A LEVEL CHEMISTRY

TOPIC 12 – ACIDS, BASES AND BUFFERS

TEST

Answer all questions

Max 50 marks

Name ……
Mark …….../50 …….% Grade …….

1. Water dissociates slightly according to the equation:

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$$

The ionic product of water, K_w, is given by the expression

$$K_w = [H^+][OH^-]$$

K_w varies with temperature as shown in the table.

Temperature / °C	**K_w / mol² dm⁻⁶**
25	1.00×10^{-14}
50	5.48×10^{-14}

(a) Explain why the expression for K_w does **not** include the concentration of water.

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(2)

(b) Explain why the value of K_w increases as the temperature increases.

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(2)

(c) Calculate the pH of pure water at 50 °C.
Give your answer to 2 decimal places.

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(3)

(d) Calculate the pH of 0.12 mol dm^{-3} aqueous NaOH at 50 °C.
Give your answer to 2 decimal places.

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(3)
(Total 10 marks)

2. (a) A sample of hydrochloric acid has a pH of 2.34
Write an expression for pH and calculate the concentration of this acid.

pH .....

Concentration .....

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(2)

(b) A 0.150 mol dm^{-3} solution of a weak acid, HX, also has a pH of 2.34

(i) Write an expression for the acid dissociation constant, K_a, for the acid HX.

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(ii) Calculate the value of K_a for this acid and state its units.

Calculation .....

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Units .....

(iii) Calculate the value of pK_a for the acid HX. Give your answer to two decimal places.

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(5)

(c) A 30.0 cm^3 sample of a 0.480 mol dm^{-3} solution of potassium hydroxide was partially neutralised by the addition of 18.0 cm^3 of a 0.350 mol dm^{-3} solution of sulphuric acid.

(i) Calculate the initial number of moles of potassium hydroxide.

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(ii) Calculate the number of moles of sulphuric acid added.

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(iii) Calculate the number of moles of potassium hydroxide remaining in excess in the solution formed.

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(iv) Calculate the concentration of hydroxide ions in the solution formed.

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(v) Hence calculate the pH of the solution formed. Give your answer to two decimal places.

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(6)
(Total 13 marks)

3. The value of the acid dissociation constant, K_a, for the weak acid HA, at 298 K, is 1.45×10^{-4} mol dm^{-3}.

(a) Write an expression for the term K_a for the weak acid HA.

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(1)

(b) Calculate the pH of a 0.250 mol dm^{-3} solution of HA at 298 K.

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(4)

(c) A mixture of the acid HA and the sodium salt of this acid, NaA, can be used to prepare a buffer solution.

(i) State and explain the effect on the pH of this buffer solution when a small amount of hydrochloric acid is added.

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(ii) The concentration of HA in a buffer solution is 0.250 mol dm^{-3}. Calculate the concentration of A^- in this buffer solution when the pH is 3.59

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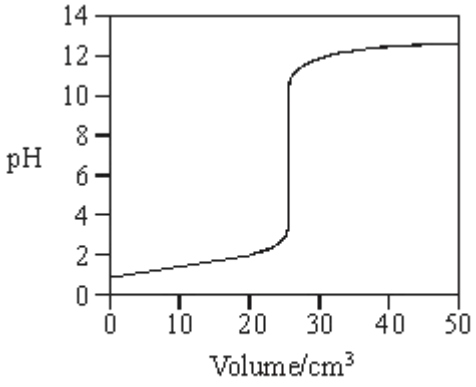
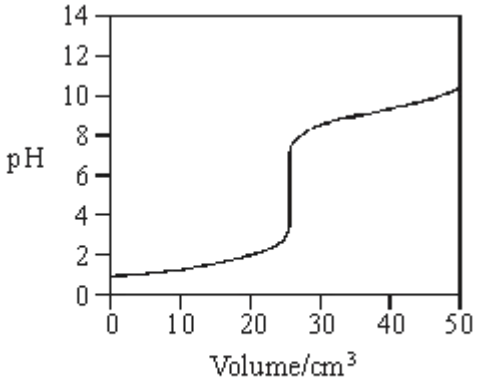
(6)
(Total 11 marks)

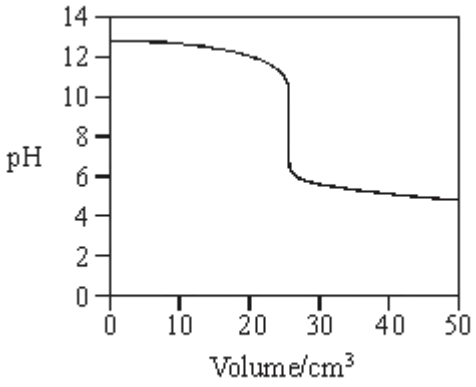
4. (a) Titration curves labelled **A**, **B**, **C** and **D** for combinations of different acids and bases are shown below. All solutions have a concentration of 0.1 mol dm^{-3}.



