Name: Date: Period:

# Part III: Determining Buffer Components for a Desired pH

Use your notes to help you answer the following questions:

1. Write a general chemical equation to represent the equilibrium that exists in an aqueous system of the weak acid HA as it ionizes in water. (See Figure 8) Assume the weak acid to be $HC_2H_3O_2$ (0.10 *M* ), with a $K_a$ value of $1.8 \times 10^{-5}$.

    a. What is the pH of this weak acid? Use the following equation: $pH = -\log (K_a \times 0.10)^{1/2}$

    b. What does the addition of $NaC_2H_3O_2$ do to the equilibrium you just represented? How would this affect the pH of the solution?

2. Write a general net ionic equation to show how a buffer solution containing an acid, HA, and the salt of its conjugate base, NaA, would respond to the addition of each of the following.

    a. The strong acid, HCl (See Figure 6)

    b. The strong base, NaOH (See Figure 7)

3. Which molarity of an acid/base buffer combination (0.1 *M* or 1.0 *M*) would be most *effective* for any buffer you might design? Why?

Name: Date: Period:

**Buffer Challenge:** Determine which buffer components from the list should be used for each scenario described below.

**Step 1:** Use the $K_a$ values to calculate the pH using Equation 4 (above) for each acid listed.

**Step 2:** Choose the appropriate acid for each scenario based on the calculated pH values. Then match the conjugate base to the chosen acid.

**Step 3:** Use stoichiometry (setup below) to calculate how many grams of salt need to be added to 100 mL of the aqueous solution of its conjugate to create a 1:1 ratio. (The concentration of all possible solutions are indicated as 0.10 M in Table 1 below. Substances without a concentration of 0.10 M can be assumed to be solid salts.)

$$\frac{100\ mL}{1} \times \frac{1\ L}{1000\ mL} \times \frac{0.10\ mol}{1\ L} \times \frac{mol}{mol} \times \frac{g}{1\ mol} =$$

**Table 1: Buffer Components for Creating Buffer Solutions**

| Acids | Bases |
|---|---|
| 0.10 M acetic acid ($CH_3COOH$)<br>➢ $K_a = 1.8 \times 10^{-5}$ | 0.10 M ammonia ($NH_3$) |
| Ammonium chloride ($NH_4Cl$)<br>➢ $K_a$ of $NH_4^+ = 5.7 \times 10^{-10}$ | Sodium dihydrogen citrate ($NaH_2C_6H_5O_7$) |
| 0.10 M citric acid ($H_3C_6H_5O_7$)<br>➢ $K_a = 7.1 \times 10^{-4}$ | Sodium acetate ($NaCH_3COO$) |
| 0.10 M sodium dihydrogen phosphate ($NaH_2PO_4$)<br>➢ $K_a$ of $H_2PO_4^- = 6.3 \times 10^{-8}$ | Sodium hydrogen phosphate ($Na_2HPO_4$) |

pH of acetic acid solution: ____________

pH of ammonium chloride: ____________

pH of citric acid solution: ____________

pH of sodium dihydrogen phosphate solution: ____________

Name: Date: Period:

**Scenario 1:** Prepare a buffer for an antibiological agent which is designed for use in the human body. This buffer should have a pH of 7.2 ± 0.5 with the ability to stay within one pH unit of this target when strong acid or base is added.

Acid: ______________________ Base: ______________________

$$\frac{100\ mL}{1} \times \frac{1\ L}{1000\ mL} \times \frac{0.10\ mol}{1\ L} \times \frac{\ \ mol}{\ \ mol} \times \frac{\ \ g}{1\ mol} =$$

Mass of salt to be added =

**Scenario 2:** Prepare a buffer for an antifungal agent which is designed for use against a fungus that attacks food sources that grow in *acidic* soil. This buffer should have a pH of 4.7 ± 0.5 with the ability to stay within one pH unit of this target when strong acid or base is added.

Acid: ______________________ Base: ______________________

$$\frac{100\ mL}{1} \times \frac{\quad}{\quad} \times \frac{\quad}{\quad} \times \frac{\quad}{\quad} \times \frac{\quad}{\quad} =$$

Mass of salt to be added =

**Scenario 3:** Prepare a buffer for an antifungal agent which is designed for use against a fungus that attacks food sources in *basic* soil. This buffer should have a pH of 9.2 ± 0.5 with the ability to stay within one pH unit of this target when strong acid or base is added.

Acid: ______________________ Base: ______________________

$$\frac{100\ mL}{1} \times \qquad\qquad\qquad =$$

Mass of salt to be added =

**Scenario 4:** Prepare a buffer for an antiviral agent which is designed for use against a strain of virus that attacks drug-producing bacteria that survive and grow in acidic environments. This buffer should have a pH of 3.1 ± 0.5 with the ability to stay within one pH unit of this target when strong acid or base is added.

Acid: ______________________ Base: ______________________

Mass of salt to be added =