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Level 1 Chemistry, 2015

90932 Demonstrate understanding of aspects of carbon chemistry

9.30 a.m. Tuesday 24 November 2015
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of aspects of carbon chemistry.	Demonstrate in-depth understanding of aspects of carbon chemistry.	Demonstrate comprehensive understanding of aspects of carbon chemistry.

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.

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.

Merit

TOTAL 16

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Annotated Exemplar: Merit

Merit exemplar for 90932 2015		Total score	16
Q	**Grade score**	**Annotation**	
1	M5	The candidate has linked the higher boiling point of butane to a greater amount of energy needed to break the intermolecular attractions between molecules, linked an incomplete combustion product (carbon) to an effect on human health, and provided a word equation. If the candidate had fully explained another effect on human health, as well as elaborating in more detail on the effect of carbon, this would have provided evidence towards E8 since the candidate already has the balanced symbol equation.	
2	M6	The candidate has explained that crude oil needs to be separated in order to be useful, completed the symbol equation for the cracking of dodecane, and made links between the size of the hydrocarbon and the relative height it is collected in the tower, as well as the size of the hydrocarbon and its boiling point. If the candidate had explained the process of fractional distillation more fully by comparing separation of the smaller and larger hydrocarbons, as well as explaining that fractions condense as they are removed, this would have provided evidence towards E7 / E8.	
3	M5	The candidate has explained why alcohols are not hydrocarbons, provided balanced symbol equations for both the fermentation of glucose and the complete combustion of ethanol, and linked a product of complete combustion to an environmental effect (carbon dioxide causes global warming / acid rain). If the candidate had fully explained two environmental effects resulting from the products of complete combustion, as well as provided more specific details about the harmful effects of the incomplete combustion of heptane, this would have provided evidence towards E8 since the candidate already has the two required balanced symbol equations.	

QUESTION ONE

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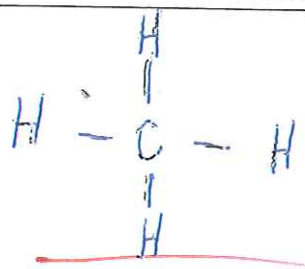
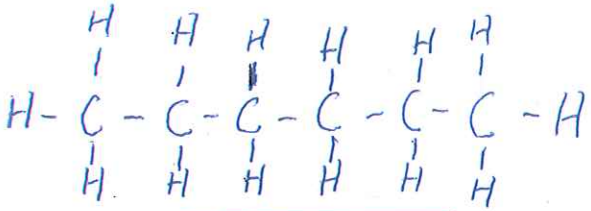
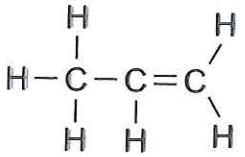
(a) Complete the table below by naming or drawing the structure of each organic compound.

Name	Structure
Methane	
Hexane	
Propene	

(b) Butane and propane are both used as fuel in camping burners.
Propane has a boiling point of –42°C.

(i) What state would propane be at room temperature (18°C)?

Gas

(ii) State whether the boiling point of butane will be higher or lower than propane.

Give a reason for your answer using your knowledge of the structure and properties of alkanes.

Boiling point of butane would be: **higher** **lower**
(*circle correct answer*)

Reason: This is because butane has more carbon atoms, which means more hydrogen atoms which means the mass of butane is heavier than the mass of propane. Because of this, the energy necesary to break apart intermolecular attractions between molecules needs to be larger than the energy necesary to break down intermolecular attractions between ~~the atoms in~~ propane. So the

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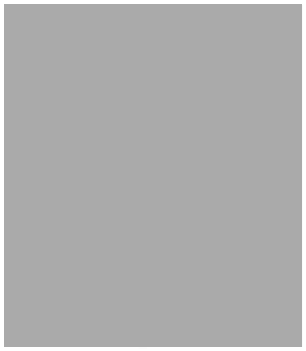
(c) Camping burners usually have a warning notice instructing people to always use them in a well-ventilated place (plenty of oxygen) otherwise serious injury or death may occur.



http://www.huntingandfishing.co.nz/camping-tramping/cookware-coolers/msr-pocket-rocket-stove.html

Elaborate on why this warning is given on camping burners.

Use a burner that contains **propane** as an example.

In your answer, you should:

- state the type of combustion reaction that occurs when there is a shortage of oxygen
- describe the observations that may be seen if there was a shortage of oxygen, and link these to the reaction occurring
- explain two effects that the combustion products can have on human health when there is a shortage of oxygen
- write a word equation and a balanced symbol equation for the reaction occurring.

