

A 15.8 G Sample Contains 3.6 G Of F, 4.9 G Of H, And 7.3 G Of C. What Is The Percent Composition Of Fluorine

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Understanding the percent composition of elements in a chemical sample is fundamental in chemistry. In this article, we will explore how to determine the percent composition of fluorine (F) in a given sample, specifically a 15.8-gram sample that contains 3.6 grams of fluorine, 4.9 grams of hydrogen (H), and 7.3 grams of carbon (C). By walking through the calculations step-by-step, you will learn how to analyze similar problems involving percent composition in various compounds and mixtures.

What Is Percent Composition in Chemistry?

Definition of Percent Composition

Percent composition refers to the percentage by mass of each element present in a compound or mixture. It indicates how much of a specific element contributes to the total mass of the sample. Calculating this value helps chemists understand the makeup of substances, assess purity, and determine empirical formulas.

Importance of Percent Composition

- Determining Empirical Formulas: Percent composition allows for the calculation of the simplest ratio of elements in a compound.
- Quality Control: Ensuring that a compound has the correct proportion of elements.
- Stoichiometry Calculations: Using percent composition to find out how much of each element is involved in reactions.

Given Data and Objective

Details of the Sample

- Total mass of the sample: 15.8 grams
- Mass of fluorine (F): 3.6 grams
- Mass of hydrogen (H): 4.9 grams
- Mass of carbon (C): 7.3 grams

Objective

Calculate the percent composition of fluorine in the sample.

Step-by-Step Calculation of Fluorine's Percent Composition

Step 1: Verify Total Mass

Ensure the sum of the individual element masses equals the total sample mass:
 $3.6 \text{ g (F)} + 4.9 \text{ g (H)} + 7.3 \text{ g (C)} = 15.8 \text{ g}$

This confirms the data is consistent.

Step 2: Use the Formula for Percent Composition

The formula to calculate the percent composition of an element is:

```
\[
\text{Percent of element} = \left( \frac{\text{Mass of element}}{\text{Total mass of sample}} \right) \times 100
\]
```

Applying this formula for fluorine:

```
\[
\text{Percent of F} = \left( \frac{3.6 \text{ g}}{15.8 \text{ g}} \right) \times 100
\]
```

Step 3: Perform the Calculation

Calculate the fraction:

```
\[
\frac{3.6}{15.8} \approx 0.2278
\]
```

Multiply by 100 to get the percentage:

$$\begin{aligned} & \left[\right. \\ & 0.2278 \times 100 \approx 22.78\% \\ & \left. \right] \end{aligned}$$

Result:

The percent composition of fluorine in the sample is approximately 22.78%.

Interpreting the Results and Additional Insights

Significance of the Percent Composition

Knowing that fluorine makes up about 22.78% of the sample provides insight into the nature of the compound or mixture. For instance, if this sample is a fluoride compound, this percentage helps in identifying its empirical formula or purity.

Other Element Percentages

Similarly, the percentages of hydrogen and carbon can be calculated:

- Hydrogen:

$$\begin{aligned} & \left[\right. \\ & \left(\frac{4.9}{15.8} \right) \times 100 \approx 31.01\% \\ & \left. \right] \end{aligned}$$

- Carbon:

$$\begin{aligned} & \left[\right. \\ & \left(\frac{7.3}{15.8} \right) \times 100 \approx 46.21\% \\ & \left. \right] \end{aligned}$$

Adding these percentages:

$$\begin{aligned} & \left[\right. \\ & 22.78\% + 31.01\% + 46.21\% \approx 100\% \\ & \left. \right] \end{aligned}$$

This confirms the calculations are consistent and complete.

Applications of Percent Composition Calculations

Determining Empirical Formulas

Using the mass percentages, chemists can convert these into mole ratios to derive the empirical formula of a compound.

Quality Assessment and Purity

Percent composition helps in verifying if a compound is pure or if it contains impurities, based on expected elemental ratios.

Stoichiometric Calculations

Percent composition is essential for calculating the amounts of reactants and products in chemical reactions, facilitating precise lab work and industrial processes.

Summary: How to Calculate Percent Composition of Fluorine

- Identify the mass of fluorine in the sample (given as 3.6 g).
- Confirm the total mass of the sample (given as 15.8 g).
- Use the formula: $\text{Percent of F} = \left(\frac{\text{Mass of F}}{\text{Total mass}} \right) \times 100$.
- Calculate and interpret the percentage value.

