WHAT IS THE SOLUTION?

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LEARNING STANDARDS

CHEM1.PS1: Matter and Its Interactions

13) Create models of solutions to describe solutes and solvents, concentration of solutions, and the process of solvation.
14) Quantitatively analyze solutions to describe concentration using molarity, percent composition, and ppm.
15) Demonstrate separation methods such as evaporation, distillation, electrophoresis, and/or chromatography. Construct an argument to justify the use of certain separation methods under different conditions.

SUCCESS CRITERIA

I can define saturated, unsaturated, and supersaturated solutions.
I can articulate how temperature and stirring affects solubility.
I can interpret a solubility graph.

STEM INTEGRATION

SCIENCE: This lesson covers chemistry learning standards but also connects to prior learning by touching on biology and astronomy.

TECHNOLOGY: Looking at data that is collected from outer space from the Dawn spacecraft and telescopes, images are shared in class

MATH: This lesson connects student learning to mathematics as they perform calculations (solubility, grams to moles: moles to grams, molarity, concentrations), students use ratios for comparison and are asked to read graphs and data tables.

NATURE OF STEM

Science is very fun and engaging, explaining unknown phenomena that is witnessed in the natural world. The content in this lesson flows together easily. Chemistry often incorporates mathematical principles and by giving the students hands on application of the concepts they are learning in math classes helps to enhance the content in both areas. Technology is used to enhance the ideas that are being taught by bringing the phenomena to the learner.

ENGAGE

Students begin lesson by learning about the Dawn spacecraft and the data collected about Vesta and Ceres. The purpose of this mission is to explore bright areas that were captured, that were later discovered to be salt deposits (halite, NaCl, and gypsum). These evaporated salts led scientists to believe there were once shallow ponds containing water.

What We've Learned from the Dawn Mission So Far - YouTube

NASA's Dawn: Highlighting Bright Areas of Ceres (youtube.com)

EXPLORE

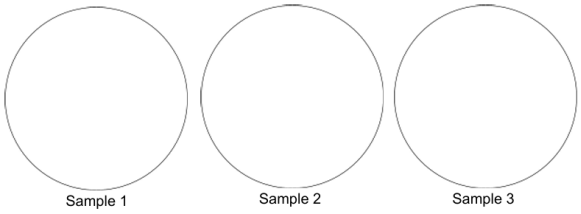
Students will complete an activity in which they will investigate different concentrations of salt water and the crystals they produce after evaporation.

Educator Guide: Mineral Mystery Experiment | NASA/JPL Edu

Students will diagram their findings in their lab notebooks by indicating solute, solvent, and concentration in Molarity (moles/L). jpl.nasa.gov/edu

Make predictions

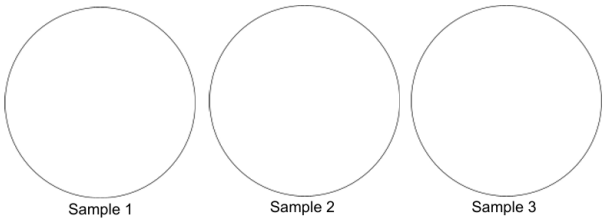
Before leaving your salty solutions out to dry, write or draw your predictions about what will happen when they dry. Be sure to think about what you might observe using different types of salt or different amounts of the same salt.



Make observations

Once your solutions have dried, look carefully at each dish. You may need to place them on a dark surface, such as dark paper or fabric. Look at the dishes close up and from an arm's length. If you have a hand lens or magnifying glass, use that to make even closer observations. Hold the dried solutions in the light or shine a flashlight on them to see if that affects their appearance.

Draw or write a description of what you observe below. Compare your observations to your predictions.



EXPLAIN

Teacher led introduction to solubility.

11.2 Solubility Graphs

Unit 11 Solutions

4. How many grams of NaCl are required to make a 0.100 M solution with 0.800 L of water?

What are the types of solutions?

