**Acid Ionization**

The pH scale depends on the concentration of H+ ion concentration in a solution.

Water has a pH of 7 at 25 oC.

Water ionizes minimally but it does: H2O(l) ↔ H+(aq) + OH-(aq)

But really: 2 H2O(l) ↔ H3O+(aq) + OH-(aq)

**pH = - log [H+]**

Therefore a pH of 7 represents an H+ ion concentration of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

If 1 water molecule ionizes it will form 1 hydrogen ion and 1 hydroxide ion.

This is an equilibrium situation which means it can be disturbed--Le Chatelier is back!!

What happens when an acid is added to water?

i) The acid ionizes according to the following:

**HA(aq) ↔ H+(aq) + A-(aq)**

What has been done to the water equilibrium?

 What happens to the hydrogen ion concentration? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 What happens to the hydroxide ion concentration? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 What happens to the pH? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Strong Acids:**

* remember the list from net ionic equations
* ionize 100 % of the time
* so whatever the concentration of the acid is the concentration of the hydrogen ion.

**Weak Acids:**

* ionize less than 100 % -- usually much closer to 1%

**Strong vs Weak and Concentrated vs Dilute--Know the difference!!**



Acids are **polar covalent** molecules which when dissolved in water ionize:

**Percent Ionization = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ x 100**

**Percent Ionization** is an indication of the strength of an acid. (It does change with concentration but we will not focus on this year).

**Acid Ionization Constant--Just another Keq**

**Acid Ionization Constant**

* also called the "acid dissociation constant" or "acidity constant"
* is a measure of how much of the acid is **deprotonated** (which is when it's unbound to a hydrogen), compared to molecules still bound to a hydrogen

* is a measure of how much H+ ion is present in a sample of an acid HA or HX

**HA(aq) ↔ H+(aq) + A-(aq)**

**Ka = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

The **acid ionization constant (Ka)** is a measure of the extent to which an acid will ionize and is therefore an indication of the **strength** of an acid i.e. how much does it ionize?

A **Ka** value usually indicates that the acid is weak i.e. at equilibrium the unionized acid

molecules are favored.

i) reactants are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

ii) the equilibrium lies to the left \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

iii) the Keq is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Ka (like any Keq**) is the ratio of the products to the reactants.

**Ka** is the ratio of the ions produced to the molecules unionized acid.

**The Ka of a weak acid** determines how acidic it is, i.e., how far its equilibrium lies to the right.

**The Ka values of weak acids** can and have been determined experimentally--refer to the Ka table.

**Strong acid at Equilibrium**

|  |  |  |
| --- | --- | --- |
| HCl(aq) + H2O(l) | http://ibchem.com/root_img/doublearrow.gif | H+(aq) + Cl-(aq) |
| Almost 0% at equilibrium |   | Almost 100% at equilibrium |

**Ka =**

**Weak acid at Equilibrium**

|  |  |  |
| --- | --- | --- |
| CH3COOH(aq) + H2O(l) | http://ibchem.com/root_img/doublearrow.gif | H+(aq) + CH3COO-(aq) |
| approx 99% |   | approx 1% |
|  |  |  |

 **Ka =**

**Problem 1:**

A student initially prepared a 0.10 *M* solution of formic acid, HCHO2, and measured its pH at equilibrium using a pH meter. The pH at 25.0 °C was found to be 2.38.

**Normally** we assume the acid is so weak that there is so little change to the concentration of the acid at equilibrium that we can safely use the initial concentration of the acid.

**(a)**Calculate *Ka* for formic acid at this temperature.

Acid Ionization Equation: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ka Expression:

pH = - log [H+]

**(b)**What percentage of the acid is ionized in a 0.10 *M* solution?

**5 % Rule:**

If you calculate the percent ionization to be greater than 5 % you must then repeat the calculations using a **RICE** table! You must subtract the concentration of hydrogen ion from the initial concentration of the acid.

**Problem 2:** Hypothetical acid HX with a concentration of 0.025 mol/L has a pH of 2.82.

 What is the Ka of HX?

Percent Ionization =

|  |  |  |  |
| --- | --- | --- | --- |
| **R** |  |  |  |
| **I** |  |  |  |
| **C** |  |  |  |
| **E** |  |  |  |

Ka =

**Problem 3:**

Consider acetic acid, HC2H3O2, the substance responsible for the characteristic odor and acidity of vinegar. Let's calculate the pH of a 0.30 *M* solution of acetic acid at 25.0 oC after referring to a Ka table -- the Ka of acetic acid is 1.8  10–5.

**Base Dissociation Constant (Kb)**

A similar equilibrium exists when a weak base is dissolved in water.

The base will accept a proton from water and form a conjugate acid, BH+.

**{\displaystyle {\hbox{B}}+{\hbox{H}}\_{2}{\hbox{O}}\leftrightarrow {\hbox{OH}}^{-}+{\hbox{BH}}^{+}}B + H2O(l) ↔ OH-(aq) + BH+(aq)**

This equilibrium has its own special constant, Kb, known as the **base dissociation constant**.

Like the acid dissociation constant, it is defined as the equilibrium constant multiplied by the concentration of water.

{\displaystyle K\_{b}=K[{\hbox{H}}\_{2}{\hbox{O}}]={\frac {[{\hbox{BH}}^{+}][{\hbox{OH}}^{-}]}{[{\hbox{B}}]}}}

**Sodium hydroxide**

|  |  |  |
| --- | --- | --- |
| NaOH(s) + H2O(l) | http://ibchem.com/root_img/doublearrow.gif | Na+(aq) + OH-(aq) |
| Virtually 0% at equilibrium |   | Virtually 100% at equilibrium |

**Kb =**

**Ammonia**

|  |  |  |
| --- | --- | --- |
| NH3(g) + H2O(l) | http://ibchem.com/root_img/doublearrow.gif | NH4+(aq) + OH-(aq) |
| > 99% |   | < 1% |

 **Kb =**