TABLE 5 Relationship of $[H_3O^+]$ to $[OH^-]$ and pH (at 25°C)

Solution	$[H_3O^+]$	$[OH^-]$	pH
1.0×10^{-2} M KOH	1.0×10^{-12}	1.0×10^{-2}	12.00
1.0×10^{-2} M NH_3	2.4×10^{-11}	4.2×10^{-4}	10.63
Pure H_2O	1.0×10^{-7}	1.0×10^{-7}	7.00
1.0×10^{-3} M HCl	1.0×10^{-3}	1.0×10^{-11}	3.00
1.0×10^{-1} M CH_3COOH	1.3×10^{-3}	7.5×10^{-12}	2.87

pH Calculations and the Strength of Acids and Bases

So far, we have discussed the pH of solutions that contain only strong acids or strong bases. We must also consider weak acids and weak bases. **Table 5** lists the $[H_3O^+]$, the $[OH^-]$, and the pH for several solutions.

KOH, the solute in the first solution listed, is a soluble ionic compound and a strong base. The molarity of a KOH solution directly indicates the $[OH^-]$, and the $[H_3O^+]$ can be calculated. Once the $[H_3O^+]$ is known, the pH can be calculated as in Sample Problem C. If the pH of this solution is measured experimentally, it will be the same as this calculated value. Methods for experimentally determining the pH of solutions will be presented in Section 2. Hydrochloric acid, HCl, is a strong acid, and similar calculations can be made for solutions that contain HCl.

Solutions of weak acids, such as acetic acid, CH_3COOH, present a different problem. The $[H_3O^+]$ cannot be calculated directly from the molar concentration because not all of the acetic acid molecules are ionized. The same problem occurs for weak bases such as ammonia, NH_3. The pH of these solutions must be measured experimentally. The $[H_3O^+]$ and $[OH^-]$ can then be calculated from the measured pH values.

extension

CROSS-DISCIPLINARY

Go to **go.hrw.com** for a full-length article on how buffers maintain the acid-base balance in blood.

Keyword: HC6ABTX

SECTION REVIEW

1. What is the concentration of hydronium and hydroxide ions in pure water at 25°C?
2. Why does the pH scale generally range from 0 to 14 in aqueous solutions?
3. Why does a pH of 7 represent a neutral solution at 25°C?
4. A solution contains 4.5×10^{-3} M HCl. Determine the following for the solution:
   a. $[H_3O^+]$ **b.** $[OH^-]$ **c.** pH
5. A $Ca(OH)_2$ solution has a pH of 8.0. Determine the following for the solution:
   a. $[H_3O^+]$ **b.** $[OH^-]$ **c.** $[Ca(OH)_2]$

Critical Thinking

6. **PREDICTING OUTCOMES** Arrange the following solutions in order from lowest to highest pH: 0.10 M HCl, 0.10 M H_2SO_4, and 0.10 M HF.