

## 19.3

## STRENGTHS OF ACIDS AND BASES

## Section Review

## Objectives

- Define strong acids and weak acids
- Calculate an acid dissociation constant ( $K_a$ ) from concentration and pH measurements
- Order acids by strength according to their acid dissociation constants ( $K_a$ )
- Order bases by strength according to their base dissociation constants ( $K_b$ )

## Vocabulary

- strong acids
- weak acids
- acid dissociation constant ( $K_a$ )
- strong bases
- weak bases
- base dissociation constant ( $K_b$ )

## Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

The strength of an acid or a base is determined by the 1 of the substance in solution. The acid dissociation constant, 2, is a quantitative measure of acid strength. A strong acid has a much 3  $K_a$  than a weak acid. The  $K_a$  of an acid is determined from measured 4 values.

Hydrochloric acid and sulfuric acid are 5 ionized in solution and are 6 acids. Ethanoic acid, which is only about 1 percent ionized, is a 7 acid. Magnesium hydroxide and calcium hydroxide are strong 8.

Weak bases react with 9 to form the hydroxide ion and the conjugate 10 of the base. Concentration in solution does not affect whether an acid or a base is 11 or weak.

- degree of ionization
- $K_a$
- higher
- pH
- completely
- strong
- weak
- bases
- water
- acid
- strong

**Part B True-False**

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- ST 12. Acids are completely dissociated in aqueous solution.
- NT 13. Diprotic acids lose both hydrogens at the same time.
- AT 14. Acid dissociation constants for weak acids can be calculated from experimental data.
- ST 15. Bases react with water to form hydroxide ions.

**Part C Matching**

Match each description in Column B to the correct term in Column A.

Column A	Column B
<u>c</u> 16. strong acids	a. ratio of the concentration of the dissociated (or ionized) form of an acid to the concentration of the undissociated acid
<u>e</u> 17. weak acids	b. bases that dissociate completely into metal ions and hydroxide ions in aqueous solution
<u>a</u> 18. acid dissociation constant ( $K_a$ )	c. acids that ionize completely in aqueous solution
<u>b</u> 19. strong bases	d. bases that do not dissociate completely in aqueous solution
<u>d</u> 20. weak bases	e. acids that are only partially ionized in aqueous solution
<u>f</u> 21. base dissociation constant ( $K_b$ )	f. ratio of concentration of conjugate acid times concentration of hydroxide ion to the concentration of conjugate base

**Part D Problem**

Answer the following in the space provided.

22. A 0.35M solution of a strong acid, HX, has a  $[H^+]$  of  $4.1 \times 10^{-2}$ . What is the value of  $K_a$  for this acid?

$$K_a = \frac{[H^+] \times [X^-]}{[HX]}$$

$$= \frac{(4.1 \times 10^{-2})(4.1 \times 10^{-2})}{0.309}$$

$$= 5.4 \times 10^{-3}$$

$$pH = 2.26$$

$$HX = 0.35 - 4.1 \times 10^{-2} = 0.309$$

# 19.4

## NEUTRALIZATION REACTIONS

### Section Review

#### Objectives

- Explain how acid–base titration is used to calculate the concentration of an acid or a base
- Explain the concept of equivalence in neutralization reactions

#### Vocabulary

- neutralization reactions
- titration
- equivalence point
- end point
- standard solution

#### Key Equations

- Acid + Base → Salt + Water
- Gram equivalent mass =  $\frac{\text{molar mass}}{\text{number of ionizable hydrogens}}$
- Normality ( $N$ ) = equiv/L
- $N_1 \times V_1 = N_2 \times V_2$
- $N_A \times V_A = N_B \times V_B$

#### Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

In the reaction of a(n) 1 with a base, hydrogen ions and 2 ions react to produce 3. This reaction, called 4, is usually carried out by 5. The 6 in a titration is the point at which the solution is neutral. At the 7 point of a titration, the number of equivalents of acid equals the number of equivalents of base.

