Prepare 400 ML Of Approximately 0.1 M Sodium Hydroxide Solution By Diluting Commercial 50% Sodium Hydroxide.

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Creating a precise sodium hydroxide (NaOH) solution is a fundamental task in many laboratories, industrial processes, and educational settings. This guide provides a detailed, step-by-step approach to prepare 400 mL of approximately 0.1 M sodium hydroxide solution by diluting commercial 50% NaOH. Understanding the proper procedures, safety precautions, and calculations involved ensures accuracy and safety in your preparation process. Whether you're a student, researcher, or professional, this comprehensive tutorial will help you achieve reliable results.

Understanding the Basics of Sodium Hydroxide Solutions

What is Sodium Hydroxide?

Sodium hydroxide, commonly known as caustic soda or lye, is a highly alkaline chemical compound with the formula NaOH. It is widely used in chemical manufacturing, soap making, water treatment, and laboratory experiments.

Concentrations and Molarity

- Concentration refers to the amount of solute (NaOH) dissolved in a specific volume of solution.
- Molarity (M) indicates moles of solute per liter of solution.
- A 0.1 M NaOH solution contains 0.1 moles of NaOH per liter, or 0.1 mol/L.

Safety Precautions Before Handling NaOH

Handling sodium hydroxide requires strict safety measures due to its highly corrosive nature:

- Wear appropriate personal protective equipment (PPE): safety goggles, chemical-resistant gloves, lab coat, and face shield if necessary.
- Work in a well-ventilated area to avoid inhaling fumes.
- Add NaOH slowly to water: never add water to NaOH directly to prevent splashing and exothermic reactions.
- Have neutralizing agents and emergency wash stations available in case of spills or contact.

Required Materials and Equipment

- Commercial 50% sodium hydroxide solution
- Distilled or deionized water
- Volumetric flask (preferably 500 mL or 1 L)
- Graduated cylinder or pipette
- Stirring rod or magnetic stirrer
- Protective gear (gloves, goggles, lab coat)
- Digital or analytical balance (for weighing if needed)

Step-by-Step Procedure for Preparing 0.1 M NaOH Solution

1. Calculate the Required Volume of 50% NaOH Solution

First, determine how much of the 50% NaOH solution is needed to prepare your desired concentration:

- Density of 50% NaOH: approximately 1.53 g/mL
- NaOH concentration: 50% w/w means 50 g NaOH per 100 g solution
- Molecular weight of NaOH: approximately 40 g/mol

Calculations:

- Determine the moles of NaOH needed:

For 400 mL of 0.1 M NaOH:

$$
\text{moles NaOH} = 0.1 \text{ mol/L} \times 0.4 \text{ L} = 0.04 \text{ mol}
$$

- Calculate the grams of NaOH required:

$$
\text{grams NaOH} = 0.04 \text{ mol} \times 40 \text{ g/mol} = 1.6 \text{ g}
$$

- Determine volume of 50% NaOH solution containing 1.6 g NaOH:

- Each mL of 50% NaOH solution contains:

$$
\text{density} \times \text{percentage} = 1.53 \text{ g/mL} \times 0.50 = 0.765 \text{ g/mL}
$$

- Volume needed:

$$
\frac{1.6 \text{ g}}{0.765 \text{ g/mL}} \approx 2.09 \text{ mL}
$$

Therefore, approximately 2.1 mL of 50% NaOH solution is required.

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2. Carefully Measure the 50% NaOH Solution

- Use a clean, dry graduated cylinder or pipette to measure approximately 2.1 mL of the 50% NaOH solution.
- Always handle NaOH solution with caution, adding it slowly to water to control exothermic reactions.

3. Prepare the Dilution

- Fill a clean 500 mL volumetric flask with about 300 mL of distilled or deionized water.
- Slowly add the measured 2.1 mL of 50% NaOH solution into the water.
- Swirl gently or use a magnetic stirrer to ensure thorough mixing.
- Carefully add more distilled water up to the 400 mL mark on the flask.
- Mix thoroughly to ensure a uniform solution.

4. Final Checks and Storage

- Verify the volume accuracy at 400 mL.
- Label the container indicating the concentration and date of preparation.
- Store the solution in a properly labeled, airtight container, preferably in a cool, dry place.

Alternative Methods and Considerations

Using a Stock Solution and Serial Dilution

Instead of directly diluting the concentrated NaOH, you can prepare a stock solution (e.g., 1 M) and dilute from it, ensuring more precise control over concentration.

Adjustments for Different Volumes or Concentrations

The calculation method described can be scaled for larger or smaller volumes or different desired molarities.

Ensuring Accuracy and Precision

- Use calibrated measuring instruments.
- Perform calculations carefully.
- Always double-check your work to avoid errors.

