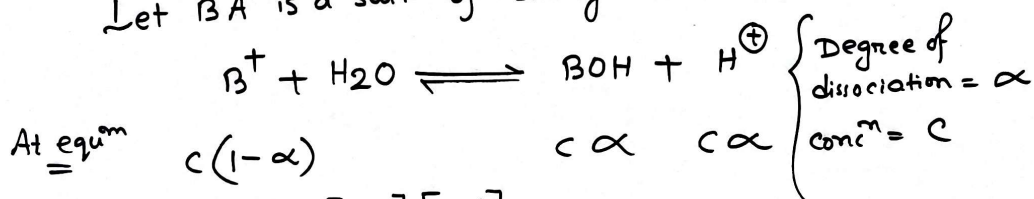


pH of salt

pH of a salt composed of strong acid & weak base :-

Let BA is a salt of strong acid HA & weak base BOH



$$\therefore \text{Equm const (K)} = \frac{[\text{BOH}][\text{H}^+]}{[\text{B}^+][\text{H}_2\text{O}]}$$

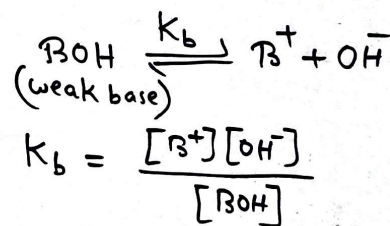
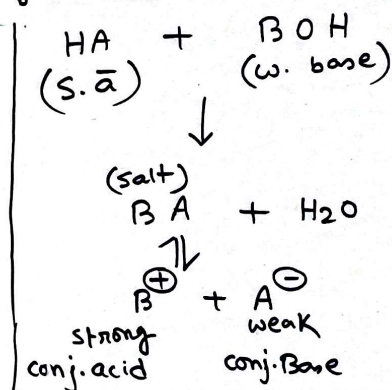
$$\Rightarrow K \cdot [\text{H}_2\text{O}] = K_h = \frac{[\text{BOH}][\text{H}^+]}{[\text{B}^+]} \quad \text{--- (i)}$$

$$\Rightarrow K_h = \frac{c\alpha \cdot c\alpha}{c(1-\alpha)} = \frac{c\alpha^2}{(1-\alpha)} \quad \left\{ \text{For weak electrolyte } \alpha \ll 1 \quad \therefore (1-\alpha) \approx 1 \right\}$$

$$\Rightarrow K_h = c\alpha^2 \Rightarrow \alpha = \sqrt{\frac{K_h}{c}} \quad \text{--- (ii)}$$

$$\text{From equm (i)} \quad K_h = \frac{[\text{BOH}][\text{H}^+]}{[\text{B}^+]} = \frac{[\text{BOH}][\text{H}^+][\text{OH}^-]}{[\text{B}^+][\text{OH}^-]}$$

$$\Rightarrow K_h = \frac{K_w}{K_b} \quad \text{--- (iii)}$$



$$[\text{H}^+][\text{OH}^-] = K_w$$

$$pH = -\log [H^+]$$

$$\Rightarrow pH = -\log (C\alpha)$$

$$\Rightarrow pH = -\log \left\{ C \sqrt{\frac{K_h}{C}} \right\} = -\log \left\{ \sqrt{\frac{C^2 K_h}{C}} \right\} = -\log \sqrt{K_h \cdot C}$$

$$\Rightarrow pH = -\log \left(\frac{K_w}{K_b} \cdot C \right)^{1/2}$$

$$\Rightarrow pH = -\frac{1}{2} \log \left(\frac{K_w \cdot C}{K_b} \right)$$

$$\Rightarrow pH = \left(-\frac{1}{2} \log K_w \right) + \left(-\frac{1}{2} \log C \right) - \left(-\frac{1}{2} \log K_b \right)$$

$$\Rightarrow pH = \left(-\frac{1}{2} \log 10^{-14} \right) - \frac{1}{2} \log C - \frac{1}{2} pK_b$$

$$\Rightarrow pH = 7 \log 10 - \frac{1}{2} \log C - \frac{1}{2} pK_b$$

$$\Rightarrow \boxed{pH = 7 - \frac{1}{2} pK_b - \frac{1}{2} \log C}$$

$$\left. \begin{array}{l} \because K_w = 10^{-14} \\ \text{gm-ion/lit} \\ -\log K_b = pK_b \end{array} \right\}$$

Eqn of pH of weak acid & strong base

$$\boxed{pH = 7 + \frac{1}{2} pK_a + \frac{1}{2} \log C}$$

Eqn of pH of weak acid & weak base

$$\boxed{pH = 7 + \frac{1}{2} pK_a - \frac{1}{2} pK_b}$$

Q Calculate the pH of 2.5×10^{-2} (M) Sodium acetate solⁿ.
(pK_a of $CH_3COOH = 4.74$ at $25^\circ C$)

Ans. Sodium acetate $\Rightarrow CH_3COONa$ is composed of CH_3COOH & $NaOH$
(weak acid) (strong base)

We know $pH = 7 + \frac{1}{2} pK_a + \frac{1}{2} \log C$

$$\Rightarrow pH = 7 + \left(\frac{1}{2} \times 4.74\right) + \frac{1}{2} \log (2.5 \times 10^{-2})$$

$$\Rightarrow \underline{pH = 8.57}$$

Strong \bar{a} + weak base

$$\Rightarrow \boxed{pH = 7 - \frac{1}{2} pK_b - \frac{1}{2} \log C}$$

Equⁿ of pH of weak acid & strong base

$$\boxed{pH = 7 + \frac{1}{2} pK_a + \frac{1}{2} \log C} \checkmark$$

Equⁿ of pH of weak acid & weak base

$$\boxed{pH = 7 + \frac{1}{2} pK_a - \frac{1}{2} pK_b}$$

$$\left\{ \begin{array}{l} pK_a = -\log K_a \\ pK_b = -\log K_b \end{array} \right\}$$