Density and Significant Figures

Objectives:

- Introduce simple techniques for measuring the mass and volume of a liquid
- Introduce simple techniques for measuring the mass and volume of a solid
- Introduce the concept of density

Materials:

- 100-mL graduated cylinder
- 250-mL Erlenmeyer flask and rubber stopper to fit
- ~75 mL of Isopropanol
- ~75 mL of Witch Hazel
- ~75 mL of DI water
- 60 pennies

Waste:
Dispose of the isopropanol and witch hazel in the waste container in the hood.

Note: You will find two types of balances in the lab. This experiment uses only the top loading balance.

Top loading balance

Top loading balances typically have greater maximum capacity than analytical balances but less precision. The top loading balance typically measures to the nearest 0.01 gram (or 0.1 gram in some cases).

Analytical balance

The analytical balance measures to the nearest 0.0001 gram (tenth of a milligram). Analytical balances have greater sensitivity but generally a lower maximum capacity. The analytical balance is sensitive enough to detect air currents; therefore, the balance pan is enclosed.

Part 1 –Density of a liquid using a graduated cylinder

1. Obtain -75 mL of water in a small beaker
2. Obtain ~75 mL of isopropanol in a small beaker
3. Obtain ~75 mL of witch hazel in a small beaker
4. Obtain a 100 mL graduated cylinder.
5. Using one of the top loading balances, determine the mass of the empty graduated cylinder and record it on the data sheet (record the correct number of significant figures).
6. Pour approximately 25 mL of the water into the graduated cylinder. Record the **actual** volume of the isopropanol on the datasheet (record the correct number of significant figures).

   > **NOTE**: When reading a volume in graduated, cylinder (or buret), always estimate one more decimal place than the markings. If your cylinder were marked in 1 mL increments, you would estimate the volume to the nearest 0.1 mL.

7. Record the mass of the graduated cylinder and the water on the data sheet (record the correct number of significant figures).
8. Repeat steps 6 & 7 to obtain measurements for ***approximately***, 35 and 45 mL of water. The water can be discarded down the drain.
9. Repeat steps 6-8 with the isopropanol and witch hazel. Pour all of the isopropanol and witch hazel in the waste container in the hood.

Part 2 - Density of a solid (pennies) by displacement

1. Obtain 30 pennies pre-1892 and 30 pennies post-1982 from the TA.
2. Obtain a 100 mL graduated cylinder.
3. Pour approximately 40 mL of water into the graduated cylinder.
4. Record the **actual** volume of water in the graduated cylinder on the data sheet (record the correct number of significant figures).
5. Using one of the top loading balances, determine the mass of the graduated cylinder plus the ~40 mL of water and record the mass on the data sheet. (record the correct number of significant figures).
6. Carefully add 15 pre-1982 pennies to the graduated cylinder and record the new volume of water in the graduated cylinder on the data sheet (record the correct number of significant figures).
7. Record the mass of the graduated cylinder plus the 15 pre-1982 pennies on the data sheet (record the correct number of significant figures).
8. Repeat steps 6 & 7 to obtain measurements for 20, 25, and 30 pre-1982 pennies.
9. Pour the water down the drain and collect and dry the pennies.
10. Repeat steps 3-9 with the post-1982 pennies.

Density and Significant Figures Lab Report

Name: **Date:**

Data Sheet

(All entries must include units and use the appropriate number of significant figures)

Part 1

Mass of empty graduated cylinder _____

Approximate volume of water	Actual Volume of water	Mass of water Plus graduated cylinder	Mass of water	Density of water
25 mL				
35 mL				
45 mL				

Approximate volume of isopropanol	Actual Volume of isopropanol	Mass of isopropanol Plus graduated cylinder	Mass of isopropanol	Density of isopropanol
25 mL				
35 mL				
45 mL				

Approximate volume of witch hazel	Actual Volume of witch hazel	Mass of witch hazel Plus graduated cylinder	Mass of witch hazel	Density of witch hazel
25 mL				
35 mL				
45 mL				

Calculate the density for each liquid of the 3 measurements and record the values in the table above (with appropriate significant figures). Show **one** sample calculation below.

Data Sheet – Part 2

Initial volume of water of water in the graduated cylinder (~40 mL) _____

Mass of graduated cylinder plus initial ~40 mL of water _____

Pre-1982 Pennies

Number of pennies	Mass of pennies plus water & graduated cylinder	Mass of pennies	Volume with pennies added to the graduated cylinder	Volume of pennies	Density of pennies
20					
25					
30					

Post-1982 Pennies

Number of pennies	Mass of pennies plus water & graduated cylinder	Mass of pennies	Volume with pennies added to the graduated cylinder	Volume of pennies	Density of pennies
20					
25					
30					

Calculate the density of the pennies for each of the three trials and record the values in the table above (with appropriate significant figures). Show **one** sample calculation below.

Post lab exercises

1. Calculate the average densities of each of the liquids from Part 1.

2. Comment on the accuracy and precision of your measurements of the density of the liquids.

3. Calculate the average density of the post- and pre- 1982 pennies from Part 2. Comment on the number of significant figures in the average.

4. Comment on the density of the post-1982 pennies vs. the pre-1982 pennies. Why are these densities different? (**Hint**: Research may be needed. Cite your source.)