



LEARN ABOUT

Measuring Matter

FIND OUT

- about mass and volume and how to measure them
- a way to use measurements of mass and volume to describe density

VOCABULARY

volume
density

When the pans of a balance are level, the pieces of matter on the two pans have the same mass. These cotton balls have the same mass as the wood block. ▼

Measuring Mass

You can compare the amount of matter in two objects by measuring the mass of each. The object with more mass has the greater amount of matter. Mass is measured in units called grams and kilograms (KIL•uh•gramz). Half a kilogram, or $\frac{1}{2}$ kg, is about the same mass as four sticks of margarine. A medium-sized paper clip masses about 1 gram, or 1 g.

One way to compare two masses is by using a pan balance. Put an object in each pan. When the pans of the balance are level, the matter in the two pans has the same mass. In the investigation, you used a pan balance to find out that a cup of raisins has more mass than a cup of cereal.

If you know the mass of the matter in one pan, you can find the mass of the matter in the other pan. This is one way scientists measure mass. They have objects with masses that are known—for example, 50 grams, 200 grams, and 1 kilogram. These objects are known as *standard masses*. Scientists put an object whose mass they don't know in one pan and put standard masses in the other pan. Then they add or remove standard masses until the two pans balance. The total of the standard masses equals the mass of the object.

✓ **Name one way you can measure mass.**





It is easy to measure the volume of a liquid by using this container marked in milliliters, or mL. This container is called a beaker, and it has about 400 mL of red liquid.

Volume

Matter has mass and takes up space. The amount of space that matter takes up is called its **volume** (VAHL•yoom). You can measure the amount of space a solid or liquid takes up. You also can measure a container such as a box and calculate its volume. Volume often is measured in cubic centimeters. A *cubic centimeter* is the space taken up by a cube that has each side equal to 1 centimeter. A cubic centimeter is the same as a milliliter.

Cooks use measuring cups and measuring spoons to find the volume of ingredients for a recipe. Scientists measure volume with a beaker or a graduate, a tall cylinder with measuring marks on the side.

A solid keeps its shape, so it is easy to see that its volume stays the same. A liquid changes shape to match its container. But it does not change its volume. A gas has no definite volume. However, the mass of a gas sample doesn't change when the volume of the gas changes.

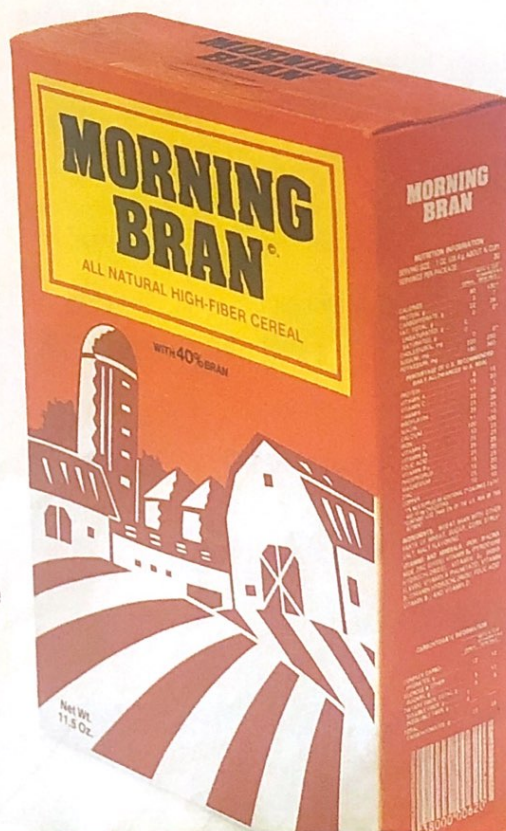
✓ What is volume?

To find the volume of a box, first measure its height, width, and length. Then multiply the three numbers together. This box is about 6 cm thick, 20 cm wide, and 30 cm tall. Its volume is $6 \text{ cm} \times 20 \text{ cm} \times 30 \text{ cm} = 3600$ cubic centimeters. ▶



You can find the volume of odd-shaped solid objects, such as these marbles, by sinking them in water. They push away some of the water, and the water level rises. The change in water level gives the volume of the solids.

The level in this graduate changed from 250 mL to 285 mL when the marbles were added. Therefore, the volume of the marbles is $285 \text{ mL} - 250 \text{ mL} = 35 \text{ mL}$.

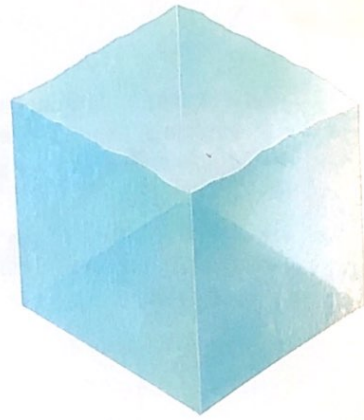


Density

Some matter takes up a large space but has a small mass. A balloon filled with gas may take up 10,000 cubic centimeters. But it may have such a small mass that it floats in the air. Other matter takes up very little space and has a large mass. A brick is smaller than the balloon, but it has much more mass.

The property of matter that compares the amount of matter to the space taken up is called **density** (DEN•suh•tee). The gas in a balloon has a low density. The density of a brick is much higher.

You can find the density of an object by dividing the mass of the object by its volume. For example, an apple may have a mass of 200 grams and a volume of 200 cubic centimeters. Its density is 200 grams $\div$ 200 cubic centimeters, or 1 gram per cubic centimeter.

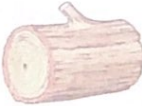


◀ One cubic centimeter of water has a mass of 1 gram. The density of water is 1 gram per cubic centimeter.

In the investigation you saw that cereal is less dense than raisins. You also found that a mixture of cereal and raisins is denser than cereal and less dense than raisins. Whenever you mix two kinds of matter, the density of the mixture is between the densities of the two separate materials.

✓ Which material in the table has the greatest density?

Density of Some Common Materials

Materials	Density (g per cubic centimeter)	Relative Size of 1-kg Disk
 Pine	0.40	
 Motor oil	0.90	
 Plastic (HDPE)	0.96	
 Lead	11.30	

◀ The disks show the volume needed to make up one kilogram of each material. Notice how the size of the disks compares to the density of the materials.

Summary

All matter has mass and volume. Mass is the amount of matter in an object. The space that matter takes up is called volume. Density compares the amount of matter in an object to the amount of space it takes up. You can find the density of an object by dividing its mass by its volume.

Review

1. What is one way to measure mass?
2. What word is used to describe the amount of space that matter takes up?
3. What property of matter compares the amount of matter to the space that the matter takes up?
4. **Critical Thinking** You are shopping for cereal. How does estimating density help you find a good buy?
5. **Test Prep** If a black ball is denser than a white ball of the same size, the black ball has —
A less volume
B more volume
C more matter taking up the same space
D less matter taking up the same space



LINKS



MATH LINK

Compare Volumes Use a pan balance and three cups to measure 100 g, 200 g, and 300 g of water. Use a beaker or a graduate to measure and compare the volumes of water.



WRITING LINK

Informative Writing—Narration You are making a short video for younger students. It will show how to measure volume and mass. Decide what you will show. Then, write a script to explain what you are showing.



HEALTH LINK

Your Density Find out how to measure and compare the mass of a person's muscles and body fat. Make a comic strip that shows how this is done.



TECHNOLOGY LINK

Learn more about measuring matter by visiting this Internet site.

www.scilinks.org/harcourt

