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:

$$HCl\,(aq) + H_2O\,(l) \longrightarrow \_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_$$

$$Na_2CO_3\,(aq) \xrightarrow{H_2O} \_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_$$

Rainbow Reactions:

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

$$H_2O\,(l) + H_2O\,(l) \rightleftharpoons \_\_\_\_\_\_\_\_\_ + \_\_\_\_\_\_\_\_\_$$

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

$K_w = 1.0\times10^{-14} = [H_3O^+][OH^-]$, so $[H_3O^+] = [OH^-] =$ _________

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 $[H_3O^+]=\dfrac{1.0\times10^{-14}}{[OH^-]}$