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Understanding the amount of magnesium nitrate ($Mg(NO_3)_2$) in a solution is fundamental in chemistry, especially when preparing solutions for experiments or industrial processes. If you're given a specific volume and molarity of magnesium nitrate solution, calculating the mass of $Mg(NO_3)_2$ present is straightforward with the right approach. In this article, we will explore how to determine the mass (in grams) of $Mg(NO_3)_2$ in 184 mL of a 0.350 M solution, providing clear steps, explanations, and relevant chemistry concepts.

Understanding the Key Concepts

Before diving into calculations, it is essential to understand some basic chemistry concepts related to molarity, volume, and molar mass.

What Is Molarity?

- Molarity (M) refers to the number of moles of solute (here, $Mg(NO_3)_2$) dissolved per liter of solution.
- It is expressed as moles per liter (mol/L).

Understanding Volume in Milliliters

- Volume given in milliliters (mL) must be converted to liters (L) because molarity is expressed in mol/L.
- Conversion: 1 L = 1000 mL.

Molar Mass of Magnesium Nitrate ($Mg(NO_3)_2$)

- Calculating the molar mass involves summing the atomic masses of all atoms in the chemical formula.
- Atomic masses (approximate):
- Magnesium (Mg): 24.305 g/mol
- Nitrogen (N): 14.007 g/mol
- Oxygen (O): 15.999 g/mol

Calculating Molar Mass of $Mg(NO_3)_2$

- $Mg(NO_3)_2$ consists of:
- 1 Mg atom
- 2 N atoms
- 6 O atoms (since each NO_3 group has 3 O atoms and there are 2 groups)

The molar mass is calculated as follows:
- Mg: 24.305 g/mol
- N: 14.007 g/mol × 2 = 28.014 g/mol
- O: 15.999 g/mol × 6 = 95.994 g/mol

Adding these:
- Total molar mass = 24.305 + 28.014 + 95.994 = 148.313 g/mol

Approximate Molar Mass of $Mg(NO_3)_2$ ≈ 148.31 g/mol

Calculating the Mass of $Mg(NO_3)_2$ in the Solution

With the foundational concepts in place, let's proceed step-by-step to find the mass.

Step 1: Convert Volume to Liters

Since molarity is in mol/L, convert 184 mL to liters:
- Volume in liters = 184 mL ÷ 1000 = 0.184 L

Step 2: Calculate Moles of $Mg(NO_3)_2$ in the Solution

Use the molarity equation:
- Moles = Molarity × Volume (in liters)
- Moles of $Mg(NO_3)_2$ = 0.350 mol/L × 0.184 L = 0.0644 mol

Step 3: Calculate the Mass of $Mg(NO_3)_2$

Multiply the number of moles by the molar mass:
- Mass = Moles × Molar mass
- Mass = 0.0644 mol × 148.31 g/mol ≈ 9.55 grams

Therefore, approximately 9.55 grams of $Mg(NO_3)_2$ are present in 184 mL of a 0.350 M solution.

Additional Considerations and Tips

Understanding how to perform such calculations is crucial in laboratory settings and chemical manufacturing. Here are some additional tips and considerations:

1. Always Convert Units Consistently

- Convert milliliters to liters before calculations to match units with molarity.

2. Use Accurate Atomic Masses

- For precise calculations, use atomic masses from reliable sources or periodic table values.

3. Round Appropriately

- When reporting final answers, consider the significant figures based on the given data. In this case, the answer is rounded to three significant figures.

4. Understand the Relationship Between Molarity, Volume, and Mass

- This relationship is fundamental in preparing solutions and converting between mass and moles.

Practical Applications of This Calculation

Knowing how to determine the mass of $Mg(NO_3)_2$ in a solution has multiple practical applications:

- Preparing solutions with precise concentrations for chemical reactions.
- Calculating reagent amounts needed for experiments.
- Industrially producing magnesium nitrate solutions with specific concentrations.
- Monitoring and controlling chemical processes in manufacturing.

