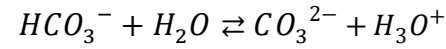
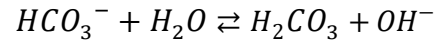
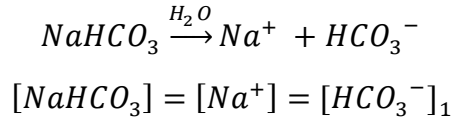


Amfolyt + svag enprotonig bas



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

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

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

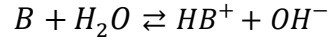
$$K_w = K_a K_b \Leftrightarrow K_{b_1} = \frac{K_w}{K_{a_1}}$$

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

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

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

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



$$K_b = \frac{[HB^+][OH^-]}{[B]_2} \Leftrightarrow [HB^+] = \frac{K_b[B]_2}{[OH^-]} = \frac{K_b[B]_2}{\frac{K_w}{[H_3O^+]}} = \frac{K_b[H_3O^+][B]_2}{K_w}$$

$$[B]_1 = [B]_2 + [HB^+] = [B]_2 + \frac{K_b[H_3O^+][B]_2}{K_w} = [B]_2 \left(1 + \frac{K_b[H_3O^+]}{K_w}\right) = [B]_2 \left(\frac{K_w + K_b[H_3O^+]}{K_w}\right) \Leftrightarrow$$

$$[B]_2 = \frac{[B]_1}{\left(\frac{K_w + K_b[H_3O^+]}{K_w}\right)} = \frac{[B]_1 K_w}{K_w + K_b[H_3O^+]}$$

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

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

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

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

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

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

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

$$\begin{aligned} & K_w [Na^+] [H_3O^+]^3 + K_w [H_3O^+]^4 + K_b [Na^+] [H_3O^+]^4 + K_b [H_3O^+]^5 + K_b [H_3O^+]^4 [B]_1 + K_w K_{a_1} [Na^+] [H_3O^+]^2 + K_w K_{a_1} [H_3O^+]^3 \\ &+ K_b K_{a_1} [Na^+] [H_3O^+]^3 + K_b K_{a_1} [H_3O^+]^4 + K_b K_{a_1} [H_3O^+]^3 [B]_1 + K_w K_{a_2} K_{a_1} [Na^+] [H_3O^+] + K_w K_{a_2} K_{a_1} [H_3O^+]^2 \\ &+ K_b K_{a_2} K_{a_1} [Na^+] [H_3O^+]^2 + K_b K_{a_2} K_{a_1} [H_3O^+]^3 + K_b K_{a_2} K_{a_1} [H_3O^+]^2 [B]_1 \\ &= K_w^2 [H_3O^+]^2 + K_w^2 K_{a_1} [H_3O^+] + K_w^2 K_{a_2} K_{a_1} + K_w K_b [H_3O^+]^3 + K_w K_b K_{a_1} [H_3O^+]^2 + K_w K_b K_{a_2} K_{a_1} [H_3O^+] \\ &+ K_w K_{a_1} [HCO_3^-]_1 [H_3O^+]^2 + 2K_w K_{a_2} K_{a_1} [HCO_3^-]_1 [H_3O^+] + K_b K_{a_1} [HCO_3^-]_1 [H_3O^+]^3 + 2K_b K_{a_2} K_{a_1} [HCO_3^-]_1 [H_3O^+]^2 \end{aligned}$$

$$\begin{aligned} & K_w [Na^+] [H_3O^+]^3 + K_w [H_3O^+]^4 + K_b [Na^+] [H_3O^+]^4 + K_b [H_3O^+]^5 + K_b [H_3O^+]^4 [B]_1 + K_w K_{a_1} [Na^+] [H_3O^+]^2 + K_w K_{a_1} [H_3O^+]^3 \\ &+ K_b K_{a_1} [Na^+] [H_3O^+]^3 + K_b K_{a_1} [H_3O^+]^4 + K_b K_{a_1} [H_3O^+]^3 [B]_1 + K_w K_{a_2} K_{a_1} [Na^+] [H_3O^+] + K_w K_{a_2} K_{a_1} [H_3O^+]^2 \\ &+ K_b K_{a_2} K_{a_1} [Na^+] [H_3O^+]^2 + K_b K_{a_2} K_{a_1} [H_3O^+]^3 + K_b K_{a_2} K_{a_1} [H_3O^+]^2 [B]_1 - K_w^2 [H_3O^+]^2 - K_w^2 K_{a_1} [H_3O^+] - K_w^2 K_{a_2} K_{a_1} \\ &- K_w K_b [H_3O^+]^3 - K_w K_b K_{a_1} [H_3O^+]^2 - K_w K_b K_{a_2} K_{a_1} [H_3O^+] - K_w K_{a_1} [HCO_3^-]_1 [H_3O^+]^2 - 2K_w K_{a_2} K_{a_1} [HCO_3^-]_1 [H_3O^+] \\ &- K_b K_{a_1} [HCO_3^-]_1 [H_3O^+]^3 - 2K_b K_{a_2} K_{a_1} [HCO_3^-]_1 [H_3O^+]^2 = 0 \end{aligned}$$

