

How Many Milliliters Of 2.0M NaCl Must You Dilute To Make 250ml Of 0.5M NaCl?

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When working in chemistry laboratories, preparing solutions with precise molarity is essential for accurate experiments and analyses. Sodium chloride (NaCl) solutions are among the most common reagents used in various scientific applications, including biological experiments, titrations, and chemical syntheses.

Understanding how to dilute a concentrated NaCl solution to achieve a desired molarity is a fundamental skill for students and professionals alike.

This article provides a comprehensive guide to calculating the volume of a 2.0 M NaCl solution required to prepare 250 mL of a 0.5 M NaCl solution. We will explore the concepts of molarity, dilution principles, and step-by-step calculation methods to ensure accuracy and confidence in laboratory practices.

Understanding Molarity and Dilution Principles

What Is Molarity?

Molarity (M) is a measure of concentration that indicates the number of moles of solute (in this case, NaCl) dissolved in one liter of solution. It is expressed as:

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

For example, a 2.0 M NaCl solution contains 2.0 moles of NaCl dissolved in 1 liter of solution.

The Concept of Dilution

Dilution involves reducing the concentration of a solute in a solution by adding more solvent without changing the amount of solute present. The fundamental relationship governing dilution is:

$$C_1 V_1 = C_2 V_2$$

Where:

- C_1 = initial concentration (molarity) of the stock solution
- V_1 = volume of the stock solution needed
- C_2 = final concentration after dilution
- V_2 = final total volume of the diluted solution

This equation states that the amount of solute before dilution equals the amount after dilution.

Step-by-Step Calculation to Determine the Required Volume

Let's apply the dilution formula to our specific problem:

Given:

- Stock solution concentration $(C_1 = 2.0\text{ M})$
- Desired concentration $(C_2 = 0.5\text{ M})$
- Final volume $(V_2 = 250\text{ mL})$

Objective:

Calculate the volume (V_1) of the 2.0 M NaCl stock solution needed to prepare 250 mL of 0.5 M NaCl.

Step 1: Convert all volumes to the same unit, preferably liters, for consistency in calculations:

$$[V_2 = 250\text{ mL} = 0.250\text{ L}]$$

Step 2: Rearrange the dilution equation to solve for (V_1) :

$$[V_1 = \frac{C_2 \times V_2}{C_1}]$$

Step 3: Substitute the known values:

$$[V_1 = \frac{0.5\text{ M} \times 0.250\text{ L}}{2.0\text{ M}}]$$

Step 4: Perform the calculation:

$$[V_1 = \frac{0.125\text{ mol}}{2.0\text{ mol/L}} = 0.0625\text{ L}]$$

Step 5: Convert back to milliliters:

$$[V_1 = 0.0625\text{ L} \times 1000\text{ mL/L} = 62.5\text{ mL}]$$

Result: You need to dilute 62.5 mL of the 2.0 M NaCl stock solution with distilled water to reach a final volume of 250 mL of 0.5 M NaCl solution.

Practical Steps for Laboratory Preparation

Preparing the solution involves precise measurement and proper technique:

1. Gather Materials:

- 2.0 M NaCl stock solution
- Volumetric flask (250 mL capacity)
- Graduated cylinder or pipette (to measure 62.5 mL)
- Distilled water
- Stirring rod or magnetic stirrer

2. Measure the Stock Solution:

- Using a graduated cylinder or pipette, carefully measure 62.5 mL of the 2.0 M NaCl solution.

3. Transfer to Volumetric Flask:

- Pour the measured stock solution into the 250 mL volumetric flask.

4. Add Distilled Water:

- Slowly add distilled water to the flask until the level reaches the 250 mL mark.
- Mix thoroughly to ensure uniform concentration.

5. Label the Solution:

- Clearly label the flask with the concentration and date for future reference.

Safety Note: Always wear appropriate protective equipment, such as gloves and safety goggles, when handling chemicals.

Importance of Accurate Dilution in Laboratory Work

Accurate dilution calculations are vital for several reasons:

- **Experimental Precision:** Ensures that experimental conditions are consistent and reproducible.
- **Chemical Safety:** Prevents over-concentration of reactive substances that could pose hazards.
- **Cost-Effectiveness:** Avoids waste of chemicals by calculating precise volumes.
- **Data Validity:** Maintains integrity of analytical results and conclusions.

Additional Tips for Successful Dilution

- Always double-check calculations.
- Use calibrated measuring devices for accuracy.
- Add water gradually and mix thoroughly.

- Use appropriate containers to avoid contamination.
- Record all measurements and steps for reproducibility.

