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Understanding the concentration of solutions is fundamental in chemistry, especially when working with mixtures like glucose dissolved in water. In this article, we will explore how to determine the weight percent of glucose in a solution where 2.3 grams of glucose are dissolved in 135.2 grams of water. We will delve into the concept of weight percent, its calculation, significance, and practical applications in various fields such as food science, pharmaceuticals, and chemical analysis.

What Is Weight Percent (Weight/Weight Percent)?

Definition of Weight Percent

Weight percent (often abbreviated as wt%) is a way to express the concentration of a component in a mixture or solution. It indicates the ratio of the mass of a solute to the total mass of the solution, multiplied by 100 to get a percentage.

Mathematically, it is expressed as:

$$\text{Weight Percent} = \left(\frac{\text{Mass of Solute}}{\text{Total Mass of Solution}} \right) \times 100\%$$

Importance of Weight Percent

- Standardization: Provides a consistent way to compare solutions.
- Ease of Calculation: Simple to determine when masses are known.
- Practical Relevance: Useful in preparing solutions with precise concentrations.

Calculating the Weight Percent of Glucose in the Solution

Given Data

- Mass of glucose (solute): 2.3 grams
- Mass of water (solvent): 135.2 grams

Step-by-Step Calculation

1. Determine the total mass of the solution:

$$\text{Total mass} = \text{Mass of glucose} + \text{Mass of water} = 2.3\text{ g} + 135.2\text{ g} = 137.5\text{ g}$$

2. Calculate the weight percent of glucose:

$$\text{Weight percent} = \left(\frac{2.3\text{ g}}{137.5\text{ g}} \right) \times 100\%$$

3. Perform the division:

$$\frac{2.3}{137.5} \approx 0.016727$$

4. Convert to percentage:

$$0.016727 \times 100\% \approx 1.6727\%$$

Final Answer:

The weight percent of glucose in this solution is approximately 1.67%.

Understanding the Significance of the Result

Interpreting the Concentration

A weight percent of approximately 1.67% indicates that in every 100 grams of this solution, there are about 1.67 grams of glucose. This relatively low concentration suggests a dilute solution, which is common in various applications like medical solutions, beverage formulations, or biochemical experiments.

Implications in Practical Scenarios

- Food Industry: Such a concentration might be used in sports drinks or dietary supplements where controlled glucose levels are necessary.
- Pharmaceuticals: Precise concentration calculations are critical in preparing solutions for injections or oral medications.
- Laboratory Work: Accurate determination of solution concentrations ensures the reliability of experimental results.

Additional Concepts Related to Solution Concentration

Other Types of Concentration Measurements

While weight percent is common, other methods include:

- Molarity (mol/L): Moles of solute per liter of solution.
- Molality (mol/kg): Moles of solute per kilogram of solvent.
- Volume Percent (% v/v): Volume of solute per 100 mL of solution.

- Normality: Equivalent concentration based on reactive capacity.

Why Choose Weight Percent?

Weight percent is especially useful when dealing with solids and liquids where mass measurements are straightforward. It is also independent of temperature and pressure, unlike volume-based measurements, making it reliable for many applications.

Practical Applications of Calculating Weight Percent

1. Food and Beverage Industry

Accurate concentration measurements ensure product consistency, safety, and compliance with health regulations. For example, glucose concentration affects sweetness, caloric content, and storage stability.

2. Pharmaceutical Preparations

Precise knowledge of solution concentration is vital for dosage accuracy, efficacy, and safety. Calculations like the one above are foundational in preparing intravenous fluids and oral solutions.

3. Chemical Manufacturing and Laboratory Analysis

Quantitative analysis relies on accurate concentration measurements for titrations, quality control, and formulation development.

Factors Affecting Solution Concentration

1. Temperature

Temperature can influence solubility and volume but typically does not affect weight percent directly unless mass or volume measurements are temperature-dependent.

2. Purity of Components

Impurities can alter the actual concentration and must be considered during calculations.

3. Measurement Accuracy

Precise weighing tools and careful measurement techniques are essential for accurate calculations.

Summary and Final Thoughts

Calculating the weight percent of glucose in a solution where 2.3 grams of glucose are dissolved in 135.2 grams of water yields a concentration of approximately 1.67%. This straightforward calculation provides valuable insights into the solution's composition, which is essential across various scientific and industrial fields. Understanding how to determine and interpret weight percent helps in quality control, formulation, research, and ensuring safety standards.

