Find The Molecular Formula Of Each Compound CCl , 189.83 G/mol C3H2N , 156.23 G/mol

Find The Molecular Formula Of Each Compound CCl , 189.83 G/mol C3H2N , 156.23 G/mol involves understanding the fundamental principles of molecular weight calculation and chemical formula derivation. Determining the molecular formula of a compound is a crucial step in understanding its structure, properties, and reactivity. In this article, we will explore how to find the molecular formulas of three compounds based on their molar masses: CCl, C3H2N, and another compound with a molar mass of 156.23 g/mol. Through detailed explanations and step-by-step methods, you will gain a solid understanding of the process involved in molecular formula determination.

Understanding the Concept of Molecular Formula

Before diving into the calculations, it is essential to clarify what a molecular formula is. The molecular formula of a compound indicates the actual number of each type of atom present in a molecule. It is different from the empirical formula, which represents the simplest whole-number ratio of atoms in the compound.

Key points to remember:

- The molecular formula provides the exact number of atoms of each element.
- It is derived from the empirical formula by multiplying by an integer factor.
- The molar mass (or molecular weight) of the compound helps determine the molecular formula.

Step-by-Step Approach to Find the Molecular Formula

The process of determining the molecular formula generally involves the following steps:

1. Determine the empirical formula

- Use percentage composition or given data to find the simplest whole-number ratio of atoms.

2. Calculate the empirical formula mass

- Sum of atomic masses based on the empirical formula.

3. Find the molecular formula factor

- Divide the molar mass of the compound by the empirical formula mass.

4. Derive the molecular formula

- Multiply the empirical formula by the factor obtained above.

Now, we will apply this approach to each compound based on the data provided.

Compound 1: CCl

The given molar mass is 189.83 g/mol. The formula appears to be CCl, but as it is not a typical molecule, we need to interpret what this could represent.

Possible interpretation:

- CCl could be shorthand or a typo, but assuming it refers to a compound with carbon and chlorine, possibly chloromethane or a related compound.

However, since the formula is just CCl, it suggests a molecule with 1 carbon and 1 chlorine atom.

- Atomic mass of Carbon (C): 12.01 g/mol
- Atomic mass of Chlorine (Cl): 35.45 g/mol

Molecular weight of CCl:

12.01 + 35.45 = 47.46 g/mol

This is significantly less than 189.83 g/mol, indicating this is not the molecular weight of a single CCl molecule but possibly the molar mass of a larger or more complex compound involving C and Cl.

Alternatively, it might be a typo or incomplete formula. Let's assume the compound is CCl_n with some number of chlorine atoms, and the molar mass is 189.83 g/mol.

Determining the number of chlorine atoms:

Suppose the molecular formula is C_xCl_y, and the molar mass is:

$M = (x \times 12.01) + (y \times 35.45)$

Given $M \approx 189.83$ g/mol, and considering possible integer values of y.

- For y = 4:

$(x \times 12.01) + 4 \times 35.45 = 189.83$

$(x \times 12.01) + 141.8 = 189.83$

$x \times 12.01 = 48.03$

$x \approx 4$

Thus, possible formula: C_4Cl_4.

Check molar mass:

$(4 \times 12.01) + (4 \times 35.45) = 48.04 + 141.8 = 189.84$ g/mol

This aligns perfectly with the given molar mass.

Therefore, the molecular formula is likely $C_{\square}Cl_{\square}$.

Compound 2: C3H2N

The molar mass is 189.83 g/mol.

Let's verify if the given molecular formula matches this molar mass.

Calculate molar mass of C3H2N:
- Carbon (C): 3 × 12.01 = 36.03 g/mol
- Hydrogen (H): 2 × 1.008 = 2.016 g/mol
- Nitrogen (N): 14.01 g/mol

Total: 36.03 + 2.016 + 14.01 = 52.056 g/mol

This is much less than 189.83 g/mol, indicating that C3H2N is likely the empirical formula, and the actual molecule is a multiple of this.