Summary

To determine the mass of magnesium nitrate ($Mg(NO_3)_2$) in a solution, you need to know the volume of the solution and its molarity. The process involves converting volume to liters, calculating the number of moles using molarity, and then converting moles to grams using the molar mass.

In our example:
- Volume = 184 mL = 0.184 L
- Molarity = 0.350 mol/L
- Moles of $Mg(NO_3)_2$ = 0.0644 mol
- Molar mass of $Mg(NO_3)_2$ ≈ 148.31 g/mol
- Mass = 9.55 grams

Thus, approximately 9.55 grams of $Mg(NO_3)_2$ are present in 184 mL of a 0.350 M solution.

By mastering these calculations, chemists and students can confidently work with solutions, ensuring precision in experiments and industrial applications.

Frequently Asked Questions

How do you calculate the mass of $Mg(NO_3)_2$ in a solution given its molarity and volume?

To calculate the mass, first convert the volume from mL to liters, then multiply the molarity by the volume in liters to find the moles of $Mg(NO_3)_2$. Finally, multiply the moles by the molar mass of $Mg(NO_3)_2$ to get the mass in grams.

What is the molar mass of magnesium nitrate, $Mg(NO_3)_2$?

The molar mass of $Mg(NO_3)_2$ is approximately 148.31 g/mol, calculated as Mg (24.31 g/mol) plus 2 times NO_3 (2 × 62.99 g/mol).

Given a 0.350 M solution of $Mg(NO_3)_2$, how many moles are present in 184 mL?

First, convert 184 mL to liters: 0.184 L. Then, multiply by the molarity: 0.350 mol/L × 0.184 L = 0.0644 mol of $Mg(NO_3)_2$.

How do you convert moles of $Mg(NO_3)_2$ to grams?

Multiply the number of moles by the molar mass: 0.0644 mol × 148.31 g/mol ≈ 9.56 grams of $Mg(NO_3)_2$.

What is the final answer for the mass of $Mg(NO_3)_2$ in the solution?

The mass of $Mg(NO_3)_2$ in 184 mL of a 0.350 M solution is approximately 9.56 grams.

Why is it important to use the correct units when calculating solution mass?

Using consistent units (liters for volume, molarity in mol/L, grams for mass) ensures accurate calculations and prevents errors in determining the amount of solute present.

Additional Resources

What Mass (in Grams) Of $Mg(NO_3)_2$ Is Present In 184 Ml Of A 0.350 M Solution Of $Mg(NO_3)_2$

Understanding the precise amount of a chemical compound present in a solution is fundamental in chemistry, whether for laboratory experiments, industrial processes, or educational purposes. Today, we delve into a specific problem: determining the mass in grams of magnesium nitrate ($Mg(NO_3)_2$) contained in 184 milliliters of a 0.350 molar (M) solution. This exercise exemplifies the practical application of molarity, molar mass, and volumetric conversions—all core concepts in analytical chemistry.

In this article, we will explore the step-by-step process to solve this problem, including the underlying principles, calculations, and relevant considerations. Whether you're a student seeking clarity or a professional brushing up on fundamentals, this comprehensive guide aims to make the process transparent and accessible.

Understanding the Core Concepts

Before diving into the calculation, it's essential to grasp the foundational concepts involved in the problem:

What Is Molarity (M)?

Molarity is a way of expressing the concentration of a solution, defined as the number of moles of solute (the substance dissolved) per liter of solution. It’s expressed as:

Molarity (M) = Moles of solute / Volume of solution in liters

In this case, the solution is 0.350 M, meaning there are 0.350 moles of $Mg(NO_3)_2$ in each liter of solution.

