91390M

913905

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

Mātauranga Matū, Kaupae 3, 2019

91390M Te whakaatu māramatanga ki ngā tikanga matūrewarau me ngā āhuatanga o ngā korakora me ngā matū

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

Paetae	Kaiaka	Kairangi
Te whakaatu māramatanga ki ngā tikanga matūrewarau me ngā āhuatanga o ngā korakora me ngā matū.	Te whakaatu māramatanga hōhonu ki ngā tikanga matūrewarau me ngā āhuatanga o ngā korakora me ngā matū.	Te whakaatu māramatanga matawhānui ki ngā tikanga matūrewarau me ngā āhuatanga o ngā korakora me ngā matū.

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 2–21 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) Whakaotihia te tūtohi e whai ake nei.

Tohu	Whakanaha irahiko (whakamahia te tuhinga *s, p, d*)
Cr	
Fe^{3+}	
Ge	

(a) Whakaotihia te tūtohi e whai ake nei.

	SF_4	**SF_3^-**
Hanganga a Lewis		
Te ingoa o te hanga		

(c) (i) Whakamāramahia mai he aha i rerekē ai ngā pūtoro o te ngota S me te katote S^{2-}.

	Pūtoro / pm
Ngota S	104
Katote S^{2-}	184

QUESTION ONE

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(a) Complete the following table.

Symbol	Electron configuration (use *s, p, d* notation)
Cr	
Fe^{3+}	
Ge	

(b) Complete the following table.

	SF_4	SF_3^-
Lewis structure		
Name of shape		

(c) (i) Explain why the radii of the S atom and the S^{2-} ion are different.

	Radius / pm
S atom	104
S^{2-} ion	184

(ii) Parahautia te rerekētanga i waenga i ngā tōrarotanga-hiko mō te hāora, te konutai me te pūngāwhā.

MĀ TE KAIMĀKA ANAKE

Pūmotu	Tōrarotanga-hiko
Hāora, O	3.44
Konutai, Na	0.93
Pūngāwhā, S	2.58

(ii) Justify the difference in electronegativities for oxygen, sodium, and sulfur.

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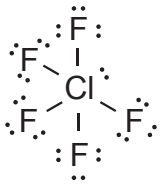
Element	Electronegativity
Oxygen, O	3.44
Sodium, Na	0.93
Sulfur, S	2.58

(d) E whakaaturia ana te hanganga Lewis mō ClF_5 i raro.



Tautohua me te whakamārama i te hanga me te tōranga o ClF_5.

MĀ TE KAIMĀKA ANAKE

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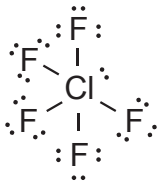
(d) The Lewis structure of ClF_5 is given below.



Identify and explain the shape and polarity of ClF_5.

TŪMAHI TUARUA

MĀ TE KAIMĀKA ANAKE

(a) Ko te whārite o te rehuwaitanga o te owaro he:

$C_6H_{14}(\ell) \rightarrow C_6H_{14}(g)$

Porohitatia te kupu e tino whakaahua ana i tēnei tukanga:

Putawera **Pauwera**

Homai tētahi pūtake mō tō kōwhiringa.

(b) Ko te whārite mō te hanganga o te wē owaro he:

$6C(s) + 7H_2(g) \rightarrow C_6H_{14}(\ell)$

Tātaihia te hāwera noa (standard enthalpy) o te waihanga o te wē owaro, $\Delta_f H°(C_6H_{14}(\ell))$, mā te whakamahi i ēnei raraunga e whai ake nei:

$C_6H_{14}(\ell) + 9.5O_2(g) \rightarrow 6CO_2(g) + 7H_2O(\ell)$

$\Delta_c H°(C_6H_{14}(\ell)) = -4163$ kJ mol^{-1}

$\Delta_c H°(C(s)) = -394$ kJ mol^{-1}

$\Delta_c H°(H_2(g)) = -286$ kJ mol^{-1}

QUESTION TWO

ASSESSOR'S USE ONLY

(a) The equation for the vaporisation of hexane is:

$$C_6H_{14}(\ell) \rightarrow C_6H_{14}(g)$$

Circle the term that best describes this process:

Exothermic **Endothermic**

Give a reason for your choice.

