**Amfolyt + stark syra**

$$NaHCO_3 \xrightarrow{H_2O} Na^+ + {HCO_3}^-$$

$$[NaHCO_3] = [Na^+] = [{HCO_3}^-]_1$$

$${HCO_3}^- + H_2O \rightleftarrows H_2CO_3 + OH^-$$

$${HCO_3}^- + H_2O \rightleftarrows {CO_3}^{2-} + H_3O^+$$

$$K_{b_1} = \frac{[H_2CO_3][OH^-]}{[{HCO_3}^-]_2} \Leftrightarrow [H_2CO_3] = \frac{K_{b_1}[{HCO_3}^-]_2}{[OH^-]}$$

$$K_{a_2} = \frac{[{CO_3}^{2-}][H_3O^+]}{[{HCO_3}^-]_2} \Leftrightarrow [{CO_3}^{2-}] = \frac{K_{a_2}[{HCO_3}^-]_2}{[H_3O^+]}$$

$$K_w = [OH^-][H_3O^+] \Leftrightarrow [OH^-] = \frac{K_w}{[H_3O^+]}$$

$$K_w = K_a K_b \Leftrightarrow K_{b_1} = \frac{K_w}{K_{a_1}}$$

$$[{HCO_3}^-]_1 = [{HCO_3}^-]_2 + [H_2CO_3] + [{CO_3}^{2-}]$$

$$[{HCO_3}^-]_1 = [{HCO_3}^-]_2 + \frac{K_{b_1}[{HCO_3}^-]_2}{[OH^-]} + \frac{K_{a_2}[{HCO_3}^-]_2}{[H_3O^+]} = [{HCO_3}^-]_2\left(1 + \frac{K_{b_1}}{[OH^-]} + \frac{K_{a_2}}{[H_3O^+]}\right) = [{HCO_3}^-]_2\left(1 + \frac{\frac{K_w}{K_{a_1}}}{\frac{K_w}{[H_3O^+]}} + \frac{K_{a_2}}{[H_3O^+]}\right)$$

$$[{HCO_3}^-]_1 = [{HCO_3}^-]_2\left(1 + \frac{K_w\,[H_3O^+]}{K_{a_1}K_w} + \frac{K_{a_2}}{[H_3O^+]}\right) = [{HCO_3}^-]_2\left(1 + \frac{[H_3O^+]}{K_{a_1}} + \frac{K_{a_2}}{[H_3O^+]}\right) = [{HCO_3}^-]_2\left(\frac{K_{a_1}[H_3O^+] + [H_3O^+]^2 + K_{a_2}K_{a_1}}{K_{a_1}[H_3O^+]}\right)$$

$$\Leftrightarrow [HCO_3^-]_2 = \frac{[HCO_3^-]_1}{\left(\frac{K_{a_1}[H_3O^+] + [H_3O^+]^2 + K_{a_2}K_{a_1}}{K_{a_1}[H_3O^+]}\right)} = \frac{[HCO_3^-]_1 K_{a_1}[H_3O^+]}{[H_3O^+]^2 + K_{a_1}[H_3O^+] + K_{a_2}K_{a_1}}$$

$$HA + H_2O \rightarrow A^- + H_3O^+$$

$$[HA]_1 = [A^-]$$

$$[Na^+] + [H_3O^+] = [OH^-] + [A^-] + [HCO_3^-]_2 + 2[CO_3^{2-}]$$

$$[Na^+] + [H_3O^+] = \frac{K_w}{[H_3O^+]} + [HA]_1 + \frac{[HCO_3^-]_1 K_{a_1}[H_3O^+]}{[H_3O^+]^2 + K_{a_1}[H_3O^+] + K_{a_2}K_{a_1}} + 2\frac{K_{a_2}[HCO_3^-]_2}{[H_3O^+]}$$

$$[Na^+] + [H_3O^+] = \frac{K_w}{[H_3O^+]} + [HA]_1 + \frac{[HCO_3^-]_1 K_{a_1}[H_3O^+]}{[H_3O^+]^2 + K_{a_1}[H_3O^+] + K_{a_2}K_{a_1}} + \frac{2K_{a_2}\frac{[HCO_3^-]_1 K_{a_1}[H_3O^+]}{[H_3O^+]^2 + K_{a_1}[H_3O^+] + K_{a_2}K_{a_1}}}{[H_3O^+]}$$

$$[Na^+] + [H_3O^+] = \frac{K_w}{[H_3O^+]} + [HA]_1 + \frac{[HCO_3^-]_1 K_{a_1}[H_3O^+]}{[H_3O^+]^2 + K_{a_1}[H_3O^+] + K_{a_2}K_{a_1}} + \frac{2K_{a_2}[HCO_3^-]_1 K_{a_1}}{[H_3O^+]^2 + K_{a_1}[H_3O^+] + K_{a_2}K_{a_1}}$$

