Name: Key
Blk:___Date:___

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:

$HCl_{(aq)} + NaOH_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)} + 59\,kJ$

Complete Net Ionic Equation:

$H^+_{(aq)} + Cl^-_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)} + H_2O_{(l)} + 59\,kJ$

Net Ionic Equation:

$H^+_{(aq)} + OH^-_{(aq)} \rightleftharpoons H_2O_{(l)} + 59\,kJ$

By CONVENTION, the SELF-IONIZATION reaction of water is written as: an endothermic rxn. c hydronium ion

$2H_2O_{(l)} + 59\,kJ \rightleftharpoons H_3O^+_{(aq)} + OH^-_{(aq)}$

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

Kw= $[H_3O^+][OH^-] = 1.00\times10^{-14}$ @ 25°C   specialized keq

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?

If ↑ heat → Kw ↑ & both OH^- & H_3O^+ increase equally
If ↓ heat → Kw ↓ & both OH^- & H_3O^+ decrease equally

SOME IMPORTANT RELATIONSHIPS:
In a NEUTRAL SOLUTION- $[H_3O^+] = [OH^-]$

In an ACIDIC SOLUTION- $[H_3O^+] > [OH^-]$

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

Recall: In an aqueous solution the [Strong acid] = [H_3O^+]
In an aqueous solution the [Strong base]=[OH^-]
} due to levelling effect of H_2O!

Example 1. What is the [H_3O^+] and [OH^-] in 0.0010 M HCl (aq)? (SA ?) $Kw = [H_3O^+][OH^-]$

$HCl \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$ ∴ $[H_3O^+] = 0.0010\,M$, $Kw = [H_3O^+][OH^-]$
0.0010 0.0010 0.0010

$[OH^-] = \frac{Kw}{[H_3O^+]} = \frac{1.00\times10^{-14}}{0.0010} = 1.0\times10^{-11}\,M\ OH^-$

SB

Example 2. What is the [H_3O^+] and [OH^-] in 0.150 M $Ca(OH)_2$? $K_w = [H_3O^+][OH^-] = 1.00 \times 10^{-14}$

$0.150\ M\ Ca(OH)_2 \rightleftharpoons Ca^{2+} + 2OH^-$
0.150 M 0.300 M

$\therefore$ $[OH^-] = 0.300\ M$; $[H_3O^+] = \frac{K_w}{0.300} = \frac{1.00 \times 10^{-14}}{0.300} = 3.33 \times 10^{-14}\ M\ H_3O^+$

To solve problems for [H_3O^+] or [OH^-] using the Kw =1.00 x 10^{-14} note that if the [H_3O^+] increases then the [OH^-] decreases, and vice versa so that the Kw value is kept CONSTANT!!! @ 25°C & must be of either SA or SB.

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}

$Keq = \frac{[Products]}{[Reactants]} \rightarrow Ka = \frac{[Products]}{[Reactants]}$

THE ACID IONIZATION CONSTANT (for weak acids): specialized Keq!

ex. $CH_3COOH(aq) + H_2O(l) \longleftrightarrow CH_3COO^-(aq) + H_3O^+(aq)$

Ka= $\frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]} = 1.8 \times 10^{-5}$ from the table

The value for Ka is called the ACID IONIZATION CONSTANT. The larger the Ka the STRONGER the acid and vice versa.

THE BASE IONIZATION CONSTANCT (for weak bases): specialized Keq!

ex. $NH_3(aq) + H_2O(l) \longleftrightarrow NH_4^+(aq) + OH^-(aq)$

Kb= $\frac{[NH_4^+][OH^-]}{[NH_3]}$ ⇒ ? $Kb(NH_3) = \frac{K_w}{Ka(NH_4^+)} = \frac{1.00 \times 10^{-14}}{5.6 \times 10^{-10}} = 1.8 \times 10^{-5}$ must solve

The value for the Kb is called the BASE IONIZATION CONSTANT. The larger the Kb the STRONGER the 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