EXPERIMENT

3 Density Determinations

Objective

Density is an important characteristic property of matter, and may be used as a method of identification. In this experiment, you will determine the densities of regularly and irregularly shaped solids as well as of pure liquids and solutions.

Introduction

The density of a sample of matter represents the mass contained within a unit volume of space in the sample. For most samples, a unit volume means 1.0 mL. The units of density, therefore, are quoted in terms of grams per milliliter (g/mL) or grams per cubic centimeter (g/cm^3) for most solid and liquid samples of matter.

Since we seldom deal with exactly 1.0 mL of substance in the general chemistry laboratory, we usually say that the density of a sample represents the mass of the specific sample divided by its particular volume.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Because the density does in fact represent a *ratio*, the mass of any size sample, divided by the volume of that sample, gives the mass of 1.0 mL of the same sample.

Densities are usually determined and reported at 20°C (around room temperature) because the volume of a sample, and hence the density, will often vary with temperature. This is especially true for gases, with smaller (but still often significant) changes for liquids and solids. References (such as the various chemical handbooks) always specify the temperature at which a density was measured.

Density is often used as a point of identification in the determination of an unknown substance. In later experiments, you will study several other physical properties of substances that are used in the identification of unknown substances. For example, the boiling and melting points of a given substance are characteristic of that substance and are used routinely in identification of unknown substances. Suppose an unknown's boiling and melting points have been determined, but on consulting the literature, it is found that more than one substance has these boiling and melting points. The *density* of the unknown might then be used to distinguish the unknown. It is very unlikely that two substances would have the same boiling point, melting point, and density.

Density can also be used to determine the concentration of solutions in certain instances. When a solute is dissolved in a solvent, the density of the *solution* will be different from that of the *pure solvent* itself. Handbooks list detailed information about the densities of solutions as a function of their composition (typically, in terms of the *percent solute* in the solution). If a sample is known to contain only a single solute, the density of the solution could be measured experimentally, and then the handbook could be consulted to determine what concentration of the solute gives rise to the measured density of the solution.

The determination of the density of certain physiological liquids is often an important screening tool in medical diagnosis. For example, if the density of urine differs from normal values, this may indicate a problem

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