1. Unsaturated
   - Can add more solute to it and it will dissolve
2. Saturated
   - Dissolved as much solute as possible
   - If you add more, it won't dissolve! (ex. if you add too much sugar to tea...the sugar sits on the bottom)
3. Supersaturated
   - More solute than normal is dissolved because of a change in temperature or pressure

What affects solubility?

- Temperature and solubility have a direct relationship.
  - As temp **increases**, solubility will **increase**. As temp decreases, solubility will *decrease*.
  - *Ex. less sugar will dissolve in tea the colder it is*
  - *Ex. more sugar will dissolve in tea the hotter it is*

Catalyst

1) How would you describe a solution to a friend?
2) 95 moles of sucrose are dissolved in 0.5L of water. Identify the solute and solvent in the solution.
3) What is the molarity of a solution of 23 moles of NaCl in 9.2 L of water?
4) How many grams of NaCl are required to make a 0.100 M solution with 0.800 L of water?

Topic: 11.2 Solubility

Date:

Success Criteria

- I can define saturated, unsaturated, and supersaturated solutions. L1
- I can articulate how temperature and stirring affects solubility. L2
- I can interpret a solubility graph. L3

What are the types of solutions?

1. Unsaturated
   - Can add more solute to it and it will dissolve
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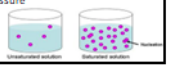


What affects solubility?

- Stirring helps the solute dissolve *more quickly*
  - Stirring does not increase the solubility of a substance, it just helps it dissolve faster

3. What is the molarity of a solution of 23 moles of NaCl in 9.2 L of water?

Topic of the Day:
11.2 Solubility

Essential Question: How do I represent the solubility of a substance in a graph?

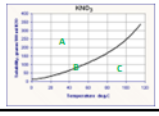
What is solubility?

- **Solubility:** maximum amount of solute that will dissolve in a solvent
  - High solubility means A LOT of solute will dissolve
  - Low solubility means little solute will dissolve

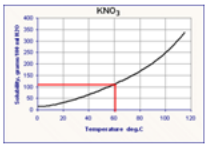
How do I read a solubility curve?

- On the line, solution is saturated
- Below the line, solution is unsaturated
- Above the line, solution is supersaturated

Example:
A = Supersaturated B = Saturated
C = Unsaturated



Example 1: How many grams of KNO_3 will dissolve at 60˚C?

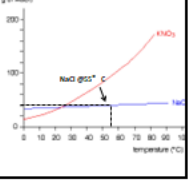


110 grams

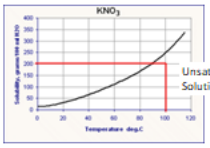
Example #4

At 55˚C, up to how many grams of NaCl will dissolve?

Answer: 40 grams



Example 2: When 200 grams of KNO_3 are dissolved at 100˚C?

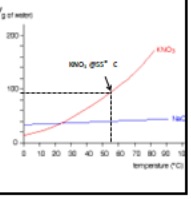


Unsaturated Solution

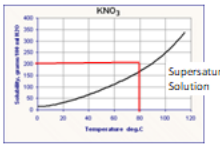
Example #5

How many grams would it take to make a saturated solution of KNO_3 at 55˚C?

Answer: about 90-95 grams KNO_3



Example 3: When 200 grams of KNO_3 are dissolved at 80˚C?



Supersaturated Solution

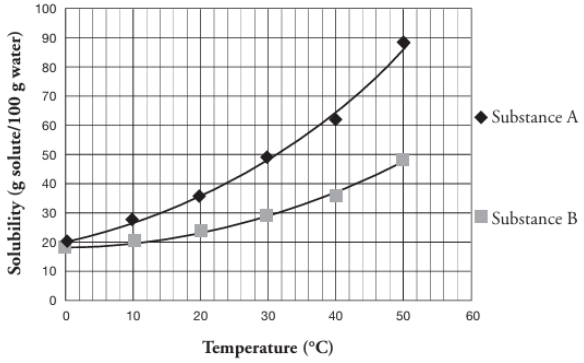
Student led lesson on solubility, concentration, solubility, and saturation, students will work their way through a POGIL (Process Oriented Guided Inquiry Learning) activity. In this activity they are given different models to explore and investigate to glean information about the topic of solutions.

