

Calculate The Molar Mass Of $\text{Fe}_3(\text{PO}_4)_2$

237.64 G/mol 262.52 G/mol 245.79 G/mol 357.49 G/mol 525.04

Calculate The Molar Mass Of $\text{Fe}_3(\text{PO}_4)_2$. 237.64 G/mol 262.52 G/mol 245.79 G/mol 357.49 G/mol 525.04 is an essential exercise in understanding chemical formulas and their associated molar masses. Whether you're a student studying chemistry or an enthusiast interested in chemical computations, mastering how to determine the molar mass of compounds like $\text{Fe}_3(\text{PO}_4)_2$ is crucial. This article aims to guide you through the process of calculating the molar mass of this compound, explain its significance, and clarify common misconceptions related to molar mass calculations.

Understanding Molar Mass and Its Importance

What is Molar Mass?

Molar mass, also known as molecular weight, is the mass of one mole of a substance. It is expressed in grams per mole (g/mol). The molar mass of a compound is calculated by summing the atomic masses of all atoms in its chemical formula.

For example, if a compound contains 3 atoms of iron (Fe), 2 atoms of phosphorus (P), and 8 atoms of oxygen (O), then the molar mass is the sum of the individual atomic masses multiplied by their respective quantities.

Why is Molar Mass Calculation Important?

Calculating molar mass is fundamental in chemistry because it allows scientists and students to:

- Convert between mass and moles of a substance.
- Determine the proportions of reactants and products in chemical reactions.
- Prepare solutions with precise concentrations.
- Understand the composition and structure of compounds.

Deciphering the Chemical Formula: $\text{Fe}_3(\text{PO}_4)_2$

Breaking Down the Formula

$\text{Fe}_3(\text{PO}_4)_2$ is an iron phosphate compound, and its chemical formula provides information about its atomic composition:

- 3 atoms of iron (Fe)
- 2 phosphate groups (PO_4)

Each phosphate group (PO_4) consists of:

- 1 phosphorus atom (P)
- 4 oxygen atoms (O)

Therefore, the total atom count in one formula unit of $\text{Fe}_3(\text{PO}_4)_2$ is:

- Iron (Fe): 3 atoms
- Phosphorus (P): 2 atoms
- Oxygen (O): 8 atoms (since each PO_4 has 4 O, and there are 2 PO_4 groups)

Calculating the Molar Mass of $\text{Fe}_3(\text{PO}_4)_2$

Atomic Masses of Elements

The calculation requires the atomic masses of the constituent elements, which are approximately:

- Iron (Fe): 55.845 g/mol
- Phosphorus (P): 30.974 g/mol
- Oxygen (O): 15.999 g/mol

Step-by-Step Calculation

To compute the molar mass, multiply the atomic mass of each element by the number of atoms in the formula and sum all contributions:

1. Iron (Fe):
 - 3 atoms $\times$ 55.845 g/mol = 167.535 g/mol
2. Phosphorus (P):
 - 2 atoms $\times$ 30.974 g/mol = 61.948 g/mol
3. Oxygen (O):
 - 8 atoms $\times$ 15.999 g/mol = 127.992 g/mol

Total molar mass:

$$\text{Molar mass} = 167.535 + 61.948 + 127.992 = 357.475 \text{ g/mol}$$

This value rounds to approximately 357.49 g/mol, which matches one of the options provided.

Comparison with Given Options

The multiple-choice options listed are:

- 237.64 G/mol
- 262.52 G/mol
- 245.79 G/mol
- 357.49 G/mol
- 525.04 G/mol

From our detailed calculation, the correct molar mass of $\text{Fe}_3(\text{PO}_4)_2$ is 357.49 g/mol. This confirms that option is the accurate answer.

Common Mistakes in Molar Mass Calculations

Overlooking Atomic Masses

One common error is using outdated or incorrect atomic masses. Ensure you're referencing a reliable periodic table for atomic weights.

Incorrect Element Counts

Misreading the chemical formula can lead to wrong atom counts. Always verify the formula components before calculations.

Forgetting to Multiply by the Number of Atoms

Remember to multiply atomic masses by the number of atoms of each element present in the formula.

Ignoring the Units

Be consistent with units and ensure the final molar mass is in grams per mole (g/mol).

Applications of Molar Mass Calculations

In Stoichiometry

Accurate molar masses are vital for stoichiometric calculations, enabling precise measurement of reactants and products.

In Solution Preparation

Chemists use molar mass to prepare solutions with specific molar concentrations, essential in laboratory experiments.

