Dancing Raisins

Section **PROPERTIES OF MATTER** *Topic* **DENSITY**

Estimated Time Setup: 5 minutes; Procedure: 10 minutes

OVERVIEW

Students will explore the concepts of density and solubility as they watch raisins "dance" in a glass of soda water or pop.

What makes the raisins "dance" or causes them to sink and float? In this activity, students observe as bubbles form in a carbonated liquid. The bubbles cling to each raisin because of its textured surface, lowering the density of the raisin and air bubbles together until the raisin floats to the surface. As the bubbles pop and reform, the raisins "jump" and "dance" in the glass.

MATERIALS

For one setup:

- Tall, clear glass or plastic cup
- Clear soda (This can be soda water, pop, or any other carbonated beverage; it should be cold for the experiment to work best.)
- Raisins

INQUIRY QUESTIONS

Getting Started:

- What causes an object to sink or float?

Learning More:

- Where do the bubbles in a carbonated drink come from and where do they go?

Diving Deeper:

- Why are gases released from carbonated liquids at certain sites?

CONTENT TOPICS

This activity covers the following content topics: density, carbonation, solubility, buoyancy

This activity can be extended to discuss: environmental science (weather, oceans), food science, equilibrium

NGSS CONNECTIONS

This activity can be used to achieve the following Performance Expectations of the Next Generation Science Standards:

- **2-PS1-1: P**lan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
- **5-PS1-3:** Make observations and measurements to identify materials based on their properties.
- **MS-PS1-1:** Develop models to describe the atomic composition of simple molecules and extended structures.

ACTIVITY NOTES

This activity is good for:

- Demonstrations
- Small groups
- Large groups

Safety Tips & Reminders:

- Be sure to either give the seltzer time to settle or to pour the seltzer into a glass before starting the experiment and adding the raisins in slowly. Otherwise, when you drop the raisins in it will release a lot of gas and you might get sprayed!
- Even though this activity uses edible food, there is no eating or drinking in the lab.
- Review the Safety First section in the Resource Guide for additional information.

Fun Fact **#1**

Most raisins you see are a dark purple color. These are raisins from red grapes. Raisins that are yellow in color are produced from green grapes.

ENGAGE

Use the following ideas to engage your students in learning about density:

- Have the raisin and soda pop mixture ready before class, and ask students to either guess what is in it or explain what is happening.
- Have one glass of water and one glass of soda. Ask your students to predict what will happen when the raisins are dropped into each cup. Then drop the raisins in and observe. Ask students why the raisins behave differently in the water and in the soda.

See more ideas for engagement in the Density Background section! You can also look at the Elaborate section of this activity for other ideas to engage your students.

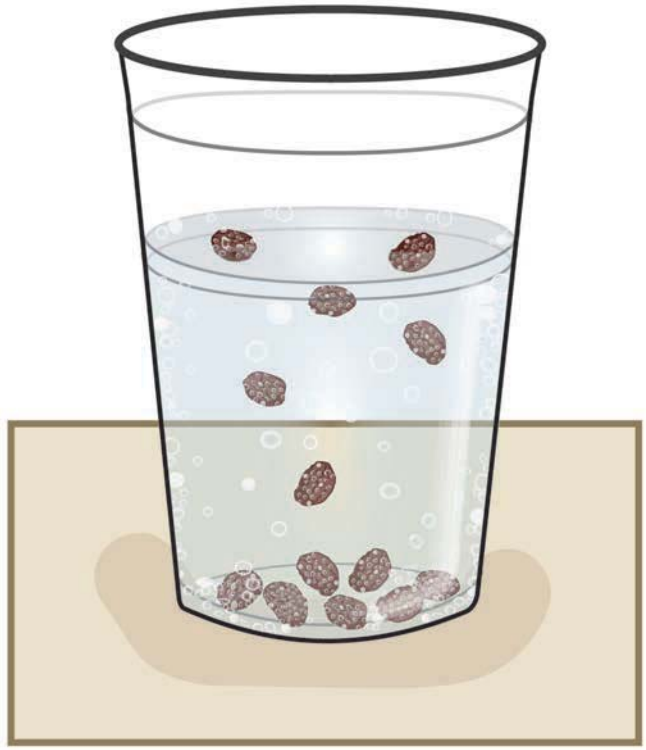
Fun Fact #2

Soda water is often called "seltzer." The word seltzer comes from the German town Selters, which is known for its mineral springs that were originally found in the year 1000 CE! In 2014 the world's oldest bottle of corked Selters water was found in the Baltic Sea. The bottle is believed to be at least 200 years old!

