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91390M

913905

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

91390M Te whakaatu māramatanga ki ngā mātāpono matū rewarau me ngā āhuatanga o ngā korakora me ngā matū

Ngā whiwhinga: E rima

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki ngā mātāpono matū rewarau me ngā āhuatanga o ngā korakora me ngā matū.	Te whakaatu māramatanga ki ngā mātāpono matū rewarau me ngā āhuatanga o ngā korakora me ngā matū, kia hōhonu.	Te whakaatu māramatanga ki ngā mātāpono matū rewarau me ngā āhuatanga o ngā korakora me ngā matū, 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) Whakaotingia te tūtohi kei raro iho nei.

	PF_5	**$SeCl_4^{2-}$**
Te hanganga Lewis		
Te āhua		

(b) (i) E taikaha ana te tauhohe i waenganui i te haumāota pūkōwhai-toru (chlorine trifluoride), $ClF_3(g)$, me te hauwaiota (hydrazine), $N_2H_4(\ell)$. I tūhuratia te pitomata o te hauwaiota hei kora tākiriringi. E whakaaturia ana te tauhohe kei raro iho nei.

$$4ClF_3(g) + 3N_2H_4(\ell) \rightarrow 12HF(g) + 3N_2(g) + 2Cl_2(g)$$

Tātaihia te $\Delta_r H°$ mō te tauhohe, i runga i ngā raraunga e whai nei.

$N_2H_4(\ell) + O_2(g) \rightarrow N_2(g) + 2H_2O(\ell)$ $\quad \Delta_r H° = -623$ kJ mol^{-1}

$2ClF_3(g) + 2NH_3(g) \rightarrow 6HF(g) + N_2(g) + Cl_2(g)$ $\quad \Delta_r H° = -1200$ kJ mol^{-1}

$4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$ $\quad \Delta_r H° = -1270$ kJ mol^{-1}

$H_2O(\ell) \rightarrow H_2O(g)$ $\quad \Delta_{vap} H° = 40.7$ kJ mol^{-1}

QUESTION ONE

(a) Complete the table below.

	PF_5	$SeCl_4^{2-}$
Lewis structure		
Shape		

(b) (i) The reaction between chlorine trifluoride, $ClF_3(g)$, and hydrazine, $N_2H_4(\ell)$, is explosive. It was investigated as a potential rocket fuel. The reaction is shown below.

$$4ClF_3(g) + 3N_2H_4(\ell) \rightarrow 12HF(g) + 3N_2(g) + 2Cl_2(g)$$

Calculate $\Delta_r H°$ for the reaction, given the following data.

$N_2H_4(\ell) + O_2(g) \rightarrow N_2(g) + 2H_2O(\ell)$	$\Delta_r H° = -623$ kJ mol^{-1}
$2ClF_3(g) + 2NH_3(g) \rightarrow 6HF(g) + N_2(g) + Cl_2(g)$	$\Delta_r H° = -1200$ kJ mol^{-1}
$4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$	$\Delta_r H° = -1270$ kJ mol^{-1}
$H_2O(\ell) \rightarrow H_2O(g)$	$\Delta_{vap} H° = 40.7$ kJ mol^{-1}

(ii) Parahautia te take i tūpono noa ake ai te tauhohenga i waenganui i te haumāota pūkōwhai-toru (chlorine trifluride) me te hauwaiota (hydrazine), i runga i ngā panonitanga kaumingomingo o te pūnaha me te takiwā.

$$4ClF_3(g) + 3N_2H_4(\ell) \rightarrow 12HF(g) + 3N_2(g) + 2Cl_2(g)$$

(ii) Justify, in terms of the entropy changes of the system and the surroundings, why the reaction between chlorine trifluoride and hydrazine is spontaneous.

$$4ClF_3(g) + 3N_2H_4(\ell) \rightarrow 12HF(g) + 3N_2(g) + 2Cl_2(g)$$

TE TŪMAHI TUARUA

(a) (i) Kei te tūtohi o raro iho nei te whakatakotoranga irahiko o ngā pūmotu e toru.

