

3.F.3 Rock Candy: Solids, Liquids, Gases

The creation of sugar crystals: exploring evaporation, crystallization, and the metric system

Grade Level	3
Sessions	(2): 1 at 50-60 minutes, 1 at 50-80 minutes
Seasonality	None
Instructional Mode(s)	Whole Class, Small Groups
Team Size	2 students
WPS Benchmarks	03.SC.TE.04, 03.SC.TE.05, 03.SC.PS.03, 03.SC.PS.06, 03.SC.IS.06
MA Frameworks	3-5.TE.2.2, 3-5.PS.0.3
Key Words	Condensation, Crystallization, Evaporation, Seeding

Summary

This lesson introduces children to the creation of sugar crystals, which occurs when water evaporates from a saturated sugar-water solution. Students will have the opportunity to explore the metric measuring system and will practice writing laboratory reports. Students will experience evaporation first-hand and will learn that sugar dissolves in hot water.

Learning Objectives

2002 Worcester Public Schools (WPS) Benchmarks for Grade 3

1. 03.SC.TE.04 Describe different ways in which a problem can be represented, e.g., sketches, diagrams, graphic organizers, and lists.
2. 03.SC.TE.05 Develop a knowledge and understanding of the metric measurement system.
3. 03.SC.PS.03 Compare and contrast solids, liquids, and gases based on the basic properties of each of these states of matter.
4. 03.SC.PS.06 Do simple investigations with evaporation, condensation, freezing and melting. Confirm that water expands upon freezing.
5. 03.SC.IS.06 Record data and communicate findings to others using graphs, charts, maps, models, oral and written reports.

2001 Massachusetts Frameworks for Grade 3

1. 3-5.TE.2.2 Describe different ways in which a problem can be represented, e.g., sketches, diagrams, graphic organizers, and lists.

2. 3-5.PS.0.3 Describe how water can be changed from one state to another by adding or taking away heat.

Additional Learning Objectives

1. Students will work with the metric system to measure volume and mass.
2. Students will discover that when sugar is added to cold water a mixture (water and undissolved sugar) is formed; however, when sugar is added to hot water, a solution is formed (water and dissolved sugar).
3. Students will apply their knowledge of evaporation and condensation.
4. Students will become familiar with writing a laboratory report.

Required Background Knowledge

1. Basic knowledge of the properties of solids, liquids and solids.
2. Basic understanding of evaporation and condensation.
3. Basic knowledge of physical and chemical changes.
4. Basic knowledge of the metric system.

Essential Questions

1. What is the difference between adding sugar to cold and hot water?
2. What happened to the sugar-water solution after seven days?
3. What is the phase of water after the water is evaporated?
4. What is the phase of the sugar after the water is evaporated?
5. What are the different parts of a laboratory report?

Introduction / Motivation

The instructor might begin the lesson by asking the students what they remember about the properties of solids, liquids and gases. The instructor might then ask how many students have eaten rock candy and which flavor is their favorite.

Procedure

The Instructor will:

Part 1: (50-80 minutes)

1. Divide the students into pairs (optional).
2. Lead students through the “Purpose” section of the Laboratory Report worksheet.

