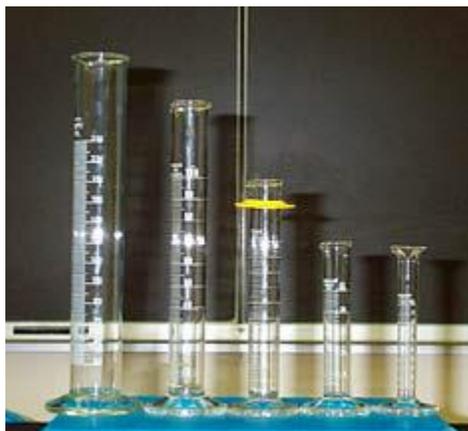


## Liquid Volume Measuring Devices: The Graduated Cylinder and Buret

Like weighing, measuring liquid volume is a fundamental and frequently encountered lab operation. Liquid volume is usually measured using either a graduated cylinder or a buret.

As the name implies, a graduated cylinder is a cylindrical glass or plastic tube sealed at one end, with a calibrated scale etched (or marked) on the outside wall. Graduated cylinders come in a range of sizes, or volume capacities, and much like a measuring cup, volume is measured by adding liquid to the cylinder and comparing the liquid level to the graduated scale. The measured volume corresponds to the volume of liquid contained in the cylinder. Hence, the graduated cylinder and equipment like it (volumetric flasks, Erlenmeyer flasks, and beakers) are classified as to-contain (TC) equipment.



The volume of liquid in a graduated cylinder is obtained directly by reading the calibrated scale. In most situations, the liquid will be water or an aqueous solution.

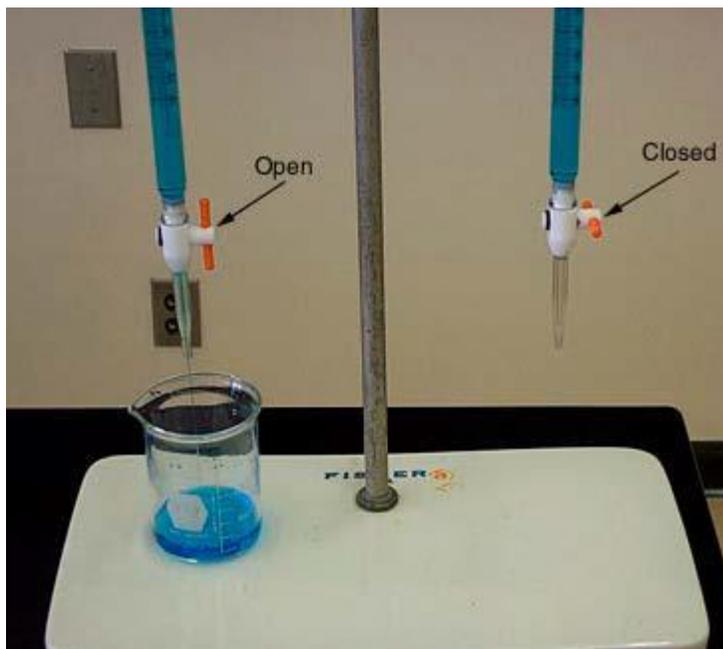
- If the cylinder is made from glass, the liquid surface is curved (U-shaped) rather than horizontal, due to the relatively strong attractive force between water and glass. The curved surface is called the meniscus—cylinder on the left in the following figure. As a general rule, the bottom of the meniscus is taken as the liquid level in a glass cylinder (or any other volume measuring device made from glass).
- If the cylinder is made from plastic, the liquid surface is flat (horizontal). There is no meniscus—cylinder on the right in the following figure.



The scale divisions on a graduated cylinder are generally determined by its size. For example, the 50-mL graduated cylinder is divided into 1 mL increments. However, the scale of a 10-mL graduated cylinder is divided into 0.1 mL increments, and the scale of a 500-mL graduated cylinder is divided into 5 mL increments.

The graduated cylinder scale is a ruled scale, and it is read like a ruler. The scale is read to one digit beyond the smallest scale division by estimating (interpolating) between these divisions. With a 50-mL graduated cylinder, read and record the volume to the nearest 0.1 mL. The 10-mL graduated cylinder scale is read to the nearest 0.01 mL and the 500-mL graduated cylinder scale is read to the nearest milliliter (1 mL).

A buret is a scaled cylindrical tube attached to a stopcock, or valve. A buret is designed to dispense or transfer a precisely measured volume of liquid to another container. The volume of liquid dispensed is determined by reading and recording the buret scale that corresponds to the liquid level in the buret before any liquid is transferred,  $V_{initial}$  (or  $V_i$ ), and after the transfer is complete,  $V_{final}$  (or  $V_f$ ). The volume of liquid transferred is obtained by difference ( $V_f - V_i$ ) and it is sometimes designated as  $V_t$ .



Burets are available in a limited range of sizes; the most common size is 50-mL. The scale of a 50-mL buret is divided into 0.1 mL increments. Therefore, when the liquid level in a buret is read, it is read and recorded to the nearest 0.01 mL. Water or aqueous solutions are the most common liquids used with a buret, and, if made the buret is made from glass, the bottom of the meniscus is taken as the liquid level.

The buret and equipment like it, such as pipets and syringes, are classified as to-deliver (TD) equipment.