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See back cover for an English translation of this cover.

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91392M

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Tuhia he (☒) ki te pouaka mēnā kāore koe i tuhi kōrero ki tēnei puka

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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Te Mātai Matū, Kaupae 3, 2024

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.

Kei te Puka Rauemi L3–CHEMR tētahi taka pūmotu me ētahi atu rauemi tautoko.

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

Tirohia kia kitea ai e tika ana te raupapatanga o ngā whārangi 2–23 kei roto i tēnei pukapuka, ka mutu, kāore tētahi o aua whārangi i te takoto kau.

Kaua e tuhi ki tētahi wāhi e kitea ana te kauruku whakahāngai (✂). Ka poroa taua wāhi 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 e puta haere ana i tētahi mehanga kohura o te hiriwa pākawa pungatara, Ag_2SO_4.

(ii) Tuhia te kīanga mō $K_s(Ag_2SO_4)$.

(iii) Tātaihia te mehamehanga o te Ag_2SO_4 i te wai e 25 °C ana te pāmahana, ka whakatakoto ai i te $[Ag^+]$ me te $[SO_4^{2-}]$.

$K_s(Ag_2SO_4) = 1.20 \times 10^{-5}$

(b) Kei raro iho nei tētahi rārangi mehanga e ōrite nei te kukū, e wātea ana ki ngā ākonga hei āpititanga mā rātou ki te mehanga kohura o te Ag_2SO_4:

$HNO_3(aq)$, $Na_2SO_4(aq)$, $NH_3(aq)$, $KNO_3(aq)$

Tīpakohia, parahautia hoki tētahi mehanga e tika ana hei āpititanga mā te ākonga, tae atu ki ngā whārite e hāngai ana:

(i) e kaha ake ai te mehamehanga o te Ag_2SO_4

(ii) e iti iho ai te mehamehanga o te Ag_2SO_4

(c) Matapaetia, mā te tātai, te huanga ake rānei o tētahi huatoka hiriwa pākawa pungatara, Ag_2SO_4, ki te āpitihia te 20.0 mL o te 0.0188 mol L^{-1} o te hiriwa pākawa ota, $AgNO_3$, ki te 30.0 mL o te 0.0146 mol L^{-1} o te konumohe pākawa pungatara, $Al_2(SO_4)_3$.

$K_s(Ag_2SO_4) = 1.20 \times 10^{-5}$

QUESTION ONE

(a) (i) Write the equation for the equilibrium occurring in a saturated solution of silver sulfate, Ag_2SO_4.

(ii) Write the expression for $K_s(Ag_2SO_4)$.

(iii) Calculate the solubility of Ag_2SO_4 in water at 25 °C, and give $[Ag^+]$ and $[SO_4^{2-}]$.

$K_s(Ag_2SO_4) = 1.20 \times 10^{-5}$

(b) Below is a list of solutions of the same concentration available for a student to add to a saturated solution of Ag_2SO_4:

$HNO_3(aq)$, $Na_2SO_4(aq)$, $NH_3(aq)$, $KNO_3(aq)$

Select and justify, including any relevant equations, an appropriate solution the student could add to:

(i) increase the solubility of Ag_2SO_4

(ii) decrease the solubility of Ag_2SO_4

(c) Predict, by calculation, whether a precipitate of silver sulfate, Ag_2SO_4, will form when 20.0 mL of 0.0188 mol L^{-1} silver nitrate, $AgNO_3$, is added to 30.0 mL of 0.0146 mol L^{-1} aluminium sulfate, $Al_2(SO_4)_3$.

$K_s(Ag_2SO_4) = 1.20 \times 10^{-5}$

TE TŪMAHI TUARUA

(a) (i) Whakarārangihia ngā momo katoa kei roto i tētahi mehanga konutai winika, CH_3COONa, kia hāngai ai te raupapa ki te hekenga o te kukūtanga. Kaua e whakaurua te wai.

Na^+	>		>		=	OH^-	>	

(ii) E pai ana kia whakaranua te konutai winika ki te waikawa winika, CH_3COOH, e hua mai ai tētahi mehanga whakatautika (buffer solution).

