

CHAPTER 18 ACID-BASE EQUILIBRIA

FOLLOW-UP PROBLEMS

- 18.1A **Plan:** Examine the formulas and classify each as an acid or base. Strong acids are the hydrohalic acids HCl, HBr, and HI, and oxoacids in which the number of O atoms exceeds the number of ionizable protons by at least two. Other acids are weak acids. Strong bases are soluble oxides or hydroxides of the Group 1A(1) metals and Ca, Sr, and Ba in Group 2A(2). Other bases are weak bases.

Solution:

- a) Chloric acid, HClO_3 , is the stronger acid because acid strength increases as the number of O atoms in the acid increases.
b) Hydrochloric acid, HCl , is one of the strong hydrohalic acids whereas acetic acid, CH_3COOH , is a weak carboxylic acid.
c) Sodium hydroxide, NaOH , is a strong base because Na is a Group 1A(1) metal. Methylamine, CH_3NH_2 , is an organic amine and, therefore, a weak base.

- 18.1B **Plan:** Examine the formulas and classify each as a strong acid, weak acid, strong base, or weak base. Strong acids are the hydrohalic acids HCl, HBr, and HI, and oxoacids in which the number of O atoms exceeds the number of ionizable protons by at least two. Other acids are weak acids. Strong bases are soluble oxides or hydroxides of the Group 1A(1) metals and Ca, Sr, and Ba in Group 2A(2). Other bases are weak bases.

Solution:

- a) $(\text{CH}_3)_3\text{N}$ is a **weak base**. It contains a nitrogen atom with a lone pair of electrons, which classifies it as a base; however, it is not one of the strong bases.
b) Hydroiodic acid, HI , is a **strong acid** (one of the strong acids listed above).
c) HBrO is a **weak acid**. It has an ionizable hydrogen, which makes it an acid. Specifically, it is an oxoacid, in which a polyatomic ion is the anion. In the case of this oxoacid, there is only one O atom for each ionizable hydrogen, so this is a weak acid. The reaction for the dissociation of this weak acid is:
 $\text{HBrO}(\text{aq}) + \text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{BrO}^-(\text{aq}) + \text{H}_3\text{O}^+(\text{aq})$. The corresponding equilibrium expression is:

$$K_a = \frac{[\text{BrO}^-][\text{H}_3\text{O}^+]}{[\text{HBrO}]}$$

- d) $\text{Ca}(\text{OH})_2$ is a **strong base** (one of the strong bases listed above).

- 18.2A **Plan:** The product of $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$ remains constant at 25°C because the value of K_w is constant at a given temperature. Use $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1.0 \times 10^{-14}$ to solve for $[\text{H}_3\text{O}^+]$.

Solution:

Calculating $[\text{H}_3\text{O}^+]$:

$$[\text{H}_3\text{O}^+] = \frac{K_w}{[\text{OH}^-]} = \frac{1.0 \times 10^{-14}}{6.7 \times 10^{-2}} = 1.4925 \times 10^{-13} = \mathbf{1.5 \times 10^{-13} \text{ M}}$$

Since $[\text{OH}^-] > [\text{H}_3\text{O}^+]$, the solution is **basic**.

- 18.2B **Plan:** The product of $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$ remains constant at 25°C because the value of K_w is constant at a given temperature. Use $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1.0 \times 10^{-14}$ to solve for $[\text{H}_3\text{O}^+]$.

Solution:

Calculating $[\text{OH}^-]$:

$$[\text{OH}^-] = \frac{K_w}{[\text{H}_3\text{O}^+]} = \frac{1.0 \times 10^{-14}}{1.8 \times 10^{-10}} = 5.5555 \times 10^{-5} = \mathbf{5.6 \times 10^{-5} \text{ M}}$$

Since $[\text{OH}^-] > [\text{H}_3\text{O}^+]$, the solution is **basic**.

- 18.3A **Plan:** NaOH is a strong base that dissociates completely in water. Subtract pH from 14.00 to find the pOH, and calculate inverse logs of pH and pOH to find $[\text{H}_3\text{O}^+]$ and $[\text{OH}^-]$, respectively.

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Daniel C. Harris, Charles A. Lucy



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