# Calculate The Percent Composition Of A 35.4 G Piece Of Silver (Ag) That Combines Completely With 22.3

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Understanding the percent composition of a compound or element is fundamental in chemistry, providing insights into its elemental makeup and purity. In this article, we will explore how to calculate the percent composition of a 35.4 g piece of silver (Ag) that reacts completely with a certain amount of another substance, specifically 22.3 grams. The problem involves concepts of chemical reactions, molar mass calculations, and percentage compositions, all of which are crucial in analytical chemistry and material science.

## Overview of Percent Composition and Silver Chemistry

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

$$
\text{Percent composition of element} = \left( \frac{\text{Mass of element in the compound}}{\text{Total mass of the compound}} \right) \times 100\%
$$

Silver (Ag), a transition metal with atomic number 47, is widely used in jewelry, electronics, and photography. Its chemical behavior, especially its reactions with other elements, often involves forming various compounds such as silver chloride (AgCl), silver nitrate ($AgNO_3$), or silver sulfide ($Ag_2S$).

In this specific scenario, the silver reacts completely with another substance, which suggests a stoichiometric reaction. The problem hints at a known amount of another reactant, 22.3 grams, that combines with the silver. To solve for the percent composition of silver in the initial piece, we need to understand the nature of this reaction and the identity of the other reactant.

## Interpreting the Problem: What Does "Combines Completely" Mean?

The phrase "combines completely" indicates a stoichiometric, reaction-based process where all of the silver

in the 35.4 g piece reacts with a certain amount of another reactant. Usually, in such problems, the reactant is specified, or we can deduce it from context. The missing information here is the identity of the 22.3 g substance.

Possible interpretations:

- The 22.3 g substance could be a reactant that forms a compound with silver, such as chlorine (Cl), sulfur (S), or nitrate ($NO_3$).
- The problem might be about calculating the amount of silver in the initial sample based on a known reaction with this other substance.

Given the problem's phrasing, we can assume the following:

- The silver reacts completely with 22.3 g of a certain substance.
- The total initial mass of the silver piece is 35.4 g.
- Our goal is to determine the percentage of silver in the initial piece, possibly in relation to the reaction with the other substance.

Note: If the reaction involves a known compound, such as silver chloride, the molar ratios are critical for calculations.

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Important: For completeness, in real-world problems, the identity of the other reactant and the chemical reaction are vital. Since the problem states only the mass of silver and the other reactant, it's typical to assume the reaction involves a simple stoichiometry between silver and the other substance.

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# Step-by-Step Calculation Strategy

To determine the percent composition of silver in the piece, follow these steps:

1. Identify the molar mass of silver (Ag):
Ag has an atomic mass of approximately 107.87 g/mol.

2. Determine the molar amount of silver in the 35.4 g sample:
$$
\text{Moles of Ag} = \frac{\text{Mass of Ag}}{\text{Molar mass of Ag}} = \frac{35.4\, \text{g}}{107.87\, \text{g/mol}}
$$

3. Understand the reaction with the other substance:
For example, if silver reacts with chlorine to form AgCl, the molar ratio is 1:1.

4. Calculate the molar amount of the other reactant (assuming it's known):
If the 22.3 g of the reacting substance is, for instance, $Cl_2$, with a molar mass of 70.90 g/mol, then:
$$
\text{Moles of Cl}_2 = \frac{22.3\, \text{g}}{70.90\, \text{g/mol}}
$$

5. Relate the moles to the amount of silver reacted:
Based on the stoichiometry, find the moles of silver that reacted with the 22.3 g of the other reactant.

6. Calculate the mass of silver that reacted:
$$
\text{Mass of Ag reacted} = \text{Moles of Ag} \times 107.87\, \text{g/mol}
$$

7. Determine the percent composition of silver in the initial piece:

$$
\text{Percent of Ag} = \left( \frac{\text{Mass of Ag in initial sample}}{\text{Total initial mass}} \right) \times 100\%
$$

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However, since the problem states the entire 35.4 g piece combines completely with 22.3 g of another substance, it's likely that the 22.3 g is the mass of the compound formed or the amount of reactant consumed in the reaction. To proceed accurately, we'll make an assumption that the 22.3 g of reactant refers to a compound containing the reacting element (e.g., Cl in AgCl).

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# Calculating the Percent Composition of Silver in the Sample

Assuming the 22.3 g of the reactant is a compound, such as silver chloride (AgCl), formed by reacting the silver with chlorine, we can proceed with the calculations.

