Select The Correct Mass For Each Of The Samples Described Below.3.01 1023 Molecules H2O8.32 1020 Formula

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Understanding the precise mass of molecular samples is fundamental in chemistry, especially when working with molecules at the atomic or molecular level. Whether you're preparing solutions, conducting experiments, or performing calculations in stoichiometry, knowing how to accurately determine the mass corresponding to a specific number of molecules or formulas is essential. In this article, we will explore how to select the correct mass for two different samples, based on the number of molecules and formulas provided: 3.01 × 10^23 molecules of water (H_2O) and 8.32 × 10^20 formulas. We will delve into concepts such as Avogadro’s number, molar mass, and conversion techniques to ensure a comprehensive understanding.

Understanding the Basics: Molecules, Formulas, and Molar Mass

Before calculating the mass of each sample, it is crucial to review some fundamental concepts:

What is a Mole?

- A mole (mol) is a standard SI unit used to count particles such as atoms, molecules, or ions.
- One mole contains exactly 6.022 × 10^23 particles, known as Avogadro’s number.

Avogadro’s Number

- 6.022 × 10^23 is the number of particles in one mole of a substance.
- It provides a link between the microscopic scale (particles) and the macroscopic scale (grams).

Molar Mass

- The molar mass is the mass of one mole of a substance, usually expressed in grams per mole (g/mol).
- For water (H_2O), the molar mass is approximately 18.015 g/mol.

Calculating the Mass of 3.01 × 10^23 Molecules of Water (H_2O)

Let's examine how to determine the mass corresponding to 3.01 × 10^23 molecules of water.

Step 1: Convert Molecules to Moles

- Recall that 1 mole of any substance contains 6.022 × 10^23 particles.
- To find the number of moles represented by 3.01 × 10^23 molecules:

$$
\text{Number of moles} = \frac{\text{Number of molecules}}{\text{Avogadro’s number}} = \frac{3.01 \times 10^{23}}{6.022 \times 10^{23}} \approx 0.5 \text{ mol}
$$

Step 2: Calculate the Mass of Water

- Use the molar mass of water:

$$
\text{Molar mass of H}_2\text{O} \approx 18.015 \text{ g/mol}
$$

- Multiply the number of moles by molar mass:

$$
\text{Mass} = \text{moles} \times \text{molar mass} \approx 0.5 \text{ mol} \times 18.015 \text{ g/mol} \approx 9.0075 \text{ g}
$$

Result:

- The correct mass for 3.01 × 10^23 molecules of water is approximately 9.01 grams.

Calculating the Mass for 8.32 × 10^20 Formulas

Next, analyze how to determine the mass corresponding to 8.32 × 10^20 formulas. The term "formulas" here generally refers to the molecular formulas of the compound, which in this context are the same as molecules for water.

Assumption: Formulas refer to molecules of water

If "formulas" refers to molecules similar to "molecules," then the calculation is similar to the previous one, but with a different number of particles.

Step 1: Convert Formulas to Moles

- Using Avogadro's number:

$$
\text{Number of moles} = \frac{8.32 \times 10^{20}}{6.022 \times 10^{23}} \approx 1.38 \times 10^{-3} \text{ mol}
$$

Step 2: Calculate the Mass

- Multiply by molar mass:

$$
\text{Mass} = 1.38 \times 10^{-3} \text{ mol} \times 18.015 \text{ g/mol} \approx 0.0248 \text{ g}
$$

Result:

- The correct mass for 8.32×10^{20} formulas of water is approximately 0.025 grams.

Summary of Calculations

Sample Description	Number of Particles	Moles Calculated	Approximate Mass (g)
3.01×10^{23} molecules of H_2O	3.01×10^{23} molecules	0.5 mol	9.01 g
8.32×10^{20} formulas of H_2O	8.32×10^{20} formulas	1.38×10^{-3} mol	0.025 g

Why These Calculations Are Important

Understanding how to convert between particles, moles, and mass is fundamental in laboratory and industrial chemistry. Accurate calculations ensure proper reagent preparation, yield calculations, and quality control.

These conversions also demonstrate the practical application of fundamental constants like Avogadro’s number.

Additional Considerations in Mass Calculations

While the above calculations are straightforward, several factors can influence the accuracy of such measurements:

Purity of the Sample

- Impurities can affect the actual mass and molecular composition.
- Always consider the purity percentage when preparing or analyzing samples.

Measurement Precision

- Use calibrated balances for precise mass measurements.
- Be aware of potential errors or contamination.

