

The Sugar Crystal Experiment

Lesson Objective & Summary

Objective: After exploring the history of sugar cane in Mauritius, students will experiment with sugar and water solutions, evaporation, and sugar crystal formation. Students will explore some of the implications for sugar cane production and how sugar cane is changing the world.

Summary: Students will brainstorm a list of products they have used in the last day with sugar in them. Students will consider where sugar comes from and why it is used. Students will read [The British Period blog](#) and watch the episodes on [Sugarcane in Mauritius](#) and [The Great Experiment](#) to learn about indentured servitude and the process of harvesting sugar cane. Then, students will develop and conduct an experiment to see how sugar crystals form. After one day, students will record and discuss their observations from their sugar crystal experiment. Lastly, students will explore and consider some of the other implications for sugar cane production.

Standards & Benchmarks

From the Common Core Reading Standards for English Language Arts & Literacy (Grades 3-5)

- Students will quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text (*Key Ideas and Details*)
- Students will draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently (*Integration of Knowledge and Ideas*)

From National Science Education Standards, Grades 5-8:

- *Standard A: Science as Inquiry: Abilities and Understandings*
 - Students identify questions that can be answered through scientific investigations.
 - Students use appropriate tools and techniques to gather, analyze, and interpret data.
 - Students develop descriptions, explanations, predictions, and models using evidence.
- *Standard B: Physical Science: Properties and Changes of Properties in Matter*
 - Students understand that substances have characteristic properties that are independent of the amount of the sample, and that mixtures can be separated.

Grade Level:
Upper Elementary

DURATION:
2 - 3 Lessons

SUBJECTS:
Science, Social Studies,
World History

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Background Information for Educators

Although the Dutch introduced the sugarcane plant to Mauritius in the early 17th century, it wasn't until the British gained control of the island that sugar production became a major industry in Mauritius. Following the abolishment of slavery in the 1820s in Great Britain, the British hired indentured servants from India to cultivate and harvest the sugar cane plantations on the island. Mauritius soon became one of the most important sugar-producing colonies under British rule. Sugar was then exported to Great Britain and other British colonies to be used for table sugar, molasses, and other sugar-derived products.

Sugar cane is a grass that can grow nearly 20 feet tall. When harvested, the leaves are removed and the stalks are cut and squeezed to extract the juices that will later be processed into sugar. In sugar cane processing plants, the juice is cleaned with lime (a mineral similar to chalk), and then the water is boiled off, leaving a sugar syrup. Unlike evaporating salt / water mixtures, evaporating sugar syrup (a solution, not a mixture) to retrieve sugar crystals is a bit more complex. Sugar processing plants will often add sugar dust to the saturated syrup to help initiate the crystallization process. After crystals have formed, the sugar is then tossed, dried, and later refined into what we know as table sugar. The byproduct of sugar processing is molasses, which is either used for cattle food or alcohol distillation.

Sugar cane is not only an energy source for our physical bodies, but it also has other implications as a clean energy source for the future. Sugar cane is a low-cost crop, requiring only soil, water, and sunlight to grow, which makes it an economical crop for developing nations. Ethanol is a clean fuel (low emissions) that is derived from sugar cane that could potentially replace gasoline (petroleum) in the future in vehicles. Scientists continue to develop other uses and products derived from sugar cane, including electrical power sourcing, bioplastics, and biohydrocarbons (similar to jet fuel). At present, Brazil is the leading sugar cane producer in the world, while also leading the way in developing innovative ideas for using this simple crop.

<http://sugarcane.org> is an excellent resource for further information regarding sugar production and uses for sugar cane that extend beyond table sugar.

Guiding Questions	Key Vocabulary
<p>Where does table sugar come from?</p> <p>What are some of the other products that we get from sugar cane?</p> <p>Do our bodies need sugar?</p> <p>What is a solution? How is it different from a mixture?</p> <p>How do sugar crystals form?</p> <p>What are some of the characteristics of sugar crystals that make it different from other types of crystals?</p> <p>Why is sugar cane an important crop for the world? How else might it be used?</p>	<p>Indentured Servants</p> <p>Solution</p> <p>Mixture</p> <p>Saturation</p> <p>Evaporation</p> <p>Crystals</p> <p>Ethanol</p>

