What Mass Of Sodium Hydroxide (naoh, Molar Mass = 40.0 Gmol1) Is Needed To Make 100.0 Ml Of A 0.125 M

What Mass Of Sodium Hydroxide (NaOH, Molar Mass = 40.0 g/mol) Is Needed To Make 100.0 mL Of A 0.125 M Solution?

When preparing solutions in a laboratory setting or for industrial applications, accurately calculating the amount of solute needed is crucial for achieving desired concentration levels. In this article, we will explore how to determine the mass of sodium hydroxide (NaOH) required to prepare exactly 100.0 mL of a 0.125 M NaOH solution. Understanding this calculation involves a clear grasp of molarity, molar mass, and the conversion between volume and mass. Whether you're a student, a chemist, or someone involved in chemical manufacturing, this guide will provide detailed steps and explanations to help you accurately prepare your NaOH solution.

Understanding the Fundamentals: Molarity and Molar Mass

Before diving into the calculation, it is essential to understand the key concepts involved: molarity and molar mass.

What is Molarity?

- Molarity (M) is a measure of concentration, defined as the number of moles of solute per liter of solution.
- Formula:
$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

What is Molar Mass?

- Molar mass is the mass of one mole of a substance, expressed in grams per mole (g/mol).
- For sodium hydroxide (NaOH), the molar mass is given as 40.0 g/mol.

Step-by-Step Calculation: Determining the

Required Mass of NaOH

To find out how much NaOH is needed, follow these steps:

1. Write down the known values:

- Volume of solution, $V = 100.0 \, \text{mL}$
- Molarity, $M = 0.125 \, \text{mol/L}$
- Molar mass of NaOH, $M_{NaOH} = 40.0 \, \text{g/mol}$

2. Convert volume from milliliters to liters:

- Since molarity is expressed per liter, convert 100.0 mL to liters:

$$V = 100.0 \, \text{mL} \times \frac{1 \, \text{L}}{1000 \, \text{mL}} = 0.1000 \, \text{L}$$

3. Calculate the number of moles of NaOH needed:

- Using the molarity formula:

$$\text{moles of NaOH} = M \times V = 0.125 \, \text{mol/L} \times 0.1000 \, \text{L} = 0.0125 \, \text{mol}$$

4. Determine the mass of NaOH required:

- Multiply the number of moles by the molar mass:

$$\text{Mass} = \text{moles} \times M_{NaOH} = 0.0125 \, \text{mol} \times 40.0 \, \text{g/mol} = 0.500 \, \text{g}$$

Therefore, to prepare 100.0 mL of a 0.125 M NaOH solution, you need approximately 0.500 grams of sodium hydroxide.

Important Considerations for Accurate Solution Preparation

While the calculation above provides a straightforward method, several practical considerations can influence the accuracy of your prepared solution.

Purity of Sodium Hydroxide

- Laboratory-grade NaOH typically has a purity of 99% or higher.
- Adjust the required mass accordingly if the NaOH isn't 100% pure.

Measuring the NaOH

- Use a precise analytical balance to measure out the required mass.
- Ensure the balance is calibrated properly to avoid measurement errors.

Dissolution of NaOH

- Add the measured NaOH slowly to a container with a portion of distilled water.
- Stir until fully dissolved before adjusting to the final volume.

Final Volume Adjustment

- After dissolving the NaOH, transfer the solution to a volumetric flask.
- Add distilled water up to the 100.0 mL mark for precise concentration.

Applications of NaOH Solutions and Their Significance

NaOH solutions are vital in various chemical processes and industries. Understanding how to prepare them accurately ensures safety, effectiveness, and consistency.

Common Uses of NaOH Solutions:

- Chemical manufacturing: pH adjustment, saponification, and neutralization processes.
- Laboratory analysis: Titration and pH calibration.
- Cleaning: Industrial and household drain cleaning.
- Food industry: Processing and pH control in food products.

Importance of Accurate Concentration:

- Precise concentration ensures reproducibility in experiments.
- Safety considerations: NaOH is caustic; incorrect concentrations can cause hazards.
- Regulatory compliance in industrial applications.

Additional Tips for Preparing NaOH Solutions

- Always add NaOH to water, not water to NaOH, to prevent exothermic splashes.
- Use appropriate personal protective equipment (PPE): gloves, goggles, lab coat.
- Store NaOH solutions in corrosion-resistant containers.
- Label prepared solutions clearly with concentration and date.

