# What Is The Sulfate Ion Concentration Of The Resulting Solution When 75.0 Ml Of 1.50 M Cuso4 And 50.0

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Understanding how to calculate the sulfate ion concentration after mixing solutions is fundamental in chemistry, especially in solution chemistry and titrations. When dealing with solutions like copper(II) sulfate ($CuSO_4$), knowing the sulfate ion concentration in the final mixture is essential for applications ranging from industrial processes to laboratory experiments. In this article, we will explore the detailed steps to determine the sulfate ion concentration when 75.0 mL of 1.50 M $CuSO_4$ is combined with another solution of 50.0 mL (the specific molarity of the second solution will be discussed). We will also delve into the concepts of molarity, dilution, and solution mixing to clarify this common chemistry calculation.

## Understanding the Components of the Problem

Before diving into calculations, it’s important to understand the given data and what is being asked:

- Initial volume of $CuSO_4$ solution: 75.0 mL
- Concentration of $CuSO_4$ solution: 1.50 M (moles per liter)
- Additional solution volume: 50.0 mL (the molarity of this solution will be specified or assumed for calculations)

The main goal is to determine the final sulfate ion concentration in the combined solution after mixing.

## What is Copper(II) Sulfate ($CuSO_4$)?

Copper(II) sulfate is an inorganic compound commonly used in agriculture, chemistry labs, and industry. Its chemical formula is $CuSO_4$, consisting of:

- Copper ion ($Cu^{2+}$)
- Sulfate ion ($SO_4^{2-}$)

When dissolved in water, $CuSO_4$ dissociates completely into its ions:

$CuSO_4 \rightarrow Cu^{2+} + SO_4^{2-}$

This dissociation is important because the sulfate ion concentration directly depends on the amount of $CuSO_4$ dissolved.

# Calculating the Moles of $CuSO_4$ in the Initial Solution

The first step involves calculating the total moles of $CuSO_4$ present in the initial 75.0 mL solution.

## Using Molarity to Find Moles

Molarity (M) is defined as:

$$ \text{Molarity} (M) = \frac{\text{moles of solute}}{\text{liters of solution}} $$

Rearranged to find moles:

$$ \text{Moles of CuSO}_4 = M \times \text{Volume (L)} $$

Given:

- M = 1.50 M
- Volume = 75.0 mL = 0.0750 L

Calculation:

$$ \text{Moles of CuSO}_4 = 1.50 \times 0.0750 = 0.1125\, \text{moles} $$

Since $CuSO_4$ dissociates fully into sulfate ions:

$$ \text{Moles of SO}_4^{2-} = 0.1125\, \text{moles} $$

This is the initial amount of sulfate ions in the 75.0 mL solution.

# Considering the Second Solution: Volume and Molarity

The problem mentions adding 50.0 mL of a solution, but the molarity of this second solution is not provided in your prompt. For the purpose of this comprehensive explanation, let's consider three possible scenarios:

1. The second solution is pure water (no additional sulfate ions).
2. The second solution has a known molarity of sulfate ions.
3. The second solution is a different concentration of $CuSO_4$.

For clarity, we will assume the second solution contains no sulfate ions (i.e., pure water). If you have a different molarity, the calculation can be adjusted accordingly.

Assumption: Second solution is pure water (0 M sulfate ions).

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Scenario 1: Second Solution is Pure Water

In this case, only the initial sulfate ions contribute to the final concentration, and the total volume increases due to mixing.

Calculating Final Volume:

$$ V_{\text{total}} = 75.0\, \text{mL} + 50.0\, \text{mL} = 125.0\, \text{mL} = 0.1250\, \text{L} $$

Calculating Final Sulfate Ion Concentration:

Since no additional sulfate ions are introduced:

$$ \text{Final sulfate concentration} = \frac{\text{Total sulfate moles}}{\text{Total volume in liters}} $$

$$ = \frac{0.1125\, \text{moles}}{0.1250\, \text{L}} = 0.900\, \text{M} $$

Result: The sulfate ion concentration in the resulting solution is 0.900 M.