In this case, fluorine constitutes approximately 22.78% of the sample, providing valuable information about the sample's composition.

Conclusion

Determining the percent composition of elements like fluorine in a compound is a fundamental skill in chemistry. By understanding the relationship between the mass of individual elements and the total sample mass, chemists can uncover important details about the nature, purity, and structure of chemical substances. In our example, calculating that fluorine makes up about 22.78% of the 15.8-gram sample illustrates this process clearly and effectively. Whether you're analyzing simple mixtures or complex compounds, mastering percent composition calculations is essential for success in chemical analysis and research.

Frequently Asked Questions

How do you calculate the percent composition of fluorine in a sample with given masses of elements?

To calculate the percent composition of fluorine, divide the mass of fluorine by the total sample mass and multiply by 100. For example: $(3.6 \text{ g} / 15.8 \text{ g}) \times 100 \approx 22.78\%$.

What is the percent composition of fluorine in a 15.8 g sample containing 3.6 g of F?

The percent composition of fluorine is approximately 22.78%, calculated as $(3.6 / 15.8) \times 100$.

Is the percent composition of fluorine affected by the presence of other elements like hydrogen and carbon?

No, the percent composition of fluorine is based solely on its mass relative to the total sample; other elements do not affect this calculation.

How do I verify the total mass of the sample matches the sum of individual element masses?

Add the masses of all elements: $3.6 \text{ g (F)} + 4.9 \text{ g (H)} + 7.3 \text{ g (C)} = 15.8 \text{ g}$, confirming it matches the total sample mass.

What is the significance of knowing the percent composition of fluorine in a compound?

Knowing the percent composition helps determine the compound's empirical

formula, purity, and helps in chemical analysis and formulation.

Can the percent composition of fluorine be used to identify a compound?

Yes, comparing the percent composition of fluorine with known data can help identify or confirm the chemical formula of a compound.

Additional Resources

Percent Composition

Understanding the percent composition of a compound is fundamental in chemistry, especially when analyzing the purity, formulation, or potential applications of a substance. Today, we delve into a fascinating example: a 15.8-gram sample containing fluorine (F), hydrogen (H), and carbon (C). Specifically, the sample comprises 3.6 grams of fluorine, 4.9 grams of hydrogen, and 7.3 grams of carbon. Our goal is to determine the percent composition of fluorine within this sample. This analysis not only enhances our grasp of chemical quantification but also exemplifies the importance of precise measurements in chemical analysis.

Understanding the Basics of Percent Composition

Before diving into calculations, it's essential to clarify what percent composition entails. In chemistry, percent composition refers to the percentage by mass of each element within a compound or mixture. It is calculated using the formula:

$$\text{Percent Composition of Element} = \left(\frac{\text{Mass of Element}}{\text{Total Mass of Sample}} \right) \times 100$$

This measurement provides insights into the relative abundance of each element, which can be crucial for tasks such as:

- Determining empirical formulas
- Assessing purity levels
- Understanding molecular structures
- Designing chemical reactions or materials

In our case, the focus is on fluorine—the most electronegative and reactive halogen—and its proportion within the sample.

Step-by-Step Calculation of Fluorine's Percent Composition

To find the percent composition of fluorine, we follow a systematic approach:

1. Identify the known quantities:

- Total sample mass: 15.8 g
- Mass of fluorine (F): 3.6 g

2. Apply the formula:

$$\text{Percent F} = \left(\frac{3.6 \text{ g}}{15.8 \text{ g}} \right) \times 100$$

3. Perform the calculation:

$$\frac{3.6}{15.8} \approx 0.2278$$

$$0.2278 \times 100 \approx 22.78\%$$

Result: The fluorine constitutes approximately 22.78% of the entire sample by mass.

Contextualizing the Percent Composition of Fluorine

Understanding that fluorine makes up roughly 22.78% of this sample offers several key insights:

- **Relative Abundance:** Fluorine, though less abundant than carbon and hydrogen in this sample, still constitutes a significant fraction, reflecting its potential role in the compound's properties.
- **Chemical Significance:** Fluorine's high electronegativity and reactivity mean that even a roughly 23% presence can have substantial implications for the compound's behavior, stability, and potential applications.