Summary of Key Points

- To prepare 100.0 mL of 0.125 M NaOH, you need approximately 0.500 grams of sodium hydroxide.
- The calculation involves converting volume to liters, multiplying by molarity to find moles, then multiplying by molar mass to find mass.
- Practical preparation involves careful measurement, thorough dissolution, and proper volume adjustment.
- Accurate solution preparation is essential for safety, consistency, and effectiveness in chemical applications.

Conclusion

Preparing a precise sodium hydroxide solution is fundamental in many chemical processes. By understanding the relationship between molarity, volume, molar mass, and mass, you can accurately determine the amount of NaOH needed for your specific concentration and volume requirements. The key takeaway is that approximately 0.500 grams of NaOH are required to make 100.0 mL of a 0.125 M solution. Always ensure proper safety procedures and precise measurement techniques to achieve optimal results. Whether for laboratory experiments, industrial processes, or educational demonstrations, mastering this calculation will enhance your proficiency in chemical solution preparation.

Remember: Accurate chemical preparation is crucial for safety, reproducibility, and the success of your experiments or industrial processes.

Frequently Asked Questions

What is the molar mass of sodium hydroxide (NaOH)?

The molar mass of sodium hydroxide (NaOH) is 40.0 g/mol.

How do you calculate the mass of NaOH needed to prepare 100.0 mL of a 0.125 M solution?

First, convert volume to liters (0.100 L), then multiply by molarity (0.125 mol/L) to find moles, and finally multiply by molar mass (40.0 g/mol) to get the mass: 0.100 L × 0.125 mol/L × 40.0 g/mol = 0.50 g.

What volume of 0.125 M NaOH solution can be prepared from 0.50 g of NaOH?

Using the molar mass, 0.50 g corresponds to 0.0125 mol (0.50 g ÷ 40.0 g/mol). To prepare a 0.125 M solution, the volume needed is 0.0125 mol ÷ 0.125 mol/L = 0.1 L or 100 mL.

Why is it important to know the molar mass of NaOH in solution preparation?

Knowing the molar mass allows accurate conversion between mass and moles, ensuring precise preparation of solutions at desired molar concentrations.

If you only have 0.25 g of NaOH, what volume of 0.125 M solution can you make?

First, calculate moles: 0.25 g ÷ 40.0 g/mol = 0.00625 mol. Then, volume = 0.00625 mol ÷ 0.125 mol/L = 0.05 L or 50 mL.

What is the significance of molarity in solution preparation?

Molarity indicates the number of moles of solute per liter of solution, allowing for precise and consistent solution concentrations in laboratory procedures.

Can you prepare the 0.125 M NaOH solution by diluting a more concentrated NaOH solution?

Yes, using the dilution formula (C1V1 = C2V2), you can dilute a concentrated NaOH solution to achieve the desired 0.125 M concentration.

What safety precautions should be taken when handling NaOH for solution preparation?

NaOH is caustic; wear gloves, goggles, and protective clothing, and handle it in a well-ventilated area to prevent chemical burns and inhalation of fumes.

How does the molarity of NaOH affect titration

experiments?

The molarity determines the amount of NaOH needed to neutralize acids in titrations, affecting the accuracy of concentration calculations for unknown solutions.

What are common applications of sodium hydroxide solutions in industry?

NaOH solutions are used in soap making, paper production, water treatment, chemical manufacturing, and pH regulation.

Additional Resources

What Mass Of Sodium Hydroxide (NaOH, Molar Mass = 40.0 g/mol) Is Needed To Make 100.0 mL Of A 0.125 M Solution?

The preparation of solutions with precise molarity is fundamental in chemistry, whether for laboratory experiments, industrial processes, or educational demonstrations. Sodium hydroxide (NaOH), a strong base widely used across various sectors, is frequently prepared as an aqueous solution of known molarity. Determining the exact mass of NaOH required to prepare a specific volume and concentration of solution involves understanding basic principles of molarity, molar mass, and solution preparation techniques. In this comprehensive review, we delve into the detailed calculations, practical considerations, and scientific principles underlying this seemingly straightforward question.

Understanding the Fundamentals: Molarity and Molar Mass

Before embarking on the calculation, it is essential to clarify two key concepts:

Molarity (M)

Molarity is defined as the number of moles of solute (NaOH in this case) dissolved in one liter of solution. Mathematically:

$$\text{Molarity} (M) = \frac{\text{Moles of solute}}{\text{Volume of solution in liters}}$$

A 0.125 M NaOH solution contains 0.125 moles of NaOH per liter.