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Scenario 2: Second Solution Contains Sulfate Ions

If the second solution has a molarity $M_2$ of sulfate ions, the total moles of sulfate in the second solution are:

$$ \text{Moles of SO}_4^{2-} = M_2 \times 0.0500\, \text{L} $$

Total sulfate moles after mixing:

$$ \text{Total sulfate} = 0.1125 + (M_2 \times 0.0500) $$

Total volume:

$$ V_{\text{total}} = 0.0750 + 0.0500 = 0.1250\, \text{L} $$

Sulfate ion concentration:

$$ \text{Final concentration} = \frac{0.1125 + (M_2 \times 0.0500)}{0.1250} $$

This formula allows calculating the final sulfate ion concentration for any known second solution molarity.

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Additional Considerations in Solution Chemistry

Dilution Effect

When solutions are mixed, the concentration of ions depends on the total moles present and the total volume after mixing. The key principles are:

- Number of moles remains constant if no chemical reactions occur.
- Concentration decreases as volume increases (dilution).

Complete Dissociation Assumption

In dilute aqueous solutions, salts like $CuSO_4$ dissociate completely, which simplifies calculations. However, in concentrated solutions, some ion pairing or incomplete dissociation might occur, but for typical lab concentrations, assuming full dissociation is valid.

Precautions and Practical Tips

- Always convert volumes to liters before calculating molarity.
- When mixing solutions, consider the total volume carefully.
- If the second solution's molarity is unknown, clarify before performing calculations.
- Use significant figures appropriately to match the precision of your data.

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# Summary of Step-by-Step Calculation

1. Calculate moles of $CuSO_4$ in initial solution:

$$ \text{Moles} = M \times V_{L} $$

2. Determine sulfate moles:

Since $CuSO_4$ dissociates fully, moles of sulfate are equal to moles of $CuSO_4$.

3. Calculate total volume after mixing:

$$ V_{total} = V_1 + V_2 $$

4. Compute final sulfate concentration:

$$ \text{Concentration} = \frac{\text{Total sulfate moles}}{V_{total}} $$

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Final Remarks

Understanding how to determine the sulfate ion concentration after mixing solutions is crucial for various chemical applications. Whether you're preparing solutions for titrations, industrial processes, or research, mastering these calculations empowers you to predict solution behaviors accurately.

In the specific scenario of mixing 75.0 mL of 1.50 M $CuSO_4$ with 50.0 mL of another solution, the key steps involve calculating initial moles, considering the molarity of the second solution, and applying the dilution principle. If the second solution's molarity is known, the formula provided can be directly used to find the final sulfate ion concentration.

Always ensure your units are consistent, and double-check your calculations for accuracy. With practice, calculating ion concentrations in mixed solutions becomes a straightforward and valuable skill in the chemist's toolkit.

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Keywords: sulfate ion concentration, $CuSO_4$, molarity, solution mixing, dilution, solution chemistry, ion dissociation, molar calculations, solution preparation

# Frequently Asked Questions

## What is the sulfate ion concentration in the resulting solution when 75.0 mL of 1.50 M $CuSO_4$ is mixed with 50.0 mL of another solution?

To determine the sulfate ion concentration, first calculate the moles of sulfate in the $CuSO_4$ solution: 75.0 mL × 1.50 M = 0.1125 mol. Then, find the total volume after mixing: 75.0 mL + 50.0 mL = 125.0 mL or 0.125 L. The sulfate concentration is 0.1125 mol / 0.125 L = 0.90 M.

## How does the dilution affect the sulfate ion concentration when mixing 75.0 mL of 1.50 M $CuSO_4$ with 50.0 mL of another solution?

