Determine The Number Of CHCl3 Molecules In 25.9 G CHCl3.

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Understanding how to calculate the number of molecules in a given amount of a chemical substance is a fundamental aspect of chemistry. In this article, we will explore the step-by-step process to determine the number of chloroform ($CHCl_3$) molecules in 25.9 grams of the compound. This process involves concepts such as molar mass, Avogadro's number, and basic stoichiometry. By the end of this guide, you'll have a clear understanding of how to approach such calculations and apply them to various chemical problems.

Introduction to $CHCl_3$ and Its Importance

Chloroform, also known as trichloromethane, with the chemical formula $CHCl_3$, is an organic compound historically used as an anesthetic and solvent. Today, it is mainly used in chemical research and manufacturing processes. Understanding the quantity of molecules in a sample of chloroform is essential for laboratory experiments, safety assessments, and chemical synthesis.

Knowing the number of molecules helps chemists determine reaction yields, prepare solutions with precise molarity, and understand molecular-level interactions. Since molecular quantities are often expressed in terms of moles, knowing how to convert grams to molecules involves understanding molar mass and Avogadro's number.

Key Concepts and Definitions

Before diving into calculations, let's review some essential concepts:

Molar Mass

- The molar mass of a compound is the mass of one mole of its molecules, expressed in grams per mole (g/mol).
- For $CHCl_3$, the molar mass is calculated based on atomic weights.

Avogadro's Number

- Avogadro's number (6.022×10^{23}) is the number of particles (atoms, molecules, ions) in one mole of a substance.

Moles

- A mole is a unit that quantifies the amount of substance.
- Converting grams to moles is fundamental for molecular calculations.

Calculating the Molar Mass of $CHCl_3$

The first step in determining the number of molecules is to find the molar mass of $CHCl_3$.

Atomic Weights of Elements

- Carbon (C): approximately 12.01 g/mol
- Hydrogen (H): approximately 1.008 g/mol
- Chlorine (Cl): approximately 35.45 g/mol

Calculating Molar Mass of $CHCl_3$

The molecular formula contains:
- 1 Carbon atom
- 1 Hydrogen atom
- 3 Chlorine atoms

Therefore, the molar mass is:

Molar mass of $CHCl_3$ = (1 × 12.01 g/mol) + (1 × 1.008 g/mol) + (3 × 35.45 g/mol)

Calculations:
- Carbon: 12.01 g/mol
- Hydrogen: 1.008 g/mol
- Chlorine: 3 × 35.45 g/mol = 106.35 g/mol

Adding these:
12.01 + 1.008 + 106.35 = 119.368 g/mol

Rounded for simplicity:
Molar mass of $CHCl_3$ ≈ 119.37 g/mol

Converting Grams to Moles

Now, convert the given mass of 25.9 grams of $CHCl_3$ to moles:

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

$$

Plugging in the values:

$$
\text{Number of moles} = \frac{25.9\, \text{g}}{119.37\, \text{g/mol}} \approx 0.217\, \text{mol}
$$

This means that 25.9 grams of $CHCl_3$ corresponds to approximately 0.217 moles of molecules.

Calculating the Number of Molecules

With the number of moles known, the next step is to find the actual number of molecules.

Using Avogadro’s Number

- One mole of any substance contains approximately 6.022×10^{23} molecules.

The total number of molecules in the sample:

$$
\text{Number of molecules} = \text{Number of moles} \times \text{Avogadro’s number}
$$

Calculating:

$$
0.217\, \text{mol} \times 6.022 \times 10^{23}\, \text{molecules/mol} \approx 1.308 \times 10^{23}\, \text{molecules}
$$

Therefore, there are approximately 1.308×10^{23} $CHCl_3$ molecules in 25.9 grams of chloroform.

Summary of the Calculation Process

To summarize, here’s the step-by-step procedure:

1. Determine the molar mass of $CHCl_3$: approximately 119.37 g/mol.
2. Convert the given mass to moles: 25.9 g ÷ 119.37 g/mol ≈ 0.217 mol.

