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68 G Of A Compound Contain 64 G Of Oxygen And 4 G Of Hydrogen. Which Of The Following Is A Plausible Molecular?

Understanding the composition of chemical compounds is fundamental in chemistry, especially when analyzing their molecular formulas. In this article, we will explore how to determine plausible molecular formulas based on given mass data, specifically focusing on a compound weighing 68 grams, containing 64 grams of oxygen and 4 grams of hydrogen. We will delve into the principles of mass-to-mole conversions, empirical formulas, molecular formulas, and the importance of stoichiometry. This comprehensive guide aims to clarify how to approach such problems for students, educators, and chemistry enthusiasts alike.

Introduction to Compound Composition and Molecular Formulas

Chemicals are characterized by their composition in terms of atoms and molecules. The molecular formula provides the exact number of each type of atom in a molecule, whereas the empirical formula gives the simplest whole-number ratio of elements within the compound. Determining the plausible molecular formula based on mass data involves several steps, including calculating the moles of each element, deriving the empirical formula, and then establishing the molecular formula.

Key Concepts Covered in This Article:
- Mass-to-mole conversion
- Empirical formula determination
- Molecular formula calculation
- Validating plausible molecular structures

Understanding the Given Data

The problem provides specific details:
- Total mass of the compound: 68 grams
- Mass of oxygen: 64 grams
- Mass of hydrogen: 4 grams

From these data points, the goal is to deduce the most plausible molecular formula for this compound.

Key Observations:
- The entire mass of the compound is composed of oxygen and hydrogen.
- The sum of the given masses (64 g oxygen + 4 g hydrogen) equals 68 g, matching the total mass, confirming data consistency.

Step-by-Step Approach to Determining the Molecular Formula

1. Calculate the number of moles of each element

To find the moles, divide the mass of each element by its molar mass:

Element	Mass (g)	Molar Mass (g/mol)	Moles
Hydrogen (H)	4	1.008	4 / 1.008 ≈ 3.97 mol
Oxygen (O)	64	16.00	64 / 16.00 = 4 mol

Interpretation:
- Moles of hydrogen ≈ 3.97 mol
- Moles of oxygen = 4 mol

The close proximity of these values suggests the simplest mole ratio approximates 4:4, which simplifies further.

2. Determine the empirical formula

The mole ratio is approximately:

- Hydrogen: 3.97 mol ≈ 4 mol
- Oxygen: 4 mol

Dividing both by the smallest number (which is 4 mol):

Element	Moles	Divided by 4	Ratio (approximate)
Hydrogen	3.97	3.97 / 4 ≈ 1	1
Oxygen	4	4 / 4 = 1	1

Thus, the empirical formula is HO.

Note:
- The empirical formula suggests a 1:1 ratio between hydrogen and oxygen atoms.

3. Calculate the molar mass of the empirical formula

- Molar mass of HO:
- Hydrogen: 1.008 g/mol
- Oxygen: 16.00 g/mol
- Total: 1.008 + 16.00 ≈ 17.008 g/mol

4. Determine the molecular formula

- The molecular formula is a multiple (n) of the empirical formula:

$$
\text{Molecular weight} = n \times \text{Empirical formula weight}
$$

- The molecular weight is the total mass of the compound, which is 68 g (from the given data).

- Calculate n:

$$
n = \frac{\text{Molecular weight}}{\text{Empirical formula weight}} = \frac{68}{17.008} \approx 4
$$

- Therefore, the molecular formula is:

$$
(\text{HO})_4 = \text{H}_4\text{O}_4
$$

Validating the Plausibility of the Molecular Formula

The derived molecular formula H_4O_4 (or more accurately, a multiple of HO) appears plausible based on the mass data and molar ratios. However, additional factors can influence the plausibility:

Factors to Consider:

- Chemical stability: Does H_4O_4 exist as a stable molecule?
- Chemical structure: Are such molecules known or theoretically stable?
- Comparison with known compounds: For instance, peroxides and certain hydrated oxides contain multiple oxygen atoms bonded with hydrogen.

Known Compounds Similar to H_4O_4:
- Hydrogen peroxide (H_2O_2): Contains peroxide bonds, a well-known molecule.
- Hydrated forms of oxides: Sometimes contain multiple oxygen atoms per molecule.

Since H_4O_4 is not a common or stable molecule, the actual plausible structures may be derivatives or related compounds with similar ratios.

Common Examples of Similar Molecular Formulas

Understanding existing compounds helps validate the plausibility of the derived formula:

- Hydrogen peroxide (H_2O_2): Contains 2 hydrogen and 2 oxygen atoms.
- Peroxides: Contain O–O bonds, often with hydrogen or other elements.
- Hydrated oxides: Such as $CuCl_2 \cdot 2H_2O$, which contain multiple water molecules.

