

What Is The Final Volume Of NaCl Solution After Diluting A 0.10 L Of 2.0 M NaCl Into A 0.5 M Solution?

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Understanding how to determine the final volume of a NaCl solution after dilution is fundamental in chemistry, especially in preparing solutions with precise molarity for various experiments. This article provides a comprehensive explanation of the process involved in calculating the final volume when diluting a specific volume and concentration of sodium chloride (NaCl) into another solution with a different molarity. We will explore the concepts of molarity, dilution principles, step-by-step calculations, and practical implications to ensure clarity and thorough understanding.

Understanding Key Concepts in Solution Dilution

Before diving into the calculations, it is essential to understand the foundational concepts related to solution concentration and dilution.

What Is Molarity?

- Definition: Molarity (M) is a measure of concentration expressed as the number of moles of solute (NaCl in this case) per liter of solution.
- Formula:

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

- Units: Moles per liter (mol/L).

Principles of Dilution

- The process of dilution involves adding solvent (usually water) to a solution to decrease its concentration.
- The fundamental relationship in dilutions 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 assumes that the amount of solute remains constant before and after dilution.

Problem Breakdown: Diluting 0.10 L of 2.0 M NaCl into a 0.5 M Solution

Given:

- Initial volume $V_1 = 0.10 \text{ L}$
- Initial concentration $C_1 = 2.0 \text{ M}$
- Desired concentration $C_2 = 0.5 \text{ M}$

Question:

- What is the final volume (V_2) after dilution?

Step-by-Step Calculation of Final Volume

The core of this problem hinges on using the dilution equation to find the unknown final volume.

Step 1: Calculate the moles of NaCl in the initial solution

- Moles of NaCl initially present:

$$n_{\text{Moles}} = C_1 \times V_1$$

$$n_{\text{Moles}} = 2.0 \, \text{mol/L} \times 0.10 \, \text{L}$$

$$n_{\text{Moles}} = 0.20 \, \text{mol}$$

Step 2: Recognize that the moles of solute remain constant during dilution

- The moles of NaCl after dilution:

$$n_{\text{Moles}} = 0.20 \, \text{mol}$$

- This is true regardless of the final volume.

Step 3: Use the dilution equation to find V_2

- Rearranged:

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

$$V_2 = \frac{0.20 \text{ mol}}{0.5 \text{ mol/L}}$$

$$V_2 = 0.40 \text{ L}$$

- Therefore, the final volume of the solution after dilution is 0.40 liters.

Implications and Practical Considerations

Understanding the calculated final volume is critical in laboratory settings for accurate solution preparation. Here are some key points and considerations:

1. Accuracy of Measurements

- Use precise volumetric tools such as graduated cylinders or volumetric flasks.
- Ensure measurement accuracy to avoid errors in concentration.

2. Dilution Process

- When diluting, always add solvent gradually to avoid overshooting the desired volume.
- Mix thoroughly to ensure homogeneity.

3. Application in Laboratory Settings

- Accurate dilutions are crucial for experiments requiring specific molarity solutions.
- Knowledge of final volume helps in scaling up or down preparations.

4. Safety Precautions

- Handle chemicals with appropriate safety gear.
- Be aware of the properties of NaCl solutions, especially in high concentrations.

Additional Examples and Related Calculations

To reinforce understanding, consider other scenarios involving solution dilution:

Example 1: Diluting a Different Volume

- If you start with 0.05 L of 2.0 M NaCl and dilute to 0.5 M, what is the final volume?

$$[\text{Moles}] = 2.0 \, \text{mol/L} \times 0.05 \, \text{L} = 0.10 \, \text{mol}]$$

$$[V_2 = \frac{0.10 \, \text{mol}}{0.5 \, \text{mol/L}} = 0.20 \, \text{L}]$$

- Final volume: 0.20 liters.

Example 2: Adjusting for Different Concentrations

- What if the initial concentration was 3.0 M instead of 2.0 M, with the same initial volume?

$$n = 3.0 \text{ mol/L} \times 0.10 \text{ L} = 0.30 \text{ mol}$$

$$V_2 = \frac{0.30 \text{ mol}}{0.5 \text{ mol/L}} = 0.60 \text{ L}$$

- Final volume: 0.60 liters.

Summary and Key Takeaways

- The final volume of an NaCl solution after dilution can be accurately determined using the molarity and volume of the initial solution combined with the desired final concentration.
- The core formula used is:

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

- In the given problem, diluting 0.10 L of 2.0 M NaCl to a 0.5 M solution results in a final volume of 0.40 liters.
- Precise measurements and proper techniques are vital to ensure the accuracy of solution preparations in laboratory settings.
- Understanding these principles aids in various applications, from research experiments to industrial processes.

