



Activity 1: Connecting

1. What do you think it means for a solution to become saturated? *Be sure to explain what you think it would look like on the macroscopic level and on the submicroscopic level. Support your claim with evidence.*
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Recall that Kool-Aid® is a solution. When making Kool-Aid®, sugar is added according to the directions on the packet. However, some people may like it sweeter, so they might add more sugar and see it dissolve. More sugar can be added because the solution is **unsaturated**, which means the solvent is able to dissolve more solute. In the case of making Kool-Aid® with extra sugar, the solution can dissolve more sugar without it settling to the bottom.

If too much sugar is added to the solution, some of the sugar will eventually settle at the bottom of the pitcher and no more sugar will dissolve no matter how much the solution is stirred. The Kool-Aid® has now become **saturated**. A saturated solution is a solution that has reached a point where no more solute can be dissolved in the solvent. A saturated solution is as concentrated as possible at a given temperature.

Besides humans, many animals can create solutions. Bees create honey, which is a *solution* composed of fructose, glucose, water, oil, flower pollen, and special enzymes produced by bees. Honey not only supplies bees with food in the summer and winter months, it is also used by humans as a natural sweetener that is easy for the body to digest. When buying honey at the store, various labels might indicate their product is pure honey.



2. Do you think you can tell the difference between a saturated solution and an unsaturated solution at the macroscopic level? *Explain your answer.*
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3. Do you think you can tell the difference between a saturated solution and an unsaturated solution at the submicroscopic level? *Explain your answer.*



Activity 2: Simulations of Saturation

Part 1: Use Simulation 4, Set 1

Sketch each of the three simulations that your teacher shows to you. Make sure you record the simulation temperature. The simulation is for a solution of KCl and water.

Submicroscopic sketch of Simulation 1 at 0 °C	Submicroscopic sketch of Simulation 2 at 25°C	Submicroscopic sketch of Simulation 3 at 99 °C
Observations	Observations	Observations
Key		

4. Classify Set #1 as saturated or unsaturated. *Support your claim with evidence.*



5. Classify Set #2 as saturated or unsaturated. *Support your claim with evidence.*

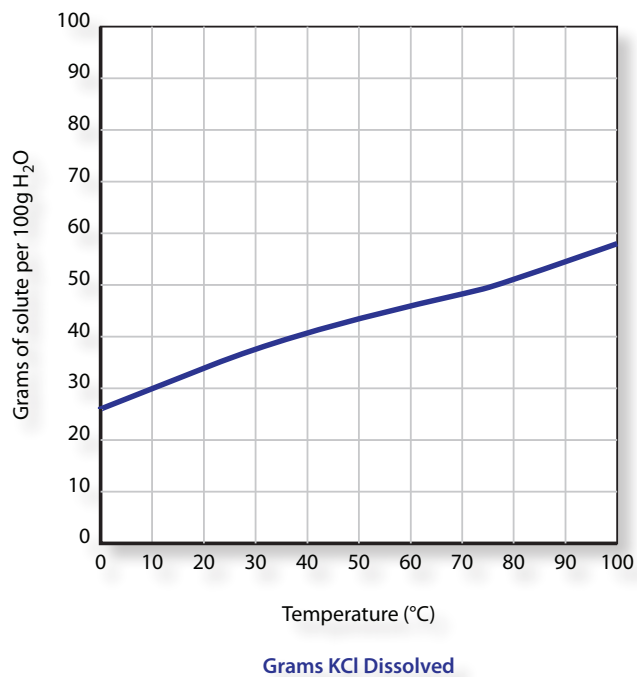
6. Classify Set #3 as saturated or unsaturated. *Support your claim with evidence.*

7. What is the limitation of just using the submicroscopic simulation to determine saturation?

Part 2

A student created a solubility graph for KCl. The teacher asked the student to label two points on the graph which represent a saturated and unsaturated solution for KCl. Recall the meaning of these two types of solutions.

