Calculate The Grams Of Solute Needed To Prepare 107 ML Of A 2.75 M Magnesiumchloride SolutionYour Answer:Answer

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Preparing a specific concentration of a solution requires precise calculations to determine the amount of solute needed. In this guide, we will walk through the process of calculating how many grams of magnesium chloride ($MgCl_2$) are required to prepare 107 mL of a 2.75 M solution. Understanding these calculations is essential for students, chemists, and laboratory technicians to ensure accurate solution preparation for experiments or industrial processes.

Understanding the Basics of Molarity and Solution Preparation

What is Molarity?

Molarity (M) is a way to express the concentration of a solution. It is defined as the number of moles of solute dissolved in one liter of solution. Mathematically:

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

For example, a 2.75 M $MgCl_2$ solution contains 2.75 moles of $MgCl_2$ per liter of solution.

Importance of Accurate Calculations

Accurate calculations ensure:
- Proper chemical reactions
- Reproducible experimental results
- Safety in handling chemicals
- Cost efficiency in laboratories

Step-by-Step Calculation to Find the Required Grams of $MgCl_2$

1. Convert Volume from Milliliters to Liters

Since molarity is expressed per liter, convert 107 mL to liters:

$$ 107\, \text{mL} = \frac{107}{1000} = 0.107\, \text{L} $$

2. Use Molarity to Find Moles of $MgCl_2$ Needed

Apply the formula:

$$ \text{moles of MgCl}_2 = \text{Molarity} \times \text{volume in liters} $$

$$ \text{moles of MgCl}_2 = 2.75\, \text{mol/L} \times 0.107\, \text{L} $$

$$ \text{moles of MgCl}_2 = 0.29425\, \text{mol} $$

3. Find the Molar Mass of $MgCl_2$

To convert moles to grams, know the molar mass of $MgCl_2$:

Element	Atomic Mass (g/mol)	Quantity in $MgCl_2$	Total Mass (g)
Magnesium (Mg)	24.305	1	24.305
Chlorine (Cl)	35.453	2	70.906

Total molar mass of $MgCl_2$:

$$ 24.305 + (2 \times 35.453) = 24.305 + 70.906 = 95.211\, \text{g/mol} $$

4. Calculate the Grams of $MgCl_2$ Needed

Multiply the number of moles by the molar mass:

$$ \text{grams of MgCl}_2 = 0.29425\, \text{mol} \times 95.211\, \text{g/mol} $$

$$ \text{grams of MgCl}_2 \approx 28.02\, \text{g} $$

Summary of the Calculation

Step	Calculation	Result
Convert volume	107 mL to liters	0.107 L
Find moles	2.75 mol/L × 0.107 L	0.29425 mol
Molar mass of $MgCl_2$	95.211 g/mol	—
Calculate grams	0.29425 mol × 95.211 g/mol	28.02 g

Therefore, approximately 28.02 grams of magnesium chloride are needed to prepare 107 mL of a 2.75 M solution.

Additional Tips for Preparing Solutions

Choosing the Correct Equipment

- Use a volumetric flask for precise measurement of volume.
- Use an analytical balance for accurate weighing of solutes.

Steps for Accurate Solution Preparation

1. Weigh out the calculated grams of $MgCl_2$.
2. Add the solute to a container.
3. Add distilled water gradually while stirring.
4. Transfer the solution to a volumetric flask.
5. Fill to the calibration mark with distilled water.
6. Mix thoroughly to ensure homogeneity.

Handling and Safety

- Wear appropriate personal protective equipment (PPE).
- Handle chemicals in a well-ventilated area.
- Be aware of the chemical properties and hazards of $MgCl_2$.

Common Mistakes to Avoid

- Using an incorrect molar mass, especially if dealing with hydrated forms.
- Forgetting to convert volume units.
- Not accounting for solution density if working with concentrated solutions.
- Mishandling weighing equipment or not calibrating balances.

Conclusion

Calculating the amount of solute needed for solution preparation is fundamental in chemistry. By understanding molarity, molar mass, and unit conversions, you can confidently prepare solutions with precise concentrations. For 107 mL of a 2.75 M magnesium chloride solution, approximately 28.02 grams of $MgCl_2$ are required. Accurate calculations ensure the success of experiments, safety, and efficiency in laboratory operations.

FAQs

Q1: Can I prepare a larger or smaller volume of this solution using the same method?

Yes, simply adjust the volume in liters in the calculations and multiply by the molar mass to find the corresponding grams of $MgCl_2$ needed.

Q2: What if I only have hydrated magnesium chloride? How does that affect the calculation?

You must use the molar mass of the hydrated form (e.g., $MgCl_2 \cdot 6H_2O$) in your calculations, which increases the molar mass and, consequently, the grams needed.

Q3: Is it necessary to dissolve the entire amount of $MgCl_2$ at once?

It’s best to add the solute gradually, ensuring complete dissolution to achieve uniform concentration.

In summary, precise calculations are the cornerstone of effective solution preparation. By following the steps outlined here, you can confidently determine the amount of magnesium chloride needed for your specific solution needs, ensuring accuracy and consistency in your laboratory work.

Frequently Asked Questions

How do I calculate the grams of magnesium chloride needed to prepare 107 mL of a 2.75 M solution?

First, convert the volume to liters (107 mL = 0.107 L), then multiply by the molarity and molar mass of $MgCl_2$: grams = 0.107 L × 2.75 mol/L × 95.21 g/mol ≈ 27.97 grams.

What is the molar mass of magnesium chloride ($MgCl_2$) used in this calculation?

