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91390M

913905

SUPERVISOR'S USE ONLY

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Tohua tēnei pouaka mēnā kāore he tuhituhi i roto i tēnei pukapuka

Te Mātauranga Matū, Kaupae 3, 2020

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

2.00 i te ahiahi Rāmere 27 Whiringa-ā-rangi 2020
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 2–19 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

MĀ TE KAIMĀKA ANAKE

TŪMAHI TUATAHI

(a) (i) Tautuhia ngā momo tōpana kume katoa i waenga i ngā korakora o ngā matū e whai ake i te āhua wē.

Matū	Pae koropupū /°C	Ngā tōpana kume
Mewaro pūkane, $CH_3Br(\ell)$	3.6	
Pūkane, $Br_2(\ell)$	59	
Konupūmā pūkane, $CaBr_2(\ell)$	1815	

I runga i ngā kōrero mō te kaha o tēnā tōpana kume, o tēnā tōpana kume i waenga i ngā korakora kei ia matū, parahautia ēnei e whai ake:

(ii) He teitei ake te pae koropupū o te konupūmā pūkane i te mewaro pūkane me te pūkane.

QUESTION ONE

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

Substance	Boiling point / °C	Attractive forces
Bromomethane, $CH_3Br(\ell)$	3.6	
Bromine, $Br_2(\ell)$	59	
Calcium bromide, $CaBr_2(\ell)$	1815	

With reference to the relative strength of the attractive forces between the particles in each substance, justify the following:

(ii) Calcium bromide has a higher boiling point than both bromomethane and bromine.

(iii) He teitei ake te pae koropupū o te pūkane i te mewaro pūkane.

MĀ TE KAIMĀKA ANAKE

(b) Ka memeha noa te konutai waihā totoka, NaOH(*s*), i roto i te wai:

$$NaOH(s) \rightarrow Na^{+}(aq) + OH^{-}(aq) \qquad \Delta_r H^\circ = -44.5 \text{ kJ mol}^{-1}$$

Tātaihia te huringa paemahana ina memeha ana te 1.70 g o te konutai waihā totika i roto i te 35.0 g wai.

Me kī, ko te kītanga pōkākā motuhake o te mehanga konutai waihā he 4.18 J g^{-1} °C^{-1}.

Me kī, ko te papatipu o te mehanga konutai waihā he 36.7 g.

M(NaOH) = 40.0 g mol^{-1}

ASSESSOR'S USE ONLY

(iii) Bromine has a higher boiling point than bromomethane.

(b) Solid sodium hydroxide, $NaOH(s)$, readily dissolves in water:

$$NaOH(s) \rightarrow Na^{+}(aq) + OH^{-}(aq) \qquad \Delta_r H^\circ = -44.5 \text{ kJ mol}^{-1}$$

Calculate the temperature change when 1.70 g of solid sodium hydroxide is dissolved in 35.0 g of water.

Assume the specific heat capacity of the sodium hydroxide solution is 4.18 J g^{-1} $°C^{-1}$.

Assume the mass of the sodium hydroxide solution is 36.7 g.

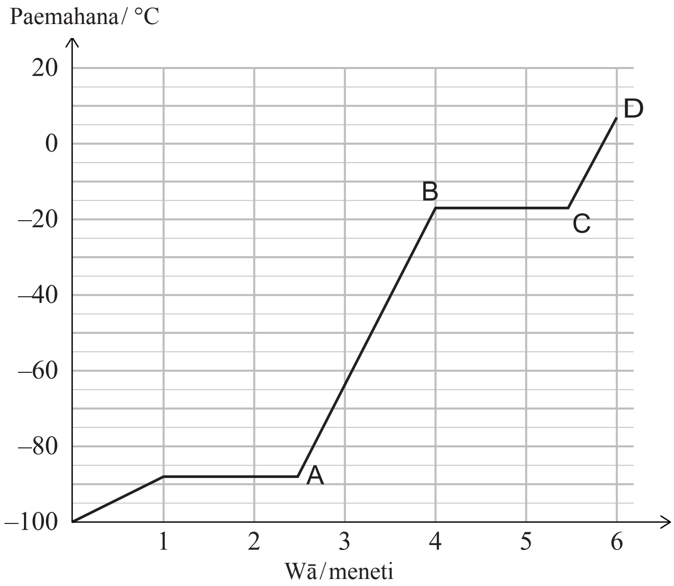
$M(NaOH) = 40.0$ g mol^{-1}

MĀ TE KAIMĀKA ANAKE

TŪMAHI TUARUA

(a) E whakaatu ana te ānau whakawera i te huringa o te paemahana ina ka tukuna te pōkākā aumou ki tētahi tauira o te tipine (stibine), SbH_3, i roto i te ono meneti.

