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NZQA

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Level 3 Chemistry, 2015

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

2.00 p.m. Wednesday 11 November 2015
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 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 and clearly number the question.

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.

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QUESTION ONE

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(a) Complete the following table.

Symbol	Electron configuration
Al	
Cu^{2+}	
Sc	

(b) Define the terms electronegativity and first ionisation energy.

Electronegativity: _____

First ionisation energy: _____

(c) The following table shows the first ionisation energy values for elements in the third period of the periodic table.

Element	First ionisation energy / kJ mol^{-1}
Na	502
Al	584
Si	793
Ar	1 527

Justify the periodic trend of first ionisation energies shown by the data in the table above, and relate this to the expected trend in atomic radii across the third period.

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QUESTION TWO

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The equation for $\Delta_f H°$ of $H_2O(\ell)$ is:

$H_2(g) + ½O_2(g) \rightarrow H_2O(\ell)$ $\quad -286$ kJ mol^{-1}

(a) (i) Write the equation for $\Delta_c H°$ ($H_2(g)$).

(ii) Using the equations above, explain why $\Delta_c H°$ (H_2) and $\Delta_f H°$ (H_2O) have the same value of -286 kJ mol^{-1}.

(b) The enthalpy of formation would change if the water was formed as a gas rather than a liquid.

(i) Circle the correct phrase to complete the sentence below.

$\Delta_f H°$ ($H_2O(g)$) is:

less negative than / the same as / more negative than $\Delta_f H°$ ($H_2O(\ell)$).

(ii) Justify your choice.

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(c) Calculate the $\Delta_f H°$ for $B_2H_6(g)$, given the following data:

$\Delta_f H°\ (B_2O_3(s))$ $= -1255$ kJ mol^{-1}

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

$B_2H_6(g) + 3O_2(g) \rightarrow B_2O_3(s) + 3H_2O(\ell)$ $\Delta_r H° = -2148$ kJ mol^{-1}

The melting point of boron is 2300°C.

QUESTION THREE

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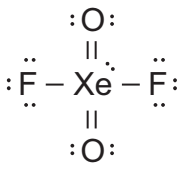
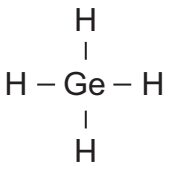
(a) Complete the following table.

	AsF_5	SeF_6
Lewis diagram		
Name of shape		

(b) The Lewis diagrams and shapes for XeO_2F_2 and GeH_4 are shown below.



see-saw



tetrahedral

Compare and contrast the polarities and shapes of these two molecules.

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Question Three continues on the following page.

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(c) The two molecules below have the same molecular formula ($C_5H_{12}O$) but have different boiling points.

Name	Pentan-1-ol	Dimethylpropan-1-ol
Structure	$CH_3-CH_2-CH_2-CH_2-CH_2-OH$	$CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{\displaystyle |}{\underset{\displaystyle |}{C}}}}-CH_2-OH$
Boiling point	138°C	113°C

(i) List all the forces of attraction between these molecules in each of their liquid states.

(ii) Use the information above to explain the difference in the boiling points of pentan-1-ol and dimethylpropan-1-ol by comparing and contrasting the relative strengths of the attractive forces between the molecules involved.

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(d) The equation for the combustion of pentan-1-ol is:

$$C_5H_{12}O(\ell) + 7\frac{1}{2}O_2(g) \rightarrow 5CO_2(g) + 6H_2O(\ell)$$

Calculate $\Delta_c H^\circ$ for pentan-1-ol, given the following data:

$\Delta_f H^\circ$ ($C_5H_{12}O(\ell)$) = −295 kJ mol^{-1}

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

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

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

QUESTION NUMBER

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