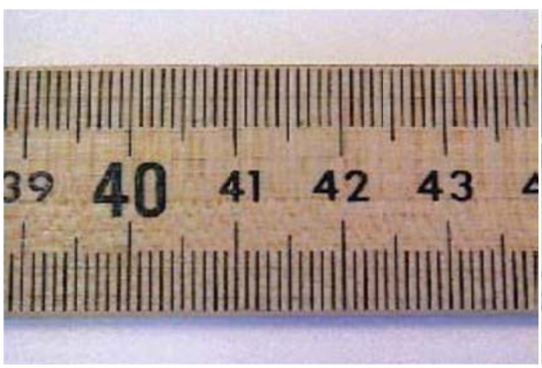
KINGSBOROUGH COMMUNITY COLLEGE

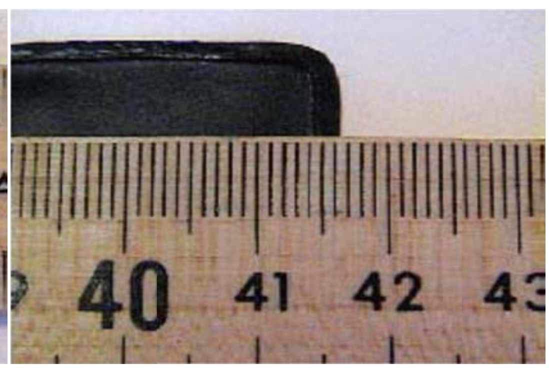
The Science of Nutrition Laboratory
Science 70

The Metric System and Density

Nutrition is a science, relying on accurate measurements of fundamental properties such as time, length, mass and temperature. To ensure measurements of these properties are accurate and precise, instruments such as a meter sticks, a tape measure, cent-o-gram balance, analytical balance, and laboratory thermometers are often used. It is important to understand how to properly use these devises. With any measurement tool, the student should always try to achieve the greatest accuracy the apparatus will allow.

Meter stick. The simplest way to measure length is to use an ordinary meter stick. In the laboratory, our meter sticks are carefully calibrated in centimeters with a millimeter least count. That is, the millimeter is the smallest subdivision on the meter stick, which can be seen in Figure 1. This means the millimeter is the unit of the smallest reading that can be made without estimating.





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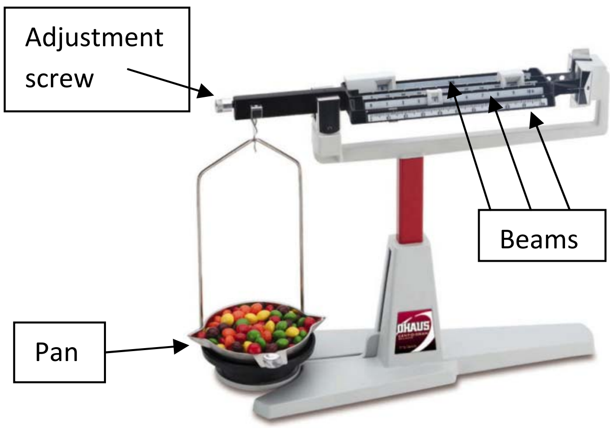
A measurement reading usually has one more significant figure than the least count reading of the scale. The least count of our laboratory meter sticks is 0.1 cm and therefore a reading can be made to 0.01cm. Figure 2. Above shows a meter stick being used to measure the length of a plastic strip. The meter stick is calibrated in centimeters, so we know that the strip is between 41 and 42 cm. The least count of this meter stick is one millimeter, so we know with absolute certainty that the object is between 41.6 cm and 41.7 cm. We then estimate the object's length to the fractional part (doubtful figure) of the least count subdivision. In Figure 2, it we may estimate that the strip is closer to 41.6cm than it is to 41.7 and report the length to be 41.64 cm or .4164m.

Cent-o-gram balance. The cent-o-gram balance, or laboratory balance, measures the mass of an object by balancing the unknown mass with sliding masses of known values. The cent-o-gram balance is usually calibrated in grams with a least count of 0.1g. A measurement, then, can be made to 0.01g. It is important to note that laboratory balances are used to make measurements of an object's mass, not weight. (The weight of an object is the product of the object's mass, m, and the acceleration due to gravity, g, or W=mg)

Before the cant-o-gram balance is used to make a measurement, verify that the balance is properly zeroed. Fine adjustments may be made by turning the knob under the balance pan.



Cent-o-gram balance

Analytical balance

<u>Objective:</u> To become familiar with the metric system and the Celsius (centigrade) scale of temperature, as well as to learn how to use a meter stick, a tape measure, an analytical balance, a graduated cylinder and thermometers. Students will work in pairs, as well as individually, in order to learn both cooperation and independent observation. A review is included of the concepts of calculations and conversions form British system of units to the metric system and vice versa.

<u>Procedure:</u>

Part 1.

