

900 Ml Of Water Is Added To 100 Ml Of A 0.1 M Solution. What Is The New Concentration?

900 Ml Of Water Is Added To 100 Ml Of A 0.1 M Solution. What Is The New Concentration?

Understanding how dilution affects the concentration of a solution is fundamental in chemistry. When water is added to a solution, the amount of solute remains constant, but the total volume increases, resulting in a decreased concentration. This article explores the process of calculating the new concentration after dilution, specifically focusing on adding 900 mL of water to 100 mL of a 0.1 M solution. We will discuss the concepts involved, step-by-step calculations, practical applications, and important considerations in solution dilution.

Fundamentals of Solution Concentration and Dilution

What Is Solution Concentration?

Solution concentration refers to the amount of solute present in a given volume of solution. It is commonly expressed in units such as molarity (M), which indicates moles of solute per liter of solution.

Molarity (M) Formula:

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

Understanding Dilution

Dilution involves decreasing the concentration of a solute by adding solvent, usually water, to the original solution. The key principle is that the number of moles of solute remains unchanged during dilution:

Dilution Equation:

$$C_1 V_1 = C_2 V_2$$

Where:

- C_1 = initial concentration
- V_1 = initial volume
- C_2 = final concentration
- V_2 = final volume

This equation is essential for calculating the new concentration after dilution, given the initial conditions and the volume of solvent added.

Step-by-Step Calculation of the New Concentration

Given Data

- Initial volume of the solution, $(V_1) = 100 \text{ mL}$
- Initial concentration, $(C_1) = 0.1 \text{ M}$
- Volume of water added, $(V_{\text{water}}) = 900 \text{ mL}$
- Final volume, $(V_2) = (V_1 + V_{\text{water}}) = 100 \text{ mL} + 900 \text{ mL} = 1000 \text{ mL}$

Step 1: Calculate the Moles of Solute in the Original Solution

Since molarity is moles per liter, convert the initial volume to liters:

$$V_1 = 100 \text{ mL} = 0.1 \text{ L}$$

Calculate the moles of solute:

$$\text{moles of solute} = C_1 \times V_1 = 0.1 \text{ mol/L} \times 0.1 \text{ L} = 0.01 \text{ mol}$$

This amount of solute remains unchanged during dilution.

Step 2: Determine the Final Volume in Liters

Convert the total volume after dilution to liters:

$$V_2 = 1000 \text{ mL} = 1 \text{ L}$$

Step 3: Calculate the New Concentration (C_2)

Using the dilution formula:

$$C_2 = \frac{\text{moles of solute}}{V_2} = \frac{0.01 \text{ mol}}{1 \text{ L}} = 0.01 \text{ M}$$

Result: The new concentration of the solution after adding 900 mL of water is 0.01 M.

Implications and Practical Applications

Why Is Understanding Dilution Important?

Dilution calculations are essential in various fields, including:

- Laboratory experiments where precise concentrations are required.
- Pharmaceutical preparations to achieve desired drug concentrations.
- Industrial processes involving chemical manufacturing.
- Environmental science for analyzing pollutant concentrations.

Examples of Real-World Scenarios

- Preparing a diluted solution: A scientist might need a specific concentration of a reagent for an experiment, which involves diluting a stock solution.
- Medical applications: Diluting a concentrated medication to a safe dosage.
- Water treatment: Adjusting chemical concentrations to meet safety standards.

Additional Considerations in Solution Dilution

Accuracy and Precision

When performing dilutions, precise measurement of volumes is crucial to ensure the accuracy of the final concentration. Use calibrated equipment such as pipettes and volumetric flasks.

Effect of Temperature

Temperature can influence solution volume due to thermal expansion or contraction. While usually negligible for dilute aqueous solutions at room temperature, it's important to consider in sensitive applications.

Multiple Dilutions

Sometimes, solutions are diluted stepwise. The same dilution formula applies iteratively, but it's often easier to calculate the overall dilution factor:

Dilution Factor (DF):

$$DF = \frac{V_{\text{final}}}{V_{\text{initial}}}$$

Total dilution is the product of individual dilution factors.

Summary and Key Takeaways

- When 900 mL of water is added to 100 mL of a 0.1 M solution, the total volume becomes 1 liter.
- The molarity decreases proportionally with the increase in volume, following the principle $(C_1 V_1 = C_2 V_2)$.
- The new concentration after dilution is 0.01 M.
- Accurate measurements are vital for precise solution preparation.
- Understanding dilution principles is crucial in scientific research, medicine, and industrial processes.

Conclusion

Dilution is a straightforward yet powerful concept in chemistry that allows scientists and professionals to manipulate solution concentrations to meet specific needs. The example of adding 900 mL of water to a 100 mL, 0.1 M solution demonstrates how to apply fundamental equations to determine the resulting concentration. Mastery of these principles ensures accurate experimental results, safe medical practices, and efficient industrial processes.

By comprehending the relationship between volume and concentration, you can confidently perform dilutions and interpret their outcomes, making this knowledge an essential part of your chemical toolkit.

Frequently Asked Questions

What is the initial concentration of the solution before water is added?

The initial concentration is 0.1 M.

How much water is added to the original solution?

900 mL of water is added.

What is the total volume of the solution after adding water?

The total volume becomes $100 \text{ mL} + 900 \text{ mL} = 1000 \text{ mL}$ or 1 L.

How do you calculate the new concentration after dilution?

Use the dilution formula: $C_1 V_1 = C_2 V_2$, where C_1 and V_1 are the initial concentration and volume, and C_2 and V_2 are the new concentration and volume.

What is the initial volume of the solution?

The initial volume is 100 mL.