$$[Na^+] + [H_3O^+] = \frac{K_w}{[H_3O^+]} + [HA]_1 + \frac{[HCO_3^-]_1 K_{a_1}[H_3O^+] + 2K_{a_2}[HCO_3^-]_1 K_{a_1}}{[H_3O^+]^2 + K_{a_1}[H_3O^+] + K_{a_2}K_{a_1}}$$

$$[Na^+][H_3O^+] + [H_3O^+]^2 = K_w + [H_3O^+][HA]_1 + \frac{[HCO_3^-]_1 K_{a_1}[H_3O^+]^2 + 2K_{a_2}[HCO_3^-]_1 K_{a_1}[H_3O^+]}{[H_3O^+]^2 + K_{a_1}[H_3O^+] + K_{a_2}K_{a_1}}$$

$$\begin{aligned}[Na^+][H_3O^+]^3 + [H_3O^+]^4 + [Na^+][H_3O^+]^2 K_{a_1} + K_{a_1}[H_3O^+]^3 + [Na^+][H_3O^+]K_{a_2}K_{a_1} + [H_3O^+]^2 K_{a_2}K_{a_1} \\ = K_w[H_3O^+]^2 + K_w K_{a_1}[H_3O^+] + K_w K_{a_2}K_{a_1} + [H_3O^+]^3[HA]_1 + [H_3O^+]^2[HA]_1 K_{a_1} + [H_3O^+][HA]_1 K_{a_2}K_{a_1} \\ + [HCO_3^-]_1 K_{a_1}[H_3O^+]^2 + 2K_{a_2}[HCO_3^-]_1 K_{a_1}[H_3O^+]\end{aligned}$$

$$[Na^+][H_3O^+]^3 + [H_3O^+]^4 + [Na^+][H_3O^+]^2K_{a_1} + K_{a_1}[H_3O^+]^3 + [Na^+][H_3O^+]K_{a_2}K_{a_1} + [H_3O^+]^2K_{a_2}K_{a_1} - K_w[H_3O^+]^2 - K_wK_{a_1}[H_3O^+] - K_wK_{a_2}K_{a_1} - [H_3O^+]^3[HA]_1 - [H_3O^+]^2[HA]_1K_{a_1} - [H_3O^+][HA]_1K_{a_2}K_{a_1} - [HCO_3^-]_1K_{a_1}[H_3O^+]^2 - 2K_{a_2}[HCO_3^-]_1K_{a_1}[H_3O^+] = 0$$

$$[H_3O^+]^4 + [H_3O^+]^3\left([NaHCO_3] + K_{a_1} - [HA]_1\right) + [H_3O^+]^2\left(K_{a_1}[NaHCO_3] + K_{a_2}K_{a_1} - K_w - K_{a_1}[HA]_1 - [NaHCO_3]K_{a_1}\right) + [H_3O^+]\left([NaHCO_3]K_{a_2}K_{a_1} - K_wK_{a_1} - [HA]_1K_{a_2}K_{a_1} - 2K_{a_2}K_{a_1}[NaHCO_3]\right) - K_wK_{a_2}K_{a_1} = 0$$

$$[H_3O^+]^4 + [H_3O^+]^3\left(K_{a_1} + [NaHCO_3] - [HA]_1\right) + [H_3O^+]^2\left(K_{a_1}\left([NaHCO_3] + K_{a_2} - [HA]_1 - [NaHCO_3]\right) - K_w\right) + [H_3O^+]\left(K_{a_1}\left([NaHCO_3]K_{a_2} - 2K_{a_2}[NaHCO_3] - [HA]_1K_{a_2} - K_w\right)\right) - K_wK_{a_2}K_{a_1} = 0$$

$$[H_3O^+]^4 + [H_3O^+]^3\left(K_{a_1} + [NaHCO_3] - [HA]_1\right) + [H_3O^+]^2\left(K_{a_1}\left(K_{a_2} - [HA]_1\right) - K_w\right) + [H_3O^+]\left(K_{a_1}\left(-K_{a_2}[NaHCO_3] - [HA]_1K_{a_2} - K_w\right)\right) - K_wK_{a_2}K_{a_1} = 0$$

$$[H_3O^+]^4 + [H_3O^+]^3\left(K_{a_1} + [NaHCO_3] - [HA]_1\right) + [H_3O^+]^2\left(K_{a_1}\left(K_{a_2} - [HA]_1\right) - K_w\right) - [H_3O^+]\left(K_{a_1}\left(K_{a_2}[NaHCO_3] + K_{a_2}[HA]_1 + K_w\right)\right) - K_wK_{a_2}K_{a_1} = 0$$