Applications of Prepared 0.1 M NaOH Solution

This solution is versatile and can be used in:

- Titration experiments in analytical chemistry
- pH adjustments in chemical processes

- Cleaning and etching in industrial applications
- Laboratory standardizations and calibrations

Summary of Key Steps for Preparation

- Calculate the amount of 50% NaOH needed based on your target volume and concentration.
- Measure the NaOH solution accurately.
- Add NaOH gradually to water to prevent splashing.
- Mix thoroughly and fill to the desired volume.
- Label and store properly.

Conclusion

Preparing a 0.1 M sodium hydroxide solution from commercial 50% NaOH is a straightforward process that requires precise calculations and careful handling. By following the detailed steps outlined above, you can produce an accurate and safe solution suitable for various laboratory and industrial applications. Always prioritize safety, accuracy, and proper storage to ensure the integrity and longevity of your prepared solution.

Keywords: sodium hydroxide, NaOH solution, dilute NaOH, prepare 0.1 M NaOH, laboratory chemicals, chemical safety, solution preparation, titration, industrial chemicals

Frequently Asked Questions

What is the step-by-step process to prepare 400 mL of approximately 0.1 M sodium hydroxide solution from commercial 50% NaOH?

First, calculate the required volume of 50% NaOH stock solution using molarity and dilution formula. Then, carefully measure this volume, dilute it with distilled water to reach a total volume of 400 mL, and mix thoroughly to ensure uniform concentration.

How do I calculate the volume of 50% NaOH needed to prepare 400 mL of 0.1 M NaOH solution?

Use the dilution formula: C1V1 = C2V2. With C1 = 50% NaOH (~ 15.9 M), C2 = 0.1 M, and V2 = 400 mL, solve for V1: V1 = (C2 × V2) / C1, which equals approximately 2.52 mL.

Why is it important to add the NaOH solution to water slowly during dilution?

Adding NaOH solution slowly prevents exothermic reactions that can cause splashing and boiling, ensuring safety and accurate measurement.

What safety precautions should I take when preparing sodium hydroxide solutions?

Wear appropriate PPE including gloves, goggles, and lab coat. Work in a well-ventilated area, add NaOH to water slowly, and handle with care to avoid burns or splashes.

Can I use tap water to dilute the NaOH solution? Why or why not?

It is recommended to use distilled or deionized water to avoid introducing impurities that could affect the concentration and purity of the solution.

How do I verify the concentration of my prepared sodium hydroxide solution?

You can perform a titration using a standard acid solution, such as hydrochloric acid, with an appropriate indicator to determine the exact molarity of your NaOH solution.

What are the common errors to avoid when preparing dilute NaOH solutions?

Errors include using impure water, incorrect calculations, adding NaOH too quickly, not mixing thoroughly, or not measuring volumes accurately.

How long can I store the prepared 0.1 M NaOH solution, and how should I store it?

Store the solution in a labeled, airtight container made of resistant material (like glass or certain plastics) at room temperature. It can be stored for several weeks if properly sealed and protected from contamination.

What is the significance of preparing a 0.1 M NaOH solution in laboratory applications?

A 0.1 M NaOH solution is commonly used for titrations, pH adjustments, and chemical analysis, providing a standardized and consistent reagent for precise experiments.

Additional Resources

Prepare 400 ML Of Approximately 0.1 M Sodium Hydroxide Solution By Diluting Commercial 50% Sodium Hydroxide

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Introduction

Sodium hydroxide (NaOH), commonly known as caustic soda, is a highly versatile chemical used extensively across industries, laboratories, and educational settings. Its strong alkaline properties make it essential for pH adjustment, soap manufacturing, chemical synthesis, and cleaning applications. Precise preparation of sodium hydroxide solutions is critical, especially in laboratory environments where accuracy influences experimental outcomes.

This article provides a comprehensive, investigative overview of how to prepare approximately 400 mL of a 0.1 M sodium hydroxide solution by diluting commercially available 50% NaOH. It delves into the chemical principles, calculation methods, safety precautions, and practical considerations involved in the process,

ensuring clarity and reproducibility for practitioners and students alike.

Understanding the Starting Material: Commercial 50% Sodium Hydroxide

Commercial sodium hydroxide solutions are typically concentrated and highly corrosive. A 50% NaOH solution means that 50 grams of NaOH are dissolved in 100 mL of solution, which translates to a very high molarity and concentration.

Key Characteristics of 50% NaOH:

- Density: Approximately 1.52 g/mL at room temperature.
- Mass of NaOH per mL: 0.76 g/mL (since 50 g/100 mL).
- Molar mass of NaOH: 40.00 g/mol.

