Chemistry 3.6
Aqueous Systems

Buffer solutions

Common weak acid and base

Weak acid	**Weak base**
Most Organic acid	Most organic Amine
CH_3COOH	$CH_3CH_2NH_2$
Some inorganic acid	Some Inorganic base
HF	NH_3, CO_3, HCO_3^-
Conjugate acid	Conjugate base
NH_4^+	CH_3COO^-

Buffer solution

- **Buffer solution** is a **mixture** of **weak acid** and its **conjugate base**. (CH_3COOH and CH_3COO^-)
- **Or** vice versa, a mixture of **weak base** and its **conjugate acid**. (NH_3 and NH_4^+)
- Because both **acid and base** is present in the **mixture**, therefore its able to **maintain** a reasonable **constant pH** on addition of small amounts of H^+ or OH^-.

Example

- A buffer solution of ammonia (**NH_3**) and ammonium chloride (**NH_4Cl**)
  - NH_4^+ is the conjugate acid of NH_3
- When small amount of sodium hydroxide (**OH^-**) is added

$$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$$

- When small amount of HCl (**H^+**) is added

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

- In both scenarios, there are **no** overall **change** in **$[H^+]$** and **$[OH^-]$** so no pH changed.

How to make buffer solution

- There are two possible ways to prepare a buffer solution

1. Mix a **weak acid** (or weak base) with its **conjugate base** (or conjugate acid)

   Example: **NH_4Cl** mixed with **NH_3**

2. React some (usually 1/2) of the weak acid (or weak base) with a strong base (or strong acid) to create a mixture of weak acid and its conjugate base

   Example: **CH_3COOH** + NaOH → **$NaCH_3COO$** + H_2O

Calculations

- Many ways to approach a buffer calculation
- Simplest way is to use the K_a expression

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

- Another way is to use the formula

This formula is mathematically the same as above

(see whiteboard)

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