Hauhauhā, Ar	Haukura, Ne	Pūtūtaewhetū, P
$1s^2 2s^2 2p^6 3s^2 \mathbf{3p^6}$	$1s^2 2s^2 2p^6$	$1s^2 2s^2 2p^6 3s^2 3p^3$

Ka whakaarohia ana te wāhanga $3p^6$ o te whakatakotoranga irahiko o te hauhauhā, e whakaatu ana ngā mea e whai ake nei i te aha?

3 _____

p _____

6 _____

(ii) Whakaraupapahia ngā pūmotu e toru - te Ar, te Ne, me te P, kia hāngai ai ki te hekenga iho o te pūngao katotetanga tuatahi.

Whakamahia ō mōhiotanga ki ngā ia pūmotu hei parahau i tō whakaraupapatanga.

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(b) Ko ngā momo hanga e rua e taea ana mō te pūkane pūhaumāota-toru (bromine trichloride), $BrCl_3$, ko te pū T me te papapito-toru (trigonal planar). E hāngai ana ēnei hanga e rua ki te takoto ā-koeko-tapatoru e rua (trigonal bipyramidal) o ngā punarua irahiko e karapoti ana i te ngota pū.

E ai ki ngā rangahau, he paku tōrunga tētahi pito, he paku tōraro tētahi pito o te rāpoi ngota $BrCl_3$.

Whakatauritea ngā hanga e rua e taea ana mō te rāpoi ngota $BrCl_3$ hei tautohu i te momo hanga e hua mai ai te rāpoi ngota $BrCl_3$ he paku tōrunga tētahi pito, he paku tōraro tētahi pito.

I tō whakautu, me puta te kōrero mō te hononga tōranga me te whakatakotoranga o ngā hononga whakawhiti irahiko (bond dipoles).

QUESTION TWO

(a) (i) The table below gives the electron configurations of three elements.

Argon, Ar	Neon, Ne	Phosphorus, P
$1s^2 2s^2 2p^6 3s^2 \mathbf{3p^6}$	$1s^2 2s^2 2p^6$	$1s^2 2s^2 2p^6 3s^2 3p^3$

When considering the $3p^6$ part of the electron configuration of argon, what is represented by the following?

3 _____

p _____

6 _____

(ii) Arrange the three elements Ar, Ne, and P, in order of decreasing first ionisation energy.

Use your knowledge of periodic trends to justify your order.

[ ] > [ ] > [ ]

(b) The two possible shapes of bromine trichloride, $BrCl_3$, are T-shaped and trigonal planar. Both of these shapes are based on the trigonal bipyramidal arrangement of electron pairs around the central atom.

Research shows that the $BrCl_3$ molecule is polar.

Compare the two possible shapes of the $BrCl_3$ molecule to identify which shape would result in the $BrCl_3$ molecule being polar.

Your answer should refer to bond polarity and the arrangement of the bond dipoles.

TE TŪMAHI TUATORU

(a) (i) Tautohua ngā momo tōpana pipiri katoa i waenga i ngā korakora o ngā matū kei te tūtohi o raro iho nei ka wē ana te hanga.

Te matū	Te pae koropupū / °C	Ngā tōpana pipiri
Haukini, NH_3	–33	
Pungatara hāora-rua, SO_2	–10	
Pewaro, $CH_3CH_2CH_2CH_2CH_3$	36	

(ii) Whakamāramahia mai te rerekētanga o ngā pae koropupū o te haukini me te pungatara hāora-rua.

QUESTION THREE

(a) (i) Identify all the types of attractive forces between particles of the following substances in their liquid state in the table below.

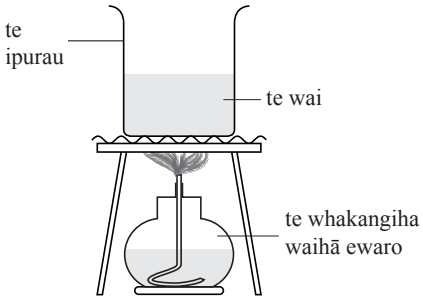
Substance	Boiling point / °C	Attractive forces
Ammonia, NH_3	–33	
Sulfur dioxide, SO_2	–10	
Pentane, $CH_3CH_2CH_2CH_2CH_3$	36	

(ii) Explain the difference in the boiling points of ammonia and sulfur dioxide.