$$\begin{aligned}
& K_b[H_3O^+]^5 + [H_3O^+]^4(K_w + K_b[NaHCO_3] + K_bK_{a_1} + K_b[B]_1) \\
& + [H_3O^+]^3(K_w[NaHCO_3] + K_wK_{a_1} + K_bK_{a_1}[NaHCO_3] + K_bK_{a_1}[B]_1 + K_bK_{a_2}K_{a_1} - K_wK_b - K_bK_{a_1}[NaHCO_3]) \\
& + [H_3O^+]^2(K_wK_{a_1}[NaHCO_3] + K_wK_{a_2}K_{a_1} + K_bK_{a_2}K_{a_1}[NaHCO_3] + K_bK_{a_2}K_{a_1}[B]_1 - K_w^2 - K_wK_bK_{a_1} - K_wK_{a_1}[NaHCO_3] \\
& - 2K_bK_{a_2}K_{a_1}[NaHCO_3]) + [H_3O^+](K_wK_{a_2}K_{a_1}[NaHCO_3] - K_w^2K_{a_1} - K_wK_bK_{a_2}K_{a_1} - 2K_wK_{a_2}K_{a_1}[NaHCO_3]) - K_w^2K_{a_2}K_{a_1} \\
& = 0
\end{aligned}$$

$$\begin{aligned}
& K_b[H_3O^+]^5 + [H_3O^+]^4(K_b([NaHCO_3] + K_{a_1} + [B]_1) + K_w) \\
& + [H_3O^+]^3(K_b(K_{a_1}[NaHCO_3] + K_{a_1}[B]_1 + K_{a_2}K_{a_1} - K_w - K_{a_1}[NaHCO_3]) + K_w[NaHCO_3] + K_wK_{a_1}) \\
& + [H_3O^+]^2(K_w(K_{a_1}[NaHCO_3] + K_{a_2}K_{a_1} - K_w - K_bK_{a_1} - K_{a_1}[NaHCO_3]) + K_bK_{a_2}K_{a_1}[B]_1 + K_bK_{a_2}K_{a_1}[NaHCO_3] \\
& - 2K_bK_{a_2}K_{a_1}[NaHCO_3]) + [H_3O^+](K_wK_{a_1}(K_{a_2}[NaHCO_3] - K_w - K_bK_{a_2} - 2K_{a_2}[NaHCO_3])) - K_w^2K_{a_2}K_{a_1} = 0
\end{aligned}$$

$$\begin{aligned}
& K_b[H_3O^+]^5 + [H_3O^+]^4(K_b([NaHCO_3] + K_{a_1} + [B]_1) + K_w) + [H_3O^+]^3(K_b(K_{a_1}[B]_1 + K_{a_2}K_{a_1} - K_w) + K_w[NaHCO_3] + K_wK_{a_1}) \\
& + [H_3O^+]^2(K_w(K_{a_2}K_{a_1} - K_w - K_bK_{a_1}) + K_bK_{a_2}K_{a_1}[B]_1 - K_bK_{a_2}K_{a_1}[NaHCO_3]) \\
& + [H_3O^+](K_wK_{a_1}(-K_w - K_bK_{a_2} - K_{a_2}[NaHCO_3])) - K_w^2K_{a_2}K_{a_1} = 0
\end{aligned}$$

$$\begin{aligned}
& K_b[H_3O^+]^5 + [H_3O^+]^4(K_b([NaHCO_3] + K_{a_1} + [B]_1) + K_w) + [H_3O^+]^3(K_b(K_{a_1}[B]_1 + K_{a_2}K_{a_1} - K_w) + K_w[NaHCO_3] + K_wK_{a_1}) \\
& + [H_3O^+]^2(K_w(K_{a_2}K_{a_1} - K_w - K_bK_{a_1}) + K_bK_{a_2}K_{a_1}[B]_1 - K_bK_{a_2}K_{a_1}[NaHCO_3]) \\
& - [H_3O^+](K_wK_{a_1}(K_w + K_bK_{a_2} + K_{a_2}[NaHCO_3])) - K_w^2K_{a_2}K_{a_1} = 0
\end{aligned}$$