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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2 Chemistry, 2014

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

2.00 pm Tuesday 11 November 2014
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 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.

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QUESTION ONE

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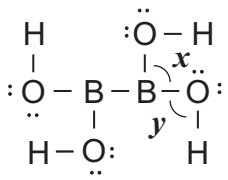
(a) Draw the Lewis structure (electron dot diagram) for each of the following molecules.

Molecule	HCN	CH_2Br_2	AsH_3
Lewis structure			

(b) The Lewis structure for a molecule containing atoms of boron, oxygen, and hydrogen, is shown below.



(i) The following table describes the shapes around two of the atoms in the molecule above.

Complete the table with the approximate bond angles ***x*** and ***y***.

Central atom	**Shape formed by bonds around the central atom**	**Approximate bond angle**
B	trigonal planar	***x*** =
O	bent	***y*** =

(ii) The bond angles ***x*** and ***y*** in the molecule above are different.

Elaborate on why the bond angles are different.

In your answer you should include:

- factors which determine the shape around the:
  - **B** atom for bond angle ***x***
  - **O** atom for bond angle ***y***
- reference to the arrangement of electrons around the **B** and **O** atoms.

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(c) Molecules can be described as being polar or non-polar.

The following diagrams show the Lewis structures for two molecules, **SO_2** and **CO_2**.

Circle the term that describes the **polarity** of each of the molecules.

SO_2	**Polar**	**Non-polar**
CO_2	**Polar**	**Non-polar**

For each molecule, justify your choice.

There is more space for your answer to this question on the following page.

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(d) Hydrogen gas, $H_2(g)$, reacts with oxygen gas, $O_2(g)$, as shown by the following equation

$$H_2(g) + \tfrac{1}{2}O_2(g) \rightarrow H_2O(g) \qquad \Delta_r H^o = -242 \text{ kJ mol}^{-1}$$

Given the average bond enthalpies in the table below, calculate the average bond enthalpy of the **O – H** bond in H_2O.

Bond	**Average bond enthalpy / kJ mol^{-1}**
H – H	436
O = O	498

QUESTION TWO

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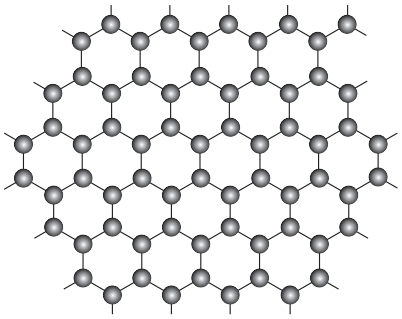
(a) Complete the table below by stating the type of substance, the type of particle, and the type of bonding (attractive forces) between the particles for each of the two substances.

Solid	Type of substance	Type of particle	Attractive forces between particles
Mg(*s*) (magnesium)			
$I_2(s)$ (iodine)			

(b) Graphene is a new 2-dimensional material made of carbon atoms. Graphene can be described as a 'one-atom-thick' layer of graphite. A diagram of graphene and two of its properties is shown below.



Properties of graphene:

Melting point: very high

Electrical conductivity: excellent

Use your knowledge of structure and bonding to explain the two properties of graphene given above.

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(c) Solid Mg and I_2 were tested for three physical properties. The table below shows the results of the tests.

	Physical property		
Substance tested	Ductile	Soluble in cyclohexane (non-polar solvent)	Conducts electricity
Mg	yes	no	yes
I_2	no	yes	no

Use your knowledge of structure and bonding to explain the results of the tests.

QUESTION THREE

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(a) (i) When solid sodium hydroxide is added to water, the temperature increases.

Circle the term that best describes this reaction.

Exothermic **Endothermic**

Give a reason for your choice.

(ii) The freezing of water to form ice can be represented by the following equation.

$$H_2O(\ell) \rightarrow H_2O(s)$$

Circle the term that best describes this reaction.

Exothermic **Endothermic**

Explain your choice.

(b) Use your knowledge of structure and bonding to explain the dissolving process of sodium chloride in water.

Support your answer with an annotated (labelled) diagram.

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(c) Methanol and ethanol can both be used as fuels. Their combustion reactions can be represented by the following equations:

Methanol combustion: $2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ $\Delta_r H^o = -1450$ kJ mol^{-1}

Ethanol combustion: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ $\Delta_r H^o = -1370$ kJ mol^{-1}

Justify which fuel, methanol or ethanol, will produce more heat energy when 345 g of each fuel is combusted in excess oxygen.

$M(CH_3OH) = 32.0$ g mol^{-1}

$M(C_2H_5OH) = 46.0$ g mol^{-1}

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

QUESTION NUMBER

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