Homework - #3-5,7,8

Arrhenius: Acids → H^+

Bases → OH^-

Bronsted-Lowry: Acids → proton donor (H^+)

Bases → proton acceptors

7. a) $HNO_{3(aq)} + H_2O_{(l)} \rightleftharpoons NO^-_{3(aq)} + H_3O^+_{(aq)}$

b) $CO^{2-}_{3(aq)} + H_2O_{(l)} \rightleftharpoons HCO^-_{3(aq)} + OH^-_{(aq)}$

Water Equilibrium

Conductivity is due to the presence of ions. For water:

$$H_2O_{(l)} \Longleftrightarrow H^+_{(aq)} + OH^-_{(aq)}$$

- therefore $K = \dfrac{[H^+]\,[OH^-]}{[H_2O]}$ is very small

- slight conductivity shows that equilibrium greatly favors water molecules (less than 2 H^+ per billion water)

- therefore the concentration of water in pure water and in dilute aqueous solutions is essentially constant and can be combined with the equilibrium constant to produce a new constant called the *Ion Product Constant*

<u>Ionization Constant for water</u> (ion product constant)

$\mathbf{K_w = [H^+]\,[OH^-] = 1.0 \times 10^{-14}}$ at SATP $K[H_2O] = [H^+][OH^-]$

Since $[H^+]$ and $[OH^-]$ are found in 1:1 ratio
($H_2O_{(l)} \Longleftrightarrow H^+_{(aq)} + OH^-_{(aq)}$)

$[H^+_{(aq)}] = [OH^-_{(aq)}] = 1.0 \times 10^{-7}$ mol/L in **neutral** solutions.

<u>Arrhenius's Theory</u> - acid is a substance that ionizes water to produce H^+ ions.
- additional ions produced by the acid increases the H^+ concentration in the water. (more acid, more H^+)

Therefore acids always have a $[H^+] > 10^{-7}$ mol/L

Basic solutions produce a $[OH^-]$ greater than 10^{-7} mol/L

K_w can be used to calculate either $[H^+]$ or $[OH^-]$

since $\mathbf{K_w = [H^+]\,[OH^-]}$ then $[H^+] = K_w / [OH^-]$

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

pH and pOH

$pH = -\log[H^+_{(aq)}]$ $pOH = -\log[OH^-_{(aq)}]$

$[H^+_{(aq)}] = 10^{-pH}$ $[OH^-_{(aq)}] = 10^{-pOH}$

Ex. Calculate the pH of a solution where
$[H^+_{(aq)}] = 3.24 \times 10^{-4}$M.

$pH = -\log[H^+_{(aq)}]$

$pH = -\log[3.24 \times 10^{-4}]$

$\boxed{pH = 3.489}$

Ex. Calculate the concentration of hydroxide ions in a solution with a pOH of 10.14.

$[OH^-_{(aq)}] = 10^{-pOH}$

$[OH^-_{(aq)}] = 10^{-10.14}$

$\boxed{[OH^-_{(aq)}] = 7.2 \times 10^{-11}\ M}$

$\boxed{10^x}\ (\boxed{-}\ \boxed{10.14})$

Strong Acids

Calculate the concentration of the hydroxide ions, pH and pOH of a 0.15 mol/L solution of hydrochloric acid at 25°C.

Strong acids will always completely ionize

$$HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$$

0.15 mol/L 0.15 mol/L

pH = ?
pOH = ?
$[OH^-]$ = ?

$$pH = -\log[H^+_{(aq)}]$$

$$pH = -\log[0.15]$$

$$\boxed{pH = 0.82}$$

$$K_w = [H^+_{(aq)}][OH^-_{(aq)}]$$

$$[OH^-_{(aq)}] = \frac{K_w}{[H^+_{(aq)}]}$$

$$[OH^-_{(aq)}] = \frac{1.0 \times 10^{-14}}{0.15\ mol/L}$$

$$\boxed{[OH^-_{(aq)}] = 6.7 \times 10^{-14}\ M}$$

$$pOH = -\log[OH^-_{(aq)}]$$

$$pOH = -\log[6.7 \times 10^{-14}]$$

$$\boxed{pOH = 13.18}$$

#11,12 p.599
#13,14 p.600
#15,16 p.601

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