

90700



NEW ZEALAND QUALIFICATIONS AUTHORITY
 MANA TOHU MĀTAURANGA O AOTEAROA

3

SUPERVISOR'S USE ONLY

Level 3 Chemistry, 2012

90700 Describe properties of aqueous systems

2.00 pm Tuesday 20 November 2012

Credits: Five

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 attempt 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 2–11 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.

ASSESSOR'S USE ONLY				Achievement Criteria		
Achievement		Achievement with Merit		Achievement with Excellence		
Describe properties of aqueous systems.	<input type="checkbox"/>	Explain and apply properties of aqueous systems.	<input type="checkbox"/>	Discuss properties of aqueous systems.	<input type="checkbox"/>	<input type="checkbox"/>
Overall level of performance				<input type="checkbox"/>		

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

QUESTION ONE

(a) Write equations for the reactions occurring when each of the following is added to water.

(i) HCl

(ii) CH₃NH₂

(iii) NH₄Cl

(b) For each of the following 0.100 mol L⁻¹ solutions, list all species in order of **decreasing** concentration.

Do not include water.

(i) HCl

(ii) CH₃NH₂

(iii) NH₄Cl

QUESTION TWO

Iron(II) hydroxide, $\text{Fe}(\text{OH})_2$, has a K_s of 4.10×10^{-15} at 25°C .

- (a) (i) Write the equation for $\text{Fe}(\text{OH})_2$ dissolving in water.

- (ii) Write the expression for $K_s(\text{Fe}(\text{OH})_2)$.

- (b) Calculate the solubility (in mol L^{-1}) of iron(II) hydroxide in water at 25°C .

- (c) (i) Determine whether a precipitate of iron(III) hydroxide, $\text{Fe}(\text{OH})_3$, will form when $\text{Fe}(\text{NO}_3)_3$ is dissolved in water. $[\text{Fe}(\text{NO}_3)_3] = 1.05 \times 10^{-4} \text{ mol L}^{-1}$.

Assume the pH of the water is 7.

$$K_s(\text{Fe}(\text{OH})_3) = 2.00 \times 10^{-39}$$

- (ii) Discuss the effect of decreasing the pH of the water on the solubility of $\text{Fe}(\text{OH})_3$.

QUESTION THREE

- (a) Calculate the pH of 0.150 mol L^{-1} aqueous ammonia, NH_3 .

$$\text{p}K_a(\text{NH}_4^+) = 9.24$$

A mixture of aqueous solutions of NH_3 and ammonium chloride, NH_4Cl , can act as a buffer solution.

- (b) Calculate the mass of NH_4Cl required, when added to 250 mL of a 0.150 mol L^{-1} NH_3 solution, to give a buffer solution with a pH of 8.60.

Assume there is no change in volume.

$$M(\text{NH}_4\text{Cl}) = 53.5 \text{ g mol}^{-1} \quad \text{p}K_a(\text{NH}_4^+) = 9.24$$

(c) Discuss the ability of the $\text{NH}_3/\text{NH}_4\text{Cl}$ solution to act as a buffer at a pH of 8.60.

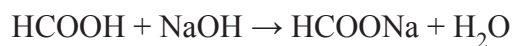
In your answer you should:

- describe the function of a buffer solution
- evaluate its effectiveness when small amounts of acid or base are added
- include any relevant equations.

QUESTION FOUR

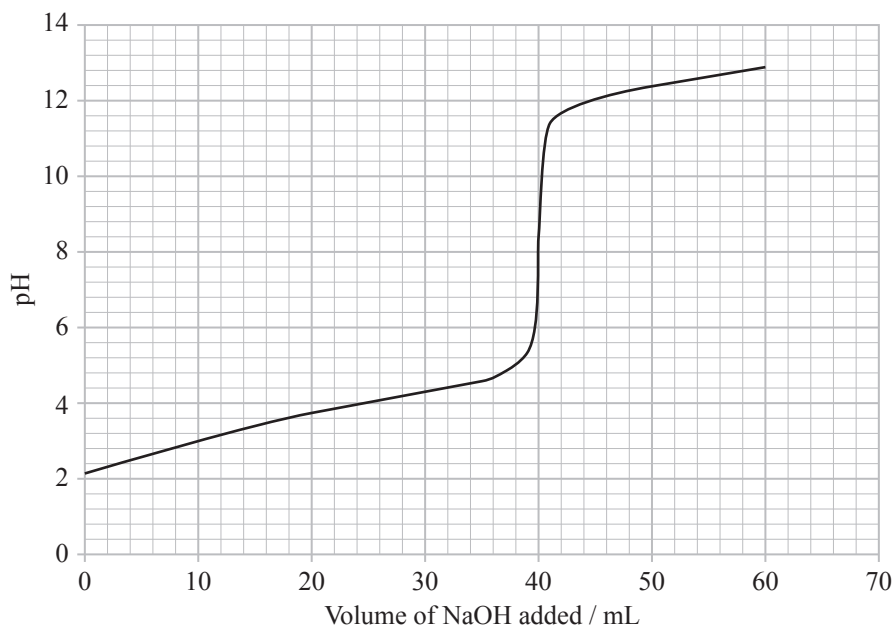
A titration was carried out with methanoic acid and sodium hydroxide.

The equation for the reaction is:



$$\text{p}K_{\text{a}}(\text{HCOOH}) = 3.74$$

The curve for this titration is given below:



25.0 mL of methanoic acid solution is titrated with 0.180 mol L⁻¹ sodium hydroxide.

- (a) (i) Show that the concentration of the HCOOH solution is 0.288 mol L⁻¹.

- (ii) **Calculate** the initial pH of the 0.288 mol L⁻¹ HCOOH solution.

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- (b) Discuss the pH of the reaction mixture, in terms of the species present, after 20 mL of NaOH has been added.

No calculations are necessary.

Question Four continues on page 10

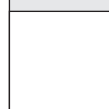
- (c) Some indicators and their pK_a values are shown in the table below.

Indicator	pK_a
Bromocresol green	4.7
Cresol red	8.3
Alizarin yellow	11.0

Discuss the suitability of **each** of these indicators for this titration.

In your answer you should include:

- an identification of the most suitable indicator(s)
- the consequences of choosing an unsuitable indicator
- an explanation of the significance of the pK_a in selecting an indicator.



**Extra paper if required.
Write the question number(s) if applicable.**

QUESTION
NUMBER

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