Lesson Plan

1. Ask students to create a list of the items they have used in the past day with sugar in them. Then, ask students if they know where sugar comes from and why we use sugar. (**Challenge question:** Ask students if they can name different sugars, such as sucrose, glucose, maltose, and fructose).
2. Watch the episodes [Sugarcane in Mauritius](#) and [The Great Experiment](#), and read [The British Period blog](#). Ask students to share their observations about sugar cane in Mauritius, guiding with questions as needed (e.g.: When and why was sugar cane grown in Mauritius? Who was responsible for working on the sugar cane plantations? What products can be made from sugar cane?)
3. Have students examine a small spoonful of sugar. What physical properties do students observe about sugar? What is its form called (crystal)? What do they notice about each sugar granule? If desired, distribute copies of the Sugar Crystals Experiment Student Learning Log (attached below) to students so they may record their answers.
4. Ask students if they know how sugar crystals are formed. Explain how sugar is extracted from the sugar cane, boiled, evaporated, and sent through processing and refining to make the table sugar we use. This resource may give additional insight into the process: <http://sugarcane.org/about-sugarcane/virtual-mill-tour>
5. Explain to students that they will be conducting an experiment to grow sugar crystals (see directions below). Ask students to consider what kinds of questions they might need to ask to help them develop their experiment. If appropriate, have students brainstorm and develop ideas for how to build the apparatus and what their experiment might look like before beginning the experiment with them. Use the Sugar Crystals Experiment Student Learning Log as a guide, if you desire.
6. Once students have completed their sugar crystal experiment, ask students to think about why sugar cane might be an important crop (hint: what do we get from sugar?). This video shows a fascinating explanation of how sugar cane is a low-cost, eco-friendly product that can help reduce carbon emissions and create other sustainable and renewable products for the future: <http://sugarcane.org/about-sugarcane/sugarcane-overview-video>
7. Have students read and summarize the following e-magazine that shares interesting ways that sugar cane can change the world: <http://sugarcane-solidaridad.org/recipebook>

Science Experiment

For the experiment, each student (or group) will need:

- Sugar (about 3 cups per experiment)
- 1 Spoon
- Stove top & a pot
- Water (about 1 cup per experiment)
- 1 clean glass jar
- A Pencil
- String (long enough to be tied around the pencil but short enough that it does not touch the bottom or sides of the jar; do not use nylon string)
- Optional: Food Coloring to add color; Paper towel or coffee filter to keep dust from getting in

Directions

1. Tie the string to the pencil and place across the lip of the jar to measure and cut string length. The string should be able to hang without touching the edges or bottom of the jar. Set the pencil and string to the side.
2. Heat water until almost boiling. Stir in sugar one spoonful at a time, until sugar does not dissolve any more. Explain to students that a “solution” is a special kind of mixture that cannot be easily separated into its different parts.
3. At this point, explain to students that the sugar solution is “saturated.” Add a few drops of food coloring, if desired.
4. Carefully pour the sugar solution into the jar, but try to keep any undissolved sugar from entering the jar.
5. Have students describe the liquid that is in the jar. Ask them if they can see the sugar. Challenge students with the following question: Although we can’t see the sugar, is it still there? How do we know? What could we do to find out?
6. Place pencil and string across jar lip, letting string dangle into sugar solution, making sure that the string does not touch either the sides or bottom of the jar. Place jar in an area where it won’t be disturbed. If desired, cover with a paper towel or coffee filter. Students should be able to see crystals form by the next day. Crystals can be allowed to continue to grow for as long as desired until water has completely evaporated (at least one week, in most cases). Once completed with the experiment, it is safe for students to eat their sugar creations.
7. Have students record and share their observations of their sugar crystals. How are they similar to the sugar granules they examined? How are they different? What happened to the water that was in the jar?

Possible Science Experiment Extensions and Variation

Have students experiment with making sugar solutions with different amounts of sugar dissolved. Will sugar crystals still form if the solution is not saturated?

Challenge students to try the same experiment using other sweeteners, such as brown sugar, aspartame, sucralose, Stevia, and agave nectar, or even table salt or Epsom salts. How might the results be similar or different?

Possible Geography Connection

Ask students to think about what climates might be necessary for growing sugar cane. If possible, show students a world map and point to some of the countries where sugar cane is grown (i.e.: Mauritius, Brazil, Thailand). Have students note where these countries are in relation to the Equator. <http://www.sucrose.com/learn.html>

Assessment / Evidence of Understanding

- Students can orally summarize, quote, and explain information gained from reading The British Period blog and the Sugar Solidaridad E-magazine.
- Students can follow steps to complete a scientific investigation, using appropriate tools and techniques while making observations, predictions, explanations, and conclusions.
- Students will be able to explain that the sugar crystals formed on the string once water in the solution evaporated.

