Buffers

A buffer is an equilibrium b/w a weak acid and it's conjugate. The difference here is that that conjugate is added in comparable amounts, usually as a salt. Buffers are able to maintain a relatively constant pH when an acid or base is added. Important for a buffer - $[CH_3COOH] \approx [CH_3COO^-]$

Ex. CH_3COOH/CH_3COO^- system.

$$CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons CH_3COO^-_{(aq)} + H_3O^+_{(aq)}$$

Buffering action

1) Adding **acid** to a buffer

If an acid is added to a buffer then H^+ combine w/ the CH_3COO^- ions & shift equilibrium to the LEFT – decrease in $[H^+]$

- $[CH_3COOH]$ increase a little bit
- $[CH_3COO^-]$ decrease a little bit
- $[H^+]$ stays about the same though!

2) Adding **base** to a buffer

If a base is added to a buffer then OH^- ions combine w/ the CH_3COOH & shift equilibrium to the RIGHT – increase in $[H^+]$

- $[CH_3COOH]$ decrease a little bit
- $[CH_3COO^-]$ increase a little bit
- $[H^+]$ stays about the same though!

Buffer Capacity

Capacity refers to the amount of base or acid that a buffer can absorb w/o a significant change in pH. It is dependent on the **number** of moles of weak acid AND moles of conjugate base used for the buffer.

Most buffers have [ACID] ≈ [SALT]

The higher the [ ]'s (above) the more capacity a buffer has to buffer.

Choosing a buffer

$$K_a = \frac{[\text{Salt}][H^+]}{[\text{Acid}]}$$ but in a buffer [ACID] = [SALT]

Then $\mathbf{K_a = [H^+]}$

Therefore a buffer w/ [ACID] ≈ [SALT]. The pH of the buffer should stay around the pKa of the acid!

You can choose an acid/salt combo that yields the pH you want your buffer to be

Buffers… and you ☺

pH of your blood is IMPORTANT – enzymes, blood, hemoglobin

Your blood should have a pH of 7.4 (or else stuff goes wrong – important stuff, like breathing)

$$HCO^-_{3(aq)} + H^+_{(aq)} \rightleftharpoons H_2CO_{3(aq)} \rightleftharpoons CO_{2(g)} + H_2O_{(l)}$$

Increase $[CO_2]$ ➔ decrease in pH
Decrease $[CO_2]$ ➔ increase in pH

Ex. What buffer system could you use to create a pH of?

a) 4.7

b) 9.2

Ex. Which combos produce buffer systems?

a) H_2SO_3 / $LiHSO_3$

b) H_2O / NaOH

c) KCl / HCl

d) HCN / KCN

Titration Curves

3 types dealing with in Chemistry 12: **SA/SB, SA/WB** and **WA/SB** (won't do WA/WB)

Strong Acid/Strong Base (Pg 166/167)

Ex. Volume of 1.000M NaOH added to 1.000L of 1.000M HCl vs pH

Data given on pg 166 but let's do some calculations to prove the data

NaOH (mL)	Calculation	pH
0.00		0
250.0		0.22

999.0		3.30
1000.0		7.00
1000.1		9.70
1500.0		13.30

Weak Acid/Strong Base

Ex. Volume 1.000M NaOH added to 1.000L of 1.000M CH_3COOH vs pH

Data given on pg 169 but let's do some calculations to prove the data

NaOH (mL)	Calculation	pH
0.00	$RICE\ TABLE!$	2.37

250.0		4.27
999.0		7.74
1000.0		9.23
1000.1		9.70
1500.0		13.30

1 Block = 1/4 "

From the graph

At the mid-point (half-way from zero to the end-point) you have added half the moles of base to completely neutralize the weak acid.

Here the moles of acid = moles of salt so…

[Salt] = [Acid]

$$\mathrm{Ka} = \frac{[\mathrm{H}^+]\,[\mathrm{Salt}]}{[\mathrm{Acid}]} \qquad \mathrm{so} \ldots \mathbf{Ka} = [\mathbf{H}^+]$$

At Midpoint pH = pKa

Titration curves can be used as a diagnostic for figuring out the identity of unknown acids