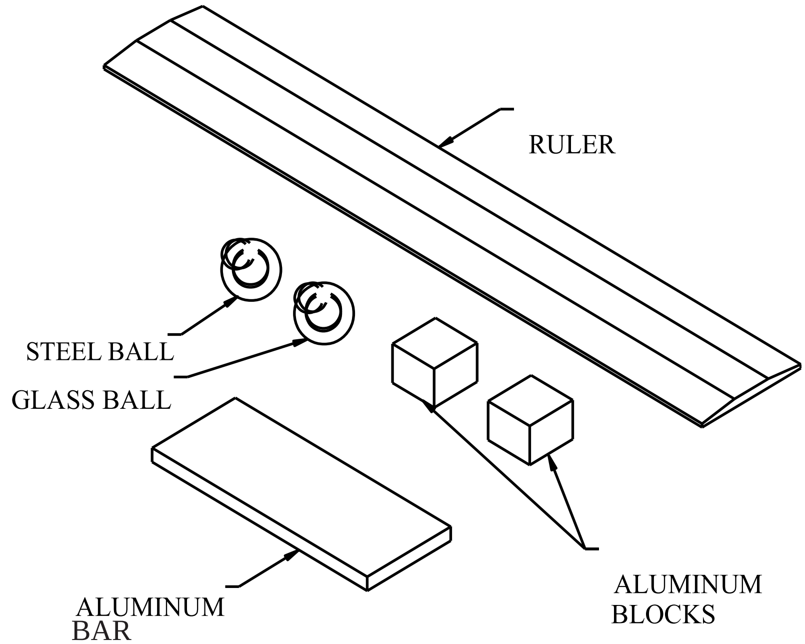
16210 Density Kit

Purpose:

To investigate the properties of mass and volume while developing the concept of density.

Contents:

One (1) Aluminum bar
Two (2) Aluminum cubes
One (1) Steel sphere
One (1) Glass sphere
One (1) Metric ruler



Required Accessories:

Pan balance (accuracy to 0.1 grams)
Rock samples (3 different rock types)
Graduated cylinder

Discussion:

In the course of the day, you will pick up many different objects; some large and some small. You may also notice that these objects have many different weights. If you pay close attention, you may find objects of about the same size that have vastly different weights. Why is this? After all, if two objects are the same size, shouldn't they be the same weight? This is not necessarily true. It all depends upon the type of material from which the object is made. You know from experience that a gallon of milk is much heavier than a fluffy pillow you may sleep on, even though the pillow is larger.

These types of experiences have led us to describe materials in a way that is independent of their physical shapes and sizes. This property of a material is known as its *density.*

Experiment:

Look over the materials in the kit. Pick them up, turn them over, and feel how heavy they are. Are there differences in weight (mass)? Which is the heaviest? How does this compare to their differences in size? Which objects take up the most space or has the largest volume? How would you measure this to know your guess was correct? If all of the samples were the same size (took up the same amount of space) which one would be the heaviest?

Density is just a comparison of mass between objects that all have the same volume. However, since gathering samples of materials having exactly the same volume is unlikely, we need a more convenient way to determine density. Density is the amount of mass an object has in a given volume or in other words, how much "mass per volume". The mathematical equivalent of "per" is division. So, density can be written as "mass per volume" as:

$$D = M / V$$

The object of this experiment is to determine the density of each object in this kit by measuring its mass and its volume and then use the formula above to calculate the objects density.

For example, if you choose to determine the density of the metal bar, you would first determine its mass by weighing it on a pan balance to the nearest 0.1 gram. Record this value as M. You would next measure the bar to determine its thickness, width, and length. Record the volume of the bar. The density is then found by dividing the mass of the bar, M, by the volume of the bar, V.

The volume of various solids can be calculated from the following formulas:

Rectangular Solid
Volume (V) = Thickness x Width x Length

Sphere
Volume (V) = 4/3 x π x radius3

Cube
Volume (V) = side3

Which object has the greatest density? (Steel sphere).