Whakamāramahia te āhua o te tauhohe o tēnei mehanga whakatautika ki te āpitihia he paku waikawa hauwai pūkane, HBr, ka mutu, tuhia (t)ētahi whārite taurite hei tautoko i tō tuhinga.

(iii) Tātaihia te papatipu o te konutai winika me āpiti ki te 250 mL o te 0.354 mol L^{-1} CH_3COOH e hua mai ai he mehanga whakatautika e 4.11 ana te pH.

Me whakapae koe kāore te rōrahi e rerekē ka āpitihia ana te totoka.

$K_a(CH_3COOH) = 1.74 \times 10^{-5}$ $\quad pK_a(CH_3COOH) = 4.76$ $\quad M(CH_3COONa) = 82.0$ g mol^{-1}

QUESTION TWO

(a) (i) List all the species present in a solution of sodium ethanoate, CH_3COONa, in order of decreasing concentration. Do not include water.

Na^+	>		>		=	OH^-	>	

(ii) Sodium ethanoate can be mixed with ethanoic acid, CH_3COOH, to form a buffer solution.

Explain how this buffer solution would react upon the addition of a small volume of hydrobromic acid, HBr, including a balanced equation(s) to support your answer.

(iii) Calculate the mass of sodium ethanoate that must be added to 250 mL of 0.354 mol L^{-1} CH_3COOH to give a buffer solution with a pH of 4.11.

Assume there is no change in volume when the solid is added.

$K_a(CH_3COOH) = 1.74 \times 10^{-5}$ $pK_a(CH_3COOH) = 4.76$ $M(CH_3COONa) = 82.0$ g mol^{-1}

(b) Kua ngaro ngā tapanga o ngā mehanga kano-kore 0.110 mol L^{-1} e toru, o te CH_3NH_2, o te CH_3COOH, me te NH_4Cl. Ka matapōkere te tapanga o ngā mehanga ki te A, ki te B, me te C. E whakaaturia ana i te tūtohi o raro iho nei te kawenga hiko o ia mehanga, me te kano o te mehanga ka āpitihia ana te taetohu waikawa-pāpāhua, te *bromothymol blue* ($pK_a = 7.2$).

Te mehanga	**Te kawenga hiko**	**Te kano ka āpitihia ana te *bromothymol blue***
A	He koretake	Kōwhai
B	He koretake	Kahurangi
C	He pai	Kōwhai

Tautohua ngā mehanga e toru.

Parahautia tō tautohunga i runga i te nui o te wehewehenga me te kukūtanga hāngai o ngā katote i ia mehanga, tae atu ki ngā whārite e hāngai ana.

Kāore e hiahiatia ana he tātainga.

(b) Three colourless 0.110 mol L^{-1} solutions of CH_3NH_2, CH_3COOH, and NH_4Cl have lost their labels. The solutions are randomly labelled A, B, and C. The electrical conductivity of each solution, and the colour of the solution when the acid-base indicator bromothymol blue ($pK_a = 7.2$) was added, are shown in the table below.

Solution	Electrical conductivity	Colour with bromothymol blue
A	Poor	Yellow
B	Poor	Blue
C	Good	Yellow

Identify the three solutions.

Justify your identification in terms of the degree of dissociation and the relative concentration of ions in each solution, including relevant equations.

No calculations are necessary.

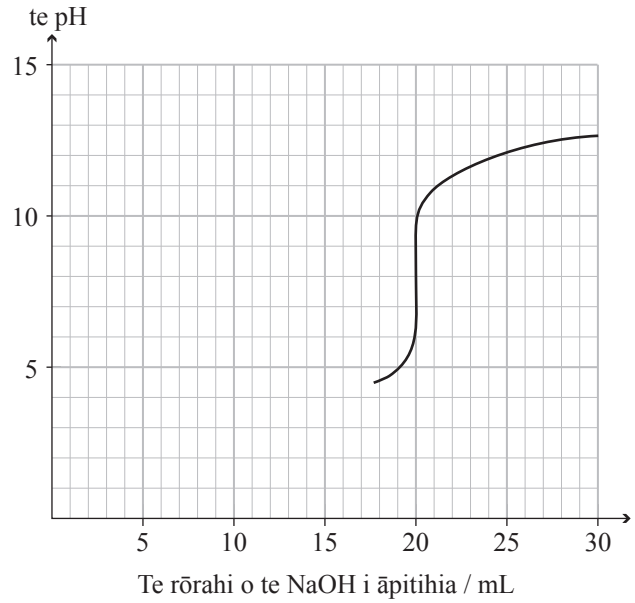
TE TŪMAHI TUATORU

I whakahaerehia tētahi tātairanga kukū mā te tāpiri i te 0.169 mol L^{-1} o te konutai waihā, NaOH, ki te 25.0 mL o te 0.135 mol L^{-1} o te waikawa waikōwhai, HF.