Conclusion

Determining the final volume of NaCl solution after dilution is a fundamental skill in chemistry, essential

for preparing solutions with specific molarities. By applying the dilution equation and understanding the relationship between concentration, volume, and moles, chemists can accurately predict and prepare solutions tailored to their experimental needs. The process outlined here underscores the importance of careful calculations and practical execution in achieving desired chemical concentrations, ensuring the success and reproducibility of scientific work.

Frequently Asked Questions (FAQs)

Q1: Why does the moles of solute remain constant during dilution?

A1: Because dilution involves adding solvent to decrease concentration without adding or removing the solute itself, the total number of moles of solute stays the same.

Q2: Can I dilute NaCl solutions directly without calculating?

A2: While you can dilute solutions directly, it is best practice to perform calculations to ensure the final concentration and volume meet your specific requirements.

Q3: How does temperature affect solution dilution?

A3: Temperature can influence solution volume and solubility but generally has a minimal effect on the molarity calculations unless extreme conditions are involved.

Q4: What equipment should I use for accurate dilutions?

A4: Use calibrated volumetric flasks, graduated cylinders, or pipettes for precise measurement.

Q5: Is it necessary to mix thoroughly after dilution?

A5: Yes, thorough mixing ensures uniform concentration throughout the solution.

This comprehensive guide equips you with the knowledge to accurately determine the final volume of NaCl solutions after dilution, a vital aspect of laboratory chemistry and solution preparation.

Frequently Asked Questions

What is the final volume of NaCl solution after diluting 0.10 L of 2.0 M NaCl into a 0.5 M solution?

The final volume can be calculated using the dilution formula: $C_1V_1 = C_2V_2$. Substituting values: $2.0 \text{ M} \times 0.10 \text{ L} = 0.5 \text{ M} \times V_2$. Solving for V_2 : $V_2 = (2.0 \text{ M} \times 0.10 \text{ L}) / 0.5 \text{ M} = 0.20 \text{ L}$.

How do you calculate the final volume after diluting a solution?

Use the dilution equation: $C_1V_1 = C_2V_2$, where C_1 and V_1 are the initial concentration and volume, and C_2 and V_2 are the final concentration and volume. Rearrange to find V_2 : $V_2 = (C_1V_1) / C_2$.

What is the purpose of dilution in chemistry?

Dilution is used to decrease the concentration of a solute in a solution, often to achieve desired molarity for experiments or reactions.

Can you dilute a 2.0 M NaCl solution to 0.5 M? How is it done?

Yes, by adding water to the 2.0 M solution until its concentration decreases to 0.5 M. Using the dilution formula, you can calculate the final volume needed.

What is the significance of molarity in solution preparation?

Molarity indicates the number of moles of solute per liter of solution, essential for preparing precise chemical solutions.

If I start with 0.10 L of 2.0 M NaCl, what volume should I add water to get a 0.5 M solution?

You can use $V_2 = (C_1V_1) / C_2$: $V_2 = (2.0 \text{ M} \times 0.10 \text{ L}) / 0.5 \text{ M} = 0.20 \text{ L}$. So, the final volume should be 0.20 L, meaning you add 0.10 L of water.

What assumptions are made when using the dilution formula?

It assumes the solution is ideal, volumes are additive, and no chemical reactions occur during dilution.

How does dilution affect the concentration of NaCl in the solution?

Dilution decreases the concentration of NaCl proportionally; increasing volume reduces molarity.

What are common applications of solution dilution in laboratories?

Dilution is used for preparing standard solutions, calibrating instruments, and adjusting reagent concentrations for experiments.

Is the final NaCl solution still considered the same molarity after dilution?

No, the molarity decreases after dilution because the same amount of solute is spread over a larger volume.

Additional Resources

Understanding the Final Volume of NaCl Solution After Dilution: A Comprehensive Guide

When working with solutions in chemistry, one of the fundamental concepts is understanding how dilution affects concentration and volume. In this detailed exploration, we will analyze the specific scenario: What is the final volume of NaCl solution after diluting 0.10 L of a 2.0 M NaCl solution into a

0.5 M NaCl solution? This question encompasses core principles such as molarity, dilution, and the conservation of moles, providing a rich context to deepen your understanding of solution chemistry.

Introduction to Solution Concentration and Dilution

Before delving into the problem specifics, it's essential to revisit some foundational concepts:

What is Molarity?

