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300.0 mL Of A 0.425 M Solution Of NaI Is Diluted To 700.0 mL. What Is The New Concentration Of The Solution?

Understanding solution dilution is a fundamental concept in chemistry, especially when working with solutions of various concentrations. Whether you are a student conducting laboratory experiments, a chemist preparing reagents, or someone involved in industrial processes, calculating the concentration of a diluted solution is a vital skill. In this article, we will explore the process of calculating the new concentration of a sodium iodide (NaI) solution after dilution, using the example of diluting 300.0 mL of a 0.425 M NaI solution to a total volume of 700.0 mL.

Introduction to Solution Concentration and Dilution

Before diving into the specific calculation, it's important to understand some fundamental concepts related to solutions:

- Molarity (M): The concentration of a solution expressed in moles of solute per liter of solution (mol/L).
- Dilution: The process of reducing the concentration of a solute in a solution by adding more solvent, usually water, without changing the amount of solute present.

The primary principle governing dilution calculations is the dilution equation:

$$C_1 V_1 = C_2 V_2$$

Where:

- C_1 = initial concentration
- V_1 = initial volume
- C_2 = final concentration
- V_2 = final volume

This equation states that the amount of solute before and after dilution remains constant, assuming no solute is added or removed during the process.

Problem Breakdown: Diluting NaI Solution

Let's analyze the given problem:

- Initial volume (V_1): 300.0 mL
- Initial concentration (C_1): 0.425 M
- Final volume (V_2): 700.0 mL
- Final concentration (C_2): ?

Our goal is to find C_2 , the concentration of NaI after dilution to 700.0 mL.

Step-by-Step Solution Approach

Step 1: Convert volumes to consistent units

Since molarity is expressed in mol/L, convert milliliters to liters:

- $V_1 = 300.0 \text{ mL} = 0.300 \text{ L}$
- $V_2 = 700.0 \text{ mL} = 0.700 \text{ L}$

Step 2: Calculate the moles of NaI initially present

Using the initial concentration and volume:

$$\text{Moles of NaI} = C_1 \times V_1$$

$$= 0.425 \text{ mol/L} \times 0.300 \text{ L} = 0.1275 \text{ mol}$$

This value remains constant during dilution because no solute is added or removed.

Step 3: Apply the dilution formula to find the new concentration

Using the principle that moles before and after dilution are equal:

$$C_1 V_1 = C_2 V_2$$

Rearranged to solve for C_2 :

$$C_2 = \frac{C_1 V_1}{V_2}$$

\]

Substitute known values:

$$C_2 = \frac{0.425 \text{ mol/L} \times 0.300 \text{ L}}{0.700 \text{ L}} = \frac{0.1275 \text{ mol}}{0.700 \text{ L}} \approx 0.1821 \text{ M}$$

Result:

The new concentration of the NaI solution after dilution is approximately 0.182 M.

Understanding the Results and Practical Implications

The calculation reveals how dilution affects solution concentration, emphasizing the importance of precise volume measurements in laboratory settings. A reduction from 0.425 M to approximately 0.182 M signifies a significant decrease in molarity, which could influence experimental outcomes or industrial processes.

Key points:

- Dilution reduces concentration proportionally to the increase in total volume.
- Accurate initial measurements are critical for precise final concentrations.
- The molar amount of solute remains constant during dilution.

Additional Considerations in Solution Dilution

Factors Affecting Dilution Accuracy

While the basic calculation is straightforward, real-world applications often require considerations such as:

- Measurement precision: Using calibrated equipment for volume measurement.
- Solution homogeneity: Ensuring complete mixing of the solution after dilution.
- Temperature effects: Recognizing that volume and molarity can vary with temperature changes.

Common Mistakes to Avoid

- Confusing initial and final volumes or concentrations.
- Forgetting to convert all units to consistent measures.
- Assuming volume change affects molarity directly without proper calculation.

Practical Applications of Dilution Calculations

Understanding and performing accurate dilution calculations is essential across various fields:

- Laboratory research: Preparing solutions of desired concentrations for experiments.
- Pharmaceuticals: Diluting stock solutions to specific dosages.
- Industrial chemistry: Adjusting concentrations in manufacturing processes.
- Environmental testing: Diluting samples for analysis.

Example Scenario

Suppose a lab technician needs a more dilute NaI solution for a spectroscopic analysis. They start with a 0.425 M stock solution, take 300 mL, and dilute it to 700 mL. Using the calculation above, they determine the final concentration to ensure it falls within the instrument's detection range.

Conclusion

Calculating the concentration of a solution after dilution is a fundamental skill that combines understanding of molarity, volume conversions, and the dilution equation. In our specific example, diluting 300.0 mL of a 0.425 M NaI solution to 700.0 mL results in a new concentration of approximately 0.182 M. Mastery of this concept enables accurate preparation of solutions in scientific, industrial, and educational settings, ensuring experimental consistency and reliability.

By carefully applying these principles, chemists and students can confidently perform dilution calculations and adjust solutions to meet precise specifications, advancing both research and practical applications in chemistry.

Frequently Asked Questions

What is the initial concentration of NaI solution before dilution?

The initial concentration of NaI solution is 0.425 M.

What is the initial volume of the NaI solution before dilution?

The initial volume is 300.0 mL.

What is the final volume of the solution after dilution?

The final volume after dilution is 700.0 mL.

How do you calculate the new concentration after dilution?

Use the dilution formula: $C_1 \times V_1 = C_2 \times V_2$, where C_1 and V_1 are initial concentration and volume, and C_2 and V_2 are the final concentration and volume.

