CH. 16 Acid-Base Chemistry Math

Key Equations, Numerical Relationships

1. $[H^+][HO^-] = 1.00 \times 10^{-14}$

2. $pH = -\log[H^+]$ $\quad [H^+] = 10^{-pH}$ (on calculator, enter –pH, then punch the **10^x** button)

   $pOH = -\log[OH^-]$ $\quad [OH^-] = 10^{-pOH}$ (on calculator, enter –pOH, then punch the **10x** button)

3. $pH + pOH = 14$ $\qquad pH = 14 - pOH$

Weak acid problems

$K_a = [H^+][A^-]/[HA]$ but when HA is placed in water, $[H^+] = [A^-]$ so:

When the simplifying assumptions are used:

4. $\mathbf{K_a = \dfrac{[H^+]^2}{[HA]_{init}}}$	**5.** $\mathbf{[H^{\oplus}] = \sqrt{K_a \times [HA]_{init}}}$

When the first simplifying assumption is not used (but the second one is)

6. $K_a = \dfrac{[H^+]^2}{[HA]_{init} - [H^+]}$ $\quad [H^{\oplus}]$ requires a quadratic solution

7. Quadratic Equation: for $ax^2 + bx = c = 0\, x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Weak base problems

$K_b = [Base\text{-}H^+][OH^-]/[Base]$ but when Base is place in water, $[Base\text{-}H^+] = [OH^-]$ so:

When the simplifying assumptions are used:

8. $\mathbf{K_b = \dfrac{[HO^-]^2}{[Base]_{init}}}$	**9.** $\mathbf{[HO^{\ominus}] = \sqrt{K_b \times [Base]_{init}}}$

When the first simplifying assumption is not used but the second one is

10. $K_b = \dfrac{[HO^-]^2}{[Base]_{init} - [HO^-]}$ $\quad [HO^{\ominus}]$ requires a quadratic solution

11. $K_a K_b = 10^{-14}$ for a conjugate acid/base pair.

Note: This relationship is routinely used when a K value for your acid or base is not provided, but the K value for it's conjugate is. So get it indirectly.

Some Calculation Logic Scenarios

1. Strong acid → pH $\quad$ [Strong acid] → $[H^{\oplus}]$ → pH
2. Strong base → pH $\quad$ [Strong base] → $[HO^{\ominus}]$ → pOH → pH
3. Weak acid + K_a → pH $\quad$ [Weak acid] + K_a → $[H^{\oplus}]$ → pH
4. pH of weak acid → K_a $\quad$ pH → solve for $[H^{\oplus}]$ → K_a
5. Weak base + K_b → pH $\quad$ [Weak base] + K_b → $[HO^{\ominus}]$ → pOH → pH
6. pH of weak base → K_b $\quad$ pH → solve for $[HO^{\ominus}]$ → pOH → pH
7. Weak base + K_a of conjugate acid → pH $\quad$ K_a → K_b → $[HO^{\ominus}]$ → pOH → pH

Simple Acid-Base Concept Map