Calculating pH

To calculate the pH of an aqueous solution you need to know the concentration of the hydronium ion in moles per liter (molarity). The pH is then calculated using the expression:

$$pH = - \log [H_3O^+].$$

Example: Find the pH of a 0.0025 M HCl solution. The HCl is a strong acid and is 100% ionized in water. The hydronium ion concentration is 0.0025 M. Thus:

$$pH = - \log (0.0025) = - (- 2.60) = 2.60$$

Calculating the Hydronium Ion Concentration from pH

The hydronium ion concentration can be found from the pH by the reverse of the mathematical operation employed to find the pH.

$$[H_3O^+] = 10^{-pH} \quad \text{or} \quad [H_3O^+] = \text{antilog} (- pH)$$

Example: What is the hydronium ion concentration in a solution that has a pH of 8.34?

$$8.34 = - \log [H_3O^+]$$
$$- 8.34 = \log [H_3O^+]$$
$$[H_3O^+] = 10^{-8.34} = 4.57 \times 10^{-9} \text{ M}$$

On a calculator, calculate $10^{-8.34}$, or "inverse" log (- 8.34).

Calculating pOH

To calculate the pOH of a solution you need to know the concentration of the hydroxide ion in moles per liter (molarity). The pOH is then calculated using the expression:

$$pOH = - \log [OH^-]$$

Example: What is the pOH of a solution that has a hydroxide ion concentration of 4.82×10^{-5} M?

$$pOH = - \log [4.82 \times 10^{-5}] = - (- 4.32) = 4.32$$

Calculating the Hydroxide Ion Concentration from pOH

The hydroxide ion concentration can be found from the pOH by the reverse mathematical operation employed to find the pOH.

$$[OH^-] = 10^{-pOH} \quad \text{or} \quad [OH^-] = \text{antilog} (- pOH)$$

Example: What is the hydroxide ion concentration in a solution that has a pOH of 5.70?

$$5.70 = -\log [OH^-]$$
$$-5.70 = \log[OH^-]$$
$$[OH^-] = 10^{-5.70} = 2.00 \times 10^{-6}\ M$$

On a calculator calculate $10^{-5.70}$, or "inverse" log (- 5.70).

Relationship Between pH and pOH

The pH and pOH of a water solution at 25°C are related by the following equation.

$$pH + pOH = 14$$

If either the pH or the pOH of a solution is known, the other can be quickly calculated.

Example: A solution has a pOH of 11.76. What is the pH of this solution?

$$pH = 14 - pOH = 14 - 11.76 = 2.24$$