NOTES
Introduction to K_w & pH

Name ____________________
Period _____ Date ______________

Rainbow Demo: Add saturated $NaCO_3$ (aq) to 0.1 M HCl (aq) containing Universal Indicator

Solutions:

$$HCl\ (aq) + H_2O\ (l) \longrightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$$

$$Na_2CO_3\ (aq) \xrightarrow{H_2O} 2Na^+ + CO_3^{2-}$$

Rainbow Reactions:

RED ORANGE	Excess Acid, Solution is Acidic (pH < 7): $HCl\ (aq) + H_2O\ (l) \longrightarrow H_3O^+ + Cl^-$ $[H_3O^+]$ is **(high, low)**; $[OH^-]$ is **(high, low)**
GREEN	Neutral (pH = 7) $H_3O^+\ (aq) + CO_3^{2-}\ (aq) \rightleftharpoons H_2O + HCO_3^-$ $[H_3O^+]$ and $[OH^-]$ are equal
BLUE VIOLET	Excess Base, Solution is Basic (pH > 7): $CO_3^{2-}\ (aq) + H_2O\ (l) \rightleftharpoons HCO_3^- + OH^-$ $[H_3O^+]$ is **(high, low)**; $[OH^-]$ is **(high, low)**

Thus, the relationship between $[H^+]$ and $[OH^-]$ is **(direct, inverse)**.

Self-Ionization of Water

Even in neutral water, there is some $[H^+]$ and $[OH^-]$. Why?

$$\underset{B}{H_2O\ (l)} + \underset{A}{H_2O\ (l)} \rightleftharpoons H_3O^+ + OH^-$$

Thus, in neutral water, $[H_3O^+]$ and $[OH^-]$ are explained by the following relationship:

$$K_w = 1.0\times10^{-14} = [H_3O^+][OH^-], \text{ so } [H_3O^+] = [OH^-] = \sqrt{1\times10^{-14}} = 1\times10^{-7}$$

So, since $1.0\times10^{-14} = [H_3O^+][OH^-]$,

- As acid is added, $[H_3O^+]$ **(increases, decreases)** and $[OH^-]$ **(increases, decreases)**
- As base is added, $[OH^-]$ **(increases, decreases)** and $[H_3O^+]$ **(increases, decreases)**

If you know $[H^+]$ or $[OH^-]$, you can determine other: $[OH^-] = \dfrac{1.0\times10^{-14}}{[H_3O^+]}$ and $[H_3O^+] = \dfrac{1.0\times10^{-14}}{[OH^-]}$