Experiment#1 Introduction to the Chemistry Laboratory

(Determination of accuracy of volume markings on glassware)

I. PURPOSE OF THE EXPERIMENT
To become familiar with the physical layout of the room; to handle liquid reagent bottles properly; to light and properly adjust a Bunsen burner; and to develop skills in using and reading the electronic balance, graduated cylinder, pipette, conical flask (Erlenmeyer flask), volumetric flask, and burette; to determine accuracy of volume markings on glassware.

II. INTRODUCTION
This experiment is designed to introduce you to the chemistry laboratory and introduce techniques you will need to work effectively this semester.

In the laboratory students encounter a variety of glassware with volume markings on them. Some of it is intended to determine volumes and some is not. The markings on volumetric glassware are placed much more carefully and more accurately than that on non-volumetric glassware. It is the volumetric glassware (graduated cylinders, burettes, pipettes, volumetric flasks, etc.) that is intended to give reasonably accurate indications of volume. Among this glassware some are more accurate in their measurements than others. For example, a small graduated cylinder may be able to determine volumes that are accurate to within about 0.55 while burettes may be able to determine volume to about 0.15. Common beakers and Erlenmeyer flasks (conical flasks) have volume markings on them, but are NOT intended to give very accurate volume measurements. This glassware is usually only accurate to 5% or less.

One method commonly used to evaluate the accuracy of volume measurements is based on the density of water. Water has a definite density (mass / volume) at each temperature.
Table 1: Density of water at different temperatures

<table>
<thead>
<tr>
<th>Temperature(°C)</th>
<th>Density (g/mL)</th>
<th>Temperature(°C)</th>
<th>Density (g/mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>0.9973</td>
<td>30</td>
<td>0.9957</td>
</tr>
<tr>
<td>25</td>
<td>0.9970</td>
<td>31</td>
<td>0.9953</td>
</tr>
<tr>
<td>26</td>
<td>0.9968</td>
<td>32</td>
<td>0.9950</td>
</tr>
<tr>
<td>27</td>
<td>0.9965</td>
<td>33</td>
<td>0.9947</td>
</tr>
<tr>
<td>28</td>
<td>0.9962</td>
<td>34</td>
<td>0.9944</td>
</tr>
<tr>
<td>29</td>
<td>0.9959</td>
<td>35</td>
<td>0.9940</td>
</tr>
</tbody>
</table>

The absolute value of the difference in volume calculated using density, and that measured using the glassware (Subtract one from the other and take the absolute value of the result.) was calculated and the percent difference is calculated by:

\[
\% \text{Difference} = \left| \frac{(\text{Volume Calculated} - \text{Volume Equipment})}{\text{Volume Calculated}} \right| \times 100\%
\]

\[
\text{Difference} = \left| \text{Volume Equipment} - \text{Volume Calculated} \right|
\]

III. EXPERIMENTAL

3.1 Chemicals..................Nil

3.2 Equipment...Beaker, Graduated Cylinder (Measuring Cylinder), Pipette, Thermometer, Volumetric Flask, and Burette

3.3 Procedure.

(A) Accuracy of volume markings on glassware

Measure out a volume of water using the volume markings on your glassware; determine the mass of this water at known temperature; to then calculate the volume of the weighted water using the density of water given in your manual: volume = mass / density. Then compare the volume calculated from the mass of water with the volume you thought you measured out, based on the markings on the piece of glassware, to evaluate the accuracy of those volume markings.
There are actually at least **TWO** major factors involved in the correlation between the volumes you measured and those calculated:

1) as noted above: the accuracy of the volume markings on your glassware, and 
2) the care and accuracy you demonstrate in filling the glassware to the correct mark and dispensing the water accurately.

Your task in this experiment is to accurately fill and dispense the water.

Carry out this procedure for three pieces of glassware: 1) Graduated cylinder  
2) Pipette, 3) Volumetric flask and 4) a 50 mL burette.

**Pour some distilled water into a large, clean beaker. Using your thermometer, determine and record the temperature of this water, rounded off to the nearest 1°C. Use this water in the volume determinations.**

1. **Graduated cylinder (measuring cylinder)**

   (a) Wash your graduated cylinder with soap solution and rinse at least three times with tap water. Shake out excess water and rinse with distilled water using a wash bottle. When properly cleaned, droplets of water will not adhere to the glass.

   (b) Weigh, and record the mass of your empty 100 -mL beaker. Make sure it is dry on the outside, though it does not have to be completely dry on the inside. Carefully fill the graduated cylinder with 10-mL of distilled water, record the exact volume you added. You should add the last drops of water with a dropper in order to position the meniscus at a specific volume marking. Pour out all of this water into the 100-mL beaker, reweigh the beaker with its contents, and record the mass. **DO NOT** empty the water out of the beaker after the weighing.

