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%

HA and **HB** are two strong monobasic acids.
25.0 cm^3 of 6.0 mol dm^{-3} **HA** is mixed with 45.0 cm^3 of 3.0 mol dm^{-3} **HB**.

What is the $H^+(aq)$ concentration, in mol dm^{-3}, in the resulting solution?

A 1.9

B 2.1

C 4.1

D 4.5 **[1]**

A solution of propanoic acid, CH_3CH_2COOH, has a pH of 2.89 at 25 °C.

What is $[H^+]$ in this solution?

A 1.7×10^{-6} mol dm^{-3}

B 4.6×10^{-4} mol dm^{-3}

C 1.3×10^{-3} mol dm^{-3}

D 0.46 mol dm^{-3}

[1]

A student is supplied with 0.500 mol dm^{-3} potassium hydroxide, KOH, and 0.480 mol dm^{-3} propanoic acid, C_2H_5COOH.

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

(a) C_2H_5COOH 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 mol dm^{-3} potassium hydroxide. [2]

(c) The student dilutes 25.0 cm^3 0.480 mol dm^{-3} C_2H_5COOH by adding water until the total volume is 100.0 cm^3.

(i) Write the expression for K_a for C_2H_5COOH. [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 mol dm^{-3}.

The following equilibrium is set up.

$$C_2H_5COOH(aq) \rightleftharpoons C_2H_5COO^-(aq) + H^+(aq)$$

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

(i) Calculate the pH of this buffer solution.

Give your answer to **two** decimal places. [1]

(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^3 of this buffer solution.

Calculate the pH of the new buffer solution.

Give your answer to **two** decimal places [4]

[Total: 16 Marks]

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

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

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

Show any working in calculations. [5]

(b) Aluminium powder is added to aqueous ethanoic acid, CH_3COOH.

[2]

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

(c) Calculate the pH of a 0.40 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^3 of 3.20 mol dm^{-3} HCOOH (K_a = 1.70 × 10^{-4} mol dm^{-3}) and
800 cm^3 of 0.500 mol dm^{-3} NaOH.

The volume of the buffer solution is 1.00 dm^3.

- 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]