

25.0 ML Of 3.80M HNO₃ Diluted To 0.250 L. Express Your Answer In Moles Per Liter To Three Significant

25.0 ML Of 3.80M HNO₃ Diluted To 0.250 L. Express Your Answer In Moles Per Liter To Three Significant is a common problem in chemistry that involves concentration calculations, specifically molarity, which measures the number of moles of solute per liter of solution. This scenario illustrates the process of diluting a concentrated nitric acid (HNO₃) solution and determining its molarity after dilution. Understanding how to approach such problems is essential for students and professionals working in chemistry labs, environmental science, and related fields. In this article, we will explore the step-by-step process to solve this problem, explain the underlying concepts, and provide additional insights to strengthen your understanding of solution dilution and molarity calculations.

Understanding the Problem

Before diving into the calculations, it's crucial to understand what the problem is asking:

- You start with a specific volume of a concentrated nitric acid solution: 25.0 mL of 3.80 M HNO₃.
- This solution is diluted to a total volume of 0.250 L (which is 250 mL).
- The goal is to find the molarity of the diluted solution, expressed in moles per liter (M), rounded to three significant figures.

This type of problem tests your understanding of the relationship between concentration and volume before and after dilution, based on the principle that the number of moles of solute remains constant during dilution.

Key Concepts and Formulas

To correctly solve this problem, it's essential to understand some fundamental concepts and formulas related to solution concentration and dilution.

1. Molarity (M)

- Definition: Molarity is the number of moles of solute per liter of solution.

$$M = \frac{\text{moles of solute}}{\text{liters of solution}}$$

\]

2. Moles of Solute

- Calculated as:

$$\text{moles} = M \times \text{volume in liters}$$

3. Dilution Formula

- The key relationship for dilution is:

$$M_1 V_1 = M_2 V_2$$

where:

- M_1 = initial molarity
- V_1 = initial volume
- M_2 = final molarity
- V_2 = final volume

This equation states that the number of moles before and after dilution remains the same.

Step-by-Step Solution

Let's proceed through the problem systematically.

Step 1: Convert Initial Volume to Liters

Since molarity is expressed in moles per liter, convert the initial volume from milliliters to liters:

$$V_1 = 25.0 \text{ mL} = 0.0250 \text{ L}$$

Step 2: Calculate the Moles of HNO_3 in the Initial Solution

Using the initial molarity:

$$\text{moles}_{\text{initial}} = M_1 \times V_1 = 3.80 \text{ mol/L} \times 0.0250 \text{ L}$$

$$\text{moles}_{\text{initial}} = 0.095 \text{ mol}$$

This is the total amount of HNO_3 in moles in the initial sample.

Step 3: Apply the Dilution Formula

Since the moles of solute remain constant during dilution:

$$M_1 V_1 = M_2 V_2$$

Rearranged to solve for M_2 :

$$M_2 = \frac{M_1 V_1}{V_2}$$

Substitute known values:

$$M_2 = \frac{3.80 \text{ mol/L} \times 0.0250 \text{ L}}{0.250 \text{ L}}$$

$$M_2 = \frac{0.095 \text{ mol}}{0.250 \text{ L}}$$

$$M_2 = 0.38 \text{ mol/L}$$

Thus, the molarity of the diluted nitric acid solution is 0.380 M, expressed to three significant figures.

Additional Considerations and Tips

Understanding the principles behind dilution and concentration calculations is essential for accurate laboratory work. Here are some tips and considerations:

1. Always Convert Volumes to Liters

- Since molarity is in mol/L, ensure all volume measurements are in liters before calculations to maintain consistency.

2. Maintain Significant Figures

- Pay attention to the number of significant figures in your given data. The initial molarity (3.80 M) has three significant figures, so your final answer should reflect this precision.

3. Know When to Use the Moles Formula

- Sometimes, it's easier to find the moles first and then divide by total volume to find molarity after dilution.

4. Understand the Concept of Conservation of Moles

- During dilution, the total number of moles of solute remains unchanged, which simplifies the calculation.

Practical Applications of Dilution Calculations

Dilution calculations are fundamental in various scientific and industrial contexts. Here are some practical applications:

- Preparing solutions of desired concentrations for laboratory experiments.
- Diluting concentrated acids or bases to safe working strengths.
- Adjusting reagent concentrations in manufacturing processes.
- Environmental monitoring where sample concentrations need to be adjusted for analysis.