While H_4O_4 is not a typical molecule, the ratio and mass data align with a compound that could be a hydrate or peroxide derivative.

Summary and Final Considerations

Based on the calculations:

- The empirical formula for the compound is HO.
- The molecular formula, considering the molar mass ratio, is approximately H_4O_4.
- The approximate molecular weight matches the total mass of 68 grams, indicating the structure is plausible.

Final Notes:
- Always verify the chemical stability and known compounds before concluding.
- Consider whether the compound could be a hydrate, peroxide, or another derivative.
- Use additional spectroscopic or structural data for confirmation when possible.

Conclusion

Determining the plausible molecular formula from mass data involves careful calculations of moles, empirical formulas, and molecular formulas. In the case of 68 grams of a compound containing 64 grams of oxygen and 4 grams of hydrogen, the calculations suggest a molecular formula of approximately H_4O_4. While this formula is theoretically consistent with the data, real-world chemical stability and known compounds should guide further validation.

Understanding these principles enhances your ability to analyze chemical compositions, deduce molecular structures, and appreciate the complexities of chemical compounds in both academic and practical contexts.

FAQs

Q1: Can the molecular formula be different from the empirical formula?
A1: Yes. The empirical formula shows the simplest ratio, but the molecular formula is a multiple of this ratio. In some cases, the empirical and molecular formulas are the same.

Q2: How do I know if a molecule like H_4O_4 is stable?
A2: Stability depends on chemical bonding, known compounds, and experimental data. Consult chemical literature or databases to verify if such molecules exist or are plausible.

Q3: What if the masses provided do not match exactly?
A3: Small discrepancies can occur due to measurement errors or experimental conditions. Use ratios and percentages to approximate the empirical formula.

Q4: Are there other possible molecular formulas for this compound?
A4: Given the data, H_4O_4 is the most straightforward. Alternative formulas would require different mass distributions or assumptions.

Keywords for SEO optimization:
- Molecular formula determination
- Compound composition analysis
- Empirical and molecular formulas
- Chemistry stoichiometry
- Hydrogen oxygen compounds
- Mass-to-mole conversion
- Plausible chemical structures
- Chemical compound analysis
- Hydrate and peroxide compounds
- Chemical formula calculation examples

Frequently Asked Questions

Given a compound with 68 g total mass, containing 64 g oxygen and 4 g hydrogen, what is its molecular formula?

The molecular formula is likely H_2O_2 (hydrogen peroxide) since it matches the given masses and molar ratios.

How do you determine the empirical formula from the given masses of a compound containing oxygen and hydrogen?

Convert the masses to moles, divide by the smallest number of moles, and write the ratio to find the empirical formula; then compare molar mass to find the molecular formula.

Which molecular formula is plausible for a compound with 64 g of oxygen and 4 g of hydrogen in a total of 68 g?

A plausible molecular formula is H_2O_2, as it reflects the ratio of hydrogen to oxygen and the total mass.

Why is H_2O_2 a likely molecular formula for the compound with 64 g oxygen and 4 g hydrogen?

Because the mass ratio corresponds to two hydrogen atoms and two oxygen atoms, matching H_2O_2, which has a molar mass close to the total mass and the given composition.

What steps are involved in confirming the molecular formula from the given mass data?

Calculate moles of each element, determine the simplest ratio, find the empirical formula, and then multiply by an integer to match the molar mass with the total mass to confirm the molecular formula.

Additional Resources

Understanding the Composition: An In-Depth Analysis of the Compound Containing 68 g of Substance, 64 g of Oxygen, and 4 g of Hydrogen

In the realm of chemistry, deciphering the molecular structure of a compound based on its elemental composition is both an art and a science. Given a compound with a total mass of 68 grams, composed of 64 grams of oxygen and 4 grams of hydrogen, the question arises: which molecular formula plausibly corresponds to this composition? This inquiry not only demands an understanding of elemental ratios and molecular formulas but also invites a comprehensive review of potential compounds that fit these parameters.

Breaking Down the Composition: Fundamental Data and Its Implications

The Basic Data

- Total mass of compound: 68 grams
- Mass of oxygen: 64 grams
- Mass of hydrogen: 4 grams

These figures immediately suggest that the compound is predominantly oxygen, with a small fraction of hydrogen. To understand this better, we need to analyze the molar quantities of each element.