When there is a shortage of oxygen in a combustion reaction, it is called incomplete combustion. When incomplete combustion occurs either carbon monoxide is formed or carbon in the form of soot, and water is formed. Carbon monoxide is a poisonous gas which affects human health and the soot, or carbon assists in smog pollution which can cause lung problems for humans.

Word equation:

$C_3H_8 + 3\frac{1}{2}O_2 \longrightarrow 3CO + 4H_2O$

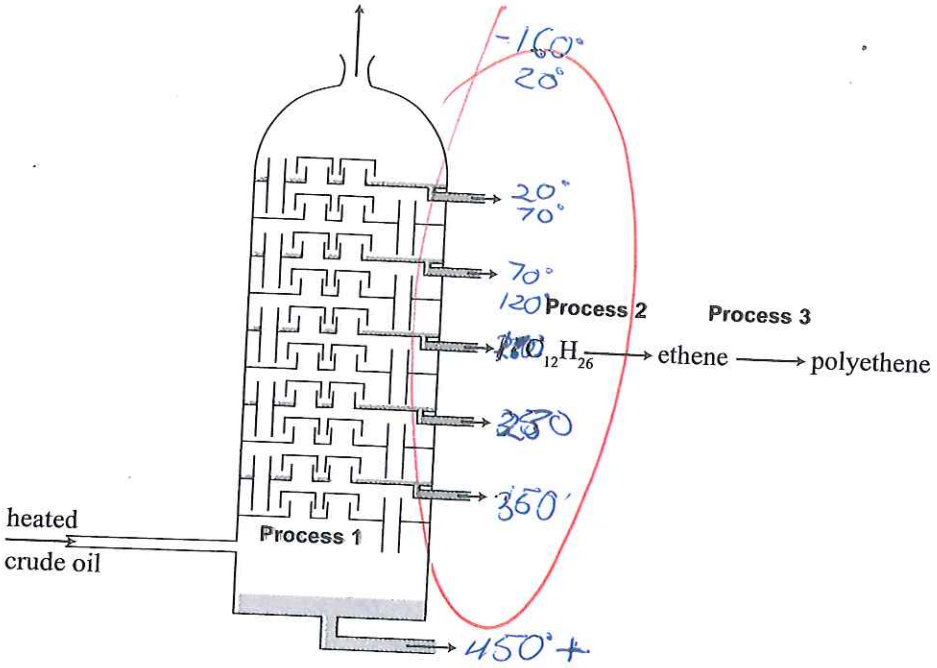
Balanced symbol equation:

Propane + Oxygen → Carbon Monoxide + Water

M5

QUESTION TWO

Crude oil, a mixture of many compounds, undergoes several processes to produce useful products. The diagram below shows three of the processes that may be involved.



(a) (i) Give the name of each of the processes identified in the diagram above.

Process	Name of process
1	Fractional Distillation
2	Cracking
3	Polymerisation

(ii) Explain how the structure of ethene allows it to undergo **Process 3**, to form polyethene.

Ethene is an alkene, which is a hydrocarbon with at least one double covalent bond between atoms. When polymerisation occurs, the ethene is saturated, or fully seperated having only a single covalent bond between atoms*, which are then tangled and linked together in multiple repeating units to form the polymer, Polyethene.

* called monomers.

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(b) Dodecane, $C_{12}H_{26}$, can be reacted in **Process 2**, to form ethene and octane.

(i) State one condition that is needed during **Process 2**.

A high temperature and lots of pressure and/or a catalyst.

(ii) Complete the following symbol equation for the reaction of dodecane during **Process 2**.

Remember to balance the equation.

$C_{12}H_{26} \rightarrow C_2H_4 + C_8H_{18}$

(c) Give a detailed account of **Process 1**, as shown in the diagram on the opposite page.

In your answer, you should:

- explain why **Process 1** is necessary
- elaborate on what occurs during **Process 1**, and link this to the structure and properties of the hydrocarbons in crude oil.
- name two products, other than dodecane, that are formed during **Process 1**.

