Determination of Concentration of an Unknown Using Density Measurements

Introduction:
Density can be used to determine the concentration of solutions in certain instances. When a solute is dissolved in a solvent, the density of the solution will be different from that of the pure solvent itself. Handbooks list detailed information about the densities of solutions as a function of their composition (typically, in terms of percent solute in the solution). If a sample is known to contain only a single solute, the density of the solution could be measured experimentally, and then the handbook could be consulted to determine what concentration of the solute gives rise to the measured solution density.

The determination of the density of certain physiological liquids is often an important screening tool in medical diagnosis. For example, if the density of urine differs from normal values, this may indicate a problem with the kidneys secreting substances that should not be lost from the body. The determination of density (specific gravity) is almost always performed during urinalysis.

A convenient method for routine density determinations for liquids is to weigh a particular volume of liquid as contained in a graduated cylinder. It is this technique that will be used in this lab.

The concentration of solutions is often expressed in terms of the solution's *percentage composition* on a weight basis. For example, a 5% sodium chloride solution contains 5 g of sodium chloride in every 100 grams of solution. This corresponds to 5 g of NaCl in every 95 g of water present. Since pure water has a density of 1 g/mL at room temperature, the solutions are prepared by measuring the VOLUME of water to combine with the MASS of NaCl.

Purpose: The purpose of the lab is to use measured values of density for solutions of known and unknown concentration in order to determine the concentrations of the unknown solutions.

Materials:
10.00 mL Graduated cylinder
Analytical balance
NaCl solutions: 5%, 10%, 15%, 20%, 25%, 2 unknowns
Transfer pipets

Procedure:
1. Determine the mass of your empty graduated cylinder and record this mass in your data table.
2. Your instructor has prepared NaCl solutions of the following percentages by weight: 5%, 10%, 15%, 20%, and 25%. Make a mass determination for 10.00 mL of each solution, using the balance and your graduated cylinder. Record these values in your data table. Attempt to clean and DRY your graduated cylinder between each measurement.
3. Make a mass determination for 10.00 mL of each of the two unknown solutions, again recording the data in your data table.

RESULTS
Data and Observations

	Solutions						
	5%	10%	15%	20%	25%	Unknown #1	Unknown #2
1. Mass of empty graduated Cylinder (grams)							
2. Mass of graduated cylinder + 10 mL NaCl Solution (grams)							
3. Mass of 10 mL NaCl Solution (grams). (Subtract #1 from #2)							
4. Volume (mL) of NaCl Solution	10 mL	10 mL	10 mL	10 mL	10 mL	10 mL	10 mL
5. Density (g/mL) (divide #3 by #4)							

Calculations and Graphs

1. Draw a graph of concentration vs. density for the five solutions of KNOWN concentration.
    a. Put concentration on the x-axis and density on the y-axis.
    b. Be sure to make the graph LARGE.
    c. Make sure that the intersection of the x and y axes is at (0,0).
    d. Your graph should be a straight line graph, and it should intersect the y-axis at a density value of "1" (that is the density of pure water.
    e. Determine the slope of the line, and write a linear equation for the line in the form ***y = mx + b*** where ***m*** is the slope and ***b*** is the y-intercept.
2. Use the graph to determine the concentrations of the unknown solutions.
    a. Plot the density of Unknown #1 on y-axis. Run a dashed line (- - - -) from the density value to the line you graphed, and another dashed line straight down to the x-axis.
    b. Estimate the value of the concentration for Unknown #1 from the place that your dashed line intersects the x-axis.
    c. Repeat this procedure for Unknown #2.
3. **Be certain to report, in YOUR RESULTS, the concentration values you determined for Unknowns #1 and #2**