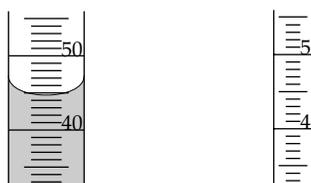


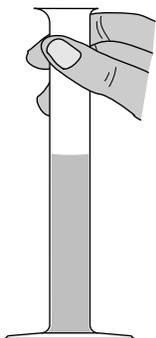
Graduated Cylinders

Graduated cylinders are the tools commonly used to make moderately precise measurements of volumes in the laboratory. The volumes can be measured to 3 significant digits if care is taken. The cylinders come in a variety of sizes. The divisions on different sized cylinders have different values. Here are drawings of segments of two cylinders. The larger one (shown with liquid in it) has 1 ml divisions, the smaller one has 0.1 ml divisions.



100 ml cylinder; each division is 1 ml 10 ml cylinder; each division is 0.1 ml

Common sense and availability dictate which size to use. Care must be taken in their use. They are tall and thin, and tip over easily. When they tip, they spill out their contents and frequently break. When pouring liquid into a graduated cylinder, **NEVER** crouch down so your head is on the same level as the table top. If the cylinder tipped while you were in that position, its contents could splash into your face and over your body. To put liquid into a cylinder, hold it in one hand while pouring the liquid from its container with your other hand.

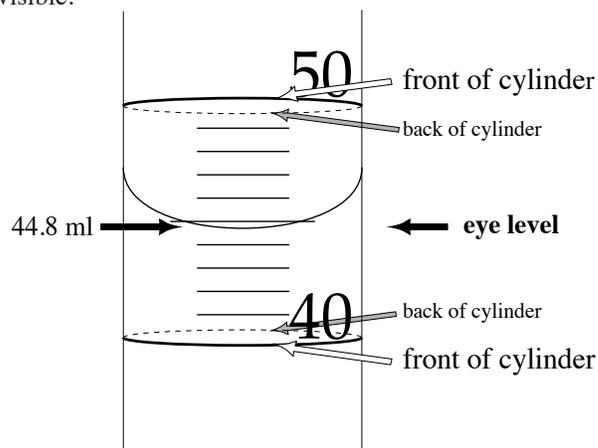


To see how much liquid is in the cylinder, hold it up to eye level. Hold it at the top so it hangs straight down. In order to use the full accuracy of the measurement possible on the cylinder, you will have to observe the bottom of the meniscus of the liquid level. (The meniscus is the curved

surface many liquids take on near the walls of a container. The liquid is attracted to the wall by molecular forces.) Your eye must be on the same level as the bottom of the meniscus to read the volume correctly.

The diagram shows how to observe the position of the wraparound rings on the cylinder to estimate when your eye is level with the meniscus. The ring above the observation point should have a mirror image relationship with the ring below the observation point.

It is sometimes helpful to hold a piece of paper with a heavy black line on it in back of and below the meniscus. The reflection of the line on the meniscus makes it more visible.



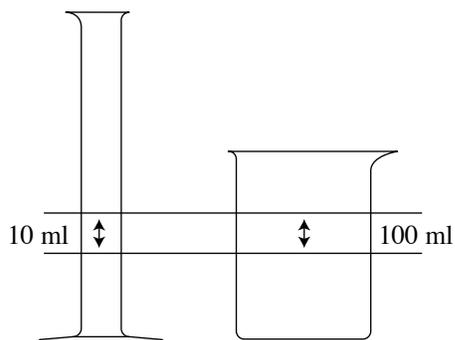
When you are estimating how far the liquid level is between lines, you do the best job that you can. Mentally split the distance in half and estimate how far up or down the meniscus is in its half portion of the distance, then assign a value of 1 to 9 to its position. You will get a good understanding of the rules for significant digits as you estimate volume on graduated cylinders. It is difficult to get used to estimating to the nearest tenth or hundredth of a milliliter between the lines.

Occasionally, you will be required to fill the graduated cylinder as accurately as possible to a certain volume. You might be asked to measure 25.0 ml of a liquid, for example. To do this, use a transfer pipet. Add liquid to the cylinder to near the mark by pouring from the liquid's container. Then, use a transfer pipet to add liquid drop by drop, or

to remove liquid, until the level is right on the mark. The transfer pipet must be clean and dry, or if not, it must be rinsed with the liquid you are adding before using it. Never put a reagent back into its bottle with the transfer pipet. Rather, use a small beaker to hold as much of the liquid as is necessary, and when finished measuring, dispose of the excess liquid as directed.

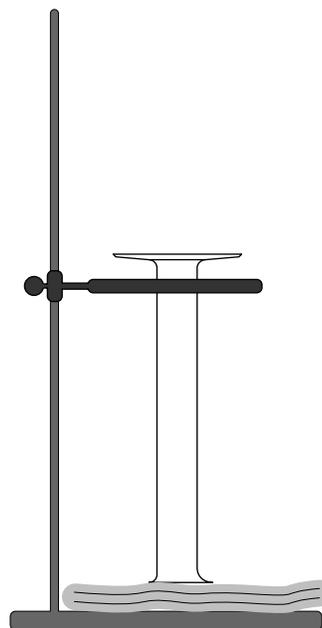
More often, you will be asked to measure a quantity of liquid with less accuracy than the graduated cylinder can give. If you are told to use the cylinder to measure "about 25 ml" of a substance, then anywhere from 24 to 26 ml is OK.

You will often be instructed to use the markings on flasks or beakers for very rough measurements. You might be told to fill a beaker half full, or to add water to the 50 ml mark in the beaker. Using the marks on flasks and beakers gives a rough guide ($\pm 5\%$ or more) to the volume. This is primarily a matter of the larger cross sectional area of the beaker or flask. Small differences in height give large differences in volume.



Another common instruction is to add liquid within a range and then accurately read the volume of liquid present. The directions will read something like: "Add liquid until the level is between 50 and 60 ml, and then read the volume to the nearest 0.1 ml."

Graduated cylinders are usually rinsed with deionized water and allowed to drip dry between uses. Turn them upside down on a piece of paper towel. **Protect them from falling over by using a ring on a ring stand to support them.**



To dry a cylinder

Sometimes you will be directed to rinse the cylinder with the incoming liquid before using it. At other times, you will be directed to dry the cylinder with a paper towel. To do this, take a piece of paper towel a few inches longer than the graduated cylinder. Then fold the paper towel lengthwise, then fold again, and again, until the folded paper towel has a circumference that will allow it to fit inside the cylinder. Now insert it, and thrust it up and down a few times to absorb the liquid from the inside surface of the cylinder.

Never attempt to dry the cylinder by blowing compressed air into it. Water does not evaporate very quickly, and the compressed air carries a bit of oil in it.

Refer to this handout as needed throughout the semester. An important part of the training you receive during general chemistry involves the proper use of tools in the laboratory. Proper use of tools gives you more confidence in the lab, and keeps you from losing points on your lab grades.