# A Chemist Must Dilute 41.6 ML Of 3.13 M Aqueous Sodium Thiosulfate (Na2S20,) Solution Until The Concentration

A Chemist Must Dilute 41.6 ML Of 3.13 M Aqueous Sodium Thiosulfate ($Na_2S_2O_3$) Solution Until The Concentration

In laboratory settings, precise dilution of solutions is fundamental to ensuring accurate experimental outcomes, especially when working with reagents like sodium thiosulfate ($Na_2S_2O_3$). When a chemist is tasked with diluting 41.6 mL of a 3.13 M aqueous sodium thiosulfate solution to a specific, lower concentration, it involves understanding the principles of molarity, volume, and the dilution equation. This process is crucial in applications such as titrations, photographic development, and analytical chemistry, where the concentration of sodium thiosulfate directly affects the reaction's accuracy and reliability. In this article, we will delve into the step-by-step methodology, theoretical foundations, and practical considerations involved in performing such a dilution, ensuring a comprehensive understanding of the process.

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## Understanding the Fundamentals of Solution Dilution

### What is Molarity and Why is It Important?

Molarity (M) is a measure of the concentration of a solute in a solution, expressed as moles of solute per liter of solution. It provides a standardized way to quantify the amount of substance in a given volume, which is essential for stoichiometric calculations in chemistry.

- Definition:
Molarity (M) = Moles of solute / Liters of solution

- Relevance in Dilution:
When diluting solutions, the number of moles of solute remains constant; only the volume changes.

## The Principle of Dilution

Dilution involves adding solvent (usually water) to a concentrated solution to achieve a desired lower concentration. The key concept is that the amount of solute before and after dilution remains the same, which is expressed mathematically by 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 allows calculation of unknown quantities when the other three are known.

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# Step-by-Step Dilution Calculation for Sodium Thiosulfate

## Given Data and Desired Outcomes

- Initial concentration ($C_1$): 3.13 M
- Initial volume ($V_1$): 41.6 mL
- Final concentration ($C_2$): To be determined based on experimental needs (for example, 0.50 M)
- Final volume ($V_2$): To be calculated

Note: For the purposes of this guide, we will assume the chemist aims to dilute the solution to a final concentration of 0.50 M. Adjust as necessary for specific experimental requirements.

## Calculating the Final Volume ($V_2$)

Using the dilution equation:

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

Substituting the known values:

$$V_2 = \frac{3.13\, \text{M} \times 41.6\, \text{mL}}{0.50\, \text{M}}$$

$$ V_2 = \frac{130.288\, \text{mol·mL}}{0.50\, \text{mol/L}} $$

Since molarity units are mol/L and volume is in mL, convert mL to L:

$$ V_1 = 41.6\, \text{mL} = 0.0416\, \text{L} $$

Similarly,

$$ V_2 = \frac{3.13\, \text{mol/L} \times 0.0416\, \text{L}}{0.50\, \text{mol/L}} $$

$$ V_2 = \frac{0.1303\, \text{mol}}{0.50\, \text{mol/L}} $$

$$ V_2 = 0.2606\, \text{L} $$

Converting back to milliliters:

$$ V_2 = 260.6\, \text{mL} $$

Therefore, to dilute 41.6 mL of 3.13 M sodium thiosulfate to 0.50 M, the total volume of the solution should be approximately 260.6 mL.

Volume of solvent to add:

$$ V_{water} = V_2 - V_1 = 260.6\, \text{mL} - 41.6\, \text{mL} = 219\, \text{mL} $$

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# Practical Procedure for Dilution

## Materials Needed

- Concentrated sodium thiosulfate solution (3.13 M)
- Volumetric flask or graduated cylinder (at least 260 mL capacity)
- Pipette or graduated cylinder for measuring 41.6 mL
- Distilled or deionized water
- Stirring rod or magnetic stirrer (optional)
- Personal protective equipment (gloves, goggles)

## Step-by-Step Process

1. Preparation and Safety Measures
- Wear appropriate PPE.
- Ensure all glassware is clean and dry.

2. Measuring the Initial Solution
- Use a pipette or graduated cylinder to measure 41.6 mL of the 3.13 M sodium thiosulfate solution.
- Transfer this carefully into the volumetric flask or mixing container.

3. Adding Water for Dilution
- Calculate the volume of water needed (219 mL in our example).
- Slowly add distilled water to the sodium thiosulfate solution, swirling gently to mix thoroughly.

4. Adjusting to Final Volume
- Transfer the mixture into a volumetric flask.
- Add water up to the 260 mL mark precisely.
- Mix thoroughly to ensure uniform concentration.

5. Labeling and Storage
- Clearly label the diluted solution with its final concentration and date.
- Store as recommended, typically in a cool, dark place to prevent degradation.

