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91164

NZQA

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Level 2 Chemistry, 2015

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

9.30 a.m. Monday 23 November 2015
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– 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.

Not Achieved

TOTAL 5

QUESTION ONE

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

Molecule	O_2	OCl_2	CH_2O
Lewis structure	O≡O	:Cl̈–Ö–C̈l:	$\overset{..}{O}$ ‖ H–C–H

(b) Carbon atoms can bond with different atoms to form many different compounds.

The following table shows the Lewis structure for two molecules containing carbon as the central atom, CCl_4 and $COCl_2$. These molecules have different bond angles and shapes.

Molecule	CCl_4	$COCl_2$
Lewis structure	:Cl̈: ‖ :Cl̈–C–C̈l: ‖ :Cl̈:	:Ö: ‖ :Cl̈–C–C̈l:

Evaluate the Lewis structure of each molecule to determine why they have different bond angles and shapes.

In your answer, you should include:

• the approximate bond angle in each molecule

• the shape of each molecule

• factors that determine the shape and bond angle for each molecule.

$COCl_2$ – Trigonal planar
Bond angle: 120°

CCl_4 – Tetrahedral Planar
Bond angle: 109°

(c) $BeCl_2$ and BF_3 are unusual molecules because there are not enough electrons for the central atoms, Be and B, to have a full valence shell. Their Lewis structures are shown below.

:Cl̈–Be–C̈l: :F̈–B–F̈:
                    |
                   :F̈:
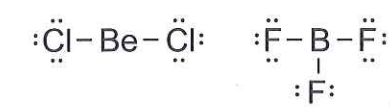
Both molecules have the same polarity.

Circle the word that describes the polarity of these molecules.
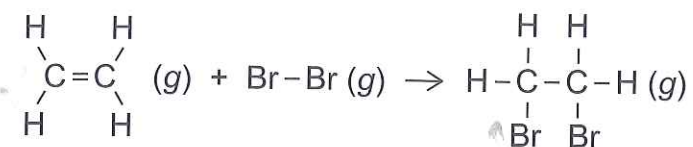
polar   non-polar

Justify your choice.

Both of these molecules are symmetrical, meaning that the dipoles cancel out. As the molecules are symmetrical, there is no polarity, making these molecules non-polar.

(d) Ethene gas, $C_2H_4(g)$, reacts with bromine gas, $Br_2(g)$, as shown in the equation below.

Calculate the enthalpy change, $\Delta_rH°$, for the reaction between ethene and bromine gases, given the average bond enthalpies in the table below.

Show your working and include appropriate units in your answer.

Bond	Average bond enthalpy/kJ mol^{-1}
Br–Br	193
C–C	346
C=C	614
C–Br	285
C–H	414

QUESTION TWO

(a) Hand warmers contain a supersaturated solution of sodium ethanoate which, when activated, crystallises and releases heat.

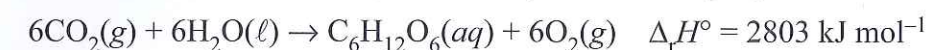Circle the term that best describes this reaction.

exothermic   **endothermic**

Give a reason for your choice.

"Releases heat" = External reaction.
Physical representation of reaction. //

(b) (i) Glucose is made in plants during photosynthesis when carbon dioxide gas, $CO_2(g)$, and water, $H_2O(\ell)$, react to produce glucose, $C_6H_{12}O_6(aq)$, and oxygen gas, $O_2(g)$. The photosynthesis reaction can be represented by the following equation:

$$6CO_2(g) + 6H_2O(\ell) \rightarrow C_6H_{12}O_6(aq) + 6O_2(g) \quad \Delta_rH° = 2803 \text{ kJ mol}^{-1}$$

Circle the term that best describes this reaction.

exothermic   **endothermic**

Give a reason for your choice.

+ve = Exothermic
Energy released > stored energy = observable reaction

(ii) Calculate how much energy is absorbed or released in the photosynthesis reaction if 19.8 g of carbon dioxide gas, $CO_2(g)$, reacts completely with excess water, $H_2O(\ell)$, to form glucose, $C_6H_{12}O_6(aq)$, and oxygen gas, $O_2(g)$.

Show your working and include appropriate units in your answer.
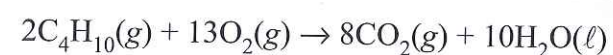
$M(CO_2) = 44.0 \text{ g mol}^{-1}$

(c) A small camp stove containing butane gas, $C_4H_{10}(g)$, is used to heat some water, as shown in the diagram below. A student measures the temperature change in the water and calculates that when 3.65 g of butane is combusted, 106 kJ of heat is released.