Additional Resources

Assessment Rubric	Below Expectations	Meets Expectations	Exceeds Expectations
<p>Oral Explanations</p>	<p>After reading The British Period blog and excerpts from the Sugar Solidaridad E-magazine, student may recall general information from each text but explanations do not reflect a clear understanding of the subject material.</p>	<p>After reading The British Period blog and excerpts from the Sugar Solidaridad E-magazine, student recalls main points from each text and can clearly summarize and explain the main ideas from the text.</p>	<p>After reading The British Period blog and excerpts from the Sugar Solidaridad E-magazine, student recalls main points from each text, and summaries and explanations also include implications and applications for the concepts learned from the text.</p>
<p>Sugar Crystals Experiment Student Observations</p>	<p>Student's descriptions of physical characteristics of sugar granules and crystals are overly simplistic and may or may not have accurate labeling. Student can list the experiment's steps but may be missing some of the important labels or details. Student may have difficulties following the directions for completing the experiment. Student's observations, predictions, explanations, and conclusions are not reflective of grade-level expectations. Student does not accurately explain that sugar crystals formed when the water in the sugar solution evaporated.</p>	<p>Student's descriptions of physical characteristics of sugar granules and crystals are clear and include labeling that uses the appropriate vocabulary. Student lists the experiment's steps and includes important labeling and details. Student accurately follows the directions for completing the experiment. Student's observations, predictions, explanations, and conclusions are reflective of grade-level expectations. Student accurately explains that sugar crystals formed when the water in the sugar solution evaporated.</p>	<p>Student's descriptions of physical characteristics of sugar granules and crystals are clear and include labeling that uses vocabulary that exceeds grade-level expectations. Student lists the experiment's steps and includes important labeling and details. Student accurately follows the directions for completing the experiment and poses thought-provoking questions that reflect higher-level thinking and inquiry. Student's observations, predictions, explanations, and conclusions are reflective of above grade-level expectations. Student accurately explains that sugar crystals formed when the water in the sugar solution evaporated.</p>

How Cane Sugar is Made

<http://www.sucrose.com/lcane.html>

Differences in Sugar Types

<http://www.sugar.org/all-about-sugar/types-of-sugar/>

Sugar Crystal Experiment

<http://chemistry.about.com/od/growingcrystals/ht/blsugarcystal.htm>

Other Crystal Experiments

<http://www.kidzworld.com/article/26598-make-your-own-crystals>

The Science of Sugar Solutions

<https://www.exploratorium.edu/cooking/candy/sugar.html>

Sugar Cane Solidaridad: An e-magazine entitled How Can You Change the World with Sugar Cane?

<http://sugarcane-solidaridad.org/recipebook>

***** **Sugar Crystals Experiment Worksheet follows on next page** *****

Name: _____

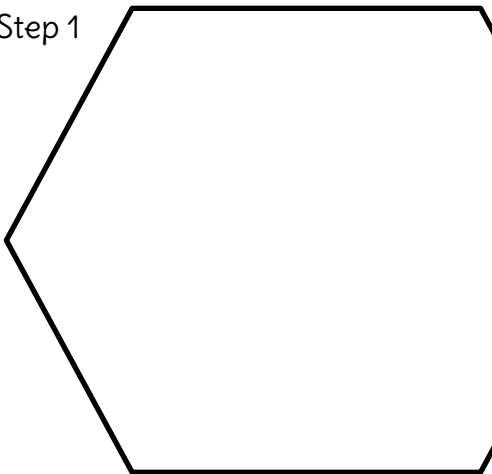
Sugar Crystals Experiment: Student Learning Log

Part I:

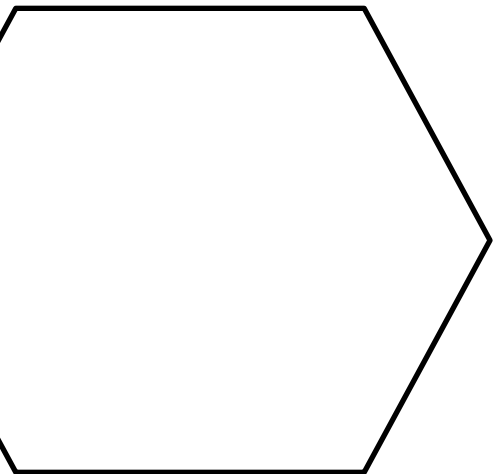
1. Examine a single grain of sugar. In the space below, draw what you see. Use words to describe the **physical properties** of a grain of sugar.

