Amfolyt + stark bas

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

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

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

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

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

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

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

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

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

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

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

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

$$BOH \xrightarrow{H_2O} B^+ + OH^-$$

$$[BOH] = [B^+]$$

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

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

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

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

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

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

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

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

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

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

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