Nishant Jindal

① $NaHCO_3$

$$HCO_3^- \longrightarrow H^+ + CO_3^{2-} \qquad K_{a_2} = \frac{[H^+][CO_3^{2-}]}{[HCO_3^-]}$$

K_{b_2}

$$HCO_3^- + H_2O \longrightarrow OH^- + H_2CO_3 \qquad \frac{K_w}{K_{a_1}} = \frac{[OH^-][H_2CO_3]}{[HCO_3^-]}$$

(K_{a_1})

$$\frac{K_{a_2}K_{a_1}}{K_w} = \frac{[H^+]}{[OH^-]} = \frac{[H^+]^2}{K_w}$$

$$[H^+] = \sqrt{K_{a_2}K_{a_1}}$$

$$pH = \frac{1}{2}(pK_{a_2} + pK_{a_1})$$

S-I 24 – 38

$ZnCl_2$ acidic salt

(29) $C_5H_5NH^+ + H_2O \rightarrow C_5H_5N + H_3O^+$ (K_b)

$0.25-x$ x x

$$\frac{K_w}{K_b} = \frac{x^2}{0.25-x}$$

$pH = 2.699$
$= 2.7$

$[H^+] = 2 \times 10^{-3}$
$= x$

(33) 5×10^{-3} M K_2CrO_4

$$CrO_4^{2-} + H_2O \longrightarrow HCrO_4^- + OH^-$$

$C(1-h)$ $\quad$ Ch $\quad$ Ch

$$\frac{K_w}{K_2} = \frac{Ch^2}{1-h}$$

$H_2CrO_4 \longrightarrow H^+ + HCrO_4^-$

A^{2-}

A^-

(34) $PuO_2^{2+} + H_2O \longrightarrow PuO_2(OH)^+ + H^+$ $\quad x = 10^{-4}$

$$\frac{K_w}{K_{b_2}} = \frac{x^2}{0.01 - x}$$

$$\frac{K_{b_2}[PuO_2(OH)^+]}{PuO_2(OH)_2}$$

B^+

B^{2+}

(35) $Zn^{2+} + H_2O \longrightarrow Zn(OH)^+ + H^+$

$B^{2+} + H_2O \longrightarrow B(OH)^+ + H^+$

NaH_2PO_4 (Na_2HPO_4)

$H_2PO_4^- \longrightarrow H^+ + HPO_4^{2-}$ $\quad Ka_2$

~~$HPO_4^{2-} \longrightarrow H^+ + PO_4^{3-}$~~

$H_2PO_4^- + H_2O \longrightarrow OH^- + H_3PO_4$ $\quad \frac{Kw}{Ka_1}$

$HPO_4^{2-} \longrightarrow H^+ + PO_4^{3-}$ $\quad Ka_3$

$HPO_4^{2-} + H_2O \longrightarrow OH^- + H_2PO_4^-$ $\quad \frac{Kw}{Ka_2}$

$$pH = \frac{1}{2}(pKa_2 + pKa_1)$$

$NaHCO_3$
$NaHS$
$NaHC_2O_4$

$$pH = \frac{1}{2}(pKa_3 + pKa_2)$$

$Ka_3 \quad \overline{Ka_2 \quad Ka_1}$

Nishant Jindal

find the expression of pH for

① Na_2H_2A $\quad \frac{1}{2}(pKa_3 + pKa_2)$

② Na_3HA $\quad \frac{1}{2}(pKa_4 + pKa_3)$

③ NaH_3A $\quad \frac{1}{2}(pKa_2 + pKa_1)$

④ Na_4A

$$A^{4-} + H_2O \longrightarrow HA^{3-} + OH^-$$

$C - x \qquad x \qquad x$

$$\frac{K_w}{K_{a_4}} = \frac{x^2}{C-x}$$

H_4A

$K_{a_1} \quad K_{a_2} \quad K_{a_3} \quad K_{a_4}$

Nishant Jindal

- Salt formed by
  - SA + SB (NaCl)
  - SA + WB (NH_4Cl)
  - WA + SB (CH_3COONa)
  - WA + WB
  - Multivalent cation/anion
  - Amphiprotic salt

$H_2A^{2-} \longrightarrow H^+ + HA^{3-}$ K_{a_3}

H_4A

$H_3A^- + H_2O \longrightarrow H_4A + OH^-$ K_{b_4} K_{a_1} $\frac{K_w}{K_{a_1}} = K_{b_4}$

$H_3A^- \longrightarrow H^+ + H_2A^{2-}$ K_{a_2}

$HA^{3-} + H_2O \longrightarrow H_2A^{2-} + OH^-$ K_{b_2} K_{a_3} $\frac{K_w}{K_{a_3}}$

$H_2A^{2-} \longrightarrow H^+ + HA^{3-}$ K_{a_3}

H_4A

$H_3A^- + H_2O \longrightarrow H_4A + OH^-$ K_{b_4} K_{a_1} $\frac{K_w}{K_{a_1}} = K_{b_4}$

