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Level 2 Chemistry, 2017

91164 Demonstrate understanding of bonding, structure, properties and energy changes

2.00 p.m. Thursday 16 November 2017
Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of bonding, structure, properties and energy changes.	Demonstrate in-depth understanding of bonding, structure, properties and energy changes.	Demonstrate comprehensive understanding of bonding, structure, properties and energy changes.

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 L2–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 2–12 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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QUESTION ONE

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(a) When solid calcium chloride, $CaCl_2(s)$, reacts with water, the temperature increases.

Circle the term that best describes this reaction.

endothermic **exothermic**

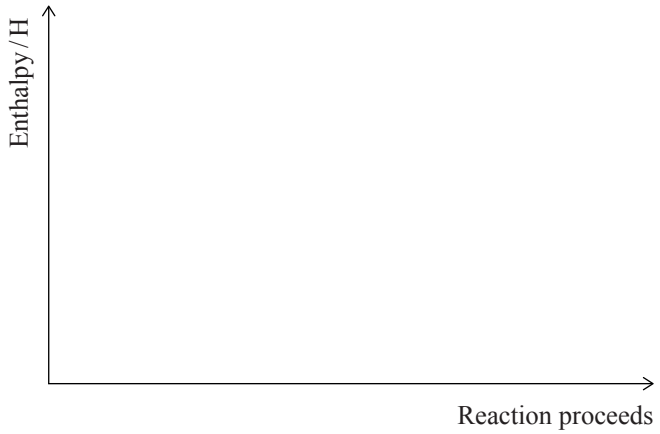
Give a reason for your choice.

(b) When a person sweats, water is lost from the body by evaporation. This is an endothermic process. This evaporation speeds up when a person exercises.

(i) Explain why the evaporation of water in sweat from the body is endothermic, and why exercise increases this evaporation.

(ii) Draw a labelled enthalpy diagram for the evaporation of water, $H_2O(\ell)$.

$H_2O(\ell) \rightarrow H_2O(g)$ $\Delta_r H° = 40.7$ kJ mol^{-1}



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(iii) Sodium chloride, NaCl, is another compound that is excreted from the body in sweat.

Use your knowledge of structure and bonding to explain the dissolving process of sodium chloride, NaCl, in water.

Support your answer with a labelled diagram.

Space for diagram

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(c) Thermite reactions occur when a metal oxide reacts with a metal powder.

The equations for two thermite reactions are given below:

Reaction 1: $Fe_2O_3(s) + 2Al(s) \rightarrow 2Fe(s) + Al_2O_3(s)$ $\Delta_r H° = -852$ kJ mol^{-1}

Reaction 2: $3CuO(s) + 2Al(s) \rightarrow 3Cu(s) + Al_2O_3(s)$ $\Delta_r H° = -1520$ kJ mol^{-1}

Use calculations to determine which metal oxide, iron(III) oxide, $Fe_2O_3(s)$, or copper(II) oxide, $CuO(s)$, will produce more heat energy when 50.0 g of each metal oxide is reacted with aluminium powder, $Al(s)$.

$M(Fe_2O_3) = 160$ g mol^{-1} $M(CuO) = 79.6$ g mol^{-1}

QUESTION TWO

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(a) (i) Draw the Lewis structure (electron dot diagram) for the following molecules, and name their shapes.

Molecule	HOCl	$COCl_2$	NF_3
Lewis structure			
Name of shape			
Approximate bond angle around the central atom	109.5°	120°	109.5°

(ii) Justify the shapes and bond angles of HOCl and $COCl_2$.

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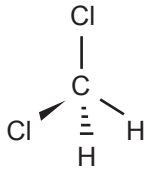
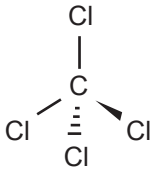
(b) Three-dimensional diagrams for two molecules are shown below.

Molecule		
Name	Dichloromethane	Tetrachloromethane
Polarity of molecule		

(i) In the boxes above, identify the polarity of each molecule, by writing either **polar** or **non-polar.**

(ii) Justify your choices.

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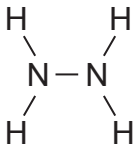
(c) Hydrazine, N_2H_4, is used as rocket fuel.

Use calculations to determine which of **Reaction 1** or **Reaction 2** releases more energy.

Reaction 1: $N_2H_4(g) + O_2(g) \rightarrow N_2(g) + 2H_2O(g)$

Reaction 2: $N_2H_4(g) + 2F_2(g) \rightarrow N_2(g) + 4HF(g)$

The structure of each chemical species is shown in the box below.

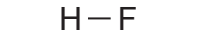

hydrazine


oxygen


fluorine


nitrogen


water


hydrogen fluoride

Use the average bond enthalpies given in the table below.

Bond	Average Bond enthalpy /kJ mol^{-1}	Bond	Average Bond enthalpy /kJ mol^{-1}
H–H	436	N–N	158
H–F	567	F–F	159
N–H	391	O=O	498
O–H	463	N≡N	945

Show your working and include appropriate units in your answer.

QUESTION THREE

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(a) Complete the table below by stating the type of solid, the type of particle, and the type of bonding (attractive forces) between the particles in each solid.

Solid	Type of solid	Type of particle	Attractive forces between particles
Al(*s*) (aluminium)			
$MgCl_2$(*s*) (magnesium chloride)			
S_8(*s*) (sulfur)			

(b) Circle the substance which has the lowest melting point.

Al(*s*) $MgCl_2$(*s*) S_8(*s*)

Justify your choice, referring to the attractive forces between the particles of ALL three substances.

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Question Three continues on the following page.

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(c) Circle the substance which is malleable.

$Al(s)$ $MgCl_2(s)$ $S_8(s)$

Justify your choice by referring to the structure and bonding of your chosen substance.
You may include a diagram or diagrams in your answer.

Space for diagram

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

QUESTION NUMBER

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