ACCURACY AND PRECISION

Introduction:

Mass and volume are extrinsic properties, which depend on the quantity of substance. Density, which is the ratio of mass to volume (D=m/V), is an intrinsic property. The density of a substance is a constant and is characteristic of the substance. Therefore, density can be used to aid in the identification of the substance. However, the density of a substance may vary with its temperature. In this lab the mass and volume of water will be measured, and the density of the water will be calculated. This value will be compared to the accepted density of water at the relevant temperature. The accuracy and precision of the measurements will also be determined.

Purpose:

The purpose of this experiment is to determine the density of water and calculate the accuracy of the density determination and the precision of the density determination.

Equipment/Materials:

30 mL beaker
250 mL beaker
10 mL graduated cylinder
50 mL graduated cylinder
10 mL pipet
25 ml, pipet
1 mL micropipet
top loader balance
analytical balance
thermometer

Procedure:

Beaker and top loader balance

1. Place ~100 mL of distilled water in a beaker. Measure the temperature of the water and record it on the data table.

2. Place a clean dry 30 mL beaker on the top loader balance. Tare.

3. Remove the beaker from the balance and pour a small amount of distilled water into it. Using the graduations on the beaker, read the volume and record it in the data table.

4. Place the beaker on the balance and record the mass of the water in the data table.

5. Repeat for trials 2 & 3.

Graduated cylinder and top loader balance

6. Place a clean dry 30 mL beaker on the top loader balance. Tare.

7. Pour a small amount of distilled water in a 10 mL graduated cylinder. Using the graduations on the cylinder, read the volume as precisely as possible and record in the data table.

8. Pour the water into the tared beaker and place the beaker on the balance. Record the mass in the data table.

9. Repeat for trials 2 & 3.

Pipet and top loader balance

10. Place a clean dry 30 mL beaker of the top loader balance. Tare.

11. Using the volumetric pipet, add distilled water to the 30 mL beaker. Record the volume of water added to the beaker.

12. Place the beaker on the balance and record the mass in the data table.

13. Repeat for trials 2 & 3.

Micropipet and top loader balance

14. Place a clean dry 30 mL beaker on the top loader balance. Tare.

15. Using the 1.000 mL micropipet as the measuring instrument for volume, add 1.000 mL of distilled to the 30 mL beaker. Record the volume of water added to the beaker.

16. Place the beaker on the balance and record the mass of the water in the data table.

17. Repeat for trials 2 & 3.

Analytical balance

18. Repeat each of the above sets of procedures using the analytical balance in place of the top loader balance.

Name_____

Name_____

Period_____

Date_____

ACCURACY AND PRECISION

Data

Temperature of water: _____ºC

Beaker and top loader balance

Trial	Vol	Mass	Density
1			
2			
3			

Average Density_____

Beaker and analytical balance Trial	Vol	Mass	Density
1			
2			
3			

Average Density_____

Graduated cylinder and top loader balance

Trials	Vol	Mass	Density
1			
2			
3			

Average Density_____

Graduated cylinder and analytical balance

Trials	Vol	Mass	Density
1			
2			
3			

Average Density_____

Pipet and top loader balance

Trials	Vol	Mass	Density
1			
2			
3			

Average Density_____

Pipet and analytical balance

Trial	Vol	Mass	Density
1			
2			
3			

Average Density_____

Micropipet and top loader balance

Trials	Vol	Mass	Density
1			
2			
3			

Average Density_____

Micropipet and analytical balance

Trial	Vol	Mass	Density
1			
2			
3			

Average Density_____

Calculations/Results:

1. Actual density of water at recorded temperature :

2. Calculate the % error (accuracy) for each density average

   % ERROR = (|Actual - Ave calc density| / actual density) x 100%

	Top loader	Analytical
BEAKER		
GRAD		
PIPET		
MICRO		

3. Calculate the precision (standard deviation) of each set of

   standard deviation = $\hat{u}\{\Sigma(x - x_1)^2/(n - 1)\}$

   where x = density for each individual trial x_1= average density
   n = number of trials

	Top loader	Analytical
BEAKER		
GRAD		
PIPET		
MICRO		

ACCURACY AND PRECISION TEACHER NOTES

Lab Time: 60-80 minutes

Preparations:

Time: 15 minutes

Make available stations for each combination of equipment.

Answers to Questions:

1. Which method of determining density was most accurate? *Answers will vary depending upon data.*

2. Which method of determining density was most precise? *Answers will vary depending upon data.*

3. Did the mass shown on the analytical balance tend to decrease with time? If so, why? If not, why not?
   Yes. This loss of mass is due to the evaporation of water.

4. Density can be determined mathematically and graphically. What are the advantages of each method? What are the disadvantages of each method?
   Answers will vary. Some answers may include less time for mathematically but graphically eliminates some error due to individual measurements.

Science in Motion

Materials List

Lab: Accuracy and Precision

Number of Lab Groups Prepared:

Equipment per lab group	**Delivered**	**Returned**
30 mL Beaker		
250 mL Beaker		
10 mL Graduated cylinder		
50 mL Graduated cylinder		
10 mL Pipet		
25 mL Pipet		
1 mL Micropipet		
To loader balance		
Analytical balance		
Thermometer		