See back cover for an English translation of this cover

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91392M

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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

SUPERVISOR'S USE ONLY

Tohua tēnei pouaka mēnā KĀORE koe i tuhi kōrero ki tēnei pukapuka

Mātai Matū, Kaupae 3, 2022

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

Ngā whiwhinga: E rima

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki ngā mātāpono taurite i ngā pūnaha waiwai.	Te whakaatu māramatanga ki ngā mātāpono taurite i ngā pūnaha waiwai, kia hōhonu.	Te whakaatu māramatanga ki ngā mātāpono taurite i ngā pūnaha waiwai, kia tōtōpū.

Tirohia kia kitea ai 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.

Ki te hiahia wāhi atu anō koe mō ō tuhinga, whakamahia ngā whārangi wātea kei muri o tēnei pukapuka.

Tirohia kia kitea ai 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.

Kaua e tuhi ki tētahi wāhi e kitea ai te kauruku whakahāngai (⁄⁄⁄). Ka poroa pea taua wāhanga ka mākahia ana te pukapuka.

HOATU TĒNEI PUKAPUKA KI TE KAIWHAKAHAERE Ā TE MUTUNGA O TE WHAKAMĀTAUTAU.

TE TŪMAHI TUATAHI

(a) (i) Tuhia te whārite mō te tauritenga i roto i te mehanga kohura o te hiriwa pākawa konukita, Ag_2CrO_4.

(ii) Tuhia te kīanga mō te $K_s(Ag_2CrO_4)$.

(iii) Tātaia te hua mehamehanga, K_s, o te Ag_2CrO_4 i roto i te wai e 25 °C tōna pāmahana. Ko te 6.50×10^{-5} mol L^{-1} te mehamehanga o te Ag_2CrO_4.

(b) Whakamāramahia mai, mā te whakamahi i ngā mātāpono taurite, te pānga o ngā mea e whai ake nei ki te mehamehanga o te Ag_2CrO_4 i roto i te wai.

Me whakauru ki tō tuhinga te/ngā whārite e hāngai ana.

Kāore e hiahiatia ana he tātaitanga.

(i) Ka tāpirihia te hiriwa pākawa ota waimeha, $AgNO_3(aq)$:

(ii) Ka tāpirihia te konutai *cyanide* waimeha, NaCN(*aq*):

(c) Whakaaturia mai, mā te tātaitanga, ka puta tētahi huatoka o te hiriwa pūhaumāota, AgCl, ka tāpirihia ana te 30.0 mL o te 0.0686 mol L^{-1} konupūmā pūhaumāota, $CaCl_2$, ki te 50.0 mL o te 0.00154 mol L^{-1} hiriwa pākawa ota, $AgNO_3$.

$K_s(AgCl) = 1.80 \times 10^{-10}$

QUESTION ONE

(a) (i) Write the equation for the equilibrium occurring in a saturated solution of silver chromate, Ag_2CrO_4.

(ii) Write the expression for $K_s(Ag_2CrO_4)$.

(iii) Calculate the solubility product, K_s, of Ag_2CrO_4 in water at 25 °C, given Ag_2CrO_4 has a solubility of 6.50×10^{-5} mol L^{-1}.

(b) Explain, using equilibrium principles, the effect of the following on the solubility of Ag_2CrO_4 in water.

Include relevant equation(s) in your answer.

No calculations are necessary.

(i) Dilute silver nitrate, $AgNO_3(aq)$, is added:

(ii) Dilute sodium cyanide, NaCN(*aq*), is added:

(c) Show, by calculation, that a precipitate of silver chloride, AgCl, will form when 30.0 mL of 0.0686 mol L^{-1} calcium chloride, $CaCl_2$, is added to 50.0 mL of 0.00154 mol L^{-1} silver nitrate, $AgNO_3$.

$K_s(AgCl) = 1.80 \times 10^{-10}$

TE TŪMAHI TUARUA

Ko te konutai *hypochlorite*, NaOCl, te wāhanga hohe i roto i te whakatoki. He pāpāhua ngoikore te katote *hypochlorite*, OCl^-.