The molar mass of $MgCl_2$ is approximately 95.21 grams per mole.

If I need to prepare 50 mL of a 2.75 M $MgCl_2$ solution, how many grams of solute are required?

Convert 50 mL to liters (0.05 L), then calculate: grams = 0.05 L × 2.75 mol/L × 95.21 g/mol ≈ 13.07 grams.

Why is it important to convert volume from milliliters to liters in this calculation?

Because molarity is expressed in moles per liter, so converting to liters ensures the calculation aligns with the units of molarity.

Can I directly multiply the volume in milliliters by molarity to find grams of solute?

No, you must first convert milliliters to liters and then multiply by molarity and molar mass to find the grams of solute needed.

Additional Resources

Magnesium Chloride Solution Preparation: Precise Calculation of Solute Needed for 107 mL of a 2.75 M Solution

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Preparing chemical solutions with accuracy is fundamental in scientific research, industrial processes, and educational laboratories. Among various compounds, magnesium chloride ($MgCl_2$) is a versatile salt used in numerous applications—from chemical syntheses to de-icing solutions. Achieving the correct molarity ensures consistency, safety, and efficacy. This guide provides an in-depth, step-by-step explanation of how to calculate the exact grams of magnesium chloride required to prepare 107 mL of a 2.75 M $MgCl_2$ solution, combining theoretical fundamentals with practical insights.

Understanding the Fundamentals: Molarity and Molar Mass

Before diving into calculations, it's crucial to grasp the key concepts involved:

What is Molarity?

Molarity (M) is a measure of concentration expressed as moles of solute per liter of solution:

$$
\text{Molarity} (M) = \frac{\text{Moles of solute}}{\text{Liters of solution}}
$$

In this context, a 2.75 M $MgCl_2$ solution contains 2.75 moles of magnesium chloride in every liter (1000 mL) of solution.

Molar Mass of Magnesium Chloride ($MgCl_2$)

Calculating the molar mass involves summing atomic masses:

- Magnesium (Mg): approximately 24.305 g/mol
- Chlorine (Cl): approximately 35.453 g/mol

Since $MgCl_2$ contains one Mg atom and two Cl atoms:

$$
\text{Molar mass of MgCl}_2 = 24.305 + 2 \times 35.453 = 24.305 + 70.906 = 95.211\, \text{g/mol}
$$

For simplicity and precision, we'll use 95.211 g/mol as the molar mass.

Step-by-Step Calculation Process

1. Convert the Desired Volume from mL to Liters

Since molarity is based on liters, convert 107 mL:

$$
107\, \text{mL} \times \frac{1\, \text{L}}{1000\, \text{mL}} = 0.107\, \text{L}
$$

2. Calculate the Moles of $MgCl_2$ Needed

Using the molarity formula:

$$
\text{Moles of MgCl}_2 = \text{Molarity} \times \text{Volume in liters}
$$

$$
= 2.75\, \text{mol/L} \times 0.107\, \text{L} = 0.29425\, \text{mol}
$$

This is the number of moles of $MgCl_2$ required to prepare the solution.

3. Determine the Mass of $MgCl_2$ Needed

Now, multiply the moles by the molar mass:

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

$$
= 0.29425\, \text{mol} \times 95.211\, \text{g/mol} \approx 28.00\, \text{g}
$$

Therefore, approximately 28.00 grams of magnesium chloride are needed.

Practical Considerations and Tips

Precision and Measurement

- Use a calibrated analytical balance for measuring the $MgCl_2$ to ensure accuracy.
- When weighing, consider the purity of the reagent. If the $MgCl_2$ is not 100% pure, adjust the amount accordingly.

Dissolution Process

- Add the measured $MgCl_2$ to a volumetric flask or a suitable container.
- Add distilled or deionized water gradually, swirling gently to facilitate dissolution.
- Once fully dissolved, add more water until the total volume reaches exactly 107 mL.

Safety Precautions

- Magnesium chloride is generally safe but handle with appropriate personal protective equipment (PPE).
- Avoid inhaling dust; wear gloves and eye protection.

Additional Insights: Adjustments and Variations

Concentration Variations

Changing the desired molarity or volume will directly affect the calculation:

- Higher molarity: more grams of $MgCl_2$ per unit volume.
- Larger volume: proportionally more $MgCl_2$.

Alternative Units

- For smaller or larger scale preparations, convert units accordingly.
- Use online calculators or software for complex or repetitive calculations.

Reagent Purity and Quality

- Always check the purity grade of $MgCl_2$.
- Adjust the calculated grams based on purity percentage if necessary.

Summary of the Calculation

Step	Description	Calculation	Result
1	Convert volume to liters	107 mL = 0.107 L	—
2	Calculate moles of $MgCl_2$	2.75 mol/L × 0.107 L	0.29425 mol
3	Calculate grams of $MgCl_2$	0.29425 mol × 95.211 g/mol	28.00 g

Final Answer: To prepare 107 mL of a 2.75 M magnesium chloride solution, you need approximately 28.00 grams of $MgCl_2$.

Conclusion: Precision in Solution Preparation

Accurate calculation of the solute mass is essential for consistency in experiments and industrial applications. By understanding the relationship between molarity, volume, and molar mass, scientists and technicians can prepare solutions with confidence and precision. This detailed approach not only ensures the correct quantity of magnesium chloride but also reinforces fundamental principles of solution chemistry, making it invaluable for both educational and professional settings.

Remember, always double-check your calculations, consider reagent purity, and follow best practices for measurement and dissolution to achieve optimal results.

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