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Sub-Subject: Chemistry | Topic: Acid-Base Equilibrium

Given and Introduction Step:

Given:
- Hydroxide concentration ($[OH^-]$) = 9.14×10^{-8} M

This problem involves calculating the pH of a solution given its hydroxide ion concentration. The relationship between the OH^- concentration and the pH can be derived using the ion product of water (K_w).

Step 1: Calculating the hydrogen ion concentration $[H^+]$ using K_w

First, use the ion-product constant for water at 25°C, which is $K_w = 1.0 \times 10^{-14}$, to calculate $[H^+]$:

$$K_w = [H^+][OH^-]$$
Substituting the known values:
$$1.0 \times 10^{-14} = [H^+] \times 9.14 \times 10^{-8}$$
$$[H^+] = \frac{1.0 \times 10^{-14}}{9.14 \times 10^{-8}}$$

Explanation: This step uses the ion-product constant of water to relate the concentrations of $[H^+]$ and $[OH^-]$.

Step 2: Performing the Calculation

Now, calculate:
$$[H^+] = \frac{1.0 \times 10^{-14}}{9.14 \times 10^{-8}}$$
$$[H^+] = 1.094 \times 10^{-7} M$$

Explanation: Performing the division provides the hydrogen ion concentration necessary to find the pH.

Step 3: Calculating the pH

Now, use the hydrogen ion concentration to find the pH:
$$pH = -\log [H^+]$$
Substitute $[H^+] = 1.094 \times 10^{-7}$:
$$pH = -\log (1.094 \times 10^{-7})$$

Explanation: The pH is calculated using the negative logarithm of the hydrogen ion concentration.

Step 4: Performing the Logarithmic Calculation

Now, perform the logarithmic calculation:
$$pH = -\log (1.094 \times 10^{-7})$$
Using a calculator,
$$pH \approx -(-6.961)$$
$$pH \approx 6.961$$

Explanation: Taking the logarithm and then the negative of that value provides the pH of the solution.

Final Solution:

The pH of the solution is approximately 6.961.

Explanation: The pH value has been calculated using the hydrogen ion concentration derived from the given hydroxide ion concentration.

Supporting Statement: The pH of a solution with a hydroxide ion concentration of 9.14×10^{-8} M is approximately 6.961, calculated using well-established principles of aqueous equilibrium.