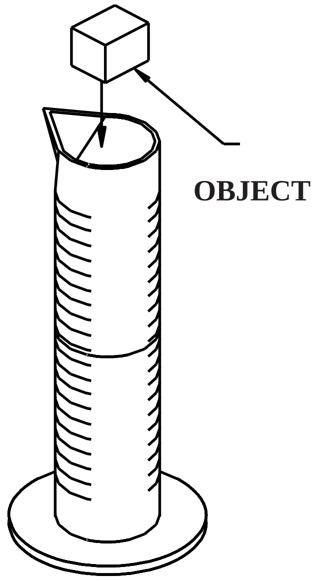
Which object has the smallest density? (Glass sphere).

Would the density of a steel sphere be different if it were a cube? (No. An objects density is independent of shape and size).

If the volume increases, does the density increase? (No. The mass increases proportionately).

How would you go about measuring the density of an irregular solid for which there is no formula for the volume? You can measure the mass in the usual way, but the volume appears to be a different problem. Remember, solids take up space. Whenever you place a solid in a liquid (like water), it displaces that liquid. In fact, the volume of liquid displaced is exactly the same as the volume occupied by the solid. To see how this works, take a graduated cylinder partially filled with water and record the liquid volume in milliliters. Then take the irregular sample and slowly lower it into the water making sure no bubbles cling to the sample. When it is completely submerged, release it, and then measure the new volume indicated by the water level. The volume of the sample is just the difference between the two volumes. But, you might ask, "Isn't my volume supposed to be in cubic centimeters and not milliliters?" That is true, and it is a simple matter to convert because 1 cubic centimeter is equal to 1 milliliter.

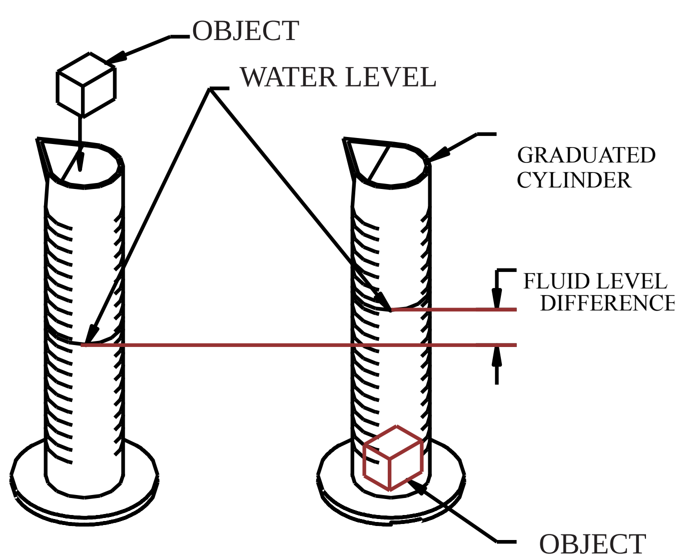
How would you go about measuring the density of a liquid? As we have seen, measuring the volume of a liquid is a simple matter and only requires the use of a graduated cylinder. But how would you measure the mass of the liquid? Some may happen upon the method sooner than others, but the key lies in weighing the container for the liquid separately. The mass of the liquid is the difference between the weight of the container with liquid and the weight of the container by itself.



Using a graduated cylinder to measure volume

How would you measure the density of an irregular object that is less dense than water? In other words, how would you measure the density of an object that floats? The key to this question lies in the fact that the object only needs to be submerged, it does not necessarily need to sink. So, if the object floats, just push it under the surface of the liquid long enough to record the level of the fluid displaced.

What effect does the shape of an object have upon its density? (None).



Comparing levels of fluid before and after irregular object has been submerged

Is there any way to change an objects density? (An objects density is affected by temperature because an objects volume will change with temperature, but no change in its mass).

One last challenge for you:

How would you measure the density of an irregular object that is soluble in water (such as sugar or salt)?

Time Allocation:

No prior assembly is required for this product. Individual experiment times will vary depending methods of instruction, but normally will not exceed one class period.

Feedback:

If you have a question, a comment, or a suggestion that would improve this product, you may call our toll free number below.