

Exercise walk-through

8.4

Acid-Base Reactions and Buffers

AP Chemistry

Buffers and Henderson-Hasselbalch

A **buffer** holds pH steady with **both** a weak acid and its conjugate base:

- added acid $\Rightarrow$ conjugate base soaks up H^+
- added base $\Rightarrow$ weak acid soaks up OH^-

Henderson-Hasselbalch

$$\text{pH} = \text{p}K_a + \log \frac{[\text{A}^-]}{[\text{HA}]}$$

Equal amounts $\Rightarrow \text{pH} = \text{p}K_a$.
Capacity grows with total concentration.

Worked example – the Henderson-Hasselbalch equation

A buffer holds 0.20 M acetic acid ($pK_a = 4.74$) and 0.30 M acetate. Find its pH.

- $pH = pK_a + \log \frac{[A^-]}{[HA]}$
- $= 4.74 + \log \frac{0.30}{0.20} = 4.74 + 0.18$
- $= 4.92$

When the two concentrations are **equal** the log is zero and $pH = pK_a$ exactly. That is the point of maximum **buffer capacity**.

pH and Solubility

The solubility of a salt with a basic anion **rises** in acidic solution: the added H^+ reacts with the anion.

So pH can control whether an ionic solid dissolves.

Exercises 2.1-2.3

2.1 What two components make a buffer?

[1]

2.2 Which part of a buffer neutralizes added H^+ ?

[1]

2.3 Is $\text{HCl} + \text{NaCl}$ a buffer? Give a reason.

[2]

Exercises 2.1-2.3

2.1 What two components make a buffer? [1]

2.1

- A weak acid and its conjugate base (in comparable amounts)
-

2.2 Which part of a buffer neutralizes added H^+ ? [1]

2.2

- The conjugate base
-

2.3 Is $\text{HCl} + \text{NaCl}$ a buffer? Give a reason. [2]

2.3

- No – HCl is a strong acid with no weak-acid reservoir and Cl^- is not a base, so it cannot resist pH change both ways

Exercise 3.1

3.1 A buffer is made from a weak acid and its

[1]

☐

A conjugate base

B strong acid

C metal

D water only

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[1]

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A conjugate base

B strong acid

C metal

D water only

3.1 A

- its conjugate base

Exercise 3.2 (a)

3.2 A buffer contains CH_3COOH and CH_3COO^- .

(a) Write the reaction when a small amount of OH^- is added.

[2]

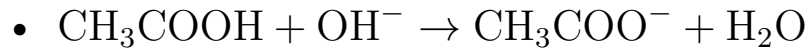
Exercise 3.2 (a)

3.2 A buffer contains CH_3COOH and CH_3COO^- .

(a) Write the reaction when a small amount of OH^- is added.

[2]

(a)



Exercise 3.2 (b)

3.2 A buffer contains CH_3COOH and CH_3COO^- .

(b) Explain why the pH changes only slightly.

[2]

Exercise 3.2 (b)

3.2 A buffer contains CH_3COOH and CH_3COO^- .

(b) Explain why the pH changes only slightly.

[2]

(b)

- The weak acid neutralizes the added base, so free OH^- is consumed and the pH stays nearly constant

Exercise 3.3

3.3 State which of these is a buffer and why: (i) $\text{NH}_3 + \text{NH}_4\text{Cl}$; (ii) $\text{NaOH} + \text{NaCl}$. [2]

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3.3

(i)

- is a buffer – NH_3 (weak base) with its conjugate acid NH_4^+

(ii)

- is not – NaOH is a strong base with no conjugate weak-acid partner