(a) (i) Whakaraupapatia mai ngā hanga katoa i roto i tētahi mehanga o te NaOCl i runga i te heke haere o te kukūtanga.

Kaua e whakaurua te wai.

(ii) Ko te waikawa *hypochlorous*, HOCl, te waikawa haere kōtui o te katote *hypochlorite*.

Mēnā he 4.80 te pH o tētahi mehanga waikawa *hypochlorous*, tātaihia tōna kukūtanga.

$K_a(HOCl) = 2.95 \times 10^{-8}$ $pK_a(HOCl) = 7.53$

(iii) Whakatairitea te kahakawe iahiko o ngā mehanga HOCl me te NaOCl he ōrite te kukūtanga.

Whakamahia te/ngā whārite e hāngai ana i tō tuhinga.

(b) Ka tāpirihia ana tētahi rōrahi iti o te waikawa *hydrochloric*, HCl, ki tētahi mehanga whakatautika (*buffer solution*) kua mahia i te HOCl me te NaOCl, ka puta mai te tauhohenga e whai ake nei:

$$OCl^- + H_3O^+ \rightarrow HOCl + H_2O$$

Whakamāramahia mai te hiranga o tēnei tauhohenga mō te taha ki te mahi a te mehanga whakatautika.

QUESTION TWO

Sodium hypochlorite, NaOCl, is the active ingredient in bleach. The hypochlorite ion, OCl^-, is a weak base.

(a) (i) List all the species present in a solution of NaOCl in order of decreasing concentration.
Do not include water.

(ii) Hypochlorous acid, HOCl, is the conjugate acid of the hypochlorite ion.

If a hypochlorous acid solution has a pH of 4.80, calculate its concentration.

$K_a(HOCl) = 2.95 \times 10^{-8}$ $pK_a(HOCl) = 7.53$

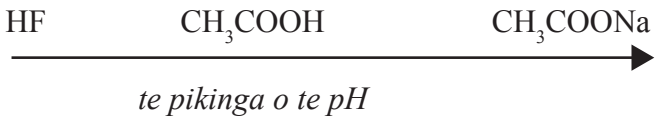
(iii) Compare the electrical conductivity of HOCl and NaOCl solutions of equal concentration.
Use relevant equation(s) in your answer.

(b) When a small volume of hydrochloric acid, HCl, is added to a buffer solution made from HOCl and NaOCl, the following reaction occurs:

$$OCl^- + H_3O^+ \rightarrow HOCl + H_2O$$

Explain the significance of this reaction in terms of the function of the buffer solution.

(c) He mea whakaraupapa te pH o ngā mehanga e toru e ōrite ana te kukūtanga kia hāngai ai te raupapa ki te pikinga o te pH:

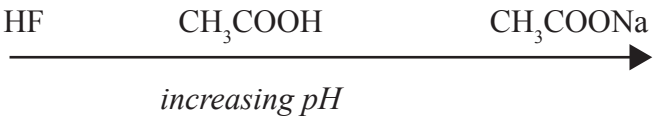


Parahautia te raupapa.

I tō tuhinga, me whakauru:

- ngā kukūtanga o ngā katote *hydronium* ina whakatairitea tētahi mehanga ki tētahi
- te/ngā whārite e hāngai ana.

(c) The pH of three solutions of equal concentration were ranked in order of increasing pH:



Justify the order.

Your answer should include:

- relative concentrations of hydronium ions
- relevant equation(s).

