Chapter 3

$[H^+]_{wa} = \sqrt{K_{a(HA)} + K_w}$

$[H^+]_{wa} = \sqrt{K_a c}$ $\quad [H^+]_{wa} = \frac{-K_a + \sqrt{K_a^2 + 4K_a c}}{2}$ $\quad [H^+]_{wa} = \sqrt{K_a c + K_w}$

$[H^+]_{ab} = \sqrt{\frac{K_{a_1}(K_{a_2} c + K_w)}{c + K_{a_1}}}$ $[H^+]_{ab} = \sqrt{\frac{K_{a_1}(K_{a_2} c + K_w)}{c}}$ $[H^+]_{ab} = \sqrt{\frac{K_{a_1} K_{a_2} c}{c + K_{a_1}}}$

$[H^+]_{ab} = \sqrt{K_{a_1} K_{a_2}}$ $[H^+]_{sa+wa} = \frac{(c_{sa} - K_{wa}) + \sqrt{(c_{sa} - K_{wa})^2 + 4K_{wa}(c_{sa} + c_{wa})}}{2}$

$[H^+]_{wa+wa} = \sqrt{K_{HA} c_{HA} + K_{HB} c_{HB}}$

$[H^+]_{buffer} = K_a \frac{c_a + [OH^-] - [H^+]}{c_b + [H^+] - [OH^-]} = K_a \frac{c_a - [H^+]}{c_b + [H^+]} = K_a \frac{c_a + [OH^-]}{c_b - [OH^-]} = K_a \frac{c_a}{c_b}$

$\beta = (2.303[H^+] + 2.3[OH^-]) + 2.3 \frac{cK_a[H^+]}{([H^+] + K_a)^2} = 2.3\delta_1 \delta_2 c$

Chapter 4

$K_{stable,n} = \frac{[ML_n]}{[ML_{n-1}][L]}$ $\quad \beta_n = K_1 K_2 \cdots K_n = \frac{[ML_n]}{[M][L]^n}$ $\quad [ML_n] = \beta_n [M][L]^n$

$c_M = [M](1 + \beta_1[L] + \beta_2[L]^2 + \cdots + \beta_n[L]^n)$ $\quad \delta_{ML_n} = \delta_M \beta_n [L]^n$

$\alpha_Y = \frac{[Y']}{[Y]} = \alpha_{Y(H)} + \alpha_{Y(N)} - 1 \approx \alpha_{Y(H)} + \alpha_{Y(N)}$

$\alpha_Y(approx.) = \alpha_{Y(H)} = \frac{[Y] + [HY] + [H_2Y] + \cdots + [H_6Y]}{[Y]} = \frac{1}{\delta_Y}$ $\quad \alpha_{Y(H)} = 1 + \sum_{i=1}^{n} \beta_i^H [H]^i$

$\alpha_{Y(N)} = \frac{[Y']}{[Y]} = 1 + K_{NY}[N]$ $\quad \alpha_{Y(N_1, N_2, \cdots N_n)} = \alpha_{Y(N_1)} + \alpha_{Y(N_2)} + \cdots \alpha_{Y(N_n)} - (n-1)$

$\alpha_{M(L)} = \frac{[M']}{[M]} = 1 + \sum_{i=1}^{n} \beta_i [L]^i$ $\quad \alpha_{M(OH)} = \frac{[M']}{[M]} = 1 + \sum_{i=1}^{n} \beta_i [OH]^i$

$\alpha_M = \alpha_{M(L)} + \alpha_{M(A)} - 1$ $\quad \alpha_M = \alpha_{M(L_1)} + \alpha_{M(L_2)} + \cdots \alpha_{M(L_n)} - (n-1)$

$\alpha_{MY(H)} = 1 + K_{MHY}^H [H]$ $\quad \alpha_{MY(OH)} = 1 + K_{M(OH)Y}^{OH} [OH]$

$K'_{MY} = K_{MY} \cdot \frac{\alpha_{MY}}{\alpha_M \alpha_Y}$ $\quad \alpha = \frac{A'}{[A]}$

$lgK'_{MY} = lgK_{MY} - lg\alpha_M - lg\alpha_Y + lg\alpha_{MY} \approx lgK_{MY} - lg\alpha_M - lg\alpha_Y \approx lgK_{MY'} = lgK_{MY} - lg\alpha_{Y(H)}$

(buffer)$pM = lgK_{ML} - lg\alpha_{L(H)} + lg\frac{[L']}{[ML]}$ $\quad [M] = \frac{1}{K_{ML'}} \frac{[ML]}{[L']} = \frac{\alpha_{L(H)}}{K_{ML}} \frac{[ML]}{[L']}$

(sp)$[M']_{sp} = \sqrt{\frac{c_{sp,M}}{K'_{MY}}}$ $\quad pM'_{sp} = \frac{1}{2}[lgK'_{MY} + p(c_{sp,M})]$

(indicator) $pM_t = lgK_{MIn'} = lgK_{MIn} - lg\alpha_{In(H)}$

(T error)$E_t = \frac{10^{\Delta pM'} - 10^{-\Delta pM'}}{\sqrt{K'_{MY} \cdot c_{sp,m}}} \times 100\% = \frac{10^{\Delta pM} - 10^{-\Delta pM}}{\sqrt{K'_{MY} \cdot c_{sp,m}}} \times 100\%$

$= (\frac{1}{[M']_{ep} \cdot K'_{MY}} - \frac{[M']_{ep}}{c_{sp,M}}) \times 100\%$

$lg(c_{sp,M} \cdot K'_{MY}) \geq 6$ $\quad lg\alpha_{Y(H)} \leq lgK_{MY} - 8$ $\quad [OH^-] < \sqrt[n]{\frac{K_{sp}}{c_{M^{n+}}}}$

$pH < 14 - \frac{1}{n}(pK_{sp} + lgc_{M^{n+}})$

$lg(K'c) = \Delta lgK + lg\frac{c_M}{c_N} \geq 6$ or $\Delta lg(K'c) = lg(K'_1 c_1) - lg(K'_2 c_2) \geq 6$

$lgK'_{MY} = lgK_{MY} - lg\alpha_{Y(N)} = lgK_{MY} - lgK_{NY} - lg\frac{c_N}{\alpha_{N(A)}} = \Delta lgK + p(c_N) + lg\alpha_{N(A)}$