Understanding how to accurately perform dilutions ensures safety, precision, and reproducibility in scientific work.

Common Mistakes to Avoid

When performing dilution calculations, be cautious of these common errors:

- Using the wrong units for volume (e.g., mixing mL and L without conversion).
- Forgetting to convert volumes to liters before calculation.
- Misapplying the dilution formula or confusing initial and final conditions.
- Rounding off too early or too late, leading to loss of significant figures.

By paying attention to these details, you ensure accurate and reliable results.

Conclusion

The calculation of molarity after diluting a solution is a fundamental skill in chemistry, reflecting an understanding of how concentration relates to volume and moles of solute. In the case of 25.0 mL of 3.80 M HNO_3 diluted to 0.250 L, the resulting molarity is 0.380 M, rounded to three significant figures. Mastering these calculations enhances your ability to prepare solutions accurately and interpret experimental data confidently. Whether you're working in a research lab, educational setting, or industrial environment, these principles are essential for ensuring safety, consistency, and scientific rigor in your work.

Remember: Always verify unit conversions, maintain significant figures, and understand the underlying principles to perform successful dilution calculations in chemistry.

Frequently Asked Questions

What is the molarity of HNO_3 after diluting 25.0 mL of 3.80 M HNO_3 to a total volume of 0.250 L?

The molarity remains 0.380 M because dilution does not change the number of moles; it only changes the volume.

How do you calculate the molarity of HNO_3 after dilution when given initial concentration and volume?

Use the dilution formula: $M_1V_1 = M_2V_2$. Rearrange to find $M_2 = (M_1V_1) / V_2$.

What is the number of moles of HNO_3 in 25.0 mL of 3.80 M solution before dilution?

Number of moles = concentration $\times$ volume = $3.80 \text{ mol/L} \times 0.025 \text{ L} = 0.095 \text{ mol}$.

Why does the molarity of HNO_3 decrease after dilution from 3.80 M to a smaller concentration?

Because the same number of moles is spread over a larger volume, reducing the concentration.

If 25.0 mL of 3.80 M HNO_3 is diluted to 0.250 L, what is the final concentration in mol/L?

Final concentration = (initial moles) / (final volume) = $0.095 \text{ mol} / 0.250 \text{ L} = 0.380 \text{ M}$.

How accurate are the significant figures when expressing the final molarity in this dilution problem?

The final answer should be expressed to three significant figures, so 0.380 M is appropriate based on the given data.

Additional Resources

25.0 mL of 3.80 M HNO_3 Diluted to 0.250 L: An In-Depth Analysis

Understanding the process of diluting a concentrated solution like 3.80 M nitric acid (HNO_3) to a specific volume is fundamental in chemistry, especially for preparing solutions with precise molarity for experiments or industrial applications. This article offers a comprehensive review of the calculation involved, the significance of concentration units, and practical considerations for achieving accurate dilutions. The focus centers on the problem: "25.0 mL of 3.80 M HNO_3 diluted to 0.250 L," and expressing the resulting molarity in mol/L to three significant figures.

Understanding the Fundamentals of Molarity and Dilution

What Is Molarity?

Molarity (M) is a measure of concentration that expresses the number of moles of solute per liter of solution. It is defined as:

$$M = \frac{\text{moles of solute}}{\text{liters of solution}}$$

This unit is crucial because it allows chemists to precisely specify the amount of substance in a given volume, facilitating reactions, titrations, and solution preparations.

The Dilution Concept

Dilution involves decreasing the concentration of a solution by adding solvent (usually water) without changing the number of moles of solute. 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
- V_2 = final volume

This relationship assumes ideal behavior and no loss of solute during the process.

Step-by-Step Calculation of the Final Molarity

Given Data

- Initial volume of concentrated HNO_3 solution: $V_1 = 25.0 \text{ mL}$
- Initial molarity: $C_1 = 3.80 \text{ M}$
- Final volume after dilution: $V_2 = 0.250 \text{ L}$

First, convert the initial volume to liters:

$$V_1 = 25.0 \text{ mL} = 0.0250 \text{ L}$$

Calculate the initial moles of HNO₃

Using the molarity:

$$n_{\text{moles of HNO}_3} = C_1 \times V_1$$

$$n = 3.80 \, \text{mol/L} \times 0.0250 \, \text{L}$$

$$n = 0.095 \, \text{mol}$$

This is the amount of HNO₃ present in the initial 25.0 mL solution.

