Lab 1: Accuracy in Measurement (Using the right tool for the Job)
and Density of Metals

Objectives:

- To understand the meaning of accuracy and precision—You will determine the relative precision and accuracy of different glassware items.
- Learn to measure volumes and masses (using volumetric glassware and top-loading balances).

Pre Lab Questions: (Answers submitted at the beginning of lab)

1. Summary of the procedure in your own words.
2. The 10 mL graduated cylinder is marked to tenths of a mL. How many decimal places should you record? Hint you want to estimate one digit beyond the markings.
3. Is the estimated digit significant?
4. Would you expect a piece of glassware marked to the nearest mL or nearest tenth of a mL to be more accurate?
5. Why is it best to determine the mass of the metal before placing it into the graduated cylinder of water rather than after?
6. What would happen if you used a very small amount of metal? How would this affect your measurements? Hint: Consider the number of sig figs in your answer if you use more than 1.00 mL of metal or less than 1.00 ml of metal.

Part 1

Introduction: When we work in a laboratory environment it is important to make measurements that are accurate. Accuracy is related to the actual or "truthful' value of the object measured. A ruler that can measure out to the millimeter is more accurate than a ruler that can measure out to the centimeter.

How to determine accuracy? We will measure a volume of water with 3 different pieces of glassware each with varying degrees of accuracy and precision. By knowing the density of water (an exact number) and an accurate weight of a given volume of water we can ascertain the accuracy of the volume measured.

Notes:

1. Measure water volume at the <u>bottom</u> of the meniscus.
2. Use the same balance for the entire lab (do not move the balance!)
3. Remember to use correct significant figures throughout when recording measurements and in calculations.
4. Perform all work at your station <u>not</u> at the balance. The balances are shared so do not monopolize them!

Determination of Accuracy of various glassware items:

1. Weigh a 100 mL beaker, a 10 mL graduated cylinder and a 100/50 mL graduated cylinder and record the dry mass for each on your data sheet.

2. Using the markings on the side of each container to measure 10 mL of water with each glassware item. Do not use the 10 mL graduated cylinder to measure water for each container or transfer the same water from container to container. You want to measure the water using the marking on the container.

3. Weigh and record the mass for each item containing the 10 mL of water.

Part 2

Objectives:

- Practice basic measurement techniques.
- Determine the density of solid samples using water displacement method. By measuring the volume of water a solid displaces and by recording its weight we have the 2 components that make up density-- Mass and Volume.

Notes:

Record any aspects of the metal's appearance that might help identify it.

Procedures:

1. Choose a cylinder of unknown metal, weigh it and record the mass and letter.

2. Place enough water in the graduated cylinder that the metal cylinder will be completely submerged and record the volume. If the cylinder does not fit into your 10 mL graduated cylinder then use the 100 mL graduated cylinder.

3. Tilt the graduated cylinder and add the metal cylinder letting it slide in rather than dropping.

4. Record the new volume.

5. Calculate the volume of the metal and record.

6. Calculate the density of the metal and record.

7. Repeat steps 1-4 for each unknown metal.

Lab Report Guide:

- **1. Results (3 pts)**
  - **Tables neatly filled out with data**
  - **Proper significant figures**
  - **Legible sample calculations**

- **2. Error Analysis (3 pts)**
  - **Determination of percent error (for glassware and metal densities)**
  - **Typed discussion of measured results vs literature results and description of possible sources of error. Note that "human error" is not an acceptable answer. Please be specific.**

- **3. Post Lab Questions (4 pts)**
  - **Typed answers to the Post Lab questions. Note that single sentence answers will not suffice. State the answer to the question followed by a brief description of the evidence supporting that answer.**

Post Lab Questions:

1. Which Piece of Glassware (100 mL beaker, a 10 mL graduated cylinder or the 100/50 mL graduated cylinder) is most accurate according to your results? Explain why you came to this conclusion. Do your results match the expect results?
2. If you were asked to measure out 86.0 mL water, which piece of glassware would you choose and why?
3. Would this technique work to measure materials with densities less than 1.00 g/mL? Explain why or why not.
4. Metals with greater atomic number often have higher density. Why do you think this is?

Data 1A: (Please fill out this table and submit with the lab report. Recopy if messy)

For each piece of glassware, calculate the mass of the water added, then use the density of water (0.998 g/mL) to find the **calculated volume** of the water. Record your three volume calculations below. Be sure to that all measurement include the correct number of significant figures and appropriate units.

	100 mL beaker	10 mL grad. cyl.	100/50 mL grad. cyl.
Dry Mass			
Dry Mass of container + H_2O			
Mass of H_2O (subtract the masses)			
CalculatedVolume (from mass of H_2O)			

Sample Calculations: (Show a sample of each type of calculation you did)

Data 1B: (Please fill out this table and submit with the lab report. Recopy if messy)

	Metal A	Metal B	Metal C	Metal D	Metal E
Mass of metal(g)					
Initial Volume of Water					
Volume of water + metal (mL)					
Volume of metal (mL) (subract volumes)					
Density of metal (g/mL)					
Identity of metal					

Sample Calculations: (Show a sample of each type of calculation you did)