Chemistry of Our Environment

Experiment #2

Density

In today’s experiment we will need to use a measuring device called a Vernier Caliper.

Now we will use this newly learned technique to measure a property of matter, called density. But first we need to learn how to calculate density.

Part A: Relationship between mass and physical dimensions:

1) Select several ball bearings of different sizes.
2) Using Vernier calipers, measure the diameter of each of the ball bearings, as accurately and precisely as you can.
3) Measure the mass of each of the ball bearings using the balances.
4) Using a graphing program or a spreadsheet, enter the mass and diameter data for each ball bearing. We will do this as a class.
5) Calculate the volume of each ball bearing, using the formula: \( V = \frac{4}{3} \pi r^3 \).
6) Calculate the surface area of each ball bearing, using the formula: \( S = 4\pi r^2 \).
7) Prepare graphs of mass vs diameter, mass vs. surface area, and mass vs. volume. Determine a regression line (best straight line) for each graph.
8) Which straight line seems to be the best representation of the data?
9) From the slope of this best straight line, determine the density of the ball bearings.
10) Determine the formula for density, from the formula of slope.
11) Discuss the validity of the formula for density, including an explanation of why density for a substance in liquid or solid form is the same, regardless of the size of the sample.

Part B: Density of an Unknown Liquid:

In our determination of the density of the bearings, the volumes were expressed in mm\(^3\), which is a volume unit for solids. A more common unit for the volume of solids is cm\(^3\). In chemistry, the usual volume unit for liquids is the milliliter, mL. Since 1 cm\(^3\) = 1 mL exactly, the 2 volume units are really the same.

1) Place a clean, dry 25 mL graduated cylinder on a balance and tare the balance so that it reads 0.000.
2) Add 10-15 mL of your unknown liquid to the graduated cylinder.
3) Immediately, accurately measure the volume of the liquid.
4) Also, record the mass of the graduated cylinder with the liquid, without delay. This is the mass of the liquid.
5) Using the formula for density, calculate the density of the unknown liquid.