Name: _____

Microscale: Density Determination

Background: Various physical properties can be determined for a substance. These include linear expansion, melting and boiling points, density, vapor pressure, and critical temperature. Density is easily determined in the laboratory using readily available equipment. Density is defined as the mass per unit volume.

For Liquids and solids: Density = (mass in grams)/(volume in milliliters or cm^3)
For gases: Density = (mass in grams)/(volume in liters)

In Part 1, the density of six liquids will be determined using microtechniques. In Part 2, the density of six solids will be determined. The absolute error and percent relative error will be calculated for each material.

Objectives:

- To measure physical properties and calculate and compare the density of metals and liquids.
- To determine absolute error and percent relative error.

Safety: Wear safety goggles. Be sure to wash your hands after completing the laboratory. Ethanol, isopropanol, propanol, and acetone are flammable liquids. Keep these chemicals away from ignition sources.

Disposal: Return the ethanol, isopropanol, propanol, and acetone to their respective recycling containers. Decant the water from the solids and return them to the properly labeled weighing dish.

Materials-Part 1

Apparatus	**Chemicals**
• beral pipet • centigram or electronic balance • 10 ml graduated cylinder • Paper towels	• distilled water • propanol • acetone • isopropanol • ethanol •

Materials-Part 2

Apparatus	**Chemicals**
• 50 ml graduated cylinder • balance (centigram or electronic) • 6 weighing boats (labeled) • glass rod	• nickel shot • copper shot • tin shot • aluminum shot • silicon lumps

Procedure

Part 1: Liquids:

"Fill" the beral pipet with distilled water and determine its mass to two decimal places. Record this mass in Data Table 1. Empty the beral pipet into a 10-ml graduated cylinder and record the volume to the appropriate decimal. Mass the "empty" pipet and record. Discard the pipet in the non-hazardous waste receptacle. Dry your graduated cylinder with a paper towel then repeat the above procedure with ethanol, isopropanol, propanol, and acetone.

Part 2: Solids

1. Add approximately 20 ml of distilled water to a 50 ml graduated cylinder.
2. In Data Table 2, record the mass and volume to the appropriate decimal place.
3. Add enough solid material to increase the volume by 8–12 ml. Precisely record the new volume in Data Table 2.
3. Mass the cylinder containing the water and solid and record the result in Data Table 2.
4. Decant the water from the cylinder and place the solid in the appropriate labeled weighing boat and place in drying oven. Be sure nearly all the water is removed.
5. Repeat Steps 1–4 with the remaining solids.

Calculations

Part 1: liquids

1. Calculate the mass of liquid and record it in Calculations Table 1
2. Calculate the density of each liquid and record.

   Density = mass in grams/volume in milliliters or cm^3
3. Look up the density of all liquids (except the oil) in a reference manual. Record.
4. Determine the absolute error E_a for each liquid (except the oil) and record.

   $E_a = O - A$, where O = observed and A = accepted
5. Determine the % relative error $E_r = E_a/A \cdot 100\%$ using accepted reference information.

Part 2: Solids

1. Calculate the mass of each solid and record it in Calculations Table 2.
2. Calculate the volume of each solid and record it in Calculations Table 2.
3. Determine the density of each solid by dividing the mass by the volume. Record.

   Density = mass in grams/volume in milliliters
4. Determine the absolute and percent relative error for each metal and record.
5. For your discussion, determine the mean (arithmetic average) and the range of values for solids and liquids.

Report

In just a few sentences, tell me

- Are your calculated densities are about equal to the accepted values?
- Do the calculated values tend to be higher than accepted, lower than accepted, or do they b racket the accepted values?
- What experimental conditions influence the accuracy and precision of your calculated values?

Data Table 1

Substance	Mass of **full** pipet (g)	Mass of emptied pipet (g)	Volume (ml)
distilled water			
ethanol			
isopropanol			
propanol			
acetone			

Data Table 2

Substance	Mass of cylinder + water (g)	Mass of cylinder + water + metal (g)	Water Volume Initial (ml)	Water Volume Final (ml)
nickel				
copper				
tin				
aluminum				
silicon				

Calculations Table 1

Substance	Mass Liquid (g)	Density calculated (g/cm^3)	Density accepted (g/cm^3)	E_a	E_r (%)
distilled water			**0.995**		
ethanol			**0.789**		
isopropanol			**0.785**		
propanol			**0. 804**		
acetone			**0.786**		

Calculations Table 2

Substance	Mass of metal (g)	Volume of metal (ml)	Density calculated (g/cm^3)	Density accepted (g/cm^3)	E_a	E_r (%)
nickel				**8.91**		
copper				**8.92**		
tin				**7.31**		
aluminum				**2.70**		
silicon				**2.33**		