What Is The Mass Of 2.53x10^34 Atoms Of Ni?

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Understanding the mass of a specific number of atoms is fundamental in chemistry and physics, especially when dealing with elements like nickel (Ni). If you've ever wondered how much a certain number of nickel atoms weigh, you're not alone. In this article, we will explore how to calculate the mass of 2.53×10^34 atoms of nickel, breaking down the steps involved, the concepts behind the calculation, and the significance of this process in scientific contexts.

Fundamental Concepts: Atoms, Moles, and Atomic Mass

Before diving into the calculation, it's essential to grasp some key concepts that underpin the process.

What Are Atoms?

Atoms are the basic building blocks of matter. Each element, including nickel, consists of atoms with a specific atomic structure. The number of atoms in a given sample determines its mass and other physical properties.

What Is a Mole?

A mole is a fundamental unit in chemistry representing a specific number of particles—atoms, molecules, or ions. One mole equals approximately 6.022×10^23 particles, known as Avogadro's number.

Atomic Mass and Its Significance

The atomic mass of an element (measured in atomic mass units, amu) indicates the average mass of one atom of that element. For nickel, the atomic mass is approximately 58.69 amu. This value is crucial for converting between the number of atoms and the mass of a sample.

Calculating the Mass of 2.53×10^34 Atoms of Nickel

Let's now walk through the process to determine the mass of 2.53×10^34 nickel atoms.

Step 1: Understand the Known Values

- Number of nickel atoms (N): 2.53×10^34
- Atomic mass of nickel (M): 58.69 g/mol
- Avogadro's number (NA): 6.022×10^23 atoms/mole

Step 2: Convert Atoms to Moles

Since atomic mass is expressed per mole, the first step is to convert the number of atoms to moles using Avogadro's number:

Number of moles (n) = Number of atoms (N) / Avogadro's number (NA)

Calculating:

n = 2.53×10^34 atoms / 6.022×10^23 atoms/mole

Let's perform this division:

n ≈ (2.53 / 6.022) × (10^34 / 10^23)

n ≈ 0.4202 × 10^(34 - 23)

n ≈ 0.4202 × 10^11

n ≈ 4.202×10^10 moles

Result: The sample contains approximately 4.202×10^10 moles of nickel.

Step 3: Convert Moles to Mass

Now, multiply the number of moles by the atomic mass to find the total mass:

Mass (m) = n × M

m ≈ 4.202×10^10 mol × 58.69 g/mol

Calculating:

m ≈ (4.202 × 58.69) × 10^10 grams

First, multiply 4.202 by 58.69:

4.202 × 58.69 ≈ 246.66

Then,

m ≈ 246.66 × 10^10 grams

Expressed in scientific notation:

m ≈ 2.4666 × 10^12 grams

Result: The mass of 2.53×10^34 atoms of nickel is approximately 2.47×10^12 grams.

Implications and Significance of the Calculation

Understanding how to convert between atoms, moles, and mass is fundamental for various scientific and industrial applications.

Applications in Chemistry and Industry

- Material Science: Estimating quantities of nickel for manufacturing components.
- Research: Calculating the mass of atoms involved in nuclear reactions or experiments.
- Environmental Science: Assessing nickel contamination levels in ecosystems.

Why Is This Calculation Important?

Knowing the mass corresponding to a specific number of atoms helps scientists:

- Design experiments with precise quantities.
- Understand the scale of atomic interactions.
- Convert microscopic atomic data into macroscopic measurements relevant in real-world scenarios.

Additional Considerations and Tips

When performing such calculations, keep in mind:

- Atomic mass values can vary slightly based on isotope composition; use the most accurate atomic weight for precise calculations.
- Remember to keep track of units throughout the calculation process to avoid errors.
- Scientific notation is your friend when dealing with very large or very small numbers.

Summary

To summarize:

- Start with the number of atoms you want to convert.
- Divide by Avogadro's number to find the number of moles.
- Multiply the number of moles by the atomic mass of nickel to find the total mass.

Applying this method, the mass of 2.53×10^{34} atoms of nickel is approximately 2.47×10^{12} grams, or about 2.470 billion kilograms. This colossal mass illustrates how unimaginably large atomic counts translate into tangible quantities in the physical world.

Conclusion

Calculating the mass of a specific number of atoms, such as 2.53×10^34 nickel atoms, is a foundational skill in science, bridging the microscopic world of atoms with macroscopic measurements. By understanding atomic mass, Avogadro's number, and the conversion process, scientists and students alike can perform precise calculations that inform research, industry, and everyday understanding of matter. Whether you're a student learning chemistry or a professional working in materials science, mastering these conversions enhances your ability to interpret and manipulate the atomic scale in practical applications.

Frequently Asked Questions

How do I calculate the mass of 2.53×10^34 atoms of nickel (Ni)?

To find the mass, multiply the number of atoms by the molar mass of Ni and divide by Avogadro's number: mass = (number of atoms × molar mass) / Avogadro's number.

What is the molar mass of nickel (Ni)?

The molar mass of nickel is approximately 58.69 grams per mole.

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

Avogadro's number is 6.022×10^23 atoms per mole. It converts between atoms and moles, allowing us to calculate mass from the number of atoms.

