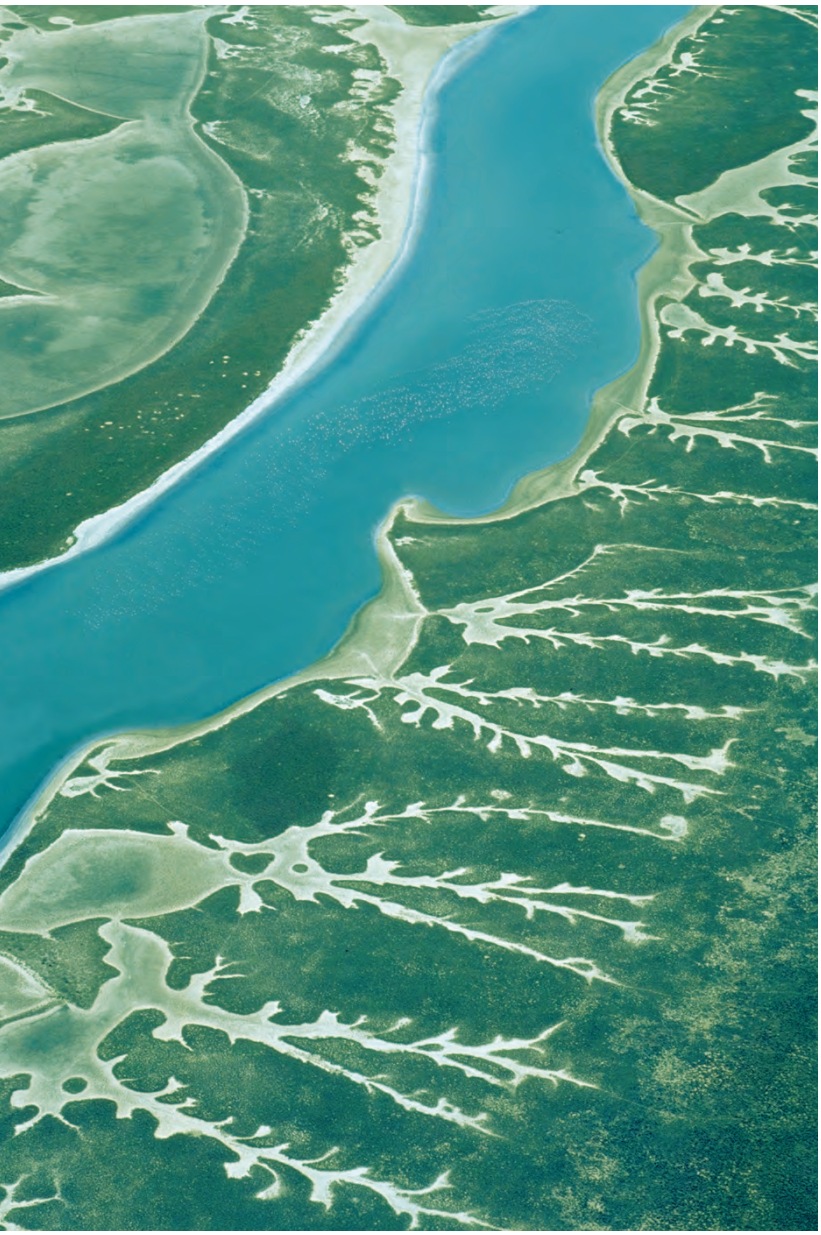
LESSON 13

How Much Solute Dissolves in a Solvent?



Solid soluble salt and water are seen next to each other in this lake in Namibia, Africa. How can solid soluble salt and water exist in the same place?

INTRODUCTION

As you know from Lesson 12, solutions are made from solvents and solutes. When you add a spoonful of common salt (sodium chloride) to a pan of water, it dissolves. Salt is soluble in water. Add a second spoonful, and that also dissolves. But what would happen if you kept adding salt? Would it continue to dissolve? Could you add more salt than there was water, or would the salt eventually stop dissolving? What would happen if you used a soluble substance other than salt? Would the same amount of that substance dissolve? These are some of the questions you will try to answer in this lesson. You will start by examining a blue liquid and explaining your observations of the liquid on the basis of what you already know. You will then investigate two white crystalline substances. One is sodium chloride, and the other is sodium nitrate. They look almost the same, but as you will discover, they have different characteristics when they are added to water. Could these different characteristics be used to help identify these two substances?

OBJECTIVES FOR THIS LESSON

Make solutions using different amounts of solute.

Discover what is meant by the term "saturated solution."

With your class, design and conduct an experiment to determine the solubility of two different substances.

