

## Volume Measurements

Name: \_\_\_\_\_

**Introduction**

The purpose of this laboratory experience is to gain confidence in the use of common volume measuring glassware and laboratory balances. Throughout this semester, you will be using graduated cylinders and balances to measure volume and mass. Periodically, you will be expected to interpolate an extra decimal place when reading a cylinder. It is important to master these skills before applying them. While we will not frequently use volumetric pipettes in this course, we will use them today as a way of accurately dispensing a fixed volume of water.

**Volumetric Pipettes**

Obtain a 25 mL volumetric pipette. The accuracy of these pipettes ranges from  $\pm 0.01$  mL to  $\pm 0.06$  mL depending on the “class” and size of pipette used. Using a pipette bulb, fill the pipette with water until the water is a few centimeters above the graduation—quickly replace the bulb with your index finger tip. Now slowly release water from the pipette, by easing up on the finger pressure, until the bottom of the meniscus coincides with the graduation mark. To deliver the water, release your finger and allow the water to flow into the receiving vessel. Do not blow into the pipette to speed up the delivery, and do not blow out the last remaining drop in the tip. Practice delivering 25.00 mL of water until you are comfortable with the operation of the pipette.

**Part 1 - The Accuracy of Beakers (or lack thereof)***Step 1*

Obtain a 50 mL beaker. Examine the graduations (markings) on the side of the beaker. Determine the value of each graduation (in other words, determine how much the volume changes between graduations).

Value of each Graduation	
--------------------------	--

*Step 2*

Using the volumetric pipette, transfer 25.00 mL of water to the 50 mL beaker. Read the volume of the water in the beaker to the nearest 1 mL, and record the value below. It will be necessary to interpolate.

Volume of Water in Beaker (read from the beaker graduations)	
---	--

Is there a difference in the volume delivered by the pipette and that read from the beaker? Is this difference substantial?

If an experimental procedure calls for 25 mL of water, should you use the beaker to measure the water? Explain your response.

## Part 2 - Reading Graduated Cylinders

### 10 mL Graduated Cylinder

#### Step 1

Carefully examine the 10 mL graduated cylinder in your drawer. Determine the value of each major and minor graduation. Record the values of the graduations below.

In general, you can estimate the volume to one-tenth of the smallest division. For example, if the smallest divisions are every 1 ml, it is possible to estimate your readings to the nearest  $\pm 0.1$  mL.

Value of Major Graduations		Value of Minor Graduations	
----------------------------	--	----------------------------	--

#### Question

If you interpolate between the graduations on your 10 mL cylinder (i.e., read between the lines), to what decimal place can you report the result?  $\pm 0.1$  mL?  $\pm 0.01$  mL? Other?

#### Step 2

Transfer 5.00 mL of water to a 10 mL graduated cylinder using the 5 mL volumetric pipette. Record the volume of the water in the graduated cylinder interpolating to the appropriate decimal place. Record the value below.

Volume of Water (measured with 10 mL graduated cylinder)	
---	--

### 25 mL Graduated Cylinder

*Step 1* Carefully examine the 25 mL graduated cylinder in your drawer. It will likely have at least two different graduations. Determine the value of each major and minor graduation. Record the values of the graduations below.

Value of Major Graduations		Value of Minor Graduations	
----------------------------	--	----------------------------	--

#### Question

If you interpolate between the graduations on your 25 mL cylinder (i.e., read between the lines), to what decimal place can you report your result?  $\pm 1$  mL?  $\pm 0.1$  mL?  $\pm 0.01$  mL? Other?

#### Step 2

Transfer 5.00 mL of water to a 25 mL graduated cylinder using a 5 mL volumetric pipette. Record the volume in the graduated cylinder interpolating to the appropriate decimal place. Record the measurement below.

