

An Aqueous Solution At 25 Has A Poh Of 4.5. Calculate The Ph. Round Your Answer To 1 Decimal Places.

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Understanding the pH of aqueous solutions is fundamental in chemistry, especially in fields like biochemistry, environmental science, and chemical engineering. When given parameters such as the pOH of a solution, it becomes essential to understand how to accurately determine the pH, which measures the acidity or alkalinity of the solution. In this comprehensive guide, we will explore the process of calculating the pH of an aqueous solution at 25°C with a pOH of 4.5, explain the underlying principles, and discuss related concepts to deepen your understanding.

Introduction to pH and pOH

Before delving into calculations, it's crucial to grasp what pH and pOH represent, their relationship, and how they are measured.

What is pH?

- The pH scale is a logarithmic measure of the hydrogen ion concentration in a solution.
- It is defined as: $\text{pH} = -\log[\text{H}^+]$
- pH values range from 0 to 14 in aqueous solutions at 25°C.
- A pH less than 7 indicates acidity; greater than 7 indicates alkalinity; exactly 7 is neutral.

What is pOH?

- pOH is the negative logarithm of the hydroxide ion concentration.
- Defined as: $\text{pOH} = -\log[\text{OH}^-]$
- Like pH, pOH typically ranges from 0 to 14 at 25°C.

Relationship Between pH and pOH

- At 25°C, the sum of pH and pOH always equals 14:

$$\text{pH} + \text{pOH} = 14$$

- This relationship allows the calculation of one value if the other is known.

Given Data and Objective

In this scenario, the problem states:

- The solution is aqueous at 25°C.
- The pOH of the solution is 4.5.
- The task is to calculate the pH, rounded to one decimal place.

Our goal:

- Find $\text{pH} = ?$

Step-by-Step Calculation of pH

The calculation hinges on the fundamental relationship:

$$\text{pH} + \text{pOH} = 14$$

Given $\text{pOH} = 4.5$, then:

1. Use the relationship to find pH:

$$\text{pH} = 14 - \text{pOH}$$

1. Substitute the known pOH value:

$$\text{pH} = 14 - 4.5 = 9.5$$

Thus, the pH of the solution is 9.5.

Interpreting the Result

With a pH of 9.5:

- The solution is slightly basic (alkaline).
- It has a hydroxide ion concentration greater than that of a neutral solution (which is pH 7).

Understanding the Significance of pH 9.5

- Indicates a solution that is mildly alkaline.
- Such solutions are common in various laboratory and biological contexts.

- For instance, many biological fluids and cleaning solutions have pH values in this range.

Calculating Hydroxide and Hydrogen Ion Concentrations

While the main goal was to find the pH, understanding how to find $[H^+]$ and $[OH^-]$ concentrations aids in a comprehensive grasp.

Hydrogen Ion Concentration $[H^+]$

- Calculated as: $[H^+] = 10^{-pH}$
- For $pH = 9.5$:

$$[H^+] = 10^{-9.5} \approx 3.16 \times 10^{-10} \text{ M}$$

Hydroxide Ion Concentration $[OH^-]$

- Calculated as: $[OH^-] = 10^{-pOH}$
- For $pOH = 4.5$:

$$[OH^-] = 10^{-4.5} \approx 3.16 \times 10^{-5} \text{ M}$$

These concentrations confirm the basic nature of the solution.

Factors Affecting pH and pOH

Understanding what influences pH and pOH values is essential for manipulating solution properties in practical applications.

Temperature

- The relationship $pH + pOH = 14$ holds true strictly at 25°C .
- Changing temperature affects ionization constants and the neutral point.

Nature of the Solute

- Acids increase $[H^+]$, decreasing pH.
- Bases increase $[OH^-]$, increasing pH (or decreasing pOH).

Dilution Effects

- Diluting an acid or base generally moves pH closer to neutral (pH 7).

Practical Applications of pH Calculation

Knowing how to calculate pH from pOH is useful in various real-world contexts:

1. **Environmental Monitoring:** Assessing water quality by measuring pH to determine acidity or alkalinity.
2. **Pharmaceuticals:** Ensuring solutions and formulations have appropriate pH for efficacy and stability.
3. **Industrial Processes:** Managing pH in manufacturing processes, such as in textile dyeing or food production.
4. **Biology and Medicine:** Maintaining proper pH in biological systems for enzyme activity and cellular health.