Discuss the design of your inquiry.

Discuss solubility as a characteristic property of matter.

Getting Started

1. One student from your group should collect the plastic box containing the materials.

2. Take out the test tube rack and the test tube containing the blue liquid. Pass the test tube around your group so that each member of your group can examine it closely. Discuss with other members of your group precisely what you observe in the tube. Write your observations in your science notebook. What can you conclude from your observations?

3. Participate in a class discussion of your observations.

4. Before proceeding with Inquiry 13.1, hand in the test tube containing the blue liquid. Clean the remaining test tube. Return the test tube rack to the plastic box.

SAFETY TIP

Wear your safety goggles at all times.

MATERIALS FOR LESSON 13

For you

- 1 copy of Student Sheet 13.1: Saturating a Solution
- 1 copy of Student Sheet 13.2: Determining Solubility
- 1 pair of safety goggles

For you and your lab partner

- 1 100-mL graduated cylinder
- 2 test tubes
- 1 test tube rack
- 2 rubber stoppers
- 1 lab scoop
- 1 jar containing sodium chloride
- 1 jar containing sodium nitrate
- Access to an electronic balance

For your group

- 1 test tube containing a blue liquid

Inquiry 13.1
Saturating a Solution

PROCEDURE

1. Check the materials in your plastic box against the materials list, and divide them equally between the two pairs in your group.

2. How much salt (sodium chloride) can you get to dissolve in a test tube filled halfway with water? Fill one test tube halfway with water. Add one level lab scoop of salt to the test tube. Shake the mixture to help the salt dissolve faster. If it completely dissolves, add more salt. Keep adding salt until no more dissolves.

3. Answer the following questions on Student Sheet 13.1: How many scoops of sodium chloride dissolved in the water? How did you know that no more would dissolve?

4. After a short class discussion, write your definition of a saturated solution on the student sheet.

5. Think about how you could adapt the technique you used in Step 2 to find out how many grams of sodium chloride dissolved in water.

6. Rinse the test tube with water. Put the test tube in the test tube rack.

Inquiry 13.2
Determining Solubility

PROCEDURE

1. Using the apparatus you have been given, how could you compare how much of each of the two substances (sodium nitrate and sodium chloride) will dissolve in water? Here are some questions you need to discuss with your partner:

   A. What will you need to measure?

   B. How will you know when you have a saturated solution?

   C. How will you calculate the amount dissolved?

2. Your teacher will conduct a short brainstorming session. Be prepared to contribute to the discussion. By the end of the brainstorming session, the class will have agreed on a procedure for determining solubility.

3. Answer the following questions on Student Sheet 13.2: What are you trying to find out? What materials will you use? What is your procedure?

4. Under Step 4 of Student Sheet 13.2, design a data table to record your results and calculations.

5. Follow the class procedure for determining solubility, and record your results in the data table. When you have finished, pour the solutions down the drain with lots of water. Clean the test tubes and return the materials to the plastic box.

6. Under Step 5 on the student sheet, calculate the number of grams of each substance that dissolved in the water and answer the following question: Are the different substances equally soluble in water?

7. Under Step 6 on the student sheet, write any problems you had with the experiment or the approach and answer the following question: Could any of these problems have affected your results?

REFLECTING ON WHAT YOU'VE DONE

1. You will have an opportunity to look at the results of other pairs. Be prepared to discuss how these results could give a more accurate measure of the solubility of these two substances.

2. Answer the following question on Student Sheet 13.2: How could you use the property of solubility to help you identify a type of matter?

3. Read "Solubility and Saturated Solutions."

SOLUBILITY AND SATURATED SOLUTIONS

At room temperature, a solvent (such as water) can dissolve only a certain amount of solute. For example, in Inquiry 13.1, after adding a few lab scoops of sodium chloride to the water, you could see a white solid (undissolved sodium chloride) at the bottom of the tube. The white solid indicated that the water could not dissolve any more sodium chloride. When this happens, the solution is called saturated. The mass of solute dissolved in a given volume or mass of a solvent is its solubility. Solubility is usually measured in grams of solute per unit volume of solvent (for example, grams per liter) or in grams per 100 g of solvent.

The solubility of a solute changes with changing temperature. For example, sodium nitrate becomes more soluble as the temperature rises. It is about twice as soluble at 80 °C as it is at 1 °C. There are some substances that become less soluble as the temperature rises. When you heated water in Lesson 7, you may have noticed that bubbles appeared, even though the water was well below the boiling point. These were bubbles of gases, such as oxygen and nitrogen, that were dissolved in the water. The gases became less soluble as the water was heated, and they were released from solution.
