

With seawater, it contains acid H_2CO_3 , which dissociates



Notice that adding H^+ and OH^- , adding something acidic/basic, will shift to making HCO_3^- rather than add more H^+/OH^- . Therefore pH doesn't change very much

Buffers: a substance that helps a solution resist pH change

- contains almost/relatively high and equal concentrations of both the acid and its conjugate base

↳ adding a small amount of acid/base only slightly neutralizes one component of the buffer = pH doesn't change much



$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$

$$[\text{H}^+] = K_a \frac{[\text{HA}]}{[\text{A}^-]}$$

$$\text{pH} = -\log [\text{H}^+] = -\log K_a - \log \frac{[\text{HA}]}{[\text{A}^-]}$$

$$\underbrace{-\log [\text{H}^+]}_{\text{pH}} = \underbrace{-\log K_a}_{\text{pKa}} + \log \frac{[\text{A}^-]}{[\text{HA}]} \quad (\log \text{ laws})$$

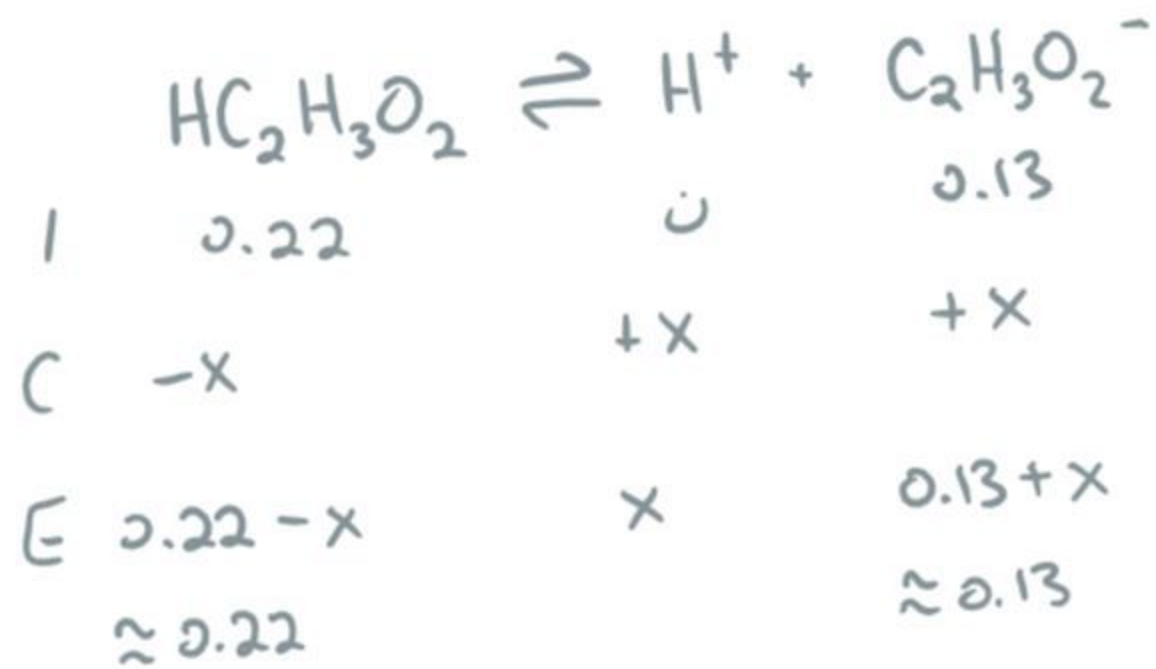
$$\text{pH} = \text{pKa} + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

Henderson-
= Hasselbalch
Equation

(for buffer solns @ equilibrium)

- This equation is ONLY for buffers

Calc. pH of soln containing 0.22 M acetic acid and 0.13 M sodium acetate (K_a acetic acid = 1.8×10^{-5})



↳ Since we take the "ignore x approx." when calculating x, we are saying the equilibrium is pretty much equal to its initial concentration because x is so small

HH Equation method:

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

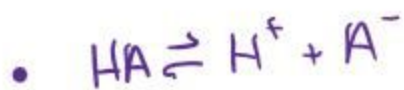
$$pH = (-\log(1.8 \times 10^{-5})) + \log \frac{(0.13)}{(0.22)}$$

$$pH = 4.74 + \log \frac{0.13}{0.22} = \boxed{4.51}$$

↳ if $[A^-] = [HA]$, then

$$pH = pK_a + \log \frac{[A^-]}{[HA]} = pK_a + \log(1) = pK_a$$

Under what conditions makes a buffer good?



- ideal pH of a buffer is when $pH = pK_a$

- ↳ when $[HA] = [A^-]$

- Buffer is effective buffer when ratio $\frac{[A^-]}{[HA]}$ is in the range of 0.1 to 10

- ↳ pH range ± 1 from pK_a

- Capacity of Buffer = how much acid can you add and still have an effective buffer?

- ↳ the greater the initial concentrations of HA and A^- , the stronger the acid/base can be added without changing the pH

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

1 M A^-	0.1 M A^-	0.01 M A^-
1 M HA	0.1 M HA	0.01 M HA

↳ largest capacity

↳ if H^+ is more than buffer, pH will change more drastically

- Buffer reacts with H^+ to avoid pH change

find # moles of sodium acetate that must be added
to 250.0 mL of 0.16 M acetic acid in order to prepare
a pH 4.70 buffer ($K_a = 1.76 \times 10^{-5}$)

$$\text{pH} = \text{p}K_a + \log \frac{[A^-]}{[HA]}$$

$$K_a = 1.76 \times 10^{-5}$$

$$\text{p}K_a = 4.75$$

$$4.70 = 4.75 + \log \frac{[A^-]}{0.16}$$

$$-0.05 = \log \frac{[A^-]}{0.16}$$

$$10^{-0.05} = \frac{[A^-]}{0.16}$$

$$(0.16)(10^{-0.05}) = [A^-] = 0.143 \text{ M}$$

$$(0.143 \text{ M})(0.250 \text{ L}) = 0.0358 \text{ mol sodium acetate } (\text{CH}_3\text{COO}^-)$$