3. Hand out one paper cup and one craft stick to each member of the group.
4. Put a small amount of cold water and sugar into each cup and have the students mix it with their craft stick (a total of 240 ml (1 cup) of sugar will be used, divided up among all students in the class).
5. Ask students to record their observations in the “Results” section of their worksheets.
6. Hand out another paper cup and a small piece of string to each student. Ask each student to take a pencil out of his or her desk.
7. Put a large pot, a wooden spoon and measuring spoons on a table in front of the classroom.
8. Ask each student to add 45 ml (3 tbsp) of sugar to the pot.
9. Carefully add the hot water (see Materials List for quantity) to the pot and, using a wooden spoon, mix, until all sugar is dissolved.
 - Either use a heat source in the classroom or heat the water before the lesson (this can be done using a coffee machine).
10. Add food coloring (optional).
11. Ask students to record their observations of the sugar and hot water mixture in the “Results” section of the worksheet.
12. Have each student tie their piece of string to the middle of their pencil.
13. Give each student/group a small amount of sugar on a paper towel.
14. Have each student/group soak their string in water and then roll it in sugar; this process is called “seeding” (See Vocabulary with Definitions).
15. Have each group or student put their string into the second paper cup, ensuring that the string *almost* touches the bottom of the cup. The pencil should lie across the top of the cup.
16. Have each pair of students come to the front of the classroom. Carefully pour the very warm sugar water into their paper cups (about $\frac{3}{4}$ full). ***Ensure that the mixture is not too HOT; very hot water will seriously injure students.***
17. Place a small piece of plastic wrap over the top of each cup – this will prevent dust and dirt from contaminating the students’ candy.
18. Have each student weigh his/her cup and record the weight in the “Results” section of the worksheet.

19. Put the cups in a place where they will not be disturbed and let them sit for about seven days.
20. Have the students record the weight of their cups each day in the “Results” section of the Laboratory Report worksheet.

Part 2: (50 – 60 minutes)

1. *Complete this part of the lesson once students’ candy has crystallized.*
2. Ask the students to reform previous pairs and hand out paper towels to each pair.
3. Have each student/group weigh their cup one last time and record the weight in the results section of the Laboratory Report worksheet.
4. Have each student observe his or her rock candy and draw what he or she sees in the “Results” section of the Laboratory Report worksheet.
5. Discuss what happened to the water (it evaporated) (See Vocabulary with Definitions).
6. Discuss the water droplets on the plastic wrap (it condensed) (See Vocabulary with Definitions).
7. Have the students carefully remove the sugar crystals and put them on the paper towel. The students may need help when removing the sugar crystals.
8. Have each group measure the length of their largest crystal (in centimeters) and have them record it in the “Results” section of the Laboratory Report worksheet and on the blackboard.
9. Make one bar graph of the measurements of all the groups’ largest crystals, whether by free hand or using graph paper.
10. In the “Results” section of the Laboratory Report worksheet, have the students graph their data for the mass of the crystal over the seven days.
 - a. The students may need help filling out the scale for the y-axis.
11. Ask each student to complete the “Materials” and “Procedure” sections of the Laboratory Report worksheet: students may need help with these parts.
12. Lead the students through the “Discussion and Conclusions” sections of the Laboratory Report worksheet.
13. Let the students eat and enjoy their treats!

Materials List

Materials per class	Amount	Location
Sugar	30 ml (2 Tbsp) multiplied by number of students Additional 480 ml (2 cups) (separated)	Grocery store
Water	7.5 ml (1 ½ tsp) of hot water multiplied by number of students Additional 240mL (1 cup) of cold water	Classroom
Food Coloring (optional)	Several drops	Home
Wooden Spoon	One	Home
Plastic Wrap	One roll	Home
Large Pot	One	Home
String	One roll	Home, craft store
Heat Source	One	Classroom, home, teacher's room
Measuring Cups and Spoons	One 240 ml (1 cup) One 15 ml (1 Tbsp) One 2.5 ml (½ tsp)	Home
Scale or Balance	Several	Classroom

Materials per student	Amount	Location
<u>Laboratory Report</u>	One	End of lesson plan – print or photocopy
Worksheet		
Craft Sticks	Two	Craft store
Paper Cup	Two	Grocery store
Pencil	One	Classroom

Vocabulary with Definitions

1. *Condensation* – the process by which a gas changes into a liquid, usually by cooling.
2. *Crystallization* – the process by which a material solidifies into a definite, regular shape.
3. *Evaporation* – the process by which a solid (ex. ice) or liquid (ex. water) changes into a gas (ex. water vapor), which is usually done when the solid or liquid is heated.
4. *Metric* – a unit of measurement that is based on the meter.
5. *Seeding* – adding water and a small amount of sugar directly to the string to activate crystal growth.