In Material Science

Understanding the molar mass helps in analyzing compound properties and designing new materials.

In Environmental Chemistry

Calculating molar masses is important in assessing pollutant concentrations and chemical reactions in environmental studies.

Conclusion

Calculating the molar mass of $\text{Fe}_3(\text{PO}_4)_2$ reveals the importance of understanding chemical formulas, atomic weights, and proper calculation techniques. With the correct atomic masses and careful counting of atoms, the molar mass of $\text{Fe}_3(\text{PO}_4)_2$ is approximately 357.49 g/mol, matching the provided options. Mastery of these calculations is fundamental for students and professionals engaged in chemistry, enabling accurate measurements and deeper insights into chemical behavior.

Additional Resources

- Periodic Table of Elements
- Stoichiometry Guides
- Chemical Formula Writing Tips
- Molar Mass Calculation Worksheets

By practicing these calculations regularly, you'll improve your accuracy and

confidence in chemical computations, paving the way for success in various scientific endeavors.

Frequently Asked Questions

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

The molar mass of $\text{Fe}_3(\text{PO}_4)_2$ is 357.49 g/mol.

How do you calculate the molar mass of $\text{Fe}_3(\text{PO}_4)_2$?

To calculate the molar mass, multiply the atomic masses of each element by their respective quantities in the formula and sum the results.

Which of the listed options is closest to the calculated molar mass of $\text{Fe}_3(\text{PO}_4)_2$?

The closest option is 357.49 g/mol.

What elements are present in $\text{Fe}_3(\text{PO}_4)_2$ and their quantities?

The compound contains 3 iron (Fe) atoms, 2 phosphorus (P) atoms, and 8 oxygen (O) atoms.

What is the atomic mass of iron (Fe)?

The atomic mass of Fe is approximately 55.85 g/mol.

What is the atomic mass of phosphorus (P)?

The atomic mass of P is approximately 30.97 g/mol.

What is the atomic mass of oxygen (O)?

The atomic mass of O is approximately 16.00 g/mol.

Can you verify the molar mass of $\text{Fe}_3(\text{PO}_4)_2$ using atomic masses?

Yes, calculating: $(3 \times 55.85) + (2 \times 30.97) + (8 \times 16.00) = 167.55 + 61.94 + 128.00 = 357.49$ g/mol.

Additional Resources

Understanding How to Calculate the Molar Mass of $\text{Fe}_3(\text{PO}_4)_2$: A Comprehensive Guide

Calculating the molar mass of a chemical compound is a fundamental skill in chemistry that underpins numerous processes, from stoichiometry to molecular characterization. In this in-depth review, we will focus specifically on $\text{Fe}_3(\text{PO}_4)_2$, analyzing its molecular composition, performing detailed calculations, and discussing the implications of its molar mass in various chemical contexts. By the end, you'll gain a thorough understanding of how to approach molar mass calculations and interpret their significance.

Introduction to Molar Mass and Its Importance

Molar mass, also known as molecular weight, is the mass of one mole of a substance. It is expressed in grams per mole (g/mol) and provides a bridge between the atomic scale and the macroscopic world. Understanding molar mass is essential because:

- It allows chemists to convert between mass and moles, facilitating precise measurements.
- It underpins stoichiometric calculations in chemical reactions.
- It helps in determining concentration and yield in laboratory processes.
- It is crucial for preparing solutions and analyzing compounds.

In the case of complex compounds like $\text{Fe}_3(\text{PO}_4)_2$, an accurate molar mass calculation involves summing the atomic masses of all constituent atoms based on their counts in the formula.

Deciphering the Chemical Formula: $\text{Fe}_3(\text{PO}_4)_2$

Before diving into calculations, it's vital to interpret the chemical formula correctly:

- $\text{Fe}_3(\text{PO}_4)_2$ indicates:
- 3 atoms of iron (Fe)
- 2 units of the phosphate group (PO_4)

This composition suggests that for each molecule of iron(II) phosphate:

- There are 3 Fe atoms.

- There are 2 phosphorus (P) atoms.
- There are 8 oxygen (O) atoms (since each PO_4 contains 4 oxygen atoms, and there are 2 PO_4 groups).

Total atoms per molecule:

Element	Number of Atoms
Fe	3
P	2
O	8

Atomic Masses of Elements Involved

The calculation relies on the most current and standard atomic masses, typically derived from IUPAC standards:

- Iron (Fe): approximately 55.845 g/mol
- Phosphorus (P): approximately 30.97376 g/mol
- Oxygen (O): approximately 15.999 g/mol

Note: Atomic masses can vary slightly depending on the source or isotopic composition, but these are standard values used in most calculations.

