25.1 Acids and bases

Name: _____ Class: _____ Date: _____ **Total: 13 marks**

KEY WORDS buffer solution • conjugate acid • solubility product • conjugate base • conjugate acid–base pair

Objective

Build the skills to answer exam questions on **acids and bases** – **conjugate pairs**, **pH**, K_a, K_w, **buffers** and **solubility product** (K_{sp}).

You must be able to:

- identify conjugate acid–base pairs and use pH, K_a, pK_a, K_w
- calculate pH for strong acids, strong alkalis, weak acids and buffers
- define a buffer, explain its action, and use K_{sp}

1 Key knowledge and worked examples

Conjugate pairs and key relationships

conjugate pair: differ by one H^+

$$\underset{\text{acid}}{CH_3COOH} \rightleftharpoons \underset{\text{conjugate base}}{CH_3COO^-} + H^+$$

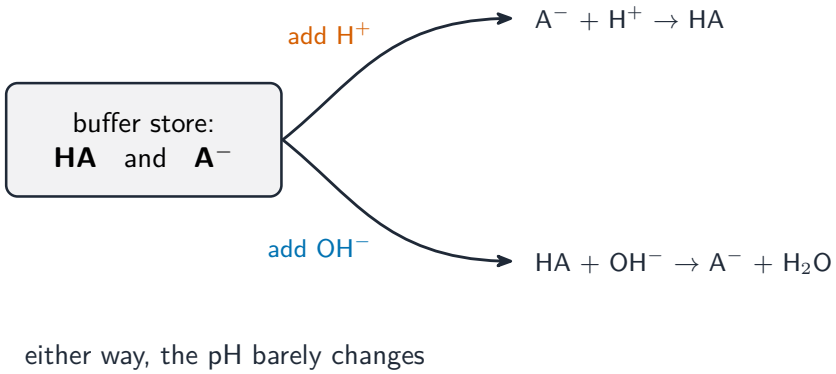
$$\underset{\text{base}}{NH_3} + H^+ \rightleftharpoons \underset{\text{conjugate acid}}{NH_4^+}$$

A conjugate pair differs by one H^+

$$pH = -\log[H^+];\ K_a = \frac{[H^+][A^-]}{[HA]};\ K_w = [H^+][OH^-] = 1.0 \times 10^{-14}.$$

- **strong acid:** $[H^+]$ = the acid concentration.
- **strong alkali:** $[H^+] = K_w/[OH^-]$.
- **weak acid:** $[H^+] = \sqrt{K_a \times [HA]}$.

■ **Buffers**



$$\textit{A buffer (a weak acid + its salt) resists pH change: } [H^+] = K_a \frac{[HA]}{[A^-]}$$

Added H^+ reacts with A^-; added OH^- reacts with HA. In blood, HCO_3^- buffers the pH. $K_{\mathbf{sp}}$ = the product of the ion concentrations of a saturated solution of a sparingly soluble salt.

2 Practice

2.1 Write the conjugate base of HNO_3. [1]

2.2 Calculate the pH of 0.010 mol dm^{-3} hydrochloric acid (a strong acid). [1]

3 Exam-style questions

3.1 A buffer solution can be made from: [1]

- ☐ **A** a strong acid and a strong base
- **B** a weak acid and its sodium salt
- **C** water only
- **D** two strong acids

3.2 The pH of 0.10 mol dm^{-3} NaOH (a strong base) is ($K_w = 1.0 \times 10^{-14}$): [1]

- ☐ **A** 1
- **B** 7
- **C** 13
- **D** 14

3.3 A weak acid HA has $K_a = 1.8 \times 10^{-5}$ mol dm^{-3}.

(a) Calculate the pH of a 0.10 mol dm^{-3} solution of HA. [3]

(b) Explain why this pH is higher than that of 0.10 mol dm^{-3} HCl. [2]

3.4 A buffer contains 0.20 mol dm^{-3} ethanoic acid and 0.20 mol dm^{-3} sodium ethanoate ($K_a = 1.8 \times 10^{-5}$).

(a) Calculate its pH. [2]

(b) Explain, with an equation, how the buffer resists a small addition of acid. [2]