

## Understanding and Calculating Density

**Density** is a way to measure how much "stuff" (or matter) is packed into a certain amount of space. Imagine you have a small bag of sand and a big, fluffy pillow. Even if they take up different amounts of space, the sand might feel much heavier than the pillow because it has more matter tightly packed in a small area. This is what density helps us measure!

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### What is Density?

Density tells us how much mass is in a given space, or volume. **Mass** is the amount of matter in an object, which we often measure in grams (g), while **volume** is how much space it takes up, often measured in milliliters (mL) or cubic centimeters (cm<sup>3</sup>).

To find the density, we use this simple formula:

$$d = \frac{m}{V}$$

where:

- $d$  stands for density,
- $m$  is the mass (in grams),
- $V$  is the volume (in milliliters or cubic centimeters).

The units for density are usually grams per milliliter (g/mL) or grams per cubic centimeter (g/cm<sup>3</sup>).

### Why is Density Important?

Density helps us understand why some things float and others sink! If an object has a lower density than the liquid it's placed in, it will float. If it has a higher density, it will sink. For example:

- Oil floats on water because it has a lower density.
- A stone sinks in water because it has a higher density.

## Step-by-Step Guide: How to Calculate Density

To calculate the density of any liquid or solid, you need to follow these steps:

### Step 1: Measure the Mass

1. Use a scale to measure the mass of the object or liquid. If it's a liquid, you'll need to weigh the container first, then weigh it again after adding the liquid, and subtract the container's mass.
2. Write down the mass in grams (g).

### Step 2: Measure the Volume

1. If it's a liquid, pour it into a graduated cylinder or measuring cup, and read the volume in milliliters (mL).
2. If it's a solid with a regular shape, like a cube, you can find the volume by measuring its dimensions and calculating using a formula (like  $\text{length} \times \text{width} \times \text{height}$ ).
3. Write down the volume in milliliters (mL) or cubic centimeters (cm<sup>3</sup>).

### Step 3: Calculate the Density

1. Use the formula  $d = \frac{m}{V}$ , where  $m$  is the mass, and  $V$  is the volume.
2. Divide the mass by the volume to find the density in g/mL or g/cm<sup>3</sup>.

## Examples of Density Calculations

Let's go through three examples to make this clearer!

### Example 1: Density of Water

1. Imagine you have 50 mL of water. You weigh the water, and it has a mass of 50 grams.
2. Calculate density:

$$d = \frac{m}{V} = \frac{50 \text{ g}}{50 \text{ mL}} = 1 \text{ g/mL}$$

So, the density of water is 1 g/mL.

### Example 2: Density of Oil

1. You pour 40 mL of oil into a measuring cup, and it has a mass of 36 grams.
2. Calculate density:

$$d = \frac{m}{V} = \frac{36 \text{ g}}{40 \text{ mL}} = 0.9 \text{ g/mL}$$

The density of the oil is 0.9 g/mL, which is why oil floats on water—it's less dense!

### Example 3: Density of a Rock

1. You have a rock that weighs 120 grams. You place it in a graduated cylinder with 100 mL of water, and the water level rises to 140 mL. This means the rock's volume is:

$$V = 140 \text{ mL} - 100 \text{ mL} = 40 \text{ mL}$$

2. Calculate density:

$$d = \frac{m}{V} = \frac{120 \text{ g}}{40 \text{ mL}} = 3 \text{ g/mL}$$

The rock's density is 3 g/mL, which is much higher than water, so it sinks!

## Quick Review

- Density is a way of measuring how much matter is packed into a certain space.
- The formula for density is  $d = \frac{m}{V}$ .
- If something has a lower density than the liquid it's in, it will float. If it's more dense, it will sink.