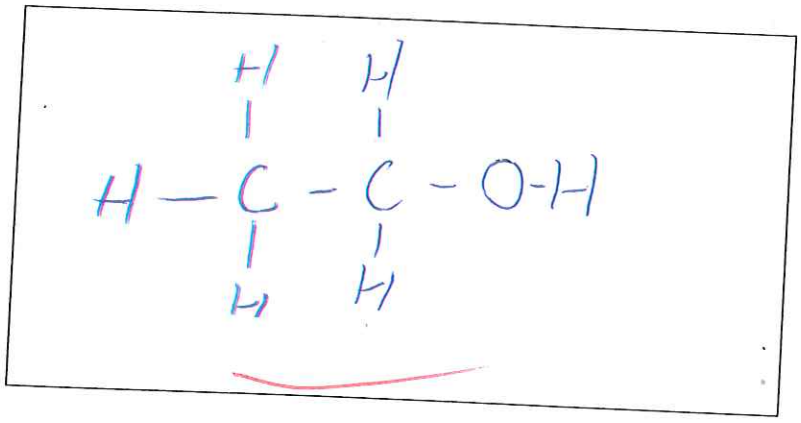
Fractional distillation occurs because crude oil is a mixture of different alkanes which all have different boiling points and are of different states (gas, liquid and solid). As crude oil they do not have a use, but as seperate products the all have very important uses, which is why the process is necesary. During the process, the crude oil is heated and put into a column in which the temperature increases, as the gas of crude oil rises. At certain intervals there are trays to catch the alkanes that have risen past their boiling point and become liquids. The smaller alkanes (methane, ethane, propane) rise higher than the larger alkanes (dodecane, octane, Heptane) because the smaller the alkane, the lower the boiling as the intermolecular attraction between molecules are stronger as the amount of the molecules increase. Two products formed by fractional distillation are paraffin

M6

QUESTION THREE

Alcohols, such as ethanol, are carbon compounds, but are not hydrocarbons like alkanes and alkenes.

(a) (i) Draw the structural formula of ethanol in the box below.



(ii) Explain why alcohols are not hydrocarbons, but alkanes and alkenes are.

Hydrocarbons are molecules that contain only hydrogen and carbon atoms, which alkanes and alkenes do, which is why they are hydrocarbons, but alcohols also contain oxygen, therefore they are a carbohydrate

(iii) Describe how a sample of ethanol could be distinguished from a sample of octane using only water.

Explain how the physical properties of the compounds allow them to be identified in this way.

Alcohols such as ethanol are soluble in water due to the fact that both oxygen and hydrogen atoms are present in an alcohol, whereas, all hydrocarbons are insoluble in water as they are only made up of only carbon and hydrogen atoms. Because of this physical property, water can be used to distinguish a sample of ethanol from a sample of octane as when put in water, the ethanol will dissolve whereas the octan will not

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(b) One method of producing ethanol is by fermentation.

Explain how ethanol is produced by fermentation.

In your answer, you should:

- complete the following word equation and balanced symbol equation
- identify and elaborate on any conditions required for fermentation to occur.

Word equation:

glucose $\xrightarrow{\text{Yeast}}$ Ethanol + Carbon Dioxide

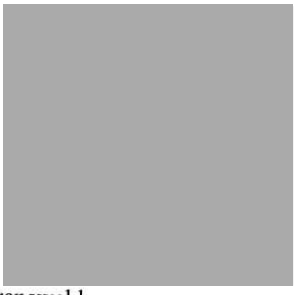
Balanced symbol equation:

$C_6H_{12}O_6 \xrightarrow{\text{Yeast}} 2C_2H_5OH + 2CO_2$

For fermentation to occur, the glucose and yeast need to be heated at a very high temperature as it catalyses the reaction,

(c) Ethanol made from sugar cane can be mixed with petrol to produce a biofuel for cars.

Ethanol burns in air with an almost invisible flame, and has some useful advantages as a biofuel compared to some hydrocarbons found in petrol, such as heptane, C_7H_{16}.



www.renewablegreenenergypower.com/biofuel-101/

Evaluate the use of ethanol in biofuels for cars.

In your answer, you should:

- state the type of combustion reaction that ethanol usually undergoes, and name the products formed
- explain two effects that the combustion products of ethanol can have on the environment
- elaborate on the advantages of using ethanol as a biofuel compared to hydrocarbon fuels, such as those containing heptane
- include a balanced symbol equation for the combustion of ethanol.

The type of combustion occuring is complete combustion, in which Carbon dioxide and water are formed in a gaseous state. An effect the carbon dioxide formed by complete combustion has on the environment is it increases global warming. ~~It has~~ Carbon dioxide is also a component in acid rain, which is damaging to some plant life. Ethanol is a better biofeul to use in comparison to heptane, because they burn ~~incomplete~~ incompletely with a yellow flame, which is more harmful to the environment than ethanol is, due to the products formed.

Balanced symbol equation:

$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ //

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

QUESTION NUMBER

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