Paddington Academy
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OCR A2 CHEMISTRY

UNIT 5 MODULE 1

ASSESSMENT POINT 1

54 MINUTES

45 MARKS

2   Solutions of hydrogen peroxide, H_2O_2, are colourless and widely used as oxidising agents, antiseptic and bleaches for hair and cloth.

Hydrogen peroxide reacts with iodide ions, I^-, in the presence of acid, $H^+(aq)$, forming iodine, I_2.

(a) Suggest a balanced equation for the overall reaction between $H_2O_2(aq)$, $I^-(aq)$ and $H^+(aq)$ to form aqueous iodine.

.... [2]

(b) Three experiments were carried out using different initial concentrations of $H_2O_2(aq)$, $I^-(aq)$ and $H^+(aq)$. The initial rate of formation of I_2 was measured for each experiment.

The experimental results are shown below.

experiment	$[H_2O_2(aq)]$ /mol dm^{-3}	$[I^-(aq)]$ /mol dm^{-3}	$[H^+(aq)]$ /mol dm^{-3}	rate /mol dm^{-3} s^{-1}
1	0.050	0.010	0.005	5.75×10^{-6}
2	0.050	0.020	0.005	1.15×10^{-5}
3	0.050	0.040	0.010	2.30×10^{-5}

(i) Showing all your reasoning, determine the orders of reaction for I^- and H^+.

....

....

....

....

....

.... [4]

(ii) This reaction is first order with respect to H_2O_2.

Use this information and your answers to (i) to write the rate equation for this reaction.

.... [1]

(iii) Calculate the rate constant, k, for this reaction. State the units for k.

rate constant, k: .... units: .... [3]

Answer all the questions.

1   The preparation of ethyl ethanoate from ethanoic acid and ethanol is a reversible reaction which can be allowed to reach equilibrium.

$$CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$$
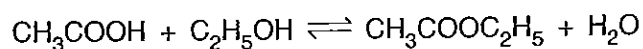
(a)   Write the expression for K_c for this equilibrium system.

[1]

(b)   A student mixed together 8.0 mol ethanoic acid and 14.5 mol ethanol. A small amount of hydrochloric acid was also added to catalyse the reaction. He left the mixture for two days to reach equilibrium, after which time 1.5 mol ethanoic acid remained.

(i)   Complete the table below to show the equilibrium composition of the mixture.

component	CH_3COOH	C_2H_5OH	$CH_3COOC_2H_5$	H_2O
initial amount/mol	8.0	14.5	0.0	0.0
equilibrium amount/mol				

[2]

(ii)   Calculate K_c to **two** significant figures.

The total volume of the equilibrium mixture is 1.0 dm³.

K_c = ... [2]

(c) The student added more ethanol to the mixture at constant temperature.

  (i) State, giving a reason, what would happen to the equilibrium composition of the mixture.

  ....

  ....

  .... [1]

  (ii) What happens to the value of K_c?

  .... [1]

(d) State, giving a reason, what would happen to the equilibrium position if the concentration of the acid catalyst were to be increased.

  ....

  ....

  .... [2]

(e) The student repeated the experiment at a higher temperature and found that the value of K_c decreased.

  Explain what additional information this tells you about this reaction.

  ....

  ....

  ....

  .... [2]

[Total: 11]

3 This question looks at several acids.

(a) Hydroiodic acid, $HI(aq)$, is a strong acid that is an aqueous solution of hydrogen iodide gas. In the laboratory, hydroiodic acid is prepared by the method below.

A mixture of iodine and water is put into a flask. The mixture is stirred and hydrogen sulphide gas, $H_2S(g)$, is bubbled through the mixture for several hours. The mixture becomes yellow as sulphur separates out.

The sulphur is filtered off and the solution is purified by fractional distillation.

A 225 cm^3 sample of hydroiodic acid is collected containing 47.2g of HI.

(i) Construct a balanced equation, with state symbols, for the preparation of hydroiodic acid from iodine and hydrogen sulphide.

.... [2]

(ii) Calculate the pH of the hydroiodic acid sample that is collected.

pH = ... [2]

(b) Ethanoic acid, CH_3COOH, is a weak acid with a K_a value of 1.70×10^{-5} mol dm^{-3}.

(i) Write an equation for the dissociation of ethanoic acid.

.... [1]

(ii) The concentration of ethanoic acid in a solution **X** was 2.74×10^{-3} mol dm^{-3}.

Calculate the pH of solution **X**.

pH = ... [3]
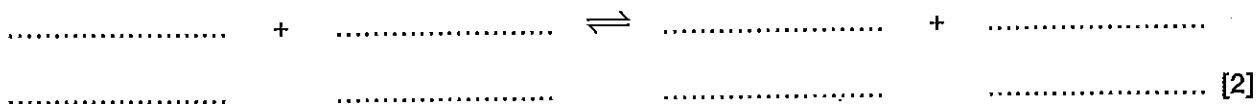
(iii) When ethanoic acid is mixed with hydroiodic acid, an acid–base reaction takes place.

Complete the acid–base equilibrium that is set up and identify the acid–base pairs.

- label **one** conjugate acid–base pair as **acid 1** and **base 1**,
- label the other conjugate acid–base pair as **acid 2** and **base 2**.

.... + ... $\rightleftharpoons$ .... + ...

.... **[2]**

(c) Methanoic acid, HCOOH, is an ant's main defence mechanism, squirted at potential intruders and injected in 'ant bites'.

(i) The recommended treatment for an ant bite is 'bicarbonate of soda', which contains $NaHCO_3$.

Suggest, with an equation, how $NaHCO_3$ helps to relieve the effect of an ant bite.

....

....

.... **[2]**
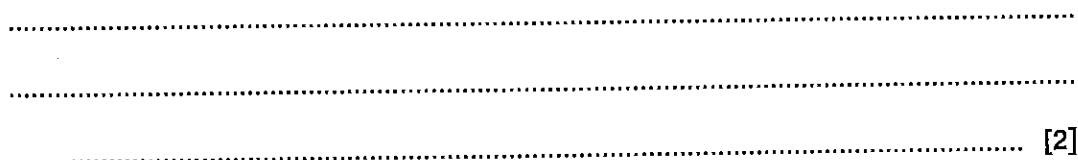
(ii) Wasp stings are treated with vinegar. What does this suggest about the nature of the active ingredient in a wasp sting? Explain your answer.

....

....

.... **[2]**

(iii) Methanoic acid can be used in buffer solutions.

Calculate the pH of a buffer solution containing equal volumes of 0.75 mol dm^{-3} methanoic acid and 1.92 mol dm^{-3} sodium methanoate.

For HCOOH, $K_a = 1.60 \times 10^{-4}$ mol dm^{-3}.

pH = ... **[2]**

[Total: 16]

Turn over

4 **(a)** A student analysed an unsaturated branched carboxylic acid, **A**, using a titration procedure.

The student dissolved 1.368 g of the compound in water and made the solution up to 100.0 cm^3. The student titrated 25.0 cm^3 of this solution with 0.152 mol dm^{-3} NaOH. The volume of NaOH(aq) required to reach the end-point was 19.80 cm^3.

Each molecule of **A** has one acidic hydrogen atom and it behaves as a monoprotic (monobasic) acid.

- Calculate the molar mass of the unsaturated branched carboxylic acid **A**.

- Determine the molecular formula and show **two** possible structural isomers of the unsaturated branched carboxylic acid **A**.

[8]