3. Calculate the total number of molecules: 0.217 mol × 6.022 × 10^{23} molecules/mol ≈ 1.308 × 10^{23} molecules.

Practical Applications of This Calculation

Understanding how to determine the number of molecules from a given mass has numerous practical applications:

1. Preparing Solutions with Precise Concentrations

Chemists often need to prepare solutions with specific molarity. Knowing the molecule count helps in accurately measuring and dissolving substances.

2. Reaction Stoichiometry

Calculating the number of molecules involved in reactions allows chemists to predict yields and optimize reaction conditions.

3. Safety and Exposure Assessments

Knowing the molecule count can aid in assessing potential exposure risks, especially with volatile or toxic compounds like chloroform.

4. Laboratory Quantitative Analysis

Quantitative analysis relies on converting mass measurements to molecular quantities, ensuring precise experimental results.

Additional Considerations and Tips

While the above calculations are straightforward, there are some tips and considerations to keep in mind:

- **Accurate Atomic Weights:** Use the most recent atomic weights for precise calculations, especially in sensitive experiments.
- **Significant Figures:** Maintain appropriate significant figures based on your initial data.
- **Unit Consistency:** Ensure units are consistent throughout calculations to

avoid errors.

- **Molecular Formulas:** Verify molecular formulas before calculations, especially if dealing with derivatives or salts.

Conclusion

Determining the number of $CHCl_3$ molecules in a given mass is a fundamental skill in chemistry that combines concepts of molar mass, Avogadro’s number, and stoichiometry. For a sample of 25.9 grams of chloroform, the calculation reveals approximately 1.308×10^{23} molecules. Mastering this process enables chemists to perform precise measurements, predict reaction outcomes, and conduct safe laboratory practices. By understanding these principles, you build a strong foundation for exploring more complex chemical calculations and concepts.

Remember: Always double-check your calculations and use accurate atomic weights for best results in your chemical endeavors.

Frequently Asked Questions

How do you determine the number of CHCl3 molecules in 25.9 g of CHCl3?

To find the number of molecules, first calculate the number of moles by dividing the mass (25.9 g) by the molar mass of CHCl3, then multiply the moles by Avogadro's number (6.022×10^{23} molecules/mol).

What is the molar mass of chloroform (CHCl3)?

The molar mass of CHCl3 is approximately 119.38 g/mol, calculated as (1 × 12.01) + (1 × 35.45) + (3 × 35.45).

How many moles of CHCl3 are there in 25.9 g of the compound?

Number of moles = 25.9 g ÷ 119.38 g/mol ≈ 0.217 mol.

What is Avogadro's number and how is it used in this

calculation?

Avogadro's number is 6.022×10^{23} molecules/mol; it is used to convert moles to individual molecules by multiplying the number of moles by this constant.

How many CHCl3 molecules are present in 25.9 g of chloroform?

Number of molecules = $0.217 \text{ mol} \times 6.022 \times 10^{23}$ molecules/mol $\approx 1.31 \times 10^{23}$ molecules.

Why is it important to know the molar mass when calculating molecules from mass?

The molar mass allows conversion from grams to moles, which is essential because molecular counts are based on moles, not mass directly.

Can this method be used for any compound to find the number of molecules from mass?

Yes, as long as you know the compound's molar mass, this method applies universally to convert mass to number of molecules.

Additional Resources

Determine The Number Of CHCl3 Molecules In 25.9 G CHCl3 is a classic problem in chemistry that combines concepts of molar mass, Avogadro’s number, and stoichiometry to find the quantity of molecules present in a given mass of a compound. Whether you're a student preparing for exams, a science enthusiast, or a professional chemist, understanding how to determine the number of molecules in a sample is fundamental. This guide will walk you through each step of the process, providing clarity and context to ensure you grasp not just the "how" but also the "why" behind each calculation.

