OPEN LESSON LTF
SAMPLE LESSONS FOR THE CLASSROOM FROM LAYING THE FOUNDATION

Sugar and Salt Solutions
Exploring Common Substances Using a PhET Simulation

About this Lesson

This activity is designed to be a guided inquiry lesson using a simulation produced by the PhET group from the University of Colorado at Boulder. The lesson has two parts, and can be used in a unit on chemical bonding or solutions.

In Part I, students are given the opportunity to explore the simulation and the effect of adding sugar and salt to water. In Part II, students are introduced to the terms *electrolyte* and *nonelectrolyte*. In the Extension, students have the opportunity to explore several other substances, and are introduced to the ideas of ionic and covalent bonding.

This lesson is included as an Open Lesson on the LTF website as well as on the PhET website.

Objectives

Students will:

- Compare the behavior of sugar and salt in water
- Identify sugar and salt as either an electrolyte or a nonelectrolyte
- Draw a particulate representation of salt in water and sugar in water
- Propose an explanation for why a light bulb glows or does not glow
- Extend the definition of electrolytes versus nonelectrolytes to other substances and qualitatively relate bond type to this observation

Level

Middle Grades Science

Common Core State Standards for Science Content

LTF Science lessons will be aligned with the next generation of multi-state science standards that are currently in development. These standards are said to be developed around the anchor document, *A Framework for K–12 Science Education*, which was produced by the National Research Council. Where applicable, the LTF Science lessons are also aligned to the Common Core Standards for Mathematical Content as well as the Common Core Literacy Standards for Science and Technical Subjects.

Code	Standard	Level of Thinking	Depth of Knowledge
(LITERACY) W.4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	Apply	II
(LITERACY) W.1	Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.	Apply	II

Connections to AP*

AP Chemistry: I. Structure of matter B. Chemical bonding 1. Binding forces a. Types: ionic and covalent II. States of matter C. Solutions

Materials and Resources

Each lab group will need the following:

computer with online access

Assessments

The following types of formative assessments are embedded in this lesson:

- Assessment of Prior Knowledge
- Guided Questions

The following additional assessments are located on the LTF website:

- Middle Grades Assessment: Chemical Bonding
- Middle Grades Assessment: States of Matter

Teaching Suggestions

This guided inquiry activity might easily be introduced to students by posing a question such as, "How can you tell the difference between table salt and sugar?" Allow the students a few minutes to brainstorm with each other, and allow some students to share their ideas. Inform the students that today they will have the opportunity to collect data that will help them distinguish between these two common household substances.

Ideally, students will each have an individual computer for their work. If not enough computers are available, have students work in pairs to complete this exploration. It may save time if the simulation is already open and running on each of the computers. Allow the students about five minutes to explore the simulation, and then share what they learned with the class.

Have students begin the activity and complete the "Macro" tab and the "Water" tab. Move around the classroom, checking that students are on track and exploring appropriately. Look for examples that you might highlight during class discussions. You may have to ask guiding questions to those having trouble.

Bring the class back together and have students explain how salt and sugar can be distinguished from each other using what they learned in this activity.

The Extension activity serves as a great introduction to the LTF lesson, "Electrolytes and Nonelectrolytes." This activity allows students to identify a variety of substances and connect bond type with electrolyte and nonelectrolyte properties.

This simulation may be downloaded from the PhET website at http://phet.colorado.edu/en/simulation/sugar-and-salt-solutions.

Acknowledgements

Executable versions of all PhET Interactive Simulations (PhET) of the University of Colorado are distributed under a Creative Commons Attribution 3.0 United States License. PhET™ is a registered trademark of the University of Colorado.

Answer Key

Procedure

Part I: Open Exploration

1. Students may share how the conductivity tester works; how to shake the shaker; how to add water to the container; and how the evaporation slider works.

