<u>Lecture Notes – Ch 15.5 & 15.6</u>   Std 5

<u>Ch 15.5 – pH of strong Acids</u>

For the preclass today we did these problems:

Page 506, problem 53 in class and you will see problems like this on the quiz. Here are the answers:

53. a. $[H^+]$ = anti-log [-8.51] = 3.1×10^{-9} M
   pOH = 14 - 8.51 = 5.49
   $[OH^-]$ = anit-log [-5.49] = 3.2×10^{-6} M

b. $[0H^-]$ = anti-log [-9.39] = 4.1×10^{-10} M
   pOH = 14 – 9.39 = 4.61
   $[H^+]$ = anit-log [-4.61] = 2.5×10^{-5} M

c. $[H^+]$ = anti-log [-2.54] = 2.9×10^{-3} M
   pOH = 14 – 2.54 = 11.46
   $[OH^-]$ = anit-log [-11.46] = 3.5×10^{-12} M

d. $[0H^-]$ = anti-log [-4.82] = 1.5×10^{-5} M
   pOH = 14 – 4.82 = 9.18
   $[H^+]$ = anit-log [-9.18] = 6.6×10^{-10} M

<u>FOR STRONG ACIDS</u>

Concentrations of $[H^+]$ ions = concentrations given of strong acids

<u>Example</u>:

$HCl \rightarrow H^+ + Cl^-$ Notice !!! No backwards arrow for the equilibrium. This means that the **<u>HCl ionizes 100% in water.</u>**

Next we did problem 57 on page 506, from the homework. As you see in each problem, the $[H^+]$ is always the same as the concentration of the strong acid. That is because all the HCl become H^+ and Cl^- ions. Here are the answers:

P. 506 problem 57

a. $[H^+]$ 1.04×10^{-4} M and to find the pH we take the - log $[H^+]$ = 3.98
b. $[H^+]$ 0.00301 or 3.01×10^{-3} M and to find the pH we take the - log $[H^+]$ = 2.5
c. $[H^+]$ 5.41×10^{-4} M and to find the pH we take the - log $[H^+]$ = 3.27
d. $[H^+]$ 6.42×10^{-2} M and to find the pH we take the - log $[H^+]$ = 1.19

<u>Ch 15.6 – Buffers</u>

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

$HC_2H_3O_2$ <------------------------	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**

The 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 to where is was. Because the H^+ isn't in the water any more, the $[H^+]$ returns to where is was before we put in the HNO_3, which is pH = 4 .

b. **ADD BASE**

NaOH ----> Na^+ + OH^- **NEXT** OH^- + $HC_2H_3O_2$ ----> H_2O + $HC_2H_3O_2$ (strong base) **IT MIXES & REACTS**

The OH^- ions act like "assassins" and "grab" the H^+ awau from the $HC_2H_3O_2$ to form water. That takes the OH^- ions out of the water and makes more $C_2H_3O_2^-$. Adding the OH^- will at first make the solution more basic for a short time, but when this second reaction takes place the pH returns to pH = 4 because the OH^- ions are used up forming water.

Here are additional explanations of Buffers given in class just before Quiz 3.1

Buffer examples

1. **H**ydrofluoric acid (HF) a weak acid, and potassium fluoride (KF) the salt of the conjugate base.

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

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

If we add OH^- (NaOH) - What takes out the OH^- so the pH doesn't change much?

If we add H^+ (HCl) – What takes out the H^+ 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 takes out the OH^- so the pH doesn't change much? If we add OH^- (NaOH) - What takes out the OH^- so the pH doesn't change much?

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

If we add H^+ (HCl) – What takes out the H^+ 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

4. 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 react with the H^+ ions from weak acid and take the hydrogen away from them.