AP CHEMISTRY • EXERCISE SHEET

8.8 Properties of Buffers

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS acid 酸 • buffer 缓冲溶液 • ph pH 值 • base 碱 • conjugate base 共轭碱

Objective

Build the skills to answer exam questions on the **properties of buffers**.

You must be able to:

- explain why a buffer works best when $[HA] \approx [A^-]$
- state that a buffer's pH is near its pK_a
- choose an acid for a target buffer pH

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

A buffer's pH is near its pKa

A buffer's pH is set by the acid's pK_a and the ratio of base to acid. When $[A^-] = [HA]$, the ratio is 1 and $pH = pK_a$.

Best buffering near pKa

A buffer resists change best when it has **plenty of both** members and they are **comparable** in amount — near a 1:1 ratio, i.e. near $pH = pK_a$.

Choosing the acid

To make a buffer at a target pH, pick a weak acid whose pK_a is **close to** that pH (within about ±1). For a pH-5 buffer, choose an acid with $pK_a \approx 5$ (like acetic acid, $pK_a = 4.7$).

Range

A buffer is effective roughly within $pK_a \pm 1$; outside that range one component is nearly used up.

2 Practice

Now apply the methods above.

2.1 When $[HA] = [A^-]$, the pH equals what? [1]

2.2 To make a buffer at pH 9, what pK_a should the acid have? [1]

2.3 Over what pH range is a buffer effective? [1]

3 Exam-style questions

3.1 A buffer works best when the acid and its conjugate base are [1]

- **A** in very different amounts
- **B** in comparable amounts
- **C** both absent
- **D** both strong

3.2 You need a buffer at pH 4.5. Available acids: formic ($pK_a = 3.7$), acetic ($pK_a = 4.7$), and hypochlorous ($pK_a = 7.5$).

(a) Which is the best choice? [1]

(b) Justify your choice. [2]

3.3 Explain why a buffer loses its effectiveness far from its pK_a. [2]

Solutions

2.1 pK_a.

2.2 About 9.

2.3 Roughly p$K_a \pm 1$.

3.1 B — comparable amounts.

3.2 (a) Acetic acid. (b) Its p$K_a = 4.7$ is closest to the target pH 4.5 (within ± 1), so the acid and base are in comparable amounts and buffer effectively.

3.3 Far from pK_a the ratio $[A^-]/[HA]$ is extreme, so one component is nearly depleted and cannot neutralize added acid or base — buffering fails.