Water

Water ⇝ It has many properties due to H-bond formed due to polarity of water
- → water properties include: Cohesion and the high ability to be a solvent
- → Water is reactive because it is nucleophile (electron rich) ⇝ so it can attract ⊕

Acids & Bases

Acid: Form H_3O^+ / Release, donate H^+

Base: Form OH^- / Accept H^+

Amphoteric ⇝ can act as acid or base
- → Examples: Water, any molecule having Free H and ⊖ charge at the same time

Strength: the ability to ionize
- → Strong acids and bases: Complete ionization, 1 way Reaction
- → Weak acids and bases: Partial ionization, Reverse Reaction

Strong acids	Strond bases
HCl, HBr, HI HNO_3, $HClO_4$ H_2SO_4	LiOH, NaOH, KOH $Ca(OH)_2$, $Ba(OH)_2$ $Sr(OH)_2$

↑Ka

As the acid is stronger, its Conjugate base is weaker

$$\underset{\text{acid}}{HA} \rightleftharpoons H^+ + \underset{\text{Conjugate base}}{A^-}$$

Ionization of water $H_2O \rightleftharpoons H^+ + OH^-$
- → In the pure water $[H^+] = [OH^-] = 10^{-7}$
- → H^+ and OH^- are inversely related

PH increased from 3 to 4 what is the change on ions concentration?

Step ① $pH\uparrow = \downarrow H^+ = \uparrow OH^-$

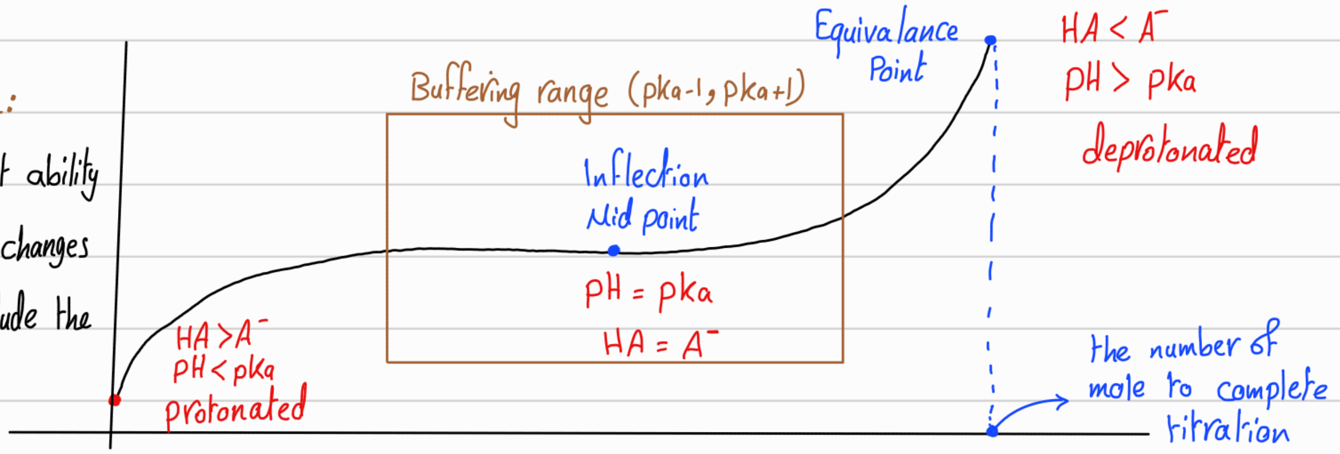
Step ② $10^{\Delta pH}$

pH ⇝ It is a logarithmic scale of $[H^+]$ ⇝ 10 Folds difference
- → pH inversely related to $[H^+]$
- → acids ⇝ pH < 7, Neutral ⇝ pH = 7, Base ⇝ pH > 7

PH measurments ⇝ Acid base indicators ⇝ litmus papar, universal indicator
- → Electronic pH meter

