No part of the candidate evidence in this exemplar material may be presented in an external assessment for the purpose of gaining credits towards an NCEA qualification.

2

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91164

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Level 2 Chemistry, 2016

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

9.30 a.m. Monday 21 November 2016
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 – 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.

Achievement

TOTAL 08

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QUESTION ONE

(a) Instant cold packs are useful for treating sports injuries on the field. They contain salts such as ammonium nitrate, NH_4NO_3. When the packs are activated, the salt dissolves in water, causing the temperature to decrease.

Circle the term that best describes the dissolving process.

endothermic **exothermic**

Give a reason for your choice.

Decrease in temperature, Release of heat of heat energy. U

(b) The equation for hydrating anhydrous copper sulfate is as follows:

$$CuSO_4(s) + 5H_2O(\ell) \rightarrow CuSO_4.5H_2O(s) \qquad \Delta_r H^\circ = -78.2 \text{ kJ mol}^{-1}$$

Circle the term that best describes this reaction.

endothermic **exothermic**

Give a reason for your choice.

Water forms changes from Liquid to solid causing it to release heat energy U

(c) Pentane, C_5H_{12}, is a liquid at room temperature. It evaporates at 36.1°C in an endothermic process.

(i) Explain why the evaporation of pentane is an endothermic process.

The pentane absorbs the heat energy causing it to evaporate as the heat energy is breaking the C-H bonds. U

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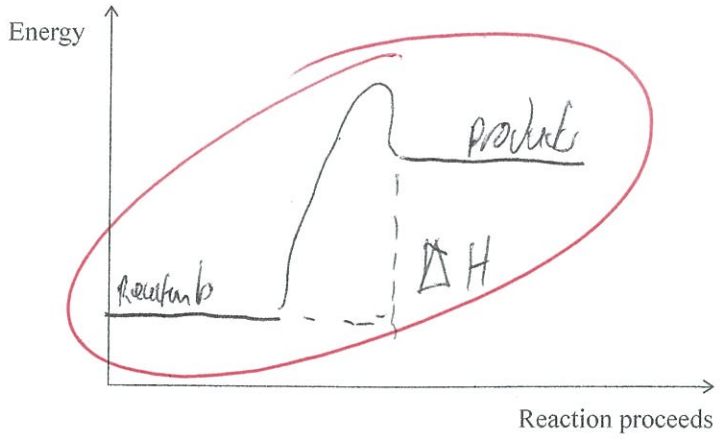
(ii) Draw, including labels, the energy diagram for the combustion of pentane, $C_5H_{12}(\ell)$.

Pentane combustion:

$$C_5H_{12}(\ell) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(\ell) \qquad \Delta_r H^\circ = -3509 \text{ kJ mol}^{-1}$$

Include in your diagram the reactants, products, and change in enthalpy.



(iii) Hexane, C_6H_{14}, like pentane, will combust (burn) in sufficient oxygen to produce carbon dioxide gas and water.

Hexane combustion:

$$2C_6H_{14}(\ell) + 19O_2(g) \rightarrow 12CO_2(g) + 14H_2O(\ell) \qquad \Delta_r H^\circ = -8316 \text{ kJ mol}^{-1}$$

Justify which alkane – pentane or hexane – will produce more heat energy when 125 g of each fuel is combusted in sufficient oxygen.

$M(C_5H_{12}) = 72.0 \text{ g mol}^{-1}$ $M(C_6H_{14}) = 86.0 \text{ g mol}^{-1}$

C5 H12 $n = m/M = 125/72 = 1.736 \text{ mol} \times 1 = 1.736 \times 3509 = 6092 \text{ kJ}$

C6 H14 $n = m/M = 125/86.0 = 1.453 \times 2 = 2.906 \text{ mol}$

$2.906 \times 8316 = 24166 \text{ J}$

The pentane will produce the most heat energy.

A3

QUESTION TWO

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

Substance	Type of substance	Type of particle	Attractive forces between particles
$ZnCl_2(s)$ (zinc chloride)	Ionic	Ions	Ionic
$C(s)$ (graphite)	Metallic	Atom	Inter molecular network
$CO_2(s)$ (carbon dioxide / dry ice)	~~Ionic~~ Covalent	molecule	Inter-molecular

u.

(b) Carbon (graphite) conducts electricity when it is solid, whereas zinc chloride, $ZnCl_2$, will not conduct electricity when solid, but will conduct when molten.

Justify this statement in terms of the particles, structure, and bonding for both substances.

Graphite is ~~one~~ one of the hardest substances in the world. Graphite is a Metallic bonding with atoms in a network these atoms in the network have a strong Inter-molecular forces causing the network to be a solid. It allows to conduct electricity as the outer atoms of the network are free to move/charge being able to pass current. ~~Zinc~~ $ZnCl_2$ is a Ionic bond to make up metal and non-metal Ions. ~~Ions cannot~~ Ionic Compounds cannot pass current when in Ionic form as the bonds are set. When Ionic ~~Ionic~~ substances are melted they have the ability to conduct electricity as ~~they~~ Ions are free to move. ~~Can~~ and can conduct electricity. u

u

(c) Solid zinc chloride, $ZnCl_2(s)$, is soluble in water. Dry ice, $CO_2(s)$, is not readily soluble in water.

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Justify these statements in terms of the particles, structure, and bonding of these substances.

