### Lab #2: Density



# Which is More Massive?

# A kilogram of feathers or a kilogram of lead?

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Answer: Neither! They both have a mass of one kilogram!

In other words, they have the same number of protons and neutrons.

# Mass vs. Weight

• Mass and weight are **NOT** the same!

Mass	Weight
Measure of how much stuff is in something	Measure of the amount that gravity pulls on stuff, or the <i>force</i> exerted by gravity on stuff
Has the same value everywhere in the universe	<ul> <li>Value depends on where you are</li> <li>For example, a given object weighs more on the surface of the Earth than it does on the Moon.</li> </ul>
Measured in kilograms	Measured in pounds or Newtons

# Volume

- Volume is a measure of how much space something takes up
- For example, your textbook has a smaller volume than BX 102

#### How to Calculate Volume

 For a rectangular, or box-shaped, object, use

Volume = length x width x height

For a sphere, use

Volume =  $(4/3) \times \pi \times (radius)^{3}$ 

- Volume of your textbook
- Length = 27.5 cm
- Width = 21.5 cm
- Height = 2.0 cm
- So

Volume = 27.5 cm x 21.5 cm x 2.0 cm = 1,182.5 cm<sup>3</sup>

# Density

- Measure of how much stuff per unit volume
- Defined as

Density = Mass/Volume

• Has units of g/cm<sup>3</sup>

- What is the density of your textbook?
- Mass = 3.0 kilograms = ? grams

- What is the density of your textbook?
- Mass = 3.0 kilograms = 3,000 grams

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- Mass = 3.0 kilograms = 3,000 grams
- Volume = 1,182.5 cm<sup>3</sup>
- So

Density = Mass/Volume = 3,000 grams/ 1,182.5 cm<sup>3</sup> = 2.54 grams/cm<sup>3</sup>

#### Some Densities of Common Materials

Material	Density
Gold	19.3 g/cm <sup>3</sup>
Iron	7.5 g/cm <sup>3</sup>
Rock	2.5 g/cm <sup>3</sup>
Water	1.0 g/cm <sup>3</sup>
lce	0.92 g/cm <sup>3</sup>
Air	1.3 x 10 <sup>-3</sup> g/cm <sup>3</sup>
Helium	1.8 x 10 <sup>-4</sup> g/cm <sup>3</sup>

# Which is Denser?

• A kilogram of feathers or a kilogram of lead?

## Which is Denser?

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Answer: Lead

This is because lead has the same amount of mass in a smaller volume.

Lead:  $11.4 \text{ g/cm}^3$ Feathers:  $2.5 \times 10^{-3} \text{ g/cm}^3$ 

# Volumes of Irregular Objects

- Unfortunately, not all objects are boxes and spheres
- No nice formula
- Use displacement method developed by Archimedes
- Volume of water displaced = volume of object
- 1 milliliter (ml) =  $1 \text{ cm}^3$

# **Additional Information**

- Volume of object = (Volume of water after object is added) – (Volume of water before object is added)
- Measure masses using the balances
- For bigger objects, use scale and the formula

Mass = 454 g x [(Your weight with object) – Your weight without object)]