Name: _____ Date: _____

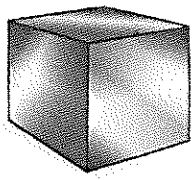
Density

READ

- The density of a substance does not depend on its size or shape. As long as a substance is homogeneous, the density will be the same. This means that a steel nail has the same density as a cube of steel or a steel girder used to build a bridge.

Steel density

Steel cube
Volume: 1.0 cm^3
Mass: 7.8 g
Density: 7.8 g/cm^3



Nail
Volume: 1.6 cm^3
Mass: 12.5 g
Density: 7.8 g/cm^3

- The formula for density is: $\text{density} = \frac{\text{mass}}{\text{volume}}$
- One milliliter takes up the same amount of space as one cubic centimeter. Therefore, density can be expressed in units of g/mL or g/cm^3. Liquid volumes are most commonly expressed in milliliters, while volumes of solids are usually expressed in cubic centimeters.
- Density can also be expressed in units of kilograms per cubic meter (kg/m^3).
- If you know the density of a substance and the volume of a sample, you can calculate the mass of the sample. To do this, rearrange the equation above to find mass: $\text{volume} \times \text{density} = \text{mass}$
- If you know the density of a substance and the mass of a sample, you can find the volume of the sample. This time, you will rearrange the density equation to find volume: $\text{volume} = \frac{\text{mass}}{\text{density}}$

EXAMPLES

Example 1: What is the density of a block of aluminum with a volume of 30.0 cm^3 and a mass of 81.0 grams?

$$\text{density} = \frac{81.0\ \text{g}}{30.0\ \text{cm}^3} = \frac{2.70\ \text{g}}{\text{cm}^3}$$

Answer: The density of aluminum is 2.70 g/cm^3.

Example 2: What is the mass of an iron horseshoe with a volume of 89 cm^3? The density of iron is 7.9 g/cm^3.

$$\text{mass} = 89\text{cm}^3 \times 7.9\frac{\text{g}}{\text{cm}^3} = 703\ \text{grams}$$

Answer: The mass of the horseshoe is 703 grams.

Example 3: What is the volume of a 525-gram block of lead? The density of lead is 11.3 g/cm^3.

$$\text{volume} = \frac{525\ \text{g}}{11.3\frac{\text{g}}{\text{cm}^3}} = 46.5\ \text{cm}^3$$

Answer: The volume of the block is 46.5 cm^3.

PRACTICE 112m = 4 sec 8.1

PRACTICE

1. A solid rubber stopper has a mass of 33.0 grams and a volume of 30.0 cm^3. What is the density of rubber?
2. A chunk of paraffin (wax) has a mass of 50.4 grams and a volume of 57.9 cm^3. What is the density of paraffin?
3. A marble statue has a mass of 6,200 grams and a volume of 2,296 cm^3. What is the density of marble?
4. The density of ice is 0.92 g/cm^3. An ice sculptor orders a one cubic meter block of ice. What is the mass of the block? Hint: 1 m^3 = 1,000,000 cm^3. Give your answer in grams and kilograms.
5. What is the mass of a pure platinum disk with a volume of 113 cm^3? The density of platinum is 21.4 g/cm^3. Give your answer in grams and kilograms.
6. The density of seawater is 1.025 g/mL. What is the mass of 1.000 liter of seawater in grams and in kilograms? (Hint: 1 liter = 1,000 mL)
7. The density of cork is 0.24 g/cm^3. What is the volume of a 240-gram piece of cork?
8. The density of gold is 19.3 g/cm^3. What is the volume of a 575-gram bar of pure gold?
9. The density of mercury is 13.6 g/mL. What is the volume of a 155-gram sample of mercury?
10. Recycling centers, for example, use density to help sort and identify different types of plastics so that they can be properly recycled. The table below shows common types of plastics, their recycling code, and density. Use the table to solve problems 10a -d.

Plastic name	Common uses	Recycling code	Density (g/cm^3)	Density (kg/m^3)
PETE	plastic soda bottles	1	1.38-1.39	1,380 - 1,390
HDPE	milk cartons	2	0.95-0.97	950 - 970
PVC	plumbing pipe	3	1.15-1.35	1,150 - 1,350
LDPE	trash can liners	4	0.92-0.94	920 - 940
PP	yogurt containers	5	0.90-0.91	900 - 910
PS	cd "jewel cases"	6	1.05-1.07	1,050 - 1,070

   a. A recycling center has a 0.125 m^3 box filled with one type of plastic. When empty, the box had a mass of 0.755 kilograms. The full box has a mass of 120.8 kilograms. What is the density of the plastic? What type of plastic is in the box?

   b. A truckload of plastic soda bottles was finely shredded at a recycling center. The plastic shreds were placed into 55-liter drums. What is the mass of the plastic shreds inside one of the drums? Hint: 55 liters = 55,000 milliliters = 55,000 cm^3.

   c. A recycling center has 100 kilograms of shredded plastic yogurt containers. What volume is needed to hold this amount of shredded plastic? How many 10-liter (10,000 mL) containers do they need to hold all of this plastic? Hint: 1 m^3 = 1,000,000 mL.

   d. A solid will float in a liquid if it is less dense than the liquid, and sink if it is more dense than the liquid. If the density of seawater is 1.025 g/mL, which types of plastics would definitely float in seawater?