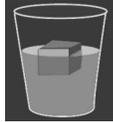


Lect 3: Density

1. What is density?
2. How do you measure density?



6. Eureka! Volume & Density:

take notes at the top of the page



What is density?



- ∨ Think about the many kinds of matter you come into contact with every day.
 - ∨ Wood, cement, aluminum, plastic, foam, liquids, steel, etc.
- ∨ In solids, we have huge differences.
- ∨ A block of steel and a block of aluminum may be the same size, but one has a lot more mass than the other.

What is density?



- ∨ Density describes how much **mass** is in a given **volume** of a material.
- ∨ Steel has a high density; 7.8 grams of mass per cubic centimeter.
- ∨ Aluminum has a lower density; 2.7 grams/ cm³.
- ∨ Liquids & gases are matter & have density too.

Measuring Density

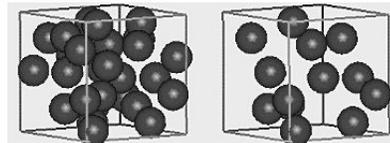
$$\text{Density (g/mL or g/cm}^3\text{)} \rightarrow D = \frac{m}{V}$$

Mass (kg or g)

Volume (mL or cm³)

- ∨ The more matter you place into a defined volume, the **denser** it becomes.
- ∨ For example, New York City is DENSELY populated because there are a lot of people in a small area.
- ∨ 20 people in an elevator is DENSER than 2 people in an elevator.
- ∨ Notice our units...cm³

Which one is MORE dense?



- ∨ If each box has the same volume, and each ball has the same mass, which box would weigh more? Why?

Which weighs more?

100 pounds of lead or 100 pounds of feathers?



Feathers



Lead

Lead and Feathers

- ✓ Although 100 pounds of feathers may take up much more room than 100 pounds of lead, they both still weigh 100 pounds.
- ✓ The steel is heavier for its size, due to the fact that it is denser!!!
- ✓ Thus, a material such as feathers takes up much more room (volume) than a denser material such as steel, for the same mass or weight.

Density of Common Materials

- ✓ Density is a property of materials - independent of shape or quantity.
- ✓ For example, a steel nail and a steel cube have different amounts of matter and therefore different masses.
- ✓ They also have different volumes.
- ✓ However, if you calculate density by dividing mass by volume, the result is the same for both the nail and the cube.

Steel density

Steel cube
Volume: 1.0 cm³
Mass: 7.8 g
Density: 7.8 g/cm³



Nail
Volume: 1.6 cm³
Mass: 12.5 g
Density: 7.8 g/cm³



Density of Common Materials

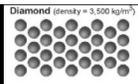
- Solids that are **strong**, such as steel, typically have **high** density.
 - High density means there are many atoms per cubic centimeter.
- **Soft** materials typically have **lower** density.
 - Solids with low density, such as cork or foam, are often used as cushioning material.
 - Low density means there are relatively large spaces between atoms.

Densities of Common Substances	
Substance	Density (g/cm ³)
Mercury	13.60
Lead	11.34
Aluminum	2.70
Bone	1.85
Milk (whole)	1.03
Seawater	1.03
Water	1.00
Ice	0.92
Gasoline	0.73
Cork	0.24

Why does density vary?

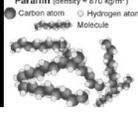
- The density of a material depends on two things:
 - the **individual mass** of each atom or molecule
 - on **how tightly** the atoms are packed
- A diamond is made of carbon atoms and has a density of 3,500 kg/m³.
- The carbon atoms in diamonds are closely packed.

Diamond (density = 3,500 kg/m³)



Carbon atom

Paraffin (density = 870 kg/m³)



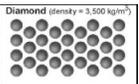
Carbon atom Hydrogen atom

Molecule

Why does density vary?

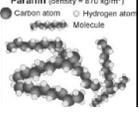
- ✓ Paraffin wax is mostly carbon, but the density of paraffin is only 870 kg/m³.
- ✓ The density of paraffin is low because the carbon atoms are mixed with hydrogen atoms in long molecules that take up a lot of space.

Diamond (density = 3,500 kg/m³)



Carbon atom

Paraffin (density = 870 kg/m³)



Carbon atom Hydrogen atom

Molecule

Calculating Density Problems

- Here are 3 density problems you are going to do with the video:
Follow the video as we do them
- 1. A student determines the density of manganese to be 5.54 g/cm^3 . If a sample had a mass of 3.43g what was the volume?
- 2. A cube 5.7cm on a side has a mass of 630 g . Find the Density!
- 3. The density of a gas is 0.0043 g/cm^3 . Find the mass of 280 cm^3 of this gas.

Video 8. Density Calculations



Calculating Density

$$\text{Density (g/mL or g/cm}^3\text{)} \rightarrow D = \frac{m}{V}$$

Mass (kg or g) (pointing to m)
Volume (mL or cm³) (pointing to V)

- There are several different ways to find the density of an object's.
- It depends on the shape of the object.

For the next few slides...

- You will NOT be completing the "You Try It"
Simply follow along as volume is explained.

Cubes & Rectangular Prisms



- Find mass**
 - Use a **balance**
 - Units: **grams** or kg
- Find volume**
 - Use a ruler
 - Measure all 3 **sides**: length, width, height
 - Units: **cm³**, m³, km³
 - Use this equation: $\text{Volume} = \text{length} \times \text{width} \times \text{height}$
 $V = l \times w \times h$
- Density = mass / volume**
 - Units: **g/cm³**



Cylinders



- Find mass**
- Find volume**
 - Use a ruler
 - Measure the height & **diameter**
 - Divide the diameter in half to find the **radius**
 - Units: cm³, m³, km³
 - Use this equation:
 $\text{Volume of a cylinder} = 3.14 \times \text{radius}^2 \times \text{height}$
 $V = \pi r^2 h$
- Density = mass / volume**
 - Units: g/cm³

Irregular Objects

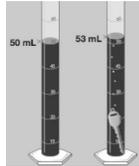
1. Find mass

2. Find volume

- ∨ **Displacement** method
- ∨ Fill a graduated cylinder with water.
- ∨ Drop the object in without splashing water.
- ∨ Calculate the change in volume!
- ∨ Units: mL, L

3. **Density = mass / volume**

- ∨ Units: g/mL



9. Finding Density:

Answer the questions at the bottom of your page