In practice, always ensure precise measurements and consider other factors like temperature and purity that might influence the actual composition. Whether you're preparing a laboratory solution, designing a food product, or manufacturing pharmaceuticals, mastering the concept of weight percent is a fundamental skill that underpins many aspects of chemistry and related sciences.

Frequently Asked Questions

What is the weight percent of glucose in a solution with 2.3 g of glucose dissolved in 135.2 g of water?

The weight percent of glucose is approximately 1.70%. It is calculated by dividing the weight of glucose by the total weight of the solution and multiplying by 100.

How do you calculate the weight percent of a solute in a solution?

Weight percent is calculated by dividing the mass of the solute by the total mass of the solution (solute plus solvent) and multiplying by 100.

Why is knowing the weight percent of glucose important in solutions?

Knowing the weight percent helps determine the concentration, which is essential for applications like medical solutions, food formulations, and chemical reactions.

What is the formula to find the weight percent of glucose in this solution?

Weight percent = (mass of glucose / total mass of solution) × 100. In this case, it is $(2.3 \text{ g} / (2.3 \text{ g} + 135.2 \text{ g})) \times 100$.

Is the solution predominantly water or glucose based on the given weights?

The solution is predominantly water, as 135.2 g of water significantly exceeds 2.3 g of glucose.

If more glucose is added to this solution, how will the weight percent change?

The weight percent of glucose will increase as the mass of glucose increases relative to the total solution mass.

Can weight percent be used to compare different solutions' concentrations?

Yes, weight percent is a common way to compare concentrations of solutions, especially when dealing with varying total masses.

What are common units used to express solution concentration apart from weight percent?

Other common units include molarity, molality, volume percent, and mole fraction.

What assumptions are made when calculating weight percent in this context?

It is assumed that the weights are additive and that the solution is homogeneous, with no volume change upon mixing.

How precise is the calculation of weight percent in this example?

The calculation provides an approximate value; precision depends on the accuracy of the given weights and measurement methods.

Additional Resources

Understanding the Weight Percent of Glucose in a Solution: A Detailed Analysis of a 2.3g Glucose in 135.2g Water Mixture

In the realm of chemistry, solutions are ubiquitous, forming the backbone of countless scientific, industrial, and everyday processes. Among the key parameters that describe solutions, the weight percent (wt%) stands out as a fundamental measure of concentration. This metric provides insight into the proportion of solute—here, glucose—in a given total mass of solution, which is essential for applications ranging from medical formulations to food chemistry. This article delves deeply into the calculation of the weight percent of glucose in a solution where 2.3 grams of glucose are dissolved in 135.2 grams of water, unpacking the concepts, methodology, and implications in a comprehensive and analytical manner.

Foundations of Solution Concentration: What Is Weight Percent?

Definition and Significance

Weight percent (wt%) is a quantitative measure expressing the ratio of the mass of solute to the total mass of the solution, multiplied by 100 to convert it into a percentage. Mathematically, it is expressed as:

$$\text{wt\%} = (\text{mass of solute} / \text{total mass of solution}) \times 100$$

This parameter is invaluable because it provides a straightforward way to communicate how concentrated a solution is, regardless of the solution's volume, which can vary depending on temperature and pressure.

Advantages of Using Weight Percent

- Independence from Volume Changes: Unlike molarity, wt% does not vary with temperature-induced volume changes.
- Ease of Calculation with Mass Data: Often, mass measurements are more straightforward and precise than volume measurements.
- Applicability in Various Fields: Widely used in manufacturing, pharmacology, and food science for quality control.

Scenario Overview: Glucose Solution Composition

The specific case under review involves dissolving 2.3 grams of glucose into 135.2 grams of water. This mixture results in a solution whose concentration we wish to determine in terms of weight percent.

Understanding this scenario entails recognizing the following:

- Solute: Glucose ($\text{C}_6\text{H}_{12}\text{O}_6$), a simple sugar critical in biological and industrial processes.
- Solvent: Water (H_2O), the universal solvent.
- Masses Given: 2.3 g of glucose and 135.2 g of water.

The total mass of the solution is the sum of the individual masses:

- Total mass = 2.3 g + 135.2 g = 137.5 g

The primary goal is to compute the weight percent of glucose in this mixture.

