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CHEMISTRY

PHYSICAL CHEMISTRY II

Level & Board	AQA (A-LEVEL)
TOPIC:	ACIDS AND BASES
PAPER TYPE:	QUESTION PAPER - 2
TOTAL QUESTIONS	10
TOTAL MARKS	50

Acids and Bases - 2

1. Propanoic acid (C_2H_5COOH) is a weak acid.

The acid dissociation constant (Ka) for propanoic acid is 1.35×10^{-5} mol dm^{-3} at 25 ^oC

(a) State the meaning of the term weak acid.

(1)

(b) Give an expression for the acid dissociation constant for propanoic acid.

(1)

(c) A student dilutes 25.0 cm^3 of 0.500 mol dm^{-3} propanoic acid by adding water until the total volume is 100.0 cm^3

Calculate the pH of this diluted solution of propanoic acid.
Give your answer to 2 decimal places.

(4)

(d) A buffer solution with a pH of 4.50 is made by dissolving x g of sodium propanoate (C_2H_5COONa) in a solution of propanoic acid.

The final volume of buffer solution is 500 cm^3 and the final concentration of the propanoic acid is 0.250 mol dm^{-3}
Calculate x in g For propanoic acid, Ka = 1.35×10^{-5} mol dm^{-3}

(6)

2. The table shows the pKa values for two acids.

Name of acid	pKa
Propanoic acid	4.87
Butanoic acid	4.82

Which statement is correct?

A. Propanoic acid is a stronger acid than butanoic acid.
B. The value of Ka for propanoic acid is greater than that for butanoic acid.
C. The value of Ka for propanoic acid is 1.35×10^{-5} mol dm^{-3}
D. The value of Ka for butanoic acid is 6.61×10^{4} mol $dm.^{-3}$

(1)

3. A mixture of methanoic acid and sodium methanoate in aqueous solution acts as an acidic buffer solution.

The equation shows the dissociation of methanoic acid.

$HCOOH(aq) \rightleftharpoons HCOO^{-}(aq) + H^{+}(aq)$

Calculate the mass, in g, of sodium methanoate (HCOONa) that must be added to 25.0 cm^3 of 0.100 mol dm^{-3} methanoic acid to produce a buffer solution with
pH = 4.05 at 298 K
For methanoic acid, pKa = 3.75 at 298 K

(5)

4. The diagram shows a pH curve produced by adding a strong alkali to a weak acid.

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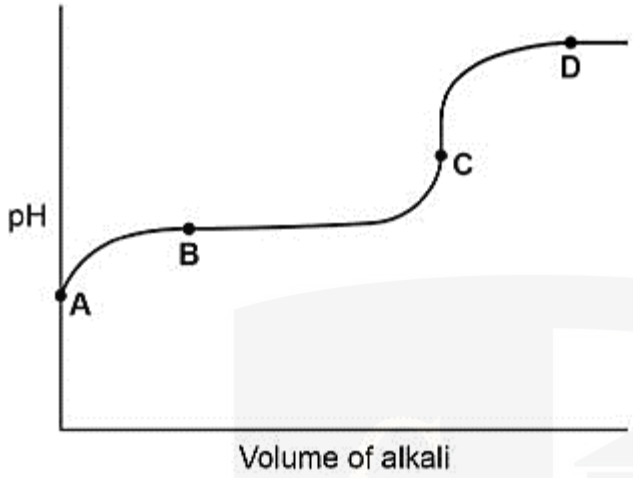

Which point on the curve represents a solution that can act as a buffer?

A. A
B. B
C. C
D. D

(1)

5. This question is about sulfuric acid and its salts.

(a) Draw the displayed formula of a molecule of H_2SO_4

(1)

(b) In aqueous solution, sulfuric acid acts as a strong acid.

The H_2SO_4 dissociates to form HSO_4^- ions and H^+ ions.

The HSO_4^- ions act as a weak acid and dissociate to form SO_4^{2-} ions and H^+ ions.

Give an equation to show each stage in the dissociation of sulfuric acid in aqueous solution.

Include appropriate arrows in your equations.

(2)

(c) A student is required to make 250 cm^3 of an aqueous solution that contains an accurately measured mass of sodium hydrogensulfate ($NaHSO_4$).

Describe the method that the student should use to make this solution.

(4)

(d) A solution that contains 605 mg of $NaHSO_4$ in 100 cm^3 of solution has a pH of 1.72

Calculate the value of Ka for the hydrogensulfate ion (HSO_4^-) that is behaving as a weak acid.

Give your answer to three significant figures.

State the units of Ka

(6)

(e) Some sodium sulfate is dissolved in a sample of the solution from part (d).

Explain why this increases the pH of the solution.

(2)

6. A solution of sodium ethanoate has a pH of 8.91 at 25 °C.

The hydrogen ion and hydroxide ion concentrations in this solution are

A. $[H^+] = 1.00 \times 10^{-9}$ mol dm^{-3} $[OH^-] = 1.00 \times 10^{-5}$ mol dm^{-3}
B. $[H^+] = 1.00 \times 10^{-9}$ mol dm^{-3} $[OH^-] = 8.13 \times 10^{-6}$ mol dm^{-3}
C. $[H^+] = 1.23 \times 10^{-9}$ mol dm^{-3} $[OH^-] = 1.00 \times 10^{-5}$ mol dm^{-3}
D. $[H^+] = 1.23 \times 10^{-9}$ mol dm^{-3} $[OH^-] = 8.13 \times 10^{-6}$ mol dm^{-3}

(1)

7. In this question, give all pH values to 2 decimal places.

(a) Write expressions for the ionic product of water, Kw, and for pH.

(2)

(b) At 318 K, the value of Kw is 4.02×10^{-14} mol^2 dm^{-6} and hence the pH of pure water is 6.70 State why pure water is not acidic at 318 K.

(2)

(c) Calculate the number of moles of sodium hydroxide in 2.00 cm^3 of 0.500 mol dm^{-3} aqueous sodium hydroxide.

(2)

(d) Use the value of Kw given above and your answer to calculate the pH of the solution formed when 2.00 cm^3 of 0.500 mol dm^{-3} aqueous sodium hydroxide are added to 998 cm^3 of pure water at 318 K.

(2)

8. Which is the concentration of NaOH(aq), in mol dm^{-3} , that has pH = 14.30?

$K_w = 1.00 \times 10^{-14}$ mol^2 dm^{-6} at 25 °C

A. –1.16
B. 5.01×10^{-15}
C. 2.00×10^{14}
D. 2.00

(1)

9. A sample of the 0.220 mol dm^{-3} solution of ethanoic acid was titrated against sodium hydroxide solution.

(a) Calculate the volume of a 0.150 mol dm^{-3} solution of sodium hydroxide required to neutralise 25.0 cm^3 of the ethanoic acid solution.

(2)

(b) From the list below, select the best indicator for this titration and explain your choice.

Name of indicator	pH range
Bromophenol blue	3.0 – 4.6
Methyl red	4.2 – 6.3
Bromothymol blue	6.0 – 7.6
Thymol blue	8.0 – 9.6

(3)

10. Addition of which one of the following to 10 cm^3 of 1.0 M NaOH would result in the pH being halved?

A. 10 cm^3 of water
B. 100 cm^3 of water
C. 5 cm^3 of 1.0 M HCl
D. 10 cm^3 of 1.0 M HCl

(1)

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