- Thermometer
- Metal can
- Water
- Tap
- Small camping gas 'bottle'

GAS
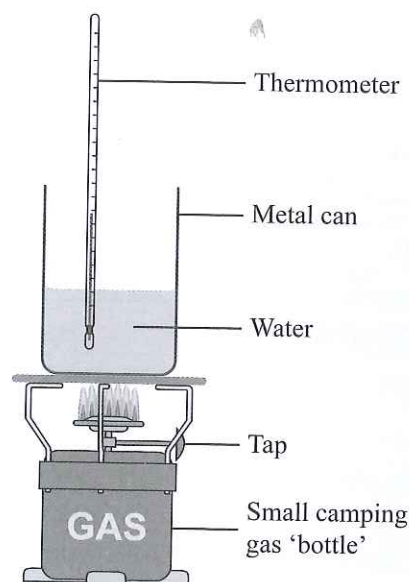
The reaction for the combustion of butane is shown in the equation below.

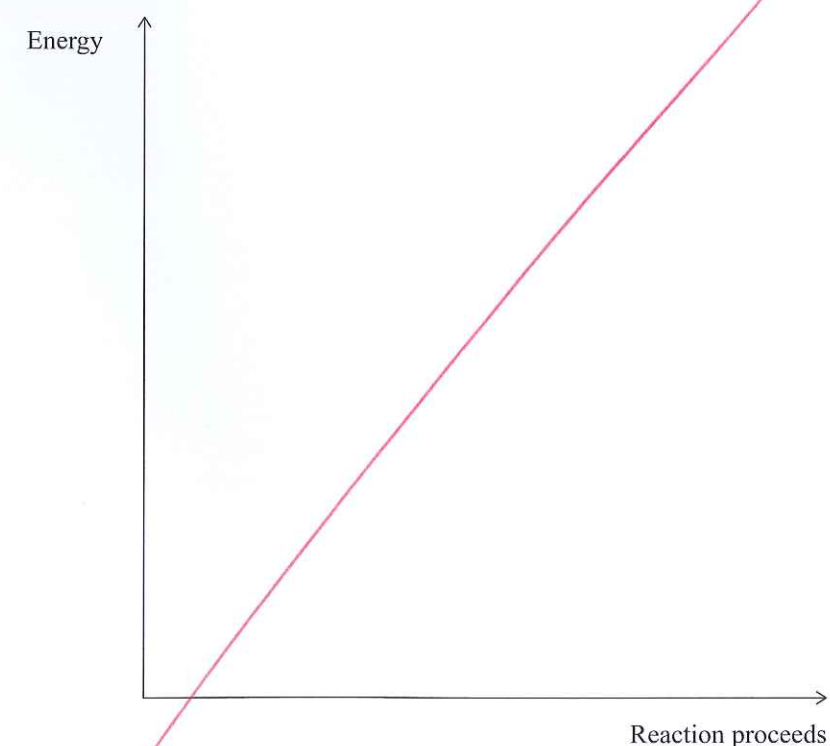$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(\ell)$$

(i) Calculate the enthalpy change ($\Delta_r H$) for this reaction, based on the above measurements.

$$M(C_4H_{10}) = 58.0 \text{ g mol}^{-1}$$

(ii) The accepted enthalpy change for the combustion reaction of butane gas, $C_4H_{10}(g)$, is $\Delta_r H = -5754$ kJ mol^{-1}.

Explain why the result you calculated in part (c)(i) is different to the accepted value.

In your answer, you should include at least TWO reasons.

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

Energy

Reaction proceeds

(iv) Butane gas is a useful fuel because when it undergoes combustion, energy is released.

Explain why energy is released in this reaction, in terms of making and breaking bonds.

No calculations are required.

QUESTION THREE

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

Solid	Type of solid	Type of particle	Attractive forces between particles
Cu(s) (copper)			
PCl$_3$(s) (phosphorus trichloride)			
SiO$_2$(s) (silicon dioxide)			
KCl(s) (potassium chloride)			

(b) Phosphorus trichloride, PCl$_3$, is a liquid at room temperature, and does not conduct electricity.

Explain these two observations in terms of the particles, structure, and bonding of PCl$_3$.

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(c) Consider each of the solids copper, Cu, silicon dioxide, SiO_2, and potassium chloride, KCl.

Complete the table below by identifying which of these solids have the listed physical properties:

Physical properties	Solid
The solid is insoluble in water and is malleable.	Cu
The solid is soluble in water and is not malleable.	KCl
The solid is insoluble in water and is not malleable.	SiO_2

Justify TWO of your choices in terms of the particles, structure, and bonding of these solids. You may use diagrams in your justification.

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

QUESTION
NUMBER

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