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90700

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Level 3 Chemistry, 2005

90700 Describe aqueous systems using equilibrium principles

Credits: Five
9.30 am Wednesday 23 November 2005

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

Show all working for all calculations.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

A periodic table is provided on the Resource Sheet in your Level 3 Chemistry package.

Check that this booklet has pages 2–8 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

For Assessor's use only	**Achievement Criteria**	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe aqueous systems using equilibrium principles.	Apply information about aqueous systems, using equilibrium principles.	Analyse and interpret information about aqueous systems, using equilibrium principles.
Overall Level of Performance		

You are advised to spend 50 minutes answering the questions in this booklet.

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QUESTION ONE: ACIDS AND BASES

Arrange the following 0.1 mol L^{-1} solutions in order of increasing pH.

NH_3

NH_4Cl

HCl

NaCl

NaOH

Lowest pH _____ _____ _____ _____ _____ *Highest pH*

Give reasons for arranging in this order, including equations for any reactions occurring to produce solutions that **do not** have a pH of 7.

QUESTION TWO: PRECIPITATING SILVER CHLORIDE

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(a) Describe what is meant by the term '**solubility**'.

(b) The solubility product, K_s, of AgCl has a value of 1.56×10^{-10} at 25°C and this value increases to 2.15×10^{-8} at 100°C.

Explain why K_s is higher at 100°C. Include reference to the relevant equilibrium equation in your answer.

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The chloride ion concentration in sea water can be determined by titrating a sample with aqueous silver nitrate ($AgNO_3$) using potassium chromate (K_2CrO_4) as the indicator.

As the silver nitrate is added, a precipitate of silver chloride, (AgCl) forms. When most of the AgCl has precipitated, the $Ag^+(aq)$ concentration becomes high enough for a red precipitate of Ag_2CrO_4 to form.

(c) Show that the solubility of Ag_2CrO_4 in pure water at 25°C is higher than that of AgCl.

$K_s(AgCl) = 1.56 \times 10^{-10}$ $K_s(Ag_2CrO_4) = 1.30 \times 10^{-12}$

(d) If the concentration of chromate ions is 6.30×10^{-3} mol L^{-1} at the point when the Ag_2CrO_4 starts to precipitate, calculate the concentration of Ag^+ ions in the solution.

QUESTION THREE: ETHANOIC ACID SOLUTIONS

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(a) Explain how a mixture of ethanoic acid (CH_3COOH) and sodium ethanoate (CH_3COONa) can act as a buffer. Include balanced equations for any reactions occurring.

(b) Calculate the concentration of ethanoate ions (CH_3COO^-) in a buffer solution of pH 5.00 if the concentration of CH_3COOH in the buffer is 0.0500 mol L^{-1}.

$$K_a\ (CH_3COOH) = 1.76 \times 10^{-5} \text{ at } 25°C$$

QUESTION FOUR: ANALYSIS OF A WEAK ACID

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The active ingredient in many sunscreens is *para*-aminobenzoic acid. It is a weak monoprotic acid and can be represented as HPab, while its conjugate base is Pab^-.

(a) Write an equation for the reactions occurring at equilibrium when HPab is dissolved in water.

(b) Write the expression for K_a(HPab).

K_a(HPab) =

A solution of HPab in water was prepared at 25°C and its pH was found to be 3.22.

c) Calculate the concentration of H_3O^+ in the solution.

$[H_3O^+]$ = _____

(d) The concentration of the HPab solution was determined by titration. A 20.0 mL sample of the HPab solution required 12.0 mL of 0.0500 mol L^{-1} NaOH to reach the equivalence point. The equation for the reaction occurring is

$$HPab + NaOH \rightarrow NaPab + H_2O$$

(i) Calculate the concentration of the HPab solution.

[HPab] = _____

(ii) Using the results from parts (c) and (d)(i), show that pK_a(HPab) = 4.92.

