**Acids and Bases**

\*Acids taste sour, are corrosive to metals, change litmus ( a dye extracted from lichens ) red, and become less acidic when mixed with bases e.g. HCl , H2SO4, HNO3 , H3PO4 ………..etc.

\*Bases feel slippery , change litmus blue , and become less basic when mixed with acids e.g. NaOH , KOH ,NH4OH , Mg(OH)2………..etc.

Neutralization

As you can see from the equations, acids release H+ into solution and bases release OH- . If we were to mix an acid and base together , the H+ ion would combine with the OH- ion to make the molecule H2O, or plain water.: H+(aq) + OH-(aq) → H2O

The neutralization reaction of an acid with base will always produce water and a salt , as shown below: Acid + Base → Water +Salt

HCl + NaOH → H2O + NaCl

HBr + KOH → H2O + KBr

Problems and answers

1) If the hydrogen ion concentration is 0.1 mole / liter. Then the [OH-] could be found by the equation : [H+][OH-] =1X 10-14

10-1 X [OH-] =1X10-14 ………… [OH-] = 1X10-14 / 10-1 =10-13 mole /liter

POH =- log [OH-] = - log (1 x 10-13) = - (log 1 +log 10-13) = -(0 - 13 ) =13

PH = - log [H+] = -log ( 1x10-1) =- (log 1 + log 10-1 ) = -( 0 -1 ) =1

Or PH +POH =14

One can have a PH that is a negative value in for example strong acid solutions greater than 1 mole /liter. For a 10 M H+ ………. PH = -log ( 1 x 101) =-(0 +1 ) =-1

Most acidic and basic substances whose PH lie between the 0 – 14 range . Do not confuse the term acid strength with PH. The strength of an acid has to do with the percentage of the initial protons that are ionized . If a higher percentage of the original protons are ionized and therefore donated as hydrated protons ( hydronium ions ) then the acid will be stronger . Strong acids are Hydrochloric , Hydrobromic , Nitric , Sulfuric, and Perchloric acids. In each of these molecular acids the percentage of ionization is almost 100% .

Determining the {H3O+} when given the PH.

Example 1 : What would be the [H3O+] of a solution that has a PH =5.4 .

[H3O+] = [H+]

PH = - log [H+] 5.4 =- log [H+] ( X -1 )

-5.4 =log [H+] (÷/ log )

Log-1 -5.4 = [ H+ ]………. [H+] = log-1 (-6 +0.6 )= log-1 -6 x log-1 o.6 =3.98 x 10-6 M =[H3O+]

Determine the [OH-] when given the POH .

Example 2 : Calculate the [OH- ] of a solution that has a POH = 8.2 ? log-1 0.8 =6.31.

POH = -log [OH-] 8.2 =-log [OH-] (X-1) then ( ÷/ log )

[OH-] = log-1( -9 +0.8 ) = log-1 -9 x log-1 0,8 =6.31 x 10-9 M

Determine the [H3O+] when given the [ OH-]and vice versa .

Water ionizes only slightly giving the following equilibrium :

H2O (l ) + H2O (l) = H3O+ (aq) + OH- (aq) According to the Law of Chemical Equilibrium :

KC = [H3O+][OH-] / [H2O]2

Note : Concentration of pure water is a constant 55.5.

Since the molar concentration of water is constant , we multiply both sides of the above expression by [H2O]2 that will result in another constant: KC [H2O]2= KW =[H3O+][OH-] =1.0 X 10-14

KW =[H3O+][OH-] = 1.0 X 10-14

Note : KW is the ionization equilibrium constant of pure water which always has a value 1 x10-14

Example 3/ Calculate the [H3O+] when the [OH-] =3.2 X 10-3M ?

KW = 1 X10-14 = [H3O+][3.2 X 10-3] [H3O+] = 1X10-14/ 3.2 X 10-3 =3.125 X10-12 M

Does it make a difference which acid or base is given in the problem? Yes, if the acid or base is a strong one , the dissociation will be 100%.For example : HCl is classified as a strong acid so:

HCl + H2O → H3O+ (aq) + Cl – (aq)

If I start with a 0.1 M HCl , then I will have 0.1 M H3O + because for every HCl that breaks apart then one H3O +  is formed and one Cl – is formed . Since strong acids ( and bases) ionize 100% , then all the original concentration will be converted to H3O + (acids) or to OH- (bases),

Typical strong acids : HCl , HBr , HI , HNO3 , H2SO4 , HClO4 .

Strong bases : All the Hydroxide compounds of Group 1 and Group 2 metals: LiOH , NaOH , KOH ,etc and Ca(OH)2 , Mg(OH)2 etc

Example 4/ What would be the [ OH -] of a 2M NaOH solution ?

NaOH + H2O → Na + (aq) + OH – (aq)  2M NaOH will produce 2M OH - , since the breakdown is 199%.

3M Ca(OH)2 will produce 6M OH – because for every one Ca(OH)2 that breaks apart two OH – ions are produced .

Example 5/ Given 0.02 M Ba(OH)2 solution . Determine the OH - , H + ions and POH , PH values. ?

Since all hydroxides of group 2 metals are strong bases dissociating 100%

Ba(OH) 2 + H2O → Ba +2  + 2 OH –

According to the balanced equation for every Ba(OH)2  that dissociates twice as OH -.

[OH - = 2 X 0.02 =0 .04 = 4 X 10 -2M

]H + ][OH - ] = 1X 10 -14 [H +] = 1 X 10-14 / 4X 10-2 = 2 .5 X 10 -13M

PH = -log 2.5 x 10 -13 =12.6

PH + POH =14 12.6 + POH = 14 POH = 1.4

Weak acids: Partially dissociate into hydronium ion and conjugate base .

CH3COOH (aq) + H2O (l) CH3COO -  + H3O +

In a weak acid , equilibrium exists between the acid , conjugate base and the hydronium ion . The degree of dissociation ( the acid ,s strength ) is described using the acid – dissociation Ka.

HA (aq )  H+ + A –

[H +][ A - ]

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

[HA ]

PKa =-log Ka

Weak bases : partially reaction with water to form conjugate acid and hydroxide ion to form an equilibrium similar to a weak acid.

NH3 (aq) +H2O (l)  NH4 +  + OH –

Kb = [ NH +][ OH -] / [NH3] PKb = - log Kb

\*All acids increase the H + concentration of water.

\*All bases increase the OH – concentration of water.

\*\*A system is at equilibrium when the concentrations of reactants and products remain constant.

Indicators :

Made with special chemical compounds that react slightly with an acid or base , indicators will change color in the presence of an acid or base . A common indicator is litmus paper . Litmus paper turns red in acidic conditions and blue in basic conditions . Phenolphthalein purple in basic conditions and colorless in acidic and neutral solutions.

Conductivity:

A less informative method is to test for conductivity . Acids and bases in aqueous solutions will conduct electricity because they contain dissolved ions. Therefore, acids and bases are electrolytes. Strong acids and bases will be strong electrolytes . Weak acids and bases will be weak electrolytes .This affects the amount of conductivity.

Physical properties:

The physical properties of acids and bases are opposites.

Acids Bases

Taste sour bitter

Feel stinging slippery

Odor sharp odorless

\*The following is for informative purposes only . DO not sniff, touch ,or taste any acids or bases as they result in injury or death.

Neutralization:

Acids will react with bases to form a salt and water. The products of neutralization reaction are much less acidic or basic than the reactants . For example :

HCl + NaOH → NaCl + H2O

Acid Base Salt Water