EXPLORE

Procedure:

1. Fill a glass with soda.
2. Drop a few raisins into the glass and turn on the music!
3. Observe what you see and draw or record your observations.



Notes

DATA COLLECTION & ANALYSIS

Analyze and discuss the results of this activity using the following questions:

- Draw a picture of the bottle of soda pop before it is opened and after it is opened. Make note of what sounds you hear and what changes are visible.
- Look closely at each raisin. What do you notice about the ones that are moving?
- Describe the movement of the raisins when they are dropped in the soda pop. What forms on the surface of the raisins? Where it is coming from? Where does it go? Explain using evidence.

Notes

EXPLAIN

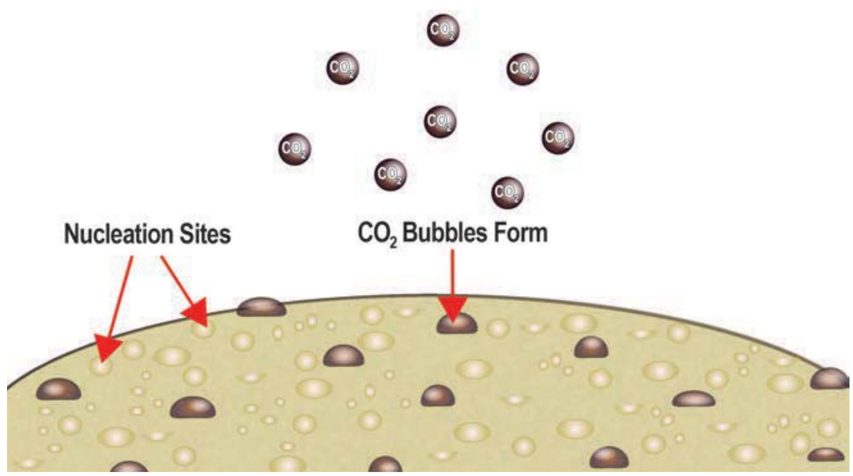
What's happening in this Activity?

First review the Density Background section to gain a deeper understanding of the scientific principles behind this activity.

In this activity, we explain how and why the raisins in the soda water "dance," or move up and down in the container. The moving raisins can be explained by a combination of carbonation and density. **Carbonation** is the process of adding carbon dioxide (CO_2) to water. Carbon dioxide is **soluble** (able to dissolve) in water. Once carbon dioxide is dissolved in water, it is no longer a gas. Instead, it exists as dissolved carbonic acid, or H_2CO_3. However, as we learned in the Liquid Rainbow activity, there is still a limit to how much can dissolve. The amount that can dissolve depends on a number of factors, including pressure.

Increasing the pressure of a liquid increases the amount of gas that can be dissolved in it. The carbon dioxide stays in the water as carbonic acid because it is under high pressure in a sealed bottle, and more gas can dissolve at a higher pressure. Once the bottle is opened, we observe the carbon dioxide released into the air, and hear a familiar hissing sound of gas escaping. The pressure decreases when the bottle is opened, so less gas can stay dissolved in the same amount of liquid. The extra carbonic acid that the liquid can no longer hold forms back into carbon dioxide gas, creating bubbles and floating to the top of the bottle.

Where do these carbon dioxide bubbles form in the liquid? Notice that most of the bubbles form on the raisins and on the inside walls of the container, rather than being spread evenly throughout the liquid. There are strong interactions (known as hydrogen bonds) between water molecules, and forming a bubble is difficult because it requires disrupting those bonds, or interactions. A bubble is not likely to just form in the middle of a liquid, it needs something to build on—think of it like a meeting place for carbon dioxide molecules. The areas where the bubbles form are called nucleation sites. **Nucleation sites** are places where there are microscopic imperfections (tiny flaws) in a material, such as scratches or dirt, which allow gas particles to come together. Every place in the container where bubbles form is a small imperfection, and a raisin's bumpy surface holds tons of ideal nucleation sites! This is why so many bubbles form on the raisins in the soda water. A raisin or an imperfection was already disrupting the interactions between solute water molecules, so it is easier for bubbles to form there.



Density is a measure of how compact a substance is. This means how much matter is in a certain amount of volume, and it is represented by the formula **Density = mass/Volume (or D=m/V)**. When an object is placed in a liquid, it will sink if its density is greater than the density of the liquid, and float if its density is less than the density of the liquid. A raisin drops to the bottom of a glass of soda water because its density is greater than that of the soda.

