

Density

Definition	Other Formulas
<ul style="list-style-type: none">■ Density is a ratio of mass to volume, or mass divided by volume $\text{density} = \frac{\text{mass}}{\text{volume}} \quad \text{or} \quad d = \frac{m}{V}$ <ul style="list-style-type: none">■ Units: g/cm³, g/ml, kg/L, kg/dm³	<p style="text-align: center;">Other Formulas</p> $d = \frac{m}{V} \quad m = d \times V \quad V = \frac{m}{d}$

Solving Density Problems
<ul style="list-style-type: none">■ Read the problem■ Identify what you are asked to calculate■ Choose the proper formula■ Plug into the formula everything you know■ Make sure you use the correct units■ Calculate■ Round off the result to the proper number of significant figures■ Show all work

Example Problems and Solutions

Example Problem 1.

A block of aluminum occupies a volume of **15.0 mL** and weighs **40.5 g**. What is the density?

Solution.

You are asked to calculate density. Hence, you take the formula for density, which is $d = m / V$. Then, you plug into the formula the values of mass and volume and calculate.

$$d = 40.5 \text{ g} / 15.0 \text{ mL} = 2.70 \text{ g/mL}$$

A zero after 2.7 is added as you need 3 significant figures.

Example Problem 2.

What is the weight of the ethyl alcohol that exactly fills a **200.0 mL** container? The density of ethyl alcohol is **0.789 g/mL**.

Solution.

You are asked to calculate weight (mass). So, you take the formula for mass, which is $m = d \times V$. Then, you plug into the formula the values of density and volume and calculate the weight.

$$m = 0.789 \text{ g/mL} \times 200.0 \text{ mL} = 157.8 \text{ g} \approx 158 \text{ g}$$

The answer is rounded to 3 significant figures.

Example Problem 3.

A rectangular block of copper metal weighs **1896 g**. The dimensions of the block are **8.4 cm** by **5.5 cm** by **4.6 cm**. From this data, what is the density of copper?

Solution.

Again, you are asked to calculate density. You take the formula for density, $d = m / V$. But the volume of the block is not given. Therefore, you need to calculate the volume of the block first. And then, you plug into the formula the values of mass and volume and calculate the density.

$$V = 8.4 \text{ cm} \times 5.5 \text{ cm} \times 4.6 \text{ cm} = 212.52 \text{ cm}^3$$
$$d = 1896 \text{ g} / 212.52 \text{ cm}^3 = 8.9215 \text{ g/cm}^3 \approx 8.9 \text{ g/cm}^3$$

The answer is rounded to 2 significant figures.

Example Problem 4.

What volume of silver metal will weigh exactly **2500.0 g**? The density of silver is **10.5 g/cm³**.

Solution.

Here, you are asked to calculate volume. You take the formula for volume, $V = m / d$. Then, you plug into the formula the values of mass and density and calculate the volume.

$$V = 2500.0 \text{ g} / 10.5 \text{ g/cm}^3 = 238.095 \text{ cm}^3 \approx 238 \text{ cm}^3$$

The answer is rounded to 3 significant figures.

Practice Problems

1. Mercury metal is poured into a graduated cylinder that holds exactly **22.5 mL**. The mercury used to fill the cylinder weighs **306.0 g**. From this information, calculate the density of mercury.

2. A flask that weighs **345.8 g** is filled with **225 ml** of carbon tetrachloride. The weight of the flask and carbon tetrachloride is found to be **703.55 g**. From this information, calculate the density of carbon tetrachloride.
Hint: First, calculate the mass of carbon tetrachloride in the flask.

3. Calculate the density of sulfuric acid if **35.4 mL** of the acid weigh **65.14 g**.

4. Find the mass of **250.0 ml** of benzene. The density of benzene is **0.8765 g/mL**.

5. The block of lead has dimensions of **4.50 cm** by **5.20 cm** by **6.00 cm**. The block weighs **1587 g**. From this information, calculate the density of lead.
6. **28.5 g** of iron shot are added to a graduated cylinder containing **45.50 mL** of water. The water level rises to the **49.10 mL** mark. From this information, calculate the density of iron.
Hint: First, calculate the volume of the iron shot.
7. What volume of silver metal will weigh exactly **2500.0 g**? The density of silver is **10.5 g/cm³**.
8. A rectangular block of wood **4.00 cm** by **30.5 cm** by **12.0 cm** has a mass of **48.0 grams**. What is the density of wood?
9. The density of air at room temperature and the sea level pressure is **1.29 g/L**. Calculate the volume occupied by **12.5 kg** of air.
Hint: Before trying to solve the problem, take a close look at the units of density and mass of air.
10. What is the mass of water in a swimming pool that is **15 m** long, **4.5 m** wide and **2.0 m** deep? The density of water is **1,000. kg/m³**.

11. At a party, a **50.0 g** bracelet made of a yellowish metal is accidentally dropped into a full glass of water. An observant chemistry student at the party noticed that exactly **2.60 mL** of water have spilled out. The owner of the bracelet claims that it is made of pure gold. Is she telling truth? Support your answer with calculations. ($d_{\text{gold}} = 19.32 \text{ g/cm}^3$ and $1 \text{ cm}^3 = 1 \text{ mL}$)
12. What is the density of benzene if **45 cm³** of benzene have a mass of **3735 cg**?
13. The density of mercury is **13.54 g/mL**. What would be the volume of **2345 g** of mercury?
14. The density of iridium, the second densest metal, is **22.56 g/cm³**. Find the mass of **0.50 m³** of iridium.
Hint: First, convert m^3 into cm^3 .
15. A piece of metal was measured to be **14.99 g**. It is placed in a graduated cylinder containing **12.3 mL** of water. The water level rises to **13.6 mL**. What is the density of the metal?
Hint: First, calculate the volume of the piece of metal.
16. A certain copper coin has a mass of **3.136 g**. The density of copper is **8.96 g/cm³**. What is the volume of the coin?