Understanding the Problem

Before diving into calculations, it's essential to clarify what the problem is asking:

- You are provided with a mass of CHCl3 (chloroform), specifically 25.9 grams.
- The goal is to determine how many molecules of CHCl3 are present in that mass.

In essence, the problem involves converting grams (a measure of mass) into

molecules (a count of individual entities). This process requires understanding the relationship between mass, moles, and molecules.

Key Concepts and Tools Needed

1. Molar Mass

The molar mass of a compound is the mass of one mole of its molecules, expressed in grams per mole (g/mol). For CHCl3:

- Carbon (C): approximately 12.01 g/mol
- Hydrogen (H): approximately 1.008 g/mol
- Chlorine (Cl): approximately 35.45 g/mol

Calculating molar mass:

```
Molar mass of CHCl3 = (1 × 12.01) + (1 × 1.008) + (3 × 35.45)
= 12.01 + 1.008 + 106.35
= 119.368 g/mol
```

Rounding to a reasonable number of significant figures, 119.37 g/mol is typically used.

2. Avogadro's Number

Avogadro's number (6.022×10^{23}) defines the number of molecules in one mole of a substance. This is the bridge between moles and individual molecules.

3. Stoichiometry

Stoichiometry involves converting between different units (mass, moles, molecules) using conversion factors derived from molar mass and Avogadro's number.

Step-by-Step Guide to Calculating the Number of Molecules

Step 1: Convert grams to moles

Using the molar mass:

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

Plugging in the values:

$$
\text{Number of moles} = \frac{25.9\, \text{g}}{119.37\, \text{g/mol}}
\approx 0.217 \text{ mol}
$$

Note: Ensure your calculator is set to sufficient decimal places for accuracy.

Step 2: Convert moles to molecules

Using Avogadro’s number:

$$
\text{Number of molecules} = \text{Number of moles} \times 6.022 \times 10^{23}
$$

Applying this:

$$
0.217 \text{ mol} \times 6.022 \times 10^{23} \approx 1.308 \times 10^{23} \text{ molecules}
$$

Final Answer:

There are approximately 1.31×10^{23} molecules of $CHCl_3$ in 25.9 grams of the compound.

Additional Considerations and Tips

Accuracy and Significant Figures

- Use the appropriate number of significant figures based on your data. Here, 25.9 g has three significant figures, so the final result should be rounded to three significant figures.

Units and Conversion Factors

- Always double-check units when performing calculations.
- Remember, molar mass is in g/mol, and Avogadro’s number is molecules per mol.

Real-world Applications

Understanding how to determine the number of molecules from a mass is crucial in various fields, including:

- Pharmacology: calculating drug molecule counts

- Environmental science: assessing pollutant molecules
- Material science: quantifying molecular constituents

Practice Problems

To solidify your understanding, try these:

1. How many molecules are in 50 g of $CHCl_3$?
2. If you have 100 moles of $CHCl_3$, how many molecules does that correspond to?
3. What mass of $CHCl_3$ contains 2×10^{24} molecules?

Summary

Determining the number of $CHCl_3$ molecules in a given mass involves:

- Calculating the molar mass of $CHCl_3$.
- Converting the given mass into moles by dividing by molar mass.
- Multiplying the number of moles by Avogadro's number to find the total molecules.

This process exemplifies the power of stoichiometry in transforming between different units and understanding the microscopic world through macroscopic measurements. Mastering these steps provides a strong foundation for tackling more complex chemical calculations and enhances your overall comprehension of molecular chemistry.

Final Remarks

Determine The Number Of $CHCl_3$ Molecules In 25.9 G $CHCl_3$ is a straightforward yet vital calculation in chemistry. It demonstrates how fundamental constants and conversion factors work together to bridge the gap between mass and molecular count. With practice, these steps become second nature, enabling you to analyze and interpret chemical data efficiently and accurately.

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