- acid
- hydroxide
- water
- neutralization
- titration
- end point
- equivalence

### Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- AT 8. A solution of known concentration is called a standard solution.
- AT 9. The end point of a titration of a strong base with a strong acid occurs when  $[H^+] = [OH^-]$ .
- AT 10. The point of neutralization is the end point of titration.
- NT 11. The reaction of an acid and a base produces only water.

### Part C Matching

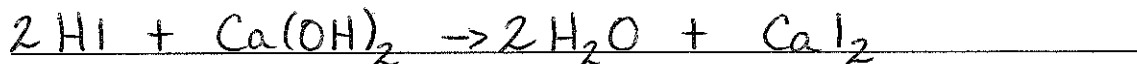
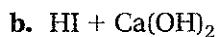
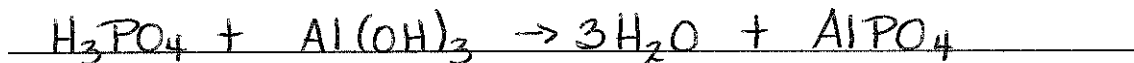
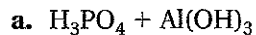
Match each description in Column B to the correct term in Column A.

- | Column A                              | Column B   |
|---------------------------------------|--|
| <u>c</u> 12. titration                | a. when the number of moles of hydrogen ions equals the number of moles of hydroxide ions                    |
| <u>e</u> 13. neutralization reactions | b. a solution of known concentration   |
| <u>a</u> 14. equivalence point        | c. a process for determining the concentration of a solution by adding a known amount of a standard solution |
| <u>b</u> 15. standard solution        | d. point of neutralization   |
| <u>d</u> 16. end point                | e. reactions between acids and bases to produce a salt and water   |

### Part D Problem

Answer the following in the space provided.

17. Complete and balance the equations for the following acid-base reactions.



## 19.5

## SALTS IN SOLUTION

## Section Review

## Objectives

- Define when a solution of a salt is acidic or basic
- Demonstrate with equations how buffers resist changes in pH

## Vocabulary

- salt hydrolysis
- buffers
- buffer capacity

## Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

A 1 forms when an acid is neutralized by a base. Salts can be neutral, 2, or 3 in solutions. Salts of strong acid–strong base reactions produce 4 solutions with water. Salts formed from the neutralization of weak acids or weak bases 5 water. They produce solutions that are acidic or basic.

For example, the pH of a solution at the equivalence point is greater than 7 for a 6 base–7 acid titration. Solutions that resist changes in pH are called 8 solutions. The buffer 9 is the amount of acid or base that can be added to a buffer without changing the pH greatly.

1. salt
2. acidic
3. basic
4. neutral
5. hydrolyze
6. strong
7. weak
8. buffer
9. capacity

### Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- NT 10. An aqueous solution of  $\text{NH}_4\text{Cl}$  is basic.
- NT 11.  $\text{HCl-NaCl}$  would be a good buffer system.
- ST 12. A buffer is a solution of a weak acid and one of its salts.
- AT 13. A strong acid and a weak base produce an acidic solution.

### Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
<u>a</u> 14. salt hydrolysis	a. the cations or anions of a dissociated salt remove hydrogen ions from or donate hydrogen ions to water
<u>d</u> 15. buffer	b. the amount of acid or base that can be added to a buffer solution before a significant change in pH can occur
<u>b</u> 16. buffer capacity	c. the salt produced by the titration of ammonia with hydrochloric acid.
<u>c</u> 17. $\text{NH}_4\text{Cl}$	d. a solution in which the pH remains relatively constant when small amounts of acid or base are added

### Part D Question

Answer the following in the space provided.

18. Predict whether an aqueous solution of each salt will be acidic, basic, or neutral.

- a.  $\text{NH}_4\text{Cl}$  ( $\text{NH}_4\text{OH} + \text{HCl}$ )  $\rightarrow$  acidic
- b.  $\text{Na}_2\text{CO}_3$  ( $\text{NaOH} + \text{H}_2\text{CO}_3$ )  $\rightarrow$  ~~neutral~~ basic
- c.  $\text{NH}_4\text{NO}_3$  ( $\text{NH}_4\text{OH} + \text{HNO}_3$ )  $\rightarrow$  acidic