

# 19 ACIDS, BASES, AND SALTS

## Chapter Test B

### A. Matching

Match each term in Column B with the correct description in Column A. Write the letter of the correct term on the line.

Column A	Column B
<u>b</u> 1. a substance that can donate a pair of electrons to form a covalent bond	a. the ion-product constant for water
<u>g</u> 2. a compound that produces hydroxide ions when dissolved in water	b. Lewis base
<u>d</u> 3. the particle formed when a weak base gains a hydrogen ion	c. acid
<u>a</u> 4. $1.0 \times 10^{-14} \text{ (mol/L)}^2$	d. conjugate acid
<u>f</u> 5. a substance that can accept a pair of electrons to form a covalent bond	e. neutralization reaction
<u>c</u> 6. a compound that produces hydrogen ions when dissolved in water	f. Lewis acid
<u>h</u> 7. $\text{H}_2\text{SO}_4$	g. base
<u>k</u> 8. when the number of moles of hydrogen ions equals the number of moles of hydroxide ions in titration	h. diprotic acid
<u>i</u> 9. describes a substance that can act as both an acid and a base	i. amphoteric
<u>j</u> 10. the process of adding a known amount of solution of known concentration to determine the concentration of another solution	j. titration
<u>e</u> 11. reactions in which an acid and a base react in an aqueous solution to produce a salt and water	k. equivalence point

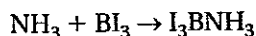
### B. Multiple Choice

Choose the best answer and write its letter on the line.

- b 12. Which of the following is true about acids?
- Acids give foods a bitter taste.
  - Aqueous solutions of acids conduct electricity.
  - Acids have a pH value greater than 7.
  - all of the above

- d 13. The products of the neutralization reaction between  $\text{HNO}_2(aq)$  and  $\text{Ca}(\text{OH})_2(aq)$  are  
 a.  $\text{CaNO}_3 + \text{H}_2\text{O}$ . c.  $\text{CaNO}_3 + 2\text{H}_2\text{O}$ .  
 b.  $\text{Ca}(\text{NO}_3)_2 + \text{H}_2\text{O}$ . d.  $\text{Ca}(\text{NO}_3)_2 + 2\text{H}_2\text{O}$ .
- a 14. A solution in which the  $[\text{H}^+]$  is  $1.0 \times 10^{-4}$  mol/L is said to be  
 a. acidic. c. neutral.  
 b. basic. d. none of the above
- b 15. What is the pH of the solution in question 14?  
 a. 1.00 c. 10.00  
 b. 4.00 d. 14.00
- c 16. A solution with a pH of 9 has a  $[\text{OH}^-]$  concentration of  
 a.  $1.0 \times 10^{-14}$  mol/L. c.  $1.0 \times 10^{-5}$  mol/L.  
 b.  $1.0 \times 10^{-9}$  mol/L. d.  $1.0 \times 10^{-7}$  mol/L.
- b 17. Among the following, which solution is the most acidic?  
 a.  $[\text{H}^+] = 1 \times 10^{-5}$  mol/L. c.  $[\text{OH}^-] = 1 \times 10^{-7}$  mol/L.  
 b. pH = 3 d. pH = 10
- d 18. The monoprotic acid from among the following is  
 a.  $\text{H}_2\text{CO}_3$  c.  $\text{H}_3\text{PO}_4$   
 b.  $\text{H}_2\text{SO}_4$  d. HCl.
- a 19. The Brønsted-Lowry theory defines an acid as a(n)  
 a. hydrogen ion donor. c. electron-pair donor.  
 b. hydrogen ion acceptor. d. electron-pair acceptor.
- d 20. Which of the following is true about neutralization reactions?  
 a. They involve strong acids and strong bases.  
 b. They result in the production of a salt and water.  
 c. They are all double-replacement reactions.  
 d. all of the above
- a 21. In the reaction:  $\text{HCl}(g) + \text{NH}_3(aq) \rightarrow \text{NH}_4^+(aq) + \text{Cl}^-(aq)$ ,  $\text{HCl}(g)$  is acting as a(n):  
 a. Brønsted-Lowry acid. c. Lewis acid.  
 b. Brønsted-Lowry base. d. Lewis base.
- c 22. The conjugate acid in the reaction described in question 21 is  
 a.  $\text{HCl}(g)$ . c.  $\text{NH}_4^+(aq)$ .  
 b.  $\text{NH}_3(aq)$ . d.  $\text{Cl}^-(aq)$ .
- a 23. Which of the following is true about indicators?  
 a. They are weak acids or bases.  
 b. They are as accurate as a pH meter.  
 c. They maintain their colors across the range of pH values for which they are used.  
 d. all of the above

