Chapter Ten: Properties of Matter

- 10.1 Density
- 10.2 Properties of Solids
- 10.3 Properties of Fluids
- 10.4 Buoyancy

Section 10.1 Learning Goals

- Define density in terms of mass and volume.
- Identify units used to express the density of materials.
- Apply the density formula to solve problems.

Investigation 10A

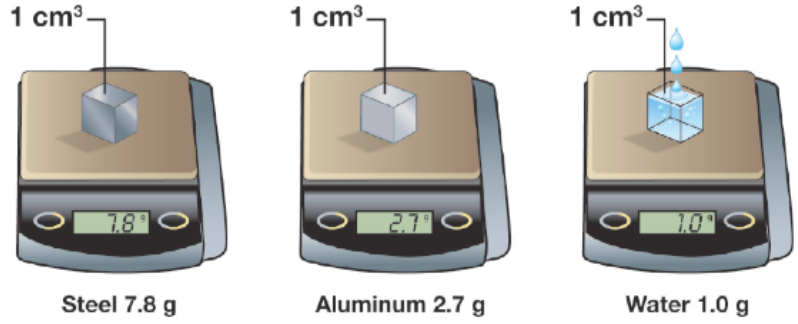
Density

- **Key Question:**

  How is an object's density related to its volume, mass, and tendency to sink or float?

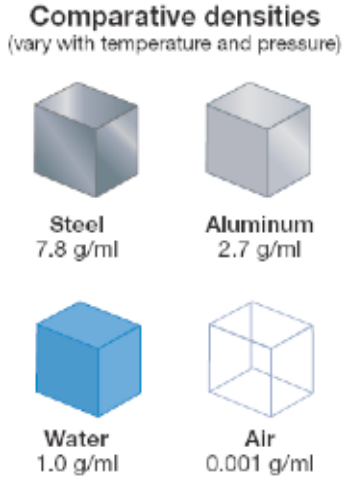
10.1 Density

- **Density describes how much mass is in a given volume of a material.**



10.1 Density

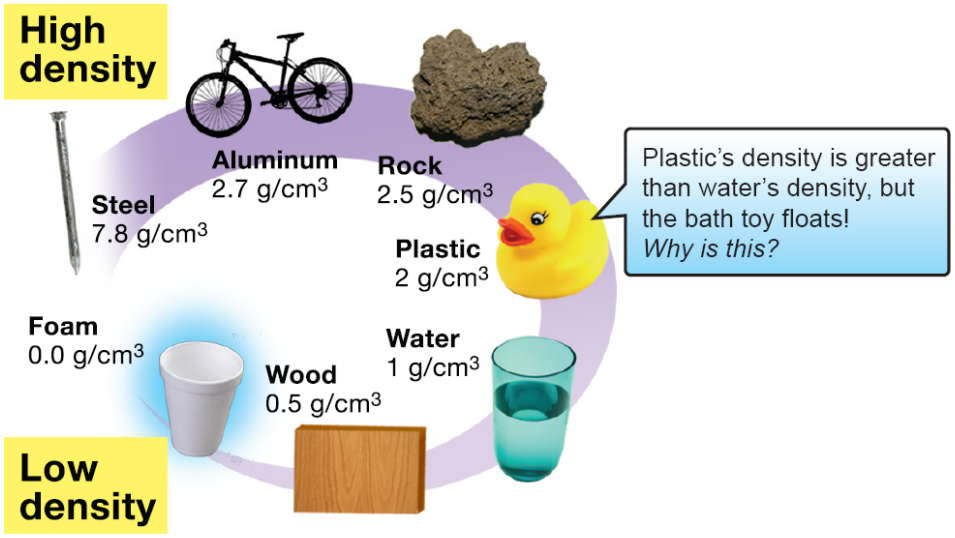
- Solids, liquids and gases are matter, so they all have density.
- The density of water is about one gram per cubic centimeter.



Material	(kg/m^3)	(g/cm^3)
Platinum	21,500	21.5
Lead	11,300	11.3
Steel	7,800	7.8
Titanium	4,500	4.5
Aluminum	2,700	2.7
Glass	2,700	2.7
Granite	2,600	2.6
Concrete	2,300	2.3
Plastic	2,000	2.0
Rubber	1,200	1.2
Liquid water	1,000	1.0
Ice	920	0.92
Ash (wood)	670	0.67
Pine (wood)	440	0.44
Cork	120	0.12
Air (avg.)	0.9	0.0009

- **The units used for density depend on whether the substance is solid or liquid.**
  - **For liquids use units of grams per milliliter (g/mL)**
  - **For solids use density in units of g/cm^3 or kg/m^3.**

Density Range of Common Materials

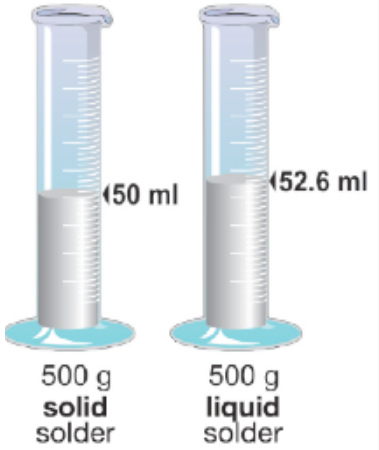


10.1 Density of common materials

- **Density is a property of material <u>independent</u> of quantity or shape.**

10.1 Density of common materials

- Liquids tend to be <u>less</u> dense than solids of the same material.
  - Ex. solder



10.1 Density of common materials

- Water is an exception to this rule.
- The density of solid water (ice) is less than the density of liquid water.

Material	(kg/m^3)	(g/cm^3)
Liquid water	1,000	1.0
Ice	920	0.92

10.1 Determining Density

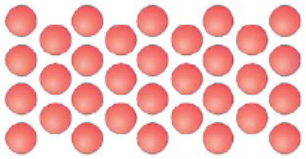
- To find the density of a material, you need to know the mass and volume of a solid sample of the material.
  1. Mass is measured with a balance or scale.
  2. Use the displacement method or calculate the volume.

10.1 Density

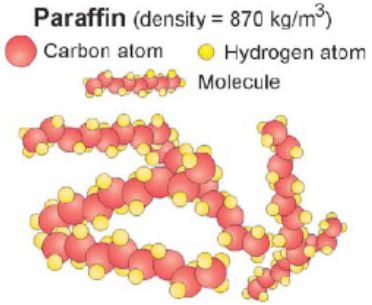
Density changes for different substances because:

1. Atoms have different masses.
2. Atoms may be "packed" tightly or loosely.

Diamond (density = 3,500 kg/m^3)



Paraffin (density = 870 kg/m^3)



To Find:	Use:
density	$D = \frac{m}{V}$
volume	$V = \frac{m}{D}$
mass	$m = D \times V$

Solving Problems

A solid wax candle has a volume of 1,700 mL.

The candle has a mass of 1.5 kg (1,500 g).

What is the density of the candle?

Solving Problems

Calculating Density

1. **Looking for:**
   - …the density of the candle
2. **Given:**
   - …mass = 1500 g; volume = 1700 mL
3. **Relationship:**
   - D = m/V
4. **Solution:**
   - 1,500 g ÷ 1,700 mL = 0.8823529 g/mL

 # Sig. fig = .88 g/mL