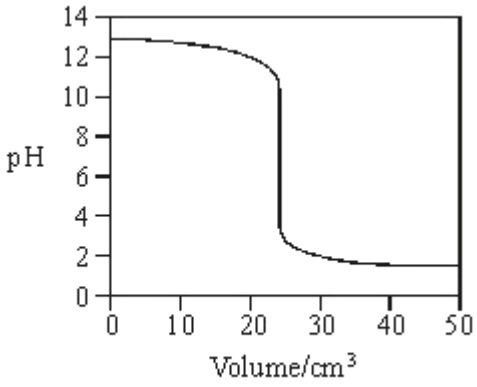
A



B



C



D

(i) Select from **A**, **B**, **C** and **D** the curve produced by the addition of

ammonia to 25 cm^3 of hydrochloric acid .....

ethanoic acid to 25 cm^3 of sodium hydroxide .....

sodium hydroxide to 25 cm^3 of hydrochloric acid .....

(ii) A table of acid–base indicators and the pH ranges over which they change colour is shown below.

Indicator	**pH range**
Thymol blue	1.2 – 2.8
Bromophenol blue	3.0 – 4.6
Methyl red	4.2 – 6.3
Cresolphthalein	8.2 – 9.8

Thymolphthalein	9.3 – 10.5

Select from the table an indicator which could be used in the titration which produces curve **A** but not in the titration which produces curve **B**.

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(4)

(b) (i) Write an expression for the term *pH*.

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(ii) A solution of potassium hydroxide has a pH of 11.90 at 25°C. Calculate the concentration of potassium hydroxide in the solution.

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(4)

(c) The acid dissociation constant, K_a, for propanoic acid has the value of 1.35×10^{-5} mol dm^{-3} at 25 °C.

$$K_a = \frac{[H^+][CH_3CH_2COO^-]}{[CH_3CH_2COOH]}$$

In each of the calculations below, give your answer to 2 decimal places.

(i) Calculate the pH of a 0.117 mol dm^{-3} aqueous solution of propanoic acid.

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(ii) Calculate the pH of a mixture formed by adding 25 cm^3 of a 0.117 mol dm^{-3} aqueous solution of sodium propanoate to 25 cm^3 of a 0.117 mol dm^{-3} aqueous solution of propanoic acid.

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(5)
(Total 13 marks)

6. The pH of 0.001 M NaOH at 25°C is

A 13

B 11

C 9

D 3

(Total 1 mark)

7. A weak acid HA dissociates in aqueous solution as shown below

$$HA(aq) \rightleftharpoons H^+(aq) + A^-(aq) \qquad \Delta H = +20 \text{ kJ mol}^{-1}$$

Which one of the following changes will result in a decrease in the pH of an aqueous solution of the acid?

A addition of a little aqueous sodium hydroxide solution

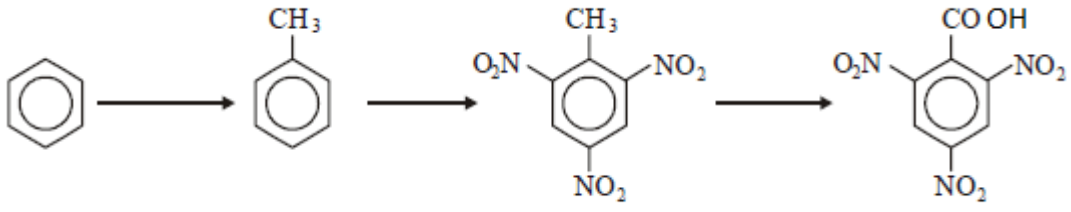
B raising the temperature of the solution

C dissolving a little of the sodium salt, NaA, in the solution

D adding a platinum catalyst to the solution

(Total 1 mark)

8. This question is based on the reactions and compounds shown in the scheme below.



X

A 0.100 mol dm^{-3} solution of **X** is found to have a pH of 2.50. The value of K_a in mol dm^{-3} is

A 3.16×10^{-2}

B 3.16×10^{-3}

C 1.00×10^{-4}

D 1.00×10^{-5}

(Total 1 mark)