Step 1: Molar Mass of Silver Chloride (AgCl)

- Silver (Ag): 107.87 g/mol

- Chlorine (Cl): 35.45 g/mol
- Total molar mass:
$$
107.87 + 35.45 = 143.32\, \text{g/mol}
$$

Step 2: Moles of AgCl formed

$$
\text{Moles of AgCl} = \frac{22.3\, \text{g}}{143.32\, \text{g/mol}} \approx 0.1555\, \text{mol}
$$

Step 3: Moles of silver in AgCl

Since the molar ratio of Ag to AgCl is 1:1:

$$
\text{Moles of Ag} = 0.1555\, \text{mol}
$$

Step 4: Mass of silver in the 22.3 g of AgCl

$$
\text{Mass of Ag} = 0.1555\, \text{mol} \times 107.87\, \text{g/mol} \approx 16.77\, \text{g}
$$

Step 5: Determine the percentage of silver in the original 35.4 g piece

Assuming all silver in the 35.4 g piece is involved in forming AgCl with the 22.3 g of chloride:

$$
\boxed{
\text{Percent Ag} = \left( \frac{\text{Mass of Ag}}{\text{Total mass of sample}} \right) \times 100\% = \left( \frac{16.77\, \text{g}}{35.4\, \text{g}} \right) \times 100\% \approx 47.4\%
}
$$

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# Additional Considerations and Clarifications

- Purity of the sample: The calculation assumes the entire 35.4 g sample is pure silver that reacts completely with 22.3 g of chloride to form AgCl.
- Reaction completeness: The problem states "combines completely," indicating a stoichiometric reaction with no excess reactants.
- Alternative reactions: If the reactant is different (e.g., sulfur to form $Ag_2S$), the molar masses and ratios will differ, and calculations should be adjusted accordingly.
- Practical applications: Understanding the percent composition helps in analyzing the purity of silver samples, designing alloy compositions, and quality control in manufacturing.

## Summary of the Calculation Process

To summarize, calculating the percent composition of silver in the given sample involves:

- Determining the molar mass of the compound formed.
- Calculating moles based on the mass of the reactant.
- Using molar ratios to find the amount of silver involved.
- Converting molar quantities back to mass.
- Computing the percentage with respect to the total initial mass.

This approach provides a systematic way to analyze any elemental composition based on reaction data, essential for chemists and materials scientists.

## Conclusion

Calculating the percent composition of a metal like silver in a sample that reacts completely with a known amount of another substance requires understanding chemical reactions, molar ratios, and stoichiometry. By applying these principles, the example demonstrates that approximately 47.4% of the initial 35.4 g silver sample is silver itself, assuming the formation of silver chloride and the provided data.

Through careful analysis and step-by

## Frequently Asked Questions

### What is the total mass of silver (Ag) in the compound if 22.3 g of another element fully combines with 35.4 g of silver?

The total mass of silver (Ag) remains 35.4 g, as it is the element in question; the 22.3 g refers to the other

element it combines with.

## How do you calculate the percent composition of silver in the compound?

Percent composition of silver is calculated by dividing the mass of silver (35.4 g) by the total mass of the compound (35.4 g + 22.3 g) and multiplying by 100: (35.4 / 57.7) × 100 ≈ 61.3%.

## What is the molar mass of silver (Ag), and how does it relate to calculating the percent composition?

The molar mass of silver (Ag) is approximately 107.87 g/mol. It helps in converting mass to moles for stoichiometric calculations, but for percent composition, the mass ratio is sufficient.

## If 22.3 g of the other element combines with 35.4 g of silver, what is the formula mass of the compound?

The formula mass of the compound is the sum of the masses of both elements: 35.4 g + 22.3 g = 57.7 g.

## How can you determine the empirical formula of the compound from the given masses?

Convert each element's mass to moles by dividing by their molar masses, then find the simplest whole-number ratio of moles to determine the empirical formula.

## What assumptions are made when calculating percent composition in this scenario?

It is assumed that the entire 35.4 g of silver reacts completely with 22.3 g of the other element, and the compound is pure with no impurities.

## Why is calculating percent composition important in understanding chemical compounds?

Percent composition helps determine the relative amounts of each element in a compound, which is essential for stoichiometry, formulation, and understanding the compound's properties.

# Additional Resources

Calculate The Percent Composition Of A 35.4 G Piece Of Silver (Ag) That Combines Completely With 22.3 G Of A Substance

Understanding the percent composition of compounds is fundamental in chemistry, as it reveals the relative amounts of each element in a compound. When dealing with metals such as silver (Ag), calculating the percent composition becomes particularly insightful, especially in reactions where silver combines completely with another substance. In this article, we will explore how to determine the percent composition of a 35.4 g piece of silver that reacts fully with 22.3 g of another substance. We will delve into the theoretical background, step-by-step calculations, and discuss the significance of such computations in practical scenarios.

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## Introduction to Percent Composition

Percent composition refers to the percentage by mass of each element present in a compound or mixture. It is a crucial concept for chemists to understand the makeup of substances, analyze purity, and prepare compounds with desired properties. The general formula for calculating percent composition by mass is:

$$
\text{Percent composition of element} = \left( \frac{\text{Mass of element in compound}}{\text{Total mass of compound}} \right) \times 100
$$

In the context of a reaction involving silver, this calculation helps chemists determine how much silver is present relative to other components in the system.

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## Understanding the Reaction: Silver and the Other Substance

Before proceeding with calculations, it is essential to clarify what the phrase "that combines completely with 22.3 g" implies. Typically, this indicates a complete chemical reaction where silver reacts with a substance—possibly a non-metal such as sulfur, oxygen, or halogens—to form a compound.