(b) The equation for the formation of liquid hexane is:

$$6C(s) + 7H_2(g) \rightarrow C_6H_{14}(\ell)$$

Calculate the standard enthalpy of formation for liquid hexane, $\Delta_f H°(C_6H_{14}(\ell))$, using the following data:

$$C_6H_{14}(\ell) + 9.5O_2(g) \rightarrow 6CO_2(g) + 7H_2O(\ell)$$

$\Delta_c H°(C_6H_{14}(\ell)) = -4163$ kJ mol^{-1}
$\Delta_c H°(C(s)) = -394$ kJ mol^{-1}
$\Delta_c H°(H_2(g)) = -286$ kJ mol^{-1}

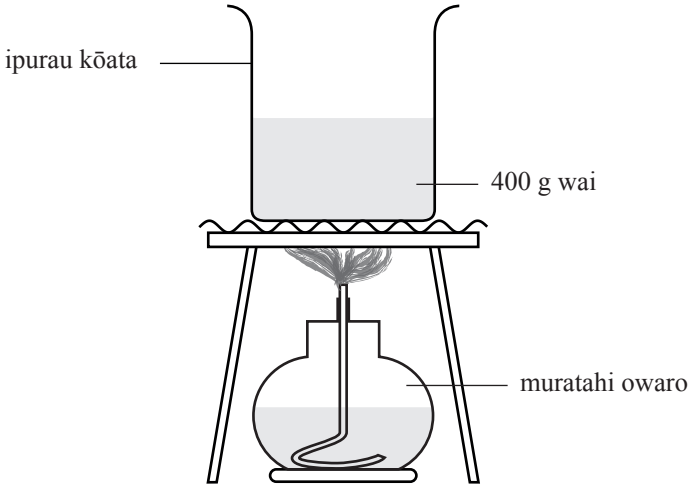
(c) Ka taea te hāwera o te ngingiha o te wē owaro, $\Delta_c H(C_6H_{14}(\ell))$, te whakatau mā te tahu i tētahi papatipu o te owaro e mōhiotia ana me te ine i te panoni o te paemahana i roto i tētahi papatipu o te wai e mōhiotia ana i runga ake o te owaro e tahuna ana.

(i) Mēnā ka tahuna te 5.22 g o te owaro, ka piki te paemahana o te 400 g o te wai mai i te 20.5°C ki 36.7°C.

Mā te whakamahi i ēnei otinga, tātaihia te uara whakamātautau o te $\Delta_c H(C_6H_{14}(\ell))$.

Ko te kītanga wera motuhake o te wai he 4.18 J g^{-1} $°C^{-1}$.

$M(C_6H_{14})$ = 86.0 g mol^{-1}



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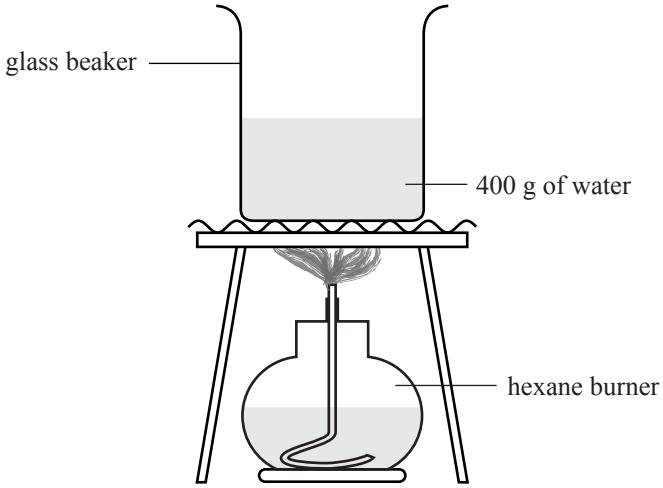
(c) The enthalpy of combustion of liquid hexane, $\Delta_c H(C_6H_{14}(\ell))$, can be determined by burning a known mass of hexane and measuring the temperature change in a known mass of water above the burning hexane.

(i) If 5.22 g of hexane is burned, the temperature of 400 g of water increases from 20.5°C to 36.7°C.

Using these results, calculate an experimental value of $\Delta_c H(C_6H_{14}(\ell))$.