2. You will be conducting an experiment to make sugar crystals. In the spaces below, write and/ or draw the steps you will use to make the sugar crystals. Be sure to label!

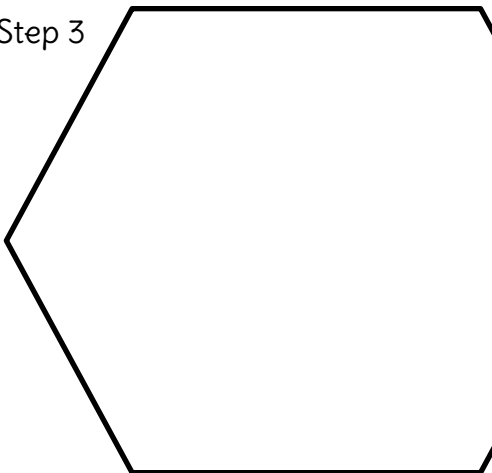
Step 1



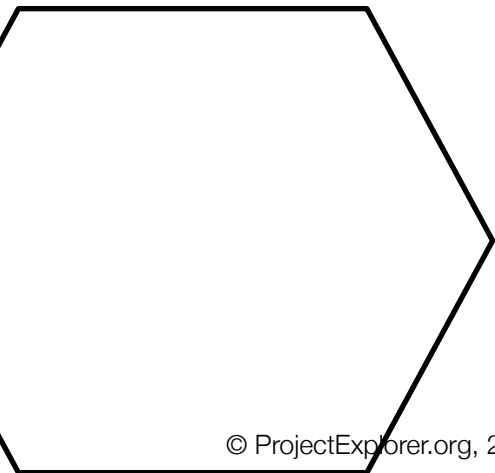
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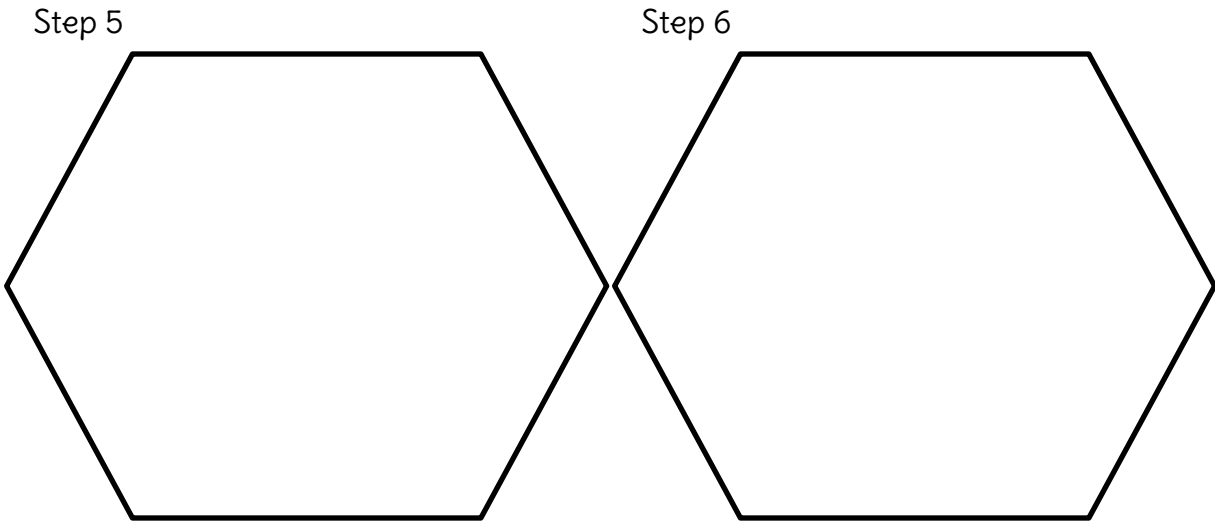


Step 3



Step 4





3. Make a prediction: How do you think the sugar crystals will form? What do you think might happen.

4. What do these words mean?

mixture -

solution -

saturation -

PART II (Completed after sugar crystals have formed)

1. Examine the sugar crystals that formed on your string. In the space below, draw what you see. Use words to describe the **physical properties** of your sugar crystals.

2. How are the grains of sugar that you examined at the beginning of the lesson similar to the sugar crystals? How are they different?

3. What happened to the water that was in the jar? How do you think the sugar crystals formed?