For this analysis, let's assume the reaction involves silver reacting with a substance—say, sulfur—to form silver sulfide ($Ag_2S$). The complete reaction can be written as:

$$
2 \text{Ag} + \text{S} \rightarrow \text{Ag}_2\text{S}
$$

Given that the silver completely reacts with 22.3 g of sulfur, and the initial amount of silver available is 35.4 g, we aim to find the percent composition of silver in the resulting compound.

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# Step-by-Step Calculation Process

To determine the percent composition, we need to:

1. Confirm the amount of silver that has reacted.
2. Understand the total mass of the compound formed.
3. Calculate the percentage of silver in the compound.

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## Step 1: Determine the amount of silver that reacted

Since the silver reacts completely, and the initial amount available is 35.4 g, the amount of silver that reacts is critical for the calculation.

If all 35.4 g of silver reacts with 22.3 g of sulfur, then the total mass of the compound ($Ag_2S$) formed is:

$$
\text{Mass of Ag}_2\text{S} = \text{Mass of silver} + \text{Mass of sulfur} = 35.4\, \text{g} + 22.3\, \text{g} = 57.7\, \text{g}
$$

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## Step 2: Calculate the molar masses

Knowing the molar masses helps relate the masses to the mole ratios:

- Silver (Ag): approximately 107.87 g/mol
- Sulfur (S): approximately 32.07 g/mol
- Silver sulfide ($Ag_2S$):

$$
\

$$
(2 \times 107.87) + 32.07 = 215.74 + 32.07 = 247.81\, \text{g/mol}
$$

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## Step 3: Determine the mole ratio and theoretical amounts

From the reaction:

$$
2\, \text{Ag} \rightarrow 1\, \text{Ag}_2\text{S}
$$

- Moles of silver reacting:

$$
\text{Moles of Ag} = \frac{35.4\, \text{g}}{107.87\, \text{g/mol}} \approx 0.328\, \text{mol}
$$

- Moles of sulfur reacting:

$$
\text{Moles of S} = \frac{22.3\, \text{g}}{32.07\, \text{g/mol}} \approx 0.695\, \text{mol}
$$

The mole ratio for the reaction is 2:1 (Ag:S). The amount of silver in moles (0.328 mol) corresponds to:

$$
\text{Moles of Ag}_2\text{S} = \frac{0.328\, \text{mol}}{2} \approx 0.164\, \text{mol}
$$

Total mass of silver sulfide formed:

$$
0.164\, \text{mol} \times 247.81\, \text{g/mol} \approx 40.7\, \text{g}
$$

However, since the initial total mass was 57.7 g, and the total reacted mass is 40.7 g, this indicates excess sulfur or other factors in a real-world scenario. For simplicity, assuming all silver reacts to form $Ag_2S$, the mass of silver in the compound is:

$$
\

$$
\text{Mass of silver in Ag}_2\text{S} = (2 \times 107.87\, \text{g}) \times 0.164\, \text{mol} \approx 35.4\, \text{g}
$$

which confirms the initial amount of silver used.

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## Calculating Percent Composition of Silver

Finally, the percent composition of silver in the compound is:

$$
\text{Percent Ag} = \left( \frac{\text{Mass of silver in compound}}{\text{Total mass of compound}} \right) \times 100
$$

Using the total mass of the compound (assuming complete reaction):

$$
\text{Percent Ag} = \left( \frac{35.4\, \text{g}}{57.7\, \text{g}} \right) \times 100 \approx 61.4\%
$$

This indicates that approximately 61.4% of the compound's mass is silver when 35.4 g of silver reacts with 22.3 g of sulfur to form silver sulfide.

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## Implications and Practical Significance

Understanding the percent composition of silver in compounds like silver sulfide has several practical applications:

- Material Purity: Determines the purity of silver in raw materials.
- Alloy Formulation: Assists in designing silver alloys with precise properties.
- Chemical Analysis: Helps in qualitative and quantitative analysis of silver in samples.
- Industrial Processes: Guides in manufacturing processes involving silver compounds.
- Environmental Monitoring: Assists in assessing silver contamination levels.

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## Features, Pros, and Cons of Percent Composition Calculations

Features:

- Based on fundamental molar mass relationships.
- Utilizes mole ratios from balanced chemical equations.
- Applicable to both pure compounds and mixtures.

Pros:

- Provides detailed elemental composition.
- Useful for quality control and material analysis.
- Facilitates stoichiometric calculations for reactions.

Cons:

- Assumes complete reaction and purity.
- Sensitive to measurement inaccuracies.
- Requires balanced chemical equations, which may not always be straightforward.

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## Conclusion

Calculating the percent composition of a piece of silver that reacts completely with a known amount of another substance involves understanding the reaction's molar relationships, molar masses, and total mass calculations. In our example, a 35.4 g piece of silver reacting with 22.3 g of sulfur yields a silver content of approximately 61.4% in the resulting compound. Such calculations are vital in analytical chemistry, material science, and industrial applications, providing insights into the composition, purity, and formulation of chemical substances. Mastery of these concepts enables chemists to design better materials, analyze unknown samples, and optimize chemical processes effectively.

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