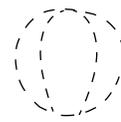
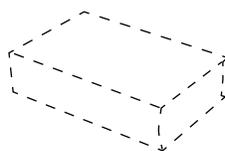
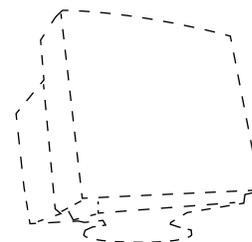
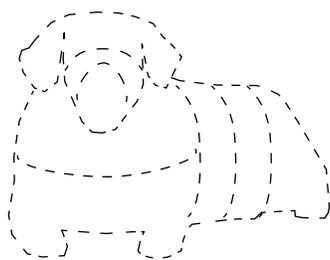


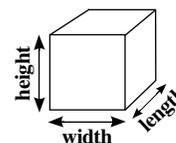
What's going on here?

One of the common definitions of matter is that matter has mass and takes up space. Let's first look at *mass*. There can be some confusion about the difference between "mass" and "weight". Mass is a measure of the amount of matter in an object. Weight is a measure of the force of gravity on an object of a certain mass. So if we could move an object from Earth to the moon, for example, where there is less gravity, its mass would stay the same but its weight would be less. Since mass and weight are directly related, if one object has more mass than another, it will also weigh more. If one object has less mass than another, it will weigh less.

So matter has mass and also takes up space. The measure of the amount of space an object takes up is called *volume*. When you think of the volume of an object, you can think about its overall shape or the amount of space it takes up in three dimensions. These pictures show the idea that every object has volume that takes up 3-dimensional space.



A common way to measure the volume of a cube, for example, is length \times width \times height. If the cube is 1 centimeter long, 1 cm wide, and 1 cm high, then the volume of the cube is $1 \text{ cm} \times 1 \text{ cm} \times 1 \text{ cm} = 1 \text{ cm}^3$ and takes up 1 cm^3 of space.



So what is density? Density has to do with both mass and volume. Density is a measure of the amount of mass in a certain amount of volume.

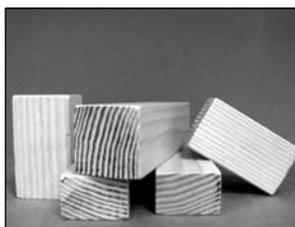
The formula for density is $D = \text{mass}/\text{volume}$. For example, if the cube above was a solid cube of clay and had a mass of 2 grams, its density would be $2 \text{ grams}/\text{cm}^3$. What if you used more clay to make a bigger cube?

What's going on here? *(continued)*

If the cube was 2 cm long, 2 cm wide, and 2 cm high, then the volume of the cube is $2\text{ cm} \times 2\text{ cm} \times 2\text{ cm} = 8\text{ cm}^3$. What would be the density of this bigger cube? If you weighed this cube, you would find that it weighs 16 grams. Since the mass is 16 grams and the volume is 8 cm^3 , the density of this clay cube is $16\text{ grams}/8\text{ cm}^3 = 2\text{ grams/cm}^3$. Whether you have a big or small solid piece of clay, the clay will always have the same density—it will always be 2 grams/cm^3 . That's why density is considered a characteristic property of a substance.

The density of substances such as iron, salt, or sugar is determined by the mass of the atoms, ions, or molecules that make up the substance and how closely they are packed together. The same is true for all other substances. A piece of pine wood has a density of about 0.55 grams/cm^3 . Whether it is a small piece of pine or the entire tree trunk, the density of both will be the same. Lead has a density of about 11.30 grams/cm^3 . Whether you have a tiny piece of lead or a gigantic piece of lead, the density of both will be the same.

Here are some examples of approximate densities of some common substances:



Wood

Wood (pine)	0.55 grams/cm^3
Wax (tealight candle)	0.75 grams/cm^3
Vegetable oil	0.85 grams/cm^3
Water	1.00 grams/cm^3
Clay	2.00 grams/cm^3
Iron	7.90 grams/cm^3
Lead	11.30 grams/cm^3



Clay



Wax



Vegetable oil

What's going on here? *(continued)*

One way to find out whether a substance will float or sink in a liquid is to compare the density of the substance to the density of the liquid. If the substance is less dense than the liquid, the substance will float. If the substance is more dense than the liquid, the substance will sink. You can answer some questions related to density and sinking and floating below.

1. Of the substances listed, which ones will float in water and which will sink?

2. Mineral oil has a density of about .8 grams/cm³. What substances from the list on p. 451 will float or sink in mineral oil?

3. The metal iron has a density of about 7.9 g/cm³.
What is the density of a solid cube of iron that is 2 cm long, 2 cm wide, and 2 cm high?

What is the density of a solid cube of iron that is 10 cm long, 10 cm wide, and 10 cm high?

Cool factoid

The Dead Sea is a body of water in the Middle East that is extremely salty. The water has different amounts of salt dissolved in it depending on the depth. The saltiest water is near the bottom and is about 9 times as salty as normal ocean water but the water at the surface is very salty, too. The water is so salty that no fish or plants can survive in it. Its high salt content makes the water very dense so floating in the Dead Sea is very easy.