Ko te whārite mō te tauhohenga, ko te:

$HF + NaOH \rightarrow NaF + H_2O$

$K_a(HF) = 6.76 \times 10^{-4}$ $\quad$ $pK_a(HF) = 3.17$



(a) (i) Whakaaturia, mā te tātai, i 2.02 te pH i te tīmatatanga o te mehanga HF.

(ii) Huahuatia te wāhanga o te kōpiko tātairanga kukū e ngaro ana i waenganui i te 0 me te 17.5 mL e oti ai te kōpiko kua tuhia ki runga ake.

Whakaarohia te pH i te tīmatatanga, i mua i te āpitihanga o te 10.0 mL o te NaOH, me te āhua o te kōpiko.

Mēnā me tā anō koe i tō kōpiko, whakamahia te kauwhata kei te whārangi 16.

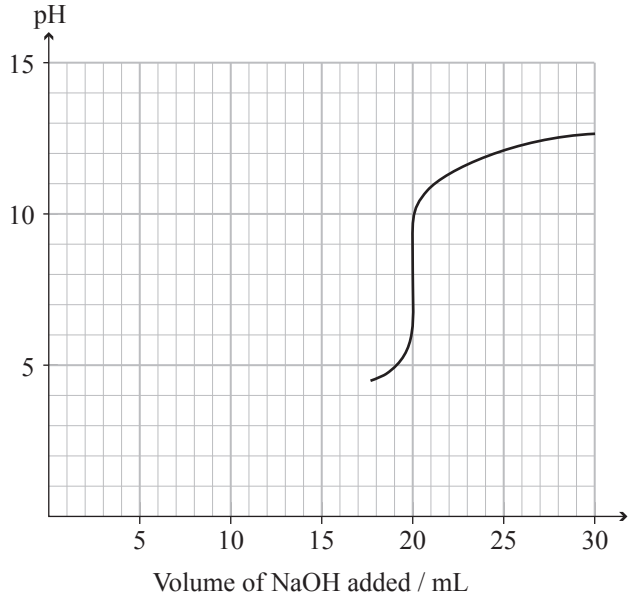
QUESTION THREE

A titration was carried out by adding 0.169 mol L^{-1} sodium hydroxide, NaOH, to 25.0 mL of 0.135 mol L^{-1} hydrofluoric acid, HF.

The equation for the reaction is:

$$HF + NaOH \rightarrow NaF + H_2O$$

$K_a(HF) = 6.76 \times 10^{-4}$ $\quad$ $pK_a(HF) = 3.17$



(a) (i) Show, by calculation, that the initial pH of the HF solution is 2.02.

(ii) Sketch the missing portion of the titration curve between 0 and 17.5 mL to complete the curve provided above.

Consider the initial pH after 10.0 mL of NaOH has been added, and the shape of the curve.

If you need to redraw your curve, use the graph on page 17.

(b) (i) I muri i te tāpiritanga o ētahi NaOH, ka 1:9 te ōwehenga o te HF me te NaF i te mehanga.

Tātaihia te pH o tēnei mehanga, ka arotake ai i tōna kaha ki te whakatautika.

(ii) Parahautia te take e tere piki ai te pH i waenganui i te 18.0 mL me te 22.0 mL.
Kāore e hiahiatia ana he tātainga.

Ka rere tonu te Tūmahi Tuatoru i te whārangi e whai ake ana.

(b) (i) After a certain volume of NaOH has been added, the HF and NaF are present in a 1:9 ratio in the solution.

Calculate the pH of this solution, and evaluate its buffering ability.

(ii) Justify why the pH increases rapidly between 18.0 mL and 22.0 mL.

No calculations are necessary.

Question Three continues on the next page.