Dilution reduces the concentration of sulfate ions because the total number of moles remains constant, but the total volume increases. In this case, the sulfate concentration decreases from 1.50 M to 0.90 M after mixing, due to the increased total volume.

## If the second solution added is pure water, what is the final sulfate ion concentration after mixing?

Assuming the second solution is pure water (no sulfate ions), the final sulfate concentration is calculated based on the initial moles of sulfate and total volume: 0.1125 mol / 0.125 L = 0.90 M.

## What assumptions are made when calculating sulfate ion concentration in this mixing scenario?

The assumptions include complete and immediate mixing, no sulfate loss or reaction during mixing, and that the second solution contains no sulfate ions if it is pure water.

## How would the sulfate ion concentration change if the volume of the $CuSO_4$ solution was doubled before mixing?

Doubling the volume to 150.0 mL while keeping concentration the same would double the moles of sulfate to 0.225 mol. After mixing with 50.0 mL of water, total volume becomes 200.0 mL or 0.200 L, resulting in a sulfate concentration of 0.225 mol / 0.200 L = 1.125 M.

# Additional Resources

What Is The Sulfate Ion Concentration Of The Resulting Solution When 75.0 Ml Of 1.50 M Cuso4 And 50.0 Ml Of Another Solution?

Understanding the intricacies of solution chemistry is fundamental in both academic and industrial settings. When dealing with solutions such as copper sulfate ($CuSO_4$), a common compound in electrochemistry, agriculture, and laboratory experiments, it's vital to determine the concentration of specific ions present after mixing different volumes and concentrations. This article aims to elucidate the process of calculating the sulfate ion concentration in a mixed solution formed by combining 75.0 mL of 1.50 M $CuSO_4$ with an additional 50.0 mL of another solution—an essential skill for chemists ensuring precise reagent preparation and analysis.

What Is The Sulfate Ion Concentration Of The Resulting Solution When 75.0 Ml Of 1.50 M Cuso4 And 50.0 Ml Of Another Solution?

This question encapsulates a common scenario in solution chemistry: mixing two solutions and determining the resulting ion concentrations. While the question initially appears straightforward, it involves a detailed understanding of molarity, moles of solute, and the effects of volume change on concentration. To answer it thoroughly, we need to clarify what the "another solution" is—assuming it is pure water or a solution with known composition—and follow systematic steps to calculate the sulfate ion concentration accurately.

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Understanding the Components of the Problem

The Key Players: Copper Sulfate ($CuSO_4$) and the Unknown Solution

- Copper sulfate ($CuSO_4$): An inorganic compound consisting of copper cations ($Cu^{2+}$) and sulfate anions ($SO_4^{2-}$). Its molarity indicates the moles of $CuSO_4$ per liter of solution.
- Volumes involved:

- 75.0 mL of 1.50 M $CuSO_4$
- 50.0 mL of another solution (assumed to be pure water unless otherwise specified)

The core task: Calculate the sulfate ion concentration after mixing both solutions.

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Step 1: Determine the Moles of $CuSO_4$ in the Initial Solution

The initial solution's molarity and volume enable us to find the total moles of $CuSO_4$:

$$
\text{Moles of } CuSO_4 = \text{Molarity} \times \text{Volume (in liters)}
$$

Given data:

- Molarity (M) = 1.50 mol/L
- Volume = 75.0 mL = 0.0750 L

Calculating:

$$
\text{Moles of } CuSO_4 = 1.50 \ \text{mol/L} \times 0.0750 \ \text{L} = 0.1125 \ \text{mol}
$$

Since each mole of $CuSO_4$ contains one sulfate ion ($SO_4^{2-}$), the initial sulfate ion moles are also 0.1125 mol.

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Step 2: Account for the Additional Volume and Its Effect

The total volume after mixing:

$$
V_{total} = 75.0\, \text{mL} + 50.0\, \text{mL} = 125.0\, \text{mL}
$$

In liters:

$$
V_{total} = 0.1250\, \text{L}
$$

If the second solution is pure water (with no sulfate ions), the total moles of sulfate remain the same, but the concentration will decrease due to dilution.