Buffers ⇝ Resist pH changes, Consist of a mixture of a weak acid and its C.base

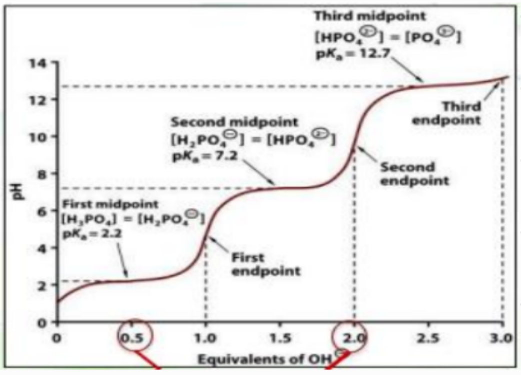
Buffering range:
- → the highest ability to resist changes
- → It must include the desired pH



☆ ↑ Concentration of the buffer ↗ ↑ capacity
↘ Doesn't affect the Buffering range

Multi-protic buffers: such as phosphate buffer

- → They donate their protons gradually
- → Each donation occurs at differant pka (strength)
  The first donation is the strongest (least pka)
- → They manage a wide range of pH values



Biological buffers:

1) DiHydrogen phosphate - Mono Hydrogen phosphate buffer ⇝ Intracellular
2) ATP, Glucose 6-Phosphate, bisphosphoglycerate ⇝ Intracellular (mainly RBCs)
3) Proteins (such as hemoglobin) ⇝ Intracellular and Extracellular
4) Carbonic acid - bicarbonate buffer ⇝ The major buffur of the blood
   ↳ Its pka ≈ 6.1, normal blood pH = 7.4 ⇝ It is effective because:

It has a high concentration, the body is an open system due to the physiological control

Calculations

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

$$pka = -\log Ka$$

Relation:

Stronger C.Base ⇝ Weaker acid

↓Ka = ↑pka

Ka and pka are constants for a given solution

$$\underset{ions}{Mass} = \frac{Eq \times M.W}{charge}$$

$$\underset{\substack{acids \\ bases}}{Eq} = \underline{N} \times M \times V = N \times moles$$

↳ number of H^+ or OH^-

we use it: 1) Eq

2) Nutralization, titration $Eq_1 = Eq_2$

↳ Require equal Eq of acid and base

→ ion product = 10^{-14}

$$\underline{Kw} = [H^+][OH^-]$$

used to calculate H^+ or OH^- when one of them is known

↳ Can be applied for any solution

Relation:

$\uparrow [H^+] \quad \downarrow [OH^-]$

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

- $[\text{strong acid}] = [H^+]$ ⇝ pH
- $[\text{strong base}] = [OH^-]$ ⇝ kw to calculate $[H^+]$ ⇝ pH
- $[\text{weak acid}]$ ⇝ $ka = \frac{x^2}{[HA]}$ to calculate $[H^+]$ ⇝ pH

Relation:
↑pH ↓H^+
↑OH^-

Note:
pH < 7 of base or pH > 7 of acid ⇝ the answer is pH = 7

$pH = pka + \log\frac{[A^-]}{[HA]}$ → used when all the values are known

If $A^- > HA$ ⇝ $\log\frac{A^-}{HA} = ⊕$

$HA > A^-$ ⇝ $\log\frac{A^-}{HA} = ⊖$

add

acid	base
$HA + X$	$HA - X$
$A^- - X$	$A^- + X$

Acidosis & Alkalosis

$$H_2O + CO_2 \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

Respiratory (CO_2) — Kidneys (HCO_3^-)

	Acidosis	Alkalosis
definition	↓ pH ↑ H^+ ↑ acid ↓ OH^- ↓ Base	↑ pH ↑ OH^- ↑ Base ↓ H^+ ↓ acid
Respiratory	↑ CO_2 Obstructive lung diseases asthma, emphysema, COAD, bronchopneumonia, Choking Metabolic Compensation loss of H^+ in urine Retention of HCO_3^-	↓ CO_2 Hyperventilation, Over-breathing Anxiety, Raised intracranial pressure Metabolic compensation Retention of H^+ loss of HCO_3^- in urine
Metabolic	X CO_2 ↑ Acids intake (aspirin) Ketone bodies (Starvation, Diabetes Mellitus), loss of bicarbonate Respiratory Compensation Hyperventilation, ↓ CO_2, ↓ H_2CO_3	X CO_2 ↑ base, salt intake Vomiting (loss of H^+) Respiratory Compensation Hypoventilation, ↑ CO_2, ↑ H_2CO_3

Compensation → Complete ⇝ Returning pH to 7.35 - 7.45 (normal)

→ Partial ⇝ Returning pH to a value near normal pH