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91390

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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

SUPERVISOR'S USE ONLY

Level 3 Chemistry, 2013

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

2.00 pm Tuesday 19 November 2013
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 space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–10 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.

TOTAL

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You are advised to spend 60 minutes answering the questions in this booklet.

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QUESTION ONE

(a) Complete the following table.

Symbol	**Electron configuration**
Se	
V	
V^{3+}	

(b) Discuss the data for each of the following pairs of particles.

(i)

Atom	**Electronegativity**
O	3.44
Se	2.55

(ii)

Atom or ion	**Radius/pm**
Cl	99
Cl^{-}	181

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(iii)

Atom	First ionisation energy / kJ mol^{-1}
Li	526
Cl	1 257

(c) (i) Complete the following table.

Molecule	BrF_3	PCl_6^-
Lewis diagram		
Name of shape		

(ii) The Lewis diagrams for SF_4 and XeF_4 are shown below.

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

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QUESTION TWO

(a) (i) Explain what is meant by the term $\Delta_{vap}H°(H_2O(\ell))$.

(ii) When gaseous hydrogen and oxygen are heated in a test tube, droplets of liquid water form on the sides of the test tube.

Calculate $\Delta_f H°(H_2O(\ell))$, given the following data:

$\Delta_f H°(H_2O(g)) = -242 \text{ kJ mol}^{-1}$

$\Delta_{vap}H°(H_2O(\ell)) = +44 \text{ kJ mol}^{-1}$

(iii) Explain why the temperature of liquid water does not change when it is heated at 100°C.

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(b) (i) When 25.0 mL of a 1.00 mol L^{-1} hydrochloric acid solution, HCl, is added to 25.0 mL of a 1.00 mol L^{-1} ammonia solution, NH_3, a temperature rise of 6.50°C is recorded, as a neutralisation reaction occurs to produce aqueous ammonium chloride and water.

Calculate $\Delta_r H°$ for this neutralisation reaction.

The mass of the mixture is 50.0 g.

Assume specific heat capacity of the aqueous ammonium chloride = 4.18 J g^{-1} $°C^{-1}$

(ii) When the $\Delta_r H°$ for the neutralisation above was found experimentally in a school laboratory, the value obtained was lower than the theoretical value.

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

QUESTION THREE

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(a)

Molecule	Boiling point / °C
Hydrazine, N_2H_4	114
Fluoromethane, CH_3F	–78.4
Decane, $C_{10}H_{22}$	174

Use the information in the table above to compare and contrast the boiling points of hydrazine, fluoromethane, and decane in terms of the relative strengths of the attractive forces between the particles involved.

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(b) Decane is a component of petrol. Carbon dioxide and water are formed when decane burns completely in oxygen.

$$C_{10}H_{22}(\ell) + 15.5O_2(g) \rightarrow 10CO_2(g) + 11H_2O(\ell)$$

Calculate $\Delta_c H°(C_{10}H_{22}(\ell))$, given the following data:

$\Delta_f H°(C_{10}H_{22}(\ell)) = –250 \text{ kJ mol}^{–1}$
$\Delta_f H°(CO_2(g)) = –393 \text{ kJ mol}^{–1}$
$\Delta_f H°(H_2O(\ell)) = –286 \text{ kJ mol}^{–1}$

(c) Hydrazine is often used as a rocket fuel. When liquid hydrazine undergoes combustion, it forms nitrogen and water:

$$N_2H_4(\ell) + O_2(g) \rightarrow N_2(g) + 2H_2O(g) \qquad \Delta_c H°(N_2H_4(\ell)) = –624 \text{ kJ mol}^{–1}$$

Explain why liquid hydrazine readily burns in oxygen.

Your answer should consider both enthalpy and entropy changes.

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

QUESTION NUMBER

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