19.3

1. strong base, weak base, weak acid, strong acid (4)

2. $HF \rightarrow H^+ + F^-$

$K_a = [H^+][F^-]$ (2)

3. $N_2H_4 + H_2O \rightleftharpoons N_2H_5^+ + OH^-$

$$K_b = \frac{[N_2H_5^+][OH^-]}{[N_2H_4]}$$ (2)

4. HCO_3^-, $H_2PO_4^-$, HCOOH, HOOCCOOH (4)

5. a) $H_2S \rightleftharpoons H^+ + HS^-$

$$K_a = \frac{[H^+][HS^-]}{[H_2S]}$$ (2)

b) $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$

$$K_a = \frac{[NH_3][OH^-]}{[NH_4^+]}$$ (2)

c) $C_6H_5COOH \rightleftharpoons H^+ + C_6H_5COO^-$ (2)

$$K_a = \frac{[H^+][C_6H_5COO^-]}{[C_6H_5COOH]}$$

6. a) 4
b) 2 (5)
c) 1
d) 5
e) 3

7. $K_b = \dfrac{[C_6H_5NH_3^+][OH^-]}{[C_6H_5NH_2]}$ (1)

8. $K_a = \dfrac{[4.2 \times 10^{-3}\ M]^2}{[0.1 - 4.2 \times 10^{-3}]}$ (1) $= 1.8 \times 10^{-4}$ (1)

9. $K_a = \dfrac{[H^+][C_6H_5COO^-]}{[C_6H_5COOH]}$

$6.3 \times 10^{-5} = \dfrac{[H^+][C_6H_5COO^-]}{[0.20\ M]}$ (1)

$(6.3 \times 10^{-5})(0.20\ M) = [H^+][C_6H_5COO^-]$

$[H^+] = 3.5 \times 10^{-3}\ M$ (1)

10. $K_a = \dfrac{[6.3 \times 10^{-6}\ M]^2}{[0.10\ M - 6.3 \times 10^{-6}]} = 4.0 \times 10^{-10}$ (2)

Name _____ Date _____ Class _____

SECTION 19.4 NEUTRALIZATION REACTIONS

1. What is the molarity of a sodium hydroxide solution if 38 mL of the solution is titrated to the end point with 14 mL of 0.75*M* sulfuric acid?
2. If 24.6 mL of a $Ca(OH)_2$ solution is needed to neutralize 14.2 mL of 0.0140*M* $HC_2H_3O_2$, what is the concentration of the calcium hydroxide solution?
3. A 12.4 mL solution of H_2SO_4 is completely neutralized by 19.8 mL of 0.0100*M* $Ca(OH)_2$. What is the concentration of the H_2SO_4 solution?
4. What volume of 0.12*M* $Ba(OH)_2$ is needed to neutralize 12.2 mL of 0.25*M* HCl?
5. A 55.0-mg sample of $Al(OH)_3$ is reacted with 0.200*M* HCl. How many milliliters of the acid are needed to neutralize the $Al(OH)_3$?

SECTION 19.5 SALTS IN SOLUTION

1. A buffer solution is prepared by mixing together equal quantities of formic acid, $HCHO_2$, and sodium formate, $NaCHO_2$. Write equations that show what happens when first acid, and then base, is added to this buffer solution.
2. Complete the following rules.
   a. strong acid + strong base →
   b. strong acid + weak base →
   c. weak acid + strong base →

19.4

1. $2NaOH + H_2SO_4 \rightarrow 2H_2O + Na_2SO_4$

C, 38 mL; 14 mL, 0.75 M

$$C_{NaOH} = 14\text{ mL} \times \frac{0.75\text{ mol}}{\text{L}} \times \frac{2\text{ mol}}{1\text{ mol}} \times \frac{1}{38\text{ mL}} = 0.55\text{ mol/L}$$

2. $Ca(OH)_2 + 2HC_2H_3O_2 \rightarrow 2H_2O + Ca(C_2H_3O_2)_2$

24.6 mL, C; 14.2 mL, 0.0140 M

$$C_{Ca(OH)_2} = 14.2\text{ mL} \times \frac{0.0140\text{ mol}}{\text{L}} \times \frac{1\text{ mol}}{2\text{ mol}} \times \frac{1}{24.6\text{ mL}} = 4.04 \times 10^{-3}\text{ mol/L}$$

3. $H_2SO_4 + Ca(OH)_2 \rightarrow 2H_2O + CaSO_4$

12.4 mL, C; 19.8 mL, 0.0100 M

$$C_{H_2SO_4} = 19.8\text{ mL} \times \frac{0.0100\text{ mol}}{\text{L}} \times \frac{1\text{ mol}}{1\text{ mol}} \times \frac{1}{12.4\text{ mL}} = 1.60 \times 10^{-2}\text{ mol/L}$$

4. $Ba(OH)_3 + 3HCl \rightarrow 3H_2O + BaCl_3$ *

0.12 M 12.2 mL

V = ? 0.25 M

$$V_{Ba(OH)_2} = 12.2\ mL \times \frac{0.25\ mol}{1000\ mL} \times \frac{1\ mol}{3\ mol} \times \frac{L}{0.12\ mol} = 8.5 \times 10^{-3}\ L$$

(5) $Al(OH)_3 + 3HCl \rightarrow 3H_2O + AlCl_3$

$$V_{HCl} = \frac{55.0\ g \cdot mol}{78.01\ g} \times \frac{3\ mol}{1\ mol} \times \frac{L}{0.200\ mol} = 10.6\ mL$$

19.5

2. a) neutral

b) acidic

c) base