Common Mistakes to Avoid

- Using incorrect units (e.g., mixing mL and L without conversion).
- Not accounting for the proper final volume.
- Overlooking solution stability or solubility limits.
- Rushing measurement processes, leading to inaccuracies.

Conclusion

Preparing a specific molarity solution from a more concentrated stock solution is a fundamental skill in chemistry. In this case, to make 250 mL of 0.5 M NaCl from a 2.0 M stock solution, you need to dilute 62.5 mL of the concentrated solution with distilled water up to the 250 mL mark. Mastering these calculations ensures accuracy, safety, and success in laboratory experiments.

Understanding and applying the principles of molarity and dilution not only enhances your laboratory skills but also contributes to the integrity of scientific research. Whether you're a student, teacher, or researcher, these skills are invaluable for precise solution preparation and reliable experimental outcomes.

Frequently Asked Questions

How do I calculate the volume of 2.0 M NaCl needed to prepare 250 mL of 0.5 M NaCl?

Use the dilution formula: $C_1V_1 = C_2V_2$. Plugging in the values: $V_1 = (C_2 \times V_2) / C_1 = (0.5 \text{ M} \times 250 \text{ mL}) / 2.0 \text{ M} = 62.5 \text{ mL}$. So, you need 62.5 mL of 2.0 M NaCl.

What is the purpose of diluting a concentrated NaCl solution to a lower molarity?

Dilution reduces the concentration of the solution to a desired level for experiments or applications that require specific molarity, ensuring accuracy and safety.

If I want 250 mL of 0.5 M NaCl, how much of a 2.0 M stock solution should I use?

You should use 62.5 mL of the 2.0 M NaCl stock solution and dilute it with distilled water to reach a total volume of 250 mL.

What is the significance of the molarity values in this dilution problem?

The molarity values (2.0 M and 0.5 M) indicate the concentration of NaCl solutions before and after dilution, guiding how much stock solution to use.

Can I use a different volume of the 2.0 M NaCl stock solution for the same final concentration?

Yes, but the volume must be adjusted accordingly using the dilution formula to achieve the same final molarity and volume.

What equipment should I use to measure the 62.5 mL of NaCl solution accurately?

Use a graduated cylinder or a volumetric flask to measure the 62.5 mL accurately.

Why is it important to perform dilutions carefully in a laboratory setting?

Accurate dilutions ensure correct concentrations for experiments, which is critical for obtaining valid and reproducible results.

What are the steps to prepare 250 mL of 0.5 M NaCl from a 2.0 M solution?

Calculate the required volume of 2.0 M NaCl (62.5 mL), measure it accurately, then add distilled water until the total volume reaches 250 mL.

How does the dilution factor relate to the initial and final concentrations?

The dilution factor is the ratio of the initial concentration to the final concentration; here, 2.0 M to 0.5 M, which is a factor of 4.

If I mistakenly use 100 mL of 2.0 M NaCl, what will be the resulting

molarity after diluting to 250 mL?

Using $V_1 = 100 \text{ mL}$, the new concentration $C_2 = (C_1 \times V_1) / V_2 = (2.0 \text{ M} \times 100 \text{ mL}) / 250 \text{ mL} = 0.8 \text{ M}$. So, the final concentration would be 0.8 M.

Additional Resources

How Many Milliliters Of 2.0M NaCl Must You Dilute To Make 250ml Of 0.5M NaCl?

Understanding the process of preparing solutions with precise molarity is fundamental in chemistry, particularly in laboratory experiments, pharmaceutical preparations, and industrial applications. This article explores the detailed calculations and theoretical principles behind diluting a concentrated sodium chloride (NaCl) solution to obtain a specific lower concentration. Specifically, we will analyze how many milliliters of a 2.0 M NaCl solution are required to prepare 250 mL of a 0.5 M NaCl solution. The discussion will encompass the concepts of molarity, dilution equations, and practical considerations to equip readers with a clear, comprehensive understanding of the process.

Introduction to Molarity and Solution Preparation

What Is Molarity?

Molarity (M) is a standard measure of concentration in chemistry, defined as the number of moles of solute dissolved in one liter (L) of solution. It provides a straightforward way to quantify how much of a substance is present in a solution, facilitating precise reactions and experiments.

Mathematically, molarity is expressed as:

$$\text{Molarity (M)} = \frac{\text{Moles of solute}}{\text{Liters of solution}}$$

For example, a 2.0 M NaCl solution contains 2.0 moles of NaCl per liter of solution.

Why Dilution Is Important

Dilution involves reducing the concentration of a solution by adding solvent, typically water, without changing the amount of solute present. It is a common laboratory procedure used to prepare solutions of desired molarity for various applications.