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# Verification of Final Concentration

## Analytical Confirmation

To ensure the accuracy of the dilution, chemists often verify the concentration through titration or spectrophotometric methods.

- Titration Method:
Use a standard iodine solution to titrate a known volume of the diluted solution, calculating the concentration based on the titration endpoint.

- Spectrophotometric Analysis:
Measure absorbance at a specific wavelength if applicable, and compare it to calibration curves.

## Calculating Error and Uncertainty

- Consider pipetting and measurement errors.
- Use calibrated equipment.
- Repeat measurements to ensure consistency.

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# Applications and Importance of Precise Dilution

## In Titration Experiments

Sodium thiosulfate is commonly used as a titrant in iodine titrations, where precise concentration is vital for accurate analysis of oxidizing agents like iodine.

## In Photography

Diluted sodium thiosulfate works as a fixer in photographic processing, removing unreacted silver halides.

## In Analytical Chemistry

Accurate dilutions are essential when preparing standard solutions for calibration curves in spectrophotometry and other quantitative analyses.

## In Industry

Manufacturing processes often require specific reagent concentrations to ensure product quality and safety.

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# Practical Tips for Successful Dilutions

- Always use calibrated volumetric glassware for measurement.
- Perform multiple dilutions if working with very high or very low concentrations to minimize errors.
- Mix solutions thoroughly after each step.
- Record all measurements meticulously for reproducibility.
- Understand the chemical properties of sodium thiosulfate, including its stability and potential hazards.

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## Conclusion

Diluting a concentrated sodium thiosulfate solution to a desired lower concentration involves a clear understanding of molarity, the dilution equation, and precise laboratory techniques. By carefully calculating the required volumes and following methodical procedures, a chemist can achieve an accurate and reliable solution tailored to specific experimental needs. Such meticulous attention to detail ensures the integrity of subsequent analytical procedures, whether in research, industrial applications, or quality control. Mastery of these dilution principles not only enhances experimental accuracy but also reinforces fundamental chemical concepts crucial across various scientific disciplines.

## Frequently Asked Questions

### How do you determine the amount of water needed to dilute 41.6 mL of 3.13 M sodium thiosulfate to a desired concentration?

To determine the required volume after dilution, use the dilution formula: $M1V1 = M2V2$. Rearranged, $V2 = (M1 \times V1) / M2$. By substituting the initial concentration and volume, and the target concentration, you can calculate the final volume and thus the amount of water to add.

### What is the step-by-step process to dilute 41.6 mL of 3.13 M sodium thiosulfate to a lower concentration?

First, decide the target concentration (M2). Then, use $V2 = (M1 \times V1) / M2$ to find the final volume. Subtract the initial volume (41.6 mL) from this to find the volume of water to add. Mix the sodium thiosulfate solution with the calculated amount of water to achieve the desired concentration.

### Why is it important to accurately dilute sodium thiosulfate solutions in laboratory experiments?

Accurate dilution ensures precise concentration levels, which are critical for reliable experimental results, especially in titrations and analytical procedures where sodium thiosulfate is used as a titrant or reagent.

### Can you explain the significance of molarity in preparing diluted solutions like sodium thiosulfate?

Molarity (M) indicates the number of moles of solute per liter of solution. Maintaining accurate molarity during dilution ensures the correct concentration for chemical reactions, measurements, and standardizations, which is essential for reproducibility and accuracy.

### What precautions should be taken when diluting concentrated sodium thiosulfate solutions?

Wear appropriate personal protective equipment (gloves, goggles), add water gradually to the concentrated solution to avoid splashing, mix thoroughly, and ensure the final solution is properly labeled. Also, perform the dilution in a well-ventilated area and handle chemicals with care.

## Additional Resources

A Chemist Must Dilute 41.6 ML Of 3.13 M Aqueous Sodium Thiosulfate ($Na_2S_2O_3$) Solution Until The Concentration

In the realm of chemical laboratory procedures, precise solution preparation is fundamental to achieving accurate and reproducible results. Among the myriad of compounds utilized across various industries—ranging from photography to analytical chemistry—sodium thiosulfate ($Na_2S_2O_3$) stands out for its versatility, especially in titrations and dechlorination processes. Recently, a chemist faced a common but critical task: to dilute 41.6 milliliters of a 3.13 molar aqueous sodium thiosulfate solution to a desired lower concentration. This seemingly straightforward operation encapsulates core principles of solution chemistry, requiring an understanding of molarity, dilution formulas, and meticulous calculations to ensure proper concentration adjustment.

This article delves into the scientific intricacies of this process, providing a comprehensive guide for chemists and students alike. We will explore the fundamental concepts behind molarity and dilution, elucidate step-by-step calculations, and discuss practical considerations to guarantee accuracy in laboratory settings.

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Understanding Molarity and Dilution: The Foundations of Solution Preparation

What Is Molarity?

