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NEW ZEALAND QUALIFICATIONS AUTHORITY
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For Supervisor's use only

Level 3 Chemistry, 2008

90700 Describe properties of aqueous systems

Credits: Five
9.30 am Friday 28 November 2008

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 2–8 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 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.

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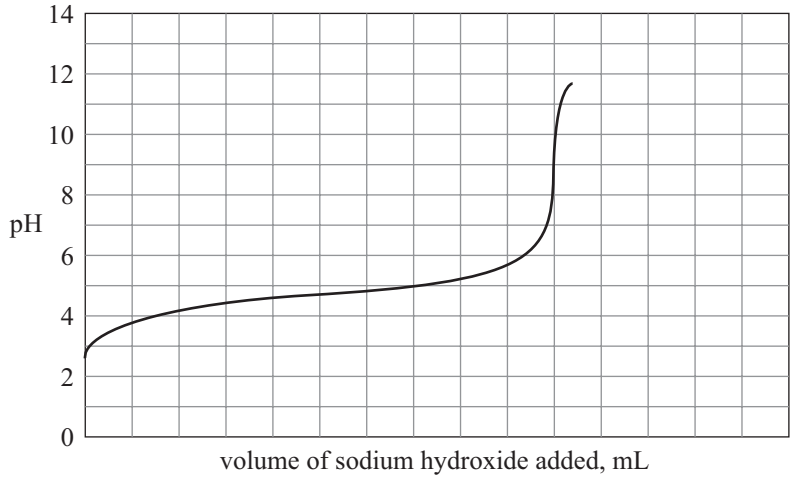
QUESTION ONE

The following titration curve shows the addition of aqueous 0.100 mol L^{-1} sodium hydroxide to a solution of hydrazoic acid, HN_3.

$pK_a(HN_3) = 4.72$



(a) (i) Draw a cross (X) on the titration curve to indicate the pH at the equivalence point of the titration.

(ii) Complete the titration curve to show how the pH changes as more aqueous sodium hydroxide is added.

(b) The initial pH of the hydrazoic acid (HN_3) is 2.6.

Calculate the concentration of the HN_3 solution used in the titration.

QUESTION TWO

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When bromine is added to water, it forms hypobromous acid (HOBr), a weak acid.

(a) (i) Write an equation to show the equilibrium system that is formed with hypobromous acid and water.

(ii) Write the K_a expression for hypobromous acid.

K_a =

(b) Calculate the pH of a 0.0525 mol L^{-1} hypobromous acid solution.

pK_a(HOBr) = 8.62

QUESTION THREE

Assessor's use only

(a) (i) Write an equation for the sparingly soluble salt lead(II) chloride ($PbCl_2$) dissolving in water.

(ii) Write the solubility product expression for lead(II) chloride.

(b) Calculate the solubility, in mol L^{-1}, of $PbCl_2$ in water at 25°C.

$K_s(PbCl_2) = 1.60 \times 10^{-5}$ at 25°C

(c) Sea water contains many dissolved salts. The chloride ion concentration in a sample of sea water is 0.440 mol L^{-1}.

Determine whether a precipitate of lead(II) chloride will form when a 1.00 g sample of lead(II) nitrate is added to 500 mL of the sea water. Your answer must be clearly justified.

$M(Pb(NO_3)_2) = 331$ g mol^{-1}

QUESTION FOUR

Assessor's use only

The K_s of aluminium hydroxide, $Al(OH)_3$, at 25°C, is 3×10^{-34}, indicating that it has very low solubility. The solubility may be altered by changes in pH (due to acidic or basic properties) and formation of complex ions such as the aluminate ion, $[Al(OH)_4]^-$.

Discuss why aluminium hydroxide becomes more soluble in aqueous solutions that have a pH less than 4, or a pH greater than 10.

In your answer include:

- the equation for the reaction that relates to $K_s(Al(OH)_3)$
- equations for the reactions that relate to changes in the solubility of aluminium hydroxide at pH less than 4 or greater than 10
- a discussion of the equilibrium principles involved.

QUESTION FIVE

Assessor's use only

Two solutions, A and B, were made as described below.

Solution A: 50 mL of aqueous 1.00 mol L^{-1} ammonium chloride was added to 50 mL of aqueous 1.00 mol L^{-1} ammonia.

Solution B: 25 mL of aqueous 0.010 mol L^{-1} hydrochloric acid was added to 50 mL of aqueous 0.010 mol L^{-1} ammonia.

(a) (i) Write the K_a expression for NH_4^+.

K_a =

(ii) **Show**, by calculation, that the pH of each of the two solutions is 9.24.

$pK_a(NH_4^+) = 9.24$

Solution A

Solution B

Assessor's use only

(b) (i) Discuss the abilities of solutions A and B to act as buffers.

(ii) Compare how the pH of each solution would be affected when 1.00 mol L^{-1} sodium hydroxide is added drop-wise to each solution. Calculations are not required, but you should include appropriate equations in your answer.

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

Assessor's use only

Question number