Section 3 Notes AP Chemistry—Acid-Base Properties of Salts

Read Ch.14 (p.686-690)

Normally, we think of salts dissolved in water as producing neutral solutions. This is only true of salts made from strong acids and strong bases.

Example: NaOH + HCl → H_2O + NaCl
(strong base) (strong acid) (neutral salt)

Because NaOH + HCl → H_2O + Na^+ + Cl^-
weak conj acid, weak conj base

Both conjugates that form the salt are weak. They do nothing in the solution (spectator ions).

But, a salt made from a weak acid and a strong base or a strong acid and a weak base, do not form neutral solutions.
A salt from a **weak acid** and a **strong base** forms a solution that is **slightly basic** not because of the strong base but because of the strong conjugate base of the weak acid.
A salt from a **strong acid** and a **weak base** forms a solution that is **slightly acidic** not because of the strong acid but because of the strong conjugate acid of the weak base.

Example: **$NaC_2H_3O_2$** is a salt made from NaOH (strong base) and $HC_2H_3O_2$ (weak acid)

$NaOH + HC_2H_3O_2 \leftrightarrow H_2O + Na^+ + C_2H_3O_2^-$

Na^+ is a spectator ion and does nothing, but the $C_2H_3O_2^-$ being a strong conjugate base reverses back combining with the H_2O to produce hydroxide ions and the weak acid.

$C_2H_3O_2^- + H_2O(l) \leftrightarrow HC_2H_3O_2 + OH^-$ (basic solution)

So simply dissolving this **salt** in H_2O would produce sodium and acetate ions and hydroxide ions rendering the **solution basic.**

~~Na^+~~ + $C_2H_3O_2^-$ + ~~$H_2O(l)$~~ $\leftrightarrow$ ~~Na^+~~ + $HC_2H_3O_2$ + OH^-

I can now find the pH of this solution by using the same equation we used for finding the pH of any weak acid or a weak base solution.
Since it is a basic solution forming, I use the following equation:

$$K_b = \frac{[OH^-][HC_2H_3O_2]}{[C_2H_3O_2^-]}$$

[salt]

But I don't have a K_b for acetic acid, only a K_a (1.8x 10^{-5}). I need a K_b since I am finding [OH^-].

Remember: $K_a = K_w/K_b$ and $K_b = K_w/K_a$

So to find $K_b = 1.0 \times 10^{-14}/1.8 \times 10^{-5}$. Therefore, $K_b = 5.56 \times 10^{-10}$

Now if I ask, what is the pH of a solution of 0.15M $NaC_2H_3O_2$ I can find it by plugging the values into the equation:

$$K_b = \frac{X^2}{[salt]} \qquad 5.56 \times 10^{-10} = \frac{X^2}{(0.15)} \qquad X = [OH^-] \text{ and } [HC_2H_3O_2]$$

$$X^2 = 8.33 \times 10^{-11}$$

$$X = 9.13 \times 10^{-6}\ M$$

$$[OH^-] = 9.13 \times 10^{-6}$$

$$pOH = -\log(9.13 \times 10^{-6}) = 5.04$$

pH = 14 - 5.04 = **8.96** (slightly basic)

Likewise, if we had a solution of a weak base and a strong acid, we would have a slightly acidic solution because of the strong conjugate acid of the weak base.

$$NH_3 + HCl \rightarrow H_2O + NH_4Cl$$

The NH_4^+ ion of the salt would reverse itself with H_2O to produce H_3O^+ and NH_3'

The salt itself in a aqueous solution would produce a slightly acidic solution.

NH_4^+ ~~+ Cl^-~~ + ~~H_2O~~ → H_3O^+ + NH_3 + ~~Cl^-~~

Now I need a K_a since I'm finding the H_3O^+ ion. I only have a K_b for NH_3 so I follow the same method to find the K_a.

$$K_a = K_w/K_b$$

$$K_a = 1.0 \times 10^{-14}/1.8 \times 10^{-5} = 5.56 \times 10^{-10}$$

What is the pH of a 0.20M solution of NH_4Cl ?

$$5.56 \times 10^{-10} = \frac{X^2}{(0.20)} \qquad X = [H_3O^+]\ \{NH_3]$$

$$X = 1.05 \times 10^{-5}$$

pH = -log $[H_30^+]$ = -log (1.05×10^{-5})= **4.98** (slightly acidic)

Since we now know that salts can make acidic or basic solutions, we can use them with their acids or bases with the same (common ion) conjugate to make solutions that resist pH changes. These solutions are called BUFFERS.

Buffers appear in your video and will be discussed in the next set of notes.

HW: Do problems **114, 116, 120, 126, and 130**. Watch Video **"Acid Base Reactions and Buffers"**