For Supervisor's use only

3

90700

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Level 3 Chemistry, 2004

90700 Describe aqueous systems using equilibrium principles

Credits: Five
9.30 am Wednesday 10 November 2004

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 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.

Achievement Criteria *For Assessor's use only*		
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 45 minutes answering the questions in this booklet.

Assessor's use only

QUESTION ONE: PRECIPITATES

Show, by calculation, that a precipitate forms when 50.0 mL of 0.100 mol L^{-1} KCl(*aq*) and 50.0 mL of 0.0200 mol L^{-1} $AgNO_3$(*aq*) are mixed.

K_s (AgCl) = 1.56×10^{-10}

QUESTION TWO: LEAD BROMIDE AND SOLUBILITY

A 50.0 mL sample of a saturated aqueous solution of lead bromide, $PbBr_2$, was evaporated to dryness. 0.422 g of solid $PbBr_2$ was obtained.

(a) (i) Write the equation for the equilibrium present in a saturated solution of lead bromide.

(ii) Complete the expression for $K_s(PbBr_2)$.

$K_s(PbBr_2)$ =

(b) Calculate the value of $K_s(PbBr_2)$.

M ($PbBr_2$) = 367 g mol^{-1}

QUESTION THREE: THE NATURE OF SOLIDS

Assessor's use only

Solutions of ionic salts may be acidic, alkaline or neutral depending on the species present in the solution.

Discuss the above statement using, as examples, the salts sodium chloride, NaCl, sodium hypochlorite, NaOCl, and ammonium chloride, NH_4Cl. Include all appropriate equations.

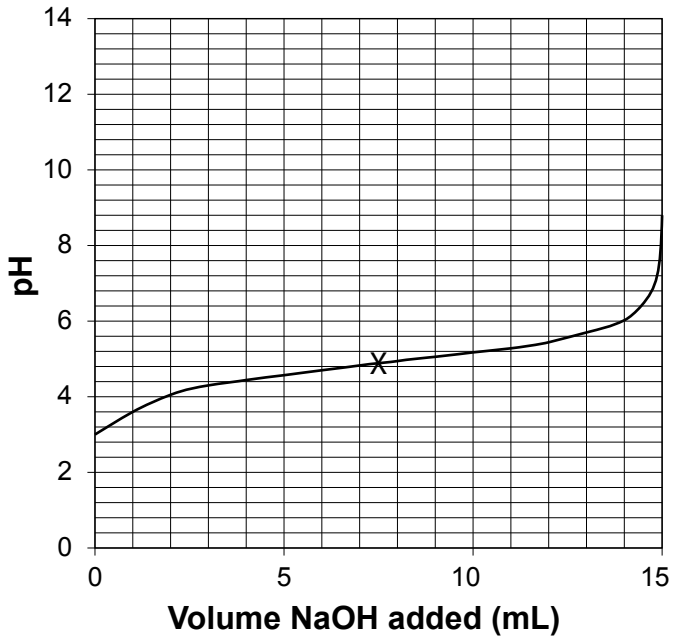
NOTE: Solutions of HCl and HOCl are both acidic but HOCl is a weaker acid.

QUESTION FOUR: TITRATION OF PROPANOIC ACID

Assessor's use only

The graph below is part of a titration curve and shows the change in pH as an aqueous solution of 0.125 mol L^{-1} NaOH is added to 25.0 mL of propanoic acid solution (CH_3CH_2COOH).

$$CH_3CH_2COOH + NaOH \rightarrow CH_3CH_2COONa + H_2O$$



(a) **Calculate** the concentration of the propanoic acid solution.

(b) What is the pK_a of propanoic acid?

(c) Calculate the pH of the solution at the equivalence point.

Assessor's use only

(d) Compare the relative concentration of all species present in the mixture at the point marked X on the titration curve shown on the previous page. No calculations are expected.

(e) The table below contains information about some pH indicators.

Assessor's use only

Name	Colour (low pH to high pH)	pH range	pK_a
Methyl orange	Red – yellow	3.1 – 4.4	3.7
Bromocresol green	Yellow – purple	5.2 – 6.8	6.3
Bromothymol blue	Yellow – blue	6.0 – 7.6	7.0
Cresol red	Yellow – red	7.2 – 8.8	8.3
Thymolphthalein	Colourless – blue	9.2 – 10.5	9.7

From this list identify any indicator(s) that could be used to determine the equivalence point in this titration. Give reasons for the suitability of the selected indicator(s).

QUESTION FIVE: BUFFER SOLUTIONS

Assessor's use only

A buffer solution can be prepared by dissolving solid ammonium chloride, NH_4Cl, in a solution of aqueous ammonia, NH_3.

$$pK_a\ (NH_4^+) = 9.24 \qquad K_a\ (NH_4^+) = 5.75 \times 10^{-10}$$

(a) Calculate the mass of solid ammonium chloride that must be added to one litre of 0.05 mol L^{-1} ammonia to produce a buffer of pH 8.80.

$$M(NH_4Cl) = 53.5\ g\ mol^{-1}$$

(b) Discuss how the pH **and** the effectiveness of this buffer vary depending on the relative concentrations of NH_3 and NH_4^+ in the solution.

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

Assessor's use only

Question number