TE TŪMAHI TUATORU

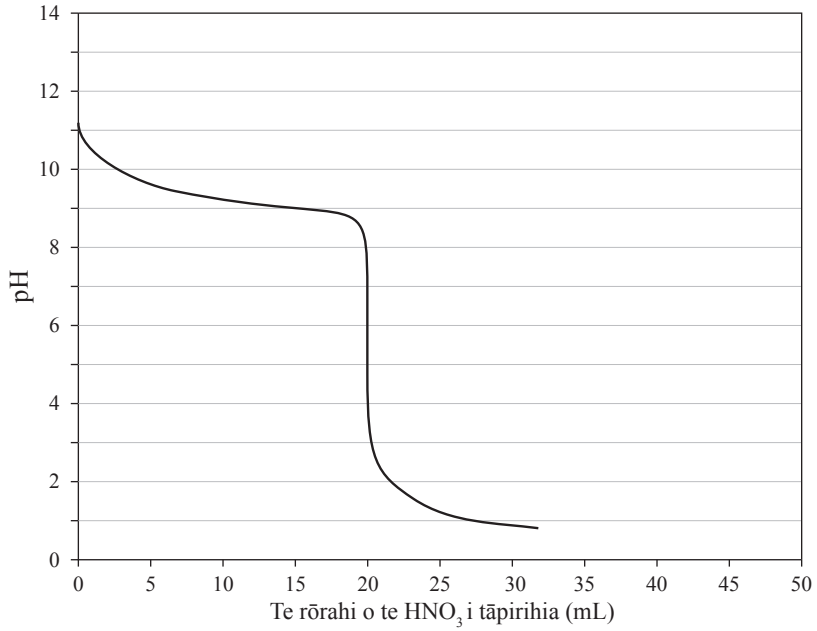
I whakahaerehia tētahi tātairanga kukū mā te tāpiri i te 0.155 mol L^{-1} waikawa hauota, HNO_3, ki te 25.0 mL o te 0.124 mol L^{-1} haukini, NH_3.

Ko te whārite mō te tauhohenga, ko te:

$NH_3 + HNO_3 \rightarrow NH_4^+ + NO_3^-$

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

Te ānau tātairanga kukū mō te NH_3 me te HNO_3



(a) Tātaihia te pH o te mehanga haukini 0.124 mol L^{-1} i mua i te tāpiritanga o te waikawa hauota.

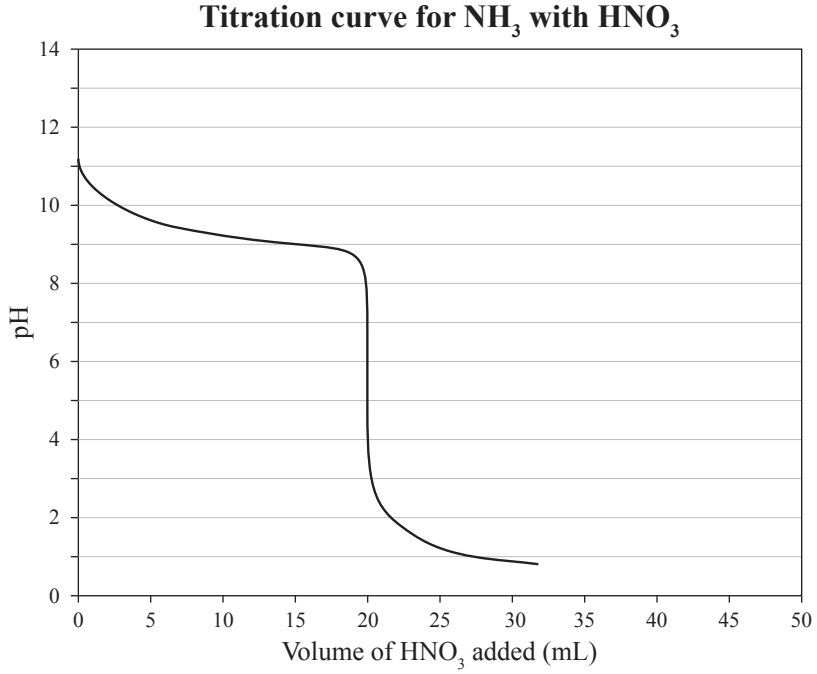
QUESTION THREE

A titration was carried out by adding 0.155 mol L^{-1} nitric acid, HNO_3, to 25.0 mL of 0.124 mol L^{-1} ammonia, NH_3.

