Find The Molarity Of A Solution With 952 Grams Of Ammonium Carbonate Are Dissolved To Make 1750 Ml Of

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Understanding how to determine the molarity of a solution is a fundamental skill in chemistry, especially when preparing solutions for laboratory experiments or industrial processes. In this guide, we will explore the step-by-step process to calculate the molarity of a solution made by dissolving 952 grams of ammonium carbonate in 1750 milliliters of solvent. This comprehensive explanation will cover the necessary concepts, calculations, and relevant tips to ensure clarity and accuracy.

What Is Molarity and Why Is It Important?

Before diving into the calculation process, it's essential to understand what molarity entails and its significance in chemistry.

Definition of Molarity

- Molarity (M) is a measure of concentration expressing the number of moles of solute dissolved in one liter of solution.
- It is represented mathematically as:
\[\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{liters of solution}} \]

Importance of Molarity

- Allows precise communication of solution strength.
- Essential for stoichiometric calculations in chemical reactions.
- Helps in preparing solutions with desired concentrations for experiments.

Understanding the Components of the Calculation

To find the molarity of the solution, the key steps involve:

1. Calculating the molar mass of ammonium carbonate $(NH_4)_2CO_3$.
2. Determining the number of moles of ammonium carbonate dissolved.
3. Converting the volume of the solution from milliliters to liters.

4. Applying the molarity formula to obtain the concentration.

Step 1: Calculating the Molar Mass of Ammonium Carbonate

The first step is to determine the molar mass of ammonium carbonate $(NH_4)_2CO_3$, which requires adding the atomic masses of all elements involved.

Atomic Masses of Elements

- Nitrogen (N): approximately 14.01 g/mol
- Hydrogen (H): approximately 1.008 g/mol
- Carbon (C): approximately 12.01 g/mol
- Oxygen (O): approximately 16.00 g/mol

Molar Mass Calculation

- For $(NH_4)_2$:
- Nitrogen: 2 × 14.01 g/mol = 28.02 g/mol
- Hydrogen: 8 × 1.008 g/mol = 8.064 g/mol
- Total for ammonium groups: 28.02 + 8.064 = 36.084 g/mol

- For CO_3:
- Carbon: 12.01 g/mol
- Oxygen: 3 × 16.00 g/mol = 48.00 g/mol
- Total for carbonate: 12.01 + 48.00 = 60.01 g/mol

- Total molar mass of ammonium carbonate:
36.084 + 60.01 = 96.094 g/mol

Note: Slight variations in atomic weights may occur depending on the source, but 96.09 g/mol is a standard approximation.

Step 2: Calculating Moles of Ammonium Carbonate

Using the mass provided, determine how many moles of ammonium carbonate are present in 952 grams:

$$
\text{Number of moles} = \frac{\text{mass of solute}}{\text{molar mass of solute}}
$$

$$
\text{Number of moles} = \frac{952\, \text{g}}{96.09\, \text{g/mol}} \approx 9.9\, \text{moles}
$$

Calculation:
- 952 ÷ 96.09 ≈ 9.898 moles
- Rounded to two decimal places: 9.90 moles

Step 3: Converting Volume from Milliliters to Liters

Molarity is expressed in moles per liter, so the volume of the solution must be converted from milliliters to liters:

$$
\text{Volume in liters} = \frac{\text{Volume in milliliters}}{1000}
$$

$$
\text{Volume} = \frac{1750\, \text{mL}}{1000} = 1.75\, \text{L}
$$

Step 4: Calculating the Molarity of the Solution

Applying the molarity formula:

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

$$
\text{Molarity} = \frac{9.90\, \text{moles}}{1.75\, \text{L}} \approx 5.66\, \text{M}
$$

Final Answer:
The molarity of the ammonium carbonate solution is approximately 5.66 molarity (M).

Additional Considerations and Tips

When performing such calculations, keep in mind some important factors for accuracy and proper practice:

Purity of the Solute

- Ensure that the ammonium carbonate used is of high purity.
- Adjust calculations if the compound contains impurities or is not pure.

Significant Figures

- Maintain appropriate significant figures based on the precision of measurements.
- In this case, the final molarity is rounded to three significant figures: 5.66 M.

Measurement Precision

- Use precise scales for weighing the solute.
- Use accurate volumetric equipment for measuring the solution volume.

Solution Preparation Tips

- Dissolve the ammonium carbonate fully in a smaller volume first, then dilute to the final volume.
- Mix thoroughly to ensure uniform concentration.

