

Density, an Ubiquitous Concept: Part 1

Based on your requests, we now begin a series of CRSEP Weekly E-mails about density. **Density** influences our everyday lives and is important in all the natural sciences.

How much of your 18 carat gold bracelet is gold?

Does that 27 gram bracelet labeled 18 carat gold really contain 21 grams of gold? If you have the right measuring equipment, density is a concept that can be used to answer the question. (For those of you interested in 18 carat gold, one of our up-coming e-mails will retell the story of Archimedes and the dishonest jeweler.)

We have chosen to address the topic of **density** based on your requests.

Keeping jewelers honest is just one way the idea of **density** is useful in our daily lives. **Density** is the reason

- You must shake Italian salad dressing before using it.
- The air temperature in a room is greater near the ceiling than the floor.
- Some soaps float, others sink in the bath water.
- We can construct ships from steel as well as from wood.
- The densities of warm and cold air masses affect weather

What makes density so difficult to understand? Let's start with the basics. One part of the challenge is sorting out whether you are measuring the **density** of a *substance* or an *object*, a second concerns what you mean by **volume**.

Density is simply the mass per unit volume of a substance or an object.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{OR } \rho = m/v$$

ρ (rho) is the symbol for density
 m is the symbol for mass
 v is the symbol for volume

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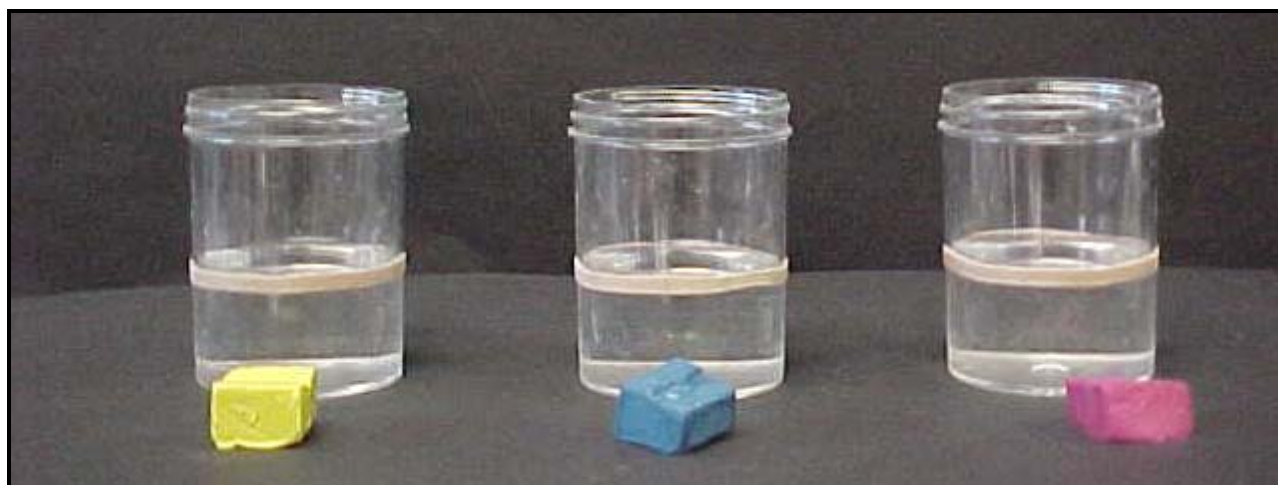
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The following activity demonstrates the difference between the **density** of an **object** and the **density** of a **substance**.

	Yellow (Y)	Blue (B)	Red (R)
Mass (m)	Mass of blue piece equals the mass of the yellow piece equals the mass of the red piece		

Take three pieces of Play-Doh, one blue, one yellow and one red. All three pieces should have the same mass. Check this using a balance. The results are represented in the following table and equation.

$$m_Y = m_B = m_R$$



What about the **volumes** of the pieces of Play-Doh? We assert that the volumes are the same. Check this by using a **tall glass partially filled with water, and a rubber band** (to mark the ORIGINAL water level). The results are represented in the following table and equation.

	Yellow (Y)	Blue (B)	Red (R)
Volume (v)	Volume of blue piece equals the volume of the yellow piece equals the volume of the red piece		

$$V_Y = V_B = V_R$$

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Now think about what happens to the volumes and masses of the three pieces of Play-Doh if you change their shapes. Form the blue piece into a sphere, the yellow piece into a cube and the red piece into a boat-shaped object.



How do the masses of the sphere, the cube and the boat compare?

	Yellow Cube (Y)	Blue Sphere (B)	Red Boat (R)
Mass (m)	Mass of blue sphere equals the mass of the yellow cube equals the mass of the red boat		

$$m_Y = m_B = m_R$$

How do the volumes of the sphere, the cube and the boat compare?

	Yellow Cube (Y)	Blue Sphere (B)	Red Boat (R)
Volume (v)	Volume of blue sphere equals the volume of the yellow cube equals the volume of the red boat		

$$v_Y = v_B = v_R$$

OR DOES IT???????

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About the masses:

We assert that the **masses** of the sphere, the cube, and the boat **remain the same** as the masses of the Play-Doh from which they were formed. YOU may believe us but younger children may NOT agree that the mass stays the same. If you do this with your students, especially younger ones, you may need to convince them that the masses are the same using a balance.

About the volumes:

The question of volume is a bit of a challenge. Using the **same tall glass, water, and rubber band**, you find that the boat acts differently from the sphere and the cube when placed in water. The sphere and the cube sink to the bottom, and the water rises to the same level above the rubber band as when the objects were just chunks of Play-Doh. Or, to say it another way, the blue and yellow Play-Doh displace the same volume of water whether they are a chunk, a sphere, or a cube. Furthermore, the volume of the sphere is the same as the volume of the piece of Play-Doh from which it was formed. The same is true of the cube.

However, the boat floats!



Now things get difficult (for kids and adults!). How does the level of water in the glass compare when the Play-Doh is in the form of a chunk to when it is in the form of a boat? In other words, how does the volume of water displaced by the chunk of Play-Doh compare with the volume of water displaced by the boat-shaped Play-Doh? (Remember, the chunk sinks while the boat shape floats. This is an important clue).

What do you think? What do your students think?

We eagerly await your responses.

Next week we will address the issue of the volume of an object versus the volume of a substance and the effect on density will help clarify this week's question.

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What do the New York State Standards say?

Elementary Science Core Curriculum, Standard 4, The Physical Setting

Major Understandings:

- 3.1d Measurements can be made with standard metric units and nonstandard units.
- 3.1e The material(s) an object is made up of determine some specific properties of the object (sink/float, conductivity, magnetism). Properties can be observed or measured with tools such as hands lens, metric rulers, thermometers, balances, magnets, circuit testers, and graduated cylinders.

Intermediate Science Core Curriculum, Standard 4, The Physical Setting

- 3.1a Substances have characteristic properties. Some of these properties include color, odor, phase at room temperature, density, solubility, heat and electrical conductivity, hardness, and boiling and freezing points.
- 3.1h Density can be described as the amount of matter that is in a given amount of space. If two objects have equal volume, but one has more mass, the one with more mass is denser.
- 3.1i Buoyancy is determined by comparative densities.

Complete Series on **Density** can be found at www.crsep.org

January 08, 2003	Density, A Ubiquitous Concept Part 1
January 15, 2003	Density, A Ubiquitous Concept Part 2
January 22, 2003	Archimedes' Part 1
January 29, 2003	Weight-Mass
February 05, 2003	Archimedes' Principle Part 2
February 12, 2003	The Balloon and the Beach Ball

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