Determine the final molarity after dilution

Applying the dilution formula:

$$C_2 = \frac{n_{\text{moles of solute}}}{V_2}$$

$$C_2 = \frac{0.095 \, \text{mol}}{0.250 \, \text{L}}$$

$$C_2 = 0.38 \, \text{M}$$

Answer: The final concentration of HNO₃ after dilution is 0.380 M when expressed to three significant figures.

Significance of the Result and Practical Implications

Why Is Precise Molarity Important?

In chemical reactions, especially titrations involving acids and bases, the molarity determines the exact amount of reagent needed to reach equivalence. An accurate concentration ensures reproducibility and validity of experimental results.

Applications in Laboratory and Industry

- Laboratory titrations: Preparing a solution of known molarity for titrating unknown samples.
- Industrial processes: Adjusting concentrations for manufacturing or

cleaning purposes.

- Educational demonstrations: Teaching students about solution preparation and molarity calculations.

Advantages of Dilution Calculations

- Enables precise control over solution concentrations.
- Facilitates safe handling by reducing the concentration of hazardous substances.
- Ensures consistency across multiple experiments or batches.

Features, Pros, and Cons of the Dilution Process

Features

- Utilizes the fundamental relationship $C_1 V_1 = C_2 V_2$.
- Requires accurate measurements of volume and concentration.
- Assumes ideal behavior with no volume change upon mixing.

Pros

- Simple and straightforward calculation.
- Cost-effective, as it minimizes the use of concentrated solutions.
- Allows customization of solution strengths for specific applications.
- Enhances safety by diluting hazardous substances.

Cons

- Sensitive to measurement errors; inaccuracies in volume measurement can lead to significant deviations.
- Assumes ideal mixing; in real systems, volume contraction or expansion might occur slightly.
- Requires precise measurement tools (e.g., volumetric flasks, pipettes).

Considerations for Accurate Dilution

Measurement Precision

Using calibrated equipment such as volumetric flasks and pipettes ensures that volumes are accurate, which is crucial for precise molarity calculation.

Temperature Effects

Solution volumes can vary with temperature; conducting dilutions at a controlled temperature (usually 20°C) helps maintain consistency.

Handling Concentrated Solutions

- Always add acid to water, not vice versa, to prevent splashing or exothermic reactions from causing hazards.
- Use appropriate personal protective equipment (PPE).

Verification

Post-dilution, the concentration can be verified via titration or other analytical methods to confirm accuracy.

Conclusion

The process of diluting 25.0 mL of 3.80 M HNO_3 to a final volume of 0.250 L results in a solution with a molarity of 0.380 M, expressed to three significant figures. This straightforward calculation exemplifies fundamental principles in solution chemistry, emphasizing the importance of understanding molarity, precise measurements, and proper procedures. Whether for laboratory experiments, industrial applications, or educational purposes, mastering dilution calculations ensures accurate, safe, and reproducible results. The key takeaway is the vital role of meticulous measurement and adherence to fundamental formulas in achieving desired concentrations, thereby supporting the integrity of chemical work across various fields.

In summary:

- Initial moles of $\text{HNO}_3 = 0.095 \text{ mol}$
- Final concentration after dilution = 0.380 M
- Emphasizes the importance of precise measurement and understanding molarity concepts.
- Highlights practical considerations for safe and accurate solution preparation.

By mastering these principles, chemists and students alike can confidently prepare solutions tailored to their specific needs, ensuring accuracy and consistency in their scientific endeavors.

25 0 Ml Of 3 80mhno3 Diluted To 0 250 L Express Your Answer In Moles Per Liter To Three Significant

25 0 Ml Of 3 80mhno3 Diluted To 0 250 L Express Your Answer In Moles Per Liter To Three Significant

Related Articles

- [\(1\) Jenna Was Excited To Have The House All To Herself. \(2\) She Was Looking Forward To Relaxing In A](#)
- [#1\) You Are Tasked With Selecting The Supplier For A New Part From Four Possible Venders A,B, C, And](#)
- [12 Snack Bars Together Weigh 1 Lb. 4 Oz. If There Are 16 Oz. In A Lb. And 453.6 G In A Lb., How Many](#)

[Back to Home](#)