Real-World Applications of Molarity Calculations

Understanding and calculating molarity is vital in various fields, including:

- Pharmaceutical formulations where precise concentrations are necessary for efficacy and safety.
- Industrial manufacturing of chemicals with specific concentration requirements.
- Academic research involving titrations and other quantitative analyses.
- Environmental testing, such as measuring pollutant concentrations.

Summary of the Calculation Process

To summarize, calculating the molarity of a solution made from 952 grams of ammonium carbonate dissolved in 1750 mL involves:

1. Finding the molar mass of ammonium carbonate (~96.09 g/mol).

2. Calculating the number of moles: 952 g ÷ 96.09 g/mol ≈ 9.90 moles.
3. Converting volume to liters: 1750 mL = 1.75 L.
4. Applying the molarity formula: 9.90 mol ÷ 1.75 L ≈ 5.66 M.

This process exemplifies how foundational chemistry concepts combine with precise measurements to determine solution concentrations accurately.

Conclusion

Determining the molarity of a solution is an essential skill in chemistry that enables accurate preparation and understanding of chemical reactions. By carefully calculating the molar mass of ammonium carbonate, converting measurements properly, and applying the molarity formula, you can confidently find that dissolving 952 grams of ammonium carbonate into 1750 mL of solution yields a concentration of approximately 5.66 molar. Mastery of these calculations enhances your laboratory precision and deepens your understanding of solution chemistry.

Frequently Asked Questions

How do you calculate the molarity of a solution when given the mass of ammonium carbonate and the volume of solution?

To find the molarity, first convert the mass of ammonium carbonate to moles using its molar mass, then divide the number of moles by the volume of solution in liters.

What is the molar mass of ammonium carbonate (NH4)2CO3?

The molar mass of ammonium carbonate is approximately 96.09 g/mol.

Given 952 grams of ammonium carbonate dissolved in 1750 mL of solution, what is the molarity of the solution?

First, convert grams to moles: 952 g ÷ 96.09 g/mol ≈ 9.91 mol. Convert volume to liters: 1750 mL = 1.75 L. Then, molarity = 9.91 mol ÷ 1.75 L ≈ 5.66 M.

Why is it important to convert volume from milliliters to liters when calculating molarity?

Because molarity is defined as moles of solute per liter of solution, so the volume must be in liters to ensure the units are correct.

What are common mistakes to avoid when calculating molarity in this type of problem?

Common mistakes include using incorrect molar mass, forgetting to convert volume to liters, or mixing units during calculation.

How does the purity of ammonium carbonate affect the molarity calculation?

If the ammonium carbonate isn't pure, the actual molar amount is less than expected, so the measured molarity would be lower unless purity is taken into account.

Can you use this method to calculate molarity for other compounds given their mass and volume? How?

Yes, by converting the mass to moles using the compound's molar mass and dividing by the solution volume in liters, you can calculate molarity for any solute.

What is the significance of knowing the molarity of a solution in chemistry?

Molarity helps chemists understand the concentration of solutions, which is essential for reactions, titrations, and preparing solutions accurately.

If the solution volume was increased to 2000 mL while keeping the same mass of ammonium carbonate, how would the molarity change?

Increasing the volume decreases the molarity. For 2000 mL (2.00 L), molarity = 9.91 mol ÷ 2.00 L ≈ 4.96 M.

What tools or equipment are typically used to prepare a solution of a known molarity like this?

Graduated cylinders, analytical balances, volumetric flasks, and pipettes are used to accurately measure and prepare solutions with specific molarity.

Additional Resources

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In the realm of chemistry, understanding the concentration of a solution is fundamental to numerous applications—from industrial manufacturing to laboratory experiments. One common measure of concentration is molarity, which indicates how many moles of solute are present in one liter of solution. Today, we delve into a practical example: determining the molarity of a solution prepared by dissolving 952 grams of ammonium carbonate into a specific volume of solvent, specifically 1750 milliliters. This process involves several key steps, including calculating the molar mass of ammonium carbonate, converting the given mass into moles, and then determining the molarity based on the total volume of the solution.

In this article, we will walk through each step comprehensively, providing clarity on the concepts and calculations necessary to arrive at the final molarity. Whether you're a student, educator, or professional chemist, understanding this process enhances your ability to prepare and analyze solutions accurately.

Understanding the Components: Ammonium Carbonate and Its Significance

What is Ammonium Carbonate?

Ammonium carbonate (chemical formula: $(NH_4)_2CO_3$) is a salt commonly used in baking, smelling salts, and as a laboratory reagent. It is a white, crystalline, odorless compound that readily dissolves in water, producing an alkaline solution. Its unique properties make it useful in various industrial and scientific contexts.