Find the ratio factor:

Factor = 189.83 / 52.056 $\square$ 3.648

Since the ratio factor should be an integer, and 3.648 is close to 4, we can assume the molecular formula is approximately 4 times the empirical formula:

- Multiply each subscript by 4:

C: 3 × 4 = 12

H: 2 × 4 = 8

N: 1 × 4 = 4

Final molecular formula: C□□H□N□

Verify molar mass:

- C: 12 × 12.01 = 144.12 g/mol
- H: 8 × 1.008 = 8.064 g/mol
- N: 4 × 14.01 = 56.04 g/mol

Total: 144.12 + 8.064 + 56.04 = 208.224 g/mol

This exceeds 189.83 g/mol, suggesting the previous approximation was slightly off. Let's try a factor of 3:

- Subscripts:

C: 3 × 3 = 9

H: 2 × 3 = 6

N: 1 × 3 = 3

Calculate molar mass:

- C: 9 × 12.01 = 108.09 g/mol
- H: 6 × 1.008 = 6.048 g/mol
- N: 3 × 14.01 = 42.03 g/mol

Total: 108.09 + 6.048 + 42.03 = 156.168 g/mol

This is very close to 156.23 g/mol, the given molar mass.

Conclusion:
The molecular formula is $C_{\square}H_{\square}N_{\square}$.

But wait, our calculation shows $C_{\square}H_{\square}N_{\square}$ for molar mass of approximately 156.23 g/mol, matching the provided molar mass.

Therefore, the molecular formula for the second compound is $C_{\square}H_{\square}N_{\square}$.

Compound 3: 156.23 G/mol (No formula provided)

Since only the molar mass is given without a formula, we need to assume it's a known compound or use similar reasoning.

If the compound has an empirical formula similar to previous ones, perhaps CxHyNz, and the molar mass is 156.23 g/mol.

Suppose the empirical formula is $C_{\square}H_{\square}N$, which has molar mass:

- $C_{\square}$: 36.03 g/mol
- $H_{\square}$: 2.016 g/mol
- N: 14.01 g/mol

Total: 36.03 + 2.016 + 14.01 = 52.056 g/mol

Factor: 156.23 / 52.056 $\approx$ 3

Multiplying subscripts by 3:

C: 3 × 3 = 9

H: 2 × 3 = 6

N: 1 × 3 = 3

Molar mass:

- C: 9 × 12.01 = 108.09 g/mol
- H: 6 × 1.008 = 6.048 g/mol
- N: 3 × 14.01 = 42.03 g/mol

Total: 108.09 + 6.048 + 42.03 □ 156.17 g/mol

Close to 156.23 g/mol, confirming the molecular formula is C□H□N□.

Summary of Findings

Based on the calculations and assumptions made, the molecular formulas are:

- Compound 1 (Molar mass 189.83 g/mol): C□Cl□
- Compound 2 (Molar mass 189.83 g/mol): C□H□N□
- Compound 3 (Molar mass 156.23 g/mol): C□H□N□

Additional Tips for Determining Molecular Formulas

- Always verify the atomic weights used, as slight variations can influence calculations.
- Use percentage composition data when available for more accurate empirical formulas.
- Consider common oxidation states and typical molecular structures to guide formula guesses.
- When molar masses are close but not exact multiples, re

Frequently Asked Questions

How do you determine the molecular formula of a compound given its molar mass and empirical formula?

To determine the molecular formula, first find the molar mass of the empirical formula, divide the given molar mass by this value to find a multiplication factor, and then multiply each subscript in the empirical formula by this factor to get the molecular formula.

What is the molecular formula of the compound with a molar mass of 189.83 g/mol and an empirical formula of CCl?

First, calculate the molar mass of CCl: 12.01 (C) + 35.45 (Cl) = 47.46 g/mol. Then, divide 189.83 g/mol by 47.46 g/mol to get approximately 4.00. Multiplying the empirical formula subscripts by 4 gives the molecular formula: C4Cl4.

How do you find the molecular formula for C3H2N with a molar mass of 156.23 g/mol?

Calculate the molar mass of the empirical formula C3H2N: (3×12.01) + (2×1.008) + 14.01 = 37.03 + 2.016 + 14.01 = 53.05 g/mol. Divide 156.23 g/mol by 53.05 g/mol to get approximately 2.95, rounding to 3. Multiply subscripts by 3: C9H6N3.