Dilution allows scientists to:

- Achieve specific, lower concentrations necessary for experiments.
- Save costly or limited stock solutions.
- Standardize solutions for analytical measurements.

The core principle governing dilution is the conservation of moles: the total amount of solute remains constant before and after dilution.

Understanding the Dilution Equation

The Fundamental Relationship

The key to solving dilution problems is the dilution equation:

$$C_1 V_1 = C_2 V_2$$

where:

- C_1 = concentration of the initial (stock) solution
- V_1 = volume of the stock solution needed
- C_2 = concentration of the diluted solution
- V_2 = final volume of the diluted solution

This equation states that the moles of solute in the stock solution ($C_1 V_1$) must equal the moles in the diluted solution ($C_2 V_2$), assuming no solute is lost during the process.

Application to NaCl Solution Preparation

In our specific case:

- The stock solution is 2.0 M NaCl.
- The desired solution is 0.5 M NaCl.
- The final volume (V_2) is 250 mL, which is 0.250 L.

Our goal: determine V_1 , the volume of the 2.0 M solution needed.

Step-by-Step Calculation

Converting Units for Consistency

Before calculating, ensure all units are compatible:

- Convert final volume to liters:

$$V_2 = 250 \text{ mL} = 0.250 \text{ L}$$

- Given concentrations are already in molarity (mol/L), so no further conversion is necessary.

Applying the Dilution Equation

Plugging into the equation:

$$C_1 V_1 = C_2 V_2$$

$$(2.0 \text{ mol/L}) \times V_1 = 0.5 \text{ mol/L} \times 0.250 \text{ L}$$

Calculate the right side:

$$0.5 \text{ mol/L} \times 0.250 \text{ L} = 0.125 \text{ mol}$$

Now, solve for V_1 :

$$V_1 = \frac{0.125 \text{ mol}}{2.0 \text{ mol/L}} = 0.0625 \text{ L}$$

Convert liters back to milliliters:

$$0.0625 \text{ L} = 62.5 \text{ mL}$$

Result: To prepare 250 mL of 0.5 M NaCl solution from a 2.0 M stock, precisely 62.5 mL of the concentrated solution is required.

Practical Considerations and Experimental Tips

Measuring and Mixing

Accurate measurement of the stock solution is crucial. Use calibrated pipettes or graduated cylinders to measure the 62.5 mL volume. When transferring, ensure minimal spillage and complete transfer to maintain concentration accuracy.

After measuring the stock solution:

- Pour the 62.5 mL of 2.0 M NaCl into a volumetric flask or a suitable container.
- Add distilled water gradually to reach the 250 mL mark.
- Mix thoroughly to ensure homogeneity.

Ensuring Precision and Accuracy

- Use high-quality, calibrated equipment.
- Add water in stages, mixing after each addition.
- Record measurements carefully.
- If high precision is required, perform replicate dilutions and average the results.

Handling Safety and Disposal

- NaCl solutions are generally safe, but standard laboratory precautions apply.
- Dispose of excess solutions according to local regulations.

Additional Insights and Theoretical Implications

Understanding Concentration Changes

The process exemplifies how a small volume of a concentrated solution can produce a larger volume of a dilute solution. This principle is vital in chemical manufacturing, pharmaceutical formulation, and analytical chemistry, where precise molarities are required.

In the example, diluting 62.5 mL of a 2.0 M solution yields 250 mL of a 0.5 M solution, a fourfold decrease in molarity corresponding to a fourfold increase in volume relative to the amount of solute.

Limitations and Assumptions

- Assumes ideal behavior; real solutions may deviate slightly due to activity coefficients.
- Assumes complete and accurate transfer of the measured volume.
- Does not account for temperature effects, which can influence volume and concentration.

Scaling and Alternative Approaches

- For larger or smaller batches, scale the calculations proportionally.

- Use serial dilutions for very dilute solutions to improve accuracy.
- Consider preparing a larger stock solution if multiple dilutions are required.

Conclusion

In summary, creating a 0.5 M NaCl solution from a 2.0 M stock involves calculating the appropriate volume of the concentrated solution to dilute. Using the fundamental dilution equation $(C_1 V_1 = C_2 V_2)$, the calculation reveals that 62.5 mL of the 2.0 M NaCl solution needs to be diluted with water to a final volume of 250 mL to achieve the desired molarity. This process underscores the importance of understanding solution concentrations, precise measurement, and the theoretical principles that underpin chemical preparation techniques. Mastery of these concepts ensures accuracy in laboratory work and contributes to the reproducibility and reliability of scientific experiments and industrial processes.

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