

A 400 G Sample Is Composed Of 100 G Of Cesium (Cs) And 300 G Of Iodine (I). What Is The Percent By Mass

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Understanding the composition of chemical samples is fundamental in chemistry, especially when analyzing mixtures and compounds. In this article, we will explore how to determine the percent by mass of each element within a sample, focusing on a specific example where a 400-gram sample contains 100 grams of cesium (Cs) and 300 grams of iodine (I). This example provides a practical application to understand the concepts of mass percentage calculations, which are essential in various scientific and industrial contexts.

What Is Percent By Mass?

Percent by mass, also known as mass percent or weight percent, is a way of expressing the concentration of a component in a mixture or compound. It indicates how many grams of a particular substance are present per 100 grams of the total mixture.

Formula for Percent by Mass:

$$\text{Percent by mass} = \left(\frac{\text{Mass of component}}{\text{Total mass of mixture}} \right) \times 100$$

This calculation helps chemists understand the relative amount of each element or compound in a mixture, which is crucial for reactions, formulation, and quality control.

Calculating Percent By Mass for the Cesium and Iodine Sample

Given data:

- Total sample mass = 400 g
- Mass of Cesium (Cs) = 100 g
- Mass of Iodine (I) = 300 g

Let's perform the calculations step by step.

Step 1: Confirm the Total Mass

The total mass of the sample is the sum of the masses of the individual components:

$$\text{Total mass} = 100\text{ g} (\text{Cs}) + 300\text{ g} (\text{I}) = 400\text{ g}$$

This confirms the data consistency.

Step 2: Calculate Percent By Mass of Cesium

Using the formula:

$$\text{Percent by mass of Cs} = \left(\frac{100\text{ g}}{400\text{ g}} \right) \times 100 = 25\%$$

Result: Cesium makes up 25% of the sample by mass.

Step 3: Calculate Percent By Mass of Iodine

Similarly,

$$\text{Percent by mass of I} = \left(\frac{300\text{ g}}{400\text{ g}} \right) \times 100 = 75\%$$

Result: Iodine makes up 75% of the sample by mass.

Interpreting the Results

The calculations reveal that in the 400 g sample:

- Cesium constitutes 25% of the total mass.
- Iodine constitutes 75% of the total mass.

This information can be used for various purposes, such as:

- Determining molar ratios for chemical reactions.
- Preparing solutions with precise concentrations.
- Analyzing the purity or composition of materials.

Understanding the Significance of Percent By Mass in Chemistry

Percent by mass is a fundamental concept in chemistry for several reasons:

- Formulating Compounds: Helps in calculating the stoichiometry of reactions.
- Quality Control: Ensures materials meet specified compositions.
- Safety and Handling: Knowing the proportion of reactive or hazardous substances.
- Environmental Analysis: Assessing pollutant concentrations in samples.

Related Concepts and Calculations

Beyond simple percent by mass calculations, chemists often work with related concepts such as:

Molar Mass and Mole Calculations

- To convert mass percentages into molar ratios, molar masses of elements are used.
- For cesium (Cs), molar mass ≈ 132.91 g/mol.
- For iodine (I), molar mass ≈ 126.90 g/mol.

Calculating Moles of Each Element in the Sample

- Moles of Cesium:

$$\text{Moles of Cs} = \frac{100\text{ g}}{132.91\text{ g/mol}} \approx 0.752\text{ mol}$$

- Moles of Iodine:

$$\text{Moles of I} = \frac{300\text{ g}}{126.90\text{ g/mol}} \approx 2.365\text{ mol}$$

- **Mole Ratio:** The ratio of moles of Cs to I is approximately 1:3, which might suggest a compound like cesium iodide (CsI), although the actual sample composition may be a mixture.

Practical Applications of Percent By Mass Calculations

Understanding how to calculate and interpret percent by mass is vital across multiple disciplines:

- **Pharmaceuticals:** Ensuring correct dosages and formulations.
- **Environmental Science:** Measuring pollutant levels.
- **Material Science:** Developing alloys and composites.
- **Chemical Manufacturing:** Quality assurance of raw materials.