What is the significance of the ratio obtained when dividing the molar mass by the empirical formula mass?

The ratio indicates how many times the empirical formula repeats in the molecular formula. It should be a whole number or close to it, allowing for precise determination of the molecular formula.

Can the ratio obtained be a non-integer, and how should it be handled?

Ideally, the ratio is a whole number. If it is a non-integer, it suggests the empirical formula might need to be simplified or that the calculation should be rounded to the nearest whole number to accurately determine the molecular formula.

Why is it important to know the empirical formula before finding the molecular formula?

The empirical formula provides the simplest whole-number ratio of elements in a compound, serving as the basis for calculating the molecular formula once the molar mass is known.

What are common pitfalls when calculating the molecular formula from molar mass and empirical formula?

Common pitfalls include incorrect molar mass calculations, rounding errors in the ratio, and assuming the empirical formula is already the molecular formula. Careful calculation and checking are essential.

How can spectroscopic data assist in confirming the molecular formula of a compound?

Spectroscopic techniques like NMR, IR, and mass spectrometry provide structural information and molecular weight confirmation, helping to verify the molecular formula derived from calculations.

Is the molecular formula always a simple multiple of the empirical formula?

Yes, the molecular formula is always a whole-number multiple of the empirical formula, reflecting the actual number of each element in a molecule.

Additional Resources

Find The Molecular Formula Of Each Compound CCl, 189.83 G/mol C□H□N, 156.23 G/mol – this task is fundamental in understanding the composition of chemical compounds and deciphering their molecular identities. Determining the molecular formula from molecular weight and empirical data is a core skill in chemistry that enables scientists to interpret molecular structures, predict chemical behavior, and synthesize new compounds effectively. In this comprehensive guide, we'll explore step-by-step methods to find the molecular formula of each compound given their molar masses, with detailed explanations, calculations, and tips along the way.

Understanding the Importance of Molecular Formula Determination

Before diving into the calculations, it's important to grasp why identifying a molecular formula is essential:

- Molecular Identity: The molecular formula reveals the exact number of atoms of each element in a molecule, distinguishing compounds that may share the same empirical formula but differ in molecular size.
- Chemical Properties: Knowledge of the molecular structure influences reactivity, polarity, and physical properties.
- Synthesis & Analysis: Accurate molecular formulas are crucial in designing chemical syntheses and analyzing unknown substances.

Overview of the Data Provided

Let's analyze the data given for each compound:

1. First Compound:
- Molecular weight (molar mass): Not specified directly, but the formula is CCl.
- Given molar mass: 189.83 g/mol.

2. Second Compound:
- Molecular formula: C□H□N
- Molar mass: 189.83 g/mol (presumably for the second compound as well).

3. Third Compound:
- Molecular weight: 156.23 g/mol (likely for the third compound, which is C□H□N).

Note: The initial data appears to have some ambiguity, possibly due to formatting. For clarity, this guide interprets the compounds as follows:

- Compound 1: Molecular weight = 189.83 g/mol, formula to be determined.
- Compound 2: Given as C□H□N, molar mass = 189.83 g/mol (potentially same as Compound 1 or a different compound with similar molar mass).
- Compound 3: Given as C□H□N, molar mass = 156.23 g/mol.

Let's proceed assuming the task is to find the molecular formulas based on the provided molar masses and known empirical formulas.

Step 1: Recall the Basics – Empirical and Molecular Formulas

Empirical formula: the simplest whole-number ratio of atoms in a compound.

Molecular formula: the actual number of atoms in a molecule, which may be a whole-number multiple of the empirical formula.

Key relation:

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

Where:

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

Our goal is to find n, which must be a whole number, and then determine the molecular formula.

Step 2: Determine the Empirical Formula

For the compounds with known elements, the empirical formula can often be deduced if we have data about their composition or the molecular formula directly.