Assessment / Evaluation of Students

The instructor may assess the students in any/all of the following manners:

1. Collect student worksheets to determine whether students understand (a) evaporation, (b) crystallization, and (c) correct use of the metric system.

Lesson Extensions

1. Ask students to pick their favorite sandwich and write a laboratory report describing how to make the sandwich.
2. Help students make a volcano out of paper maché and lava out of baking soda, vinegar, and food coloring. Demonstrate phase changes as the liquid (vinegar) and solid (baking soda) change to gaseous form (bubbles in lava).

Attachments

1. Laboratory Report

Troubleshooting Tips

1. Water should be sufficiently hot to dissolve the sugar, but cool enough so as not to pose danger to the students.
2. When taking the rock candy out of the jar, the string might come out without the crystals; recommend that students remove the rock candy from the cups slowly and carefully.

Safety Issues

1. Ensure that students do not touch the hot water.

Additional Resources

None

Laboratory Report

Name: _____

Date: _____

Laboratory Report: Many scientists and college students use laboratory reports to organize experiments.

Directions: You will write your own laboratory report when you create rock candy. Rock candy is really the crystallized form of sugar. Complete each section below when your teacher instructs you to do so.

1. Purpose: Write one sentence about what you are going to do in this experiment.

2. Materials: List all materials that were used in the rock candy experiment.

1 Wooden Spoon _____

Procedure: Complete the remaining steps that were taken to make the sugar crystals.

Step 1: Each student put _____ milliliters of sugar into the pot.

Step 2: Add the hot _____ to the pot.

Step 3: Using a _____, mix, until all sugar is _____.

Step 4: Tie a string to the middle of a pencil.

Step 5: Soak the string in water and then roll it in sugar; this process is called

_____.

Step 6: Put the string into the cup and fill the cup with the _____.

Step 7: Put _____ over the top of the cup.

Step 8: Weigh the _____ and the crystals each day for seven days and record the mass in the "Results" section of the Laboratory Report worksheet.

Step 9: After 7 days, _____ the rock candy and _____ what I saw.

Step 10: Carefully remove the sugar crystals from the cup and put them onto a paper towel.

Step 11: _____ the largest _____ and record its mass.

Step 12: Make a _____ of the _____ versus _____ of the cup and crystals.

3. Results: Answer the following questions:

What did you observe when the sugar was mixed with cold water?