Conclusion

In summary, analyzing a sample's composition through percent by mass provides critical insight into its makeup. For the specific example of a 400 g sample containing 100 g of cesium and 300 g of iodine, the calculations reveal that cesium makes up 25%, and iodine makes up 75% of the sample by mass. Mastery of these calculations is essential for chemists and scientists working in research, industry, and environmental monitoring to ensure accurate analysis, safe handling, and proper formulation of chemical substances.

Remember:

- Always verify the total mass matches the sum of individual components.
- Use precise molar masses for accurate molar calculations.
- Percent by mass is a foundational concept that supports more complex chemical analysis and applications.

By understanding and applying these principles, professionals can better interpret material compositions and make informed decisions in scientific and industrial contexts.

Frequently Asked Questions

What is the percent by mass of cesium (Cs) in the 400 g sample?

The percent by mass of cesium is $(100 \text{ g} / 400 \text{ g}) \times 100\% = 25\%$.

What is the percent by mass of iodine (I) in the 400 g sample?

The percent by mass of iodine is $(300 \text{ g} / 400 \text{ g}) \times 100\% = 75\%$.

How do you calculate the percent by mass of each element in a mixture?

Divide the mass of each element by the total mass of the sample and multiply by 100%.

What is the significance of calculating percent by mass in a sample?

It helps determine the composition and relative abundance of elements within a sample for analysis and purity assessment.

If the sample's total mass changes, how does that affect the percent by mass of each element?

The percent by mass depends on the ratio of each element's mass to the total mass; if the total mass changes, the percentages may also change accordingly.

Can the percent by mass of elements in a compound be different from that in a mixture?

Yes, because compounds have fixed ratios of elements, whereas mixtures have variable compositions; calculating percent by mass can distinguish between the two.

What assumptions are made when calculating percent by mass in this sample?

It is assumed that the sample is homogeneous and that the given masses are accurate and representative of the entire sample.

Why is it important to know the percent by mass of elements in chemical analysis?

It allows for precise determination of composition, quality control, and formulation of chemical products.

How would you verify the correctness of the percent

by mass calculations for this sample?

Sum the individual percentages of cesium and iodine; they should total approximately 100%, confirming the calculations are correct.

Additional Resources

A 400 G Sample Is Composed Of 100 G Of Cesium (Cs) And 300 G Of Iodine (I): What Is The Percent By Mass?

Understanding the composition of chemical samples is fundamental in chemistry, especially when analyzing mixtures and compounds. In this article, we will explore the problem involving a 400-gram sample made up of 100 grams of cesium (Cs) and 300 grams of iodine (I). Our primary goal is to determine the percent by mass of each component in the mixture. This problem serves as a practical example of how mass percentages are calculated and interpreted in chemical analysis, which is essential for students, educators, and professionals working with chemical formulations or conducting quality control.

Understanding the Concept of Percent by Mass

Definition of Percent by Mass

Percent by mass, also known as mass percent or weight percent, is a way of expressing the concentration of a component within a mixture or compound. It represents the mass of a particular substance divided by the total mass of the mixture, multiplied by 100 to express it as a percentage.

Mathematically:

$$\text{Percent by mass} = \left(\frac{\text{Mass of component}}{\text{Total mass of mixture}} \right) \times 100$$

This measure provides a straightforward way to understand the composition of a sample, facilitating comparison across different samples and ensuring accurate formulation in chemical processes.

Analyzing the Sample Composition

In this specific case, we are given:

- Total sample mass = 400 grams
- Mass of Cesium (Cs) = 100 grams
- Mass of Iodine (I) = 300 grams

The task is to determine the percent by mass of cesium and iodine in the sample.

Calculating the Percent by Mass of Cesium (Cs)

Using the formula:

$$\begin{aligned} \text{Percent of Cs} &= \left(\frac{100 \text{ g}}{400 \text{ g}} \right) \\ &\times 100 = 25\% \end{aligned}$$

This indicates that cesium makes up 25% of the total sample by mass.

