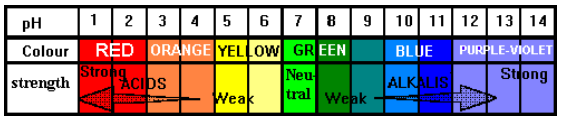
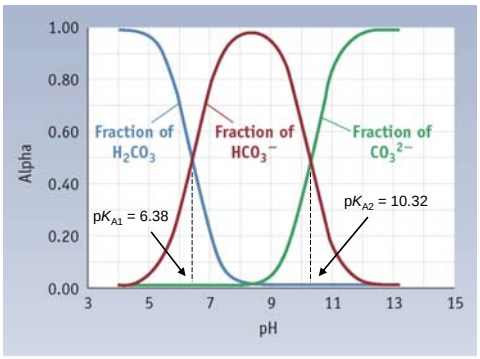
GAME?



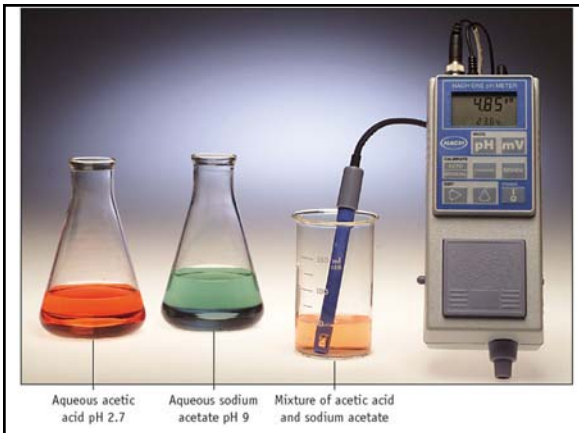
Carbonate Distribution vs. pH

Alpha = $[H_2CO_3]$/[Total Carbonate]
Alpha = $[HCO_3^-]$/[Total Carbonate]
Alpha = $[CO_3^{2-}]$/[Total Carbonate]



Questions to consider:

- How can we control the pH in a solution?
- What happens when an acid and a base are mixed in any amount?



Weak acid in water

- What is the pH of a solution 0.25 M of acetic acid (CH_3CO_2H), $K_a = 1.8\ 10^{-5}$?

$0.25 \geq 100.\ K_a = 1.8\ 10^{-3}$,

Therefore $(0.25 - x) \approx 0.25$ and we use this approximation to avoid the quadratic equation

pH = 2.67

Weak base in water

- What is the pH of a solution 0.25 M of Sodium acetate ($NaCH_3CO_2$)?

$K_b = K_w/K_a = 1\ 10^{-14}/1.8\ 10^{-3} = 5.6\ 10^{-12}$

$0.25 \geq 100.\ K_b = 5.6\ 10^{-10}$,

Therefore $(0.25 - x) \approx 0.25$ and we use this approximation to avoid the quadratic equation

pH = 9.07

Buffer Solutions

Problem: What is the pH of a buffer that has [HAcO] = 0.700 M and [AcO$^-$] = 0.600 M?

$$HAcO + H_2O \leftrightharpoons AcO^- + H_3O^+$$

$K_a = 1.8 \times 10^{-5}$

	[HAcO]	[AcO$^-$]	[H_3O^+]
initial	0.700	0.600	0
change	-x	+x	+x
equilib	0.700 - x	0.600 + x	x

Buffer Solutions

Problem: What is the pH of a buffer that has [HOAc] = 0.700 M and [OAc$^-$] = 0.600 M?

$$HAcO + H_2O \leftrightharpoons AcO^- + H_3O^+$$

$K_a = 1.8 \times 10^{-5}$

	[HAcO]	[AcO$^-$]	[H_3O^+]
equilib	0.700 - x	0.600 + x	x

Assuming that x << 0.700 and 0.600, we have

$$K_a = 1.8 \times 10^{-5} = \frac{[H_3O^+](0.600)}{0.700}$$

$[H_3O^+] = 2.1 \times 10^{-5}$ and pH = 4.68

Buffer Solutions

Notice that the expression for calculating the H^+ conc. of the buffer is

$$[H_3O^+] = \frac{\text{Orig. conc. of HOAc}}{\text{Orig. conc. of OAc}^-} \cdot K_a$$

$$[H_3O^+] = \frac{[\text{Acid}]}{[\text{Conj. base}]} \cdot K_a \qquad [OH^-] = \frac{[\text{Base}]}{[\text{Conj. acid}]} \cdot K_b$$

Notice that the H^+ or OH^- concs. depend on (1) K and (2) the ratio of acid and base concs.

Henderson-Hasselbalch Equation

$$[H_3O^+] = \frac{[\text{Acid}]}{[\text{Conj. base}]} \cdot K_a$$

Take the negative log of both sides of this equation

$$pH = pK_a - \log\frac{[\text{Acid}]}{[\text{Conj. base}]}$$

$$pH = pK_a + \log\frac{[\text{Conj. base}]}{[\text{Acid}]}$$

The pH is determined largely by the pK_a of the acid and then adjusted by the ratio of acid and conjugate base.