تفكك

Dissociation of water

when water dissociates, one of the hydrogen nuclei leaves its electron behind with the oxygen atom to become a hydrogen ion, while the oxygen and other hydrogen atoms become a hydroxide ion. Since the hydrogen ion has no electron to neutralize the positive change on its proton, it has a full unit of positive change and is symbolized as $\overset{+}{H}$. The hydroxide ion retains the electron left behind and thus has a full unit of negative charge, symbolized by $\overset{-}{O}H$. The hydrogen ion (proton) does not wander long by itself before it attaches to the oxygen atom of a second un-ionized water molecule to form a hydronium ion ($H_3\overset{+}{O}$)

$$H_2O_{(L)} + H_2O_{(L)} \rightleftharpoons H_3\overset{+}{O}_{(aq)} + \overset{-}{O}H_{(aq)}$$

water molecules dissociate into equal amounts of $H_3\overset{+}{O}$ and $\overset{-}{O}H$, so their concentration are equal to 1×10^{-7} mol/L at 25 °C

$$[\overset{+}{H}] = [\overset{-}{O}H] = 1\times10^{-7}\ M$$

The Ion-Product of water:- The self-ionization of water, the process in which water ionizes to hydronium ions and hydroxide ions to a very limited extent. When two molecules of water collide, there can be a transfer of a hydrogen ion from one molecule to the other. The products are a positively charged hydronium ion and a negatively charged hydroxide ion.

$$\underset{(L)}{H_2O} + \underset{(L)}{H_2O} \rightleftharpoons \underset{(aq)}{H_3O^+} + \underset{(aq)}{OH^-}$$

we often use the simplified form of the reaction

$$\underset{(L)}{H_2O} + \underset{(L)}{H_2O} \rightleftharpoons \underset{(aq)}{H^+} + \underset{(aq)}{OH^-}$$

The equilibrium Constant for the self-ionization of water is referred to as the ion-product for water and is given the symbol K_w, where

$$K_w = [H^+][OH^-]$$

The ion-product of water K_w is the mathematical product of the Concentration of hydrogen ions and hydroxide ions. The value of K_w is very Small, in accordance with a reaction that favors the reactants. At 25 °C, the experimentally determined value of K_w in pure water is 1.0×10^{-14}.

$$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$$

In pure water, the concentrations of hydrogen and hydroxide ions are equal to one another. pure water or any other aqueous Solution in which this ration holds is said to be neutral. To find the molarity of each ion, the square root of K_w is taken

$[H^+] = [OH^-] = 1.0 \times 10^{-7}$ mole/L

An Acidic Solution, is a solution in which the Concentration of hydrogen ions is greater than the Concentration of hydroxide ions. For example, hydrogen chloride ionizes to produce H^+ and Cl^- ions upon dissolving in water

$$HCl \rightarrow H^+ + Cl^-$$

This increases the concentration of H^+ ions in the solution, according to Le chateliers principle, the equilibrium represented by

$$H_2O_{(L)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$$

is forced to the left, towards the reactant. As a result, the Concentration of the hydrogen ion decreases.

$$[H^+] > [OH^-] \quad , \quad [H^+] > 1.0 \times 10^{-7}\ M$$

A basic Solution, is the solution in which the Concentration of hydroxide ions is greater than the Concentration of hydrogen ion. Solid potassium hydroxide dissociates in water to yield (مُنتج) potassium ions and hydroxide ions.

$$KOH_{(s)} \rightarrow K^+_{(aq)} + OH^-_{(aq)}$$

The increase in Concentration of the OH^- ions Causes a decrease in the Concentration of the H^+ ions, therefore the ion-product of $[H^+][OH^-]$ remains Constant

$[\bar{O}H] > [\overset{+}{H}]$ ، $[\bar{O}H] > 1.0 \times 10^{-7}$ M

Question (1)

calculate the concentrations each of hydrogen ion and hydroxide ions of hydrochloric acid solution its concentration 2.0×10^{-3} M.

Hydrochloric acid is a strong acid therefore Hcl is 100% ionized

$$HCl \rightarrow \overset{+}{H} + \bar{Cl}$$

$[HCl] = [\overset{+}{H}] = 2 \times 10^{-3}$ M

$K_w = 1 \times 10^{-14}$ M

$[\overset{+}{H}][\bar{O}H] = 1 \times 10^{-14} \rightarrow [\bar{O}H] = \dfrac{1 \times 10^{-14}}{2 \times 10^{-3}} = 5 \times 10^{-12}$ M

$\therefore [\overset{+}{H}] > [\bar{O}H]$ ، $2 \times 10^{-3} > 5 \times 10^{-12}$

Acidic solution.

Question (2)

Calculate the $[\overset{+}{H}]$ and $[\bar{O}H]$ for potassium hydroxide solution its 2×10^{-3} M.

potassium hydroxide is strong base therefor KoH is 100% ionzed

$$KOH \rightarrow \overset{+}{K} + \bar{OH}$$

$[KOH] = [\bar{O}H] = 2 \times 10^{-3}$ M

$K_w = 1 \times 10^{-14}$

$[\overset{+}{H}][\bar{O}H] = K_w \rightarrow [\overset{+}{H}] = \dfrac{1 \times 10^{-14}}{2 \times 10^{-3}} = 5 \times 10^{-12}$ M

$[\bar{O}H] > [\overset{+}{H}]$ ، $2 \times 10^{-3} > 5 \times 10^{-12}$

pH and pOH scale

pH is defined as the negative logarithm of hydrogen ion Concentration

$pH = -\log[H^+]$ and $[H^+] = 10^{-pH}$

pOH is defined as the negative logarithm of hydroxyl ion Concentration

$pOH = -\log[OH^-]$ and $[OH^-] = 10^{-pOH}$

pH value of an acid having $[H^+]$ Concentration more than 10^{-7} M, while the pH value of base having $[H^+]$ less than 10^{-7} M

$[H^+] > [OH]$
$[H^+] > 10^{-7}$ M
$[OH^-] < 10^{-7}$ M
$pH < pOH$
$pH < 7$
$pOH > 7$

} Acidic Solution

$[H^+] < [OH^-]$
$[H^+] < 10^{-7}$ M
$[OH^-] > 10^{-7}$ M
$pH > pOH$
$pH > 7$
$pOH < 7$

} Alkaline Solution