

# Determine The Mass In Grams Of $3.75 \times 10^{21}$ Atoms Of Zinc. (the Mass Of One Mole Of Zinc Is 65.39 G)

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Understanding how to calculate the mass of a specific number of atoms is a fundamental skill in chemistry. Whether you're a student preparing for exams, a teacher designing lesson plans, or a professional working in a lab, knowing how to convert between atoms and grams is essential. In this article, we will explore the step-by-step process to determine the mass in grams of  $3.75 \times 10^{21}$  atoms of zinc, given that the molar mass of zinc is 65.39 grams per mole. We will cover fundamental concepts such as Avogadro's number, molar mass, and the relationship between atoms, moles, and grams, supported by clear explanations and practical examples.

## Understanding Key Concepts for Calculating Atomic Mass

Before diving into the calculation, it is vital to understand some basic concepts that form the foundation of this process.

### What is a Mole?

- The mole is a standard unit in chemistry used to count particles such as atoms, molecules, or ions.
- One mole contains exactly  $6.022 \times 10^{23}$  particles (Avogadro's number).

### Avogadro's Number

- Avogadro's number ( $6.022 \times 10^{23}$ ) defines the number of particles in one mole of a substance.
- It serves as a bridge between the microscopic world (atoms and molecules) and the macroscopic world (grams).

### Molar Mass

- The molar mass of an element is the mass of one mole of its atoms.
- For zinc, the molar mass is 65.39 grams per mole, meaning one mole of zinc weighs 65.39 grams.

# Step-by-Step Calculation of the Mass of $3.75 \times 10^{21}$ Atoms of Zinc

To find the mass in grams of a specific number of zinc atoms, follow these steps:

## Step 1: Understand the Given Data

- Number of atoms:  $3.75 \times 10^{21}$
- Molar mass of zinc: 65.39 g/mol
- Avogadro's number:  $6.022 \times 10^{23}$  atoms/mol

## Step 2: Convert Atoms to Moles

Since molar mass relates grams to moles, and Avogadro's number relates atoms to moles, the first step is to convert the number of atoms into moles.

Calculation:

Number of moles of zinc = (Number of atoms) / (Avogadro's number)

Formula:

$$\text{Moles of zinc} = \frac{3.75 \times 10^{21}}{6.022 \times 10^{23}}$$

Calculation steps:

1. Divide the coefficients:  $3.75 / 6.022 \approx 0.623$
2. Subtract exponents:  $(10^{21} / 10^{23}) = 10^{21 - 23} = 10^{-2}$

Result:

$$\text{Moles of zinc} \approx 0.623 \times 10^{-2} = 6.23 \times 10^{-3}$$

So, the number of moles of zinc is approximately  $6.23 \times 10^{-3}$  mol.

## Step 3: Convert Moles to Grams

Now, multiply the number of moles by the molar mass to get the mass in grams.

Calculation:

$$\text{Mass of zinc} = (6.23 \times 10^{-3} \text{ mol}) \times (65.39 \text{ g/mol})$$

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

$$= 6.23 \times 10^{-3} \times 65.39$$

Calculation steps:

1. Multiply coefficients:  $6.23 \times 65.39 \approx 407.4$
2. Keep the exponent:  $(10^{-3})$

Result:

$$\text{Mass} \approx 407.4 \times 10^{-3} \text{ grams}$$

which simplifies to:

$$\boxed{\text{Mass} \approx 0.407 \text{ grams}}$$

Therefore, the mass of  $3.75 \times 10^{21}$  atoms of zinc is approximately 0.407 grams.

## Additional Insights and Practical Applications

Understanding this calculation opens the door to various practical applications in chemistry, such as:

### 1. Quantitative Analysis

- Chemists often need to determine how much of a substance is present in a sample based on the number of atoms or molecules.

### 2. Stoichiometry in Chemical Reactions

- Precise mass calculations allow for accurate reagent measurements, ensuring reactions proceed efficiently and safely.

### 3. Material Science and Engineering

- Engineers can calculate the amount of material required for manufacturing processes based on atomic counts.