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

$M(C_6H_{14})$ = 86.0 g mol^{-1}



(ii) Whakamāramahia mai he aha i tōraro iho te uara whakamātautau i riro mai i te wāhanga (c)(i) i te uara ariā o -4163 kJ mol^{-1} kei te wāhanga (b).

MĀ TE KAIMĀKA ANAKE

(ii) Explain why the experimental value obtained in part (c)(i) is less negative than the theoretical value of -4163 kJ mol^{-1}, given in part (b).

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TŪMAHI TUATORU

MĀ TE KAIMĀKA ANAKE

(a) Whakarārangihia mai ngā tōpana kume katoa i waenga i ēnei rāpoi ngota i te āhua wē.

Rāpoi ngota	**Pae koropupū / °C**	**Ngā tōpana kume**
Haukini, $NH_3(\ell)$	–33.3	
Ewaro, $C_2H_6(\ell)$	–88.6	
Amine mewaro, $CH_3NH_2(\ell)$	–6.3	

(b) (i) Mā te whakamahi i ngā raraunga kei te tūtohi i runga ake, tautohua te rāpoi ngota he tino kaha rawa te kukume i waenga i ngā rāpoi ngota.

(ii) Parahautia he aha i teitei ake ai te pae koropupū o te amine mewaro i te ewaro.

QUESTION THREE

ASSESSOR'S USE ONLY

(a) List all the forces of attraction between the following molecules in their liquid state.

Molecule	Boiling point / °C	Attractive forces
Ammonia, $NH_3(\ell)$	–33.3	
Ethane, $C_2H_6(\ell)$	–88.6	
Methanamine, $CH_3NH_2(\ell)$	–6.3	

(b) (i) Using the data in the above table, identify the molecule that has the strongest forces of attraction between its molecules.

(ii) Justify why methanamine has a higher boiling point than ethane.

(iii) Parahautia he aha i teitei ake ai te pae koropupū o te amine mewaro i te haukini.

MĀ TE KAIMĀKA ANAKE

(c) Ka tauhohe te haukini, NH_3, ki te mewaro, CH_4, i roto i te tauhohe e whai ake:

$$CH_4(g) + NH_3(g) \rightarrow HCN(g) + 3H_2(g)$$

Tātaihia te panoni hāwera, $\Delta_r H°$, mō tēnei tauhohe, mā te whakamahi i ngā raraunga e whai ake ana.

$\Delta_f H°(NH_3(g))$ = –45.9 kJ mol^{-1}
$\Delta_f H°(CH_4(g))$ = –74.9 kJ mol^{-1}
$\Delta_f H°(HCN(g))$ = +135 kJ mol^{-1}

Ka haere tonu te Tūmahi Tuatoru i te whārangi 18.

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(iii) Justify why methanamine has a higher boiling point than ammonia.

(c) Ammonia, NH_3, reacts with methane, CH_4, in the following reaction:

$$CH_4(g) + NH_3(g) \rightarrow HCN(g) + 3H_2(g)$$

Calculate the enthalpy change, $\Delta_r H°$, for this reaction using the following data.

$\Delta_f H°(NH_3(g))$ = –45.9 kJ mol^{-1}
$\Delta_f H°(CH_4(g))$ = –74.9 kJ mol^{-1}
$\Delta_f H°(HCN(g))$ = +135 kJ mol^{-1}

Question Three continues on page 19.

(d) Ka tauhohe te haukini ki te hāora e ai ki te whārite i raro.

MĀ TE KAIMĀKA ANAKE

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g) \qquad \Delta_r H^\circ = -906 \text{ kJ mol}^{-1}$$

Parahautia, e ai ki ngā panoni o te pūngao ngoikore (entropy) o te pūnaha me te takiwā, he aha i tūpono noa mai ai te tauhohenga.

(d) Ammonia reacts with oxygen according to the equation below.

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g) \qquad \Delta_r H^\circ = -906 \text{ kJ mol}^{-1}$$

Justify, in terms of the entropy changes of the system and surroundings, why the reaction is spontaneous.

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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

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English translation of the wording on the front cover

Level 3 Chemistry, 2019

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

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

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.

91390M

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 2–21 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.