Part II: Macro (First Tab)

1. See Table 1.

Table 1. Macro Exploration

Compound	What Happens to the Light Bulb? (Glows/Does not glow)	Observations
Water	Does not glow	When the conductivity tester is placed in water, nothing happens.
Salt	Glows	When the conductivity tester is placed in water with salt, the light appears to glow.
Sugar	Does not glow	When the conductivity tester is placed in water with sugar, nothing happens.

2. Student answers will vary but the general idea should be placing the conductivity tester into the water, add as much salt to the container as possible, and use the evaporation slider to reduce the amount of water.
3. If the evaporation is allowed to continue until all of the water is gone, a thin white layer forms on the bottom of the container representing the salt and the sugar. If the conductivity tester is left in the beaker during evaporation with salt, it glows very brightly but does not glow at all when only the solid salt is left.
4. a. Sugar: nonelectrolyte
   b. Salt: electrolyte

Answer Key (continued)

Part III: Water (Third Tab)

1. See Table 3.

Table 3. Water Exploration

Compound	Electrolyte or Nonelectrolyte?	Drawing	Observations
Salt	Electrolyte	Should show Na^+ and Cl^- ions surrounded by water	The sodium ion and the chloride ion separate and are surrounded by the water molecules. The red part (oxygen) of the water molecule is close to Na^+ whereas the white parts (hydrogen) are close to the Cl^- ion.
Sugar	Nonelectrolyte	Should show the sugar molecule surrounded by water	The sugar molecules separate from each other but do not break apart into individual charged particles like salt does. The water molecules still surround the entire molecule.

2. The salt breaks apart into ions when placed in water; sugar does not break apart.

Answer Key (continued)

Extension

Part IV: Micro (Second Tab)

1. See Table B.

Table B. Micro Exploration

Compound	Break Apart or Stay Together?		Electrolyte or Nonelectrolyte?	Ionic or Covalent?
	Prediction	Observation		
Salt (NaCl)	Break apart	Break apart	Electrolyte	Ionic
Sugar ($C_{12}H_{22}O_{11}$)	Stay together	Stay together	Nonelectrolyte	Covalent
Calcium chloride ($CaCl_2$)	Break apart	Break apart	Electrolyte	Ionic
Sodium nitrate ($NaNO_3$)	Break apart (students may not guess this)	Break apart	Electrolyte	Ionic
Glucose ($C_6H_{12}O_6$)	Stay together	Stay together	Nonelectrolyte	Covalent

Periodic Table

1. Answers will vary but students should follow the pattern of a metal paired with a nonmetal.
2. Answers will vary but students should follow the pattern of compounds containing two or more nonmetals.

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Sugar and Salt Solutions
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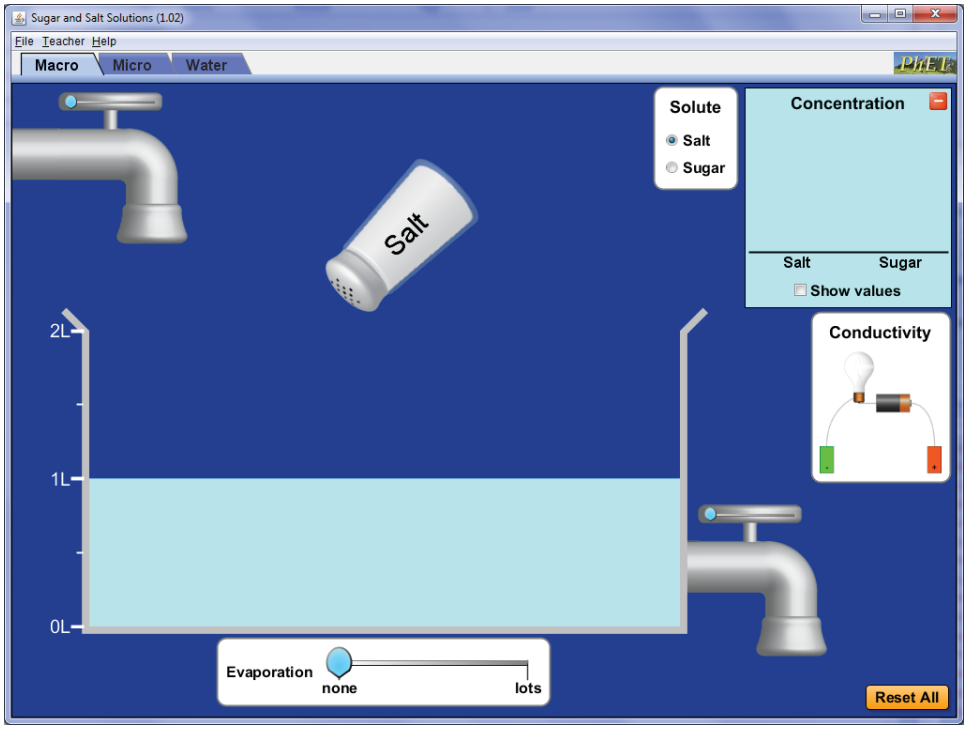
Sugar and salt are both white crystalline solids commonly found in the home. This exercise allows you to investigate how these compounds might be distinguished from each other.