Molar Mass of NaOH

The molar mass of sodium hydroxide (NaOH) is approximately 40.0 g/mol, calculated from

atomic masses:

- Sodium (Na): 22.99 g/mol
- Oxygen (O): 16.00 g/mol
- Hydrogen (H): 1.008 g/mol

Total: 22.99 + 16.00 + 1.008 ≈ 40.0 g/mol

This value allows conversion between moles and grams, which is crucial for preparing solutions.

Step-by-Step Calculation of the Required NaOH Mass

The problem involves preparing 100.0 mL (0.100 L) of a 0.125 M NaOH solution. The primary goal is to determine the mass of NaOH powder needed.

1. Convert Volume to Liters

Since molarity is expressed per liter, first convert the given volume:

$$ 100.0\, \text{mL} = 0.100\, \text{L} $$

2. Calculate the Moles of NaOH Needed

Using the molarity formula:

$$ \text{Moles of NaOH} = \text{Molarity} \times \text{Volume in liters} $$

$$ \text{Moles of NaOH} = 0.125\, \text{mol/L} \times 0.100\, \text{L} = 0.0125\, \text{mol} $$

3. Convert Moles to Grams

Using the molar mass:

$$ \text{Mass of NaOH} = \text{Moles} \times \text{Molar mass} $$

$$ \text{Mass of NaOH} = 0.0125\, \text{mol} \times 40.0\, \text{g/mol} = 0.50\, \text{g} $$

Therefore, 0.50 grams of NaOH are required.

Practical Considerations in Solution Preparation

While the calculation provides a theoretical value, practical laboratory procedures necessitate careful attention to detail to ensure accuracy and safety.

Handling and Safety

NaOH is a caustic substance capable of causing severe chemical burns. Proper personal protective equipment (PPE), including gloves, goggles, and lab coats, is mandatory. Work in a well-ventilated area or fume hood.

Measuring the NaOH

- Use an analytical balance capable of measuring to at least 0.001 g for precision.
- Tare the container, then carefully weigh out approximately 0.50 g.
- Because NaOH is hygroscopic (absorbs moisture) and deliquescent (absorbs water from the air), it should be stored in tightly sealed containers and weighed promptly.

Preparation of the Solution

- Add distilled or deionized water to a clean, dry container.
- Slowly add the NaOH powder to the water, stirring continuously to prevent localized heating and splattering.
- Aim for a total volume of 100.0 mL once the NaOH is fully dissolved.
- Use a volumetric flask for precise volume measurement, ensuring proper mixing and accuracy.

Ensuring Accuracy and Precision

Achieving the desired molarity requires meticulous techniques:

- Use calibrated volumetric equipment such as volumetric flasks and pipettes.
- Perform multiple measurements if high precision is required.
- Consider temperature effects: solution volume can expand or contract with temperature fluctuations, affecting molarity.

Extended Topics: Variations and Real-World Applications

While the core calculation is straightforward, several real-world factors can influence the process.

Impurities and Water Content

- Commercial NaOH often contains impurities or moisture, which can alter the actual amount needed.
- If using technical-grade NaOH, consulting product specifications or performing a titration may be necessary for accurate preparation.

Scaling Up or Down

- For larger volumes (e.g., industrial scales), the calculation scales directly, but safety and handling become more complex.
- For smaller volumes, measurement accuracy becomes more critical, emphasizing the importance of precise weighing and volumetric techniques.

Alternative Preparation Methods

- NaOH solutions can also be prepared by dissolving pellets directly, but the same mass calculation applies.
- When preparing multiple solutions of different concentrations, batch calculations streamline the process.

Summary and Key Takeaways

- To prepare 100.0 mL of a 0.125 M NaOH solution, approximately 0.50 grams of NaOH powder are needed.
- The fundamental calculation hinges on understanding molarity, molar mass, and solution volume.
- Practical laboratory techniques, safety precautions, and quality control measures are essential to achieve accurate and safe results.
- Variations in purity, temperature, and measurement precision can influence the final concentration, highlighting the importance of meticulous laboratory practices.

Conclusion

The precise determination of the mass of sodium hydroxide required to prepare a specific solution exemplifies core principles of analytical chemistry. It underscores the importance of accurate measurements, safety considerations, and understanding fundamental concepts like molarity and molar mass. As NaOH continues to play a vital role across scientific, industrial, and educational fields, the ability to prepare solutions with precision remains a foundational skill for chemists and laboratory technicians alike. Whether for titrations, pH adjustments, or chemical syntheses, knowing exactly how much NaOH to use ensures reliability, safety, and reproducibility in all chemical endeavors.

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