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Step 3: Calculate the Final Sulfate Ion Concentration

Using the total moles of sulfate and the total volume:

$$
\text{Final sulfate concentration} = \frac{\text{Total moles of sulfate}}{\text{Total volume in liters}}
$$

$$
= \frac{0.1125 \ \text{mol}}{0.1250 \ \text{L}} = 0.900\, \text{M}
$$

Thus, the sulfate ion concentration in the resulting solution is 0.900 M.

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Additional Considerations: What if the Second Solution Contains Sulfate?

The calculation above assumes the second solution contains no sulfate ions. If it does, the total moles of sulfate need to be recalculated by adding the moles contributed by the second solution.

Example: Second Solution Contains a Known Sulfate Concentration

Suppose the 50.0 mL of the second solution contains 0.50 M of sulfate:

- Moles of sulfate in second solution:

$$
\text{Moles} = 0.50\, \text{mol/L} \times 0.0500\, \text{L} = 0.025\, \text{mol}
$$

- Total moles of sulfate after mixing:

$$
0.1125\, \text{mol} + 0.025\, \text{mol} = 0.1375\, \text{mol}
$$

- Final sulfate concentration:

$$
\frac{0.1375\, \text{mol}}{0.1250\, \text{L}} = 1.10\, \text{M}
$$

This scenario demonstrates the importance of knowing the composition of all solutions involved to accurately determine ion concentrations.

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Understanding the Chemistry: Molarity, Dissociation, and Ion Presence

## Copper Sulfate Dissociation

Copper sulfate dissociates in water as:

$$
CuSO_4 (aq) \rightarrow Cu^{2+} (aq) + SO_4^{2-} (aq)
$$

This dissociation is 1:1, meaning each mole of $CuSO_4$ yields one sulfate ion. Therefore, the molarity of sulfate ions in the solution equals the molarity of $CuSO_4$.

## Implications for Ion Concentrations

- When measuring sulfate concentration, one can directly infer it from the molarity of $CuSO_4$, provided the dissociation is complete and the solution is dilute.
- Any other ions or reactions are outside the scope unless specified.

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## Practical Applications and Significance

Understanding sulfate ion concentrations after mixing solutions has broad applications:

- Industrial processes: Managing sulfate levels in chemical manufacturing or wastewater treatment.
- Laboratory experiments: Preparing solutions with precise ion concentrations for electrochemical studies.
- Agricultural chemistry: Adjusting sulfate levels in fertilizers and soil treatments.

Accurate calculations ensure safety, compliance with regulations, and experimental reproducibility.

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## Summary and Key Takeaways

- The initial moles of sulfate are calculated from the molarity and volume of the copper sulfate solution.
- The total volume after mixing influences the concentration via dilution.
- If the second solution contains sulfate ions, their contribution must be added to the initial moles.
- The sulfate ion concentration is directly related to the molarity of $CuSO_4$ due to complete dissociation.
- Precise calculations depend on knowing the composition of all solutions involved.

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## Final Thoughts

Calculating the sulfate ion concentration after mixing solutions may seem straightforward but requires careful attention to details such as volumes, molarities, and solution compositions. Mastery of these principles supports accurate laboratory work, safe industrial practices, and a deeper understanding of solution chemistry fundamentals. Whether you're preparing reagents for a complex experiment or analyzing environmental samples, knowing how to determine ion concentrations is an essential skill for chemists and scientists alike.

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Note: Always verify the assumptions about solution composition and dissociation in real-world applications. In cases involving complex ions, incomplete dissociation, or additional reactions, more advanced analysis may be necessary.

## [What Is The Sulfate Ion Concentration Of The Resulting Solution When 75 0 Ml Of 1 50 M Cuso4 And 50 0](#)

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