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Level 2 Chemistry 2020

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

9.30 a.m. Thursday 26 November 2020
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.

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QUESTION ONE

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(a) Complete the following table for the given substances in their solid state.

Solid	Type of solid	Type of particle	Attractive forces between the particles
Silicon dioxide $SiO_2(s)$			
Chlorine $Cl_2(s)$			
Potassium chloride $KCl(s)$			

(b) The electrical conductivity of silicon dioxide and potassium chloride in different states is given below.

Substance	Conducts electricity when solid	Conducts electricity when molten
Silicon dioxide, SiO_2	No	No
Potassium chloride, KCl	No	Yes

Use your knowledge of structure and bonding to explain these observations.

(c) Solid potassium chloride, KCl(*s*), is soluble in water. Chlorine gas, $Cl_2(g)$, is not readily soluble in water.

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Use your knowledge of structure and bonding to explain the difference in solubility of these two substances in water.

You should include a diagram in your answer to illustrate the dissolving of KCl(s) in water.

QUESTION TWO

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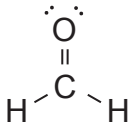
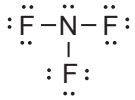
(a) Draw the Lewis structure for each of the following molecules and name their shapes.

Molecule	CS_2	NOCl	CH_2F_2
Lewis structure			
Name of shape			

(b) CH_2O and NF_3 have the same number of atoms in their formulae, but have different shapes and bond angles.

Molecule	CH_2O	NF_3
Lewis structure		
Shape	Trigonal planar	Trigonal pyramid
Bond angle	120°	109.5°

Justify the shapes and bond angles of CH_2O and NF_3.

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(c) A molecular compound consists of two different elements, X and Z, and contains three atoms. Its formula is ZX_2. The elements have different electronegativities.

Depending on the identity of the elements, the molecule could be either polar or non-polar.

(i) State the likely shape if the molecule is:

Polar: _____

Non-polar: _____

(ii) Justify your answer by explaining the factors that affect polarity.

You do not need to identify elements X or Z, or specific molecules.

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

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(d) Sulfur dioxide, $SO_2(g)$, can be made by burning sulfur, $S(s)$, in an excess of oxygen, $O_2(g)$.

$S(s) + O_2(g) \rightarrow SO_2(g)$ $\quad \Delta_r H = -296$ kJ mol^{-1}

Calculate the mass of sulfur burned when 740 kJ of energy is released.

M(S) = 32.1 g mol^{-1}

QUESTION THREE

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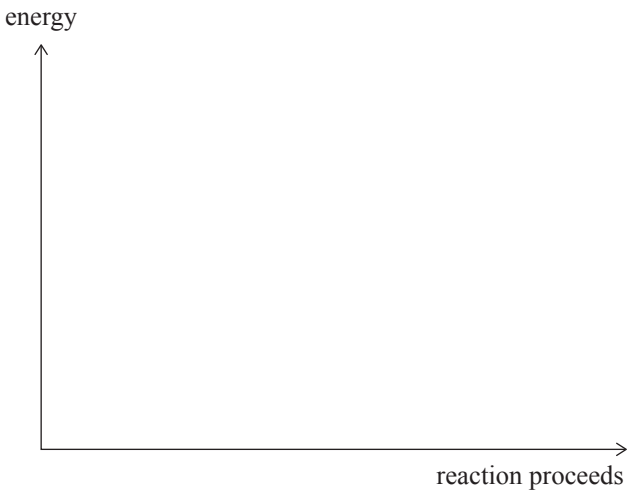
(a) Octane, $C_8H_{18}(\ell)$, is used as a fuel.

The equation for the complete combustion of octane is shown below.

$$2C_8H_{18}(\ell) + 25\,O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g) \quad \Delta_r H = -11\,018 \text{ kJ mol}^{-1}$$

(i) Classify this reaction as endothermic or exothermic, with a reason.

(ii) Complete, including labels, the energy diagram for the combustion of octane showing reactants, products, and the change in enthalpy.



(b) Ethanol, $CH_3CH_2OH(\ell)$, is a liquid at room temperature with a boiling point of 78.4 °C.

Explain whether the change of ethanol from liquid to gas is an endothermic or exothermic process by referring to the attractive forces between particles.

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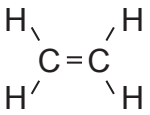
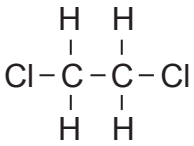
(c) The chlorination of ethene can be shown by the following equation.

$$C_2H_4(g) + Cl_2(g) \rightarrow C_2H_4Cl_2(g) \quad \Delta_r H = -148 \text{ kJ mol}^{-1}$$

Calculate the bond enthalpy of the C – Cl bond using the data below.





Bond	Average bond enthalpy/kJ mol^{-1}
C – C	346
C – H	414
C = C	614
Cl – Cl	242

(d) Ethanol can be burned as a fuel. The equation for its complete combustion is shown below.

$$CH_3CH_2OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$$

When 1.50 kg of ethanol is burned completely, it releases 40 600 kJ of energy.

Use this information to determine the enthalpy, $\Delta_r H$, in kJ mol^{-1} for this reaction.

$M(CH_3CH_2OH) = 46.0$ g mol^{-1}

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

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