For $C_xH_yN_z$:

- Calculate the empirical formula weight:

$$
\text{C} = 12.01\,g/mol \\
\text{H} = 1.008\,g/mol \\
\text{N} = 14.01\,g/mol
$$

$$
\text{Empirical weight} = (3 \times 12.01) + (2 \times 1.008) + (1 \times 14.01) \\
= 36.03 + 2.016 + 14.01 = 52.056\,g/mol
$$

Step 3: Calculate the Multiple n

Now, compare the molar mass with the empirical weight:

For the compound with molar mass 189.83 g/mol:

$$
n = \frac{189.83\,g/mol}{52.056\,g/mol} \approx 3.65
$$

Since n should be a whole number for a valid molecular formula, this value suggests an approximation or that the empirical formula is close to C_3H_2N, but the actual molecular formula might be a multiple.

Possible explanation:

- If the molar mass is approximately 189.83 g/mol, and the empirical formula weight is 52.056 g/mol, then the ratio is close to 4:

$$
n \approx 4
$$

which indicates the molecular formula might be:

$$
\text{Molecular formula} = \text{Empirical formula} \times 4 = \text{C}_{12}\text{H}_8\text{N}_4
$$

Step 4: Finalize the Molecular Formula for Each Compound

Compound 1:

- Given molar mass: 189.83 g/mol
- Empirical formula weight (if assuming CCl):

- Carbon (C): 12.01 g/mol
- Chlorine (Cl): 35.45 g/mol

$$
\text{CCl} = 12.01 + 35.45 = 47.46\,g/mol
$$

- Calculate n:

$$
n = \frac{189.83}{47.46} \approx 4.00
$$

- Molecular formula:

$$
\text{CCl}_4
$$

This is consistent with the molecular weight of carbon tetrachloride.

Compound 2:

- Given molar mass: 189.83 g/mol
- Empirical formula: C_xH_yN
- Empirical weight: 52.056 g/mol (as calculated above)
- Calculate n:

$$
n = \frac{189.83}{52.056} \approx 3.65 \approx 4
$$

- Molecular formula:

$$
\text{C}_{12}\text{H}_8\text{N}_4
$$

which suggests the compound is a multiple of the empirical formula.

Compound 3:

- Given molar mass: 156.23 g/mol
- Empirical formula: C_xH_yN (weight 52.056 g/mol)
- Calculate n:

$$
n = \frac{156.23}{52.056} \approx 3.00
$$

- Molecular formula:

$$
\text{C}_3\text{H}_2\text{N}
$$

which matches the empirical formula, indicating the compound's molecular formula equals its empirical formula.

Summary of Findings

Compound	Molar Mass (g/mol)	Empirical Formula	Empirical Formula Mass (g/mol)	Multiplier n	Molecular Formula
1	189.83	CCl	47.46	4	CCl_4
2	189.83	C_3H_3N	52.056	4	$C_{12}H_{12}N_4$
3	156.23	C_3H_2N	52.056	3	$C_9H_6N_3$

Additional Tips for Accurate Molecular Formula Determination

- Always verify the empirical formula through experimental data or known compound structures.
- When calculating n, ensure your molar mass and empirical formula weight are accurate, considering isotopic variations if necessary.

- Remember that \(n \) must be a whole number; if it's close to a fraction, consider experimental errors or rounding.
- Use additional spectroscopic or analytical data to confirm the molecular structure.

Conclusion

Finding the molecular formula of a compound is a systematic process that involves understanding empirical formulas, calculating their molar masses, and determining the multiple \(n \). By applying these principles to the compounds with molar masses of 189.83 g/mol and 156.23 g/mol, we deduced that the first compound is likely carbon tetrachloride (CCl_4), the second is a larger molecule based on $C_{\square}H_{\square}N$, and the third is a smaller molecule similar to $C_{\square}H_{\square}N$. Mastery of these calculations enhances your ability to interpret molecular data, design new compounds, and understand the fundamental architecture of chemical substances.

Find The Molecular Formula Of Each Compound Ccl 189 83 G Mol C3h2n 156 23 G Mol

Find The Molecular Formula Of Each Compound Ccl 189 83 G Mol C3h2n 156 23 G Mol

Related Articles

- Let Imn = F Sinmx Cosx Dx Then Show That-sinm-1x Cosn+1x M-1Im, N+ Im-2,n.m+nm+nC.n
- Many Project Management Activities Occur As Part Of The Planning Process Group. T/F
- True False. In General, Moist Heat Kills Microorganisms In Less Time Than Dry Heat

Back to Home