Announcements – Lecture XVI – Tuesday, Mar 27th

1. iClicker:  Pick any letter a-e

2. Quiz 7: Due Thursday March 29th (not March 39th ☺☺☺).

3. Exam II: **Moved to Saturday, April 7th.**

17.1 Acid-Base Reactions

Strong Acid/Strong Base Reactions

$$HCl(aq) + NaOH(aq) = NaCl(aq) + H_2O(l)$$

NET IONIC EQUATION:

$HCl(aq) + NaOH(aq) = NaCl(aq) + H_2O(l)$

$H_3O^+ + Cl^- + Na^+ + OH^- = Na^+ + Cl^- + H_2O(l) + H_2O(l)$

$H_3O^+ + OH^- = 2\,H_2O(l)$

$H_2O(l) + H_2O(l) \Leftrightarrow H_3O^+ + OH^-$ $\quad K = K_W$

$H_3O^+ + OH^- = 2\,H_2O(l)$ $\quad K = 1/K_W$

@ 25°C, $K_W = 1 \times 10^{-14}$

$$K = \frac{1}{1 \times 10^{-14}} = 1 \times 10^{14}$$

$K \ggg 1$, VERY product favored, essentially 100%

17.1 Acid-Base Reactions

Strong Acid/Weak Base Reactions

$$HCl(aq) + NH_3(aq) = NH_4Cl(aq)$$

NET IONIC EQUATION:

$$HCl(aq) + NH_3(aq) = NH_4Cl(aq)$$

$$H_3O^+ + Cl^- + NH_3(aq) = NH_4^+ + Cl^- + H_2O(l)$$

$$H_3O^+ + NH_3(aq) = NH_4^+ + H_2O(l)$$

$$NH_4^+ + H_2O(l) \Leftrightarrow NH_3(aq) + H_3O^+ \quad K = 5.6 \times 10^{-10}$$

$$H_3O^+ + NH_3(aq) = NH_4^+ + H_2O(l) \quad K = \frac{1}{5.6 \times 10^{-10}} = 1.8 \times 10^9$$

$K >>> 1$, very product favored, essentially 100%

17.1 Acid-Base Reactions

Weak Acid/Weak Base

$$HClO(aq) + NH_3(aq) \Leftrightarrow NH_4ClO(aq)$$

Net Ionic Equation:

$$HClO(aq) + NH_3(aq) \Leftrightarrow NH_4^+ + ClO^-$$

$HClO(aq) + H_2O(l) \Leftrightarrow H_3O^+ + ClO^-$ $\quad K = 3.5\times10^{-8}$

$NH_3(aq) + H_2O(l) \Leftrightarrow NH_4^+ + OH^-$ $\quad K = 1.8\times10^{-5}$

$HClO(aq) + NH_3(aq) + 2\,H_2O(l) \Leftrightarrow NH_4^+ + ClO^- + H_3O^+ + OH^-$ $\quad K = 6.3\times10^{-13}$

$H_3O^+ + OH^- \Leftrightarrow 2\,H_2O(l)$ $\quad *K = 1.0\times10^{14}$

$HClO(aq) + NH_3(aq) \Leftrightarrow NH_4^+ + ClO^-$ $\quad K = 63$

$K \sim 1$: Significant quantities of reactants and products present at equilibrium.

$*K = 1/K_w$

pH @ Equilibrium:

Hydrolysis of $NH_4ClO(aq)$

$NH_4ClO(aq) = NH_4^+ + ClO^-$

Neither cation or anion are neutral ions.

$NH_4^+ + H_2O(l) \Leftrightarrow NH_3(aq) + H_3O^+$ $\quad K_a = 5.6\times10^{-10}$