Ānau whakawera mō te tipine



(i) Tuhia te whārite mō te tauhohenga e whai ana i tētahi panoni hāwera e ōrite ana ki te hāwera māori o te rehuwaitanga[1], $\Delta_{vap}H°$, of SbH_3.

(ii) Mō te āhuatanga ki te ānau whakawera mō te tipine, whakamāramahia mai ngā huringa ōkiko i waenga i A me D.

Me kōrero tō tuhinga mō:

- te pūngao me te nekeneke a ngā korakora
- ngā tōpana kume i waenga rāpoi ngota.

[1] whakahaurehu

MĀ TE KAIMĀKA ANAKE

(b) (i) Ka taea te tipine te ōhiki e ai ki te tauhohenga e whai ake:

$$2SbH_3(g) + 3O_2(g) \rightarrow Sb_2O_3(g) + 3H_2O(\ell) \qquad \Delta_r H° = -1868 \text{ kJ mol}^{-1}$$

Tātaihia te hāwera māori o te hanganga o te tipine, $\Delta_f H°(SbH_3)$.

$\Delta_f H°(Sb_2O_3) = -720 \text{ kJ mol}^{-1}$

$\Delta_f H°(H_2O) = -286 \text{ kJ mol}^{-1}$

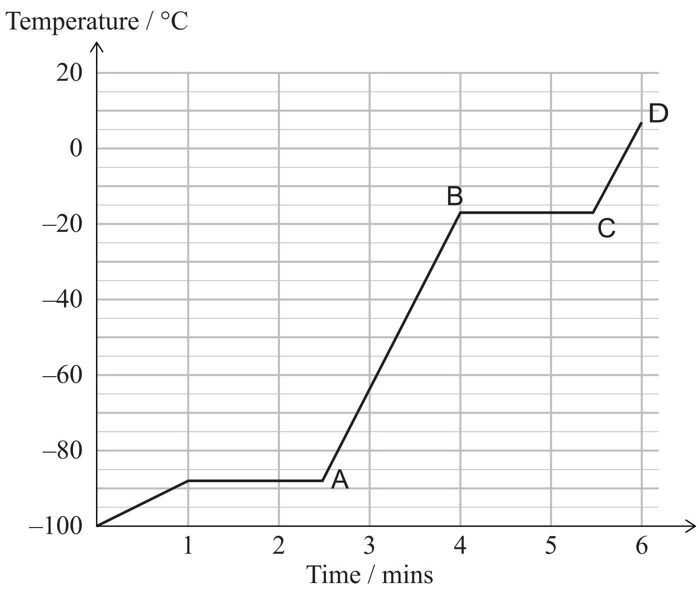
(ii) Me whakamārama mai he aha te take ka rerekē te $\Delta_r H°$ kei (i) mēnā i puta te wai hei haurehu kē, kaua hei wē.

QUESTION TWO

ASSESSOR'S USE ONLY

(a) The heating curve below shows the change in temperature as a sample of stibine, SbH_3, is supplied with a constant amount of heat over a time period of six minutes.

Heating curve for stibine



(i) Write the equation for the reaction that has an enthalpy change equal to the standard enthalpy of vaporisation, $\Delta_{vap}H°$, of SbH_3.

(ii) With reference to the heating curve for stibine, explain the physical changes between points A and D.

Your answer should refer to:

- energy and movement of particles
- intermolecular forces of attraction.

ASSESSOR'S USE ONLY

(b) (i) Stibine can be oxidised according to the following reaction:

$$2SbH_3(g) + 3O_2(g) \rightarrow Sb_2O_3(g) + 3H_2O(\ell) \qquad \Delta_r H° = -1868 \text{ kJ mol}^{-1}$$

Calculate the standard enthalpy of formation of stibine, $\Delta_f H°(SbH_3)$.