Molecular Variations

- For compounds with complex formulas, molar mass calculations become more involved.
- Always verify the molecular weight from reliable sources.

Conclusion

Selecting the correct mass for different samples based on the number of molecules or formulas involves understanding fundamental concepts such as Avogadro’s number, molar mass, and unit conversions. For the samples provided:

- 3.01×10^{23} molecules of water correspond to approximately 9.01 grams.
- 8.32×10^{20} formulas of water correspond to approximately 0.025 grams.

Mastering these conversions enhances your ability to accurately measure and work with chemical substances, which is vital for successful experiments and industrial applications. Remember, always double-check your calculations and consider the context of your measurements to ensure precision and reliability in your work.

Frequently Asked Questions

What is the mass of 3.01 x 10^23 molecules of H2O?

Approximately 18 grams, since 1 mole of H2O contains 6.022 x 10^23 molecules and weighs about 18 grams.

How do you calculate the mass of 8.32 x 10^20 molecules of a compound?

Convert molecules to moles by dividing by Avogadro's number (6.022 x 10^23), then multiply by the molar mass to find the mass.

What is the molar mass of water (H2O) used in these calculations?

Approximately 18.015 grams per mole.

What is the significance of the number 1023 in the sample description?

It indicates the number of molecules in the sample, specifically 3.01 x 10^23 molecules.

How does the number of molecules relate to the mass in grams?

The number of molecules is converted to moles, then multiplied by molar mass to find the mass in grams.

What is the formula to find the mass from molecules for H2O?

Mass = (Number of molecules / Avogadro's number) x molar mass of H2O.

If a sample contains 8.32 x 10^20 molecules, what is its approximate mass?

About 0.025 grams, calculated by converting molecules to moles and then multiplying by molar mass.

Why is it important to know the molar mass when calculating the mass of a sample?

Because molar mass links the number of molecules to the mass in grams, enabling accurate conversions.

What does the notation 3.01 x 10^23 Molecules H2O represent?

It indicates a sample containing approximately 3.01 x 10^23 molecules of water, close to one mole.

How do you determine the correct mass for each sample described in the problem?

By converting the given number of molecules to moles and then multiplying by the molar mass of the substance.

Additional Resources

Select The Correct Mass For Each Of The Samples Described Below.3.01 1023 Molecules H2O8.32 1020 Formula

Understanding the precise mass of chemical samples is fundamental in chemistry, whether for laboratory experiments, industrial applications, or academic research. Accurate calculations ensure consistency, safety, and efficiency in chemical processes. In this article, we explore how to determine the correct mass for two distinct samples: one comprising a known number of water (H_2O) molecules, and another defined by a given formula quantity. We will delve into the principles of mole concept, molecular weight calculations, and the step-by-step process to find the correct mass for each sample, providing clarity for students and professionals alike.

The Importance of Molar Quantities in Chemistry

Before we analyze the specific samples, it's critical to understand the foundational concept of the mole in chemistry. The mole serves as a bridge between the microscopic world of atoms and molecules and the macroscopic world we observe and measure. One mole of any substance contains exactly 6.022×10^{23} particles, whether atoms, molecules, or ions. This number, known as Avogadro's number, allows chemists to relate the mass of a substance to the number of particles it contains.

Why is this important?
- It standardizes measurements across different compounds.
- It enables accurate calculations of reaction stoichiometry.
- It allows for precise determination of how much of a substance is needed or produced in a chemical process.

Sample 1: Calculating the Mass of 3.01×10^{23} Molecules of Water (H_2O)

Understanding the Problem

The first sample involves a specific number of water molecules, 3.01×10^{23} molecules. Our goal is to determine the mass of this sample in grams. This process involves converting the number of molecules to moles, then using molar mass to find the mass.

Step 1: Convert Molecules to Moles

Since one mole contains 6.022×10^{23} particles (molecules in this case), we can find the number of moles in our sample:

$$
\text{Number of moles} = \frac{\text{Number of molecules}}{\text{Avogadro's number}}
$$

Plugging in the values:

$$
\text{Number of moles} = \frac{3.01 \times 10^{23}}{6.022 \times 10^{23}} \approx 0.5 \text{ mol}
$$

This calculation reveals that 3.01×10^{23} water molecules correspond approximately to 0.5 moles of water.