What is the calculation for the new concentration after dilution?

$$C_2 = (C_1 V_1) / V_2 = (0.1 \text{ M } 100 \text{ mL}) / 1000 \text{ mL} = 10 / 1000 = 0.01 \text{ M}.$$

What is the final concentration of the solution after adding water?

The new concentration is 0.01 M.

Why does the concentration decrease after adding water?

Because the amount of solute remains the same while the total volume increases, leading to a lower concentration.

Would adding more water further dilute the solution?

Yes, adding more water would decrease the concentration even more, further diluting the solution.

Additional Resources

900 mL of water is added to 100 mL of a 0.1 M solution. What is the new concentration? This question is a classic example of dilution in chemistry, illustrating how the concentration of a solution changes when the volume is increased by adding solvent—in this case, water. Understanding this process is vital for students, researchers, and professionals working with solutions, as it forms the basis of many laboratory procedures and industrial processes. In this comprehensive guide, we will explore the principles behind dilution, step through the calculations, and discuss related concepts to deepen your understanding of solution concentration changes.

Understanding the Basics: What Is Solution Concentration?

Before diving into the calculation, it's essential to clarify what solution concentration means.

What is Molarity?

- Molarity (M) is a measure of the concentration of a solute in a solution.
- It is defined as moles of solute per liter of solution.
- Formula:

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

Key Concepts:

- Solute: The substance dissolved in a solvent.
- Solvent: The medium in which the solute dissolves (water in this case).

- Dilution: The process of decreasing the concentration of a solute by adding more solvent.

Scenario Breakdown: Initial Conditions and Final State

Let's analyze the given problem:

- Initial solution:
- Volume: 100 mL
- Concentration: 0.1 M
- Added solvent:
- Water volume: 900 mL
- Final solution:
- Total volume after addition
- New concentration to be determined

Understanding the initial amount of solute and the final volume is crucial.

Step 1: Calculate the Moles of Solute in the Initial Solution

Since molarity relates moles to volume, find out how many moles of solute are in the initial solution:

$$\text{Moles of solute} = \text{Molarity} \times \text{Volume in liters}$$

Convert 100 mL to liters:

$$100\text{ mL} = 0.100\text{ L}$$

Calculate:

$$\text{Moles} = 0.1\text{ M} \times 0.100\text{ L} = 0.010\text{ moles}$$

This is the total amount of solute present before dilution.

Step 2: Determine the Final Volume of the Solution

Adding 900 mL of water to the initial 100 mL:

$$\text{Final volume} = 100\text{ mL} + 900\text{ mL} = 1000\text{ mL}$$

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Convert to liters for consistency:

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$$1000\, \text{mL} = 1.000\, \text{L}$$

\]

Step 3: Calculate the New Concentration

Since the amount of solute remains unchanged during dilution:

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$$\text{Moles of solute} = 0.010\, \text{moles}$$

\]

And the total volume is now 1.000 L, the new concentration:

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$$\text{New concentration} = \frac{\text{moles of solute}}{\text{final volume in liters}} = \frac{0.010\, \text{moles}}{1.000\, \text{L}} = 0.010\, \text{M}$$

\]

Answer:

The new concentration of the solution after dilution is 0.010 M.

In-Depth Analysis and Additional Considerations

Why Does the Concentration Decrease?

Dilution involves increasing the volume of solvent without adding more solute, thus decreasing the molarity. In this case, the initial 0.1 M solution becomes ten times less concentrated due to the tenfold increase in volume.

Key Points to Remember:

- Moles of solute remain constant during dilution.
- The concentration is inversely proportional to the volume when no additional solute is added.

Practical Applications of Dilution Calculations

Understanding this process is fundamental in various fields:

- Laboratory Work: Preparing solutions of desired concentrations.
- Pharmaceuticals: Diluting concentrated drugs to safe dosages.

- Industrial Processes: Adjusting solution concentrations for manufacturing.

Common Dilution Formula:

$$C_1 V_1 = C_2 V_2$$

Where:

- C_1 = initial concentration
- V_1 = initial volume
- C_2 = final concentration
- V_2 = final volume

Applying this formula to our problem:

$$0.1 \text{ M} \times 0.100 \text{ L} = C_2 \times 1.000 \text{ L}$$

Solve for C_2 :

$$C_2 = \frac{0.1 \times 0.100}{1.000} = 0.010 \text{ M}$$

This confirms our earlier calculation.

Variations and Related Scenarios

1. Adding Different Volumes of Water

- If more or less water is added, how does that affect the final concentration?
- Use the same principles to recalculate.

2. Adding Solute Instead of Water

- If additional solute is added, the calculation involves both the initial amount and the added amount.

3. Concentration of the Original Solution

- Changing the initial concentration alters the final concentration after dilution proportionally.

Common Mistakes and Tips

- Always convert volumes to liters when using molarity.
- Remember that moles of solute are conserved during dilution.

- Use the dilution formula for quick calculations and verify results with step-by-step methods.
- Double-check units to avoid calculation errors.

Summary: Key Takeaways

- Adding 900 mL of water to 100 mL of a 0.1 M solution results in a final concentration of 0.010 M.
- The process involves calculating the initial moles of solute, determining the final volume, and applying the molarity formula.
- Dilution is a fundamental concept in chemistry, essential for precise solution preparation.

Final Thoughts

Understanding how to determine the new concentration after adding solvent is a vital skill in chemistry. Whether you're preparing solutions in the lab, dosing medications, or designing industrial processes, mastering dilution calculations ensures accuracy and safety. The key is to remember that the total amount of solute remains constant during dilution, and the concentration inversely relates to the total volume of the solution.

By practicing these calculations and understanding the underlying principles, you'll develop a strong foundation in solution chemistry that serves across numerous scientific disciplines.

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