

How Many Grams Are In 2.190mol $\text{Mg}_2(\text{SO}_4)_3$?

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Understanding how to convert moles to grams is a fundamental skill in chemistry, especially when dealing with compounds like magnesium sulfate, $\text{Mg}_2(\text{SO}_4)_3$. In this article, we will explore the detailed process of calculating the mass in grams of 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$, including the concepts of molar mass, molecular structure, and the step-by-step calculation method. Whether you are a student preparing for exams or a chemistry enthusiast, this comprehensive guide aims to clarify the process and enhance your understanding of molar conversions.

Understanding the Concept of Moles and Grams in Chemistry

What Is a Mole?

In chemistry, a mole is a fundamental unit used to measure the amount of substance. One mole corresponds to exactly $6.02214076 \times 10^{23}$ particles (atoms, molecules, ions, etc.) of a substance. This number is known as Avogadro's number. The concept simplifies the calculation of chemical quantities, bridging the gap between atomic-scale particles and measurable mass.

Why Convert Moles to Grams?

Chemists often need to convert between moles and grams because laboratory measurements are typically made in grams, while chemical calculations are easier in moles. To perform this conversion, knowing the molar mass of the substance—its mass in grams per mole—is essential.

Understanding the Compound $\text{Mg}_2(\text{SO}_4)_3$

Deciphering the Chemical Formula

Magnesium sulfate, with the chemical formula $\text{Mg}_2(\text{SO}_4)_3$, consists of:

- 2 magnesium (Mg) atoms
- 3 sulfate (SO_4) groups

This formula indicates that each formula unit contains two magnesium atoms and three sulfate groups.

Molecular Structure and Composition

The compound is a salt formed from magnesium cations and sulfate anions. Its structure is held together by ionic bonds, and its molar mass depends on the atomic masses of magnesium, sulfur, and oxygen.

Calculating the Molar Mass of $\text{Mg}_2(\text{SO}_4)_3$

Atomic Masses Used in Calculation

The atomic masses (approximate) are as follows:

- Magnesium (Mg): 24.305 g/mol
- Sulfur (S): 32.065 g/mol
- Oxygen (O): 15.999 g/mol

Step-by-Step Molar Mass Calculation

To find the molar mass of $\text{Mg}_2(\text{SO}_4)_3$, sum the contributions of each element:

1. Magnesium:

- 2 atoms $\times$ 24.305 g/mol = 48.610 g/mol

2. Sulfate groups:

- Each sulfate (SO_4) contains 1 sulfur and 4 oxygen atoms.
- For 3 sulfate groups:
- Sulfur: $3 \times 32.065 \text{ g/mol} = 96.195 \text{ g/mol}$
- Oxygen: $3 \times 4 \times 15.999 \text{ g/mol} = 3 \times 63.996 \text{ g/mol} = 191.988 \text{ g/mol}$

3. Total molar mass:

- Mg: 48.610 g/mol
- S: 96.195 g/mol
- O: 191.988 g/mol

Sum:

$$48.610 + 96.195 + 191.988 = 336.793 \text{ g/mol}$$

Therefore, the molar mass of $\text{Mg}_2(\text{SO}_4)_3$ is approximately 336.793 g/mol.

Calculating the Mass in Grams for 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$

Using the Molar Mass to Convert Moles to Grams

The fundamental formula for conversion is:

$$\text{Mass (g)} = \text{Number of moles (mol)} \times \text{Molar mass (g/mol)}$$

Applying the values:

$$\text{Mass} = 2.190 \text{ mol} \times 336.793 \text{ g/mol}$$

Step-by-Step Calculation

1. Multiply the number of moles by the molar mass:

$$2.190 \text{ mol} \times 336.793 \text{ g/mol} \approx ?$$

2. Perform the multiplication:

$$2.190 \times 336.793 \approx 737.338$$

Result:

The mass of 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$ is approximately 737.34 grams.

Summary of the Calculation Process

To determine how many grams are in 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$:

1. Understand the chemical composition and molecular structure.

2. Calculate the molar mass based on atomic masses.

3. Use the molar mass to convert moles to grams:

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

4. Perform the multiplication to find the total mass.

Additional Tips for Molar Mass Calculations

- Always use the most recent atomic weights for accuracy.
- Break down complex compounds into constituent elements for clarity.
- Double-check your calculations, especially when dealing with multiple significant figures.

Common Mistakes to Avoid

- Mixing up atomic masses (e.g., using incorrect atomic weights).
- Forgetting to multiply the atomic mass by the number of atoms in the formula.
- Confusing molar mass with molecular weight (though similar, molecular weight is more common in molecular compounds).