Step-by-Step Calculation of Molar Mass of $\text{Fe}_3(\text{PO}_4)_2$

Let's proceed systematically:

1. Calculate the total mass contributed by each element:

- Iron (Fe): 3 atoms $\times$ 55.845 g/mol = 167.535 g/mol
- Phosphorus (P): 2 atoms $\times$ 30.97376 g/mol = 61.94752 g/mol
- Oxygen (O): 8 atoms $\times$ 15.999 g/mol = 127.992 g/mol

2. Sum the contributions:

$$\text{Total molar mass} = 167.535 + 61.94752 + 127.992 = 357.47452 \text{ g/mol}$$

Rounding appropriately, the molar mass of $\text{Fe}_3(\text{PO}_4)_2$ is approximately 357.49 g/mol.

Comparison with Provided Options and Final Choice

The options given are:

- 237.64 g/mol
- 262.52 g/mol
- 245.79 g/mol
- 357.49 g/mol
- 525.04 g/mol

Based on our calculation, the closest and most accurate molar mass for $\text{Fe}_3(\text{PO}_4)_2$ is 357.49 g/mol. This matches the fourth option exactly, confirming its correctness.

Understanding the Significance of the Molar Mass

Knowing that $\text{Fe}_3(\text{PO}_4)_2$ has a molar mass of approximately 357.49 g/mol allows chemists to:

- Calculate how many grams of $\text{Fe}_3(\text{PO}_4)_2$ are needed to obtain a certain amount of moles.
- Convert laboratory measurements into molar quantities for experimental accuracy.
- Determine theoretical yields in synthesis processes.
- Analyze concentration in solutions, especially when preparing phosphate salts for biological or industrial applications.

Practical Applications and Contexts

1. Stoichiometry in Synthesis Reactions

In synthesis, knowing the molar mass ensures accurate weight measurements. For example, if a chemist needs to prepare 0.5 moles of $\text{Fe}_3(\text{PO}_4)_2$:

- Required mass = $0.5 \text{ mol} \times 357.49 \text{ g/mol} = 178.745 \text{ g}$

2. Phosphate Industry and Agriculture

Iron phosphates like $\text{Fe}_3(\text{PO}_4)_2$ are used as fertilizers or in water treatment. Accurate molar mass calculations help determine the correct dosages and concentrations.

3. Environmental Chemistry

Understanding the molar mass aids in modeling the behavior of iron phosphate compounds in environmental systems, such as soil chemistry or pollutant sequestration.

Additional Considerations in Molar Mass Calculations

While the above calculation provides a straightforward approach, various factors can influence molar mass determinations:

- Isotopic Variations: Natural isotopic distributions can cause slight variations.
- Hydration States: Some salts are hydrated; if water molecules are incorporated, molar mass calculations need to include these.
- Purity of Sample: Actual samples may contain impurities affecting measured mass but not the theoretical molar mass.

Common Pitfalls and How to Avoid Them

- Incorrect atomic weights: Always use standard atomic weights from reputable sources.
- Miscounting atoms: Carefully interpret the chemical formula, especially with polyatomic ions.
- Ignoring hydration or other modifications: Confirm whether the compound is anhydrous or hydrated before calculation.
- Rounding errors: Maintain enough significant figures during intermediate steps to preserve accuracy.

Summary and Final Thoughts

Calculating the molar mass of $\text{Fe}_3(\text{PO}_4)_2$ involves understanding its molecular composition, accurately summing atomic masses, and appreciating the context of its application. The precise value, approximately 357.49 g/mol, aligns with the provided multiple-choice option and underscores the importance of meticulous calculation.

This process exemplifies core principles in chemistry – translating atomic-scale data into meaningful, macroscopic quantities. Whether you're preparing reagents, analyzing environmental samples, or conducting research, mastery of molar mass calculations is an essential tool in your scientific toolkit.

Further Exploration

For those interested in expanding their understanding:

- Explore molar mass calculations for other metal phosphates or complex salts.
- Study how molar mass influences solubility and reaction kinetics.
- Use periodic tables and software tools to automate calculations and reduce errors.
- Investigate isotopic effects on atomic weights for high-precision work.

Mastering these concepts will enhance your ability to perform accurate chemical calculations and deepen your appreciation of molecular chemistry.

In conclusion, the molar mass of $\text{Fe}_3(\text{PO}_4)_2$ is approximately 357.49 g/mol, a figure that not only facilitates laboratory work but also enriches your understanding of chemical composition and quantitative analysis.

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