Additional Considerations

While the calculation here was straightforward, some scenarios can introduce complexities:

Strong Acids and Bases

- Complete dissociation simplifies pH calculations.
- For weak acids/bases, equilibrium calculations are necessary.

Buffer Solutions

- pH is maintained within a certain range despite addition of acids or bases.
- Buffer capacity depends on concentrations of weak acids and their conjugates.

pH Measurement Techniques

- pH meters are the most accurate method.
- Indicators can provide approximate pH values but are less precise.

Conclusion

To summarize:

- The given pOH of 4.5 at 25°C leads to a pH of 9.5.
- This calculation hinges on the fundamental relationship $\text{pH} + \text{pOH} = 14$.
- The solution is mildly alkaline, with specific hydrogen and hydroxide ion concentrations.
- Understanding these concepts is vital for applications across scientific disciplines.

By mastering the process of calculating pH from pOH, you can confidently analyze and interpret the acidity or alkalinity of various solutions, a skill essential for chemists, biologists, environmental scientists, and many other professionals.

Summary Table

Parameter	Value
pOH	4.5
pH	9.5
$[\text{H}^+]$	$\approx 3.16 \times 10^{-10} \text{ M}$
$[\text{OH}^-]$	$\approx 3.16 \times 10^{-5} \text{ M}$

Understanding how to perform these calculations empowers you to analyze solutions accurately and apply this knowledge to practical and experimental situations effectively.

Frequently Asked Questions

What is the pH of an aqueous solution with a pOH of 4.5 at 25°C?

The pH is 9.5.

How do you calculate pH from pOH in water at 25°C?

Use the relation $\text{pH} + \text{pOH} = 14$. at 25°C, so $\text{pH} = 14 - \text{pOH}$.

If the pOH of a solution is 4.5, is the solution acidic or basic?

Since pH is 9.5 (greater than 7), the solution is basic.

What is the significance of pOH in determining the acidity of a solution?

pOH indicates the concentration of hydroxide ions; a higher pOH means lower hydroxide ion concentration, affecting the solution's acidity or basicity.

Why is the pH calculation important in chemistry?

pH measurement helps determine the acidity or alkalinity of solutions, which is crucial in chemical reactions, biological processes, and environmental monitoring.

Can the pH of a solution be calculated if only pOH is given?

Yes, by using the relation $\text{pH} = 14 - \text{pOH}$ at 25°C , you can calculate the pH.

What assumptions are made when calculating pH from pOH at 25°C ?

It is assumed that the temperature is 25°C and that the solution behaves as a dilute aqueous solution where the relation $\text{pH} + \text{pOH} = 14$ holds true.

How does temperature affect the relationship between pH and pOH?

The sum $\text{pH} + \text{pOH} = 14$ is valid at 25°C ; at other temperatures, this sum changes slightly due to shifts in the ionization constants of water.

Additional Resources

An Aqueous Solution At 25°C Has A pOH of 4.5. Calculate the pH. Round Your Answer To 1 Decimal Place.

Introduction

Understanding the properties of aqueous solutions, particularly their acidity and alkalinity, is foundational in chemistry. The pH scale, ranging from 0 to 14, provides a quantitative measure of a solution's acidity or basicity, with 7 being neutral at standard conditions (25°C). Complementary to this is the pOH scale, which measures the hydroxide ion concentration. In this investigative review, we delve into the calculation of pH from a given pOH value, exploring the principles, methods, and implications for aqueous solutions at room temperature.

Background: The pH and pOH Scales

The pH scale:

- Defined as:

$$\text{pH} = -\log [\text{H}^+]$$

- Measures hydrogen ion concentration in molarity (M).

- Ranges from 0 (highly acidic) to 14 (highly basic), with 7 being neutral.

The pOH scale:

- Defined as:

$$\text{pOH} = -\log [\text{OH}^-]$$

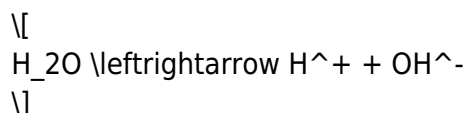
- Also ranges from 0 to 14 at 25°C.