(c) (i) Tātaihia te pH hei te pae ōrite (equivalence point).

(ii) I tētahi tātairanga kukū tuarua, ka tātaihia te kukūtanga o te 25.0 mL o te 0.135 mol L^{-1} o te waikawa winika, o te CH_3COOH, ki te mehanga o te 0.169 mol L^{-1} o te NaOH.

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

Matapaetia te āhua o te whakatairitenga o te pH i te pae ōrite ki te tātairanga kukū ki te HF, mā te porohita i tētahi o ngā kōwhiringa o raro iho nei:

He iti iho te pH $\quad$ **He rite te pH** $\quad$ **He nui ake te pH**

Whakamāramatia tō kōwhiringa.

(c) (i) Calculate the pH at the equivalence point.

(ii) In a second titration, 25.0 mL of 0.135 mol L^{-1} ethanoic acid, CH_3COOH, is titrated with the 0.169 mol L^{-1} NaOH solution.

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

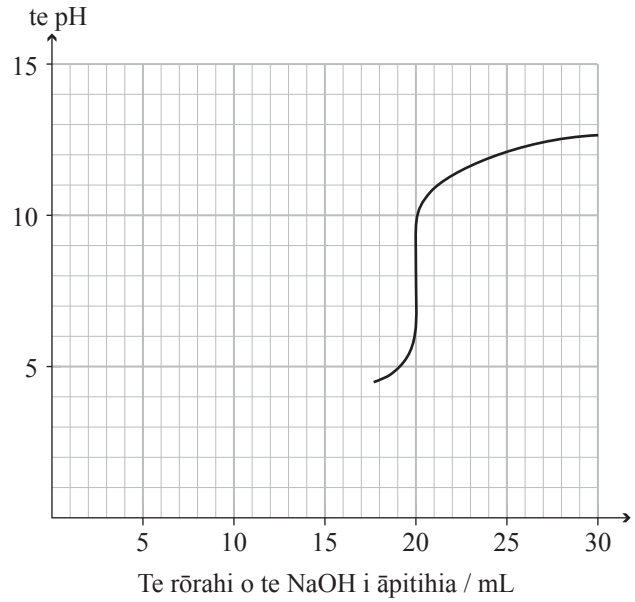
Predict how the pH at the equivalence point will compare to the titration with HF by circling one answer below:

Lower pH $\quad$ **Same pH** $\quad$ **Higher pH**

Explain your choice.

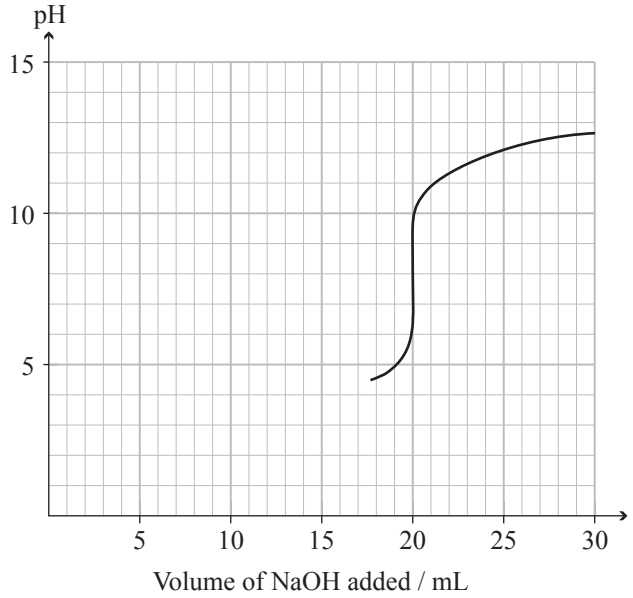
HE HOAHOA WĀTEA

Ki te hiahia koe ki te tā anō i tō whakautu ki te Tūmahi Tuatoru (a)(ii), whakamahia te kauwhata o raro iho nei. Me āta tohu koe i te whakautu e hiahia ana koe kia mākahia.



SPARE DIAGRAM

If you need to redraw your response to Question Three (a)(ii), use the graph below. Make sure it is clear which answer you want marked.



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

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

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Write the question number(s) if applicable.

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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 2024

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–CHEMR.

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 2–23 in the correct order and that none of these pages is blank.

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

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