91392M

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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

3

SUPERVISOR'S USE ONLY

Te Mātauranga Matū, Kaupae 3, 2019

91392M Te whakaatu māramatanga ki ngā mātāpono taurite i ngā pūnaha waiwai

2.00 i te ahiahi Rāpare 14 Whiringa-ā-rangi 2019
Whiwhinga: Rima

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki ngā mātāpono taurite i ngā pūnaha waiwai.	Te whakaatu māramatanga hōhonu ki ngā mātāpono taurite i ngā pūnaha waiwai.	Te whakaatu māramatanga matawhānui ki ngā mātāpono taurite i ngā pūnaha waiwai.

Tirohia mēnā e rite ana te Tau Ākonga ā-Motu (NSN) kei runga i tō puka whakauru ki te tau kei runga i tēnei whārangi.

Me whakamātau koe i ngā tūmahi KATOA kei roto i tēnei pukapuka.

He taka pūmotu me ētahi atu rauemi tautoko kei te Pukapuka Rauemi L3–CHEMMR.

Mēnā ka hiahia whārangi atu anō koe mō ō tuhinga, whakamahia ngā whārangi wātea kei muri o tēnei pukapuka, ka āta tohu ai i te tau tūmahi.

Tirohia mēnā e tika ana te raupapatanga o ngā whārangi 2–19 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

ME HOATU RAWA KOE I TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

TAPEKE

MĀ TE KAIMĀKA ANAKE

TŪMAHI TUATAHI

MĀ TE KAIMĀKA ANAKE

(a) (i) Tuhia te whārite mō te tauritenga kei roto i tētahi mehanga kōhura o te konutea waihā, $Zn(OH)_2$.

(ii) Tuhia te kīanga mō te $K_s(Zn(OH)_2)$.

(iii) Tātaihia te mehamehatanga o te $Zn(OH)_2$ i rō wai i te 25°C, ka homai i te $[Zn^{2+}]$ me te $[OH^-]$ i roto i te mehanga.

$K_s(Zn(OH)_2) = 3.80 \times 10^{-17}$

(iv) Nā te urunga o tētahi katote e kitea noatia ana ka heke te mehamehatanga o tētahi totoka meha iti noa, pērā i te $Zn(OH)_2$.

Tātaihia te kukūtanga o ngā katote waihā, OH^-, i rō mehanga whai muri i te tāpiri i te 25.0 mL o te mehanga 0.210 mol L^{-1} konutea pūhaumāota, $ZnCl_2$, ki te 25.0 mL o tētahi mehanga $Zn(OH)_2$ kōhura.

(b) Whakamahia ngā mātāpono tauritenga hei whakamārama i te take he aha i piki ai te mehamehatanga o te $Zn(OH)_2$ ina tāpirihia te konutai waihā NaOH nui rawa, he mea waimeha.

Me whakauru ko te (ngā) whārite hāngai ki tō tuhinga.

(c) Whakatau mēnā ka puta he huatoka o te $Zn(OH)_2$ ina tāpirihia te 30.0 mL o te mehanga konutai waihā, NaOH, i te pH 13.1 ki te 20.0 mL o te 0.0242 mol L^{-1} konutea pākawa ota, $Zn(NO_3)_2$.

QUESTION ONE

ASSESSOR'S USE ONLY

(a) (i) Write the equation for the equilibrium occurring in a saturated solution of zinc hydroxide, $Zn(OH)_2$.

(ii) Write the expression for $K_s(Zn(OH)_2)$.

(iii) Calculate the solubility of $Zn(OH)_2$ in water at 25°C, and give the $[Zn^{2+}]$ and $[OH^-]$ in the solution.

$K_s(Zn(OH)_2) = 3.80 \times 10^{-17}$

(iv) The presence of a common ion decreases the solubility of a sparingly soluble solid, such as $Zn(OH)_2$.