Why Calculate Molarity?

Molarity (M) is a measure of concentration that indicates the number of moles of solute per liter of solution. It is essential because:
- It allows for precise formulation of solutions.
- It ensures consistency in chemical reactions.
- It helps in stoichiometric calculations, such as titrations.

Step 1: Determining the Molar Mass of Ammonium Carbonate

Before calculating the number of moles, we need to find the molar mass of ammonium carbonate. This involves summing the atomic masses of all atoms in its chemical formula:

- Nitrogen (N): approximately 14.01 g/mol
- Hydrogen (H): approximately 1.008 g/mol
- Carbon (C): approximately 12.01 g/mol
- Oxygen (O): approximately 16.00 g/mol

The chemical formula $(NH_4)_2CO_3$ indicates:
- 2 ammonium ions (NH_4)
- 1 carbonate ion (CO_3)

Calculations:

- Mass of 2 ammonium ions:
- Nitrogen: 2 × 14.01 g/mol = 28.02 g/mol
- Hydrogen: 2 × 4 × 1.008 g/mol = 8.064 g/mol
- Total for 2 ammonium ions: 28.02 + 8.064 = 36.084 g/mol

- Mass of 1 carbonate ion:
- Carbon: 12.01 g/mol
- Oxygen: 3 × 16.00 g/mol = 48.00 g/mol
- Total for carbonate: 12.01 + 48.00 = 60.01 g/mol

- Total molar mass of ammonium carbonate:
36.084 + 60.01 = 96.094 g/mol

This value is essential for converting the given mass into moles.

Step 2: Converting Mass to Moles

Given:
- Mass of ammonium carbonate = 952 grams

Using the molar mass:

$$
\text{Number of moles} = \frac{\text{Mass}}{\text{Molar mass}}
$$

$$
\text{Number of moles} = \frac{952 \text{ g}}{96.094 \text{ g/mol}} \approx 9.902 \text{ mol}
$$

This indicates that dissolving 952 grams of ammonium carbonate provides approximately 9.902 moles of the compound.

Step 3: Converting Volume to Liters

The molarity formula requires the volume of the solution in liters:
- Volume = 1750 mL

Since 1 liter = 1000 mL:

$$
\text{Volume in liters} = \frac{1750 \text{ mL}}{1000} = 1.75 \text{ L}
$$

This is the total volume of the solution after dissolving the ammonium carbonate.

Step 4: Calculating Molarity

Now, with the number of moles and the volume in liters, we can compute the molarity:

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

$$
M = \frac{9.902 \text{ mol}}{1.75 \text{ L}} \approx 5.657 \text{ M}
$$

Therefore, the molarity of the solution is approximately 5.66 molar (M) when rounded to two decimal places.

Implications and Practical Applications

The calculated molarity provides valuable insight into the concentration of ammonium carbonate in the solution, which can be applied in various contexts:

- Industrial Processes: Ensuring the correct molarity for manufacturing processes involving ammonium carbonate.
- Laboratory Experiments: Accurate preparation of solutions for titrations, reactions, or calibration standards.
- Educational Purposes: Demonstrating the practical application of molar calculations in real-world scenarios.

Moreover, understanding how to perform such calculations enhances the precision and reproducibility of chemical experiments and formulations.

Additional Considerations

While the above calculations assume ideal conditions, real-world scenarios may involve factors such as:

- Solvent purity: Impurities in water can slightly alter the molarity.
- Dissolution completeness: Ensuring all ammonium carbonate dissolves completely.
- Temperature effects: Changes in temperature can affect volume and solute solubility.

For most practical purposes, these factors are minimal but worth considering in high-precision applications.

Conclusion

Determining the molarity of a solution involves a straightforward yet meticulous process of calculating molar mass, converting mass to moles, and relating this to the total volume of the solution. In the case of dissolving 952 grams of ammonium carbonate into 1750 mL of solution, the molarity approximates to 5.66 M.

Mastering these calculations is fundamental for chemists and students alike, enabling accurate preparation and analysis of solutions across scientific disciplines. As chemistry continues to underpin advancements in technology, industry, and research, such fundamental skills remain ever relevant and vital.

Key Takeaways:

- Molarity is a measure of concentration expressed as moles per liter.
- Calculating molar mass is essential for converting grams to moles.
- Volume must be in liters to compute molarity accurately.
- The example demonstrates applying basic stoichiometry to real-world solution preparation.

Whether you're preparing solutions for a lab experiment or designing industrial processes, understanding how to find the molarity from given mass and volume data is an invaluable skill in the chemist’s toolkit.

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