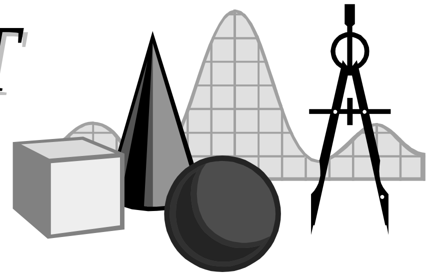
TAKE IT TO THE MAT

A NEWSLETTER ADDRESSING THE FINER POINTS OF MATHEMATICS INSTRUCTION



Math Audit Team
Regional Professional Development Program
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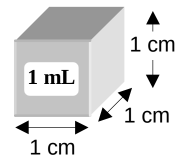
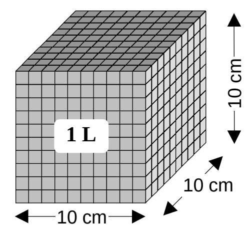
Some say that, as a system of measurement, the metric system is superior to the English system. After all, conversion between units is simply a power of ten, rather than 3, 4, 12, 16, 36, 1760, etc. But what is often missed about the metric system are **the relationships between units that measure different characteristics**—length, mass, and volume—that are not present in the English system of measure. In this issue of *Take It to the MAT* we will look at these relationships.

First, here's a little history. The *meter* was initially defined as $\frac{1}{10{,}000{,}000}$ of the distance between the North Pole and the equator. A bar of platinum of this length (about $39\frac{1}{3}$ inches) is preserved in Paris and at one time was used as the standard. Now, the meter is defined as 1,650,763.73 wavelengths of the orange spectral line of the isotope Krypton-86. Seriously! These facts, in and of themselves, are only important in that the meter does have a standard length, and that all other units of metric length are a multiple of the meter by some power of ten. (Remember $10^{-1} = \frac{1}{10}$.)



Now, let's talk about the lowly centimeter. It's $\frac{1}{100}$ of a meter and is about the width of a fingernail. What really makes the centimeter special is when we have a cube one centimeter in length on each side—slightly smaller than a sugar cube. A volume of one cubic centimeter can be expressed another way, one *milliliter*. So, 1 cm^3 = 1 mL.



Actually, the unit *liter* is defined as one cubic decimeter. Recall 1 dm = 10 cm = $\frac{1}{10}$ m. The *milliliter* is $\frac{1}{1000}$ of a liter. Or, we can think of it this way: 1 dm^3 = (10 cm × 10 cm × 10 cm) = 1000 cm^3 = 1000 mL = 1 L.

It turns out that the basic metric unit of *mass*, the *gram*, is the mass of 1 mL of water. If one were to drop 1 mL of water on a balance, it should read 1 g. Thus, one liter of water has a mass of one kilogram. Specifically, the water must be 4°C, but 1 g/mL is close at other temperatures.

Seeing this physically is not difficult; base-ten blocks, frequently used in elementary school math classes, are constructed using the centimeter as their basic unit. Thus, the small cubes (also known as *units*) are 1 cm^3 in volume or 1 mL, and the large cubes (*1000-blocks)* are 1000 cm^3 or 1 L. Were they hollow and filled with water, the mass of the water would be 1 gram and 1 kilogram, respectively.

Density is also a topic that merits attention; it is the amount of *mass per unit of volume*, that is, $\text{density} = \frac{\text{mass}}{\text{volume}}$. Thus, the density of water is $\frac{1\text{ kg}}{1\text{ L}} = 1\text{ kg/L}$ or $\frac{1\text{ g}}{1\text{ mL}} = 1\text{ g/mL}$. Any material with a greater density sinks in water, while anything with a smaller density floats.

Now you may be asking yourself, "Isn't the gram a unit of *weight*?" Technically, no; everyday language does use it as such, but truly it is a measure of *mass*. Weight depends on gravity, mass does not. Referring to the gram and kilogram as measures of weight is customarily acceptable, but be careful what you say around physicists and chemists.