## Common Mistakes to Avoid

- Forgetting to convert atoms to moles before multiplying by molar mass.
- Using incorrect values for Avogadro's number.
- Confusing molar mass with atomic mass units (amu); molar mass is in grams per mole.
- Failing to keep track of exponents during calculations.

## Summary of Key Points

- The number of particles (atoms) can be converted into moles using Avogadro's number.
- Moles can then be converted into grams using the molar mass.
- The calculation involves simple division and multiplication operations, but attention to detail is crucial.

## Final Remarks

Calculating the mass of a specific number of atoms is a fundamental skill in chemistry that combines understanding of atomic theory, molar concepts, and basic arithmetic. By mastering these steps, you can confidently convert between microscopic particles and macroscopic measurements, a vital competency in scientific research, education, and industry.

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In conclusion, the mass in grams of  $3.75 \times 10^{21}$  atoms of zinc, given the molar mass of 65.39 grams per mole, is approximately 0.407 grams. This calculation exemplifies the practical application of fundamental chemistry principles and demonstrates how microscopic quantities translate into measurable quantities in the laboratory.

## Frequently Asked Questions

### How do you calculate the mass in grams of $3.75 \times 10^{21}$ atoms of zinc?

To calculate the mass, first determine the number of moles by dividing the number of atoms by Avogadro's number ( $6.022 \times 10^{23}$ ). Then, multiply the moles by the molar mass of zinc (65.39 g/mol).

### What is the first step in finding the mass of $3.75 \times 10^{21}$ zinc atoms?

The first step is to convert the given number of atoms into moles by dividing

by Avogadro's number:  $(3.75 \times 10^{21}) / (6.022 \times 10^{23})$ .

### **How many moles of zinc are in $3.75 \times 10^{21}$ atoms?**

There are approximately  $6.23 \times 10^{-3}$  moles of zinc, calculated by dividing  $3.75 \times 10^{21}$  by  $6.022 \times 10^{23}$ .

### **What is the molar mass of zinc used in this calculation?**

The molar mass of zinc used is 65.39 grams per mole.

### **Calculate the mass in grams of $3.75 \times 10^{21}$ atoms of zinc.**

First, find the moles:  $3.75 \times 10^{21} / 6.022 \times 10^{23} \approx 6.23 \times 10^{-3}$  mol. Then, multiply by molar mass:  $6.23 \times 10^{-3}$  mol  $\times$  65.39 g/mol  $\approx$  0.407 grams.

### **What is the final answer for the mass of $3.75 \times 10^{21}$ atoms of zinc?**

The mass is approximately 0.407 grams.

## **Additional Resources**

### **Determine the Mass in Grams of $3.75 \times 10^{21}$ Atoms of Zinc: A Detailed Analytical Approach**

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#### **Introduction**

Understanding the relationship between atoms, moles, and mass is fundamental to mastering concepts in chemistry. Whether you're a student, educator, or professional, being able to convert between these quantities enables a deeper grasp of chemical composition and reactions. In this article, we will explore the process of determining the mass in grams of a specified number of zinc atoms—in this case,  $3.75 \times 10^{21}$  atoms—using the known molar mass of zinc, which is 65.39 grams per mole.

This problem exemplifies core principles in stoichiometry and atomic-mass relationships, illustrating how microscopic entities relate to macroscopic measurements. The step-by-step breakdown will not only provide the answer but will also shed light on the underlying concepts and calculations involved.

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## Understanding the Problem

Before diving into calculations, it is essential to understand what is being asked:

- Objective: Find the mass in grams of a given number of zinc atoms, specifically  $3.75 \times 10^{21}$ .
- Given Data:
- Number of atoms:  $3.75 \times 10^{21}$
- Molar mass of zinc: 65.39 grams/mole

The challenge lies in converting the number of atoms into moles, then translating moles into grams. This involves using Avogadro's number, which is a fundamental constant in chemistry.

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## Fundamental Concepts in Atomic to Mass Conversion

To comprehend and perform this conversion accurately, it is necessary to understand several key concepts:

### 1. Atoms and Moles:

- A mole is a counting unit in chemistry, representing a specific number of particles—atoms, molecules, ions, etc.
- Avogadro's number ( $6.022 \times 10^{23}$ ) defines the number of particles in one mole.

