

Chapter 17: Acid-Base Equilibria

17.2: The Buffer Solutions

Buffered Solution: - a solution that resists a change in pH when a small amount of H_3O^+ or OH^- is added.
 - consists of a pair of weak acid/conjugate base common ion or a pair of weak base/conjugate acid common ion.

Acidic Buffered Solution:

a. Small Amounts of H_3O^+ is Added:



(H^+ - Strong Acid reacts completely with A^-)

(More HA - Weak Acid: pH will only be lowered SLIGHTLY!)

b. Small Amounts of OH^- is Added:



(OH^- - Strong Base reacts completely with HA)

(More A^- - Weak Base: pH will only be raised SLIGHTLY!)

Basic Buffered Solution:

a. Small Amounts of H_3O^+ is Added:



(H^+ - Strong Acid reacts completely with B)

(More HB^+ - Weak Acid: pH will only be lowered SLIGHTLY!)

b. Small Amounts of OH^- is Added:



(OH^- - Strong Base increases $[\text{OH}^-]$; eq shifts left)

(More B - Weak Base: pH will only be raised SLIGHTLY!)

Example: $\text{HCO}_3^-_{(\text{aq})} / \text{CO}_3^{2-}$ is a buffer because HCO_3^- acts as an acid and CO_3^{2-} acts as a base whenever a small amount of strong base or acid is added to it. Thus, pH will remain somewhat constant.

When small amounts of strong base is added:



When small amounts of strong acid is added:



Example 1: Specify which of these systems can be classified as a buffer system.

a. $\text{HNO}_3 / \text{KNO}_3$

HNO_3 is a strong acid. Hence, NO_3^- is not a strong enough base to resist the change in pH. $\text{HNO}_3 / \text{KNO}_3$ is **NOT** a buffer system.

b. $\text{CH}_3\text{COOH} / \text{NaCH}_3\text{COO}$

CH_3COOH is a weak acid. Therefore, CH_3COO^- is a strong enough weak base to resist the change in pH. NaCH_3COO provides this base. $\text{CH}_3\text{COOH} / \text{CH}_3\text{COO}^-$ is a buffer system.

c. $\text{H}_2\text{SO}_4 / \text{NaHSO}_4$

H_2SO_4 is a strong acid. Hence, HSO_4^- is not a strong enough base to resist the change in pH. $\text{H}_2\text{SO}_4 / \text{NaHSO}_4$ is **NOT** a buffer.

d. $\text{NH}_3 / \text{NH}_4\text{Cl}$

NH_3 is a weak base. Therefore, NH_4^+ is a strong enough weak acid to resist the change in pH. NH_4Cl provides this acid. $\text{NH}_3 / \text{NH}_4\text{Cl}$ is a buffer system.

Example 2: Calculate the pH of a 1.00 L buffered solution consisting of 0.500 M of methylamine ($K_b = 4.38 \times 10^{-4}$) with 0.450 M of $\text{CH}_3\text{NH}_3\text{Cl}$ when:

- 0.0200 mol of KOH is added to it.
- 3.00 mL of 0.750 M of $\text{HNO}_3_{(\text{aq})}$ is added to it.
- Contrast the pH's of the above two additions against the same additions to 1.00 L of water.

Acid Base Equilibria Study Guide Answers

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