Calculating the Percent by Mass of Iodine (I)

Similarly,

$$\begin{aligned} \text{Percent of I} &= \left(\frac{300 \text{ g}}{400 \text{ g}} \right) \\ &\times 100 = 75\% \end{aligned}$$

Therefore, iodine accounts for 75% of the total sample by mass.

Interpreting the Results

The calculations show that the sample is predominantly iodine, with 75% of its weight, and contains a smaller proportion of cesium at 25%. These percentages are vital for understanding the nature of the mixture, especially

if the sample is intended for specific chemical reactions, applications, or further analysis.

Key points:

- The mass percentages add up to 100%, confirming the calculations are consistent.
- The mixture's composition suggests a significant presence of iodine, which could influence its chemical properties and reactivity.

Implications and Applications of Percent by Mass Calculation

Understanding the percent by mass in samples has several practical applications:

- Chemical Formulation: Ensuring the correct proportions of reactants for desired reactions.
- Quality Control: Verifying the composition of raw materials or finished products.
- Environmental Analysis: Determining pollutant concentrations in samples.
- Pharmaceuticals: Calculating active ingredients in drug formulations.
- Educational Demonstrations: Teaching fundamental concepts of stoichiometry and mixtures.

Pros of Using Percent by Mass

- Simplicity: Easy to calculate and interpret.
- Standardization: Widely used in scientific literature and industry.
- Comparability: Enables comparison across different samples or batches.

Cons or Limitations

- Does not account for molecular or molar ratios: For chemical reactions, molar ratios are often more relevant.
- Ignores the chemical form: Percent by mass does not specify the chemical state or bonding.
- Can be misleading in complex mixtures: For example, when components have vastly different densities or molecular weights.

Expanding the Discussion: From Mass Percent to Mole Percent

While mass percent provides a straightforward measure of composition, chemists often need to understand the molar composition for reaction stoichiometry.

Mole Percent Calculation:

- Convert the masses to moles using molar masses:
- Cesium: approximately 132.91 g/mol
- Iodine: approximately 126.90 g/mol

- Moles of Cs:

$$\text{Moles of Cs} = \frac{100 \text{ g}}{132.91 \text{ g/mol}} \approx 0.752 \text{ mol}$$

- Moles of I:

$$\text{Moles of I} = \frac{300 \text{ g}}{126.90 \text{ g/mol}} \approx 2.364 \text{ mol}$$

- Total moles:

$$0.752 + 2.364 \approx 3.116 \text{ mol}$$

- Mole percent of Cs:

$$\left(\frac{0.752}{3.116} \right) \times 100 \approx 24.1\%$$

- Mole percent of I:

$$\left(\frac{2.364}{3.116} \right) \times 100 \approx 75.9\%$$

Observation: The mole percent aligns closely with the mass percent, but they

are not identical due to differences in molar masses.

Real-World Context and Significance

Cesium and iodine are elements with significant applications in various fields:

- Cesium (Cs): Used in atomic clocks, medical imaging, and as a getter in vacuum tubes.
- Iodine (I): Essential for thyroid health, used as a disinfectant, and in radiography.

The mixture's composition could relate to specific use-cases, such as radioactive isotopes in medical imaging or research. Understanding the precise mass percentages helps in dosage calculations, safety assessments, and regulatory compliance.

Conclusion

Determining the percent by mass of components in a mixture is a fundamental skill in chemistry, providing insight into the composition and potential behavior of the sample. In our example, the 400-gram sample consisting of 100 grams of cesium and 300 grams of iodine contains 25% cesium and 75% iodine by mass. These calculations are straightforward but essential for various scientific and industrial applications. Whether for quality control, formulation, or research, understanding mass percentages enables chemists to make informed decisions and accurately interpret their samples.

Summary:

- The mass percent of cesium (Cs) in the sample is 25%.
- The mass percent of iodine (I) in the sample is 75%.
- These values reflect the composition's proportions, critical for practical applications.
- Additional molar calculations provide deeper insight into the chemical ratios involved.

This comprehensive analysis underscores the importance of basic quantitative skills in chemistry and their relevance to real-world scenarios involving chemical mixtures.

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