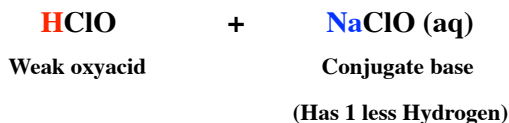


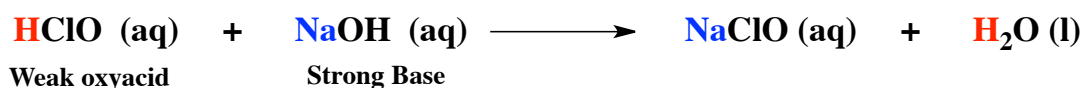
CONCEPT: BUFFERS

A buffer is a solution composed of a weak acid with its conjugate base.

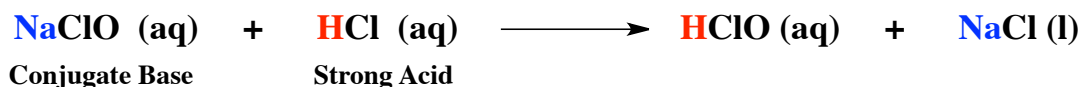


- A buffer works to keep both _____ and _____ constant.

If a **strong base** then the buffer resists a pH change by having the **weak acid** neutralize it.

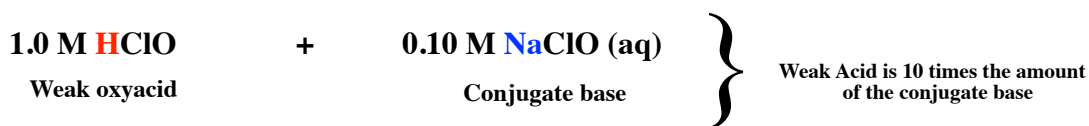


If a **strong acid** then the buffer resists a pH change by having the **conjugate base** neutralize it.

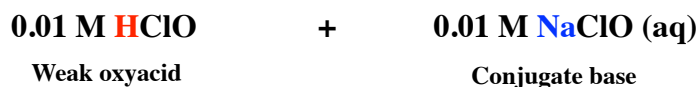
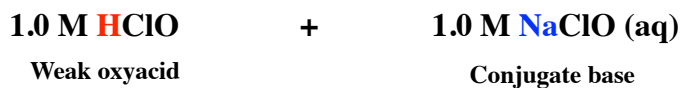


The weak acid and conjugate base can be different from one another by up to a magnitude of 10.

- This is called the _____. If they are different by more than 10 then it will not be a buffer.



The more concentrated the weak acid and conjugate base then the better the buffer can counteract strong acid or strong base added.



CONCEPT: BUFFER SYNTHESIS

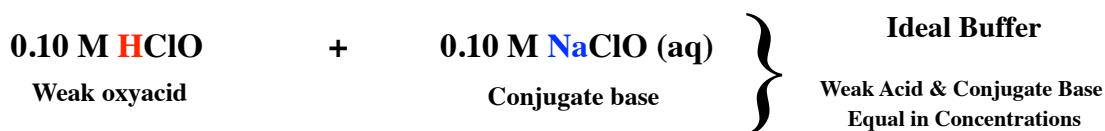
To calculate the pH of a buffer then we use the Henderson Hasselbalch Equation:

$$\text{pH} = \text{pK}_a + \log \frac{\text{conjugate base}}{\text{weak acid}}$$

There are 3 ways to form a buffer:

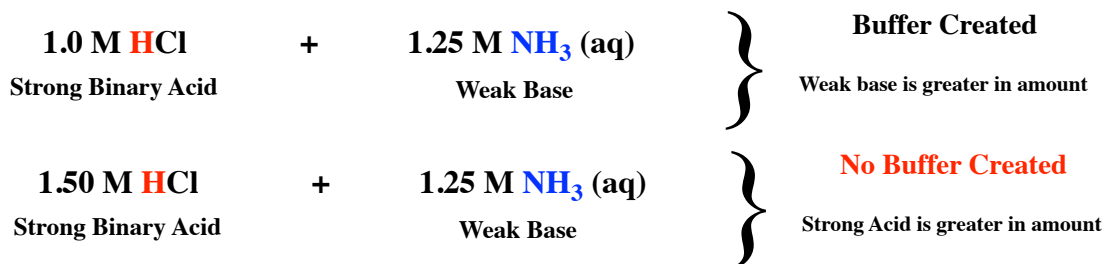
1) Mixing a _____ acid and a _____ base.