Volume of Water (measured with 25 mL graduated cylinder)	
---	--

<b>250 mL Graduated Cylinder</b>			
<i>Step 1</i> Obtain a 250 mL graduated cylinder. Examine the graduations (markings) on the side of the beaker. Determine the value of each major and minor graduation (in other words, determine how much the volume change between graduations).			
Value of Major Graduations		Value of Minor Graduations	
<i>Question</i> If you interpolate between the graduations on your 250 mL cylinder (i.e., read between the lines), to what decimal place can you report the result? $\pm 10$ mL? $\pm 1$ mL? $\pm 0.1$ mL? Other?			
<i>Step 2</i> Obtain a 250 mL beaker and fill to the 150 mL mark with water. Transfer the water into your 250 mL graduated cylinder. Read the volume of water in the graduated cylinder to the nearest 1 mL and record the value below.			
Volume of water (measured with the graduated cylinder)			
<i>Step 3</i> Obtain a plastic cup. Notice that the cup has several ridges. Fill the cup to the top-most ridge with water. Transfer the water into your <i>empty</i> 250 mL graduated cylinder. Read the volume of water in the graduated cylinder to the nearest 1 mL and record the value below.			
Volume of water (measured with 250 mL graduated cylinder)			
<b>Part 3 – Teacher Verification of Volume Measurements</b>			
There are four covered graduated cylinders with some liquid in them already. Look for them in the fume hood. Read the volume of liquid in each one and record your results in the spaces below. Remember to always estimate between the smallest divisions to determine the last digit. Include the correct number of decimal places in your measurement. As you learned earlier in this experiment, the number of decimal places will be different for different-sized graduated cylinders.			
(Remember to do this estimation between the lines for all volume measurements throughout the semester.)			
Volume of liquid in 10-mL graduated cylinder			
Volume of liquid in 25-mL graduated cylinder:			
Volume of liquid in 100-mL graduated cylinder:			
Volume of liquid in 250-mL graduated cylinder:			

### Part 4 - Measuring Volume Indirectly

The volume of a liquid can be determined indirectly by measuring the mass of the liquid, and using the known density of the liquid to calculate the volume. The density ( $d$ ) of any substance expresses the mass ( $m$ ) of the substance per unit volume ( $V$ ), and is usually expressed in units of g/mL for liquids.

As an equation it is:  $d = m/V$

*Problem:*

Rearrange the density equation to solve for volume. Use the space below.

*Mass by Difference*

When measuring the mass of a substance such as a solid powder or liquid, we usually do it by dispensing the substance into a beaker (or other container) that has been weighed empty. The substance and the beaker are then weighed together. The mass of the substance is determined by taking the difference between the beaker with substance and the empty beaker.

$$\text{Mass of Substance} = [\text{Mass of Beaker and Substance}] - [\text{Mass of Empty Beaker}]$$

*Step 1*

Our laboratory is equipped with both top loading and analytical balances. The two different types of balances have different degrees of precision (i.e., the number of decimal places it displays). Examine a top loading and an analytical balance to determine the degree of precision by locating the decimal place of the last zero (when the balance is zeroed).

Precision of Top Loading Balance:	$\pm$	Precision of Analytical Balance:	$\pm$
-----------------------------------	-------	----------------------------------	-------

*Step 2*

Record the mass of an empty small beaker using both an analytical balance, and a top loading balance. Be sure to zero the balance before using it.

Mass of Beaker (Top Loading Balance)	Mass of Beaker (Analytical Balance)
--------------------------------------	-------------------------------------

*Step 3*

Dispense 5 mL of water to the beaker using a 5 mL volumetric pipette.

*Step 4*

Measure the mass of the water and beaker on both the analytical and top loading balances. Use the same balances you used to measure the mass of the empty beaker.

Mass of Beaker and Water (Top Loading Balance)	Mass of Beaker and Water (Analytical Balance)
--	---

*Calculation 1*

Calculate the mass of water by taking the difference between the mass of beaker and water, and the empty beaker.

Mass of Water (Top Loading Balance)

Mass of Water (Analytical Balance)

*Calculation 2*

Calculate the volume of water in the beaker using the density of water at lab temperature. (The density can be found in the chemistry handbooks in the lab.) Show your calculations below.

Volume of Water (Top Loading Balance)

Volume of Water (Analytical Balance)

According to the manufacturer, the volume of water delivered by the pipette should be  $5.00 \text{ mL} \pm 0.01$ . Were the calculated volumes within the tolerance range of the pipette? If not, offer an explanation for the discrepancy.