

# pH & Buffers

## A Level only

### Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Physical Chemistry & Transition Elements
Topic	pH & Buffers
Paper	A Level only
Booklet	Question Paper 1

**Time allowed:** 54 minutes

**Score:** /40

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

## Question 1

**HA** and **HB** are two strong monobasic acids.

25.0 cm<sup>3</sup> of 6.0 mol dm<sup>-3</sup> **HA** is mixed with 45.0 cm<sup>3</sup> of 3.0 mol dm<sup>-3</sup> **HB**.

What is the H<sup>+</sup>(aq) concentration, in mol dm<sup>-3</sup>, in the resulting solution?

**A** 1.9

**B** 2.1

**C** 4.1

**D** 4.5

**[1]**

## Question 2

A solution of propanoic acid,  $\text{CH}_3\text{CH}_2\text{COOH}$ , has a pH of 2.89 at  $25\text{ }^\circ\text{C}$ .

What is  $[\text{H}^+]$  in this solution?

**A**  $1.7 \times 10^{-6} \text{ mol dm}^{-3}$

**B**  $4.6 \times 10^{-4} \text{ mol dm}^{-3}$

**C**  $1.3 \times 10^{-3} \text{ mol dm}^{-3}$

**D**  $0.46 \text{ mol dm}^{-3}$

[1]

### Question 3

A student is supplied with  $0.500 \text{ mol dm}^{-3}$  potassium hydroxide, KOH, and  $0.480 \text{ mol dm}^{-3}$  propanoic acid,  $\text{C}_2\text{H}_5\text{COOH}$ .

The acid dissociation constant,  $K_a$ , for  $\text{C}_2\text{H}_5\text{COOH}$  is  $1.35 \times 10^{-5} \text{ mol dm}^{-3}$ .

(a)  $\text{C}_2\text{H}_5\text{COOH}$  is a weak Brønsted–Lowry acid.

What is meant by a *weak acid* and *Brønsted–Lowry acid*? [1]

(b) Calculate the pH of  $0.500 \text{ mol dm}^{-3}$  potassium hydroxide. [2]

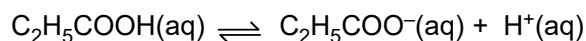
(c) The student dilutes  $25.0 \text{ cm}^3$   $0.480 \text{ mol dm}^{-3}$   $\text{C}_2\text{H}_5\text{COOH}$  by adding water until the total volume is  $100.0 \text{ cm}^3$ .

(i) Write the expression for  $K_a$  for  $\text{C}_2\text{H}_5\text{COOH}$ . [1]

(ii) Calculate the pH of the diluted solution. [3]

- (d) Aqueous propanoic acid,  $C_2H_5COOH$ , reacts with carbonates and alkalis.
- (i) Write the full equation for the reaction of aqueous propanoic acid with sodium carbonate. [1]
- (ii) Write the **ionic** equation for the reaction of aqueous propanoic acid with aqueous potassium hydroxide. [1]
- (e) A student prepares a buffer solution containing propanoic acid  $C_2H_5COOH$  and propanoate ions,  $C_2H_5COO^-$ . The concentrations of  $C_2H_5COOH$  and  $C_2H_5COO^-$  are both  $1.00 \text{ mol dm}^{-3}$ .

The following equilibrium is set up.



The acid dissociation constant,  $K_a$ , for  $C_2H_5COOH$  is  $1.35 \times 10^{-5} \text{ mol dm}^{-3}$ .

- (i) Calculate the pH of this buffer solution. [1]
- Give your answer to **two** decimal places.
- (ii) A small amount of aqueous ammonia,  $NH_3(aq)$ , is added to the buffer solution.
- Explain, in terms of equilibrium, how the buffer solution would respond to the added  $NH_3(aq)$ . [2]

(iii) The student adds 6.075 g Mg to 1.00 dm<sup>3</sup> of this buffersolution.

Calculate the pH of the new buffer solution.

Give your answer to **two** decimal places

[4]

[Total: 16 Marks]

## Question 4

This question looks at pH values and reactions of acids, bases and buffers.

- (a)  $0.14 \text{ mol dm}^{-3}$  solutions of hydrochloric acid,  $\text{HCl}$ , and chloric(I) acid,  $\text{HClO}$  ( $\text{p}K_{\text{a}} = 7.43$ ), have different pH values.

Explain why the pH values are different and calculate the pH of  $0.14 \text{ mol dm}^{-3}$  solutions of  $\text{HCl}$  and  $\text{HClO}$  to **two decimal places**.

Show any working in calculations.

[5]

- (b) Aluminium powder is added to aqueous ethanoic acid,  $\text{CH}_3\text{COOH}$ .

Write full and ionic equations for the reaction that takes place.

[2]

(c) Calculate the pH of a  $0.40 \text{ mol dm}^{-3}$  solution of NaOH.

[2]

(d) In biochemistry, buffer solutions based on methanoic acid can be used in the analysis of urine samples.

(i) Explain what is meant by the term *buffer solution*.

Describe how a buffer solution based on methanoic acid can act as a buffer.



*In your answer you should explain how the equilibrium system allows the buffer solution to control the pH.*

[7]



(ii) A chemist prepares a buffer solution by mixing together the following:

200 cm<sup>3</sup> of 3.20 mol dm<sup>-3</sup> HCOOH ( $K_a = 1.70 \times 10^{-4}$  mol dm<sup>-3</sup>) and  
800 cm<sup>3</sup> of 0.500 mol dm<sup>-3</sup> NaOH.

The volume of the buffer solution is 1.00 dm<sup>3</sup>.

- Explain why a buffer solution is formed when these two solutions are mixed together.
- Calculate the pH of this buffer solution.

Give your answer to **two** decimal places.

[6]

[Total 22 Marks]