Q. find pH of :

① 0.1M CH_3COONa (Given K_a of $CH_3COOH = 10^{-5}$) $K_b = \frac{10^{-14}}{10^{-5}} = 10^{-9}$

② 0.01M KCN (Given K_a of $HCN = 10^{-10}$ M)

③ 0.1M NH_4Cl [Given K_a of $NH_4^+ = 10^{-9}$ M)

① $CH_3COO^- + H_2O \rightarrow CH_3COOH + OH^-$ $\quad K_b = 10^{-9}$

$C-x \qquad\qquad x \qquad\quad x$

$10^{-9} = \frac{x^2}{C-x} = \frac{x^2}{0.1-x} \qquad x = 10^{-5} \qquad pOH = 5$

$pH = 9$

② $CN^- + H_2O \rightarrow HCN + OH^-$

$10^{-2}-x \qquad\quad x \qquad\quad x$

$\frac{K_w}{K_a} = K_b = 10^{-4} = \frac{x^2}{10^{-2}-x}$

$x^2 + 10^{-4}x - 10^{-6} = 0$

$x = \frac{-10^{-4} + \sqrt{10^{-8} + 4\times10^{-6}}}{2}$

$= \frac{-10^{-4} + 20\times10^{-4}}{2}$

$x = 9.5\times10^{-4}$

③ $NH_4^+ + H_2O \rightarrow NH_3 + H_3O^+$

$K_a = 10^{-9} = \frac{x^2}{0.1-x}$

$x = 10^{-5} = [H^+]$

$\therefore pH = 5$

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

for a solution WA/WB + conjugate base/acid

e.g $CH_3COOH + CH_3COO^-$

∴ Buffer soln $HCN + CN^-$

$NH_4OH + NH_4^+$

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Q. $[CH_3COOH] = a$

salt → $[CH_3COONa] = S$

Acidic Buffer

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

a	S	
$a - x$	$S + x$	x

$$K_a = \frac{(S+x)(x)}{(a-x)}$$

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

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

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

Henderson eqn

e.g $[NH_4OH] = b$ $[NH_4Cl] = S$

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

b	S	
b − x	s + x	x

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

$$[OH^-] = K_b \times \frac{b}{S}$$

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

Solubility & Solubility product

↓

maximum moles of a solute which can be dissolved in 1 lit solvent is called solubility.

OR

Molarity of a saturated solution is called solubility.

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$$BA(s) \longrightarrow \underbrace{BA(aq)}_{S(1-\alpha)} \longrightarrow \underset{S\alpha}{B^+(aq)} + \underset{S\alpha}{A^-(aq)}$$

for sparingly soluble salt $(S \ll 1) \Rightarrow \alpha = 1$

$$BA(s) \longrightarrow \underset{S}{B^+(aq)} + \underset{S}{A^-(aq)}$$

for a given solute K_{sp} depends only on temp.

$\longrightarrow K_{sp} = [B^+][A^-]$

$= S^2$

↑ Solubility product

$K_{sp} \ll 1$

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$Ag_2CrO_4(s) \longrightarrow 2Ag^+(aq) + CrO_4^{2-}(aq)$

$2S \qquad S$

$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$

$= (2s)^2(s)$

$= 4s^3$

$As_2S_3(s) \longrightarrow 2As^{3+} + 3S^{2-}$

$2S \qquad 3S$

$K_{sp} = (2s)^2(3s)^3$

$= 4 \times 27\, s^5 = 108\, s^5$

Q. find solubility of Ag_2CrO_4 if its K_{sp} is 3.2×10^{-11}

$32 \times 10^{-12} = 4s^3$

$8 \times 10^{-12} = s^3$

$2 \times 10^{-4} = s$

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Q. find Ksp of AgCl if its saturated solution contains 1.435 mg/lit AgCl.

Ag : 108
Cl : 35.5

$$S = \frac{1.435 \times 10^{-3}}{143.5} = 10^{-5}$$

$$AgCl(s) \longrightarrow Ag^{+} + Cl^{-}$$

$$S \quad S$$

$$K_{sp} = S^2 = 10^{-10}$$

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Q. find K_{sp} of PbI_2 if its saturated soln contains 8×10^{-5} M I^-.

$$PbI_2(s) \longrightarrow Pb^{2+} + 2I^-$$

$$S \qquad 2S$$

$$2S = 8 \times 10^{-5}$$

$$S = 4 \times 10^{-5}$$

$$K_{sp} = (S)(2S)^2$$

$$= 4S^3$$

$$= 4 \times (4 \times 10^{-5})^3$$

$$= 4^4 \times 10^{-15}$$

$$= 256 \times 10^{-15}$$

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