In determining the density, you must determine the mass and the volume. You will perform the steps in a certain order, but record the data in a way that is most convenient for calculations. The density of the metal cylinder can be calculated by using formula:

$$Density = \frac{Mass\ of\ cylinder\ (g)}{Volume\ (mL)}$$

1. Measure and record length and diameter of a cylinder. Convert it to centimeters, and meters.

   Height: ___________(*in.*) ____________(mm) ___________(*cm*) ____________(*m*)

   Diameter: _________(*in.*) ____________(mm) ___________(*cm*) _____________(*m*)

2. Calculate the volume of the cylinder.

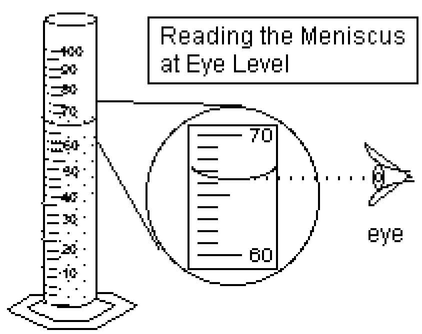
$V_{cylinder} = 2\pi r^2 h$ where π= 3.142, r is radius of the circular base, h is the height of the cylinder (we assume the cylinder to be a right circular cylinder)

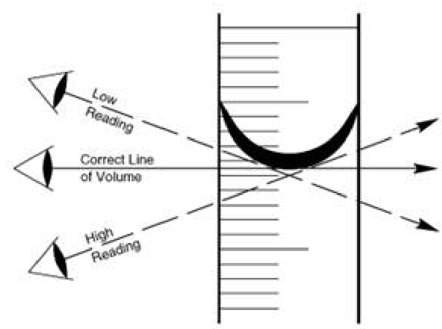
Exp #1 $V_{cylinder\ Exp\#1}$ = 2 x 3.14 x _________ ^{2}(m) x __________ (m) = ________________ (m^3)

Convert cubic centimeters into milliliters.

$1m^3 = 1{,}000{,}000cm^3$ $1\ cm^3 = 1mL$

Volume determination by using graduated cylinder:





The instructor will explain how to read a graduated cylinder, especially what is meant by the "meniscus" and how to avoid the error of parallax in reading the level.

The determination of the mass of cylinder using different balances.

1. Using the cent-o-gram balance measure and record the mass of the cylinder (to the nearest 0.01g)

   Mass of cylinder __________________ (g) Exp#1

2. Using the analytical balance measure and record the mass of the cylinder (to the nearest 0.0001g)

   Mass of cylinder ___________________(g)Exp#2

The determination of the volume of cylinder using graduated container.

1. Pour 10 to 15 mL of distilled water into the graduated container, dry the outside of the cylinder, if necessary. Record the volume below of the water.
2. Place the cylinder in the graduated container and water. Record the new volume. You are now ready to perform calculations.

a. Volume of just water __________________ (mL)

b. Volume of water plus metal cylinder __________________ (mL)

c. Volume of cylinder (Line b – Line a) __________________ (mL) Exp#2

Calculation of Density:

Density = *Mass of cylinder (g)* / *Volume (mL)* = ____________________(g)Exp#2 / (mL)Exp#2 =

Part 2.

A thermometer is an instrument that measures temperature, and it is thought to be invented by Galileo in 1592. The type which contains a liquid in a glass operates on the principle that the liquid expands and contracts uniformly and proportionally with changes in temperature. The liquid is usually mercury, or colored alcohol for very uniform bore, that is calibrated for degrees, and even for fractions degrees, usually on the Fahrenheit or the Centigrade (also called Celsius) scale.

Precision thermometers operate on the principal that the electrical resistance of wire changes with the temperature. The so-called Tempa-Dot thermometer is made up of a special mixture of organic compounds (one that is called o-chloronitrobenzene and the other o-bromonitrobenzene), mixed in the proper proportion, in order to give the color change at various temperature readings. When these solid compounds melt, a liquid is formed and a blue dye is formed, indicated by a blue color on the "dot". If the melting point has been reached, the dot changes to blue but later changes back to orange.

Andres Celsius (1701 – 1744) was a Swedish astronomer who constructed the Celsius or Centigrade thermometer in 1742. Gabriel Daniel Fahrenheit (1686 – 1736) was a German physicist. He improved the mercury thermometer to the point of practical use, devising the so-called Fahrenheit scale of temperatures which was later modified. He also discovered that boiling point of a liquid varies with the atmospheric pressure.

1. Using a Tempa-Dot strip record your temperature after 5 minute period.

   Temperature: ______________________(^{o}F)

2. Convert the temperature from ^{o}F to ^{o}C using the following equation:

$$°C = \frac{5}{9}(°F - 32) \quad \text{or} \quad °C = \frac{°F - 32}{1.8}$$

$$°F = \frac{9}{5}°C + 32 \quad \text{or} \quad °F = 1.8(°C) + 32$$