Honors Chemistry Lab #1- Beverage Density

Background: The density of a *solution* depends on its *concentration*, that is, how much solute (solid) is dissolved in the solvent (liquid). If the density of a solution is plotted on a graph against the concentration of solute, a regular pattern is evident—density is proportional to concentration. The resulting graph, called a *calibration curve*, shows a straight-line relationship between the density of a solution and the concentration of solute. A calibration curve can be used to determine the concentration of solute in an unknown solution whose density has been measured. The purpose of this cooperative class activity is to measure the densities of popular beverages and determine their sugar contents using a calibration curve obtained by plotting the densities for a series of reference solutions versus percent sugar. The experimentally determined percent sugar for the beverages will be compared against the information provided on their nutritional labels to evaluate the accuracy of this method.

How well does the sweet taste of a beverage correlate with the amount of sugar it contains? Based on your *memory* of their taste, predict the relative sugar content in the following beverages: orange cola, Coke, grape juice, and sports drink. (Rank the beverages from 1, highest sugar content, to 4, lowest sugar content.)

Procedure

1. Place a small (100-mL) beaker on the balance and hit the "tare" or "rezero" button. The scale should read 0.0 g.
2. Draw up a precisely measured 10.00 mL of 0% sugar solution into a pipet. Then empty it into the beaker, toughing the tip of the pipet to the inside wall of the beaker to help get out most of the liquid in the tip. *Do not try to shake out any liquid that remains there.* The pipets are designed TD ("to deliver") 10.00 mL and that remaining drop should not be squeezed out. Since the beaker has already been zeroed out, the mass is that of the liquid alone.
3. Record this mass in the data table below.
4. Push the "tare" button to rezero the scale for the next reading.
5. Touch the pipet to a paper towel to clean out any residual solution.
6. Repeat steps 2–5 with each of the remaining sugar solutions, and then with each of the three beverages. Do not put any of the solutions back into the cups from which they came, just leave then in the beaker. When the beaker get full, simple empty it into the sink, set it back on the scale, and push the "tare" button.
7. Calculate and record the density of each beverage sample.

Percent Sugar/ Beverage	**0%**	**5%**	**10%**	**15%**	**20%**	**Cola**	**Grape Juice**	**Sport Drink**
Mass (g)								
Density (g/mL)								

Data Analysis

1. Plot the known density on the *y*-axis versus percent sugar on the *x*-axis for the following sugar reference solutions. Use a ruler to draw a "best fit" straight line through the data points.
2. Use the graph to estimate the sugar concentration in the beverage: Locate the point on the *y*-axis that corresponds to the beverage density. Follow that point on the *y*-axis across horizontally to where it meets the best-fit straight line through the data points for the reference solutions. Draw a vertical line from this point on the best-fit line down to the *x*-axis. The point where this vertical "line" meets the *x*-axis corresponds to the percent sugar in the beverage. Estimate and record the percent sugar for the beverage.
3. Consult the nutritional label for the beverage—it should list the sugar content in grams of sugar per serving size. This value can be converted to percent sugar in the beverage by dividing the grams of sugar per serving size by the

volume of the serving size (in mL), dividing this result by the measured density of the beverage, and multiplying by 100. Record the nutrition label information and the calculated percent sugar for the beverage.

Sample calculation: Measured density = 1.038 g/mL

Nutritional label = 42 g of sugar per 355 mL

(42 g/355 mL) × (1 mL/1.038 g) = 0.114 g sugar per g of beverage

Percent sugar = 0.114 g sugar per g of beverage × 100% = 11.4%

4. Calculate the *percent error* in the experimental determination of the sugar content using the following equation.

$$\text{Percent error} = \frac{|\text{Exp. value} - \text{Known value}|}{\text{Exp. value}} \times 100\%$$

5. This lab examines the relationship between the density of a beverage and its sugar content. What assumption is made concerning the other ingredients in the beverage and their effect on its density? Is this a valid assumption? Why or why not?

6. When plotting data such as that obtained in this experiment, why is it not appropriate to "connect the dots?" If you were to repeat the lab, do you think you would get exactly the same results? Comment on sources of error in this experiment and their likely effect on the results.

Please self-assess your lab report using the rubric/checklist.