Lab: Winter Crystals

FOR THE TEACHER

Summary
In this lab, students will create a supersaturated solution by dissolving borax in boiling water. They will create a snowflake using pipe cleaner to suspend in the solution, which will serve as a nucleation site for crystallization as the solution cools and remains undistributed overnight. This lab gives students an opportunity to experience the exciting crystallization process and become more familiar with an engaging chemistry spectacle!

Grade Level
High, Middle or Elementary School

Objectives
By the end of this lab, students should be able to
- Describe the meaning of supersaturated solution as well as how to prepare one.
- Differentiate between the vocabulary terms solute, solvent and solution.
- Understand how temperature change can affect the concentration of solute in a solution.

Chemistry Topics
This lab supports students’ understanding of
- Solutions
- Solubility
- Solute
- Solvent
- Concentration
- Saturation
- Nucleation

Time
Teacher Preparation: 20 minutes
Lesson: Day 1 - 45 minutes, Day 2 – 25 minutes

Materials
Per 2 students:
- 2-3 pipe cleaners (preferably white)
- String
- Scissors
- 2 Pencil or wooden sticks
- Water (~470ml, or 2 cups)
- Hot plate
- 1-600ml beaker
- Beaker tongs/heat-resistant gloves
- 2 Styrofoam cups
- Stirring rod
- Borax (62.7grams, or 6 tbsp.)
- Weighing boat
- Electronic scale

**Safety**

- Always wear safety goggles when handling chemicals in the lab.
- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
- Exercise caution when using a heat source. Hot plates should be turned off and unplugged as soon as they are no longer needed.
- Long hair should be tied back, and loose clothing secured.

**Teacher Notes**

- This lab is fun to complete near winter break, or when it first starts to snow.
- Note that this lab can be beneficial for all ages of students, elementary through high school. However, additional adult support will be needed in an elementary classroom. See below for extension ideas when completing this activity with different grade levels.
- In a high school or middle school lab setting, the water should be boiled in 600ml beakers. This will be enough water to make borax solutions for 2 students to use.
- In an elementary classroom, the teacher should use a microwave or electric kettle to boil the water.
- When students create their snowflake, remind them that it should be able to hang inside of the cup or beaker without touching the inside of the container for best results.
- The corresponding student worksheet for this laboratory activity is written for middle and high school students.
- For reference, the ratio needed per student is 3tbsp. of borax for 1cup water, or 31.35g of borax for 235ml of water.
- Photos are shown in the student procedures to help guide students through the lab.
- Note that some students may ask to keep their snowflake, or use it as an ornament. If you allow students to take the snowflake home please caution students about the hazards related to ingestion of Borax (especially if they have pets) – ingestion may cause: gastrointestinal disturbances such as headache nausea, vomiting, abdominal pain, and diarrhea, with delayed effects of skin redness and peeling. The complete safety information for Borax can be found here.
- The photos below show the final snowflake after 6 hours and again after 24 hours:

![6 hours](image1.png) ![24 hours](image2.png)

- Extensions:
  - *High School*
    - Students can be asked to calculated molarity of the supersaturated Borax solution.
    - Students can be introduced to Solubility charts/graphs as a follow-up.
Show this Flinn Video to differentiate between unsaturated, saturated and super saturated solutions.

Students can be asked to draw a flow chart to model what is happening during this process on the molecular level.

This AACT Solubility Animation is a good resource for introducing solubility at the particle level.

Students can research Rock Candy, and the process for making it.

Many relevant topics from Middle School Chemistry's unit can be applied in the high school classroom.

**Middle School:**
- Students can further investigate concentration and solutions through this AACT lab.
- Students can research Rock Candy, and the process for making it.
- Show this Flinn Video to differentiate between unsaturated, saturated and super saturated solutions.
- MiddleSchoolChemistry.com provides an entire unit focused on dissolving solutes in water, many activities and multimedia can be used in combination with this lab.

**Elementary School:**
- This animated video can help introduce the concept of solute, solvent and solutions to young students.
- Some basic vocabulary, and a video connection to solutions and the water cycle can be found here.

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**FOR THE STUDENT**

**Lesson**

**Winter Crystals**

**Prelab Questions**

1. In your own words define solution:
2. In your own words define solute:
3. Best describe the meaning of the word saturated. Use an example to help support your description.

**Materials**

(Work as a pair)
- 2-3 white pipe cleaners
- String
- Scissors
- 2 pencils or wooden sticks
- Water (470ml or 2 cups)
- Hot plate
- 600ml beaker
- Beaker tongs or heat-resistant gloves
- 2 Styrofoam cups
- Stirring rod
- Borax (62.7grams, or 6 tbsp.)
- Weighing boat
- Electronic scale
Safety
- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- Follow the teacher’s instructions for cleanup of materials and disposal of chemicals.
- Exercise caution when using a heat source. Hot plates should be turned off and unplugged as soon as they are no longer needed.
- Long hair should be tied back, and loose clothing secured.

Procedure
1. Fill the 600ml beaker with ~400ml of water. Boil the water, by placing the beaker on a hotplate.
2. Obtain a Styrofoam cup and write your name on it.
3. Using the pipe cleaners and scissors, construct a snowflake.
4. Attach a piece of string, approximately 15cm long, to the snowflake.
5. Tie the other end of the string to a pencil, or wooden splint so that the snowflake will hang from the pencil and dangle inside the cup.
6. Make sure this figure fits entirely inside the Styrofoam cup, without touching the inside or resting on the bottom.
7. Place an empty weighing boat on the electronic scale and zero it. Measure approximately 40grams of borax.
8. When the water has boiled, turn off the hotplate. Using either beaker tongs or heat-resistant gloves, remove the beaker from the hotplate and place it on the laboratory countertop.
9. Carefully add the borax to the hot water and continuously stir the solution for ~1minute. It will become a clear solution.
10. Using either beaker tongs or heat-resistant gloves, pour the solution into the Styrofoam cups (you should have enough solution to fill each of the two cups).
11. Hang the snowflake in the cup. Roll the string around the pencil or wooden splint as needed to ensure it is not resting on the bottom of the cup.
12. The snowflake must remain in the solution undisturbed overnight!
13. Again make sure your name is on your cup.
14. Clean-up your lab station as directed by your teacher.

**Analysis**

1. What material used in this lab was the solute? What material was the solution?

2. What happens to liquid molecules as they increase in temperature?

3. Analyze the solubility chart for Borax shown below.
   a. What is the trend in solubility for Borax in water as the temperature increases?

   b. What is the approximate value for the percentage of Borax by weight in the solution you created in procedure step 9? How did you determine this?

   c. What is the approximate value for the percentage of Borax by weight in the final solution you have now, a day or more later? How did you determine this?

(Chart from [Borax.com](http://Borax.com))
4. Often when a solution is heated it increases its capacity for dissolving solutes, this is how a *supersaturated solution* is created. The borax and water solution that you created was a supersaturated solution, what happened to your snowflake after the solution cooled overnight? **Why do you think this happened?** Be thoughtful in your response, use the chart shown in question 3 to help you.