Step 2: Find the Molar Mass of Water (H_2O)

To proceed, we need the molar mass of water:

Element	Atomic Mass (amu)	Calculation	Total (amu)
Hydrogen (H)	1.008 g/mol	2 × 1.008	2.016 g/mol
Oxygen (O)	16.00 g/mol	1 × 16.00	16.00 g/mol
Total			18.016 g/mol

Rounded to a practical precision, the molar mass of water is approximately 18.02 g/mol.

Step 3: Calculate the Mass of the Sample

Using the molar mass:

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

$$
\text{Mass} = 0.5 \text{ mol} \times 18.02 \text{ g/mol} = 9.01 \text{ grams}
$$

Result: The sample of 3.01×10^{23} water molecules has a mass of approximately 9.01 grams.

Summary for Sample 1

- Molecules: 3.01×10^{23}
- Moles: ~0.5 mol
- Molar mass of H_2O: 18.02 g/mol
- Correct mass: 9.01 grams

Sample 2: Determining the Mass for a Given Formula Quantity (8.32×10^{20} Formula Units)

Understanding the Problem

The second sample is defined by a formula quantity: 8.32×10^{20} formula units. The term "formula units" typically applies to ionic compounds or substances where the basic repeating unit is defined by the chemical formula, such as salts. Our task is to find the mass of this sample, assuming it pertains to a specific compound, though the compound is not explicitly specified. For the purpose of this explanation, let's assume the compound is sodium chloride (NaCl), a common ionic compound.

Note: If a different compound is intended, the molar mass would need to be adjusted accordingly.

Step 1: Convert Formula Units to Moles

Using Avogadro's number:

$$
\text{Number of moles} = \frac{\text{Number of formula units}}{\text{Avogadro's number}}
$$

$$
\text{Number of moles} = \frac{8.32 \times 10^{20}}{6.022 \times 10^{23}} \approx 1.38 \times 10^{-3} \text{ mol}
$$

This indicates that 8.32×10^{20} formula units correspond to approximately 1.38 millimoles of NaCl.

Step 2: Find the Molar Mass of NaCl

Calculating molar mass:

Element	Atomic Mass (amu)	Calculation	Total (amu)
Sodium (Na)	22.99 g/mol	1 × 22.99	22.99 g/mol
Chlorine (Cl)	35.45 g/mol	1 × 35.45	35.45 g/mol
Total			58.44 g/mol

Note: The molar mass of NaCl is approximately 58.44 g/mol.

Step 3: Calculate the Mass of the Sample

Applying the mass formula:

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

$$
\text{Mass} = 1.38 \times 10^{-3} \text{ mol} \times 58.44 \text{ g/mol} \approx 0.0806 \text{ grams}
$$

Result: The sample with 8.32×10^{20} formula units of NaCl has a mass of approximately 0.0806 grams.

Summary for Sample 2

- Formula units: 8.32×10^{20}
- Moles: ~1.38×10^{-3} mol
- Molar mass of NaCl: 58.44 g/mol
- Correct mass: 0.0806 grams

Comparative Analysis and Practical Implications

The two samples, although expressed with vastly different particle counts, highlight important principles in chemical measurement:

- Scaling in chemistry: Small differences in particle counts translate to different mass scales, emphasizing the importance of mole conversions.
- Precision in calculations: Approximate results depend on rounding of constants like Avogadro's number and molar masses, but they are sufficiently accurate for most practical purposes.
- Application in laboratories: Accurate mass determination ensures correct reagent preparation, reaction stoichiometry, and safety.

Real-world example:
Suppose a chemist needs precisely 10 grams of water for an experiment. Knowing the mass per molecule allows them to measure out approximately:

\[
\text{Number of molecules} = \text{Mass} / \text{Mass per molecule}
\]

which underscores the importance of understanding these conversions.

Conclusion: The Interplay of Particles and Mass

Calculating the correct mass of chemical samples based on molecular or formula unit counts is a foundational skill in chemistry. By understanding the relationship between particles, moles, and mass through constants like Avogadro's number and molar masses, scientists can accurately prepare and analyze substances—be it for research, manufacturing, or education.

In our examples, we determined that:

- 3.01×10^{23} water molecules correspond to approximately 9.01 grams.
- 8.32×10^{20} formula units of NaCl equate to roughly 0.0806 grams.

These calculations exemplify the essential role of mole concepts in bridging the microscopic and macroscopic worlds, ensuring that chemists can reliably translate particle counts into measurable quantities for diverse applications. Mastery of these conversions not only enhances scientific accuracy but also empowers effective experimentation and innovation across the chemical sciences.

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