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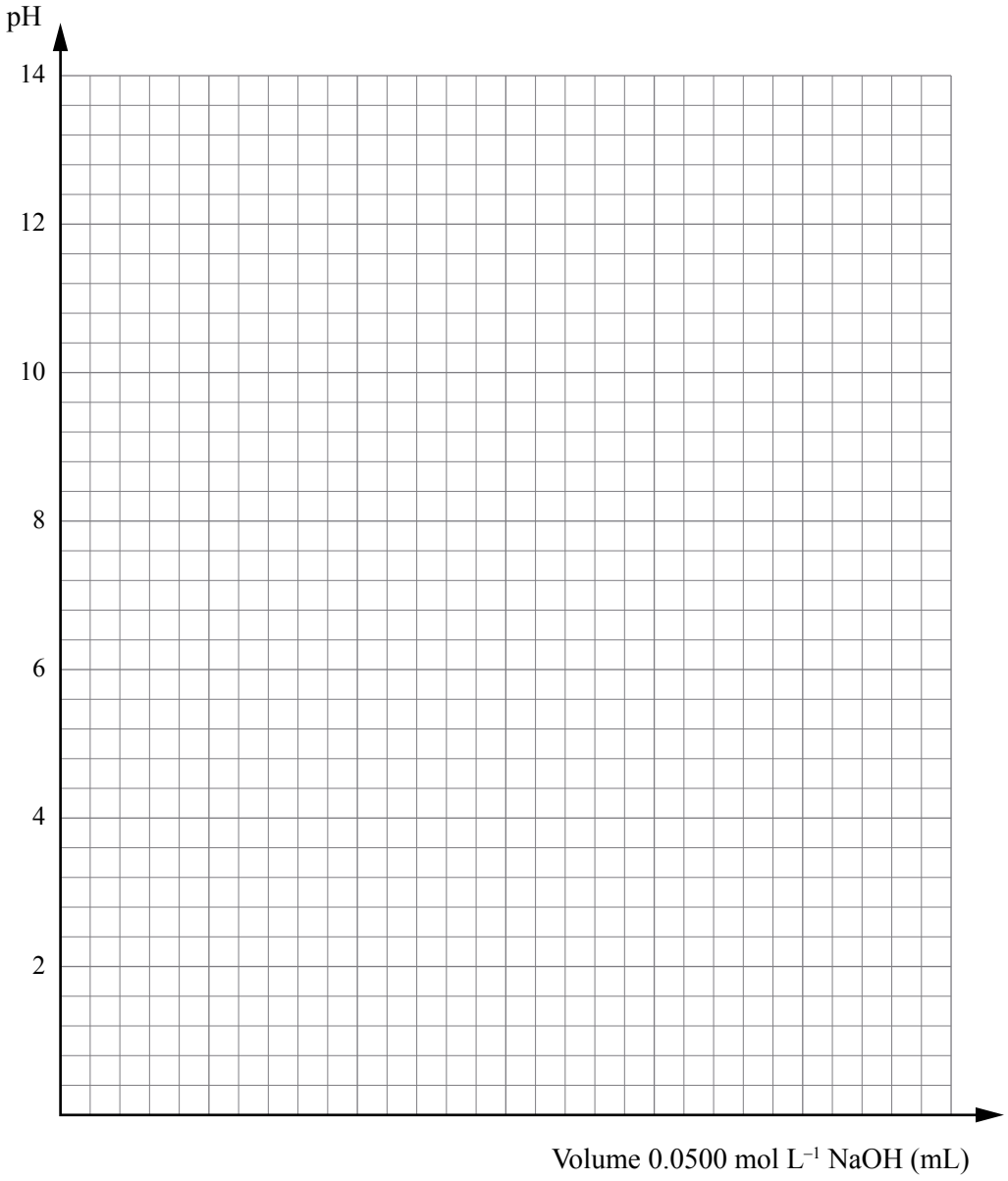
(e) Would the pH at the equivalence point of the titration of HPab with NaOH be more than 7, less than 7 or equal to 7? Give reasons and include any relevant equations that support your answer.

(f) Using the information above, sketch a curve showing the change in pH against the volume of sodium hydroxide added to the 20.0 mL HPab solution in the flask.



Extra paper for continuation of answers if required.
Clearly number the question.

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Question number	