Calculate the concentration of the hydroxide ions, OH^-, in solution after 25.0 mL of 0.210 mol L^{-1} zinc chloride, $ZnCl_2$, solution was added to 25.0 mL of a saturated $Zn(OH)_2$ solution.

ASSESSOR'S USE ONLY

(b) Use equilibrium principles to explain why the solubility of $Zn(OH)_2$ increases when an excess of dilute sodium hydroxide, NaOH, is added.

Include relevant equation(s) in your answer.

(c) Determine whether a precipitate of $Zn(OH)_2$ will form when 30.0 mL of sodium hydroxide solution, NaOH, at pH 13.1 is added to 20.0 mL of 0.0242 mol L^{-1} zinc nitrate, $Zn(NO_3)_2$.

TŪMAHI TUARUA

MĀ TE KAIMĀKA ANAKE

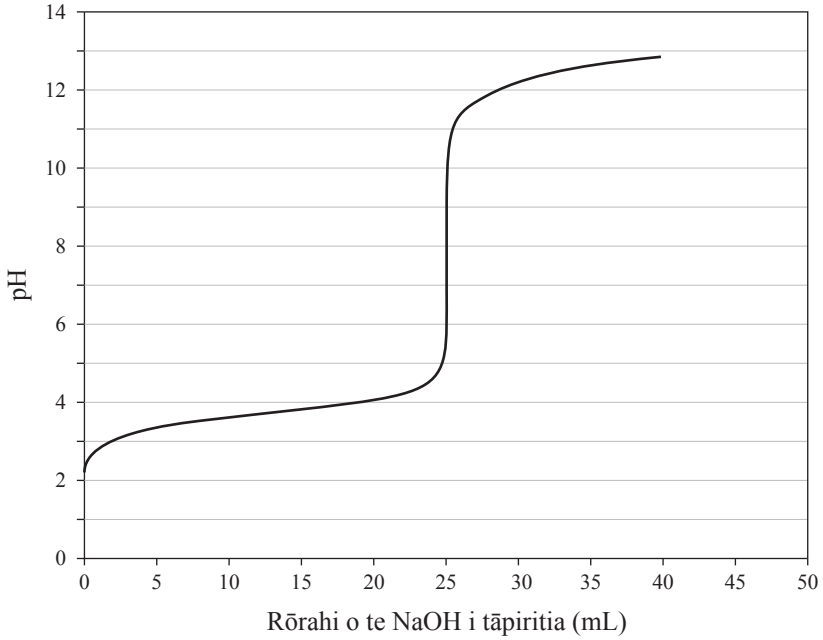
Ka whakahaerehia he tātairanga kukū mā te tāpiri i te 0.140 mol L^{-1} konutai waihā, NaOH, ki te 20.0 mL o te 0.175 mol L^{-1} waikawa mewaro, HCOOH.

Ko te whārite mō te tauhohenga ko:

$HCOOH + NaOH \rightarrow HCOONa + H_2O$

$pK_a(HCOOH) = 3.74$

$K_a(HCOOH) = 1.82 \times 10^{-4}$



(a) (i) Tuhia ngā momo KATOA i roto i te mehanga i muri i te tāpiri i te 12.5 mL o te mehanga NaOH.

Kaua e whakaatu i te wai.

(ii) I muri i te tāpiri i te 12.5 mL o te NaOH, he 3.74 te pH o te mehanga.

Whakamāramahia mai te hiranga o tēnei pH me te kōrero mō ngā kukūtanga rerekē o ngā momo kei roto.

Kāore he tātaihanga e hiahiatia.