Model 1 – Three Solutions

The following data refer to three experiments in which solute is added to water in a beaker at 20 °C. The mixtures are stirred and then allowed to sit for three hours before measuring the amount of solid that dissolves. Ten separate trials are conducted for each experiment. The same solute is used in all three experiments.

	Experiment 1 In 10.0 g water		Experiment 2 In 20.0 g water		Experiment 3 In 50.0 g water	
Trial	Mass of solute added (grams)	Mass of solute dissolved (grams)	Mass of solute added (grams)	Mass of solute dissolved (grams)	Mass of solute added (grams)	Mass of solute dissolved (grams)
1	1.0	1.0	1.0	1.0	3.0	3.0
2	2.0	2.0	2.0	2.0	6.0	6.0
3	3.0	3.0	3.0	3.0	9.0	9.0
4	4.0	3.6	4.0	4.0	12.0	12.0
5	5.0	3.6	5.0	5.0	15.0	15.0
6	6.0	3.6	6.0	6.0	18.0	18.0
7	7.0	3.6	7.0	7.0	21.0	18.0
8	8.0	3.6	8.0	7.2	24.0	18.0
9	9.0	3.6	9.0	7.2	27.0	18.0
10	10.0	3.6	10.0	7.2	30.0	18.0

Model 2 – Solubility Curves



ELABORATE

Students will go back into the lab and investigate the solubility of NaCl in cold water and hot water. The information obtained will be used to create a graph

Part 1

1. Find the temperature of the cool water
2. Obtain a beaker and add 100 mL of ice water. Find the mass of the beaker and water.
3. Add 1 scoop of NaCl and stir.
4. Continue adding NaCl until no more dissolves.
5. Once no more NaCl dissolves record the mass of your beaker + water + NaCl
6. Determine the mass of NaCl that dissolved.

1. Temperature (°C)	
2. Mass of beaker and 100 mL H_2O	
3. Mass of beaker and NaCl	
4.Mass of NaCl in solution (#3- #2)	

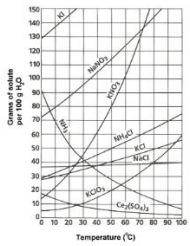
Part 2

1. Find the temperature of the hot water
2. Obtain a beaker and add 100 mL of ice water. Find the mass of the beaker and water.
3. Add 1 scoop of NaCl and stir.
4. Continue adding NaCl until no more dissolves.
5. Once no more NaCl dissolves record the mass of your beaker + water + NaCl
6. Determine the mass of NaCl that dissolved.

1. Temperature (°C)	
2. Mass of beaker and 100 mL H_2O	
3. Mass of beaker and NaCl	
4.Mass of NaCl in solution (#3- #2)	

EVALUATE

Students will be given a solubility graph. In this assessment, they will be asked to read the graph for different substances,



Using the solubility chart, answer the following questions:

1. What is the solute in the solution?
2. What is the solvent in the solution?
3. How much sodium chloride was used to saturate the solution with ice water? Is this consistent with the solubility chart?
4. How much sodium chloride was used to saturate the solution with hot water? Is this consistent with the solubility chart?
5. Based on your knowledge, where would you expect the greater concentration of sodium chloride to be, the North Pole or the equator? Explain.

EXTENSION

- Students can read more about the Dawn mission's scientific discoveries by visiting the Dawn mission science page for Ceres.
- Students may be curious about what the results would look like if they added more salt to their solution. This is an opportunity to discuss solubility and saturation in greater detail and allow students to try dissolving higher concentrations of salt in their solutions if time allows.
- Students can dissolve different types of salts into a single solution, make predictions about what will occur when the water evaporates, and compare their predictions to observations made once the solution has evaporated.