   (c) Again, fill the graduated cylinder with 10-mL of distilled water, record the exact volume of water in the graduated cylinder, pour this sample of water into the beaker. (The initial mass of beaker this time will be the mass of the beaker containing the first addition of water. Re-weigh the beaker and its contents.

   (d) Repeat this procedure for a third time and again record the mass.
2. **Pipette**

(a) Carefully wash the pipette with tap water and rinse with distilled water. Weigh the empty 100-mL beaker, making sure it is dry on the outside and record the mass. With the aid of the pipette bulb, draw distilled water into the pipette up to the marking. Transfer distilled water from the pipette into the 100-mL beaker, reweigh the beaker with its contents, and record the mass. DO NOT empty the water out of the beaker after the weighing.

(b) Again, draw distilled water into the pipette and pour this sample of water into the beaker. (The initial mass of beaker this time will be the mass of the beaker containing the first addition of water. Re-weigh the beaker and its contents.)

(c) Repeat this procedure for a third time and again record the mass.

3. **Volumetric flask**

(a) Carefully wash the Volumetric flask with tap water and rinse with distilled water. Pour water into the volumetric flask through the funnel up to the marking. Transfer water from volumetric flask into the beaker and record the mass.

(b) Pour the water out of the beaker and refill volumetric flask with distilled water up to the marking. Transfer water from volumetric flask into the beaker and record the mass again.

(c) Repeat this procedure for a third time and again record the mass.

4. **Burette**

(a) Carefully wash the burette with tap water and rinse with distilled water. Mount the burette in the burette clamp holder on the ring stand and iron plate.

(b) Dispense 10-mL of distilled water from your burette into the beaker. Determine the new burette volume, and record it. Weigh the beaker and water, record the mass. DO NOT dump out the water after weighing.

(c) Dispense another 10-mL of distilled water from the burette into the beaker. Determine and record the new burette volume. Weigh the beaker and water, record the mass again.

(d) Repeat this procedure a third time.
Lab Report:

A. **Accuracy of volume markings on glassware**

1. **Graduated (or) Measuring cylinder**

   Water temperature:......... Empty beaker:...........(g)

   Water density:........g/mL

   | No. | Measured volume (mL) | Mass of beaker and water (g) | Mass of water (g) | Calculated volume using density (mL) | | Difference| in volume (mL) | % Difference |
   |-----|----------------------|-------------------------------|-------------------|-------------------------------------|----------------|----------------|
   | 1.  |                      |                               |                   |                                     |                |                |
   | 2.  |                      |                               |                   |                                     |                |                |
   | 3.  |                      |                               |                   |                                     |                |                |

   Average | Difference|............mL...............% |

2. **Pipette**

   | No. | Measured volume (mL) | Mass of beaker and water (g) | Mass of water (g) | Calculated volume using density (mL) | | Difference| in volume (mL) | % Difference |
   |-----|----------------------|-------------------------------|-------------------|-------------------------------------|----------------|----------------|
   | 1.  |                      |                               |                   |                                     |                |                |
   | 2.  |                      |                               |                   |                                     |                |                |
   | 3.  |                      |                               |                   |                                     |                |                |

   Average | Difference|............mL...............% |
### 3. Volumetric Flask

<table>
<thead>
<tr>
<th>No.</th>
<th>Measured volume (mL)</th>
<th>Mass of beaker and water (g)</th>
<th>Mass of water (g)</th>
<th>Calculated volume using density (mL)</th>
<th>Difference in volume (mL)</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
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<tr>
<td>3.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Average | Difference|……………mL……………..% |

### 4. 50 mL Burette

<table>
<thead>
<tr>
<th>No.</th>
<th>Measured volume (mL)</th>
<th>Mass of beaker and water (g)</th>
<th>Mass of water (g)</th>
<th>Calculated volume using density (mL)</th>
<th>Difference in volume (mL)</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After Addition #1</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After Addition #2</td>
<td>30</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Average | Difference|……………mL……………..% |
IV RESULTS & DISCUSSIONS

Accuracy of volume measured by different apparatus

Water Temperature = ..........°C  
Density of water = g/mL

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Apparatus</th>
<th>Average [Difference] mL</th>
<th>Average [Difference] %</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Graduated Cylinder</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Pipette</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Volumetric Flask</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Burette</td>
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</tbody>
</table>

DISCUSSIONS

Based on the results, mention which apparatus is the most accurate one and which is the least accurate one. Why? Give reason (s) for your answer.

V. CONCLUSION

By performing above experiment, I found out that ................apparatus is the best accurate and ................apparatus is the least accurate one among all four apparatus.