$\Delta_f H°(Sb_2O_3) = -720 \text{ kJ mol}^{-1}$

$\Delta_f H°(H_2O) = -286 \text{ kJ mol}^{-1}$

(ii) Explain how the $\Delta_r H°$ provided in (i) would differ if the water was produced as a gas rather than a liquid.

MĀ TE KAIMĀKA ANAKE

(c) Ina tāpirihia te konupūmā totoka, Ca(*s*), ki te ipuipu o te mehanga waikawa pūhaumāota, HCl(*aq*), ka tino kaha te tauhohe o te konupūmā. Ka wera haere te ipuipu, ā, ka puta ake ngā mirumiru hauwai rehu, $H_2(g)$. Ka taea te tauhohenga te whakaatu mā te whārite e whai ake:

$$Ca(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2(g)$$

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

ASSESSOR'S USE ONLY

(c) When solid calcium, Ca(*s*), is added to a test tube of hydrochloric acid solution, HCl(*aq*), the calcium reacts vigorously. The test tube becomes hot, and bubbles of hydrogen gas, $H_2(g)$, are released. The reaction can be represented by the equation below:

$$Ca(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2(g)$$

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

MĀ TE KAIMĀKA ANAKE

TŪMAHI TUATORU

(a) (i) Whakaotihia te tūtohi e whai ake nei.

Tohu	Whakanaha irahiko (whakamahia te tuhinga *s, p, d*)
Mn	
As	
Cu^{2+}	

(ii) Whakamāramahia mai he aha i rerekē ai ngā pūtoro o te ngota Mg me te katote Mg^{2+}.

	Pūtoro / pm
Ngota Mg	160
Katote Mg^{2+}	72

(b) (i) Whakaotihia te tūtohi e whai ake nei.

	BrF_3	PCl_6^-
Hanganga a Lewis		
Ingoa o te hanga		

ASSESSOR'S USE ONLY

QUESTION THREE

(a) (i) Complete the following table.

Symbol	Electron configuration (use *s, p, d* notation)
Mn	
As	
Cu^{2+}	

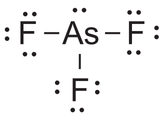
(ii) Explain why the radii of the Mg atom and the Mg^{2+} ion are different.

	Radius/pm
Mg atom	160
Mg^{2+} ion	72

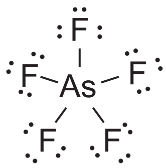
(b) (i) Complete the table below.

	BrF_3	PCl_6^-
Lewis structure		
Name of shape		

(ii) E whakaaturia ana i raro ko ngā hanganga Lewis me ngā ingoa o ngā hanga mō AsF_3 me AsF_5.



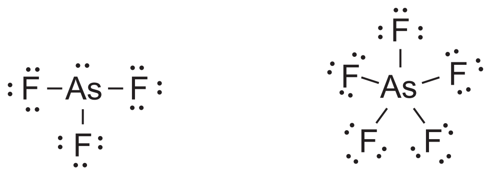
Koeko tapatoru



Koeko-rua tapatoru

Whakatauritea ngā hanga me ngā tōranga o AsF_3 me AsF_5.

(ii) The Lewis structures and shape names for AsF_3 and AsF_5 are shown below.



Trigonal pyramidal Trigonal bipyramidal

Compare and contrast the shapes and polarities of AsF_3 and AsF_5.

ASSESSOR'S USE ONLY

(c) (i) Tuhia te whārite hei whakaatu i te tauhohenga e whai ana i te panoni hāwera e ōrite ana ki te pūngao katotetanga tuatahi mō te pūmotu aheneki, As.

(ii) Parahautia te rerekētanga o ngā pūngao katotetanga tuatahi mō te hauota, te konurehu me te aheneki.

Pūmotu	Te pūngao katotetanga tuatahi / $kJ\ mol^{-1}$
Hauota, N	1407
Konurehu, K	425
Aheneki, As	953

(c) (i) Write the equation to show the reaction that has an enthalpy change equal to the first ionisation energy for the element arsenic, As.

(ii) Justify the difference in first ionisation energies for nitrogen, potassium, and arsenic.

Element	First ionisation energy / kJ mol^{-1}
Nitrogen, N	1407
Potassium, K	425
Arsenic, As	953

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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 2020

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

2.00 p.m. Friday 27 November 2020
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.

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.

91390M