Lab #23: Unsaturated, Saturated and Supersaturated Lab

Background: Each compound has its own solubility limit, the maximum amount of solute which can dissolve in a given amount of solvent at a certain temperature. When you dissolve an amount equal to that limit you have a **saturated** solution. Any solution which contains less than its limit in solute is called unsaturated. If a solution contains more solute than the maximum it should have we say that the solution is **supersaturated**. You may wonder how you can create a solution which contains more solute than what it is supposed to hold.

For most substances the solubility (the maximum that can dissolve) increases with an increase in temperature. We can use this ability to make our supersaturated solution. In our first step, we will heat our solution, increasing the temperature. At this new temperature more solute can be dissolved. Now we can't say that this solution is supersaturated yet because it is *supposed* to hold more solute at this temperature. So in our second step, in order for our solution to be supersaturated, it must cool back down. If a supersaturated solution is allowed to cool slowly, undisturbed, then the extra solute will stay dissolve and we can say that they solution is supersaturated.

It is possible to test a solution to see if it is unsaturated, saturated or supersaturated. This can be done with the help of a seed crystal. A seed crystal is just a small amount of additional (solid) solute which is added to your solution.

- In an unsaturated solution, because you have not reached your solubility limit, a seed crystal placed into the solution will dissolve.
- In a saturated solution you have reached you limit and so the seed crystal cannot dissolve. Instead it will simply fall to the bottom and not dissolve.
- In a supersaturated solution the situation is a little more complex. Remember that a supersaturated solution is holding more solute than it normally would. This makes a supersaturated solution very unstable. Any small disturbance will cause the extra solute to come out of solution. If a seed crystal is placed into a supersaturated beaker, it will act as a disturbance and all of the extra solute will fall out. Instead of just seeing one seed crystal fall to the bottom of the beaker, you will see a greater amount of solid form at the bottom of the beaker. This is all the extra solute.

In this lab we will prepare several solutions and then test each solution with a seed crystal to see if each is saturated, supersaturated or unsaturated.

Procedure, observations, and conclusions:

Situation #1

1. Weigh out 5.0 grams of sodium thiosulfate pentahydrate. ($Na_2S_2O_3$* $5H_2O$)
2. Place the sodium thiosulfate pentahydrate into a medium sized test tube.
3. Measure out 1.0 ml of distilled water in your 10 ml graduated cylinder.
4. Add the water to the test tube of sodium thiosulfate pentahydrate.
5. What do you note about the solution? Did all of the substance dissolve?
6. Make a note regarding the appearance of your test tube in your data table.

Situation #2

7. Attach a test tube clamp to the test tube of sodium thiosulfate solution from situation #1.
8. We are going to heat the solution by **passing** it through a flame. YOU ARE NOT TO HOLD THE TEST TUBE DIRECTLY IN THE FLAME. KEEP IT MOVING AND MAKE SURE THAT IT IS NOT POINTED AT ANYONE. Hold the test tube at an angle. Remember, keep it moving while you pass it through the Bunsen burner flame.
9. Continue heating until all the sodium thiosulfate has dissolved.
10. Place the hot solution of sodium thiosulfate into your test tube rack.
11. We will now test the solution with a seed crystal to determine whether it is saturated, supersaturated or unsaturated. Obtain a single small crystal of sodium thiosulfate pentahydrate from the stock bottle.
12. Add the crystal to the hot solution of sodium thiosulfate.
13. Record what you observe.

Situation #3

14. Add cold tap water to your 250 or 400 ml beaker until it's almost full.
15. Take the solution from situation #2 and gently reheat it in your flame until any solid that formed is redissolved.
16. Now place the hot test tube in the cold water and let it sit for at least 5 minutes in the cold water.
17. If, at the end of 5 minutes, the solution of sodium thiosulfate is still colorless you may continue to step 19. If not, repeat steps 15 and 16.
18. Remove the cooled solution of sodium thiosulfate from the cold water. Place the test tube in your test tube rack.
19. Once again, we will test the solution with a seed crystal. As before, place one seed crystal in the solution and observe what happens.
20. Record your observations in your data table.
21. If the seed crystal dissolved then you need to continue to step 22. If you observed the formation of crystals instead, skip ahead to step 23.

22. Add one or two more seed crystals to your test tube and then reheat it until everything dissolves. Repeat steps 16 through 21 until you have observed the extra crystals which form when a supersaturated solution is disturbed. Then proceed to step 23.
23. Gently reheat your test tube of sodium thiosulfate so that it is once again clear.
24. Pour the hot solution into the waste beaker in the fume hood.
25. Clean up your equipment and work station.

Signature for cleanup _____

PRELAB QUESTIONS: COMPLETE PRIOR TO COMING TO LAB

1. What is solubility?

2. What precautions must you take when heating a test tube?

3. What steps are involved in creating a supersaturated solution? Explain why the second step is necessary.

4. What is observed when a seed crystal is placed into a saturated solution? An unsaturated solution? A supersaturated solution?

DATA TABLE(S): COMPLETE BEFORE COMING TO LAB (USE A RULER)