4. It Is Desired To Prepare 0.5 L Of A 0.1 M Solution Of NaClfrom A 1 M Stock Solution. How Many Milliliters

4. It Is Desired To Prepare 0.5 L Of A 0.1 M Solution Of NaClfrom A 1 M Stock Solution. How Many Milliliters is a common problem in chemistry laboratories that involves calculating the volume of a concentrated stock solution needed to prepare a dilute solution of desired concentration and volume. Understanding how to perform such dilutions accurately is essential for experiments requiring precise reagent concentrations. This article will guide you through the process step-by-step, exploring the fundamental concepts of molarity, dilution calculations, and practical considerations involved in preparing solutions.

Understanding the Basics of Molarity and Dilution

What Is Molarity?

Molarity (M) is a way of expressing the concentration of a solution, representing the number of moles of solute (in this case, NaCl) dissolved in one liter of solution. It is calculated as:

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

For example, a 1 M NaCl solution contains 1 mole of NaCl in 1 liter of solution.

Understanding Dilution

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

$$
C_1 V_1 = C_2 V_2
$$

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

This equation ensures the number of moles of solute remains constant before and after dilution.

Step-by-Step Calculation for the Problem

Given Data

- Desired volume of dilute solution, $V_2 = 0.5\, \text{L}$
- Desired concentration of dilute solution, $C_2 = 0.1\, \text{M}$
- Concentration of stock solution, $C_1 = 1\, \text{M}$

Applying the Dilution Formula

Using the relation:

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

Substituting the known values:

$$
V_1 = \frac{0.1\, \text{M} \times 0.5\, \text{L}}{1\, \text{M}} = 0.05\, \text{L}
$$

Converting liters to milliliters:

$$
0.05\, \text{L} \times 1000\, \text{mL/L} = 50\, \text{mL}
$$

Therefore, you need to measure 50 mL of the 1 M NaCl stock solution.

Practical Steps for Preparing the Solution

Materials Needed

- 1 M NaCl stock solution
- Volumetric flask (preferably 500 mL or larger)
- Pipette or graduated cylinder
- Distilled water
- Stirring rod or magnetic stirrer

Preparation Procedure

1. Measure the Stock Solution: Use a pipette or graduated cylinder to carefully measure 50 mL of the 1 M NaCl stock solution.
2. Transfer to Volumetric Flask: Pour the measured 50 mL into a clean, dry volumetric flask.
3. Add Water: Fill the flask with distilled water up to the 0.5 L (500 mL) mark. Be cautious to add water slowly as you approach the mark to avoid overshooting.
4. Mix Thoroughly: Cap the flask and invert multiple times or use a stirring rod to ensure homogeneity of the solution.
5. Label the Solution: Clearly mark the flask with the concentration and date of preparation for future reference.

Additional Considerations in Solution Preparation

Accuracy and Precision

- Use calibrated equipment such as volumetric flasks and pipettes to ensure precise measurements.
- When measuring small volumes, pipettes are more accurate than graduated cylinders.
- Perform measurements at eye level to avoid parallax errors.

Safety and Handling

- Wear appropriate personal protective equipment, such as gloves and safety glasses.
- Handle chemicals in a well-ventilated area.

Common Errors to Avoid

- Overfilling or underfilling the volumetric flask.
- Using impure or contaminated reagents.
- Not mixing the solution thoroughly.

Understanding the Significance of Proper Dilution

Dilution calculations are fundamental in chemistry for preparing solutions with precise concentrations. They are essential for various applications, including titrations, spectrophotometry, and biochemical assays. Accurate dilutions ensure reproducibility and reliability of experimental results.

Furthermore, understanding how to determine the required volume of a stock solution

saves time and resources, especially when working with expensive or limited reagents.

Summary of Key Points

- To prepare 0.5 L of a 0.1 M NaCl solution from a 1 M stock, you need to measure 50 mL of the stock solution.
- Use the dilution equation $C_1 V_1 = C_2 V_2$ for calculations.
- Always use calibrated equipment and follow safety protocols.
- Proper mixing and labeling are critical for solution stability and identification.

Conclusion

Preparing dilute solutions from concentrated stock solutions is a fundamental skill in chemistry that combines theoretical knowledge with practical laboratory techniques. By understanding molarity, the dilution formula, and proper measurement practices, you can accurately prepare solutions tailored to your experimental needs. In the scenario of preparing 0.5 L of a 0.1 M NaCl solution from a 1 M stock, measuring exactly 50 mL of the stock solution and diluting it with distilled water to 0.5 L will achieve the desired concentration efficiently and accurately. Mastery of these concepts enhances lab proficiency and ensures the success of your scientific endeavors.

Keywords: solution preparation, molarity, dilution calculation, NaCl solution, laboratory techniques, solution concentration, volumetric measurement, chemical safety

Frequently Asked Questions

What is the volume of NaCl stock solution needed to prepare 0.5 L of a 0.1 M NaCl solution?

5 milliliters of 1 M NaCl stock solution are needed.

How do you calculate the volume of stock solution required for dilution?

Use the dilution formula: C1V1 = C2V2, where C1 and V1 are the concentration and volume of the stock solution, and C2 and V2 are those of the diluted solution.

What is the formula used to determine the volume of stock solution needed for dilution?

V1 = (C2 × V2) / C1.

Why is it important to accurately measure the volume of stock solution when preparing a diluted solution?

Precise measurement ensures the final concentration is accurate and the solution's intended use is effective.

