Water Properties: Water Density

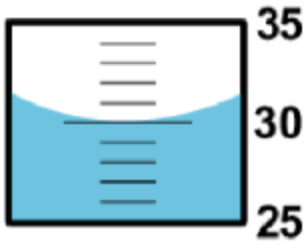
All matter has mass and volume. **Mass** is a measure of the amount of matter an object has. Its measure is usually given in grams (g) or kilograms (kg). **Volume** is the amount of space an object occupies. There are numerous units for volume including liters (l) and meters cubed (m^3).**Density** is defined as the mass per unit volume of a substance, and it is a physical property of matter. A physical property can be measured without changing the chemical identity of the substance. Since pure substances have unique density values, measuring the density of a substance can help identify that substance. Density is determined by dividing the mass of a substance by its volume:

Density = Mass / Volume

The units of density are commonly expressed as g/cm^3 for solids, g/mL for liquids, and g/L for gases.

In this lab, the mass and volume of hot and cold distilled water will be measured in order to determine the density of water. Measurements will be performed on two samples of each water to improve precision and accuracy. Mass will be measured with an electronic balance, in grams (g), and volume will be measured directly with a graduated cylinder, in milliliters (mL). Recall that when measuring liquid volumes, the graduated scale must be read from the lowest point of the curved surface of the liquid (the meniscus).

The accuracy of the experimentally determined density of water will then be evaluated by comparison to the true, accepted density of water.



The Density of Water

1. Using the electronic balance, obtain the mass of your 50-mL graduated cylinder. Make sure it is dry before you weigh it.
2. Add 50 mL of distilled water to the graduated cylinder. Then measure the combined mass using the electronic balance.
3. Add 50 mL of hot distilled water to the graduated cylinder. Then measure the combined mass using the electronic balance.
4. Use your thermometer to record the temperature of the water in your graduated cylinder.
5. *Analysis:* Subtract the mass of the empty cylinder from combined mass measurement to obtain mass measurement of water. Finally, look up the true density of water at the temperature used.

- The density of liquid water is approximately 1.0 g/mL. Let's look at the density of water at 25 °C and compare that to a higher temperature, 80 °C. The density decreases from 0.997 g/mL to 0.971 as it is heated. This makes sense because, as heat is added to the liquid water, there is greater kinetic energy of the molecules and there are also more vibrations of the water molecules. Together these mean that each H_2O unit in liquid water takes up more space as the temperature increases. Thus, the mass will be decreased.

Table 1: Density of liquid water from 0 °C to 100 °C.

Temperature (°C)	Density of Water (grams/ml)
0°	0.999
4.0°	1.000
10°	0.999
15°	0.999
20°	0.998
25°	0.997
30°	0.995
40°	0.992
60°	0.983
80°	0.971
100°	0.958