(iii) Whakamāramahia mai te take e wera ake ai te pae koropupū o te pewaro i tērā o te pungatara hāora-rua.

(iii) Explain why the boiling point of pentane is higher than that of sulfur dioxide.

(b) Ka whakataungia te hāwera ngingiha (enthalpy of combustion) o te waihā ewaro, C_2H_5OH, mā te whakamātau ki ngā taputapu o raro iho nei. I ngingiha katoatia te waihā ewaro hei whakawera i te wai i tētahi ipurau.



I tuhia ngā raraunga e whai nei:

- te pāmahana tuatahi o te wai = 22.1 °C
- te pāmahana whakamutunga o te wai = 31.2 °C
- te papatipu tuatahi o te whakangiha me te waihā ewaro = 59.2 g
- te papatipu whakamutunga o te whakangiha me te waihā ewaro = 58.7 g

Ko te tātainga a te ākonga mō te panonitanga o te whakamātaunga hāwera mō te ngingiha o te waihā ewaro e wē ana, $\Delta_c H(C_2H_5OH(\ell))$, ko te -770 kJ mol^{-1}.

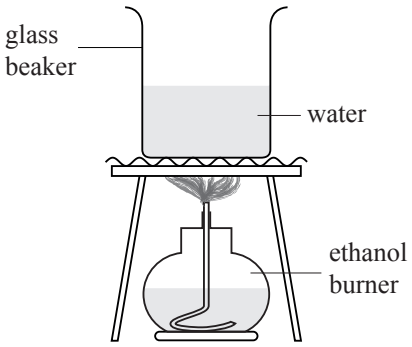
E 4.18 J g^{-1} °C^{-1} te kītanga wera e motuhake ana mō te wai.

$M(C_2H_5OH) = 46.0$ g mol^{-1}

(i) Whakamahia ngā pārongo kua hora hei tātai i te papatipu o te wai i roto i te ipurau.

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

(b) The enthalpy of combustion of ethanol, C_2H_5OH, was determined experimentally using the apparatus below. The ethanol was completely combusted to heat some water in a beaker.



The following data was recorded:

- initial water temperature = 22.1 °C
- final water temperature = 31.2 °C
- initial mass of burner and ethanol = 59.2 g
- final mass of burner and ethanol = 58.7 g

The student calculated the experimental enthalpy change for the combustion of liquid ethanol, $\Delta_c H(C_2H_5OH(\ell))$, to be -770 kJ mol^{-1}.

The specific heat capacity of water is 4.18 J g^{-1} °C^{-1}.

$M(C_2H_5OH) = 46.0$ g mol^{-1}

(i) Use the information provided to calculate the mass of the water that was in the beaker.

Question Three continues on the next page.

(ii) Ko tēhea o ēnei rahinga ka kīia pea he hapa pūtake i te tātainga o te uara o te hāwera? Porohitatia tō whakautu.

te panonitanga o te pāmahana o te wai **te papatipu o te kora i ngingiha**

Whakamāramatia mai tō kōwhiringa.

(ii) Which of these quantities calculated would have been a source of error in the calculated enthalpy value?

Circle your answer.

temperature change of water **mass of fuel combusted**

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

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

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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.

TE TAU TŪMAHI

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QUESTION NUMBER

English translation of the wording on the front cover

Level 3 Chemistry 2024

91390M Demonstrate understanding of thermochemical principles and the properties of particles and substances

Credits: Five

91390M

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of thermochemical principles and the properties of particles and substances.	Demonstrate in-depth understanding of thermochemical principles and the properties of particles and substances.	Demonstrate comprehensive understanding of thermochemical principles and the properties of particles and substances.

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.