Calculating the molarity of the stock solution:

$$
\text{Molarity} = \frac{\text{Mass of NaOH in grams per liter}}{\text{Molar mass of NaOH}}
$$

Given that:

$$
\text{Mass per mL} = 0.76\,g
$$

so per liter (1000 mL):

$$
0.76\,g/mL \times 1000\,mL = 760\,g
$$

Therefore:

$$
\text{Molarity} = \frac{760\,g}{40.00\,g/mol} = 19.0\,\text{mol/L}
$$

This confirms that commercial 50% NaOH solution has an approximate molarity of 19 M.

Calculating the Required Volume of 50% NaOH to Achieve 0.1 M Solution

The goal is to prepare 400 mL of approximately 0.1 M NaOH solution.

Step 1: Use dilution principles based on molarity:

$$
C_1 V_1 = C_2 V_2
$$

Where:
- C_1 = initial concentration (19 M)
- V_1 = volume of stock solution needed
- C_2 = desired concentration (0.1 M)
- V_2 = final volume (400 mL)

Rearranged:

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

Substitute known values:

$$
V_1 = \frac{0.1\,\text{M} \times 400\,\text{mL}}{19\,\text{M}} \approx \frac{40}{19} \approx 2.11\,\text{mL}
$$

Result: Approximately 2.11 mL of 50% NaOH stock solution is needed.

Practical Considerations and Safety Protocols

Handling concentrated sodium hydroxide requires strict safety precautions due to its corrosive nature:

- Personal Protective Equipment (PPE): Wear chemical-resistant gloves, safety goggles, and lab coat.
- Ventilation: Conduct preparations in a fume hood or well-ventilated area.
- Handling: Always add NaOH to water, never the reverse, to prevent exothermic splattering.
- Storage: Store in corrosion-resistant containers, clearly labeled, and away from incompatible materials.

Step-by-Step Preparation Procedure

Materials Needed:

- Commercial 50% sodium hydroxide solution
- Distilled or deionized water
- Volumetric flask or a graduated cylinder (minimum 500 mL capacity)
- Pipette or graduated syringe (for precise volume measurement)
- Stirring rod or magnetic stirrer
- Protective equipment

Procedure:

1. Measure the Stock Solution:
- Using a pipette or graduated syringe, carefully measure approximately 2.11 mL of 50% NaOH. For better accuracy, consider diluting a slightly larger volume and then measuring.

2. Prepare the Dilution Container:
- Take a clean, dry 500 mL volumetric flask or beaker.

3. Add Water:
- Add approximately 200 mL of distilled water to the container.

4. Add NaOH:
- Slowly transfer the measured 2.11 mL of NaOH into the water while stirring gently.
- Because of the exothermic nature of dissolving NaOH, add the NaOH gradually and allow the solution to cool if necessary.

5. Dilute to Final Volume:
- Once the NaOH is fully mixed and the temperature stabilizes, add more distilled water up to the 400 mL mark.
- Use a volumetric flask for precise measurement, or carefully add water until the combined volume reaches

exactly 400 mL.

6. Mix Thoroughly:
- Ensure the solution is homogenous by stirring or swirling gently.

7. Label and Store:
- Clearly label the container with the concentration, date, and preparer's initials.
- Store in a corrosion-resistant container away from incompatible substances.

Verifying the Concentration

While theoretical calculations are accurate, practical verification through titration or pH measurement is advisable for critical applications. Using a standardized acid solution (e.g., hydrochloric acid), titrate a small sample to confirm molarity.

Troubleshooting and Variations

- Adjusting for Slight Deviations: If the initial concentration of the stock solution differs slightly from 19 M due to manufacturer variations, recalculate the required volume accordingly.
- Scaling Up or Down: The methodology can be adjusted for other volumes or concentrations by maintaining the molarity relationship.
- Handling Impurities: Commercial NaOH solutions may contain impurities; for sensitive applications, filtration or purification steps may be necessary.

Environmental and Disposal Considerations

- Disposal: Neutralize excess NaOH with dilute acid before disposal, following local regulations.
- Environmental Impact: Avoid releasing concentrated NaOH into the environment; dilute thoroughly and neutralize.

Conclusion

Preparing a 0.1 M sodium hydroxide solution from commercial 50% NaOH is a straightforward process grounded in fundamental principles of solution dilution. Precise calculation, meticulous handling, and safety awareness are essential for success. This investigation underscores the importance of understanding both chemical properties and safety protocols to ensure accurate, safe, and effective solution preparation.

By following the detailed steps outlined, laboratory personnel, educators, and students can confidently produce consistent NaOH solutions tailored for their specific needs, ensuring the integrity of their experiments and safety in their practices.

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