

MEASURING DENSITY

One of the most important concepts in science is that of *density*. Understanding density is important in such diverse areas as chemistry, physics, meteorology, biology, economics, demography and many others.

Density is one of the key properties of any material, and you may be familiar with the equation that defines density as:

$$\text{Density} = \text{mass/volume}$$

Or in a different notation:

$$\rho = \frac{M}{V}$$

where ρ is the Greek letter “rho” and represents density, and M is the mass of the object and V is the volume of the object.

So, to find the density of an object, we merely need to measure its mass, and then its volume, and then divide the mass by the volume.

This is a pretty simple equation; there are only two variables that we measure from which we derive the value of the object’s density. Let’s examine this relationship a little more carefully.

First, what do we mean by the mass of an object, and how might we measure the value of an object’s mass?

Second (and not surprisingly) what do we mean by the volume of an object, and how might we measure that?

The activity we will do tonight will involve measuring the mass and volume of two different types of items, a sample of small rocks and a sample of U.S. cents.

Units

As you might already know, all measurements in science must include both the magnitude of the measurement (how big, how fast, how far, etc.) and also the unit of measurement. If you say to someone ‘my friend is five six’, the listener can probably figure out you mean that you are referring to the height of someone as five feet six

inches; however, in any scientific application we have to be explicit about the units we are using.

For the measurements we are making tonight, we will make use of the CGS system of units. (CGS stands for centimeter, gram, second, the fundamental units in this system for distance, mass and time.)

Gram (g) is the CGS unit for mass, and **centimeter** (cm) is the CGS unit for length (or distance). Since we have already discussed that volume is length x length x length, the appropriate units for volume are cm x cm x cm or cm^3 . Therefore, the appropriate CGS unit for density is g/cm^3 . This is read as “grams per cubic centimeter.”

For tonight:

Construct a data table showing your measurements for the mass and volume of your samples. You should make at least three separate measurements for the mass and volume of your sample; your data table might look something like:

	Mass (g)	Volume (cm^3)	Computed Density (g/cm^3)
Trial 1			
Trial 2			
Trial 3			

Construct different data tables for your samples of cents and rocks. Use these data to answer the questions below (and submit those for next class period).

For next class:

1. Submit your data and results. Each student should submit his/her own work, but indicate also the names of your group partners for this first question.
2. Suppose you did this experiment using only half as many coins as you actually used. Do you think you would get the same result for density as you report above? Explain your reasoning for this. If you think you would get a different result, would you expect that result to be larger or smaller than the result you obtained during the lab?
3. Similarly, suppose you use twice as many coins, how, if at all, would this affect your results? Again, explain your reasoning.

4. If you measured the density of rocks taken from much deeper in the Earth, would you expect the same result that you found for the rocks you used during lab? Explain your reasoning for this answer.
5. Look up the densities of common substances and report their values in cgs units; in particular, what is the value of density of water, of air, of copper?
6. What is the density of the densest object you can think of (cite whatever sources you use to find this value)? Similarly, use sources (online is fine) to find the density of the lowest density substance you have read about. What is the value of this density (cite sources). This should give you an idea of how varied matter can be.
7. The population density of a region is defined as:

Population density = number of people/area

Use sources to find the population and area of Chicago and determine the population density of Chicago. Show your work clearly, citing references for basic data. Now, look up this data for your hometown and find its population density (if Chicago is your hometown, use mine, Newark, N. J.)