Chemistry 1105 Lab: pH and K_a

Goals:

1. **To determine the concentration of aqueous protons. Determine $[H^+(aq)]$ and pH.**
2. **Determine the Percent Ionization of Strong/Weak Acids and Bases.**
3. **Determine K_a of a weak acid.**

Proton Concentration:

Proton is a hydrogen atom that has lost its lone electron.

$$H^+$$

H^+ very reactive. Attaches to water a molecule.

$$H_2O + H^+ \rightarrow H_3O^+$$

H_3O^+: hydronium ion

H_3O^+ same as $H^+(aq)$.

Important to know concentration, $[H^+(aq)]$.

Importance of $H^+(aq)$ Concentration:

Knowing the concentration of H^+ very important.

Ex: aquarium, pools, etc.

Fishtank

Aquarium in Toilet

Acids and Bases:

Bronsted/Lowry Theory

acid- Proton donor. Increase [H^+(aq)].

base- Proton acceptor. Decrease [H^+(aq)].

The strength of an acid or base depends on their ability to donate or accept protons.

K_w: Ion product of water:

Water also contains OH^- ions. At 25 °C

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$$

$$K_w = [H^+(aq)][OH^-(aq)] = 1.0\times10^{-14}$$

If $[H^+(aq)]$ increases, $[OH^-(aq)]$ decreases.

If you know one. Can calculate the other.

Quantifying Acidity(pH):

Could quantify acidity by concentration of aqueous H^+. Not practicle.

pH is a logarithmic scale of H^+ concentration.

$$pH = -Log[H^+(aq)] \quad \text{or} \quad pH = -Log[H_3O^+(aq)]$$

pH Scale:

The pH scale ranges from 0(very acidic) to 14(very basic). Pure water has a pH of 7.

0	**-**	**7**	**-**	**14**
Acidic		**Neutral**		**Basic**

Likewise,

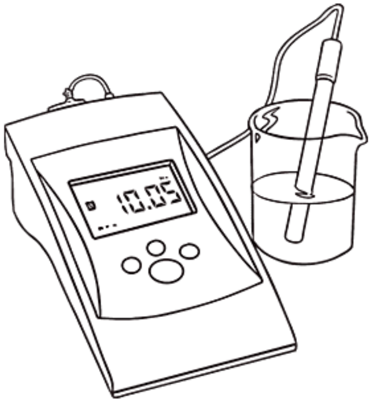
$pOH = -Log[OH^{-}(aq)]$

$$pH + pOH = 14$$

Measuring pH:

pH meter.

Uses a probe to determine the pH of a solution.



From pH, can convert to [H^+(aq)] or [OH^-(aq)].

pH of a Weak Acid:

Consider a 1.0 M weak acid HA.

$$HA(aq) \rightleftharpoons H^+(aq) + A^-(aq)$$

	HA	H^+	A^-
I:	1.0 M	0	0
C:	-X	+X	+X
E:	1.0 - X	X	X

If X is small. 1.0 – X ≈ 1.0.

X = [H^+(aq)].

By measuring pH. Can calculate [H^+(aq)].

Percent Ionization of a Weak Acid:

$$\% \text{ ionization} = \frac{\text{ionized acid concentration}}{\text{initial concentration of acid}} \text{ x } 100\ \%$$

$$\% \text{ ionization} = \frac{[H^{+}(aq)]}{[\text{HA}(\text{aq})]} \text{ x } 100\ \%$$

pH of a Weak Base:

Consider a 1.0 M weak base B.

$$B(aq) + H_2O(l) \rightleftharpoons HB(aq) + OH^-(aq)$$

	B		HB	OH^-
I:	1.0 M		0	0
C:	-X		+X	+X
E:	1.0 - X		X	X

If X is small. 1.0 – X ≈ 1.0.

X = [OH^-(aq)].

By measuring pH. Can calculate [OH^-(aq)].

Percent Ionization of a Weak Base:

$$\textbf{\% ionization} = \frac{\text{ionized base concentration}}{\text{initial concentration of base}} \textbf{ x 100 \%}$$

$$\textbf{\% ionization} = \frac{[OH^{-}(aq)]}{[\mathrm{B(aq)}]} \textbf{ x 100 \%}$$

Determining K_a of a Weak Acid :

Can calculate the K_a of a weak acid by creating equal amounts of the weak acid and its neutralized salt.

$$HA(aq) \leftrightharpoons H^+(aq) + A^-(aq)$$

I:	W	0	0
C:	-1/2W	+1/W	+1/2W
E:	W – 1/2W	1/2W	1/2W

$$HA(aq) \rightleftharpoons H^+(aq) + A^-(aq)$$

$$K_a = \frac{[H^+(aq)][A^-(aq)]}{[HA(aq)]}$$

$$K_a = \frac{[H^+(aq)][\frac{1}{2}W]}{[W - \frac{1}{2}W]} = \frac{[H^+(aq)][\frac{1}{2}W]}{[\frac{1}{2}W]}$$

$$K_a = [H^+(aq)]$$

From pH, can calculate K_a.