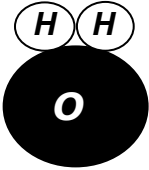




Water as the Universal Solvent

Type of Lesson:	1. <u>Content with Process</u> : Focus on constructing knowledge through active learning.	
IPC Content TEKS:	9A	Relate the structure of water to its function as the universal solvent
Learning Goal/ Instructional Goal:	<p>Learning goal: Students investigate the properties of water and learn that water's structure allows it to dissolve many substances and is therefore known as the universal solvent.</p> <p>Instructional Objectives: Students . . .</p> <ol style="list-style-type: none"> 1. Predict and prove if water can dissolve eight different substances. 2. Explain why water is called the universal solvent. 3. Identify whether a substance is a solute or a solvent 	
Key Question:	Will a variety of test substances dissolve in water?	
Related Process TEKS:		
(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>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 processes. The student uses scientific methods during field and laboratory investigations.	<p>The student is expected to:</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>	
(3) Scientific processes. The student uses critical thinking and scientific problem solving to make informed decisions.	<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>	
To the Teacher:	<p>The structure of a water molecule can help us understand how water can dissolve so many substances. A water molecule is made up of one atom of oxygen bonded with two atoms of hydrogen. The atoms are bonded by sharing electrons. This sharing is like an unequal tug of war. The oxygen atoms attract the electrons more strongly than the hydrogen atoms. The shared electrons are more attracted to oxygen than to hydrogen. The oxygen "end" of the water molecule is more negative than the hydrogen "end." The hydrogen end is more positive than the oxygen</p>	



	<p>end. The oxygen end is said to have a partial negative charge. The hydrogen end is said to have a partial positive charge.</p> <div style="text-align: center;">  </div> <p>Molecules that have ends with partial negative and positive charges are called <i>polar</i>. Water is a polar molecule. Water molecules can attract particles of other substances. Many of the substances that water dissolves are made of polar molecules.</p>
<p>Multiple Intelligences:</p>	<p><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.</p>
	<p><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.</p>
	<p><i>Spatial Intelligence</i>— 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>
	<p><i>Bodily-Kinesthetic Intelligence</i>— Is the ability to use one's mental abilities to coordinate one's own bodily movements. This intelligence challenges the popular belief that mental and physical activities are unrelated.</p>

Materials:

- Vinegar
- Graduated cylinder
- 8 test tubes per group
- test tube rack
- sugar
- salt
- vegetable oil
- alcohol
- sand
- flour
- ammonia
- soap flakes
- cornstarch



SAFETY NOTE:

Goggles and aprons may be worn during the entire lab but especially when ammonia is used.

Students must thoroughly wash hands at the end of the lab. See Texas Science Safety Manual for lab and investigation guidelines: http://www.tenet.edu/teks/science/safety/safety_manual.html

Engagement:

1. Set up a demonstration with two large beakers of water. Show the students two solutes. Unknown to them, one solute is soluble in water and one is not. Use sugar or salt as the soluble chemical and perhaps sulfur or Magnesium carbonate as the insoluble chemical. Drop some of each chemical into the water and observe whether they dissolve. Inquire what dissolving means to the students and explain how the structure of a solvent affects its ability to dissolve solutes.
2. Show mixtures that have two substances that do not dissolve. Examples might include Italian salad dressing, ocean in a bottle. Discuss how dissolving is a physical change and how students can recognize if dissolving has taken place.
3. Is water the best solvent to grow your crystal?

Explore:

1. Copy the data table in your journal and make a prediction if the substances dissolve in water by placing a yes or no in the prediction column.
2. Place the test tubes in racks. Fill each test with 10 mL of water.
3. Pour 5 mL of alcohol into Tube 1. Gently shake the test tube. Record whether or not it dissolves in water.
4. Place 1 mL of soap flakes in Tube 2. Gently shake the test tube. Record whether or not it dissolves in water.
5. Place 1 mL of sugar in Tube 3. Gently shake the test tube. Record whether or not it dissolves in water.
6. Place 1 mL of flour in Tube 4. Gently shake the test tube. Record whether or not it dissolves in water.
7. Place 1 mL of salt in Tube 5. Gently shake the test tube. Record whether or not it dissolves in water.
8. Place 1 mL of cornstarch in Tube 6. Gently shake the test tube. Record whether or not it dissolves in water.
9. Place 1 mL of sand in Tube 7. Gently shake the test tube. Record whether or not it dissolves in water.
10. Place 5 mL of oil in Tube 8. Gently shake the test tube. Record whether or not it dissolves in water.