You may include a diagram or diagrams in your answer.

$ZnCl_2$ is soluble in water as the metal and non metal atoms split apart and dissolve in water. ~~CO_2 is a~~ $ZnCl_2$ is a Ionic bond with Ions held together by Ionic bonding. ✓

CO_2 is a ~~ion~~ covalent bond with molecules held together by weak Inter-molecular bonds. CO_2 has the ~~ability to~~ cannot be soluble in water as it is a solid and bonds are really strong and cannot be broken. ✓

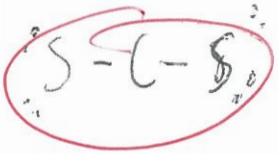
Space for diagrams

N2

QUESTION THREE

ASSESSOR'S USE ONLY

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

Molecule	H_2O	CS_2	PH_3
Lewis structure			
Name of shape	Bent	linear	trigonal pyramid
Approximate bond angle around the central atom	109.5°	180°	109.5°

4.

(ii) Compare and contrast the shapes and bond angles of H_2O, CS_2 and PH_3.

H_2O has a bent shape with bond angles around the O atom of 109.5°. The 2 H atoms try repel as far away from each other as possible causing them to have a bond angle of 109.5 and a Bent shape. CS_2 has maximum repelsion between both S atoms. Since C has no lone pairs, it is a linear shape with bond angles of 180°. PH_3 has 3 H atoms around the central P atom and 1 lone pair on the P atom causing there to be maximum repelsion from the P H atoms and the H atoms try to repel as far away from each other causing the molecule to form a shape of trigonal pyramid with approx. bond angles of 109.5.

(b) The Lewis structures for two molecules are shown.

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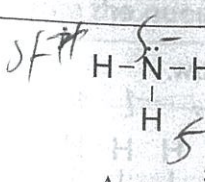
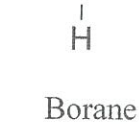
Molecule	 Ammonia	 Borane
Polarity of molecule	polar	non-polar

Ammonia, NH_3, is polar, and borane, BH_3, is non-polar.

Justify this statement.

The NH_3 is polar as the electrons are shared equally shared. ~~The bond is polar~~ The molecule is polar as the dipoles cancel out and molecule is symmetrical. NH_3 has a lone pair on it's central N atom which also why the bond is polar. BH_3 is non non-polar as the H electrons are equally shared ~~equally~~ and the electrons are the same. There is no lone pair. If BH_3 has non-polar bonds the electrons are equally shared. U

~~If The If~~ N is more electronegative than H causing them to attract the electrons and making the bond and molecule polar with non-polar bonds. U

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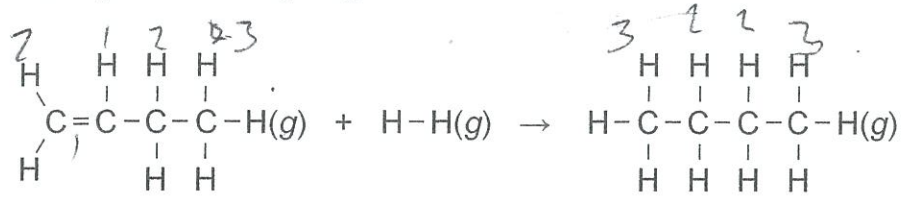
(c) Calculate the enthalpy change, $\Delta_r H°$, for the reaction of but-1-ene gas, $C_4H_8(g)$, with hydrogen gas, $H_2(g)$, to form butane gas, $C_4H_{10}(g)$.

Use the average bond enthalpies given in the table below.



Bond	Average bond enthalpy / kJ mol^{-1}
C=C	614
C–C	346
C–H	414
H–H	436

Bonds broken –

Show your working and include appropriate units in your answer.

4 Bonds Broken $\Delta_r H$ =

2(C-H + C=C + C-H + 2(C-H + 3(C-H + H-H

= (2 x 414) + 614 + 414 + (2 x 414) + (3 x 414) + 436

= 828 + 614 + 414 + 828 + 1242 + 436 =

= 4362 kJ mol^{-1}

Bonds formed

(3 C-H + 2 C-H + 2 C-H + 3 C-H

= (414 x 3) + (2 x 414) + (2 x 414) + (3 x 414)

= 1242 + 828 + 828 + 1242 = 4140 kJ mol^{-1}

Bonds Broken – Bonds formed =

4362 – 4140 = 222 kJ mol^{-1}

4

a

A3

Annotated Exemplar

Achieved exemplar 2016

Subject:	Chemistry	Standard:	91164	Total score:	08

Q	Grade score	Annotation
1	A3	The response for part (a) is incorrect, however part (b) is correct. In part (c)(i) the response states that energy is absorbed but omits the term intermolecular for the bonds broken. For part (c)(ii), the diagram is incorrect drawn (endothermic, not exothermic). For part (c)(iii) energy and moles of pentane are correct, but not for hexane.
2	N2	One row and one column correct in the table in part (a). For part (b), the response states that ions are free to move and can conduct electricity. There is insufficient evidence for part (c).
3	A3	Two diagrams and three shapes are correct in the table in part (a)(i). There is insufficient evidence in part (a)(ii) as it is identified that ‘atoms’ repel, not ‘regions of negative charge’ repel. For part (c)(iii), the two relevant bonds broken are shown. The candidate has forgotten to include Cf C from ‘bonds formed’.