- Comparison with Elements: For context, hydrogen makes up about:

$$\left[\frac{4.9}{15.8} \times 100 \approx 31.01\% \right]$$

and carbon about:

$$\left[\frac{7.3}{15.8} \times 100 \approx 46.20\% \right]$$

This distribution indicates a molecule rich in carbon, with significant hydrogen and fluorine substituents, typical of many organic fluorinated compounds.

Why Is Percent Composition Important in Chemistry?

The precise calculation of element percentages within a compound is more than an academic exercise; it underpins critical applications across various fields:

2.1. Determining Empirical Formulas

The empirical formula provides the simplest whole-number ratio of elements in a compound. Knowing the percent composition allows chemists to:

- Convert percentages to molar ratios
- Calculate the ratio of atoms
- Deduce the empirical formula, which can lead to the molecular formula once molar mass is known

2.2. Quality Control and Purity Assessment

Manufacturers and researchers rely on percent composition to verify the purity of chemicals, ensuring consistency and safety, especially in pharmaceuticals, agrochemicals, and advanced materials.

2.3. Material Design and Application

Understanding the elemental makeup guides the synthesis of materials with desired properties, such as high chemical resistance, specific reactivity, or targeted electronic characteristics.

Extending the Analysis: Additional Chemical Insights

While the primary focus is on fluorine, understanding the entire elemental makeup offers a more comprehensive picture of the compound:

2.1. Mole Calculations

Converting mass percentages to molar ratios helps in deducing the molecular structure:

- Moles of each element:

- Fluorine (F):

Atomic weight $\approx 19.00 \text{ g/mol}$

$$\left[\frac{3.6 \text{ g}}{19.00 \text{ g/mol}} \approx 0.1895 \text{ mol} \right]$$

- Hydrogen (H):

Atomic weight $\approx 1.008 \text{ g/mol}$

$$\left[\frac{4.9 \text{ g}}{1.008 \text{ g/mol}} \approx 4.854 \text{ mol} \right]$$

- Carbon (C):

Atomic weight $\approx 12.01 \text{ g/mol}$

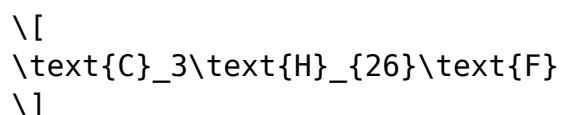
$$\left[\frac{7.3 \text{ g}}{12.01 \text{ g/mol}} \approx 0.607 \text{ mol} \right]$$

2.2. Empirical Formula Estimation

Dividing each molar quantity by the smallest value ($\approx 0.1895 \text{ mol}$ for fluorine):

Element	Moles	Ratio (approximate)
Fluorine (F)	0.1895	1.00
Hydrogen (H)	4.854	25.64
Carbon (C)	0.607	3.20

This suggests an empirical ratio near:



which indicates a highly fluorinated organic compound, possibly a fluorinated

hydrocarbon or similar structure.

Implications and Applications of Fluorine Content

The quantification of fluorine within a compound isn't merely academic; it has tangible implications:

2.1. Pharmaceutical and Material Science

Fluorinated compounds are prized in pharmaceuticals for their ability to modify biological activity, enhance metabolic stability, and improve bioavailability. Knowing the fluorine content helps in:

- Designing drugs with specific pharmacokinetics
- Developing advanced materials like fluoropolymers with exceptional chemical resistance

2.2. Environmental and Safety Considerations

Fluorinated compounds can be persistent in the environment. Accurate measurement of fluorine content assists in:

- Assessing environmental impact
- Ensuring compliance with safety regulations
- Developing biodegradable alternatives

2.3. Industrial Synthesis and Quality Assurance

Manufacturers can calibrate their processes to produce compounds with precise fluorine content, ensuring product consistency and performance.

Conclusion: The Significance of Precise Percent Composition Analysis

In summation, the calculation of fluorine's percent composition in our sample—approximately 22.78%—is a fundamental step in understanding its chemical nature, potential applications, and safety profile. This detailed analysis exemplifies the importance of meticulous measurement and calculation in chemistry, bridging the gap between raw data and meaningful insights.

Whether for academic research, industrial application, or environmental monitoring, knowing the precise elemental makeup of a sample empowers chemists and engineers to innovate, optimize, and ensure safety in their work. The ability to interpret and apply percent composition data remains a cornerstone of chemical science, exemplified vividly in this fluorine analysis.

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