Acid equilibrium

Strong acid

- dissociate fully
- [Acid] = $[H^+]$

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

Weak acid

- Partially dissociate

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

- K_a shows how much dissociate

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$$

Assumption

* $[CH_3COO^-] = [H^+]$
* $[CH_3COOH]_{initial} = [CH_3COOH]_{equilibrium}$

$[H^+] = \sqrt{K_a \times [CH_3COOH]}$

once you find $[H^+]$

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

Hint: If K_a value given then weak acid involved.

Buffer Solution

- mixture of weak acid & conjugate base
- made by mixing
  - → weak acid & it's salt
  - → weak acid in excess & NaOH

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

Large exces (under CH_3COOH) Large excess (under CH_3COO^-)

most of this comes from salt

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$$

Assumption:

- $[CH_3COO^-] = [CH_3COONa]$
- $[CH_3COOH]_{initial} = [CH_3COOH]_{equilibrium}$
- rearrange to find $[H^+]$

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

Hint: Weak acid + strong base ↳ buffer calculation

W.A + Salt ⟶ " "

Strong acid + strong base

* This is not buffer solution (Be careful !!!)

$HCl + NaOH \longrightarrow NaCl + H_2O$

- Find no. of moles of acid & base
- calculate which reageut in excess. (in no. of moles)
-
- Calculate concentration of excess of reageet in total volume of solution.
- If NaOH (alkali) in excess, find $[H^+]$ using $K_w = [H^+][OH^-]$
- Finally,

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

Hint & tips: → do not use moles as conc^n.

→ see how it differ from buffer Solution!!

pK_a value Larger

$pK_a = -\log K_a$

↓

K_a value will be smaller

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

↓

$[H^+]$ value will be smaller

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

↓

pH value will be larger

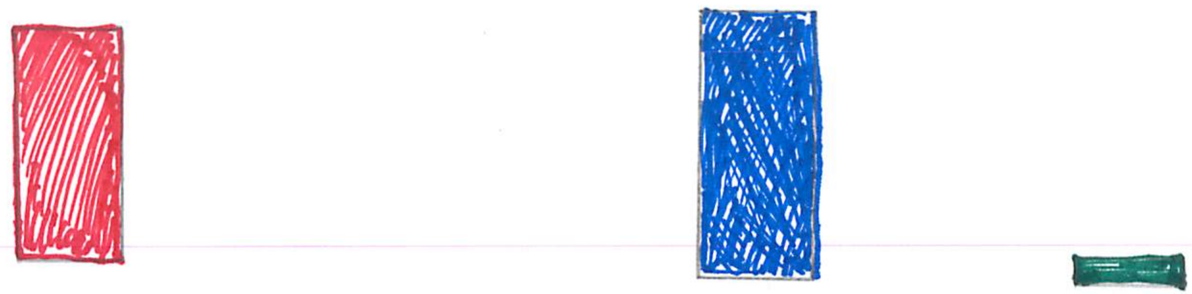
* whenever log involved values become inversely proportional.

Weak acid:

$$CH_3COOH_{(aq.)} \rightleftharpoons CH_3COO^-_{(aq.)} + H^+_{(aq.)}$$

Buffer Solution:

$$CH_3COOH_{(aq.)} \rightleftharpoons CH_3COO^-_{(aq.)} + H^+_{(aq.)}$$



- Weak acid & buffer solution equilibrium equation is the Same but the quantities of conjugate base different (much higher in buffer)
- The conjugate base in buffer is mainly from dissociation of weak acid salt.

What is buffer solution and how it works ?

- Buffer solution is a mixture of large excess of weak acid and its conjugate base. It resist the change in pH when small amount of acid or alkali added.

  For example, ethanoic acid buffer solution made by mixing ethanoic acid and sodium ethanoate equilibrium as below

$$CH_3COOH_{(aq)} \rightleftharpoons CH_3COO^- + H^+$$

  When small amount of H+ added to the buffer solution, the concentration of H^+ increases, the system counteract the change and to minimise the concentration of H^+ equilibrium shifts to the left.

- When small amount of OH^- added to the buffer solution, the concentration of H^+ decreases, the system counteract the change and to increase the concentration of H^+, the equilibrium shifts to the right.
- In both above cases, the $[CH_3COOH]$ and $[CH_3COO^-]$ remains unchanged as it is in large excess compared to $[H^+]$. This means $[H^+]$ remains almost unchanged and hence pH doesn’t change much.

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]}$$