QUESTION TWO

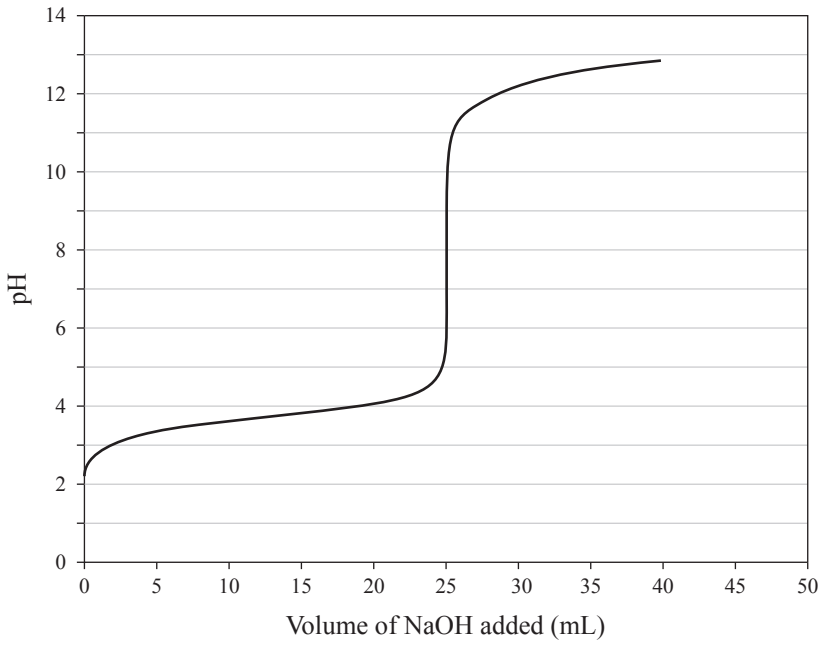
ASSESSOR'S USE ONLY

A titration was carried out by adding 0.140 mol L^{-1} sodium hydroxide, NaOH, to 20.0 mL of 0.175 mol L^{-1} methanoic acid, HCOOH.

The equation for the reaction is:

$$HCOOH + NaOH \rightarrow HCOONa + H_2O$$

$pK_a(HCOOH) = 3.74$
$K_a(HCOOH) = 1.82 \times 10^{-4}$



(a) (i) List ALL the species in solution after 12.5 mL of NaOH solution has been added.

Do not include water.

(ii) After 12.5 mL of NaOH has been added, the solution has a pH of 3.74.

Explain the significance of this pH with reference to the relative concentrations of the species present.

No calculations are necessary.

(b) (i) Whakamahia te kōrero mō te ānau tātairanga kukū, ka hoatu he tohu [√] ki te taha o te tūtohu e tino hāngai ana hei tautohu i te pae ōritenga.

MĀ TE KAIMĀKA ANAKE

Tūtohu	**pK_a**	**Tohua kia KOTAHI te pouaka i raro**
"Thymol blue"	1.70	
Kākāriki waikawa pūkane	4.70	
Whero Cresol	8.30	

Whakamāramahia mai tō kōwhiringa, me ngā mutunga iho o te kōwhiri i ētahi atu tūtohu.

(ii) Tātaihia te pH i te pae ōritenga.

ASSESSOR'S USE ONLY

(b) (i) With reference to the titration curve, put a tick next to the indicator most suited to identify the equivalence point.

Indicator	**pK_a**	**Tick ONE box below**
Thymol blue	1.70	
Bromocresol green	4.70	
Cresol red	8.30	

Explain your choice, including the consequences of choosing the other indicators.

(ii) Calculate the pH at the equivalence point.

(c) Tātaihia te pH o te mehanga i muri i te tāpiri i te 28.0 mL o te 0.140 mol L^{-1} NaOH.

MĀ TE KAIMĀKA ANAKE

(c) Calculate the pH of the solution after 28.0 mL of 0.140 mol L^{-1} NaOH has been added.

ASSESSOR'S USE ONLY

TŪMAHI TUATORU

MĀ TE KAIMĀKA ANAKE

(a) I whakaritea ngā mehanga e rua o ngā kukūtanga ōrite: ko tētahi he waikawa ewaro, CH_3COOH, ā, ko tētahi atu he haukini pūhaumāota, NH_4Cl.