What is the step-by-step calculation to find the new concentration?

First, convert volumes to liters if needed. Then, apply the formula: $C_2 = (C_1 \times V_1) / V_2$. Plug in the values: $C_2 = (0.425 \text{ M} \times 0.300 \text{ L}) / 0.700 \text{ L} = 0.182 \text{ M}$.

What is the new concentration of NaI after dilution to 700 mL?

The new concentration of NaI is approximately 0.182 M.

Why does the concentration decrease after dilution?

The concentration decreases because the same amount of solute is spread over a larger volume, resulting in a lower molarity.

Can the dilution formula be used for any solution concentration and volume?

Yes, the dilution formula applies universally to dilute solutions, provided the process is ideal and no chemical reactions occur during dilution.

What practical applications involve diluting solutions like this?

Dilutions are common in laboratories for preparing solutions of desired concentrations, in medical tests, and in chemical manufacturing processes.

Additional Resources

Solution Concentration Calculation

When dealing with solutions in chemistry, understanding how dilution affects concentration is fundamental. Whether you're a student, researcher, or industry professional, mastering the concept of dilutions ensures accurate preparation and analysis of solutions. Today, we will explore a practical example: calculating the new concentration of a sodium iodide (NaI) solution after dilution from an initial volume and molarity.

Understanding the Basics of Solution Concentration and Dilution

Before diving into the specifics of the problem, it's essential to grasp some foundational concepts.

What Is Concentration?

- Definition: Concentration refers to the amount of solute (here, NaI) present in a given quantity of solvent or solution.
- Common Units: Molarity (M), which indicates moles of solute per liter of solution, is frequently used in chemistry.

What Is Dilution?

- Definition: Dilution involves reducing the concentration of a solute in a solution by adding more solvent without adding more solute.
- Principle: The amount of solute remains constant before and after dilution, but the total volume changes.

Key Concept:

The fundamental relationship governing dilution is:

$$C_1 V_1 = C_2 V_2$$

Where:

- C_1 = initial concentration
- V_1 = initial volume
- C_2 = final concentration after dilution
- V_2 = final volume after dilution

Detailed Breakdown of the Problem

Let's analyze the problem step by step:

> "300.0 mL of a 0.425 M solution of NaI is diluted to 700.0 mL. What is the new concentration of the solution?"

Initial Data Provided

- Initial volume, V_1 : 300.0 mL

- Initial molarity, (C_1) : 0.425 M
- Final volume, (V_2) : 700.0 mL
- Final concentration, (C_2) : To be determined

Step 1: Convert Volumes to Consistent Units

While milliliters are acceptable in the calculation since the ratio remains the same, it's often clearer to convert to liters:

- $(V_1 = 300.0\text{ mL} = 0.300\text{ L})$
- $(V_2 = 700.0\text{ mL} = 0.700\text{ L})$

Step 2: Calculate the Moles of NaI in the Initial Solution

The total amount of solute (NaI) remains unchanged during dilution:

$$\text{Moles of NaI} = C_1 \times V_1$$

Plugging in the values:

$$\text{Moles of NaI} = 0.425\text{ mol/L} \times 0.300\text{ L} = 0.1275\text{ mol}$$

This is the total amount of NaI initially present in the solution.

Step 3: Determine the New Concentration After Dilution

Since the moles of solute stay the same, the final concentration (C_2) can be calculated using:

$$C_2 = \frac{\text{Moles of NaI}}{V_2}$$

Substituting the known values:

$$C_2 = \frac{0.1275\text{ mol}}{0.700\text{ L}} \approx 0.1821\text{ M}$$

Result:

The new concentration of NaI after dilution is approximately 0.182 M.

Key Takeaways and Practical Implications

1. Dilution is Conservation of Moles

The core principle is that the amount of solute remains constant during dilution. This allows us to use the initial molarity and volume to determine the new concentration after volume change.

2. Importance of Units

Always ensure units are consistent. Converting mL to liters simplifies calculations and improves accuracy.

3. Application in Laboratory Settings

This calculation method is vital for preparing solutions with precise concentrations, essential in pharmaceuticals, chemical manufacturing, and research.

Additional Considerations and Tips

- Accuracy: Always double-check your measurements and conversions.
- Significant Figures: Maintain appropriate significant figures based on the precision of your data.
- Dilution Series: When performing multiple dilutions, repeat the calculation process at each step to ensure correct final concentration.

Example: Real-World Application of the Calculation

Suppose a pharmaceutical lab needs to prepare a diluted NaI solution for an experiment. They start with a concentrated stock solution of 0.425 M and need a final volume of 700 mL at a concentration of approximately 0.182 M. Using the steps outlined above, they can accurately prepare the solution by:

- Calculating the required initial volume of stock solution
- Adding solvent to reach the final volume
- Confirming the concentration using molarity calculations

This process ensures the experiment's accuracy and reproducibility, demonstrating the critical importance of understanding solution dilution calculations.

Conclusion

Understanding how to calculate the concentration of a solution after dilution is a fundamental skill in chemistry. In our example, starting with 300 mL of a 0.425 M NaI solution and diluting it to 700 mL results in a new concentration of approximately 0.182 M. This calculation hinges on the principle that the total moles of solute remain constant during dilution, making it straightforward to determine the new molarity using the initial data and the final volume.

By mastering these calculations, scientists and students can confidently prepare solutions, ensure experimental precision, and deepen their understanding of solution chemistry's core principles. Whether for academic purposes or industrial applications, this knowledge forms the backbone of accurate chemical preparation and analysis.

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