How To Use The Glassware

CLEANING AND DRYING GLASSWARE

Determine how much time you spend cleaning a piece of glassware by thinking about its use. A beaker used to hold ice for an ice bath doesn't need to be very clean. All volumetric glassware and flasks used for reactions should be thoroughly cleaned. Water wets clean glass uniformly. If you see droplets on the glass, the glass is not clean.

To clean glassware, put detergent into a bucket and add hot water. Never put solid soap into glassware with narrow channels. Scrub with a brush. Be sure there are no exposed, sharp, metal points on the brush which can scratch the glass. Rinse well with hot water. Finally, rinse 5 or 6 times with small amounts of distilled or deionized water. Rinsing with many small portions is more effective (and cheaper) than with a few big ones. Glass is easier to clean immediately after use than after it has dried dirty!

You rarely need to dry glassware. If you must dry the inside of a flask, warm it gently over a Bunsen burner. Do not heat volumetric glassware (it will break if you do). Usually you can get around the problem of wet volumetric glassware by rinsing it with 4 or 5 small aliquots of the solution to be measured so the solution replaces the water.

Beaker

Beakers are roughly graduated and may be used for estimating the volume of a liquid. They are not to be used for volume measurements when accuracy is important. They are made of pyrex and may be heated.

Buret

Burets are long, thin calibrated columns of glass that are mounted vertically by a buret clamp to a ring stand. You can find clamps and ring stands in the back of the lab in the cupboards under the fume hoods.

Figure 1: Buret

Burets allow for very precise volume measurements, far more precise than graduated cylinders. Unlike the precise volumetric pipets (which only deliver one volume), burets can add any volume between zero and 50 mL. When you need one for an experiment, they will be available from the stockroom. Before you use it, be sure it is thoroughly clean, drains freely, and does not leak around the stopcock. See the above section on cleaning glassware. Be sure the stopcock at the end is securely in place.

To fill your buret, always place it with its ring stand on the floor, and fill it from the top with a funnel. Make sure the stopcock is closed. Put a waste beaker under the tip of the buret just in case! Rinse the buret by adding a small amount of solution, remove the buret from the ring stand and rotate and tip it to wet the interior completely. Put the buret back in the ring stand and empty it into the waste beaker. Repeat the rinse procedure at least once more.

Fill the buret to above the zero mark with the stopcock closed. Make sure there are no air bubbles trapped in the tip or stopcock by opening the stopcock completely and letting some solution drain. You can dislodge bubbles by firmly flicking the tip or stopcock near the bubble. Stop the flow a bit below the zero mark.

When using a buret for a titration, you should be able to use volumes between 10 mL and 50 mL. If you use too small of a volume, your relative error in your measurement will be very large. Using over 50 mL of titrant to reach your endpoint requires you to refill your buret, which gives twice as many measurements; i.e. two initial and final volume readings, which roughly doubles your error.

Burets are marked in 0.1 mL increments from 0 to 50 mL. You should be able to read between the marks to 0.01 mL. Always read your buret to this precision. A typical reading should be recorded as 1.53 mL or 32.17 mL, for example, not as 1.5 mL or 32.2 mL.

Carefully read and record the level of solution in the buret before the titration. See the section on graduated cylinders below for a discussion of how to do this properly. Then perform the titration and record the final reading. The volume of solution delivered is the difference between these two readings.

The uncertainty in the volume follows from the rules of error propagation; i.e.,

$$V_{\text{delivered}} = V_{\text{final}} - V_{\text{initial}} \text{ and } \sigma_{\text{delivered}} = \sigma_{\text{final}} + \sigma_{\text{initial}}. \quad (1)$$

Volumetric Flask

Volumetric flasks are made to contain (T.C.) the specified volume when the liquid meniscus is level with the line etched on the neck. See the discussion of the graduated cylinder below for a discussion of this. They are used to prepare standard solutions and to dilute samples to known volumes.

Figure 2

Make sure the flask is clean and thoroughly rinsed with a small volume to the liquid in use. See the section on cleaning glassware. Using a funnel or pipet, fill the flask to just below the etched line with liquid. Do not wet the ground glass joint at the top of the neck with the liquid. If it inadvertently is wetted, leave time for the liquid to drain off. Fill to the graduation line dropwise using a disposable pipet (available in the front of the lab) and small pipet bulb. The disposable pipets must be rinsed and placed in the broken glass container, not the trash.

There is uncertainty associated with the volumes that volumetric flasks contain:

Capacity (mL):	1	2	5	10	25	50	100	250	500	1000
Tolerance (± in mL):	0.02	0.02	0.02	0.02	0.03	0.05	0.08	0.1	0.2	0.3

Graduated Cylinder

Graduated cylinders are a simple way to measure liquid volumes. The concave surface of the liquid is called its *meniscus*. Make all measurements from the bottom of the meniscus. It helps to hold a white paper or card behind the cylinder at the meniscus. To avoid error (called parallax error), your eye should be level with the meniscus when you measure the volume, at which time you will see one single concave surface.