$pK_a(CH_3COOH) = 4.76$ $pK_a(NH_4^+) = 9.24$

(i) Whakamāramahia mai ko tēhea te mehanga he iti iho te pH.

I roto i tō tuhinga me kōrero mō te kukūtanga o te (ngā) katote hāngai i roto i ia mehanga.

Kāore he tātaihanga e hiahiatia.

(ii) Aromātaihia te kawe iahiko o ngā mehanga CH_3COOH me te NH_4Cl.

Me whakauru ko te (ngā) whārite hāngai ki tō tuhinga.

QUESTION THREE

ASSESSOR'S USE ONLY

(a) Two solutions of equal concentration were prepared: one of ethanoic acid, CH_3COOH, and one of ammonium chloride, NH_4Cl.

$pK_a(CH_3COOH) = 4.76$ $pK_a(NH_4^+) = 9.24$

(i) Explain which solution would have the lower pH.

Your answer should refer to the concentration of relevant ion(s) in each solution.

No calculations are necessary.

(ii) Evaluate the electrical conductivity of the CH_3COOH and NH_4Cl solutions.

Include relevant equation(s) in your answer.

MĀ TE KAIMĀKA ANAKE

(iii) Kei te mehanga waikawa ewaro ko te $[H_3O^+]$ o te 1.78×10^{-3} mol L^{-1}.

Tātaihia te kukūtanga o te mehanga waikawa ewaro.

(b) (i) Ka tāpirihia te waikawa pūhaumāota waimeha, HCl, ki te mehanga konutai winika, CH_3COONa, kia eke rā anō te ōwehenga o te CH_3COONa ki te waikawa ewaro, CH_3COOH, i roto i te mehanga he rua ki te rima (2:5).

Tātaihia te pH o tēnei mehanga whakatautika.

Ka haere tonu te Tūmahi Tuatoru i te whārangi 16.

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(iii) The ethanoic acid solution has a $[H_3O^+]$ of 1.78×10^{-3} mol L^{-1}.

Calculate the concentration of the ethanoic acid solution.

(b) (i) Dilute hydrochloric acid, HCl, is added to a solution of sodium ethanoate, CH_3COONa, until the ratio of CH_3COONa to ethanoic acid, CH_3COOH, in the solution is two to five (2:5).

Calculate the pH of this buffer solution.

Question Three continues on page 17.

(ii) Whakamāramahia mai he aha i whaitake ai tēnei mehanga whakatautika ki te pare i tētahi huringa ki te pH ina tāpirihia he rahinga iti o te pāpāhua kaha, kaua te waikawa kaha.

Me uru ki tō tuhinga ko tētahi whārite e whakaatu ana he pēhea te whakangū a te mehanga whakatautika i te pāpāhua kaha ka tāpirihia.

MĀ TE KAIMĀKA ANAKE

(iii) He aha te pānga ki te pH o tēnei mehanga whakatautika ina waimehatia ki te wai?

Whakamāramatia tō tuhinga.

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(ii) Explain why this buffer solution would be more effective at resisting a change in pH when a small volume of strong base is added, rather than strong acid.

Your answer should include an equation to show how the buffer neutralises added strong base.

(iii) How would the pH of this buffer solution be affected when it is diluted with water?

Explain your answer.

He whārangi anō ki te hiahiatia.
Tuhia te (ngā) tau tūmahi mēnā e tika ana.

TAU TŪMAHI

MĀ TE KAIMĀKA ANAKE

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

QUESTION NUMBER

ASSESSOR'S USE ONLY

English translation of the wording on the front cover

Level 3 Chemistry, 2019

91392 Demonstrate understanding of equilibrium principles in aqueous systems

2.00 p.m. Thursday 14 November 2019
Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of equilibrium principles in aqueous systems.	Demonstrate in-depth understanding of equilibrium principles in aqueous systems.	Demonstrate comprehensive understanding of equilibrium principles in aqueous systems.

91392M

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 and relevant formulae are provided in the Resource Booklet L3–CHEMMR.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–19 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.