*Label the graph below with the letters to correctly identify the two types of solutions:
A = Saturated, B = Unsaturated*





8. Using the graph, locate a solution of 80 grams of dissolved KCl solute per 100 grams water at 90 °C. What type of solution is this? *Please explain.*

9. At 30 °C, how many grams of KCl is needed to saturate the solution?

10. What would happen to a saturated solution composed of 90 grams KCl dissolved in 100 grams water at 70 °C, if you added two more grams of KCl?

11. How much more KCl would you need to add to make a saturated solution if you already had added 10 g at 20 °C?

12. What would make a supersaturated solution of KCl begin to precipitate out?

13. When labels indicate “pure” honey, does this mean that honey is a pure substance in scientific terms? *Support your claim with evidence.*

Honey is a special type of solution because it is a naturally made **supersaturated solution**. A supersaturated solution is a case in which the solvent contains more solute than it can hold *theoretically* at a given temperature. Supersaturated solutions are formed by heating a solution to dissolve more solute, then cooling the solution down slowly. By cooling slowly, the honey is able to dissolve more sugar at lower temperature than it can under normal circumstances.



14. What does the prefix super- mean?

15. In your own words, what do you think supersaturated means?

Honey **crystallizes**, meaning it forms a solid when sitting undisturbed for a long period of time. Supersaturated solutions are often unstable and easily crystalize. Honey and other supersaturated solutions are created by heating the solvent, which causes the solvent molecules to move farther apart from each other. This situation allows more solute particles to dissolve in between the solvent molecules than at lower temperatures. In nature, bees accomplish this by heating water (the solvent) and dissolving two different kinds of sugars, glucose and fructose (the solutes), to make a supersaturated solution. Where do the bees get the heat to create the supersaturated solution? Honey is made in the summer when the temperatures are warmer and flowers are in bloom. The summer heat causes the solvent to dissolve more sugar into the solution. Worker bees also help to regulate the temperature of the hive by vibrating their wings to generate heat. The bees then cool the solution down slowly so that the sugar still remains dissolved in the solvent.



This temperature regulation ensures that honey remains a liquid in the cold winter months. Because honey is supersaturated, addition of any extra solid sugar crystals, agitation, cooling, or even small air bubbles could cause many of the sugar molecules to precipitate out of the solution. After precipitation occurs, the honey is no longer supersaturated.

16. What does the phrase “precipitate out” mean?



17. At the submicroscopic level, what happens to the molecules of a solvent that is being heated such that it allows more solute to be dissolved into the solution?
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Activity 3: Putting It All Together: Independent Practice

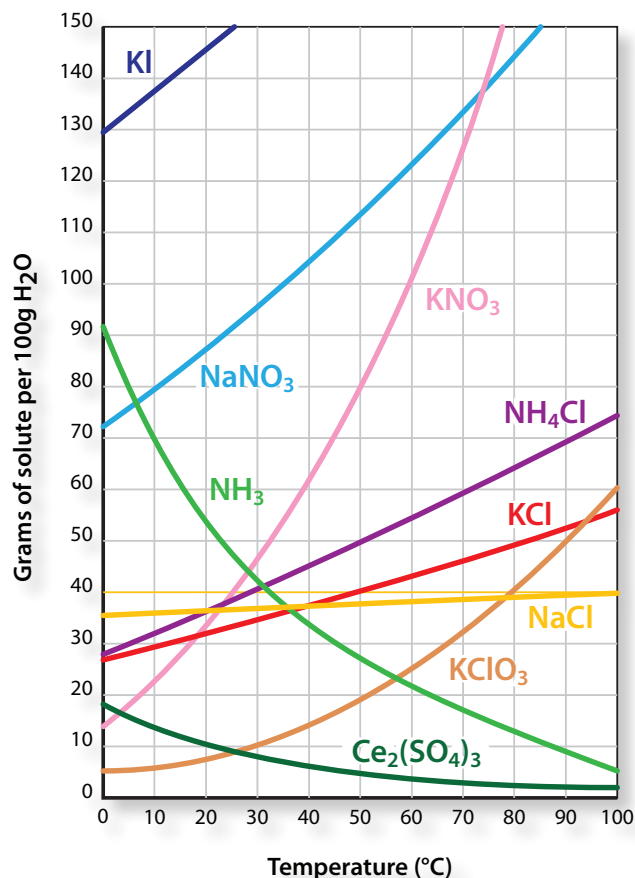
Use the graph to answer the following questions:

18. How many grams of solute are required to saturate 100 g of water in each of the following solutions?

KCl at 80 °C	
KClO ₃ at 90 °C	
NaNO ₃ at 10 °C	
NH ₃ at 20 °C	

19. What is each of the solutions below: saturated or unsaturated? All of the solutes are mixed with 100 g of water.

40 g of NaCl at 80°C	
30 g of NH ₃ at 30°C	
34 g of KCl at 20°C	
80 g of KNO ₃ at 60°C	



20. How many grams of KNO₃ per 100 g of water would be crystallized from a saturated solution as the temperature drops from each of the following temperatures?

70°C to 20°C	
60°C to 40°C	
50°C to 30°C	
50°C to 0°C	



21. How many additional grams of NaNO_3 are required to keep each of the following NaNO_3 solutions saturated during the temperature changes indicated?

100 g of water, 10°C changing to 30°C	
200 g of water, 10°C changing to 30°C	
100 g of water, 40°C changing to 90°C	
1000g of water, 40°C changing to 90°C	

22. Which solute is the least affected by changes in temperature? *Support your claim with evidence.*

23. Which two solutes show a decrease in solubility with increasing temperature? *Support your claim with evidence.*

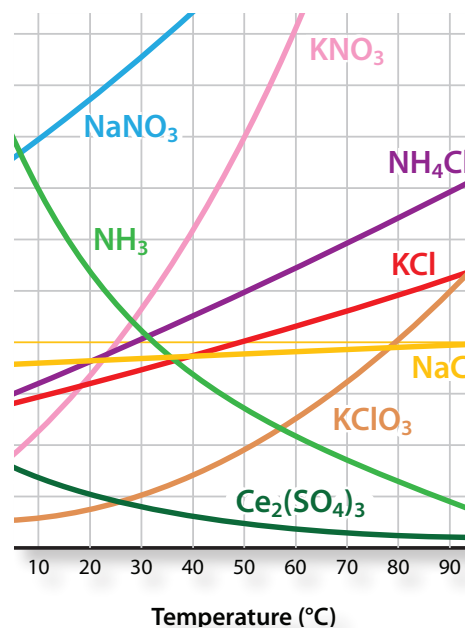
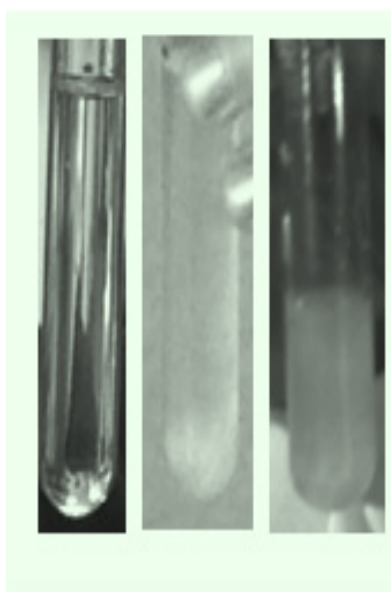
24. Can you use the graph to represent a supersaturated solution? *Support your claim with evidence.*

25. Which solute is more soluble: KCl or NaCl? *Provide evidence for your answer.*



Lesson Reflection Question

26. The image of the three test tubes shows a macroscopic image of various amount of KI mixed with water. The solubility curve for KI is shown next to the image. Do the macroscopic images show a saturated solution, unsaturated solution, or supersaturated solution? *Provide evidence for your answer.*



Activity 4: Solubility Lab: Creating a Solubility Curve

Part 1: Solubility Curve Lab

Part 2: Creating and Interpreting Solubility Curves