b 24. What is the Lewis acid in the following reaction?



- a.  $\text{NH}_3$   
 b.  $\text{BI}_3$   
 c.  $\text{I}_3\text{BNH}_3$   
 d. none of these

a 25. Among the following  $K_a$  values, which represents the strongest acid?

- a.  $K_a = 1.2 \times 10^{-3}$   
 b.  $K_a = 3.4 \times 10^{-5}$   
 c.  $K_a = 8.7 \times 10^{-8}$   
 d.  $K_a = 5.8 \times 10^{-10}$

a 26. How many moles of  $\text{Mg}(\text{OH})_2(\text{aq})$  would be required to neutralize 3.0 mol  $\text{HCl}(\text{aq})$ ?

- a. 1.5 mol  
 b. 3.0 mol  
 c. 6.0 mol  
 d. 2.0 mol

### C. Problems

Solve the following problems in the space provided. Show your work.

27. Calculate the  $[\text{OH}^-]$  for an aqueous solution in which  $[\text{H}^+] = 1.0 \times 10^{-9}$  mol/L.

Is the solution acidic, basic, or neutral?

$$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-14}$$

$$[\text{OH}^-] = 1.0 \times 10^{-14} / 1.0 \times 10^{-9} = 1.0 \times 10^{-5} \text{ mol/L}$$

BASIC

28. For each of the following, fill in the concentration of the requested ion, the pH, and the type of solution (acid, base, or neutral).

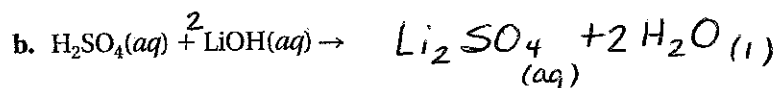
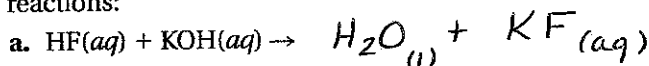
	Concentration	pH	Solution Type
a. $[\text{H}^+] = 1 \times 10^{-3}$	$[\text{OH}^-] = 1 \times 10^{-11}$	3.0	ACIDIC
b. $[\text{OH}^-] = 1 \times 10^{-8}$	$[\text{H}^+] = 1 \times 10^{-6}$	6.0	ACIDIC
c. $[\text{H}^+] = [\text{OH}^-]$	$[\text{H}^+] = 1 \times 10^{-7}$	7.0	NEUTRAL

29. Write the expression for  $K_a$  for each of the following acids. Assume that only one hydrogen is ionized.

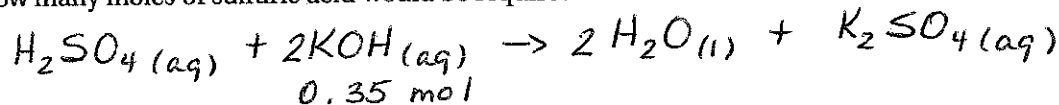
a. HI  $K_a = \frac{[\text{H}^+][\text{I}^-]}{[\text{HI}]}$

b.  $\text{H}_2\text{SO}_4$   $K_a = \frac{[\text{H}^+][\text{HSO}_4^-]}{[\text{H}_2\text{SO}_4]}$