What are the units used in the calculation of dilution for NaCl solutions?

Concentrations are in molarity (M), and volumes are in liters or milliliters.

If you need 0.5 L of a 0.1 M NaCl solution, how many grams of NaCl are required?

Approximately 2.94 grams of NaCl are needed, calculated as: mass = molarity × volume (L) × molar mass (58.44 g/mol).

What is the molar mass of NaCl used in calculations?

The molar mass of NaCl is approximately 58.44 g/mol.

Can you prepare the solution by directly measuring 5 mL of 1 M NaCl and diluting to 0.5 L?

Yes, measuring 5 mL of 1 M NaCl and diluting to 0.5 L will produce a 0.1 M solution.

What are common mistakes to avoid when preparing dilutions of NaCl solutions?

Errors include incorrect calculation of volumes, inaccurate measurement of liquids, and contamination of solutions.

How does the concentration of the stock solution affect the volume needed for dilution?

A higher concentration stock solution requires a smaller volume for dilution, while a lower concentration requires a larger volume.

Additional Resources

It is desired to prepare 0.5 L of a 0.1 M solution of NaCl from a 1 M stock solution. How many milliliters of the stock solution are needed? This common laboratory task involves understanding the principles of solution preparation, molarity, and dilution calculations. Whether you're a student working in a chemistry lab, a professional scientist, or a hobbyist exploring chemical solutions, mastering how to determine the volume of stock solution needed for dilution is fundamental. This guide provides a comprehensive step-by-step approach to solve such problems with clarity, including the theoretical background, practical calculations, and tips to avoid common pitfalls.

Understanding the Basics: Molarity and Dilution

Before diving into the calculations, it's essential to understand key concepts:

What is Molarity?

Molarity (denoted as M) is a way of expressing the concentration of a solution. It is defined as the number of moles of solute (here, NaCl) dissolved in one liter of solution:

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

For example, a 1 M NaCl solution contains 1 mole of NaCl per liter.

Dilution Concept

Dilution involves reducing 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 (stock solution)
- V_1 = volume of stock solution needed
- C_2 = desired concentration in the final solution
- V_2 = final total volume of the diluted solution

This equation ensures the number of moles of solute remains constant during dilution.

Step-by-Step Calculation

Given data:
- Stock solution concentration, $C_1 = 1\, \text{M}$
- Desired solution concentration, $C_2 = 0.1\, \text{M}$
- Final volume of solution, $V_2 = 0.5\, \text{L}$

Step 1: Write the dilution equation

$$
C_1 V_1 = C_2 V_2
$$

Step 2: Rearrange to solve for V_1

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

Step 3: Plug in the known values

$$
V_1 = \frac{0.1\, \text{M} \times 0.5\, \text{L}}{1\, \text{M}} = \frac{0.05\, \text{mol}}{1\, \text{mol/L}} = 0.05\, \text{L}
$$

Step 4: Convert liters to milliliters

$$
0.05\, \text{L} = 50\, \text{mL}
$$

Answer: You need 50 milliliters of the 1 M NaCl stock solution to prepare 0.5 liters of a 0.1 M solution.

Practical Laboratory Steps

Preparing the solution accurately involves more than just the calculation. Here’s a detailed process:

Materials Needed:
- 1 M NaCl stock solution
- Volumetric flask (at least 0.5 L capacity)
- Pipette or graduated cylinder (for measuring volume)
- Distilled or deionized water
- Stirring rod or magnetic stirrer

Procedure:
1. Measure the stock solution: Use a pipette or graduated cylinder to measure 50 mL of the 1 M NaCl solution.
2. Transfer to a volumetric flask: Pour the measured stock solution into a 0.5 L volumetric flask.
3. Add solvent: Fill the flask with distilled water up to the 0.5 L mark. Add water gradually to avoid overshooting.
4. Mix thoroughly: Stopper the flask and invert or swirl gently to ensure uniform distribution of NaCl.

5. Label the solution: Clearly mark the flask with concentration, date, and any other relevant information.

Additional Considerations and Tips

Accuracy in Measurement
- Use calibrated pipettes and volumetric flasks for precision.
- Avoid parallax errors when reading volume markings.
- Ensure the stock solution is well-mixed prior to measurement.

Safety Precautions
- Handle NaCl and other chemicals with appropriate protective gear.
- Be cautious when working with glassware to prevent breakage.

Storage and Stability
- Store prepared solutions in labeled, airtight containers.
- Check the stability of the NaCl solution if stored for extended periods.

Common Mistakes to Avoid

- Using incorrect units: Always ensure your units are consistent, especially when converting between liters and milliliters.
- Misapplying the formula: Remember that the dilution formula assumes no volume change upon mixing, which holds true for dilute solutions like NaCl.
- Overlooking solution purity: Impurities can affect concentration; use high-quality reagents and pure water.

Final Thoughts

Understanding how to determine the volume of a stock solution needed for dilute preparations is a fundamental skill in chemistry. The straightforward calculation based on the dilution equation makes it easy to scale solutions accurately. In our example, calculating that 50 mL of 1 M NaCl is required to prepare 0.5 L of 0.1 M NaCl solution demonstrates how simple principles can be applied confidently in laboratory settings. Mastery of these calculations ensures precision in experiments, consistency in results, and confidence as you work with chemical solutions.

Whether you are preparing solutions for analytical work, titrations, or biological assays, this fundamental approach will serve as a reliable guide. Remember, attention to detail and adherence to proper measurement techniques are key to achieving accurate and reproducible results.

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