### 2. Molar Mass:

- The molar mass of an element (here, zinc) signifies the mass of one mole of its atoms, expressed in grams.
- For zinc, this is 65.39 g/mol.

### 3. Conversion Factors:

- To convert from atoms to moles:

$$\begin{aligned} & \backslash[ \\ & \text{Number of moles} = \frac{\text{Number of atoms}}{\text{Avogadro's number}} \\ & \backslash] \end{aligned}$$

- To convert from moles to grams:

$$\begin{aligned} & \backslash[ \\ & \text{Mass (g)} = \text{Number of moles} \times \text{Molar mass (g/mol)} \\ & \backslash] \end{aligned}$$

Understanding these relationships is crucial for accurate calculations.

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## Step-by-Step Calculation

Step 1: Calculate the number of moles of zinc

Given:

- Number of atoms =  $3.75 \times 10^{21}$
- Avogadro's number =  $6.022 \times 10^{23}$  atoms/mole

The formula:

$$\text{Moles of zinc} = \frac{3.75 \times 10^{21}}{6.022 \times 10^{23}}$$

Calculating:

$$\begin{aligned}\text{Moles} &= \frac{3.75}{6.022} \times 10^{21 - 23} \\ &= 0.623 \times 10^{-2} \\ &= 6.23 \times 10^{-3} \text{ moles}\end{aligned}$$

This indicates that the sample contains approximately 0.00623 moles of zinc.

Step 2: Convert moles to grams

Using the molar mass of zinc (65.39 g/mol):

$$\text{Mass} = 6.23 \times 10^{-3} \times 65.39$$

Calculating:

$$\text{Mass} \approx 0.407 \text{ grams}$$

Therefore, the mass of  $3.75 \times 10^{21}$  zinc atoms is approximately 0.407 grams.

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## Analysis and Context

### Why Is This Calculation Significant?

This calculation exemplifies how chemists bridge the microscopic world of atoms with macroscopic measurements. In laboratory and industrial settings, understanding how to convert between quantities is essential for preparing solutions, predicting reaction yields, and analyzing materials.

The result—approximately 0.407 grams—is a tiny mass, illustrating how a relatively modest number of atoms corresponds to a small but measurable

amount of material.

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### Factors Influencing the Calculation

While the calculation appears straightforward, several nuances and considerations are worth noting:

- Precision of Constants:

The molar mass and Avogadro's number have high precision but can vary slightly depending on the source. For most calculations, using the standard values suffices.

- Significance of the Result:

The significant figures in the input data ( $3.75 \times 10^{21}$ ) suggest that the final answer should be reported with three significant figures, aligning with the input precision.

- Implications in Real-world Applications:

Such calculations are foundational in fields like materials science, pharmacology, and chemical engineering, where precise quantities are critical.

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### Additional Considerations

#### Alternative Approaches

- Using Proportions:

One could set up proportion equations, but direct conversion using constants is more straightforward and less error-prone.

- Error Analysis:

For highly precise work, considering measurement uncertainties and error propagation is vital.

#### Scaling to Larger or Smaller Quantities

- For larger quantities, conversions follow the same principles, but the calculations scale accordingly.

- For smaller quantities, the same approach applies, emphasizing the universality of the method.

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### Summary and Conclusion

Converting a specific number of atoms to grams involves understanding and applying the core concepts of moles, atomic mass, and Avogadro's number. In



this case, the calculation reveals that  $3.75 \times 10^{21}$  atoms of zinc correspond to approximately 0.407 grams of the element.

This process underscores the importance of fundamental constants and conversion factors in chemistry, allowing scientists to navigate seamlessly from the microscopic realm of atoms to the tangible world of grams and liters. Mastery of these conversions enhances scientific literacy and supports accurate experimentation and analysis across various disciplines.

In essence, knowing how to determine the mass of a given quantity of atoms enables detailed insights into material composition and reactivity, forming the backbone of chemical quantification and laboratory precision.

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## References

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## Final Thoughts

Accurate calculations such as these are more than mere academic exercises—they are crucial tools that underpin scientific discovery and technological advancement. Whether measuring trace amounts in pharmaceuticals or designing new materials, the ability to convert between atoms and grams forms an essential part of the chemist's toolkit.

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