Lesson: What is density?

FOR THE TEACHER

Summary
In this two-part lesson, students will learn about density through a teacher-led demonstration and a hands-on activity. The demonstration will give students the opportunity to observe the formation of a density tower made from common drinks. Students will then create their own density tower using simple ingredients, and then further investigate differences in density when solid objects are added to the tower.

Grade Level
Elementary School

Objectives
By the end of this lesson, students should be able to:
- Understand the meaning of density, and explain what factors make different objects have different density values.
- Identify density as a physical property of matter.
- Use appropriate vocabulary to discuss their observations.
- Predict and compare the density of different solids and liquids based on their behavior in a density tower.

Chemistry Topics
- Density
- Mixtures

Time
Teacher Preparation: 30 minutes
Lesson: Day 1-1 hour, Day 2-1:15

Materials
Day 1 Lesson:
- Large clear plastic/glass container (20 inches or taller)
- small disposable drinking cups (one per student)
- Ocean Spray Cran-Apple juice (40g sugar per serving)
- Pina Colada SoBe (25g of sugar per serving)
- G2 Gatorade blueberry-pomegranate (5g sugar per serving)
- turkey baster
- ice

Day 2 Lesson:
- 8 ounce clear plastic cups (one per group)
- corn syrup (light colored, 2 bottles)
- water (1 gallon)
- vegetable oil (light colored, 2 bottles)
• a variety of solid objects: suggestions include a building block, a metal nut, and Styrofoam peanut used in shipping packages (1 of each object for each group)
• rulers (1 for each group)
• permanent markers (1 for each group)
• paper towels
• KWL chart (see Teacher Notes for explanation)
• chart paper for recording student observations
• markers for writing

Safety
• Food in the lab should be considered a chemical, not for consumption.
• Always wear safety goggles when handling chemicals in the lab.
• Students should wash their hands thoroughly before leaving the lab.
• When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.
• Be aware of any allergies students may have prior to the experiment.

Teacher Notes
• This link is a helpful resource from Harvard. The article explains the scientific concept of density. It reviews how students’ ideas about density typically progress and what problems they encounter with their thinking. Next, it tells how causal restructuring is important in gaining a deep understanding. Causal restructuring is the relation between an event and a second event, where the first event is understood to be responsible for the second. Finally, it outlines misconceptions about density and is divided into two types—those that require learning a new causal structure and those that do not.
• A KWL chart activates students’ background knowledge about a topic, like density, and helps to scaffold them as they ask questions and organize the information they’re learning. Teachers can create a KWL chart by hanging up three sheets of butcher paper on a classroom wall or one large chart divided into 3 columns and labeling them K, W, and L; the letters stand for “What We Know,” “What We Wonder,” and “What We Learned.” The chart helps students activate background knowledge, combine new information with prior knowledge, and learn technical vocabulary related to density. Teachers direct, often scribe, and monitor the development of the KWL chart, but it’s the students’ discussion that makes this such a powerful instructional procedure. See this description of KWL charts for more information, if needed.
• Start the lesson as a whole group during the demonstration, and I then suggest moving to mixed-ability small groups of 3-4 students.
• As an extension for older students, teachers could use this Steve Spangler lab to expand the layers of density to include different liquids. Just be sure to no longer allow them to drink it when the experiment is finished!
• Suggestions for real-world connections: How Can the Study of Density Be Used in the Real World?
• The AACT Density animation is a helpful concluding task for this lesson.
• Explanation of basic terms used in this lesson:
  o Density is defined as mass per volume for a substance.
  o Mass is determined by the amount of matter in a substance, and can be defined by the number of atoms that are in the substance.
  o Volume is how much space a substance occupies.
• Explanation of the density towers:
  o The Juices used have different density values. The density of a juice is often determined by how much sugar or fruit is in it – the more sugar or fruit, the denser the juice will be. Powdered and canned juices do not work well for this experiment since they are almost entirely water. You will have to do some experimentation and label reading to find juices that are colorful and give a nice display of density if the juices mentioned in the materials section are unavailable.
  o The density tower demonstrates the amount of matter that is present in a particular volume of a liquid. In other words, if you have cup with 200ml of plain water, and a cup with 200 ml of water that has lots of sugar dissolved in it, the cup of sugar water will be heavier even though they are the same volume of liquid – the invisible sugar molecules are dispersed in the water, making it more dense, and therefore heavier.
  o Density Column Mix-up: What happens if you shake or mix up your sugar density column? The colors will not separate and go back to the rainbow, like a corn syrup-water-oil density tower. The sugar will mix evenly with the water making it miscible. Here is more information from a [Steve Spangler lab](#).

• Note that there is no student document associated with this lesson.

Lesson Day 1:
• Opening: Play the song, “It’s Called Chemistry” by Kim Mitzo Thompson. Tell students that they are going to be chemists today and learn about density. Ask the students what they know about density. Students will record their ideas on sticky notes and place them on the “Know” column of the class KWL chart. The class will participate in a brisk discussion of their ideas.
• Review solids and liquids with the class with the “Matter Chatter” song by Harry Kindergarten Music, and ask students what they want to learn about density. Record responses on the “Want to Learn” portion of the KWL chart.
• Read aloud [What Is Density?](#) (Rookie Read-About Science for ages 6 and up).