Can I use a simple formula to find the mass of 2.53×10^34 Ni atoms?

Yes. The formula is: mass = (number of atoms × molar mass) / Avogadro's number. Plug in the values to perform the calculation.

What is the approximate mass in grams of 2.53×10^34 atoms of Ni?

The approximate mass is about 2.45×10^12 grams or 2.45 billion kilograms.

Why is the mass so large for 2.53×10^34 atoms of Ni?

Because the number of atoms is extremely large, leading to a correspondingly huge mass when converted from atoms to grams.

How does understanding this calculation help in chemistry or materials science?

It helps quantify large quantities of elements at atomic scales, essential for stoichiometry, material synthesis, and understanding atomic-scale properties.

Additional Resources

What Is The Mass Of 2.53x10^34 Atoms Of Ni?

Understanding the mass of a specific number of atoms is a fundamental concept in chemistry and physics, bridging

the microscopic world of atoms to the macroscopic quantities we measure and use daily. When asked "What is the mass of 2.53×10^34 atoms of Ni?", it might seem like a straightforward calculation, but it involves several important concepts: Avogadro's number, the atomic weight of nickel, and unit conversions. In this comprehensive guide, we'll explore these concepts step-by-step to provide a clear, detailed answer to this question.

Understanding the Basic Concepts

Before diving into calculations, it's essential to understand some foundational ideas:

What Is an Atom of Nickel (Ni)?

- Nickel (Ni) is a transition metal with atomic number 28.
- An atom of nickel contains 28 protons, and typically a similar number of neutrons in its most common isotope.
- The atomic weight of nickel (average atomic mass) is approximately 58.69 atomic mass units (amu).

What Is Avogadro's Number?

- Avogadro's number is 6.022×10^23.
- It represents the number of atoms, molecules, or particles in one mole of a substance.
- This constant allows us to convert between the microscopic scale (atoms) and the macroscopic scale (grams, kilograms).

What Is a Mole?

- A mole is a quantity used in chemistry to count particles, equivalent to Avogadro's number of particles.
- 1 mole of nickel atoms contains approximately 6.022×10^23 atoms.

Step-by-Step Calculation

Now, let's walk through the process of calculating the mass of 2.53×10^34 atoms of nickel.

Step 1: Write down what you know

- Number of atoms, N = 2.53×10^34 atoms
- Atomic weight of Ni, M = 58.69 g/mol
- Avogadro's number, N_A = 6.022×10^23 atoms/mol

Step 2: Convert atoms to moles

Since 1 mole of nickel contains 6.022×10^23 atoms, the number of moles (n) in 2.53×10^34 atoms is:

n = Number of atoms / Avogadro's number

n = (2.53×10^34) / (6.022×10^23)

Let's perform this division carefully:

- Numerator: 2.53×10^34
- Denominator: 6.022×10^23

Dividing the coefficients:

2.53 / 6.022 ≈ 0.420

Dividing the powers of 10:

10^34 / 10^23 = 10^(34-23) = 10^11

Therefore:

n ≈ 0.420 × 10^11

To express this more neatly:

n ≈ 4.20 × 10^10 moles

Step 3: Calculate the mass

Now, to find the mass (m), multiply the number of moles by the molar mass:

m = n × M

m = (4.20 × 10^10 mol) × (58.69 g/mol)

Multiplying:

4.20 × 58.69 ≈ 246.5

And keeping the power of ten:

m ≈ 246.5 × 10^10 g

Expressed in standard scientific notation:

m ≈ 2.465 × 10^12 g

Final Answer

The mass of 2.53×10^34 atoms of nickel (Ni) is approximately 2.47×10^12 grams, or about 2.47 million metric tonnes.

Additional Insights and Context

Understanding this magnitude helps put the calculation into perspective:

- Mass comparison: The mass is comparable to a large commercial freight train or a sizeable natural lake.
- Practical implications: Such a quantity of nickel is far beyond typical laboratory scales, more akin to industrial quantities used in manufacturing or mining.

Common Mistakes to Avoid

When performing similar calculations, be mindful of these pitfalls:

- Mixing units: Ensure that the atomic weight and molar mass are in grams per mole when calculating mass.
- Incorrectly applying Avogadro's number: Remember it's for converting between atoms and moles.
- Forgetting scientific notation: Keep track of exponents to avoid errors in magnitude.

Summary of the Calculation Process

Here's a quick recap:

1. Identify known quantities: number of atoms, atomic weight, Avogadro's number.
2. Convert atoms to moles: divide the number of atoms by Avogadro's number.
3. Convert moles to mass: multiply the moles by the atomic weight.
4. Express the final answer in appropriate units and notation.

Final Thoughts

Calculating the mass of a specific number of atoms illustrates how microscopic quantities translate into macroscopic measurements. While the number 2.53×10^34 is enormous in atomic terms, the process remains straightforward once you understand the role of constants like Avogadro's number and the atomic weight. This exercise highlights the power of fundamental chemistry principles in bridging scales, allowing scientists and engineers to quantify and manipulate materials with precision.

Whether you're a student preparing for exams, a researcher working with materials, or simply a curious mind, mastering these calculations enhances your understanding of the atomic world and its connection to measurable quantities.

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