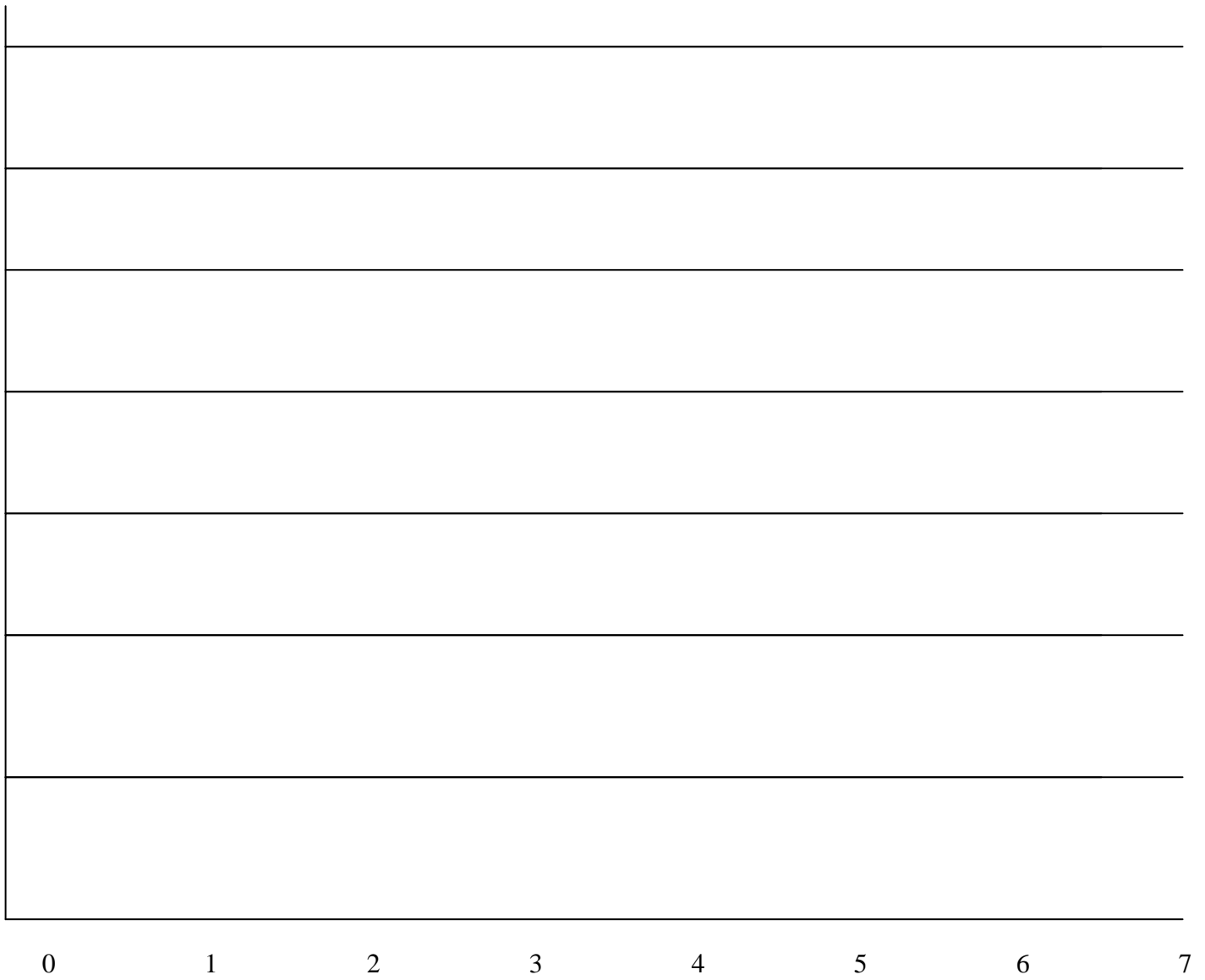
What did you observe when the sugar was mixed with the hot water?

Over a seven-day period, fill in the following table:

Day	Mass of the jar and crystals (grams)
1	
2	
3	
4	
5	
6	
7	

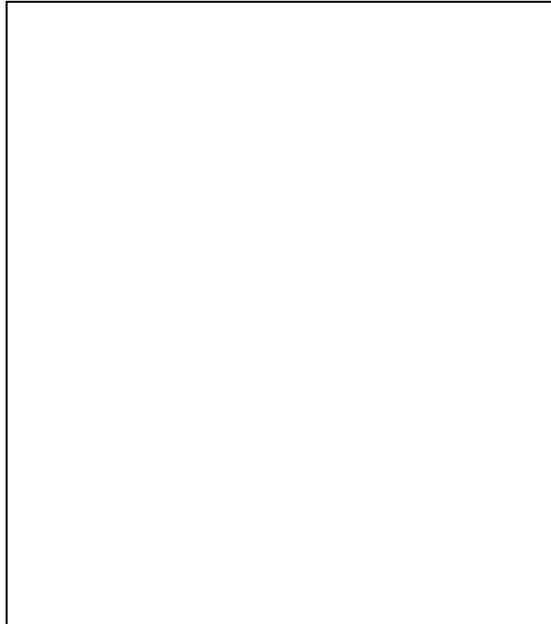
Make a bar graph, where the x-axis represents the number of days and the y-axis represents the mass of the jar and crystals. Your teacher will help you fill out the title for the y-axis and the x-axis.

Crystal Growth



What is the length of your largest crystal? _____ centimeters

Draw your sugar crystal:



3. Discussion and Conclusions: Answer the following questions:

What happened to the water in the cup?

What are the crystals made of?

What is condensation and when did you observe it?

What is evaporation and when did you observe it?

Did you enjoy making the sugar crystals?