Explain:

DATA: Copy in your journal and record your results.

Contents of Test Tube	Prediction if Substance Dissolves in Water (Yes/No)	Dissolves in Water (Yes/No)
Alcohol		
Soap Flakes		
Sugar		
Flour		
Salt		
Cornstarch		
Sand		
Oil		

1. Did all the substances dissolve in water? *No.* Why or why not? *Not all substances are polar.*
2. Which substances did not dissolve in water? *Flour, sand, and oil.*
3. What is a polar molecule? *Molecules that have ends with partial negative and positive charges.*
4. What is an ion? *An ion is an atom that has lost or gained electrons.*
5. What is a non-polar molecule? *A non-polar molecule does not have unequal sharing of electrons. The electron density is symmetrically distributed among atoms in the molecule.*
6. What is a solvent? *The component of a solution that is present in the greatest amount. It is the substance in which the solute is dissolved.* Which substance(s) are considered a solvent? *Water.*
7. What is a solute? Solute are the substances that are dissolved by the solvent. Which substances are considered solutes? *Those substances that dissolved are considered solutes – sugar, salt, alcohol, cornstarch, and soap flakes.*
8. What is hard water and how does it affect solubility? *Hard water contains ions, mainly Ca^{2+} , Mg^{2+} and Fe^{2+} . These ions increase the ability of water to dissolve polar molecules.*

Elaborate:

1. Investigate emulsifiers and apply the research to this lab.
2. Research how to make an ocean in a bottle.
3. Explore other types of mixtures such as dispersions (colloids) and suspensions and compare their properties to that of a solution.
4. Find out information about Carlsbad Caverns and other underground caves that contain stalactites and stalagmites. Explain how they are formed through the action of water.
5. Conduct an at-home investigation (with family members' assistance) to discover substances at home that do or do not dissolve in water.



Evaluate:

Students answer questions to the lab based on evidence and observations. Use the rubric to evaluate their progress. Awarding a 4 means that the student has done excellent work. Awarding a student a 1 means that the student's understanding of the subject matter and conclusions need improvement and further practice.

POINTS	Scientific Accuracy	Reasoning	Communication	Collaboration	
4	Lab procedures were conducted exactly according to the directions.	Predictions were made for all steps and lab answers show great understanding of the nature of solutes and water as the universal solvent.	Data table was completely filled out and all questions were answered in great detail showing evidence of research on the topic.	Team worked well together. Members helped each other during the experiment and discussed the lab results in great detail.	
3	Most lab procedures were conducted exactly according to the directions	Predictions were made for most steps and most lab answers show an understanding of the nature of solutes and water as the universal solvent.	Data table was mostly filled out and most questions were answered in detail showing evidence of research on the topic.	Team worked fairly well together. Members usually helped each other during the experiment and discussed the lab results in detail	
2	Some lab procedures were conducted exactly according to the directions.	Predictions were made for some steps and lab answers show some understanding of the nature of solutes and water as the universal solvent.	Data table was somewhat filled out and some questions were answered in some detail showing evidence of research on the topic.	Team worked poorly together. Members helped each other rarely during the experiment and there was little discussion of the lab results.	
1	Lab procedures were not conducted according to the directions	Predictions were made for few steps and lab answers show little understanding of the nature of solutes and water as the universal solvent.	Data table was not filled out and few questions were answered showing little evidence of research on the topic.	Team did not work together at all. Members did not help each other during the experiment and there was no interaction between the 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> (teacher lessons)