- In this case, a buffer is most ideal when both components are highly concentrated and equal to one another.



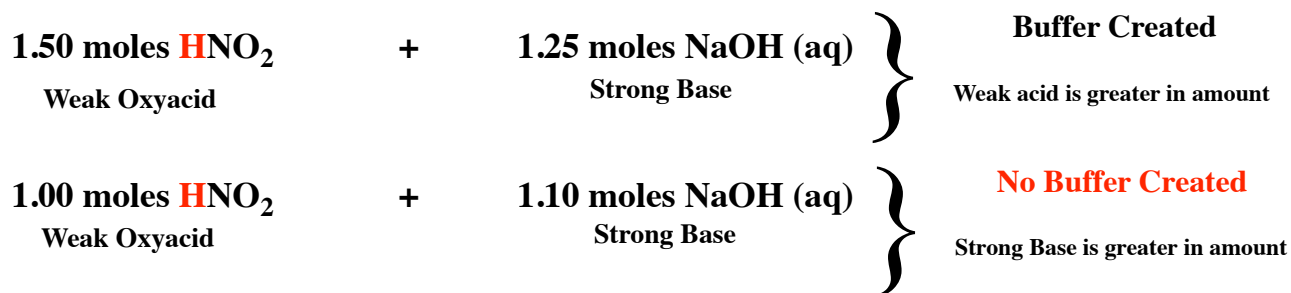
2) Mixing a _____ acid and a _____ base.

- In this case since we have a strong species mixing with a weak species then we must make sure the weak species is higher in amount.



3) Mixing a _____ acid and a _____ base.

- In this case since we have a strong species mixing with a weak species then we must make sure the weak species is higher in amount.



PRACTICE: BUFFER SYNTHESIS CALCULATIONS 1

EXAMPLE 1: Which of the following combinations can result in the formation of a buffer?

- a) 75 mL of 0.10 M HClO_3 with 50 mL of 0.10 M CH_3NH_2 .
- b) 25 mL of 0.10 M H_2SO_3 with 40.0 mL of 0.10 M NaOH .
- c) 50 mL of 0.10 M NH_4Cl with 50 mL of 0.05 M $\text{Sr}(\text{OH})_2$.
- d) 50 mL of 0.20 M HF with 40 mL of 0.20 M NaOH .

EXAMPLE 2: Calculate the pH of a solution formed by mixing 130.0 mL of a 0.300 M $\text{C}_2\text{H}_5\text{NH}_2$ solution with 70.0 mL of a 0.500 M $\text{C}_2\text{H}_5\text{NH}_3^+$ solution. (K_b of $\text{C}_2\text{H}_5\text{NH}_2$ is 5.0×10^{-4}).

PRACTICE: Which of the following molar ratios is the correct equilibrium ratio of BASE : ACID for a solution made of aniline ($K_b = 3.8 \times 10^{-10}$) and anilinium nitrate where the pH is 4.80?

- a) 1:2
- b) 3:5
- c) 7:2
- d) 2:1
- e) 5:3

PRACTICE: BUFFER SYNTHESIS CALCULATIONS 2

EXAMPLE 1: You are asked to go into the lab and prepare a buffer solution with a pH of 6.40 ± 0.2 . Which weak acid would be the best choice?

- a) carbonic acid $K_a = 4.2 \times 10^{-7}$
- b) phenol $K_a = 1.3 \times 10^{-10}$
- c) ascorbic acid $K_a = 8.0 \times 10^{-5}$
- d) hydrosulfuric acid $K_a = 9.5 \times 10^{-8}$
- e) potassium hydrogen phthalate $K_a = 3.1 \times 10^{-6}$

EXAMPLE 2: Calculate the pH of a solution made by mixing 8.627 g of sodium butanoate in enough 0.452 M butanoic acid, $\text{HC}_4\text{H}_7\text{O}_2$, to make 250.0 mL of solution. The K_a of butanoic acid is 1.5×10^{-5} .

- a) 4.75
- b) 4.82
- c) 5.00
- d) 2.58
- e) 4.65