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MANA TOHU MĀTAURANGA O AOTEAROA

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SUPERVISOR'S USE ONLY

Level 3 Chemistry, 2011

90780 Describe properties of particles and thermochemical principles

9.30 am Monday 21 November 2011
Credits: Five

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 is provided on the Resource Sheet 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 2–11 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.

ASSESSOR'S USE ONLY	Achievement Criteria	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe properties of particles and thermochemical principles. ☐	Explain and apply properties of particles and thermochemical principles. ☐	Discuss properties of particles and thermochemical principles. ☐
Overall level of performance ☐		

You are advised to spend 45 minutes answering the questions in this booklet.

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QUESTION ONE

(a) Complete the following table.

Symbol	Electron configuration
Fe	
Al	
Al^{3+}	
Na	

(b) State which has the larger radius, Al or Al^{3+}. Justify your answer.

Larger radius: _____

Justification: _____

(c) (i) Write a balanced ion-electron equation to show the first ionisation of lithium.

(ii) With reference to the graph below, discuss the general trends in ionisation energies from lithium to sodium, and account for any anomalies.

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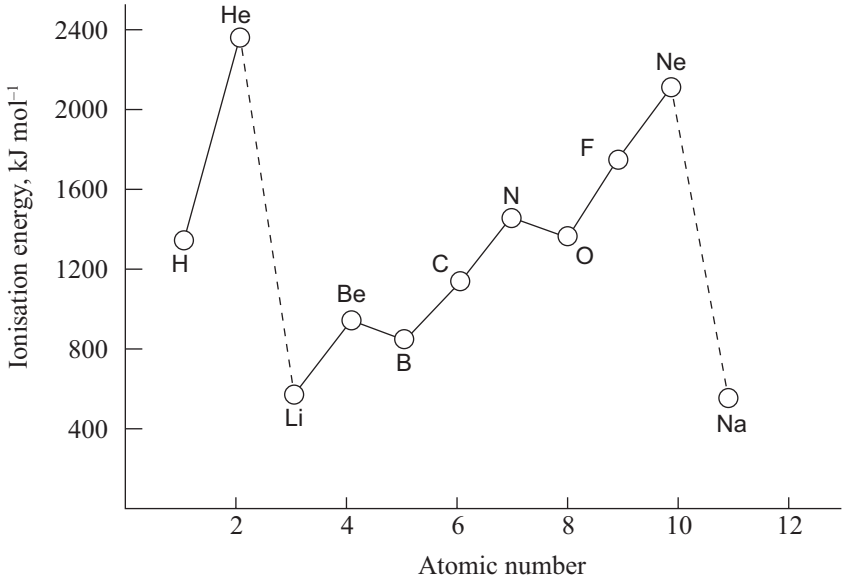
First ionisation energies of the first 11 elements



QUESTION TWO

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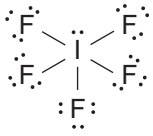
(a) Complete the table below by drawing Lewis diagrams for IF_3 and NF_3, and naming their shapes.

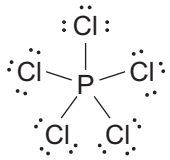
	IF_3	**NF_3**
Lewis diagram		
Shape		

(b) The Lewis diagrams for IF_5 and PCl_5 are shown below.

IF_5



PCl_5



Discuss the polarities of these molecules.

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QUESTION THREE

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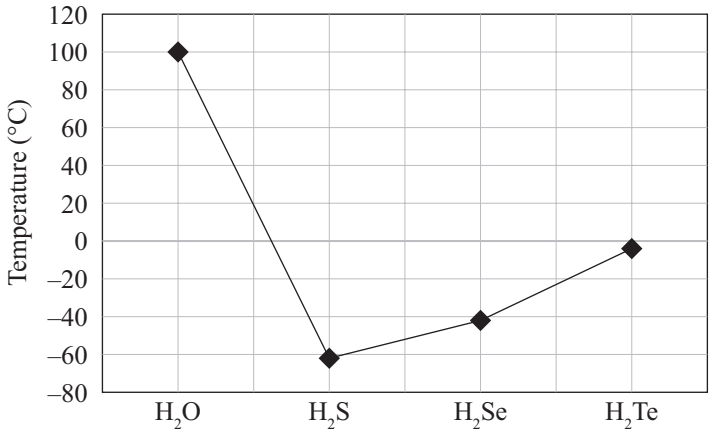
(a) Explain what is meant by the term $\Delta_{vap}H°$.

(b) Discuss the trend in boiling points shown in the graph below for the Group 16 hydrides.

In your discussion:

- explain why H_2O has a much higher boiling point than the other hydrides
- account for the rise in boiling points from H_2S to H_2Te
- compare the boiling points of H_2S, H_2Se and H_2Te, and explain the observed trend in terms of bonding AND mass.

Group 16 hydrides – boiling points



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(c) The equation for the combustion of ethanol is:

$$C_2H_5OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$$

Calculate $\Delta_c H°$ (C_2H_5OH (ℓ)), given the following data:

$\Delta_f H°$ ($C_2H_5OH(\ell)$) = –277 kJ mol^{-1}

$\Delta_f H°$ ($CO_2(g)$) = −394 kJ mol^{-1}

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

QUESTION FOUR

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(a) Explain why $\Delta_f H°$ ($CO_2(g)$) and $\Delta_c H°$ ($C(s)$) have the same value of −394 kJ mol^{-1}.

(b) Complete combustion of methanol can be represented by the following chemical equation:

$$2CH_3OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$$

Use the following bond enthalpies to calculate $\Delta_r H$ for this reaction.

Bond	Bond enthalpy kJ mol^{-1}
C–H	413
C–O	358
O–H	463
C=O	745
O=O	498

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(c) (i) Use the information below to show that the $\Delta_c H°$ of propene, $CH_2{=}CHCH_3(g)$, is $-2\,058$ kJ mol^{-1}.

$$CH_2{=}CHCH_3(g) + H_2(g) \rightarrow CH_3CH_2CH_3(g) \qquad \Delta_r H° = -124 \text{ kJ mol}^{-1}$$

$$CH_3CH_2CH_3(g) \qquad \Delta_c H° = -2\,220 \text{ kJ mol}^{-1}$$

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

Question Four continues on the following page.

(ii) The $\Delta_c H°$ of propene was found experimentally in a school laboratory to be –1 368 kJ mol^{-1}.
The theoretical value is –2 058 kJ mol^{-1}.

Account for the difference in values, and suggest how this difference could be minimised.

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

QUESTION NUMBER

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