Molar Mass of $Mg(NO_3)_2$

To convert moles to grams, we need the molar mass (molecular weight) of magnesium nitrate. The molar mass is calculated by summing the atomic masses of all atoms in the formula:

$Mg(NO_3)_2$ = Magnesium (Mg) + 2 × Nitrate (NO_3)

Atomic masses (approximate):

- Magnesium (Mg): 24.305 g/mol
- Nitrogen (N): 14.007 g/mol
- Oxygen (O): 16.00 g/mol

Calculating the molar mass:

- Mg: 24.305 g/mol
- N: 14.007 g/mol × 2 = 28.014 g/mol
- O: 16.00 g/mol × 6 (since there are 6 oxygens in 2 nitrate groups): 16.00 g/mol × 6 = 96.00 g/mol

Adding these together:

Molar mass of $Mg(NO_3)_2$ = 24.305 + 28.014 + 96.00 = 148.319 g/mol

For simplicity, we may round to 148.32 g/mol.

Volume Conversion

The solution volume is given in milliliters (mL). Since molarity relates to liters, convert milliliters to liters:

184 mL = 0.184 liters

Step-by-Step Calculation

The core task involves translating the molarity and volume into grams of $Mg(NO_3)_2$. The process involves two main steps:

1. Calculate the number of moles of $Mg(NO_3)_2$ in the given volume.
2. Convert moles to grams using the molar mass.

Let's analyze each step carefully.

Step 1: Determine Moles of $Mg(NO_3)_2$

Using the molarity equation:

Moles of solute = Molarity × Volume (in liters)

Plugging in the values:

- Molarity (M) = 0.350 mol/L
- Volume = 0.184 L

Calculating:

Moles = 0.350 mol/L × 0.184 L = 0.0644 mol

This number indicates that there are approximately 0.0644 moles of $Mg(NO_3)_2$ in 184 mL of the solution.

Step 2: Convert Moles to Grams

Now, convert moles to grams:

Mass (g) = Moles × Molar mass (g/mol)

Using the molar mass of $Mg(NO_3)_2$:

Mass = 0.0644 mol × 148.32 g/mol ≈ 9.55 g

Thus, approximately 9.55 grams of magnesium nitrate are present in 184 mL of the 0.350 M solution.

Implications and Practical Applications

Understanding such calculations is crucial in various scientific and industrial contexts.

Laboratory Preparations

When preparing solutions, chemists need to accurately determine how much of a compound to weigh out. For instance, if a researcher needs 184 mL of a 0.350 M $Mg(NO_3)_2$ solution, knowing the exact mass helps ensure the solution's concentration is precise, which is critical for reproducibility in experiments.

Industrial Processes

In manufacturing settings, controlling solution concentrations ensures product quality and process efficiency. Whether producing fertilizers, pharmaceuticals, or chemical reagents, accurate calculations of solute mass are foundational.

Educational Contexts

For students, mastering these calculations reinforces understanding of molarity, molar mass, and volumetric conversions—cornerstones of analytical chemistry.

Safety Considerations

Handling chemical solutions with known concentrations allows for safer procedures, as toxicity and reactivity depend on the amount of active substances present.

Additional Considerations and Common Pitfalls

While the calculations appear straightforward, several factors can influence accuracy:

- Precision of Atomic Masses: Using more precise atomic weights (e.g., 24.305 vs. 24.31) can affect the final answer slightly.
- Solution Homogeneity: Ensuring the solution is uniformly mixed before sampling is essential.
- Volume Accuracy: Precise measurement of solution volume using calibrated equipment prevents errors.
- Significant Figures: Maintaining appropriate significant figures ensures the result's scientific integrity; in this case, three to four significant figures are suitable.

Conclusion

Calculating the mass of magnesium nitrate in a solution involves understanding molarity, molar mass, and unit conversions. As demonstrated, in 184 mL of a 0.350 M $Mg(NO_3)_2$ solution, approximately 9.55 grams of the compound are present.

This process exemplifies fundamental principles in analytical chemistry, offering critical insights for laboratory work, industrial applications, and academic learning. Precise calculations like these underpin the broader scientific endeavor of understanding and manipulating chemical systems with accuracy and confidence.

Whether you're preparing a solution for an experiment or ensuring quality control in manufacturing, mastering these calculations equips you with the essential tools to navigate the chemical landscape effectively.

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