

Ch. 17.1 Common ion effect

- in essence, it's like applying Le Chatelier's principle

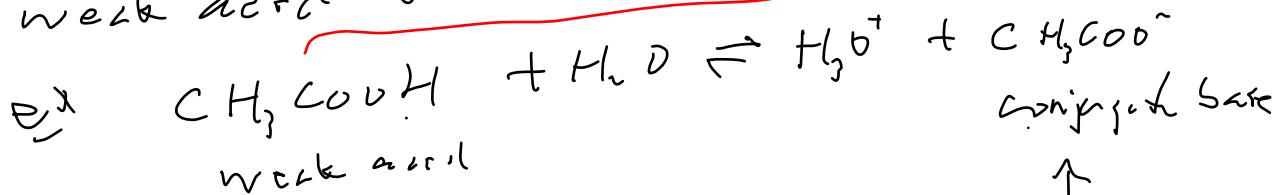


Ch 17.2 buffer

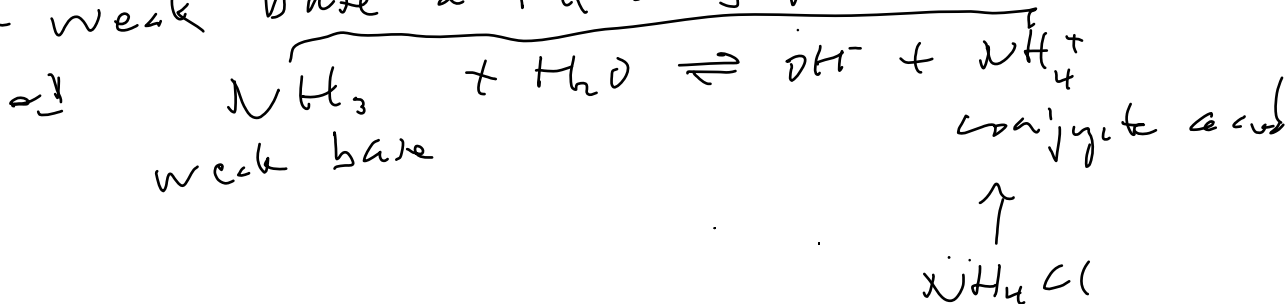
- solution that maintains its pH due to the addition of an acid or base

composition of a buffer

- weak acid & its conjugate base

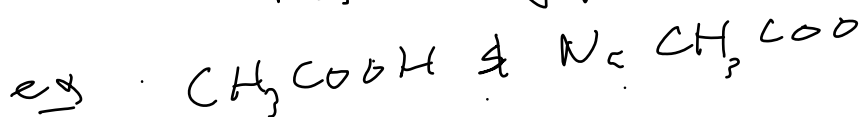


- weak base & its conjugate acid

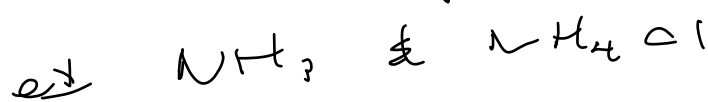


preparation of a buffer

method 1: mix weak acid & a salt containing its conjugate base



* with weak base & a salt of its conjugate acid

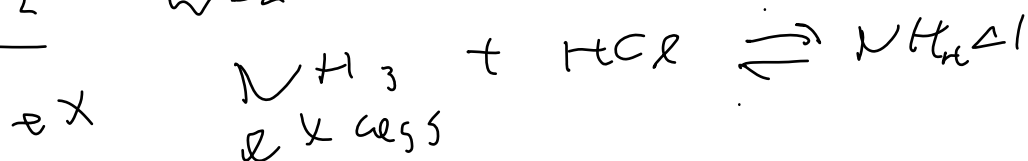


method 2 : titration

ex 1 weak acid + strong base



ex 2 weak base + strong acid



Mechanism of a buffer

recall: acid, H⁺ donor

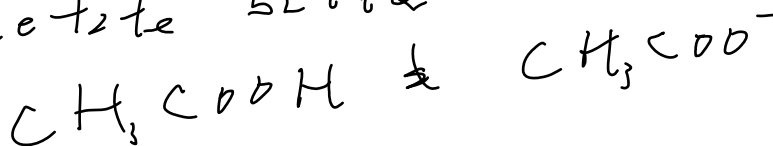
base: H⁺ acceptor

conjugate pair

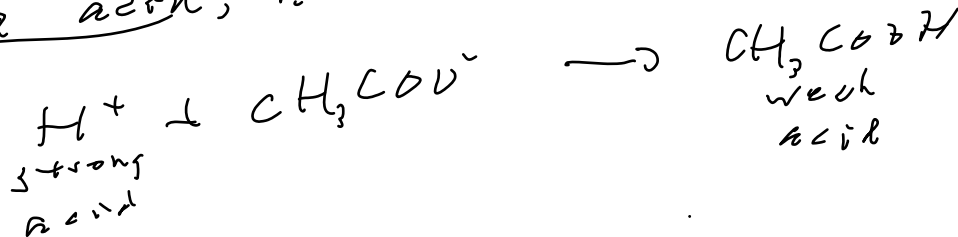
- 2 chemicals in equilibrium
- (differ by H⁺)

