Strong Bases

As we have learned previously, a **strong base** is an base that ionizes completely in water to form hydroxide ions. For example, we will assume that every molecule of $NaOH$ that dissolves in water ionizes into a Na^+ and a OH^- ion.

$$NaOH(g) \rightarrow Na^+(aq) + OH^-(aq)$$

All of the hydroxides of Group 1 elements ($LiOH$, $NaOH$, KOH, $RbOH$, and $CsOH$) are strong bases. When these bases dissolve in water, one mole of hydroxide ion is produced for every mole of base that dissolves.

This means that, for the purposes of calculations, when a Group 1 base dissolves in water, the hydroxide ion concentration will be equal to the concentration of the base before ionization. For the above example,

$$\left[OH^-\right] = \left[NaOH\right]$$

The hydroxides of Group 2 elements ($Mg(OH)_2$, $Ca(OH)_2$, $Ba(OH)_2$, and $Sr(OH)_2$) also form strong bases. When these bases dissolve in water, two moles of hydroxide ions are formed for every mole of base that dissolves.

This means that, for the purposes of calculations, when a Group 2 base dissolves in water, the hydroxide ion concentration will be equal to two times the concentration of the base before ionization. For example,

$$Ba(OH)_2(s) \rightarrow Ba^{2+}(aq) + 2OH^-(aq)$$

$$\left[OH^-\right] = 2\left[Ba(OH)_2\right]$$

Calculating $\left[H_3O^+\right]$ and $\left[OH^-\right]$ of a Strong Base

The assumption that strong bases ionize completely and the value of K_W can be used to determine the hydronium ion or hydroxide ion concentrations of strong base solutions.

Example 1
Determine the hydrogen ion and hydroxide ion concentrations in $500\ mL$ of an aqueous solution containing $2.6\ g$ of dissolved sodium hydroxide.

The pH of Strong Bases

As with acids, the pH of a basic solution can be calculated from the hydronium ion concentration.

Example 2
Calculate the pH and pOH of a solution prepared by dissolving $4.3\ g$ of $Ba(OH)_2$ in water to form $1.5\ L$ of solution.

Worksheet

1. Calculate the hydronium ion concentration in a saturated solution of calcium hydroxide. Calcium hydroxide has a solubility of $6.9 \times 10^{-3}\ mol/L$ of solution.

2. The hydroxide ion concentration in a household cleaning solution is $2.99 \times 10^{-4}\ mol/L$. Calculate the hydronium ion concentration in the cleaning solution.

3. What is the hydronium ion concentration in a solution made by dissolving $20\ g$ of potassium hydroxide in water to form $500\ mL$ of solution?

4. Calculate the pH of a $0.15\ mol/L$ sodium hydroxide solution.

5. Calculate the pH of a $0.032\ mol/L\ Ba(OH)_2$ solution.

6. Calculate the pH of a $1.0\ mol/L\ KOH$ solution.

7. Calculate the pH of a $2.4 \times 10^{-5}\ mol/L\ Mg(OH)_2$ solution.

8. A solution is made by dissolving $0.078\ g\ Ca(OH)_2$ in water to make $100\ mL$ of final solution. Calculate the pH of the solution.

9. Calculate the mass of sodium hydroxide that must be dissolved to make $2.0\ L$ of a solution with a pH of 10.35, at STP.

Answers

1. $7.2 \times 10^{-13}\ mol/L$
2. $3.34 \times 10^{-11}\ mol/L$
3. $1.40 \times 10^{-14}\ mol/L$
4. 13.18
5. 12.81
6. 14.0
7. 9.68
8. 12.3
9. 0.018 g