

Acid-Base Calculations

$$\begin{aligned} \text{pH} &= -\log [\text{H}_3\text{O}^+] & [\text{H}_3\text{O}^+] &= 10^{-\text{pH}} \\ \text{pOH} &= -\log [\text{OH}^-] & [\text{OH}^-] &= 10^{-\text{pOH}} \end{aligned}$$

$$\begin{aligned} K_w &= [\text{OH}^-][\text{H}_3\text{O}^+] = 1.008 \times 10^{-14} \text{ at } 25^\circ\text{C} \\ \text{pH} + \text{pOH} &= 13.9965 \text{ at } 25^\circ\text{C} \end{aligned}$$

Strong Acids and Strong Bases: Completely react to give H_3O^+ and OH^- .



Weak Acids and Bases: Only partially react to give H_3O^+ and OH^- . Need to take into consideration K_a or K_b .

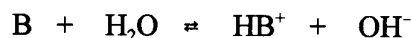


$$\boxed{K_a = \frac{[\text{A}^-][\text{H}_3\text{O}^+]}{[\text{HA}]} = \frac{x^2}{[\text{HA}]_{\text{initial}} - x} \approx \frac{x^2}{[\text{HA}]_{\text{initial}}}}$$

$$\begin{aligned} x &= [\text{H}_3\text{O}^+] = [\text{A}^-] \\ [\text{HA}]_{\text{initial}} - x &= [\text{HA}] \text{ at equilibrium} \end{aligned}$$

Can calculate pH if know $[\text{HA}]_{\text{initial}}$ and K_a .

Can calculate K_a if know $[\text{HA}]_{\text{initial}}$ and pH (convert pH to $[\text{H}_3\text{O}^+] = x$).



$$\boxed{K_b = \frac{[\text{HB}^+][\text{OH}^-]}{[\text{B}]} = \frac{x^2}{[\text{B}]_{\text{initial}} - x} \approx \frac{x^2}{[\text{B}]_{\text{initial}}}}$$

$$\begin{aligned} x &= [\text{OH}^-] = [\text{HB}^+] \\ [\text{B}]_{\text{initial}} - x &= [\text{B}] \text{ at equilibrium} \end{aligned}$$

Can calculate pH if know $[\text{B}]_{\text{initial}}$ and K_b .

Can calculate K_b if know $[\text{B}]_{\text{initial}}$ and pH (convert pH to $[\text{H}_3\text{O}^+]$, convert $[\text{H}_3\text{O}^+]$ to $[\text{OH}^-] = x$).

Conjugate Acid Base Pairs



Buffer Solutions. A buffer solution (a solution which resists changes in pH) contains significant amounts of both a weak acid and its conjugate base.

$$\text{pH}_{\text{buffer}} = \text{p}K_a + \log\left(\frac{[\text{A}^-]}{[\text{HA}]}\right) \qquad 10^{(\text{pH}_{\text{buffer}} - \text{p}K_a)} = \frac{[\text{A}^-]}{[\text{HA}]} \qquad \text{p}K_a = -\log(K_a)$$