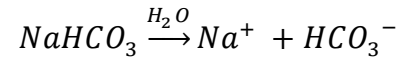
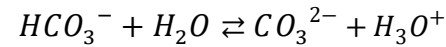
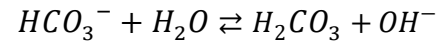


Amfolyt + stark syra



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



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

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

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

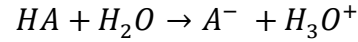
$$K_w = K_a K_b \Leftrightarrow K_{b_1} = \frac{K_w}{K_{a_1}}$$

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

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

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

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



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

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

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

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

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

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

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

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

$$\begin{aligned}
& [Na^+][H_3O^+]^3 + [H_3O^+]^4 + [Na^+][H_3O^+]^2 K_{a_1} + K_{a_1} [H_3O^+]^3 + [Na^+][H_3O^+] K_{a_2} K_{a_1} + [H_3O^+]^2 K_{a_2} K_{a_1} - K_w [H_3O^+]^2 - K_w K_{a_1} [H_3O^+] \\
& - K_w K_{a_2} K_{a_1} - [H_3O^+]^3 [HA]_1 - [H_3O^+]^2 [HA]_1 K_{a_1} - [H_3O^+] [HA]_1 K_{a_2} K_{a_1} - [HCO_3^-]_1 K_{a_1} [H_3O^+]^2 \\
& - 2K_{a_2} [HCO_3^-]_1 K_{a_1} [H_3O^+] = 0
\end{aligned}$$

$$\begin{aligned}
& [H_3O^+]^4 + [H_3O^+]^3 ([NaHCO_3] + K_{a_1} - [HA]_1) + [H_3O^+]^2 (K_{a_1} [NaHCO_3] + K_{a_2} K_{a_1} - K_w - K_{a_1} [HA]_1 - [NaHCO_3] K_{a_1}) \\
& + [H_3O^+] ([NaHCO_3] K_{a_2} K_{a_1} - K_w K_{a_1} - [HA]_1 K_{a_2} K_{a_1} - 2K_{a_2} K_{a_1} [NaHCO_3]) - K_w K_{a_2} K_{a_1} = 0
\end{aligned}$$

$$\begin{aligned}
& [H_3O^+]^4 + [H_3O^+]^3 (K_{a_1} + [NaHCO_3] - [HA]_1) + [H_3O^+]^2 (K_{a_1} ([NaHCO_3] + K_{a_2} - [HA]_1 - [NaHCO_3]) - K_w) \\
& + [H_3O^+] (K_{a_1} ([NaHCO_3] K_{a_2} - 2K_{a_2} [NaHCO_3] - [HA]_1 K_{a_2} - K_w)) - K_w K_{a_2} K_{a_1} = 0
\end{aligned}$$

$$\begin{aligned}
& [H_3O^+]^4 + [H_3O^+]^3 (K_{a_1} + [NaHCO_3] - [HA]_1) + [H_3O^+]^2 (K_{a_1} (K_{a_2} - [HA]_1) - K_w) + [H_3O^+] (K_{a_1} (-K_{a_2} [NaHCO_3] - [HA]_1 K_{a_2} - K_w)) \\
& - K_w K_{a_2} K_{a_1} = 0
\end{aligned}$$

$$\begin{aligned}
& [H_3O^+]^4 + [H_3O^+]^3 (K_{a_1} + [NaHCO_3] - [HA]_1) + [H_3O^+]^2 (K_{a_1} (K_{a_2} - [HA]_1) - K_w) - [H_3O^+] (K_{a_1} (K_{a_2} [NaHCO_3] + K_{a_2} [HA]_1 + K_w)) \\
& - K_w K_{a_2} K_{a_1} = 0
\end{aligned}$$