Name: _____

Lab Experiment: Measuring Volume

Volume refers to the amount of space occupied by a liquid, solid or gas. In the United States, we typically use English system units, such as gallons or quarts, to measure volume. For example, we buy a gallon of milk at the grocery store. We actually use the metric system for the volume of soda (the Liter is a metric unit of volume). Like virtually all lab equipment, graduated cylinders use metric units. They are usually marked in mL (milliliters). There are 1000 mL in one Liter. Directions for using graduated cylinders are below:

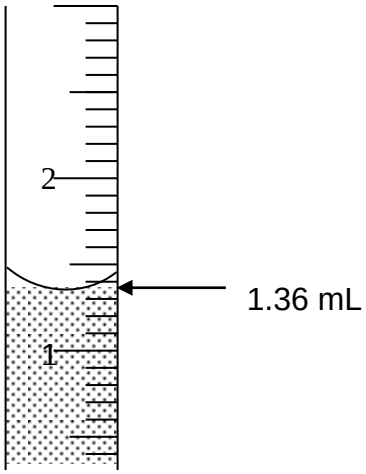
Graduated cylinders are used to contain and deliver measured amounts of liquid. They are available in many sizes. You may use the 10 mL and 100 mL sizes. In order to read any graduated cylinder accurately, it must be level (sitting on the counter, NOT hand-held). Your eye must also be at the approximate height of the water level

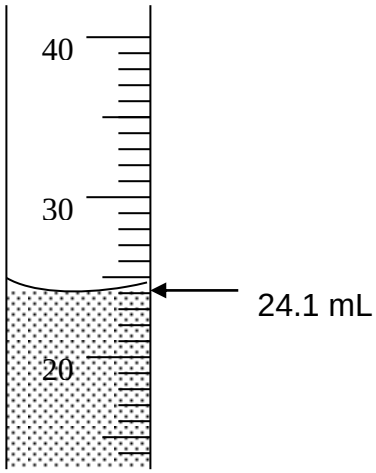
When water is placed in a glass cylinder, a concave surface forms; this curve is called a **meniscus**. Glass graduated cylinders are manufactured so that the line at the bottom of the meniscus gives the most accurate reading.

Estimate the reading one place past the smallest marks printed on the graduated cylinder as shown for the examples below.

⇒ The 10-mL graduated cylinder below is read to **two decimal places** (to the nearest 0.01 mL). Thus, the volume of liquid in the 10-mL cylinder is **1.36 mL.**

⇒ 100-mL graduated cylinders can only be read to **1 decimal place** (to the nearest 0.1 mL). For the 100 mL graduated cylinder below, the volume of the liquid is **24.1** mL.





10-mL graduated cylinder
Reading: 1.36 mL

100-mL graduated cylinder
Reading: 24.1 mL

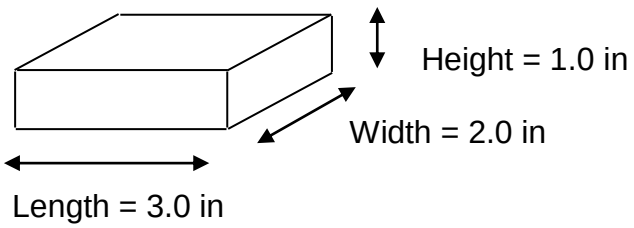
This is important! Always read the small cylinder to two decimal places and the larger cylinder to one decimal place.

Lab exercise: Wear Goggles when using glassware or chemicals!

Calculated Volumes

For a regular rectangular solid, the volume is equal to "length x width x height".

Example: Find the volume of the block below:



Volume = l x w x h
V = 3.0 in x 2.0 in x 1.0 in
V = 6.0 cubic inches (or 6.0 in^3)

Notice that the result is expressed in **cubic** inches. That happens, because in the calculation, the unit "inches" has appeared 3 times in a multiplication Other "cubic" units for volume would be cubic feet (of a room, to determine the size of an air-conditioner), cubic yards (concrete delivery)

Metric Volume Relationships

The metric system is more organized than the English system. It was constructed so that 1 cubic centimeter (abbreviation, cc or cm^3) is exactly equal to 1 milliliter (mL).

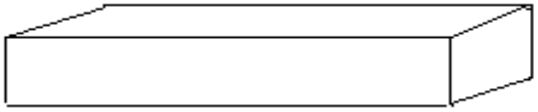
Remember, **1 cc = 1 cm^3 = 1 mL**

This means that the volume of a box 3.0 cm x 2.0 cm x 1.5 cm can be expressed as 9.0 cm^3, 9.0 cc, or 9.0 mL. Also, a 5-cc syringe delivers 5 mL. The English system, unfortunately, is not this simple. The volume of the block on the previous page is 6.0 in^3, but a box this size does not contain 6.0 pints, 6.0 quarts, 6.0 teaspoons, or 6.0 of any other common volume unit in the English system! (You can, of course, look up the number of in^3 in a pint, and get out your calculator!).

To summarize: The metric unit of volume is the liter (with its associated unit, the milliliter). The metric system is set up so that a cube, one cm on a side, has a volume of one mL.

Activity: Volume by Calculation

You will be given a small piece of aluminum bar. Use the metric side of your ruler to measure the length, width, and height of the bar to the nearest 0.01 cm. Write your measurements, including units, on the sketch below.



Calculate the volume of the aluminum bar. Be sure to include units for your answer.
Fill in the blanks below.

V = _____x_____x_____

Volume of Aluminum bar = _____

Determination of Volume by Water Displacement

If an object has an irregular shape, there is no easy way to calculate its volume by measuring dimensions. However, it can be determined by displacement as follows.
Some water is placed in a graduated cylinder and the volume recorded. The object is added to the water, and the new volume recorded. The volume of the object is the difference between the two volumes. Try this with your aluminum bar, following the directions below.

1. Add between 40-50 mL of water to your 100 mL graduated cylinder. Read and record the exact water level to **one decimal place.**

2. Tilt the cylinder, and slowly slide the aluminum bar down the inside of the graduated cylinder, so none of the liquid splashes out. Read and record the new water level to **one decimal place**.

   Water level before aluminum bar was added _____ mL

   Water level after aluminum bar was added _____ mL

   Increase in water level (equals volume of the aluminum bar) _____ mL

Comparison:

The volume of the aluminum bar calculated on page 2 was _____ cm^3 while the volume calculated by displacement was _____ mL.

In theory, these two numbers should be the same, but experimental errors will probably make them slightly different.

Questions:

1. If you had a copper bar that was 12.45 mL, how many ounces is this? (1 cup = 8 oz)

2. A measuring cup contained 1.00 cups water. A small tangerine was added to the cup and the water level rose to 1.75cups. What is the volume of the tangerine in cups?

3. You are ordering carpeting for your living room. What (English) unit would you use when you order the carpeting?

4. A shoe box measures 13 inches by 4.0 inches by 3.5 inches. What is the volume?

5. A 10 milliliter graduated cylinder was read by a student. Which number is the correct and proper volume reading for a small 10 mL graduated cylinder?
   a. 2 mL b. 2.3 mL c. 2.37 mL d. 2.375 mL e. 2.3758 mL

6. Angie had an asthma attack and was given 1.5 cc of adrenaline at the ER. How many mL is this?