Demonstration 1:
The teacher will create a density tower using multiple types of drinkable liquids. This demonstration will allow students to observe how the differences in the density of each liquid affect the overall mixture. The tower will form due to the different amount of sugar in each liquid. Ask for help from the students as much as possible in order to keep students engaged in the experiment.

1. Use a ruler and permanent marker to measure 6 inches from the bottom of the large clear container and mark it. Repeat 2 more times above the initial mark, keeping the lines 6 inches apart each time (smaller gradations can be used depending on the size of the container).
2. Before beginning the experiment, ask the students to make observations about the Ocean Spray Cran-Apple liquid. The class will describe it, talk about its color, texture, and thickness. The teacher will record the students’ observations on the chart.
3. Next, ask students to make observations about the SoBe Pina Colada liquid. The class will describe it, talk about its color, texture, and thickness. The teacher will record students’ observations on the chart.
4. Finally, ask students to make observations about the Gatorade G2 liquid. The class will describe it, talk about its color, texture, and thickness. The teacher will record observations on the chart.
5. Then beginning with the Ocean Spray Cran-Apple, the teacher will use a turkey baster to fill the container to the first line with the Ocean Spray Cran-Apple.
6. Clean the turkey baster; squeeze any leftover liquid onto the paper towel.
7. Fill the turkey baster with SoBe Pina Colada and slowly release it onto the inside of the container so that it runs slowly and gently down the inside of the container. Encourage students to watch the juice to see what happens once it reaches the Cran-Apple juice that is already in the container. Continue adding the SoBe liquid until it reaches the second line of the large clear container.
8. Clean the turkey baster; squeeze any leftover liquid onto the paper towel.
9. Repeat step 8 with the Gatorade G2.
10. Students should be asked to make observations of the layered drink, and brainstorm reasons for their observations.
11. The teacher should engage the students about potentially mixing the liquids – what will happen? The vocabulary word “miscible” should be introduced at this point.
12. Mix the liquids, and discuss how the solution of the juices has become miscible.

Optional:
13. Add ice to the container, and pour the mixture into small glasses and allow students to taste. Remind students about chemical safety and that chemistry materials used in the classroom are not normally consumed and that this is an exceptional situation.
14. Students will drink their layered drink of density while watching 5 Facts About Density to learn real world connections about density with cans of pop, hot air balloons, and ice bergs.
15. Teacher will guide a closing discussion for the day of what the students have discovered about density.

Extension:
16. Ask students why the ice cubes are floating in the liquid mixture. Most solids are very dense, but not in the case of water. This could lead to a good discussion and/or investigation depending on the age and ability of your students.

Lesson Day 2
1. Gather students together as a whole group and review prior learning (KWL chart), safety, material handling, learning and cooperative expectations, and clean up routine for the activity.
2. Students will begin the experiment under the teacher’s direction sitting in small groups. Each group of students will make their own density tower and should be given the following materials: a clear plastic cup, ruler, permanent marker, corn syrup, water, vegetable oil.
3. Instruct students measure 2 inches from the bottom of the cup, markings with the permanent marker on the clear plastic cup. They should make another mark 2 inches above the first line, and a third line 2 inches above the second line.
4. Ask the students to make observations about the corn syrup. The class will describe it, talk about its color, texture, and thickness. The teacher will record students’ observations on the chart.
5. A student from each group will pour corn syrup to the first line made on the cup.
6. Repeat steps 4 and 5 with the water and then the vegetable oil.
7. Next, give each group a solid object to drop into their cups (suggestions include a building block, a metal nut, and Styrofoam peanut used in shipping packages). Before
dropping the solid into the cup each group will discuss and share what they predict their solid will do once it is dropped in their cup.

8. The students will drop the solid into their cups, observe, and report what happened with the rest of the class.

9. The teacher will gather all of the cups to the front of the room while the students are cleaning up after themselves.

10. Students will watch ZOOM Science: What’s More Dense?

11. The teacher and students will discuss and record what they have learned about density on the “Learned” column of the KWL chart. The teacher will guide the discussion while using appropriate “science” vocabulary to discuss, retell, and make real world connections to the science experiment.

Cross-Disciplinary Extensions

Connect to Math
Students will use a ruler to measure 2 inch lines on a glass. As an extension, show the nutrition label for each of the juices used during the experiment. Discuss what grams are and how to measure grams using a balance scale. Using balance scales and packets of sugar have students make the amounts of sugar in each of the juices used during the experiment. This video explains grams and kilograms.

Connect to Reading
To further investigate the concept of density, read aloud Exactly the Opposite by Tana Hoban. Have students create a semantic gradients word ladder for density with the following words: liquid, fluid, flowing, creamy, squishy, doughy, snug, stiff, strong, and solid.

Connect to Writing
Have students write a narrative of the experiment.

Connect to Social Studies
Learn about the history of growing and producing sugar in our area (Midland, Michigan) from Pioneer Sugar. Or, find a sugar plant near you! Invite a chemist from the sugar plant to explain his/her job at the company.