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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.

TOTAL

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QUESTION ONE

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(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.

(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.

(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.

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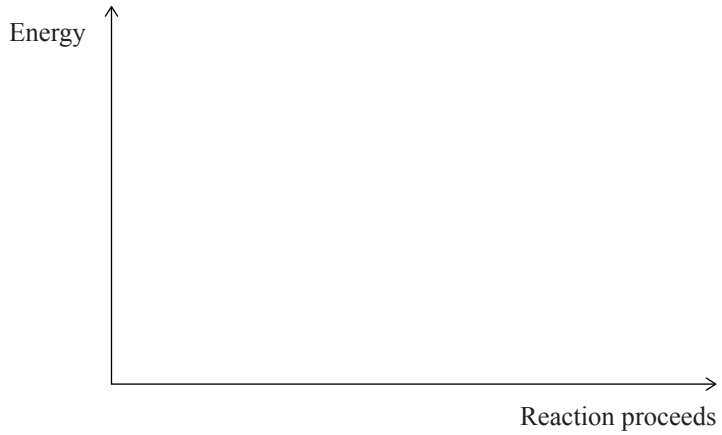
(ii) Draw, including labels, the energy diagram for the combustion of pentane, $C_5H_{12}(\ell)$.

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.

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

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)			
$C(s)$ (graphite)			
$CO_2(s)$ (carbon dioxide / dry ice)			

(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.

(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.

Space for diagrams

QUESTION THREE

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(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			
Approximate bond angle around the central atom	109.5°	180°	109.5°

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

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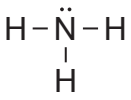
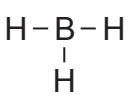
(b) The Lewis structures for two molecules are shown.

Molecule	 Ammonia	 Borane
Polarity of molecule	polar	non-polar

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

Justify this statement.

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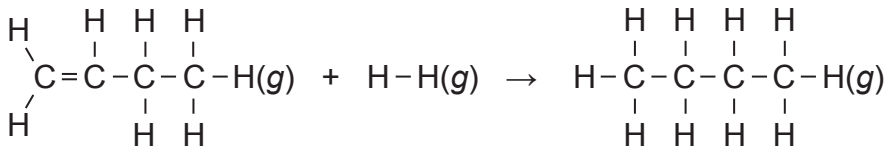
(c) Calculate the enthalpy change, $\Delta_r H°$, for the reaction of but-1-ene gas, $C_4H_8(g)$, with hydrogen gas, $H_2(g)$, to form butane gas, $C_4H_{10}(g)$.

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

Show your working and include appropriate units in your answer.

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

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