Name: _____ Lab Partner(s): _____ Date: _____

The Density of Water

PURPOSE

Students will measure the mass and volume of water in order to calculate density and to show that density for a substance does not change, even as mass and volume are changed. In addition, they will graphically illustrate the relationship between mass and volume, otherwise known as density.

BACKGROUND

The density of a substance relates its mass to its volume. Density can be calculated using a mathematical formula; or it can be determined experimentally. Using graphing techniques, a plot of mass versus volume will yield a slope equal to the density of the substance.

Density is a physical property of a substance that does not depend on the amount of material present. This experiment is designed to give the value for the density for water by finding the mass of water for five different volumes and plotting them in a line graph. Students will gain experience in making measurements of mass and volume correctly and using the measurements to determine the density of water.

PRE-LAB ACTIVITIES

1. If the volume of water is increased, its mass should _____. Therefore, the relationship between mass and volume is described as a(n) _____ relationship.
2. As mass and volume of a substance change, density _____. Density is, therefore, an _____ physical property.
3. Common units for density are _____ for solids and _____ for liquids.
4. The accepted density for water is _____ at 25°C. Give the source you used for this data.
5. The most common type of graph used in chemistry is the _____. The graph for density will yield a(n) _____ curve.

Formulas Needed: Using the textbook, find the equations to calculate density, percent error, and the slope of a line. Write the equations in the boxes below.

density	percent error	slope of a line

HYPOTHESIS

If _____,
states the tentative relationship between the dependent and independent variables

then _____.
prediction of what will happen to dependent variable when independent variable is manipulated

Reason: _____.

SAFETY

1. Safety goggles and aprons must be worn at all times.
2. Be careful using glassware.
3. Use the same balance for every measurement. Do not move the balances from their current positions.

MATERIALS

Graduated cylinder	Beaker	Water
Electronic balance	Pipette or dropper	

PROCEDURE

1. Find the mass of an empty, dry 100-mL graduated cylinder using an electronic balance. Record the mass measurement in the data table.
2. Add exactly 10.0 mL of water to the cylinder. Remember, the bottom of the meniscus should just be touching the 10.0-mL line.
3. Find the mass of the cylinder and 10.0 mL of water. Record the mass measurement in the data table.
4. Calculate the mass of the water alone [Mass of Cylinder and Water – Mass of Empty Cylinder].
5. Repeat Steps 2 through 4 with 20.0 mL, 30.0 mL, 40.0 mL, and 50.0 mL of water.

DATA TABLE

Include units and write every measurement to the proper number of decimal places.

		MASS	
	Trials	Cylinder and Water	Water Only
	Empty graduated cylinder		
1	Cylinder + 10.0 mL water		
2	Cylinder + 20.0 mL water		
3	Cylinder + 30.0 mL water		
4	Cylinder + 40.0 mL water		
5	Cylinder + 50.0 mL water		

CALCULATIONS and ANALYSIS: Steps #1, #2, and #4 should be completed on page 3 of this lab handout. Follow directions carefully. The graph (#3) must be drawn in pencil on graph paper.

Include units for every number. Pay attention to decimal place values (significant figures).

1. Using the mathematical formula for density and the measurements in your data table, calculate the density of water for each trial. Then, determine the average density for your lab data.
    a. Can these results be described as precise?
    b. Why or why not?
2. Determine the average density for your lab data.
    a. Calculate the percent error for your results, using your average density as the experimental value.
    b. How would you describe the accuracy of these results?
3. On graph paper, graph the mass of water vs. the volume of water used.
    a. Identify the independent variable (x-axis) and the dependent variable (y-axis).
    b. Calculate the range needed for each axis, using the highest and lowest values for each variable; for this particular graph, use zero as the lowest value for both axes. The range does not have to be the same for both variables. The ranges help determine which way to turn the graph paper so that the graph covers most of page.
    c. Determine the appropriate scale. What numerical value does each square of the graph paper represent? Typical scales are 0.5, 1, 2, 5, or 10. The scale does not have to be the same for both the x- and y-axes, but again, the graph should use most of the available graphing space.
    d. Number the increments for each axis. Labeling should start at the origin and end with the highest data value for each axis. Increments should be marked evenly and usually by ½s, 1s, 2s, 5s, or 10s.
    e. Label each axis with the name of the variable and the unit used.
    f. Plot each data point with an obvious dot. Label each dot with its coordinates (x, y).
    g. Draw a line of best fit, including the origin (0, 0) for this graph.
    h. Title the graph using the format: *label of dependent variable vs. label of independent variable*.
4. Determine the slope of the line, which gives the experimental density of water. Then, calculate the percent error using this calculated slope as the experimental value.

CALCULATIONS AND ANALYSIS

For each calculation, label the calculation, give the formula, and show the calculation. If the same formula is used for multiple trials, it needs to be written only once. Pay attention to significant figures. You do not need to show multiplication or division worked out. Written answers to questions should be expressed in complete sentences.

CONCLUSION

The conclusion is the most important part of the lab and is a condensed version of the laboratory experience. It should be written objectively (third person, passive voice) and in the past tense. The purpose of reporting a lab is not only to get a good grade but to document your work properly so that another person could pick up your report and duplicate your efforts in the lab.

In a well-developed paragraph below, restate the purpose of the lab and summarize its results. Describe the accuracy of lab results and use percent error to support your judgments. Determine if the results *support* or *do not support* the Hypothesis (use this language!) and **use lab data** to justify your conclusion. Identify possible nonhuman/instrumental sources of error and suggest ways to avoid errors or improve results in future experiments.