8 The nature of Acids and Bases —— Elston Almeida

8.1 Arrhenius

Acid H^+ ions　　　　Bases OH^- ions

$$\mathrm{HCl(aq)} \xrightarrow{\text{water}} \mathrm{H^+(aq) + Cl^-(aq)}$$
$$\mathrm{NaOH(s)} \xrightarrow{\text{water}} \mathrm{OH^-(aq) + Na^+(aq)}$$

Brønsted Theory

Acid is a hydrogen donor. Base is a hydrogen acceptor.

8.2 Brønsted lowry acids

$$\mathrm{HCl(aq) + H_2O(l) \rightleftharpoons Cl^-(aq) + H_3O^+(aq)}$$

Water can be both acids and bases depending on the reaction. In the reaction above, it acts as an base to accept the hydrogen ion. (HCl donates the H ion to the water)

$$\mathrm{NH_3(aq) + H_2O(l) \rightleftharpoons {NH_4}^+(aq) + OH^-(aq)}$$

NH3 is an base, H2O acts as an acid, NH4 is the conjugate acid, OH is the conjugate base

Conjugate acid is when the substance that forms then a base accepts a hydrogen ion. Conjugate base is when the substance that forms when an acid loses a hydrogen ion.

Amphiprotic is a substance that can donate and accept a hydrogen ion. Water is a Amphiprotic as you can get Hydronium, and Hydroxide.

K_a value is the eq constant for the ionization of an acid (called the acid dissociation constant)

General Equation:

$$\mathrm{K}_a = \frac{[\mathrm{H_3O^+(aq)}][\mathrm{A^-(aq)}]}{[\mathrm{HA(aq)}]} \tag{1}$$

Example:

$$HC_2H_3O_2(aq) + H_2O\,(l) \rightleftharpoons H_3O^+(aq) + C_2H_3O_2{}^-(aq)$$

$$K_a = \frac{[H_3O^+(aq)][C_2H_3O_2{}^-(aq)]}{[HC_2H_3O_2(aq)]}$$

HW492 #1, 493 #1.

8.3 Strong and Weak Acids

A strong acid ionizes almost completely in water
A weak acid is one that only partially ionizes in water

$$HCl\,(aq) + H_2O\,(l) \rightleftharpoons H_3O^+(aq) + Cl^-(aq)$$

Property	**Strong Acid**	**Weak Acid**
Value of acid ionization constant, K_a	K_a is large	K_a is small
Position of the ionization equilibrium	far to the right	far to the left
Equilibrium concentraton of H^+ (aq)	$[H^+\,(aq)]_{eq} \approx [HA\,(aq)]_i$	$[H^+\,(aq)]_{eq} << [HA\,(eq)]_i$
compared with the original concentration	Equal. pH $\approx$ Initial pH	Equal. pH << Initial pH

8.4 Stong and Weak Bases

Strong base dissociates completely in water
Weak base partially dissociates in water

The base ionization constant(Kb) is the base equilibrium constant for the ionization of a base(it is also called the base dissociation constant)

$$K_b = \frac{[BH^+(aq)][OH^-(aq)]}{[B(aq)]} \tag{2}$$

Example:

$$NH_3(aq) + H_2O\,(l) \rightleftharpoons NH_4{}^+(aq) + OH^-(aq)$$

$$K_b = \frac{[OH-(aq)][NH_4{}^+(aq)]}{[NH_3(aq)]}$$

Chart for K_b for weak acids: pg 727

The autoionization of water is the transfer of a hydrogen ion from one water molecule to another.

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

$$\begin{aligned}
K_w &= [H_3O^+(aq)][OH^-(aq)] \\
K_w &= [1.0 \cdot 10^{-7}][1.0 \cdot 10^{-7}] \\
K_w &= 1.0 \cdot 10^{-14}
\end{aligned}$$

$$K_w \text{ is always } 1.0 * 10^{-14} \text{ at SATP}$$

$[H] = [OH]$	**Neutral** solution
$[H] > [OH]$	**Acidic** solution
$[H] < [OH]$	**Basic** solution

Example to find the $[H_3O^-(aq)]$

$$\begin{aligned}
K_w &= [H_3O^+(aq)][OH^-(aq)] \\
[H_3O^+(aq)] &= \frac{K_w}{[OH^-(aq)]}
\end{aligned}$$

$$K_w = K_a \cdot K_b$$

$$\begin{aligned}
pH &= -log[H] & [H] &= 10^{-pH} \\
pOH &= -log[OH] & [OH] &= 10^{-pH} \\
14 &= pH + pOH & pK_w &= pH + pOH
\end{aligned}$$

pH meter is an electronic devide that measures the acidity of a solution and displays the result as a pH value.

An acid base indicator is a substance that changes color specific to the pH range

pg 495-509
pg 502 #1,2; pg 505 #1-3; pg 508 #1-4; pg 509 #1-10

8.5 Calculations involving acidic solutions

Since strong acids almost completely ionize in water, we can assume that the concentration of hydrogen ions is equal to the concentration of the acid.

Ex a solution of hydrochloric acid has a concentration od 0.1M. Calculate:

$$HCl\,(aq) + H_2O\,(l) \rightleftharpoons H_3O^-\,(aq) + Cl^-\,(aq)$$

$[H^+] = 0.1M$
$[OH^-] = 1$*10 e -13
pH = 1
pOH = 13

Precentage ionization is the percentage of a solute that ionizes when it dissolves in a solvent.

Calculate the ka hydrofluoric acid HF, if a 0.100M solution at equilibrium has a percentage ionization.

$HF\,(aq) + H_{20}(l) \rightleftharpoons H_3O^+(aq) + F^-\,(aq)$