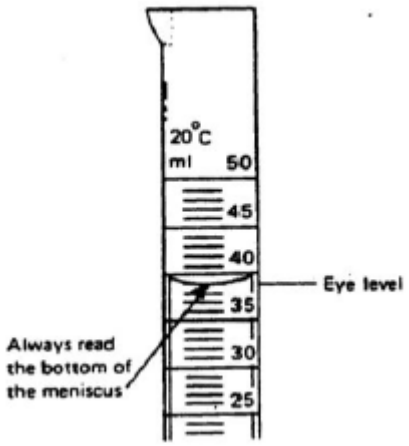

Figure 3: Finding the meniscus

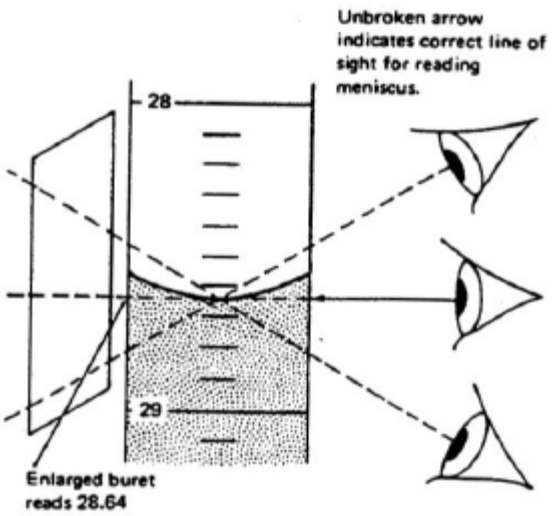

Figure 4: Line of sight to read meniscus

Some graduated cylinders (usually marked by "TC" etched in the glass) are calibrated *T*o *C*ontain the volume that is measured. With these, the volume you pour out will always be less than the measured volume. Others (usually marked by "TD" etched in the glass) are calibrated *T*o *D*eliver the measured volume. They will contain more than the measured volume, but the amount you will pour out of them will be the measured amount (the rest sticks to the walls).

Pipet

All pipeting must be done with a rubber bulb. Pipeting by mouth will result in your immediate and permanent ejection from the course.

Graduated Pipet

The graduated pipet is similar to the buret except that it is hand-held and is filled by putting a rubber suction bulb over the end, drawing the liquid up past the last calibration mark, then quickly placing the end of your finger over the end of the pipet to hold the vacuum. By gently rolling your fingertip aside, you can let excess liquid drain out until the meniscus reaches the mark. Practice this until you are smooth and confident at it. Then put the tip of the pipet over your receiving vessel and let the liquid drain until the desired volume is delivered. Graduated pipets come in different volumes.

Volumetric Pipet

Volumetric pipets are made for very precise volume transfers. They are not graduated, but deliver one given volume. They come in many sizes, e.g., 1, 5, 10, 25, and 50 mL. Be sure your pipet is clean. It takes practice to learn to use the pipet smoothly and accurately. Most people find this works best when they sit on a lab stool, where they can hold the pipet steady over the beaker of liquid and where their eyes are level with the 10 mL mark.

Figure 5

Moisten your index finger, but not with saliva. Place the rubber bulb lightly, yet securely, on top of the pipet and draw in a small quantity of the liquid. Thoroughly rinse the interior surfaces of the pipet; then, drain the rinse into a waste container. Repeat with at least two more portions.

Then carefully fill the pipet with the liquid somewhat past the graduation mark on the stem. Pay close attention so you don't draw liquid up into the rubber bulb, as this contaminates your sample. Remove the rubber bulb and immediately put your forefinger over the opening to stop the outflow of liquid. If during this the liquid level has fallen below the graduation mark, you will have to repeat the procedure.

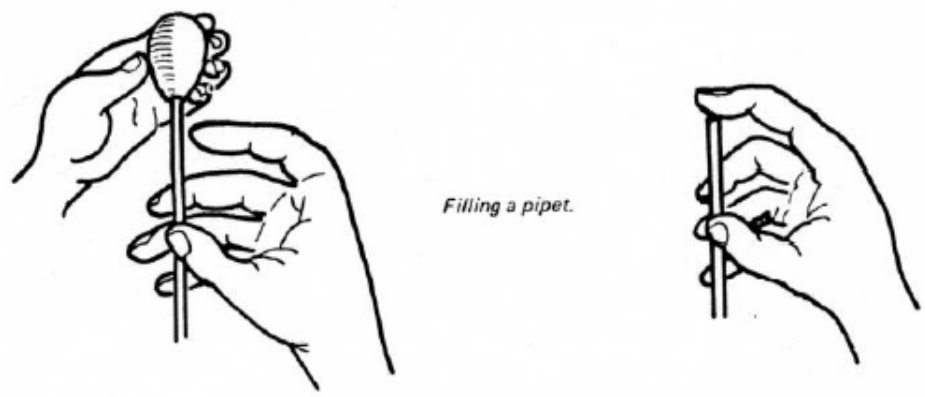

Figure 6

When you have stopped the liquid at a level above the mark, place the tip of the pipet against the inside wall of the source container and gently roll your index finger to one side so that a smooth thin flow of air barely enters the pipet. You will know that is happening when the meniscus slowly and smoothly moves down as a few drops of liquid run out the bottom of the pipet. Stop the flow by tightening your finger.

Practice until you reliably halt the flow with the bottom of the meniscus precisely at the graduation mark. Keeping your finger firmly in place, touch the tip of the pipet to the wall of your source container to drain away any loose drops that adhere to it. Then hold the pipet over the receiving container and drain it. When the pipet is empty, touch its tip to the wall of the receiving beaker to break the surface tension and leave a drop of reliable size inside the tip. Do not blow this last drop out of the tip, as the pipet is calibrated assuming that drop will stay inside.

When you are finished, rinse your pipet with distilled water.

As with all instruments, there is uncertainty in the volumes delivered by pipets:

Capacity (mL):	1	2	5	10	25	50	100
Tolerance (± in mL):	0.006	0.006	0.01	0.02	0.03	0.05	0.08