- one is an acid & the other is a base

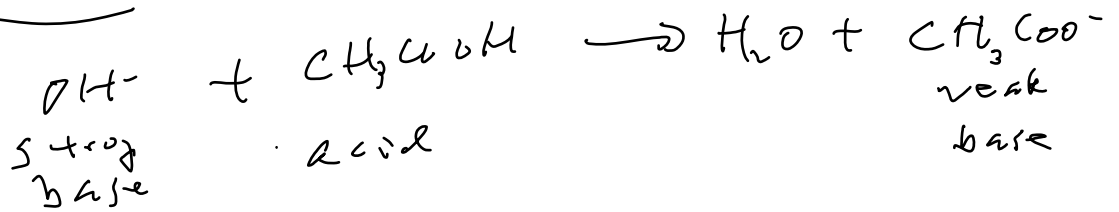
ex acetate buffer



add acid, re. H⁺



add base = OH^-



problems

① find the pH of a 10 mM CH_3COOH & 1 mM NaCH_3COO

method 1: use ICE table

i) $\text{CH}_3\text{COOH} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{CH}_3\text{COO}^-$

	10 mM	0	1 mM
[H]		+x	+x
[C]	-x	x	1 mM - x
[E]	10 mM - x		

ii) $K_a = \frac{[\text{H}_3\text{O}^+][\text{CH}_3\text{COO}^-]}{[\text{CH}_3\text{COOH}]}$

$$1.8 \cdot 10^{-5} = \frac{x(0.001 - x)}{0.01 - x}$$

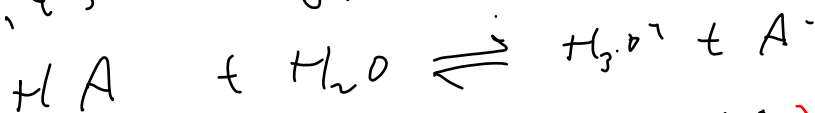
$x = -0.000117, 0.000154$

iii) $\text{pH} = -\log[\text{H}_3\text{O}^+] = -\log(0.000154)$

$$= -\log(1.54 \cdot 10^{-4}) = \underline{3.81}$$

method 2: use Henderson-Hasselbalch eq

it's an approximation



$$\log(K_a) = \log\left(\frac{[\text{H}_3\text{O}^+][\text{A}^-]}{[\text{HA}]}\right)$$

$$- \log K_a = - \log [H_3O^+] + \log \frac{[A^-]}{[HA]}$$

$$pK_a = pH - \log \frac{[A^-]}{[HA]} \quad \text{assume}$$

$$pH = pK_a + \log \frac{[A^-]}{[HA]} \quad \text{[salt]}$$

$$= -\log (1.8 \cdot 10^{-5}) + \log \frac{10^{-3}}{10^{-2}} \quad \text{[HA]}$$

$$= \boxed{3.24}$$

② find the pH a buffer with 10 mM NH_3 & 1 mM NH_4Cl

method 1: use ICE

i) $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

[H]	10 mM	/	1 mM	0
[C]	-x	/	+x	+x
[E]	10 mM - x	/	1 mM + x	x

$$ii) K_b = \frac{[OH^-][NH_4^+]}{[NH_3]}$$

$$1.8 \cdot 10^{-5} = \frac{x(0.001 + x)}{0.01 - x}$$

$$\downarrow$$

$$x = -0.000117, \quad 1.54 \cdot 10^{-4}$$

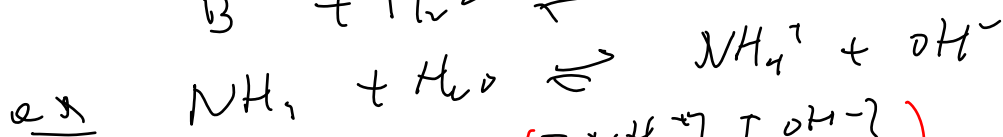
$$iii) pOH = -\log [OH^-] = -\log (1.54 \cdot 10^{-4})$$

$$= 3.81$$

$$iv) pH + pOH = 14$$

$$pH = 14 - pOH = 14 - 3.81 = \boxed{10.19}$$

method 2: use HH eqn



$$i) -\log(K_b) = \log\left(\frac{[NH_4^+][OH^-]}{[NH_3]}\right)$$

$$pOH = pK_b + \log\left(\frac{[NH_4^+]}{[NH_3]}\right)$$

$$= -\log(1.8 \cdot 10^{-5}) + \log\left(\frac{10^{-3}}{10^{-2}}\right)$$

$$= 3.74$$

$$ii) pH + pOH = 14$$

$$pH + 3.74 = 14$$

$$\boxed{pH = 10.26}$$

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How to prepare an acetate buffer @
pH = 5.0?

$$pH = pK_a + \log\left(\frac{[A^-]}{[HA]}\right)$$

$$5.0 = -\log(1.8 \cdot 10^{-5}) + \log\left(\frac{[A^-]}{[HA]}\right)$$

$$\frac{[A^-]}{[HA]} = 1.82$$

ex $[CH_3CO_2^-] = 1.82 \text{ mM}$ or
 $[CH_3COOH] = 1 \text{ mM}$

1.82 M

1 M

"better"
buffer