$H_3A^- \longrightarrow H^+ + H_2A^{2-}$ K_{a_2}

$HA^{3-} + H_2O \longrightarrow H_2A^{2-} + OH^-$ K_{b_2} K_{a_3} $\frac{K_w}{K_{a_3}}$

Buffer solution:→ A solution whose pH is not altered to any great extent by addⁿ of either small amount of H^+ or OH^- is called Buffer solⁿ

1. Contents of Buffer solution
2. Buffer mechanism
3. pH of Buffer solⁿ
4. Change in pH of Buffer solⁿ
5. Buffer capacity

Nishant Jindal

(1) (a) WA/WB + conjugate Base/acid

Mixed Buffer

$CH_3COOH + CH_3COO^-$

$NH_4OH + NH_4^+$

(b) salt formed by WA + WB

CH_3COONH_4

$CH_3COO^- + H^+ \rightarrow CH_3COOH$

$NH_4^+ + OH^- \rightarrow NH_4OH$

Simple Buffer

$pH = \frac{1}{2}(pK_w + pK_a - pK_b)$

(c) Amphiprotic soln

$NaHCO_3$

$\frac{1}{2}(pK_{a_2} + pK_{a_1})$

(11) **Buffer mechanism**

e.g $CH_3COOH + CH_3COO^-$

add^n of H^+

$CH_3COO^- + H^+ \longrightarrow CH_3COOH \quad K = 10^5$

add^n of OH^-

$CH_3COOH + OH^- \longrightarrow CH_3COO^- + H_2O \quad K = 10^9$

$\Rightarrow$ ~~X~~ $HCl + Cl^-$

add^n of OH^-

$HCl + OH^- \longrightarrow Cl^- + H_2O$

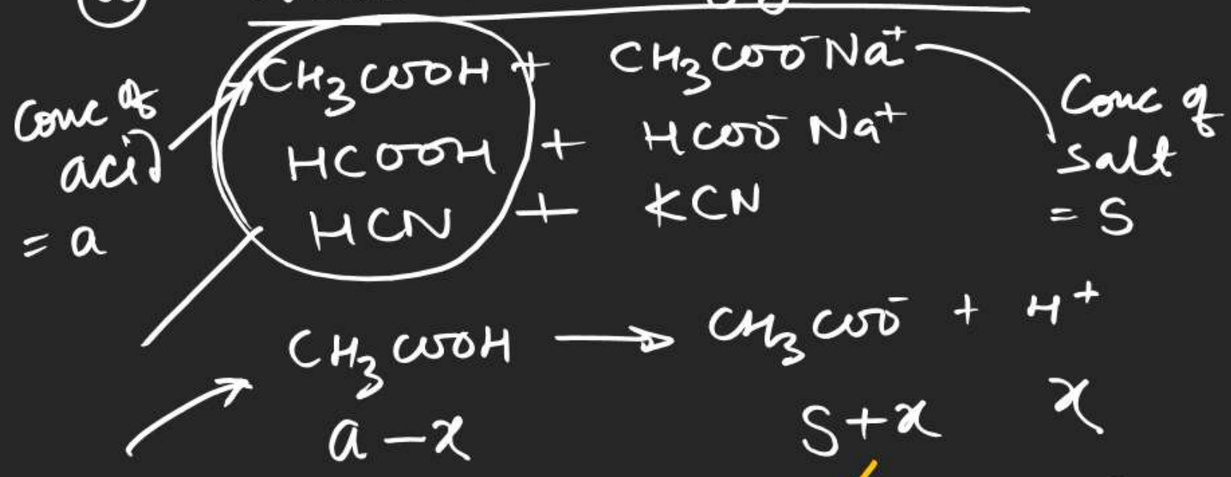
add^n of H^+

$H^+ + Cl^- \not\longrightarrow HCl$

Nishant Jindal

③ pH Calculation

ⓐ Weak acid + conjugate Base



$$CH_3COOH \longrightarrow CH_3COO^- + H^+$$

$a-x$	$S+x$	x

$$K_a = \frac{(S+x)(x)}{a-x} = \frac{S}{a} \times [H^+]$$

$$-\log K_a = -\log\frac{S}{a} - \log[H^+]$$

$$\boxed{pH = pK_a + \log\frac{[Salt]}{[Acid]}}$$

Henderson eqn

$$CH_3COO^- + H_2O \longrightarrow CH_3COOH + OH^-$$

(5) WB + conjugate acid

$NH_4OH + NH_4^+Cl^-$

$C_5H_5N + C_5H_5NH^+Cl^-$

$C_6H_5NH_2 + C_6H_5NH_3^+Cl^-$

$$pOH = pK_b + \log \frac{[Salt]}{[Base]}$$

$$NH_4OH \longrightarrow NH_4^+ + OH^-$$

$$b - x \qquad S + x \qquad x$$

$$K_b = \frac{(S+x)(x)}{b-x}$$