Practical Applications of Molar Conversions

Understanding how to convert moles to grams is essential in various chemistry applications:

- Preparing solutions with precise concentrations.
- Calculating reactant and product masses in chemical reactions.
- Analyzing experimental data and titrations.
- Determining yield and purity of chemical compounds.

Conclusion

Calculating how many grams are in a specific number of moles of a compound like $\text{Mg}_2(\text{SO}_4)_3$ involves understanding the concept of molar mass and performing straightforward multiplication. For 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$, the approximate mass is 737.34 grams, based on a molar mass of 336.793 g/mol. Mastering these conversions enhances your ability to perform accurate chemical calculations and deepens your understanding of chemical quantities and their relationships.

Frequently Asked Questions (FAQs)

1. How do I find the molar mass of a compound?

You sum the atomic masses of all atoms in the chemical formula, multiplying each atomic weight by the number of times it appears.

2. Why is molar mass important?

It allows chemists to convert between the amount of substance in moles and the mass in grams, facilitating precise measurements and reactions.

3. Can this method be used for other compounds?

Yes, the same principles apply to any chemical compound; just adjust the atomic weights and the formula accordingly.

4. What tools can help with molar mass calculations?

Periodic table references, scientific calculators, and online molar mass calculators can simplify these calculations.

5. How precise should I be with atomic weights?

Use the atomic weights from the periodic table with the appropriate number of significant figures for your application.

By mastering the process outlined in this guide, you will be well-equipped to convert moles to grams for any chemical compound, enhancing your proficiency in chemistry calculations and laboratory work.

Frequently Asked Questions

How do I calculate the grams in 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$?

To calculate the grams, first find the molar mass of $\text{Mg}_2(\text{SO}_4)_3$ and then multiply it by 2.190 mol.

What is the molar mass of $\text{Mg}_2(\text{SO}_4)_3$?

The molar mass of $\text{Mg}_2(\text{SO}_4)_3$ is approximately 342.33 g/mol.

How do I find the molar mass of $\text{Mg}_2(\text{SO}_4)_3$?

Add the atomic masses: Mg (24.305 g/mol) times 2, S (32.065 g/mol) times 3, and O (16.00 g/mol) times 12, then sum all values.

What is the total mass in grams for 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$?

Multiply 2.190 mol by the molar mass 342.33 g/mol to get approximately 750.77 grams.

Can I use a calculator to convert moles to grams for $\text{Mg}_2(\text{SO}_4)_3$?

Yes, multiply the number of moles (2.190 mol) by the molar mass (342.33 g/mol) using a calculator for accuracy.

Why is it important to know the molar mass when converting moles to grams?

Because molar mass links the amount in moles to the mass in grams, allowing accurate conversion between the two units.

Is there a shortcut to calculate grams in multiple moles of $\text{Mg}_2(\text{SO}_4)_3$?

Yes, once you know the molar mass, simply multiply it by the number of moles to find the grams directly.

What is the significance of knowing how many grams are in 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$?

It helps in practical applications like preparing solutions, chemical reactions, or inventory management involving this compound.

Additional Resources

Understanding Molar Mass and Conversion: A Deep Dive into $\text{Mg}_2(\text{SO}_4)_3$

When delving into the fascinating world of chemistry, understanding the relationship between moles and grams is fundamental. Whether you're a student preparing for exams, a researcher analyzing compound quantities, or a hobbyist exploring chemical reactions, mastering how to convert between these units is essential. Today, we'll explore this concept through a detailed examination of magnesium sulfate with the chemical formula $\text{Mg}_2(\text{SO}_4)_3$, focusing specifically on calculating how many grams are in 2.190 moles of

this compound. This comprehensive guide will illuminate each step, breaking down the concepts involved and providing clarity on the process.

Understanding the Basics: What Is a Mole?

Before we jump into calculations, it's important to grasp what a mole represents in chemistry.

Definition of a Mole

- A mole (mol) is a fundamental unit in chemistry that quantifies the amount of substance.
- It corresponds to exactly $6.02214076 \times 10^{23}$ particles (atoms, molecules, ions, etc.)—a number known as Avogadro's number.
- This concept allows chemists to count particles by weighing them, simplifying calculations and experimental procedures.

Why Moles Matter

- Moles serve as a bridge between the microscopic world of atoms and molecules and the macroscopic world of grams and liters.
- Knowing the molar mass (grams per mole) of a compound allows us to convert between mass and number of moles seamlessly.

Deciphering the Chemical Formula: $\text{Mg}_2(\text{SO}_4)_3$

To accurately determine the mass of 2.190 mol of magnesium sulfate, we need to understand its chemical composition.