EXPLAIN continued

The raisins are only able to rise to the top of the liquid once there are many bubbles of carbon dioxide on them. Gases usually have a lower density than liquids or solids because the particles in a gas are more spread out. As the bubbles form on the raisins, the volume is rapidly increasing for each raisin since the bubbles take up space. But the mass is not increasing much because the gas bubbles have low mass. From our formula for density, we know that if the volume increases more than the mass increases, the density will decrease. Eventually, the density decreases enough that the raisin and attached bubbles rise to the top of the liquid. Once the raisin reaches the surface, the carbon dioxide bubbles pop and the gas is released into the air. Without the gas, the raisin once again has its original density and sinks back to the bottom.

Differentiation for Younger or More Advanced Students

You can differentiate this activity for students of different grade levels by focusing on the concepts outlined below.

GETTING STARTED

For younger students, emphasize the following concepts:

- Density—different substances have different masses and volumes, giving them characteristic properties, like density
- Carbonation and solubility—gases can be dissolved in liquids

DIVING DEEPER

For more advanced students, emphasize the following concepts:

- Solubility
- Buoyancy
- Equilibrium—CO_2 can dissolve in water via the following equilibrium reaction:
  $CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$

ELABORATE

Elaborate on your students' new ideas and encourage them to apply them to different situations. The section below provides some alternative methods, modifications, and extensions for this activity.

- If you don't have cold carbonated liquids, you can fill a glass halfway with water and then add one tablespoon of baking soda. Stir until it dissolves completely. Add vinegar to fill the cup and add in raisins. This is similar to the reaction in the Exploding Bags activity. As the reaction slows down, add more of the reactants (baking soda and vinegar) to start it back up! Note that the chemistry behind this is slightly different, because the bubbles are being created by a chemical reaction rather than an equilibrium reaction with a dissolved gas.
- Try replacing the soda pop or the raisins with different liquids and solids. What happens when the liquid has a different level of carbonation, or when it has no carbonation? Do you see the same thing happen? What about if you use M&Ms®, pennies, or grapes instead of raisins? Why might they not behave the same way?
- Ask students to make predictions for what would happen if the raisins were flattened, or if many of them were squished together. What predictions can we make? What works better, smaller or larger raisins? Test it out and see!
- Try the experiment again but this time put a lid on the bottle or cup after a few minutes. What effect might this have and why?
- Try the experiment with samples of soda pop at different temperatures: cold, room temperature, and warm. What do you notice? Why might this happen? How does temperature affect the amount of gas dissolved in a liquid? Check out the two Activity Guide experiments Balloon in a Bottle and The Great Escape to better understand what is happening.
- This activity works best with raisins that are old and dried out. Why might that be the case?
- Connect to the Fountain of Soda Pop activity! Explore nucleation sites further by doing this activity with your students.

CHEMISTRY IN ACTION

Share the following real-world connections with your students to demonstrate how chemistry is all around us.

Real-World Applications

The same concepts of density, displacement, and buoyancy can be observed when young children wear "floaties" in pools. The air in the floaties increases the overall volume of the child, so that the child weighs less than the water displaced. As a result, the child floats more easily in water.

Water contains dissolved oxygen from which fish and other aquatic animals extract the oxygen they need as the water flows past their gills. Humans lack the ability to breathe underwater and have developed oxygen tanks to allow them to stay underwater for long periods. People are able to breathe underwater by using pressurized gas tanks that provide oxygen for divers to breathe.

The ocean naturally absorbs about one-fourth of the atmospheric carbon dioxide humans produce each year, which is converted into carbonic acid when dissolved. The concentration of carbonic acid in the oceans is increasing because of increased atmospheric carbon dioxide in the atmosphere. The increase in ocean acidity has many negative consequences for sea life, such as inhibiting corals from establishing reefs and dissolving animal shells.

Careers in Chemistry

- Food scientists need to understand carbonation of drink products. While mineral water naturally has carbonation, drinks such as tonic water and seltzer water have the carbonation added artificially. Food chemists determine how much carbonic acid to add to the water in order to achieve their desired product.

- Ships and submarines use ballasts filled with air to help them sink or float as needed. Ship captains will order for the ballast to be opened to allow water in when they need to sink below the surface, and open a compressed air valve that pushes air into the ballast (and water out) when they need to reach the surface again.

EVALUATE

- Have students explain the steps in this activity and why the raisins behaved in a certain way at the start, middle, and end of the experiment. See if they can use new vocabulary, such as density, buoyancy, sink, float, volume, mass, and more!

- What connections can students make to the world around them? Ask groups of students to make a drawing or comic strip to show these concepts in the real world. Some examples could be a child using floaties in a pool, or inflating balloons with helium. What other examples can they think of?

- Ask students to try this activity again at home with a variety of different liquids and solids. Create a worksheet where they can write their observations before, during, and after the experiment. Which objects "danced" the fastest? Slowest? Why might that be?