NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
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Level 3 Chemistry, 2009

90700 Describe properties of aqueous systems

Credits: Five
9.30 am Tuesday 17 November 2009

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.

A periodic table is provided on the Resource Sheet L3–CHEMR.

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

Check that this booklet has pages 2–10 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 properties of aqueous systems.	Explain and apply properties of aqueous systems.		Discuss properties of aqueous systems.
Overall Level of Performance			

You are advised to spend 45 minutes answering the questions in this booklet.

QUESTION ONE

Ethanoic acid, CH_3COOH, is a common organic acid.

$$pK_a (CH_3COOH) = 4.76 \qquad K_a = 1.74 \times 10^{-5}$$

(a)   (i)   Write an equation for the reaction of ethanoic acid with water.

(ii)   Write the K_a expression for ethanoic acid.

$K_a =$

(b)   Calculate the pH of a 0.0500 mol L^{-1} ethanoic acid solution.

Another organic acid is methanoic acid, HCOOH.

$$pK_a (HCOOH) = 3.74$$

(c) Account for the fact that 0.0500 mol L^{-1} methanoic acid has a lower pH than 0.0500 mol L^{-1} ethanoic acid.

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(d) A solution prepared by dissolving sodium methanoate in water has a pH of 8.65.

Determine the concentration of methanoate ions in the solution.

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QUESTION TWO

Addition of chloride ions to a solution of silver nitrate often results in the formation of a white precipitate of silver chloride (AgCl).
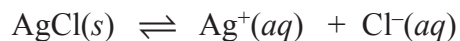
$$AgCl(s) \rightleftharpoons Ag^+(aq) + Cl^-(aq)$$
$$K_s (AgCl) = 1.56 \times 10^{-10}$$

(a) Calculate the concentration, in mol L^{-1}, of silver ions in a saturated solution of silver chloride at 25°C.

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(b) Solid sodium chloride is added to 5.00 L of 0.100 mol L^{-1} silver nitrate solution.

Calculate the minimum mass of sodium chloride that would be needed to produce a saturated solution of AgCl. Assume that there is no change in volume when the sodium chloride is added.

$$M(NaCl) = 58.5 \text{ g mol}^{-1}$$

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(c) Discuss reasons for the fact that a precipitate of silver chloride dissolves on the addition of excess aqueous ammonia.

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QUESTION THREE

25.0 mL of 0.0500 mol L^{-1} benzoic acid solution (C_6H_5COOH) is titrated with 0.0500 mol L^{-1} sodium hydroxide solution.

The equation for the reaction is:

$$C_6H_5COOH(aq) + NaOH(aq) \rightarrow C_6H_5COONa(aq) + H_2O(\ell)$$

The titration curve for the reaction is:

(a) Write the formulae of the four chemical species, apart from water and H_3O^+, that are present at the equivalence point.

(b) Explain why the solution in the titration flask has buffering properties after 9.80 mL of the NaOH solution has been added, but not when 25.0 mL has been added.

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(c)   Some indicators are shown in the table below.

Indicator	pK_a
Methyl orange	3.70
Thymol blue	8.90
Phenolphthalein	9.30

Discuss the suitability of these indicators for this titration.

Your discussion should include:
*   identification of the most suitable indicator(s)
*   consideration of how indicators are chosen for a titration
*   the consequences of choosing an unsuitable indicator.

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QUESTION FOUR

The following table lists some properties of aqueous solutions of sodium hydroxide, methylamine and methylammonium chloride.

	0.1 mol L^{-1} solutions	pH	Conductivity
A	Sodium hydroxide (NaOH)	13.0	High
B	Methylamine (CH$_3$NH$_2$)	11.8	Low
C	Methylammonium chloride (CH$_3$NH$_3$Cl)	5.3	High

The solutions above were prepared by adding the compounds to water.

(a) Write equations for the reactions occurring when each of the three compounds are added to water.

NaOH(s)

CH$_3$NH$_2$(g)

CH$_3$NH$_3$Cl(s)

(b) Justify the differences in the pH and conductivity of the three solutions.

Assessor's
use only

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

Question number