Activity 4.6
A dissolving challenge

How can you make a lemon soda that keeps as much carbonation as possible?

In *Demonstration 4b* and *Activity 4.5*, students see that dissolved gas comes out of carbonated water when a bottle is opened and when the temperature is increased. In this activity, students add objects and substances to carbonated water to discover that added objects also increase the rate dissolved gas comes out of solution. Students are then challenged to make a lemon soda that retains as much carbonation as possible by using carbonated water, sugar, and lemon juice. Students identify the difficulty in making a fizzy lemon soda, develop a better method, and then test it.

Materials needed for each group

1 Small bottle of club soda	Pipe cleaner	1 Teaspoon
Lemon juice	M&M's	4 Clear plastic cups
Sugar	Popsicle stick or stirrer	2 Small cups

Notes about the materials

- **Be sure you and the students wear properly fitting goggles.**
- Materials may vary depending on how students decide to test their lemon sodas for carbonation. The procedure described in the activity uses M&M's for the test.

Preparing materials

- Either give each group a small unopened bottle of club soda or pour about 1 cup of carbonated water into a small bottle and secure tightly with a lid.
- Label 2 small cups **sugar** and **lemon juice** for each group.
- Place about 2 tablespoons of sugar in its labeled cup.
- Add about 2 tablespoons of lemon juice to its labeled cup.

Activity sheet

Copy *Activity sheet 4.6—A dissolving challenge*, pp. 216–217, and distribute one per student when specified in the activity. Give each student a piece white construction paper to create a mini-report about the process of making a fizzy lemon soda. Instructions are included on the second page of the activity sheet.

Assessment

An assessment rubric for evaluating student progress during this activity is on pp. 218–219. For this formative assessment, check a box beside each aspect of the activity to indicate the level of student progress. Evaluate overall progress for the activity by circling either "Good", "Satisfactory", or "Needs Improvement".

Activity 4.6
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Question to investigate

How can you make a lemon soda that keeps as much carbonation as possible?

1. Have students add objects to carbonated water.

Distribute *Activity sheet 4.6—A dissolving challenge*. Have students follow the procedure and record their observations.

Procedure

1. Pour ¼ cup of club soda into a clear plastic cup.
2. Sprinkle a pinch of sugar onto the surface of the soda and observe.
3. Place an M&M in the soda. Watch it closely.
4. Place a pipe cleaner in the soda and observe.

2. Discuss student observations.

***Expected results*: Bubbles form on the sugar, M&M, and pipe cleaner, and rise to the surface.**

Ask students questions like the following:

- Does the carbonated water in your cup have as much gas as it did before you added all of the objects?
- Where did the carbon dioxide gas that was dissolved in the water go?

Students should realize that their club soda lost carbonation with the addition of each object. Explain that the gas that was dissolved in the water attached to and accumulated on the objects. When enough gas accumulated, a bubble formed and rose to the surface.

Demonstration

3. As a demonstration, make a lemon soda by adding lemon juice and sugar to carbonated water.

Procedure

1. Pour ¼ cup of club soda into a clear plastic cup.
2. Add 1 teaspoon of lemon juice and stir with the spoon until the lemon juice is dissolved.
3. Add 1 teaspoon of sugar and stir with a spoon until the sugar is completely dissolved.

4. Discuss student observations.

Have students record their observations on *Activity sheet 4.6.* Then as a whole class, discuss student observations of the demonstration.

***Expected results*: When lemon juice is added to club soda, few additional bubbles form. When sugar is added, much more bubbling occurs. Stirring until the sugar dissolves causes even more bubbles to form.**

5. Identify the problem of excessive bubbling when sugar was added.

Students should realize that adding sugar to carbonated water and stirring until it dissolves causes a great deal of carbon dioxide gas to escape. Remind students that the bubbles they saw when sugar was added were filled with carbon dioxide gas that was once dissolved in the water. When the bubbles formed, they rose to the surface of the carbonated water and popped, sending the carbon dioxide gas out of the soda and into the air. This means that the lemon soda you made has lost a lot of its carbonation, making it flat.

Then ask students questions like the following:

- What are "flat" sodas like?
- Which ingredient, lemon juice or sugar, causes most of the bubbling?

6. Have students write about the problem of making a lemon soda the way it was made in the demonstration.

Pass out one piece of white construction paper for each student. Direct students to fold the construction paper in half like a greeting card and label each page with the titles listed on the activity sheet. Students should then design a front cover and write about the problem with the way the lemon soda was made in the demonstration.

7. Challenge students to develop a method of making a lemon soda so that little gas is lost in the process.

Tell students that there must be a way to solve the problem of sugar making carbon dioxide gas leave carbonated water. After all, there are many sweet carbonated beverages on the market. Don't tell students yet, but one solution is to dissolve the sugar in the lemon juice first. Then pour this syrup into the carbonated water. This method is described in the following procedure. If students need a hint, remind them that when the lemon juice was added, there wasn't much bubbling. They will need to think of a way to add only liquids to the carbonated water.

Procedure

1. In a separate cup, combine 1 teaspoon of sugar and 1 teaspoon of lemon juice. Stir until the sugar is dissolved.
2. Fill your clear plastic cup about ¼ of the way with club soda.
3. Pour the sugar and lemon juice solution into the club soda and stir to mix.

***Expected results*: There is much less bubbling using this method than there was when the sugar was added separately from the lemon juice in the demonstration.**

8. Have students write how they made a lemon soda that kept its carbonation better than the one made in the demonstration.

Have students add to their mini-report by describing their group's method for making a fizzy lemon soda on the page titled "A Better Way".

9. Have students develop a test to compare a lemon soda made with their method to a lemon soda made like the one in the demonstration.

Ask students what they think would happen if you would have placed salt, an M&M, or a pipe cleaner, in the lemon soda that you made in the demonstration. Would many bubbles form? Would more bubbles form in the lemon soda that students made?

Challenge students to develop a test to compare the amount of carbonation left in a soda made with their method to the amount left in a soda made like the one in the demonstration. However they choose to test the sodas, students should be sure to make both sodas at the same time and test them in the same way.

Procedure

1. Make a lemon soda using your method while your partners make a lemon soda using the method shown in the demonstration.
2. Place an M&M in each soda at the same time.
3. Observe from the side to compare the amount of bubbling in each soda.

***Expected results*: More bubbles rise from the M&M placed in the lemon soda made with the students' method.**

10. Have students describe their test and results on the last page of their mini-reports.

Students should write about the test they conducted on the page titled "Testing for Carbonation".

Tell students that syrups are often used to flavor sodas. If they look at the ingredient list on a can of soda pop, they will see that corn syrup is used as a sweetener. Ask students to explain one reason why corn syrup is a better sweetener to use than granulated sugar.