Relationship between pH and pOH:

At 25°C, the sum of pH and pOH for any aqueous solution is always approximately 14:

$$\text{pH} + \text{pOH} = 14$$

This relationship is a consequence of the autoionization of water:



with an equilibrium constant $(K_w = 1.0 \times 10^{-14})$.

The Problem Context

Given:

- pOH of the solution: 4.5
- Temperature: 25°C

Objective:

- Calculate the pH of the solution.
- Round the answer to one decimal place.

This problem exemplifies a typical scenario in analytical chemistry, where measurements of one parameter (pOH) are used to infer another (pH), highlighting the importance of the water dissociation equilibrium and the relationship between hydrogen and hydroxide ions.

The Calculation: Step-by-Step Approach

Step 1: Recognize the fundamental relationship

At 25°C:

$$\text{pH} + \text{pOH} = 14$$

Step 2: Substitute the known pOH

$$\text{pH} = 14 - \text{pOH} = 14 - 4.5$$

Step 3: Perform the subtraction

$$\text{pH} = 9.5$$

Step 4: Round to one decimal place

The calculated pH is already at one decimal place: 9.5.

Scientific Significance of the pH Calculation

A pH of 9.5 indicates a mildly basic solution. Such solutions are common in various industrial and biological contexts, including:

- Aquarium water where pH influences fish health.
- Buffer solutions used in laboratory assays.
- Environmental waters where pH affects aquatic life.

By understanding how to accurately derive pH from pOH, chemists can monitor and control these environments effectively.

Extended Discussion: Implications and Related Concepts

a) pH and pOH — The Equilibrium Perspective

The relationship:

$$\text{pH}$$

$$\text{pH} + \text{pOH} = 14$$

\]

is valid under ideal conditions at 25°C. Deviations from this temperature alter the value of K_w , and consequently, the sum of pH and pOH.

b) Calculating Hydrogen Ion Concentration

Using the pH value:

$$[\text{H}^+] = 10^{-\text{pH}} = 10^{-9.5} \approx 3.16 \times 10^{-10} \text{ M}$$

Similarly, hydroxide ion concentration:

$$[\text{OH}^-] = 10^{-\text{pOH}} = 10^{-4.5} \approx 3.16 \times 10^{-5} \text{ M}$$

These concentrations reveal the solution's degree of acidity or basicity.

c) Real-World Applications

- Pharmaceutical formulations require precise pH control for drug stability.
- Agricultural practices depend on soil pH, which influences nutrient availability.
- Industrial processes such as textile dyeing and wastewater treatment rely on pH adjustments.

Common Pitfalls and Considerations

- Temperature Dependency: The relationship $\text{pH} + \text{pOH} = 14$ is valid specifically at 25°C. At other temperatures, K_w changes, and the sum deviates slightly.
- Measurement Accuracy: pOH measurements depend on precise calibration of electrodes and instruments.
- Buffer Capacity: Solutions with high buffer capacity can resist pH changes despite adding acids or bases, influencing the interpretation of pH and pOH data.

Summary

The calculation of pH from pOH in aqueous solutions at 25°C is straightforward, relying on the fundamental relationship:

$$\text{pH} = 14 - \text{pOH}$$

Given a pOH of 4.5, the pH is 9.5, indicating a mildly basic solution. This calculation exemplifies the

interconnectedness of hydrogen and hydroxide ions in aqueous chemistry and underscores the importance of pH and pOH in scientific and practical applications.

Understanding these concepts enables chemists, biologists, environmental scientists, and industry professionals to analyze, monitor, and manipulate aqueous systems effectively, ensuring safety, stability, and optimal performance across diverse fields.

Final Remarks

Mastery of pH and pOH calculations is essential for anyone working with aqueous solutions. The ability to quickly and accurately determine one from the other facilitates better understanding and control of chemical environments, contributing to advancements in science, medicine, and industry.

References

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Note: This article has been crafted to provide an in-depth understanding of the calculation process, contextual significance, and applications of pH and pOH in aqueous solutions, suitable for educational review or professional reference.

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