Calculating Moles of Each Element

The molar masses of the elements are standard:

- Hydrogen (H): 1.008 g/mol
- Oxygen (O): 16.00 g/mol

Using these values:

Moles of Hydrogen:

$$
\text{Moles of H} = \frac{4\, \text{g}}{1.008\, \text{g/mol}} \approx 3.97\, \text{mol}
$$

Moles of Oxygen:

$$
\text{Moles of O} = \frac{64\, \text{g}}{16.00\, \text{g/mol}} = 4\, \text{mol}
$$

Elemental Ratio

The molar ratio of hydrogen to oxygen is approximately:

$$
\frac{3.97}{4} \approx 0.993
$$

which is very close to 1:1. This suggests that, on a molar basis, the compound might have a simple ratio of H to O elements, close to 1:1.

Determining the Empirical Formula

Step 1: Simplify the molar ratio

The molar ratio is approximately:

- H : O ≈ 1 : 1

Given the near 1:1 ratio, the empirical formula likely involves equal numbers of hydrogen and oxygen atoms.

Step 2: Express as the simplest whole number ratio

Since the molar ratio is nearly 1:1, the simplest empirical formula could be:

- HO

Step 3: Confirming the empirical formula's mass

Calculate the molar mass of HO:

$$
\text{Mass of HO} = 1.008\, \text{g} + 16.00\, \text{g} = 17.008\, \text{g}
$$

Step 4: Scaling to match the total mass

Total mass of the compound: 68 grams.

Number of empirical units in the total mass:

$$
\frac{68\, \text{g}}{17.008\, \text{g}} \approx 4
$$

This indicates that the molecular formula is likely:

$$
\text{(HO)}_4
$$

which simplifies to:

$$
\text{H}_4\text{O}_4
$$

\]

Analyzing the Plausible Molecular Formula

The Molecular Formula: H_4O_4

Based on the calculations, the plausible molecular formula appears to be H_4O_4. This formula is consistent with the molar ratio, total mass, and elemental composition.

Structural Considerations

- Is H_4O_4 a known compound?
While not common in everyday chemistry, compounds with multiple oxygen and hydrogen atoms, such as peroxides, peracids, or hydrated forms, can sometimes have similar formulas.

- Possible molecular structures include:
- Peroxy compounds (containing O–O bonds)
- Hydrated or polymeric forms of peroxides
- Hydrogen peroxide derivatives

Stability and plausibility:

The formulation H_4O_4 can be viewed as a dimer or complex form of hydrogen peroxide (H_2O_2), possibly as a hydrated peroxide or a peroxo compound with additional oxygen atoms.

Potential Candidates for the Molecular Formula

Given the empirical formula H_4O_4, some plausible molecular candidates include:

1. Hydrogen Peroxide Dimer $(H_2O_2)_2$

- Molecular weight: 68 g/mol
- Description: Two H_2O_2 molecules joined together, sharing peroxide bonds.

Pros:

- Matches the total molecular weight (68 g).
- Consists of 4 hydrogen and 4 oxygen atoms, aligning with H_4O_4.

Cons:

- Usually, hydrogen peroxide exists as monomers or in aqueous solutions, but dimers are known in condensed phases.

2. A Peroxo-Linked Compound with Additional Oxygen

- Could be a peroxo-bridged compound stabilized in a particular form.

3. Hydrated or Complex Peroxide Structures

- Such as peroxy acids or peroxo salts with extra oxygen atoms.

Implications and Final Thoughts

Why Is H_4O_4 the Most Plausible Molecular Formula?

- The molar ratio of hydrogen to oxygen aligns with 1:1.
- The total mass matches the molecular weight of hydrogen peroxide dimer.
- The elemental analysis indicates a compound rich in oxygen and a small proportion of hydrogen, consistent with peroxide structures.

Broader Context: Significance in Chemistry and Industry

Hydrogen peroxide and its derivatives are significant in various applications:

- Antiseptic and disinfectant solutions
- Bleaching agents in the textile and paper industries
- Chemical synthesis intermediates

Understanding the molecular composition of such compounds is vital for their safe handling, storage, and application.

Final Note:

While the specific compound fitting the exact composition of 68 g total mass with 64 g of oxygen and 4 g of hydrogen is most plausibly the hydrogen peroxide dimer (H_4O_4), further structural analysis, spectroscopic data, or crystallography would be necessary to confirm the exact molecular structure.

Conclusion

In summary, analyzing the elemental composition of a compound with 68 grams total mass, 64 grams of oxygen, and 4 grams of hydrogen leads us to a compelling conclusion: the molecular formula is most likely H_4O_4, which corresponds to a hydrogen peroxide dimer or a similar peroxide-based structure. This insight not only deepens our understanding of peroxide chemistry but also exemplifies how fundamental chemical calculations can unveil the nature of complex compounds. Whether in academic research, industrial applications, or safety assessments, such detailed compositional analysis remains a cornerstone of chemical expertise.

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