Honors Chemistry Lab #1- Graphical Determination of Beverage Density

Ask a Question: How can I design an experiment to graphically determine the percentage of sugar in different beverages?

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.

Research the question and collect evidence. You will need to design your experiment to graphically determine the percentage of sugar in the different beverages. Below you will find a suggested data table for your evidence. Remember that you must determine the sugar percentages graphically (i.e., experimental values) and compare those values to the known or accepted values on the nutrition labels. To accomplish this feat graphically, you will need to make a series of standard solutions (0%-20%). The rest is entirely based on your designed experiment.

Percent Sugar/ Beverage	**0%**	**5%**	**10%**	**15%**	**20%**	**Coke**	**Grape Juice**	**Sport Drink**	**Orange Cola**
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.

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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.

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

Make your claim based on the evidence. Based on the data analysis make your claim to address the research question.

Summarize and reflect: Summarize your data, conclusions, and any modifications you would make to future investigations. Your conclusion should show how or why the data are relevant and support the claim. You should justify why the evidence is important to the claim. Your conclusion should always indicate the relationship to one or more scientific or math principles. You should also reflect upon your methodology and overall experimental design. For example, what factors could also influence the density of the beverages? What equipment could have been used to get more accurate results? Was your data replicable?

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