The equation for the reaction is:

$$NH_3 + HNO_3 \rightarrow NH_4^+ + NO_3^-$$

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



(a) Calculate the pH of the 0.124 mol L^{-1} ammonia solution before any nitric acid is added.

(b) I te wā ka tāpirihia te HNO_3 ki te mehanga NH_3, ka tauhohe te NH_3 e puta ai ngā katote haukini, NH_4^+.

(i) I muri i te tāpiritanga o tētahi rōrahi HNO_3, he 5:2 te ōwehenga o te NH_3 ki te NH_4^+ i roto i te mehanga.

Tātaihia te pH o tēnei mehanga, ā, me arotake hoki tōna whaitake hei mehanga whakatautika.

(ii) Whakamāramahia mai te hiranga o te pH o te mehanga i roto i te puoto i te pūwaenga ki te pae ōritenga o tēnei tātairanga kukū.

I tō tuhinga, me kōrero mō ngā ōwehenga kukūtanga o ngā hanga e mau mai ana ki roto.

Kāore e hiahiatia ana he tātaitanga.

(b) As HNO_3 is added to the NH_3 solution, the NH_3 reacts to form ammonium ions, NH_4^+.

(i) After a certain volume of HNO_3 has been added, NH_3 and NH_4^+ are present in a 5:2 ratio in the solution.

Calculate the pH of this solution and evaluate its effectiveness as a buffer.

(ii) Explain the significance of the pH of the solution in the flask halfway to the equivalence point of this titration.

Your answer should refer to the relative concentrations of the species present.

No calculations are necessary.

(c) I tētahi tātairanga kukū tuarua, ka tātaihia te kukūtanga o te 25.0 mL o te 0.124 mol L^{-1} konutai winika, CH_3COONa, ki te mehanga 0.155 mol L^{-1} HNO_3.

Ko te whārite mō te tauhohenga, ko te:

$$CH_3COONa + HNO_3 \rightarrow NaNO_3 + CH_3COOH$$

$K_a(CH_3COOH) = 1.74 \times 10^{-5}$ $K_a(NH_4^+) = 5.75 \times 10^{-10}$

(i) Matapaetia te āhua o te whakatairitenga o te pH tuatahi ki te tātairanga kukū ki te NH_3, mā te porohita i tētahi anake o ēnei whakautu:

pH iti iho **pH ōrite** **pH nui ake**

Whakamāramahia mai tō kōwhiringa.

(ii) Matapaetia te āhua o te whakatairitenga o te pH i te pae ōritenga ki te tātairanga kukū ki te NH_3, mā te porohita i tētahi anake o ēnei whakautu:

pH iti iho **pH ōrite** **pH nui ake**

Whakamāramahia mai tō kōwhiringa.

(c) In a second titration, 25.0 mL of 0.124 mol L^{-1} sodium ethanoate, CH_3COONa, is titrated with the 0.155 mol L^{-1} HNO_3 solution.

The equation for the reaction is:

$$CH_3COONa + HNO_3 \rightarrow NaNO_3 + CH_3COOH$$

$K_a(CH_3COOH) = 1.74 \times 10^{-5}$ $K_a(NH_4^+) = 5.75 \times 10^{-10}$

(i) Predict how the initial pH will compare to the titration with NH_3 by circling one answer:

Lower pH **Same pH** **Higher pH**

Explain your choice.

(ii) Predict how the pH at the equivalence point will compare to the titration with NH_3 by circling one answer:

Lower pH **Same pH** **Higher pH**

Explain your choice.

He whārangi anō ki te hiahiatia.
Tuhia te tau tūmahi mēnā e hāngai ana.

TE TAU TŪMAHI

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

QUESTION NUMBER

English translation of the wording on the front cover

Level 3 Chemistry 2022

91392M Demonstrate understanding of equilibrium principles in aqueous systems

Credits: Five

91392M

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.

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 other reference material 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.

Check that this booklet has pages 2 – 19 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.