Buffers – Ch 19.4 Std 5

Buffers are created by **mixing a weak acid and the salt of its conjugate base**.

$HC_2H_3O_2$ <---------- $H^+ + C_2H_3O_2^-$
(weak acid) -->

Notice the equilibrium favors the acid (left) very strongly. That is why it is a weak acid. Not many ions get formed because it doesn't ionize much.

$NaC_2H_3O_2$ ----------> $Na^+ + C_2H_3O_2^-$
(salt of conj. base)

Notice the salt ($NaC_2H_3O_2$) ionization is 100% , which means that all of the salt is ionized and none of the original $NaC_2H_3O_2$ is left. **This puts a lot of the Na^+ and $C_2H_3O_2^-$ ions into the water**.

After we put $HC_2H_3O_2$ and $NaC_2H_3O_2$ into the water, the ions and substances that can affect the pH are:

$HC_2H_3O_2$ and **$C_2H_3O_2^-$** **(IN THE WATER)**

We now call this solution a buffer. This buffer will have a pH = 4 (±2) depending on the concentrations of the ions.

Let's see what happens when we add acids or bases to the buffer:

a. **ADD ACID**

HNO_3 -----> **H^+** + NO_3^- **NEXT** **H^+** + $C_2H_3O_2^-$ ----------> $HC_2H_3O_2$
(strong acid) <--

IT MIXES & REACTS

At first H^+ ions from the HNO_3 make the solution more acidic (lower pH), but they are quickly "grabbed" by the **$C_2H_3O_2^-$** ions which act as "assassin" ions and and hold on to the H^+ ions. This will form **$HC_2H_3O_2$**, which returns the pH close to 4. The pH is again close to the original pH = 4 because the H^+ ions taken by the $C_2H_3O_2^-$ ions are no longer in the water.

b. **ADD BASE**

NaOH ----> $Na^+ + OH^-$ **NEXT** $OH^- + HC_2H_3O_2$ ----------> $H_2O + C_2H_3O_2^{1-}$
(strong base) <--

IT MIXES & REACTS

The OH^- ions act like "assassins" and "grab" the H^+ ions away from the $HC_2H_3O_2$ to form water and $C_2H_3O_2^{1-}$ ions. That removes OH^- ions from the solution and makes more $C_2H_3O_2^{1-}$ ions. Adding the OH^- ions only makes the solution more basic for a short time. When this second reaction takes place the pH come back close to pH = 4 because the OH^- ions are used up forming water.

Here are additional explanations of Buffers given in class

Buffer example questions

1. Hydrofluoric acid (HF) a weak acid, and potassium fluoride (KF) the salt of its conjugate base

HF --> H^+ + F^-
Weak acid <---------- conjugate base

==========

KF ----------> K^+ + F^-
Salt of conj base

If we add OH^- (NaOH) - What combines with the OH^- ions so the pH doesn't change much?

If we add H^+ (HCl) – What combines with the H^+ ions so the pH doesn't change much?

Answers

2. Acetic acid ($HC_2H_3O_2$), and sodium acetate ($NaC_2H_3O_2$), the salt of the conjugate base.

$HC_2H_3O_2$ --> H^+ + $C_2H_3O_2^-$
Weak acid <---------- conjugate base

$NaC_2H_3O_2$ ----------> Na^+ + $C_2H_3O_2^-$
salt of conjugate base

If we add OH^- (NaOH) - What combines with the OH^- ions so the pH doesn't change much?

If we add H^+ (HCl) – What combines with the H^+ ions so the pH doesn't change much?

Answers

3. Can salts of strong acids act as buffers by themselves?

Examples: NaCl, KCl, $CaCl_2$, $MgCl_2$

Answers

Here is an important **summary of buffer information**:

The a and b below explain how a buffer works to keep the pH relatively constant when acids or bases are added to their solutions.

a. Buffers **resist change** in pH even if H^+ or OH^- ions are added from strong acids or bases.

b. H^+ ions react with conjugate bases of weak acids. OH^- ions combine with the H^+ ions from weak acids, taking the hydrogen away from them.