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Level 2 Chemistry, 2019

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

2.00 p.m. Monday 11 November 2019
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 in the Resource Booklet 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) 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**
Na(*s*) (sodium)			
NaI(*s*) (sodium iodide)			
I_2(*s*) (iodine)			

(b) Sodium, Na(*s*), is malleable, whereas sodium iodide, NaI(*s*), is brittle.

Explain these observations by referring to the structure and bonding of each substance.

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(c) Compare the solubilities of iodine, $I_2(s)$, in water, $H_2O(\ell)$ – a polar solvent, and in cyclohexane, $C_6H_{12}(\ell)$ – a non-polar solvent.

Use your knowledge of structure and bonding to explain the solubility of iodine in these two solvents.

(d) Ice, $H_2O(s)$, is often placed into drinks. As the ice melts, the drink cools.

$H_2O(s) \rightarrow H_2O(\ell)$ $\Delta_r H = +6.01$ kJ mol^{-1}

Use your knowledge of enthalpy changes associated with changes of state to elaborate on the reason why the drink cools.

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QUESTION TWO

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

Molecule	CH_4	NCl_3	OF_2
Lewis structure			
Name of shape			

(ii) The above molecules have different shapes; however each molecule has an approximate bond angle of 109.5°.

Justify this statement by referring to the factors that determine the shape of each molecule.

There is more room for your answer on the following page.

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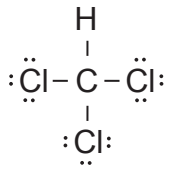
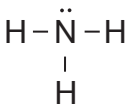
(b) The following table shows the Lewis structures (electron dot diagrams) for the molecules, $CHCl_3$ and NH_3.

Molecule	**$CHCl_3$**	**NH_3**
Lewis structure		
Polarity		

(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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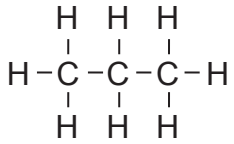
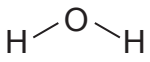
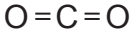
(c) When propane, $C_3H_8(g)$, is burned, it reacts with oxygen, $O_2(g)$, in the air to form water, $H_2O(g)$, and carbon dioxide, $CO_2(g)$.

$$C_3H_8(g) + 5O_2(g) \rightarrow 4H_2O(g) + 3CO_2(g) \qquad \Delta_r H = -2056 \text{ kJ mol}^{-1}$$

Calculate the average bond enthalpy of the C = O bond using the data below.







Bond	Average bond enthalpy/kJ mol^{-1}
C – C	348
C – H	413
O = O	495
O – H	463

QUESTION THREE

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(a) Classify the following chemical process as exothermic or endothermic and give a reason for your choice.

(i) $C(s) + O_2(g) \rightarrow CO_2(g)$ $\Delta_r H = -394$ kJ mol^{-1}

(ii) In the reaction above, C(*s*) in the form of graphite can conduct electricity. The product, carbon dioxide, $CO_2(g)$, does not conduct electricity.

Use your knowledge of structure and bonding to explain this observation.

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(b) When magnesium, Mg(*s*), is burned, it produces a white powder according to the equation below.

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s) \qquad \Delta_r H = -1203 \text{ kJ mol}^{-1}$$

(i) Calculate the mass of oxygen required to produce 1804.5 kJ of energy.

$M(O) = 16.0 \text{ g mol}^{-1}$

(ii) Calculate the energy change when 100 g of MgO(*s*) is produced.

$M(MgO) = 40.3 \text{ g mol}^{-1}$

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(c) A common industrial process is the extraction of metals from their ores. Aluminium is found naturally in aluminium oxide, and the oxygen is removed to produce the metal.

Information is given below of the enthalpy change when aluminium, Al(*s*), is extracted.

$2Al_2O_3(s) \rightarrow 4Al(s) + 3O_2(g)$ $\quad \Delta_r H = 3350$ kJ mol^{-1}

A production plant produces 65.0 kg (65 000 g) of aluminium per minute.

Calculate how much energy is required per hour of production of aluminium.

Round your answer to 3 significant figures.

M(Al) = 27.0 g mol^{-1}

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

QUESTION NUMBER

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