Water, Sand, and Popcorn

Two Density Demonstrations

Introduction

The difference between density, mass, volume, and weight often confuse students. The following demonstrations will help students comprehend the differences among these concepts.

Concepts

- Density
- Mass
- Volume
- Weight

Demonstration 1 — Solid, Liquid, Gas

Materials

Bottles with caps, opaque, 3 (all the same size and shape)
Sand, enough to fill one bottle
Water, enough to fill one bottle

Safety Precautions

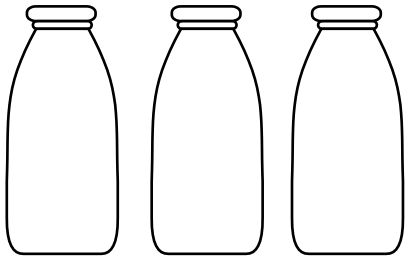
This activity is considered nonhazardous. Please follow all laboratory safety guidelines.

Preparation

Fill one bottle completely with sand and cap tightly. Fill another bottle to the top with water and cap tightly. Cap the empty bottle tightly.

Procedure

1. Pass the bottles around to the students for observation.
2. Ask for descriptions and comparisons of the bottles from different students.
3. Most students will say that the third bottle is "empty"—assure them that it is in fact full. (Full of air, but you do not need to tell them right away).
4. Ask students questions about the volume and mass of the bottles and contents. This should lead into a discussion of density.



Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The bottles may be reused many times. Materials may be placed in the trash according to Flinn Suggested Disposal Method #26a.

Tips

- Dean's® Milk Chug or yogurt "smoothie" bottles with the labels removed work well for this demonstration.
- You may wish to label each bottle with a different colored sticker or number the bottles using a permanent marker.

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Demonstration 2 — Popped versus Unpopped

Materials

Balance
Corn kernels (unpopped popcorn), 100 g
Popped popcorn, 100 g
Plastic bags, gallon size, 2
Rubber bands, 2

Safety Precautions

All food-grade items used in the lab are considered laboratory chemicals and are for lab use only. This activity is considered nonhazardous. Please follow all laboratory safety guidelines.

Preparation

1. Weigh out 100 g of corn kernels and place them into a gallon plastic bag.
2. Weigh out 100 g of popped popcorn and place it into a separate gallon plastic bag.
3. Wrap your hand around each bag near the opening and inflate each bag by blowing into the opening. Seal the inflated bag with a rubber band.

Procedure

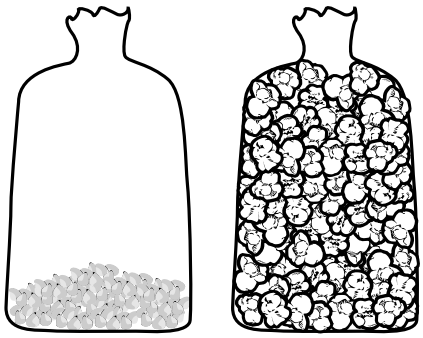
1. Ask students to compare the amount of space that is occupied in each bag.
2. Other questions related to mass, volume, and density may include the following.

   a. Which bag has a greater volume of popcorn? *The popped kernels have a larger volume than the unpopped kernels.*

   b. Which type of popcorn is more dense? *The unpopped kernels.*

   c. Which bag has a greater mass? *Both bags have the same mass.*

   d. Which bag weighs the most? *Both bags weigh the same.*
3. Now deflate the bag containing the unpopped popcorn and ask questions *a–d* again. What changed? *Volume*



Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The popcorn and bags may be saved for future use. Materials may be placed in the trash according to Flinn Suggested Disposal Method #26a.

Discussion

Density is defined as mass divided by volume. Generally speaking, it can also be said that density is the amount of a specific substance in a specific volume of space, such as grams of the substance per liter. Mass, on the other hand, relates to the amount of matter that occupies a given space. Two objects with the same dimensions may have different masses. Mass differs from weight in the fact that weight is affected by gravity. On Earth, mass and weight are extremely similar, and are often used interchangeably. The difference comes into play when discussing matter in space and on other planets. Weight is a measure of the gravitational force on an object. When astronauts are in space far away from matter such as planets or moons, they are nearly weightless since very little gravitational force is acting on them. On the moon the gravitational pull is one-sixth as strong as it is on Earth—that is why everything weighs less on the moon. The mass of astronauts remains constant in space but their weight differs.

Volume refers to the amount of space an object occupies (typically measured in liters or cm^3), regardless of the weight, mass or density of the object. Think about ice—ice is less dense than water since molecules are spread out into a crystalline structure resulting in fewer molecules occupying a given area than is found in the same amount of liquid water. Five grams of ice take up more volume than five grams (5 mL) of liquid water. On Earth, the weight of ice and water of identical mass is the same.

The *Solid*, *Liquid*, *Gas* demonstration has constant volumes but differing masses and densities (air = 0.00129 g/mL, water = 1 g/mL, and sand = approximately 2.7–5 g/mL). The *Popped versus Unpopped* demonstration involves a constant mass, with different volumes and therefore different densities of popcorn.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
MS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter
Disciplinary Core Ideas: High School
HS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter

Science and Engineering Practices
Asking questions and defining problems
Developing and using models

Crosscutting Concepts
Scale, proportion, and quantity
Structure and function

Reference

Gross, G. R., Holzer, M. A., Colangelo, E. A. *A Demo A Day—A Year of Earth Science Demonstrations;* Flinn Scientific, Inc: Batavia, IL, 2001, pp 96–97.

Materials for *Water, Sand, and Popcorn—Two Density Demonstrations* are available from Flinn Scientific, Inc.

Catalog No.	Description
S0004	Sand, fine, white, 2 kg
OB2139	Flinn Scientific Electronic Balance, 510 g × 0.1 g
AP5944	A Demo A Day™—A Year of Earth Science Demonstrations

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.