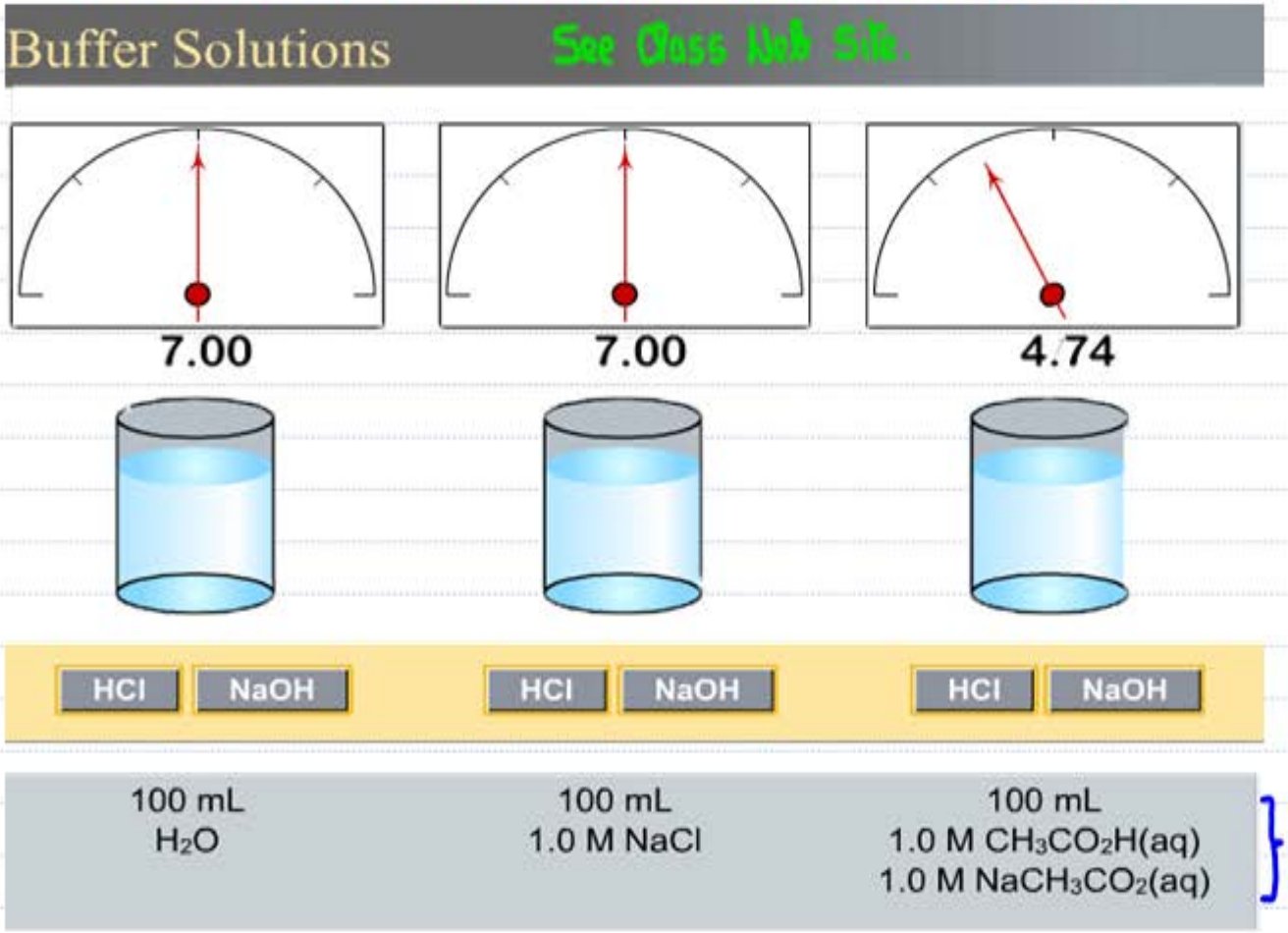
$ClO^- + H_2O(l) \Leftrightarrow HClO(aq) + OH^-$ $\quad K_b = 2.9\times10^{-7}$

$K_b > K_a$

pH > 7 ... ie basic

17.2 Buffers

What Constitutes a Buffer and why are they Special



17.2 Buffers

How do Buffers Resist Drastic pH Changes – A Summary

1. Buffer: Buffer Acid + Buffer Base
   (Weak Acid) (Weak Acids Conjugate Base)

2. What causes a pH change ... Introduction of H_3O^+ or OH^-

   a) Introduction of H_3O^+: Buffer Base + H_3O^+ = $H_2O(l)$ + Buffer Acid

   b) Introduction of OH^-: Buffer Acid + OH^- = $H_2O(l)$ + Buffer Base

17.2 Buffers

How do they Resist Drastic pH Change

Buffer: 1M CH_3CO_2H / 1M $CH_3CO_2^-$

Addition of Strong Acid – H_3O^+

CH_3CO_2H / $CH_3CO_2^-$

Weak acid — Conjugate base

↕ SA + WB = 100%

H_3O^+ : $H_3O^+ + CH_3CO_2^- = H_2O(l) + CH_3CO_2H(aq)$

Buffer base — Buffer acid

OVERALL CHANGES:

$[CH_3CO_2^-]$: ↓ ... reacted with the added H_3O^+

$[CH_3CO_2H]$: ↑ ... a product of the reaction the H_3O^+

$[H_3O^+]$: ↑ ... not by much ... a result of $[CH_3CO_2H]$↑

pH : ↓ ... not by much

17.2 Buffers

How do they Resist Drastic pH Change

Buffer: 1M CH_3CO_2H / 1M $CH_3CO_2^-$

Addition of Strong Base – OH^-

CH_3CO_2H / $CH_3CO_2^-$

Weak acid Conjugate Base

↕ → SB + WA = 100 %

OH^- : $OH^- + CH_3CO_2H(aq) = H_2O(l) + CH_3CO_2^-$

Buffer acid Buffer Base

OVERALL CHANGES:

$[CH_3CO_2H]$: ↓ ... Reacted with the added OH^-

$[CH_3CO_2^-]$: ↑ ... a product of the reaction that removed the OH^-

$[OH^-]$: ↑ ... Not by much ... a result of $[CH_3CO_2^-]$↑

pH : ↑ ... Not by much

17.2 Buffers

How do they Resist Drastic pH Change

A buffer solution made from **HF** and **KF** has a pH = 2.84.

Addition of OH^- will cause –

1. Increase significantly
2. Increase slightly
3. Decrease significantly
4. Decrease slightly
5. Increase
6. Decrease

a) pH ? 2 ... adding base

b) [HF] ? 6 ... used in the removal of OH^-

$OH^- + HF(aq) = H_2O(l) + F^-$

Buffer acid Buffer base