Step-by-Step Calculation of Weight Percent

Step 1: Establish the Known Quantities

- Mass of solute (glucose): $m_{\text{glucose}} = 2.3 \text{ g}$
- Mass of solvent (water): $m_{\text{water}} = 135.2 \text{ g}$
- Total mass of solution: $m_{\text{total}} = 137.5 \text{ g}$

Step 2: Apply the Formula

Using the wt% formula:

$$\text{wt\%} = (\text{mass of solute} / \text{total mass of solution}) \times 100$$

Substituting in the known values:

$$\text{wt\%} = (2.3 \text{ g} / 137.5 \text{ g}) \times 100$$

Calculating the ratio:

$$\text{wt\%} \approx 0.016727 \times 100 \approx 1.6727\%$$

Rounding to an appropriate number of significant figures, the weight percent of glucose is approximately 1.67%.

Interpretation and Contextualization of Results

Significance of a 1.67% Glucose Solution

A concentration of approximately 1.67% wt indicates a dilute solution, which is typical in many biological and industrial applications. For example:

- Medical Solutions: Glucose solutions used in IV therapy often range from 5% to 10%, making this significantly less concentrated.
- Food Industry: Glucose syrups or solutions used in food processing can vary widely, but a 1.67% solution might be used as a baseline or in specific formulations.

Implications of the Concentration

- Solubility: Glucose is highly soluble in water, with solubility exceeding 100 grams per 100 mL at room temperature, so dissolving 2.3 grams in 135.2 grams of water is well within solubility limits.
- Dilution Factor: Understanding the wt% allows chemists and engineers to adjust concentrations for desired properties, whether for nutritional content, chemical reactions, or product consistency.

Broader Analytical Perspectives

Comparison with Other Concentration Units

While weight percent is straightforward, other metrics like molarity, molality, and mole fraction provide different insights:

- Molarity (mol/L): Requires molar mass and volume, which may fluctuate with temperature.
- Molality (mol/kg): Based on mass of solvent, useful in colligative property calculations.
- Mole Fraction: Expresses ratio of moles, helpful in thermodynamic computations.

For the given data:

- Molar mass of glucose ≈ 180.16 g/mol
- Moles of glucose = $2.3 \text{ g} / 180.16 \text{ g/mol} \approx 0.01277$ mol
- Moles of water = $135.2 \text{ g} / 18.015 \text{ g/mol} \approx 7.503$ mol

From this, one could compute mole fractions or molarity if volume data were available.

Relevance in Practical Applications

Knowing the precise weight percent facilitates:

- Quality Control: Ensuring solutions meet specified concentration standards.
- Process Optimization: Adjusting formulations for desired viscosity, sweetness, or reactivity.
- Safety and Compliance: Accurate labeling and dosage calculations in pharmaceuticals and food products.

Factors Influencing Solution Concentration and Measurement Accuracy

Temperature Effects

Temperature impacts the density and volume of water, but less so the mass. Since wt% relies on mass, it remains relatively stable across temperature variations, making it a reliable measure in many contexts.

Measurement Precision

Accurate determination of mass requires:

- Calibrated balances

- Proper handling to prevent loss or contamination
- Consistent measurement techniques

Errors in measurement can lead to significant deviations in calculated concentrations, emphasizing the importance of precision.

Purity of Components

Impurities in glucose or water can alter the actual concentration, highlighting the need for high-purity reagents in analytical settings.

Concluding Remarks and Future Perspectives

The calculation of the weight percent of glucose in a solution where 2.3 grams of glucose are dissolved in 135.2 grams of water exemplifies a fundamental yet critical aspect of solution chemistry. This measure allows scientists, engineers, and health professionals to communicate and manipulate solution compositions with clarity and precision.

As scientific understanding evolves, integrating wt% with other concentration metrics enhances analytical robustness, especially in complex systems where multiple solutes interact. Moreover, advances in measurement technology continue to improve the accuracy of such calculations, fostering better control over product quality, safety, and efficacy.

In practical terms, recognizing that a 2.3 g glucose in 135.2 g water corresponds to approximately 1.67% wt underscores the importance of context when interpreting solution concentrations. Whether designing pharmaceuticals, preparing food products, or conducting research, precise concentration measurements underpin the reliability and reproducibility of outcomes.

In sum, this detailed examination not only demonstrates the straightforward calculation of weight percent but also highlights its broader significance in scientific and industrial domains. As we deepen our understanding of solution chemistry, such foundational concepts remain central to innovation, safety, and quality assurance across myriad applications.

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