

Q1.This question involves calculations about two strong acids and one weak acid.
All measurements were carried out at 25 °C.

- (a) A 25.0 cm³ sample of 0.0850 mol dm⁻³ hydrochloric acid was placed in a beaker and 100 cm³ of distilled water were added.
Calculate the pH of the new solution formed.
Give your answer to 2 decimal places.

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(2)

- (b) HX is a weak monobasic acid.

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

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(1)

- (ii) The pH of a 0.0850 mol dm⁻³ solution of HX is 2.79
Calculate a value for the acid dissociation constant, K_a , of this acid.
Give your answer to 3 significant figures.

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- (c) A 25.0 cm³ sample of 0.620 mol dm⁻³ nitric acid was placed in a beaker and 38.2 cm³ of 0.550 mol dm⁻³ aqueous sodium hydroxide were added.
Calculate the pH of the solution formed.
Give your answer to 2 decimal places.

The ionic product of water $K_w = 1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$ at 25 °C.

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(Total 12 marks)

Q2. This question is about the pH of some solutions containing potassium hydroxide and ethanoic acid.

Give all values of pH to 2 decimal places.

(a) (i) Write an expression for pH.

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(1)

(ii) Write an expression for the ionic product of water, K_w

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(iii) At 10 °C, a 0.154 mol dm⁻³ solution of potassium hydroxide has a pH of 13.72. Calculate the value of K_w at 10 °C.

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(b) At 25 °C, the acid dissociation constant K_a for ethanoic acid has the value 1.75×10^{-5} mol dm⁻³.

(i) Write an expression for K_a for ethanoic acid.

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(ii) Calculate the pH of a $0.154 \text{ mol dm}^{-3}$ solution of ethanoic acid at $25 \text{ }^\circ\text{C}$.

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(c) At $25 \text{ }^\circ\text{C}$, the acid dissociation constant K_a for ethanoic acid has the value $1.75 \times 10^{-5} \text{ mol dm}^{-3}$.

(i) Calculate the pH of the solution formed when 10.0 cm^3 of $0.154 \text{ mol dm}^{-3}$ potassium hydroxide are added to 20.0 cm^3 of $0.154 \text{ mol dm}^{-3}$ ethanoic acid at $25 \text{ }^\circ\text{C}$.

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- (ii) Calculate the pH of the solution formed when 40.0 cm³ of 0.154 mol dm⁻³ potassium hydroxide are added to 20.0 cm³ of 0.154 mol dm⁻³ ethanoic acid at 25 °C.

At 25 °C, K_w has the value 1.00×10^{-14} mol² dm⁻⁶.

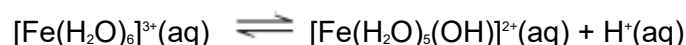
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Q3.Iron(II) sulfate is used to kill weeds in garden lawns. It is a by-product of the manufacture of steel.

When a lawn is treated with iron(II) sulfate, the iron(II) ions are oxidised to form iron(III) ions.

Iron(III) ions are acidic in aqueous solution as shown by the following equation.



In an experiment, a calibrated pH meter was used to measure the pH of an iron(III) salt in solution. At 20 °C the pH of a 0.100 mol dm⁻³ solution of iron(III) sulfate was found to be 1.62.

- (a) Explain briefly why a pH meter should be calibrated before use.

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- (b) Write an expression for the equilibrium constant, K_c , for the dissociation of iron(III) ions in aqueous solution.

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- (c) Use your answer from part (b) to calculate the value of K_c for this reaction at 20 °C. Give your answer to the appropriate precision. Show your working.

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- (d) Name the substance that is most likely to oxidise the iron(II) ions when iron(II) sulfate is used as a weed killer.

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- (e) Suggest a value for the pH of a 0.100 mol dm⁻³ solution of iron(II) sulfate.

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(Total 8 marks)

Q4. This question is about the pH of several solutions.

Give all values of pH to 2 decimal places.

- (a) (i) Write an expression for pH.

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(1)

- (ii) Calculate the pH of $0.154 \text{ mol dm}^{-3}$ hydrochloric acid.

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(1)

- (iii) Calculate the pH of the solution formed when 10.0 cm^3 of $0.154 \text{ mol dm}^{-3}$ hydrochloric acid are added to 990 cm^3 of water.

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(2)

- (b) The acid dissociation constant, K_a , for the weak acid HX has the value $4.83 \times 10^{-5} \text{ mol dm}^{-3}$ at $25 \text{ }^\circ\text{C}$.
A solution of HX has a pH of 2.48

Calculate the concentration of HX in the solution.

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- (c) Explain why the pH of an acidic buffer solution remains almost constant despite the

addition of a small amount of sodium hydroxide.

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- (d) The acid dissociation constant, K_a , for the weak acid HY has the value $1.35 \times 10^{-5} \text{ mol dm}^{-3}$ at 25°C .

A buffer solution was prepared by dissolving 0.0236 mol of the salt NaY in 50.0 cm^3 of a $0.428 \text{ mol dm}^{-3}$ solution of the weak acid HY

- (i) Calculate the pH of this buffer solution.

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- (ii) A $5.00 \times 10^{-4} \text{ mol}$ sample of sodium hydroxide was added to this buffer solution.

Calculate the pH of the buffer solution after the sodium hydroxide was added.

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(Total 18 marks)