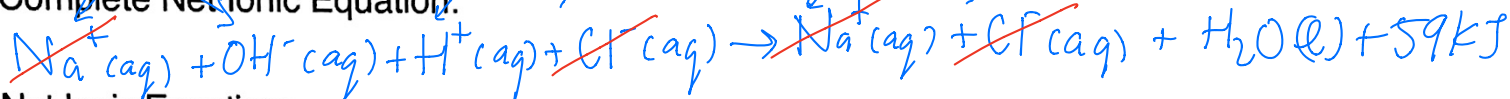# CHEMISTRY 12
ACID BASES UNIT
Lesson #7-8
K_W, K_a and K_b

When a STRONG ACID and a STRONG BASE react a great amount of HEAT is RELEASED, therefore the reaction is said to be __exothermic__.
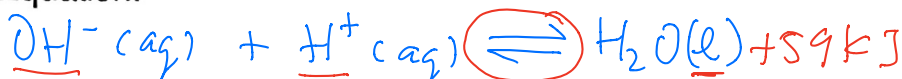
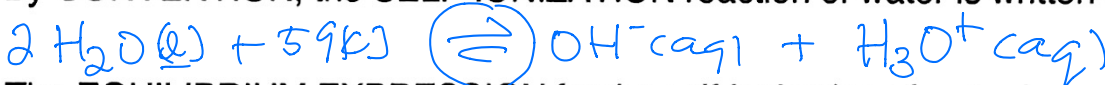Formula Equation for NaOH and HCl:

$$NaOH (aq) + HCl (aq) \longrightarrow NaCl (aq) + H_2O (l) + 59 kJ$$
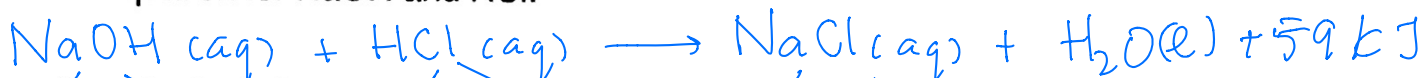
Complete Net Ionic Equation:

$$Na^+ (aq) + OH^- (aq) + H^+ (aq) + Cl^- (aq) \rightarrow Na^+ (aq) + Cl^- (aq) + H_2O (l) + 59 kJ$$

Net Ionic Equation:

$$OH^- (aq) + H^+ (aq) \rightleftharpoons H_2O (l) + 59 kJ$$

By CONVENTION, the SELF-IONIZATION reaction of water is written as:

$$2 H_2O (l) + 59 kJ \rightleftharpoons OH^- (aq) + H_3O^+ (aq)$$

The EQUILIBRIUM EXPRESSION for the self-ionization of water is:

$$K_w = [H_3O^+][OH^-] = 1.00 \cdot 10^{-14} \quad @ 25°C$$

Because the only thing that affects Keq is TEMPERATURE, what would happen to the Kw value if heat was ADDED to the system? If heat was removed from the system?

endo ∴ Kw ↑ , ↓temp ↓ Kw   H/e $[H_3O^+] = [OH^-]$ neutral

SOME IMPORTANT RELATIONSHIPS:

In a NEUTRAL SOLUTION- $[H_3O^+] = [OH^-]$

In an ACIDIC SOLUTION- $[H_3O^+] > [OH^-]$ } vice versa   0.00100M

In a BASIC SOLUTION- $[H_3O^+] < [OH^-]$

Recall: In an aqueous solution the [Strong acid] = [H₃O⁺]

$$HCl + H_2O (l) \rightarrow H_3O^+ + Cl^-$$
0.0010 M   0.0010 M

In an aqueous solution the [Strong base]=[OH⁻]   0.0010 M
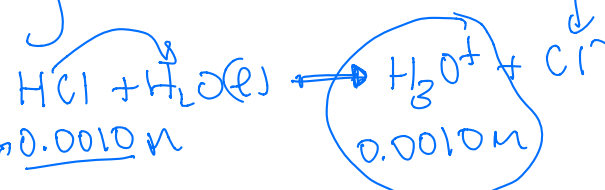
Example 1. What is the [H₃O⁺] and [OH⁻] in 0.0010 M HCl (aq)?

$$K_w = [H_3O^+][OH^-] \Rightarrow \frac{1.00 \cdot 10^{-14}}{0.0010} = \frac{[0.0010][OH^-]}{0.0010} = \boxed{1.0 \cdot 10^{-11} M \ OH^-}$$

Example 2. What is the [H₃O⁺] and [OH⁻] in 0.150 M Ca(OH)₂?

$$Ca(OH)_2 + H_2O (l) \longrightarrow Ca^{2+} (aq) + 2 OH^-$$
0.150 M   0.150 M   0.300 M
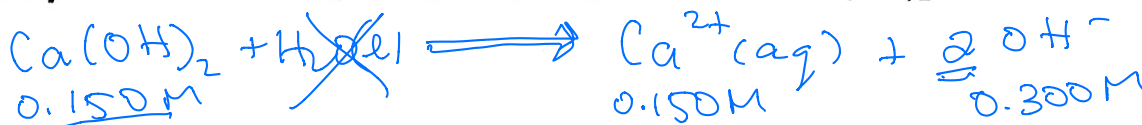
$$K_w = \frac{[H_3O^+](0.300)}{0.300} = \frac{1.00 \cdot 10^{-14}}{0.300} = \boxed{3.33 \cdot 10^{-14} M \ H_3O^+}$$

To solve problems for [H$_3$O$^+$] or [OH$^-$] using the Kw =1.00 x 10^{-14} note that if the [H$_3$O$^+$] increases then the [OH$^-$] decreases, and vice versa so that the Kw value is kept CONSTANT!!!

IMPT: unless you are told otherwise, assume the temperature is at @25 C and therefore the value of Kw is 1.00 x 10^{-14}
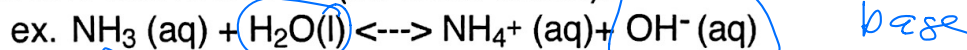
$$Keq = \frac{[P]}{[R]}$$

THE ACID IONIZATION CONSTANT (for weak acids):
    ex. CH$_3$COOH(aq) + H$_2$O(l) <---> CH$_3$COO$^-$ (aq) + H$_3$O$^+$ (aq)   acid
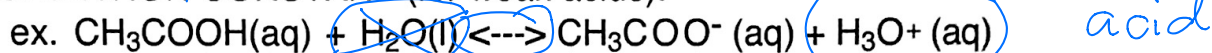
$$Ka = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]} = 1.8 \cdot 10^{-5}$$ ← value on the table

The value for Ka is called the _acid ionization constant_. The larger the Ka the _stronger the [weak acid]_ and vice versa.

THE BASE IONIZATION CONSTANCT (for weak bases):
        ex. NH$_3$ (aq) + H$_2$O(l) <---> NH$_4^+$ (aq)+ OH$^-$ (aq)   base

$$Kb = \frac{[NH_4^+][OH^-]}{[NH_3]} = ?$$ (lesson #9)

The value for the Kb is called the _base ionization constant_. The larger the Kb the _stronger the weak base_ and vice versa.

NOTICE: the TABLE OF RELATIVE STRENGTHS OF ACIDS and BASES only gives the Ka values, in the next lesson we will learn how to use the Ka to calculate the Kb.

SEATWORK/HOMEWORK: Exercises 28-34
PLO's:L1-L7 also from previous lessons you are able to do K10-K12