العلاقة 1 حمض ضعيف في الماء : $\tau_f = \frac{10^{-pH}}{C}$.

$$x_f = n(H_3O^+)_f = [H_3O^+]_f \times V$$

$$x_{max} = CV$$

$$\tau_f = \frac{x_f}{x_{max}} = \frac{[H_3O^+]_f \times V}{CV} = \frac{[H_3O^+]_f}{C} = \frac{10^{-pH}}{C}$$

العلاقة 2:حمض ضعيف في الماء: $\tau_f = \frac{Ka}{Ka+10^{-pH}}$

$$\tau_f = \frac{10^{-pH}}{C} \Rightarrow \tau_f.C = 10^{-pH}$$

$$Ka = \frac{[A^-]_f[H_3O^+]_f}{[AH]_f}$$

$$[A^-]_f = [H_3O^+]_f = 10^{-pH}$$

$$[AH]_f = \frac{CV-x_f}{V} = C - [H_3O^+]_f = C - 10^{-pH}$$

$$Ka = \frac{10^{-pH} \times 10^{-pH}}{C - 10^{-pH}} = \frac{10^{-pH} \times \tau_f.C}{C - \tau_f.C} = \frac{10^{-pH} \times \tau_f}{1 - \tau_f}$$

$$Ka\left(1 - \tau_f\right) = 10^{-pH} \times \tau_f$$

$$Ka - Ka.\tau_f = 10^{-pH} \times \tau_f$$

$$Ka = 10^{-pH} \times \tau_f + Ka.\tau_f$$

$$Ka = (10^{-pH} + Ka)\tau_f \Rightarrow \tau_f = \frac{Ka}{Ka + 10^{-pH}}$$

العلاقة 3:حمض ضعيف في الماء $\tau_f = \frac{1}{1+10^{pKa-pH}}$

لدينا: $Ka = 10^{-pKa}$, $\tau_f = \frac{Ka}{Ka+10^{-pH}}$

$$\tau_f = \frac{Ka}{Ka\left(1+\frac{10^{-pH}}{Ka}\right)} = \frac{1}{\left(1+\frac{10^{-pH}}{10^{-pKa}}\right)} = \frac{1}{1+10^{pKa-pH}}$$

العلاقة 4: محلول مائي أساسي لأساس ضعيف:

$$\tau_f = \frac{10^{pH-14}}{C}$$

$$x_f = n(OH^-)_f = [OH^-]_f \times V = \frac{10^{-14}}{[H_3O^+]_f}V$$

$$= \frac{10^{-14}}{10^{-pH}}V = 10^{pH-14}.V$$

$$x_{max} = CV$$

$$\tau_f = \frac{x_f}{x_{max}} = \frac{[OH^-]_f \times V}{CV} = \frac{[OH^-]_f}{C} = \frac{10^{pH-14}}{C}$$

العلاقة 5:أساس ضعيف في الماء $\tau_f = \frac{1}{1+Ka \times 10^{pH}}$

$$\tau_f = \frac{10^{pH-14}}{C} \Rightarrow \tau_f.C = 10^{pH-14}$$

$$Ka = \frac{[A^-]_f[H_3O^+]_f}{[AH]_f}$$

$$[AH]_f = [OH^-]_f = 10^{pH-14}$$

$$[A^-]_f = \frac{CV-x_f}{V} = C - [OH^-]_f = C - 10^{pH-14}$$

$$Ka = \frac{(C-10^{pH-14}) \times 10^{-pH}}{10^{pH-14}} = \frac{(C-\tau_f.C) \times 10^{-pH}}{\tau_f.C}$$

$$Ka = \frac{C(1-\tau_f) \times 10^{-pH}}{\tau_f.C} = \frac{(1-\tau_f) \times 10^{-pH}}{\tau_f}$$

$$Ka\left(\tau_f\right) = (1 - \tau_f) \times 10^{-pH}$$

$$Ka.\tau_f = 10^{-pH} - \tau_f \times 10^{-pH}$$
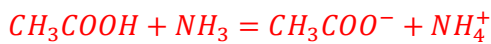
$$Ka.\tau_f + \tau_f \times 10^{-pH} = 10^{-pH}$$

$$(Ka + 10^{-pH})\tau_f = 10^{-pH}$$

$$\Rightarrow \tau_f = \frac{10^{-pH}}{(Ka + 10^{-pH})} = \frac{10^{-pH}}{10^{-pH}\left(\frac{Ka}{10^{-pH}} + 1\right)}$$

$$= \frac{1}{1 + Ka \times 10^{pH}}$$

العلاقة 6:أساس ضعيف في الماء $\tau_f = \frac{1}{1+10^{pH-pKa}}$

$$\tau_f = \frac{1}{1 + Ka \times 10^{pH}} = \frac{1}{1 + 10^{-pKA} \times 10^{pH}}$$

$$= \frac{1}{1 + 10^{pH-pKa}}$$

العلاقة 6:نمزج n_0 **من** CH_3COOH **مع** n_0 **من** NH_3 :

$$CH_3COOH + NH_3 = CH_3COO^- + NH_4^+$$

بين أن : $\tau_f = \frac{\sqrt{K}}{\sqrt{K}+1}$.

$$K = \frac{[CH_3COO^-]_f [NH_4^+]_f}{[CH_3COOH]_f [NH_3]_f}$$

$$K = \frac{\left(\frac{x_f}{V_s}\right)^2}{\left(\frac{n_0 - x_f}{V_s}\right)^2} = \left(\frac{x_f}{n_0 - x_f}\right)^2 = \left(\frac{x_f}{x_{max} - x_f}\right)^2$$

لدينا: $\tau_f = \frac{x_f}{x_{max}}$ وعليه $x_f = \tau_f \times x_{max}$

$$K = \left(\frac{\tau_f \times x_{max}}{x_{max} - \tau_f \times x_{max}}\right)^2 = \left(\frac{\tau_f}{1 - \tau_f}\right)^2$$

$$K = \left(\frac{\tau_f}{1 - \tau_f}\right)^2 \Rightarrow \sqrt{K} = \frac{\tau_f}{1 - \tau_f}$$

$$\sqrt{K} - \sqrt{K} \times \tau_f = \tau_f \Rightarrow \sqrt{K} = \tau_f\left(1 + \sqrt{K}\right)$$

$$\Rightarrow \tau_f = \frac{\sqrt{K}}{1 + \sqrt{K}}$$

العلاقة 7: حمض ضعيف في الماء: $Q_{rf} = \frac{x_{max}.(\tau_f)^2}{V(1-\tau_f)}$.

$$AH + H_2O = A^- + H_3O^+$$
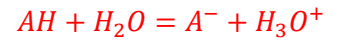
$$Q_{rf} = \frac{[A^-]_f[H_3O^+]_f}{[AH]_f}$$

$$Q_{rf} = \frac{\left(\frac{x_f}{V}\right)^2}{\left(\frac{CV - x_f}{V}\right)} = \frac{\frac{(x_f)^2}{V}}{CV - x_f} = \frac{(x_f)^2}{V(x_{max} - x_f)}$$

لدينا: $\tau_f = \frac{x_f}{x_{max}}$ وعليه $x_f = \tau_f \times x_{max}$

$$Q_{rf} = \frac{\left(\tau_f \times x_{max}\right)^2}{V(x_{max} - \tau_f \times x_{max})} = \frac{x_{max} \times (\tau_f)^2}{V(1 - \tau_f)}$$