Warm-up

- “Determining relative strengths” table

18.3 BUFFER SOLUTIONS

What is a Buffer Solution?

- **Definition:** solution that resists a change in pH when a small amount of an acid or base is added to them.

Made of:

- weak acid and its conjugate base from a salt
  - Ex: CH_3COOH/CH_3COONa
- Weak base and its conjugate acid from a salt
  - Ex: NH_3/NH_4Cl

Acidic Buffer Solutions

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

- Get a significant amount of CH_3COO^- from the sodium ethanoate.
- Describe what happens:
  a) When a small amount of HCl is added
  b) When a small amount of NaOH is added

Basic Buffer Solution

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

- Get significant amount of NH_4^+ from ammonium chloride salt
- Describe what happens:
  a) When a small amount of HCl is added
  b) When a small amount of NaOH is added

Making Buffer Solutions

- Most useful when concentration of acid and base are equal
- And pH = pKa

- Can add acid/base and its salt or acid/base and small amount of strong base/strong acid

Example 1

- Solid sodium ethanoate is added to 0.20 mol dm^{-3} ethanoic acid until the concentration of the salt is 0.050 mol dm^{-3}. Given that the K_a for ethanoic acid is 1.74×10^{-5} mol dm^{-3}. Calculate the pH of the buffer solution formed.

Warm-up 5/1

- Will 30. cm^3 of 0.100 mol dm^{-3} CH_3COOH (K_a = 1.74 x 10^{-5} mol dm^{-3}) and 10. cm^3 of 0.100 mol dm^{-3} NaOH produce a buffer solution and if so what will be its pH?

18.1 Problems (HO) –Questions?

- This week:

- Tuesday – gone at 3
- Gone Friday
- Please have your Energy Quiz A and B revisions completed by next Thursday (P3 exam)

Practice Problems

Buffer solutions resist small changes in pH. A phosphate buffer can be made by dissolving NaH_2PO_4 and Na_2HPO_4 in water, in which NaH_2PO_4 produces the acidic ion and Na_2HPO_4 produces the conjugate base ion.

(i)Deduce the acid and conjugate base ions that make up the phosphate buffer and state the ionic equation that represents the phosphate buffer. **(3)**

(ii)Describe how the phosphate buffer minimizes the effect of the addition of a strong base, $OH^-(aq)$, to the buffer. Illustrate your answer with an ionic equation.**(2)**

(iii) Describe how the phosphate buffer minimizes the effect of the addition of a strong acid, $H^+(aq)$, to the buffer. Illustrate your answer with an ionic equation.**(2)**

IB Rubric

- (i) Acid: $H_2PO_4^-$;
  (Conjugate) base: HPO_4^{2-};
  No mark for NaH_2PO_4 *or* Na_2HPO_4*.*
- $H_2PO_4^-(aq) \rightleftharpoons H^+(aq) + HPO_4^{2-}(aq)$;
  Accept reverse equation or reaction with water.
  Ignore state symbols, but equilibrium sign is required.
  Accept OH^- *(ions) react with* H^+ *(ions) to form* H_2O*.* 3
- (ii) strong base/OH^- replaced by weak base ($H_2PO_4^{2-}$, and effect minimized) / strong base reacts with acid of buffer / equilibrium in (i) shifts in forward direction;
- $OH^-(aq) + H_2PO_4^-(aq) \rightarrow H_2O(l) + HPO_4^{2-}(aq)$;
  Ignore state symbols, accept equilibrium sign.
  Accept OH^- *added reacts with* H^+ *to form* H_2O*.* 2
- (iii) strong acid/H^+ replaced by weak acid ($H_2PO_4^-$, and effect minimized) / strong acid reacts with base of buffer / equilibrium in (i) shifts in reverse direction;
  $H^+(aq) + HPO_4^{2-}(aq) \rightarrow H_2PO_4^-(aq)$;
  Accept reaction with H_3O^+*.*
  Ignore state symbols. 2

Textbook Problems

- Pg 410-412

#1, 2, 9, 12, 13, 14, 15, 16, 17, **18, 19**