30. Write complete and balanced equations for each of the following neutralization reactions:

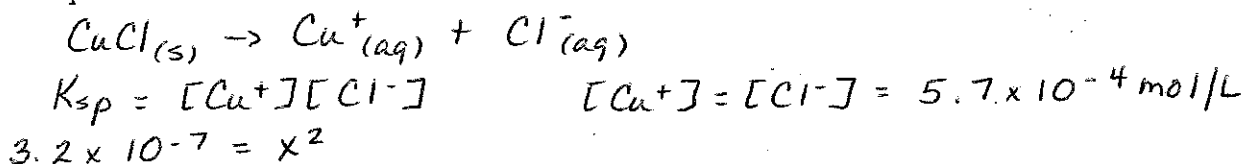


31. How many moles of sulfuric acid would be required to neutralize 0.35 mol of KOH?



$$n_{\text{H}_2\text{SO}_4} = 0.35 \text{ mol} \times \frac{1}{2} = 0.18 \text{ mol}$$

32. If the  $K_{sp}$  for a  $\text{CuCl}$  solution is  $3.2 \times 10^{-7}$ , what is the concentration of  $\text{Cu}$  and of  $\text{Cl}$  ions at equilibrium?



### D. Essay

Write a short essay for the following.

33. Distinguish between the Brønsted-Lowry and Lewis theories of acids and bases.

Br-L → acids are  $[\text{H}^+]$  donors, bases are  $[\text{H}^+]$  acceptors.  
Lewis → acids are  $e^-$  acceptors, bases are  $e^-$  donors.

### E. Additional Problems

Solve the following problems in the space provided. Show your work.

34. Determine the pH of a solution whose  $[\text{H}^+] = 3.4 \times 10^{-4} \text{ mol/L}$ . Is the solution acidic, basic, or neutral?

$$\text{pH} = -\log [\text{H}^+] = -\log [3.4 \times 10^{-4}]$$

$$= 3.47 \quad \text{ACIDIC}$$

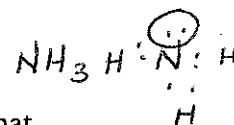
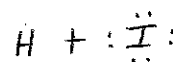
35. Use the Brønsted-Lowry definitions of acids and bases to identify the acid, base, conjugate acid, and conjugate base in each of the following reactions.

- a.  $\text{HF}(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_3\text{O}^+(aq) + \text{F}^-(aq)$   
 b.  $\text{HCl}(g) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_3\text{O}^+(aq) + \text{Cl}^-(aq)$   
 c.  $\text{HC}_2\text{H}_3\text{O}_2(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{H}_3\text{O}^+(aq) + \text{C}_2\text{H}_3\text{O}_2^-(aq)$

	Acid	Base	Conjugate Acid	Conjugate Base
a.	HF	H <sub>2</sub> O	H <sub>3</sub> O <sup>+</sup>	F <sup>-</sup>
b.	HCl	H <sub>2</sub> O	H <sub>3</sub> O <sup>+</sup>	Cl <sup>-</sup>
c.	HC <sub>2</sub> H <sub>3</sub> O <sub>2</sub>	H <sub>2</sub> O	H <sub>3</sub> O <sup>+</sup>	C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-</sup>

36. Identify the Lewis acids and bases in the following reactions:

	Lewis Acid	Lewis Base
a. $\text{H}^+ + \text{I}^- \rightarrow \text{HI}$	H <sup>+</sup>	I <sup>-</sup>
b. $\text{NH}_3 + \text{BCl}_3 \rightarrow \text{Cl}_3\text{BNH}_3$	BCl <sub>3</sub>	NH <sub>3</sub>



37. A 0.1000M solution of ethanoic acid ( $\text{HC}_2\text{H}_3\text{O}_2$ ) is only partially ionized so that  $[\text{H}^+] = 2.25 \times 10^{-3} \text{ M}$ . What is the acid dissociation constant for this acid?

$$K_a = \frac{[\text{H}^+][\text{C}_2\text{H}_3\text{O}_2^-]}{[\text{HC}_2\text{H}_3\text{O}_2]} = \frac{(2.25 \times 10^{-3})^2}{0.1 - 2.25 \times 10^{-3}}$$

$$= 5.18 \times 10^{-5}$$