step 4 in the lab, the solution was saturated because the water had dissolved all of the chemical that it could at that temperature. I heated the water and more chemical dissolved. At step 8 in the lab, the solution was supersaturated because some of the chemical should have dropped out of the solution because the water cooled and lost the ability to keep the solute dissolved. At step 8 of the lab, the solution became saturated because the extra chemical dropped out of solution when it started to "snow." The Hypo dropped out until the water was holding all of the chemical that it should be holding at that temperature.*

**Elaborate:**

*Students can investigate the solubility of other chemicals and find out the amount of solute and solvent needed. Another important part is to find the temperatures that a student must heat and cool the solutions to grow that "perfect" crystal.*

**Evaluate:**

Use the following rubric to measure students' understanding of solutions and this investigation.

POINTS	Scientific Accuracy	Reasoning	Communication	Collaboration	
<b>4 Excellent</b>	Procedures were followed accurately and safely.	Types of solutions could be identified based on their properties in this lab. Lab questions were answered showing great understanding of the properties of solutions.	Observations were fully recorded in detail. Lab questions and conclusions were well thought out and showed a great understanding of solutions.	Team worked well together. Each member was involved in the activity and there was a detailed discussion of observations and conclusions.	
<b>3 Good</b>	Most procedures were followed accurately and safely.	Most types of solutions could be identified based on their properties in this lab. Most lab questions were answered showing much understanding of the properties of solutions.	Observations were recorded in detail. Lab questions were thought out and showed much understanding of solutions.	Team worked fairly well together. Most members were involved in the activity and there was discussion of observations and conclusions.	
<b>2 Fair</b>	Some procedures were followed accurately.	Some types of solutions could be identified correctly based on their properties. Some lab questions were answered showing some understanding of the properties of solutions.	Observations were recorded in some detail. Lab questions were answered but showed some understanding of solutions.	Some members of the team worked together but with little discussion of observations and conclusions.	
<b>1 Poor</b>	Lab procedures were not followed accurately.	Solutions were incorrectly identified in this experiment. Most lab questions were incorrectly answered showing little understanding of the properties of solutions.	Few observations were recorded but were without detail. Few lab questions were answered and showed little understanding of solutions.	The team did not work together. Members did not help each other and did not discuss the lab observations and conclusions.	
	Subtotal: ____	Subtotal: ____	Subtotal: ____	Subtotal: ____	<b>TOTAL:</b> ____/16pts

**References/Resources/Websites:**



**The following sites give information about solutions and crystal growing:**

- [http://www.chemistry.co.nz/crystals\\_defined.htm](http://www.chemistry.co.nz/crystals_defined.htm)
- [http://uk.geocities.com/magoos\\_universe/crystals.htm](http://uk.geocities.com/magoos_universe/crystals.htm)
- <http://www.sdnhm.org/kids/minerals/grow-crystal.html>
- [http://webphysics.davidson.edu/alumni/MiLee/JLab/crystallography\\_www/growing.htm](http://webphysics.davidson.edu/alumni/MiLee/JLab/crystallography_www/growing.htm)
- [http://www.phschool.com/science/science\\_news/chemistry/properties\\_matter.html](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](http://science.nasa.gov/headlines/y2001/ast11dec_1.htm)
- <http://www.mos.org/cst/article/77/3.htm>

|

**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.thinkquest.org/library/cat_show.html?cat_id=36)
- <http://www.sciencenews.org/>
- [http://www.phschool.com/science/science\\_news/chemistry/properties\\_matter.html](http://www.phschool.com/science/science_news/chemistry/properties_matter.html)

