

Name: _____ Date: _____

5.1 Density

Density is a physical property of matter. A *physical property* can be measured or viewed without making any changes to the material. Some physical properties, like mass, depend on how much matter is present. The density of a substance does not depend on how much matter is present.

Suppose you were given a solid gold bar and a gold ring. How do you think the density of the gold bar would compare to the density of the gold ring? As long as both the bar and ring are made entirely of gold, their densities are equal. The density of a material is always the same, even if its size or shape changes.

- The formula for density $\text{density} = \frac{\text{mass}}{\text{volume}}$
- 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/cm³. 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/m³).

You can rearrange the density equation to find out the mass or volume of a substance.

Equation...	Gives you...	If you know...
$D = m/v$	density	mass and volume
$m = v \times D$	mass	volume and density
$v = m/D$	volume	mass and density

Example 1: What is the density of cork if a 1.5-gram sample has a volume equal to 6.25 cm³?

Looking for Density of cork sample.	Solution $\text{density} = \frac{m}{v} = \frac{1.5 \text{ g}}{6.25 \text{ cm}^3} = 0.24 \text{ g/cm}^3$ The density of cork is 0.24 g/cm ³ .
Given Mass = 1.5 grams Volume = 6.25 cm ³	
Relationship $\text{density} = \frac{m}{v}$	

Example 2: What is the volume of a lead block with a density of 11.3 g/cm³ and a mass of 60.5 grams?

Looking for Volume of lead block.	Solution $\text{volume} = \frac{m}{D} = \frac{60.5 \text{ g}}{11.3 \text{ g/cm}^3} = 5.35 \text{ cm}^3$ The volume of the lead block is 5.35 cm ³ .
Given Density = 11.3 g/cm ³ Mass = 60.5 grams	
Relationship $\text{volume} = \frac{m}{D}$	

1. What is the mass of a sample of rubber if its density is 1.1 g/cm^3 and it has a volume of 6.0 cm^3 ?

Looking for	Solution
Given	
Relationship	

2. Daniel found an oddly-shaped object while walking to school. He asked the science teacher to borrow a balance to find the mass of the object. Daniel determined the object's mass to be 4.55 grams. He then added 20.0 milliliters of water to a graduated cylinder and placed the object inside.
- After adding the object to the graduated cylinder, Daniel observed that the water level rose to 26.5 milliliters. What is the volume of the object?
 - What is the density of the object?
3. What is the density of a substance if 1.50 cubic meters has a mass of 1.89 kilograms?
4. Use the data in the table below to answer questions 4a-e.

Material	Density (g/cm^3)
mercury	13.6
silver	10.5
water	1.00
iron	7.86
gold	19.3
platinum	21.4

- Jada read a story about a miner who lived during the time of the California "gold rush." The miner found a gold-colored nugget and passed it along to his grandson as a keepsake. The miner's grandson was curious about whether the nugget was really gold. He used a balance and found the mass of the nugget to be 12.1 grams. When placed in a graduated cylinder with water, the nugget caused the water level to increase by 2.42 milliliters. Was the nugget really gold? Explain your answer. (Hint: Remember $1 \text{ mL} = 1 \text{ cm}^3$)
 - What is the mass of a sample of mercury if its volume is 4.35 cubic centimeters?
 - Suppose you had one cubic centimeter (1 cm^3) of each material listed in the table. Which material would have the greatest mass? Which would have the least mass?
 - What is the volume of a 2.45 gram sample of iron?
 - Christopher found a shiny coin on the playground. The coin had a mass of 18.9 grams. He placed the coin in a graduated cylinder filled with water to the 25.0-milliliter mark. The coin sank to the bottom of the cylinder and the water level rose to the 26.8-milliliter mark. Of what material was the coin made?
5. The density of ice is 0.920 g/cm^3 . What is the mass of a block of ice with a volume equal to 16.0 cubic centimeters?