- Molarity (M) is defined as the number of moles of solute (in this case, NaCl) per liter of solution.
- Expressed mathematically as:

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

Understanding Dilution

- Dilution involves adding solvent (usually water) to a solution to decrease its concentration.
- The key principle in dilution is the conservation of moles of solute:

$$\text{Moles before dilution} = \text{Moles after dilution}$$

- The relationship between initial and final solutions is given by the dilution equation:

$$M_1 V_1 = M_2 V_2$$

Where:

- M_1 and V_1 are the concentration and volume of the initial solution.
- M_2 and V_2 are the concentration and volume after dilution.

Problem Breakdown and Given Data

Let's analyze the problem step-by-step:

- Initial volume of the concentrated NaCl solution (V_1): 0.10 L
- Initial molarity of the concentrated solution (M_1): 2.0 M
- Target molarity after dilution (M_2): 0.5 M
- Question: What is the final volume (V_2) of the solution after dilution?

Step-by-Step Solution Approach

The core principle is that the total number of moles of NaCl remains constant before and after dilution.

Step 1: Calculate the initial moles of NaCl

$$\begin{aligned} & \text{Moles of NaCl initially} = M_1 \times V_1 \\ & \end{aligned}$$

$$\begin{aligned} & = 2.0 \, \text{mol/L} \times 0.10 \, \text{L} = 0.20 \, \text{mol} \\ & \end{aligned}$$

Step 2: Set the molar conservation equation for the final solution

$$\begin{aligned} & \text{Moles after dilution} = M_2 \times V_2 \end{aligned}$$

\]

Since the moles are conserved:

\[

$$M_1 V_1 = M_2 V_2$$

\]

Substitute known values:

\[

$$0.20\, \text{mol} = 0.5\, \text{mol/L} \times V_2$$

\]

Step 3: Solve for (V_2)

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$$V_2 = \frac{0.20\, \text{mol}}{0.5\, \text{mol/L}} = 0.40\, \text{L}$$

\]

Final Result and Interpretation

The final volume of the NaCl solution after dilution to a 0.5 M concentration is 0.40 liters (or 400 milliliters).

This calculation demonstrates how the initial amount of solute determines the final volume when diluting to a specific concentration.

Additional Considerations and Practical Implications

While the calculation appears straightforward, several practical aspects should be considered:

Accuracy in Measurement

- Use precise volumetric equipment to measure the initial volume (0.10 L) and to prepare the solution.
- Ensure thorough mixing to achieve uniform concentration.

Dilution Limitations

- The calculation assumes ideal behavior, with no volume change upon mixing.
- In practice, slight deviations can occur due to volume contraction or expansion, especially with high concentrations or temperature variations.

Applications in Laboratory Settings

- Preparing solutions of specific molarity is common in titrations, spectrophotometry, and other analytical techniques.
- Understanding how to calculate final volumes after dilution ensures accurate preparation of reagents.

Broader Context: Why This Matters in Chemistry

Understanding solution dilution principles is crucial for various applications:

- Pharmaceuticals: Precise dilutions are necessary to prepare medication solutions.
- Environmental Chemistry: Diluting samples for analysis ensures measurements fall within instrument detection ranges.
- Industrial Processes: Accurate solution preparation impacts manufacturing quality control.

Mastery of these concepts also enhances comprehension of more complex chemical equilibria, titration calculations, and solution preparations.

Summary and Key Takeaways

- The initial amount of NaCl (0.20 mol) remains constant during dilution.
- To attain a 0.5 M concentration starting from a 2.0 M solution, the volume must be increased, specifically to 0.40 L.
- The final volume after dilution is directly proportional to the initial and target concentrations, following the relation:

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

- This process highlights the importance of molarity, conservation of moles, and the dilution equation in solution chemistry.

Concluding Remarks

In summary, calculating the final volume of NaCl solution after dilution involves understanding the fundamental principles of molarity and conservation of moles. By applying the dilution equation, we found that diluting 0.10 L of a 2.0 M NaCl solution to a 0.5 M solution results in a final volume of 0.40 L. This knowledge is vital for chemists and laboratory technicians to prepare solutions accurately, ensuring experimental reliability and safety.

Whether you're a student learning these concepts for the first time or a professional applying them in research or industry, grasping the nuances of solution dilution empowers you to manipulate and understand chemical systems effectively.

[What Is The Final Volume Of Nacl Solution After Diluting A 0 10 L Of 2 0 M Nacl Inot A 0 5 M Solution](#)

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