

Teacher Guide: Density Experiment: Slice and Dice



Learning Objectives

Students will...

- Find the density of a material based on its mass and volume.
- Understand the relationship between the density of an object and its tendency to sink or float in water.
- Understand that the density of a material is independent of the amount of material.



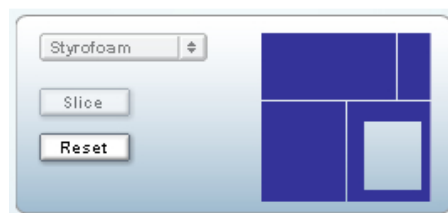
Vocabulary

density, mass, matter, volume



Lesson Overview

A common misconception is that the tendency of an object to sink or float depends only on its mass. By this logic, if a large piece of a material sinks, a smaller piece of the same material might float. The *Density Experiment: Slice and Dice Gizmo™* allows students to understand that the density of an object, as well as its tendency to float or sink, does *not* depend on the amount of material.



How does the density of a piece compare to the density of the whole?

The Student Exploration sheet contains two activities:

- Activity A – Students compare the density of different pieces of the same material.
- Activity B – Students relate the density of an object to its tendency to sink or float.



Suggested Lesson Sequence

1. Pre-Gizmo activity: Density practice (🕒 20 – 40 minutes)

Have students practice measuring and calculating the density of objects. You can do this in the classroom using a triple-beam balance to find mass and a graduated cylinder or overflow cup to find volume. You can also practice finding density using the *Density Laboratory* or *Density Gizmos*. (See the **Selected Web Resources** on page 3 of this document.) Be sure that students are familiar with the concept of density, density calculations, and density units.

Before starting the *Density Experiment: Slice and Dice* Gizmo, ask students the following trick question: “A gram of gold has a density of 19.3 grams per cubic centimeter. What is the density of 100 grams of gold?” Many students will quickly answer that the density is 1,930, which of course is incorrect. The density of gold doesn’t change, no matter how much gold you have!

2. Prior to using the Gizmo (🕒 10 – 15 minutes)

Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations.

3. **Gizmo activities** (🕒 15 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Discussion questions** (🕒 15 – 30 minutes)
As students are working or just after they are done, discuss the following questions:
- How does changing the amount of a material affect its density?
 - How does changing the amount of a material affect its tendency to float or sink?
 - What determines whether an object will float or sink in water?
 - A block of wood has a mass of 700 g and a volume of 1,000 cm³.
 - What is the volume of a 210 g piece of the block? [300 cm³]
 - What is the mass of a 200 cm³ piece of the block? [140 g]

5. **Follow-up activity** (🕒 45 – 60 minutes)
Practice finding the density of different amounts of common materials. Use a triple beam balance or an electronic scale to find mass. If the objects are rectangular prisms—blocks of wood or Styrofoam, for example—you can calculate volume by multiplying *length* × *width* × *height*. If the objects are small, calculate volume by measuring how much the water level rises when the object is submerged in a graduated cylinder. For example, if the water level is 50 mL before the object is added and 59.5 mL after the object is added, the volume of the object is 9.5 mL, or 9.5 cm³. If the objects are large, use an overflow cup to measure volume. (For instructions on building and using an overflow cup, please see the Teacher Guide for the *Density Laboratory Gizmo*.)

To compare the density of different volumes of liquid, use the following procedure:

- Place an empty beaker on the balance and record its mass.
- Measure 50 mL of liquid in a graduated cylinder. Add the liquid to the beaker and measure the total mass.
- Subtract the mass of the beaker to find the mass of the liquid. Divide the mass by 50 to find the density.

Suggested materials to measure include wood, Styrofoam, clay, mineral samples (quartz, feldspar, calcite, etc.), water, isopropyl alcohol, and corn syrup.



Scientific Background

Density is a measure of the mass in a given volume of a substance. To calculate the density of an object, divide the mass by the volume:

$$D = m \div V \quad \text{or, more formally:} \quad \rho = \frac{m}{V}$$

Like other physical properties such as melting point, boiling point, conductivity, and solubility, density is independent of the amount of the sample. No matter how much gold you have, its

density will always be close to 19.3 g/cm^3 . The *Density Experiment: Slice and Dice* Gizmo illustrates this principle by allowing students to chop up a large block of a substance into smaller pieces. While each piece has a different mass and volume, the ratio of mass to volume is the same for each piece. This is true as long as the substance is homogeneous and uniform.

If an object is *not* homogeneous, it is impossible to infer the density of a piece of the substance based on the density of the whole. The *RMS Titanic* was a good example of a non-homogeneous substance. That is why, even though the ship was made of steel, which sinks, the *Titanic* was able to float because most of its volume was occupied by air. When the *Titanic* hit the iceberg, denser water flowed into the ship and replaced the air that kept it afloat. As a result, the density of the *Titanic* increased rapidly and it sank.



Paleontology connection: How heavy were the dinosaurs?

We know about how big dinosaurs were because we have their bones, but how much did they weigh? By making an assumption about the density of a dinosaur, your students can use scale models of dinosaurs to estimate the mass of a real dinosaur.

Most animals have a density that is similar to water, about 1 g/cm^3 . That is why humans barely sink (or barely float) in water. If a dinosaur also had a density of about 1 g/cm^3 , its mass in grams would be about equal to its volume in cubic centimeters.

So how do you find the volume of a dinosaur? That's where the plastic models come in. Prepare an overflow cup, and lower the plastic dinosaur into the cup to measure its volume. Then measure the dinosaur model from head to tail. For example, a plastic dinosaur might measure 20 cm from head to tail and have a volume of 60 cm^3 . If the real dinosaur measured 10 meters (1,000 cm) from head to tail, that represents a 50-fold increase in length, or a $50^3 = 125,000$ -fold increase in volume. By this calculation, the volume of the real dinosaur is:



$$30 \times 125,000 = 7,500,000 \text{ cm}^3$$

This corresponds to 7,500,000 grams, or 7,500 kilograms (over eight tons). Pretty heavy!



Selected Web Resources

Measuring density of liquids: http://www.edinformatics.com/math_science/dens_liquid.htm
Water displacement (includes overflow cup instructions): <http://www.iit.edu/~smile/ph9504.html>
Measuring dinosaurs: <http://www.journal-for-young-scientists.net/content/view/24/48/>
Misconceptions: <http://www.csun.edu/~eed39911/coursework/690/Density%20Misconceptions%20Paper.pdf>

Related Gizmos:

Density: <http://www.explorellearning.com/gizmo/id?629>
Density Laboratory: <http://www.explorellearning.com/gizmo/id?362>
Density via Comparison: <http://www.explorellearning.com/gizmo/id?396>
Determining Density via Water Displacement: <http://www.explorellearning.com/gizmo/id?400>
Mineral Identification: <http://www.explorellearning.com/gizmo/id?640>