This simulation may be downloaded from the PhET website at http://phet.colorado.edu/en/simulation/sugar-and-salt-solutions.



Purpose

In this experiment, you will explore the behavior of sugar and salt in water and attempt to classify these substances into categories.

Materials

Each lab group will need the following:

computer with online access

Procedure

Part I: Open Exploration

1. Open the "Sugar and Salt Solutions" PhET simulation. Take five minutes to explore the functions available. Share with a partner at least two interesting items that you discovered. Record these discoveries in the space provided.

Part II: Macro (First Tab)

1. Make the light bulb glow. Record your observations in Table 1.

Table 1. Macro Exploration		
Compound	**What Happens to the Light Bulb? (Glows/Does not glow)**	**Observations**
Water		
Salt		
Sugar		

2. Make the light bulb glow as brightly as possible. Explain your procedure.

3. Explore what happens to the sugar and salt solutions with the evaporation slider. Describe what happens during the evaporation process for a solution.

Procedure (continued)

4. Using Table 2, classify sugar and salt as either an electrolyte or a nonelectrolyte:

Table 2. Electrolyte/Nonelectrolyte Reference		
Substance	**When Added to Water**	**What Happens to the Light Bulb?**
Electrolyte	Conducts electricity	Glows
Nonelectrolyte	Does not conduct electricity	Does not glow

a. Sugar: _____

b. Salt: _____

Part III: Water (Third Tab)

1. What happens as you add sugar or salt to water? Fill in Table 3 with what you find.

Table 3. Water Exploration			
Compound	**Electrolyte or Nonelectrolyte?**	**Drawing**	**Observations**
Salt			
Sugar			

2. Using the observations made with salt in water and sugar in water; propose one possible explanation for the light bulb glowing under the "Macro" tab.

Extension

Table A. Ionic/Covalent Compound Reference		
Compound	**Types of Atoms**	**When Added to Water**
Ionic	Metal + nonmetal	Breaks apart into ions in solution
Covalent	Nonmetal + nonmetal	Does not break apart into ions in solution

Part IV: Micro (Second Tab)

1. What happens when other compounds are added to water? Fill in Table B with what you discover.

Table B. Micro Exploration				
Compound	**Break Apart or Stay Together?**		**Electrolyte or Nonelectrolyte?**	**Ionic or Covalent?**
	Prediction	**Observation**		
Salt ($NaCl$)				
Sugar ($C_{12}H_{22}O_{11}$)				
Calcium chloride ($CaCl_2$)				
Sodium nitrate ($NaNO_3$)				
Glucose ($C_6H_{12}O_6$)				

Periodic Table

1. Using the "Periodic Table" button, work with your partner to identify two other combinations of elements that might be considered an ionic compound. Explain your reasoning.

2. Using the "Periodic Table" button, identify two combinations of elements that might be considered a covalent compound. Explain your reasoning.