Breakdown of $\text{Mg}_2(\text{SO}_4)_3$

- The formula indicates:
- 2 magnesium (Mg) atoms
- 3 sulfate (SO_4) groups

Significance of the Formula

- The subscript numbers tell us how many atoms of each element are present in one formula unit.

- The molar mass will be calculated by summing the atomic masses of all constituent atoms, considering their quantities.

Calculating the Molar Mass of $\text{Mg}_2(\text{SO}_4)_3$

This is the core step—adding up atomic masses to find the molar mass of the compound.

Atomic Masses of Elements Involved

Element	Atomic Mass (amu)	Approximate in g/mol
Magnesium (Mg)	24.305	24.305 g/mol
Sulfur (S)	32.065	32.065 g/mol
Oxygen (O)	15.999	15.999 g/mol

Step-by-Step Molar Mass Calculation

- Calculate the total mass contribution from magnesium:
 - Mg_2 : $2 \times 24.305 \text{ g/mol} = 48.610 \text{ g/mol}$
- Calculate the total mass from sulfur:
 - $3 \times \text{S}$: $3 \times 32.065 \text{ g/mol} = 96.195 \text{ g/mol}$
- Calculate the total mass from oxygen:
 - Each sulfate (SO_4) contains 4 oxygen atoms.
 - Total oxygen atoms: $3 \times 4 = 12$
 - Total mass from oxygen: $12 \times 15.999 \text{ g/mol} = 191.988 \text{ g/mol}$
- Sum all contributions:
 - Molar mass of $\text{Mg}_2(\text{SO}_4)_3$:
 $48.610 \text{ (Mg)} + 96.195 \text{ (S)} + 191.988 \text{ (O)} = 336.793 \text{ g/mol}$

Summary:
- The molar mass of magnesium sulfate $\text{Mg}_2(\text{SO}_4)_3$ is approximately 336.79 g/mol.

Converting Moles to Grams: The Calculation Process

Now that we know the molar mass, converting from moles to grams becomes straightforward.

Basic Formula for Conversion

$$\text{Mass (g)} = \text{Number of moles (mol)} \times \text{Molar mass (g/mol)}$$

Applying this to our specific problem:

$$\text{Mass} = 2.190 \text{ mol} \times 336.79 \text{ g/mol}$$

Step-by-Step Calculation

1. Multiply the number of moles by the molar mass:
 - $2.190 \text{ mol} \times 336.79 \text{ g/mol}$
2. Perform the multiplication:
 - $2.190 \times 336.79 \approx 737.27 \text{ g}$
3. Final Result:
 - The mass of 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$ is approximately 737.27 grams.

Additional Considerations and Precision

While the calculation above provides a precise estimate, several factors can influence the exactness of your result:

Atomic Mass Variability

- Atomic masses are average values that account for isotopic distribution.
- Using more precise atomic masses can increase calculation accuracy, especially in scientific research.

Significant Figures

- The initial data (2.190 mol) has four significant figures.
- To match precision, round the final answer to four significant figures:

737.3 g.

Practical Implications

- When preparing solutions or conducting experiments, always consider measurement uncertainties.
- Use calibrated scales and proper measurement techniques for real-world applications.

Summary and Key Takeaways

- The molar mass of $\text{Mg}_2(\text{SO}_4)_3$ is approximately 336.79 g/mol.
- To find the grams in a given number of moles, multiply the molar mass by the number of moles.
- For 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$, the mass is approximately 737.3 grams.

Practical Applications and Why It Matters

Understanding how to convert between moles and grams is invaluable across various fields:

- Chemical Manufacturing: Precise reagent measurements for synthesis.
- Pharmaceuticals: Calculating compound dosages and formulations.
- Environmental Science: Quantifying pollutant concentrations.
- Academic Research: Designing experiments with accurate quantities.

Mastering these conversions enables chemists to plan, execute, and interpret experiments effectively, ensuring safety, accuracy, and scientific integrity.

Conclusion: Becoming Proficient in Molar Conversions

Converting moles to grams might seem straightforward, but it requires a clear understanding of molar mass and chemical composition. By breaking down the molecule into its constituent atoms, summing their atomic masses, and applying basic multiplication, you can precisely determine the mass corresponding to any number of moles.

In our case, 2.190 mol of $\text{Mg}_2(\text{SO}_4)_3$ equates to approximately 737.3 grams. This knowledge not only enhances your grasp of chemical calculations but also empowers you to handle real-world chemical scenarios with confidence.

Remember, the key is understanding the fundamentals—atomic masses, molecular formulas, and conversion formulas—and practicing these calculations to build proficiency. With this expertise, you'll be well-equipped to analyze, prepare, and interpret chemical data accurately and efficiently.

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