Molarity (M) is a measure of the concentration of a solute in a solution, expressed as moles of solute per liter of solution. It provides a standardized way to quantify how much of a chemical compound is present in a given volume, enabling reproducibility across experiments.

Mathematically, molarity is defined as:

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

For example, a 3.13 M sodium thiosulfate solution contains 3.13 moles of $Na_2S_2O_3$ per liter.

### The Principle of Dilution

Dilution involves reducing the concentration of a solute by adding solvent—usually water—without altering 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)
- $V_1$ = initial volume
- $C_2$ = desired final concentration
- $V_2$ = final volume

This equation assumes no chemical reactions occur during the dilution process and that the solute's amount remains constant.

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## Step-by-Step Calculation: From Initial Solution to Desired Concentration

### Given Data

- Initial volume of sodium thiosulfate solution, $V_1$ = 41.6 mL
- Initial concentration, $C_1$ = 3.13 M
- Desired final concentration, $C_2$ = ? (to be determined based on experimental needs)

Since the problem statement indicates the necessity to "dilute until the concentration," but does not specify the target concentration, we will assume the chemist intends to achieve a specific lower concentration suitable for their application. For illustration, let's consider diluting to a final concentration of 0.5 M.

### Calculating Final Volume $V_2$

Using the dilution formula:

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

Substitute known values:

$$V_2 = \frac{3.13\, \text{M} \times 41.6\, \text{mL}}{0.5\, \text{M}}$$

$$V_2 = \frac{130.208}{0.5}$$

$$V_2 = 260.416\, \text{mL}$$

Thus, the total volume after dilution should be approximately 260.42 mL.

Determining the Volume of Water to Add

To achieve this, the chemist must add an appropriate amount of water:

$$\text{Water volume} = V_2 - V_1 = 260.42\, \text{mL} - 41.6\, \text{mL} = 218.82\, \text{mL}$$

Therefore, the process involves:

- Taking 41.6 mL of the 3.13 M sodium thiosulfate solution
- Transferring it to a volumetric container
- Adding approximately 218.82 mL of distilled or deionized water
- Mixing thoroughly to ensure homogeneity

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Practical Considerations in Laboratory Dilution

Ensuring Accuracy and Precision

- Use calibrated volumetric equipment such as graduated cylinders and volumetric flasks to measure volumes accurately.
- Mix solutions thoroughly after adding water to ensure uniform concentration.
- Avoid contamination by using clean glassware and proper handling techniques.

Safety Precautions

- Sodium thiosulfate, while generally safe, should be handled with gloves and eye protection.
- Always add acid or other reagents in a fume hood if required, and dispose of waste according to safety protocols.

Adjusting for Different Final Concentrations

Depending on the application, the target concentration may vary. To generalize, the formula can be rearranged:

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

or

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

By selecting a different $C_2$, the chemist can calculate the necessary total volume and water addition accordingly.

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Real-World Applications of Diluted Sodium Thiosulfate Solutions

Sodium thiosulfate solutions are pivotal in various fields:

- Analytical Chemistry: Used as a titrant in iodine titrations to determine oxidizing agents.
- Photographic Processing: Serves as a fixer to remove unreacted silver halides.
- Water Treatment: Acts as a dechlorinating agent, neutralizing residual chlorine.
- Medical Applications: Employed in cyanide antidote protocols.

In each case, precise solution concentration is critical to ensure safety, efficacy, and reproducibility.

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Troubleshooting Common Issues

Inaccurate Measurements

- Solution concentration not as expected may result from measurement errors or contamination.
- Solution evaporation can alter volume; always work in a controlled environment.

Incomplete Mixing

- Insufficient mixing leads to concentration gradients, affecting experimental outcomes.
- Use magnetic stirrers or vigorous manual shaking.

Equipment Calibration

- Regularly calibrate volumetric devices to maintain accuracy.

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Final Remarks: Importance of Accurate Dilution

The process of diluting a solution, though seemingly simple, underpins much of laboratory chemistry's precision. Proper understanding and application of molarity principles ensure that solutions meet exact specifications, vital for experimental reproducibility and safety.

In the case of sodium thiosulfate, a compound with widespread utility, meticulous calculation and execution of dilution steps can mean the difference between successful titrations and erroneous results. Whether for research, industrial processes, or medical treatments, mastering this fundamental skill remains essential for every chemist.

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In summary:
When a chemist is tasked with diluting 41.6 mL of a 3.13 M sodium thiosulfate solution to a specific lower concentration, they must employ the foundational formula \( C_1 V_1 = C_2 V_2 \). By selecting the target concentration, calculating the required final volume, and adjusting the water volume accordingly, they ensure the solution's integrity and suitability for subsequent use. This meticulous approach exemplifies the precision and rigor that define quality laboratory work, reinforcing the importance of fundamental chemical principles in practical applications.

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