

No part of the candidate evidence in this exemplar material may be presented in an external assessment for the purpose of gaining credits towards an NCEA qualification.

1

90932



909320



NEW ZEALAND QUALIFICATIONS AUTHORITY  
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD  
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

SUPERVISOR'S USE ONLY

## 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.**

**Excellence**

**TOTAL**

**24**

ASSESSOR'S USE ONLY

## Annotated Exemplar: Excellence

Excellence exemplar for 90932 2015			Total score	24
Q	Grade score	Annotation		
1	E8	The candidate has provided a balanced symbol equation for the incomplete combustion of propane, and fully explained two effects that the combustion products can have on human health, i.e carbon can cause asthma and heart disease, and carbon monoxide can cause oxygen starvation.		
2	E8	The candidate has explained the process of fractional distillation by linking the size of the hydrocarbon molecules to their boiling points and therefore the relative position at which they will condense in the tower.		
3	E8	The candidate has provided balanced symbol equations for both the fermentation of glucose and the complete combustion of ethanol, explained two of the environmental effects of the complete combustion of ethanol (global warming and ocean acidification), and given an advantage of ethanol over heptane (ethanol a renewable).		

## QUESTION ONE

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

Name	Structure
Methane	$\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{H} \\   \\ \text{H} \end{array}$
Hexane	$\begin{array}{ccccccc} \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \\   &   &   &   &   &   &   \\ \text{H}-\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\   &   &   &   &   &   \\ \text{H} & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} \end{array}$
<u>Propene</u>	$\begin{array}{ccccc} \text{H} & & \text{H} & & \\   & & = & &   \\ \text{H}-\text{C} & -\text{C} & =\text{C} & & \text{H} \\   &   & & &   \\ \text{H} & \text{H} & & & \text{H} \end{array}$

- (b) Butane and propane are both used as fuel in camping burners.  
 Propane has a boiling point of  $-42^{\circ}\text{C}$ .

- (i) What state would propane be at room temperature ( $18^{\circ}\text{C}$ )?

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:  
(circle correct answer)

higher

lower

Reason: For straight carbon chain alkanes, there is a trend that the longer the chain length, the higher the boiling point. In this case butane has 4 carbon atoms whereas propane only has 3.

Butane has 1 more carbon atom, therefore it's larger in mass, this means that it has stronger intermolecular forces of attraction between neighbouring butane molecules, therefore require more heat energy to fully overcome those attractive forces. So butane has a higher boiling point than propane.

- (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.

Elaborate on why this warning is given on camping burners.

Use a burner that contains propane as an example.

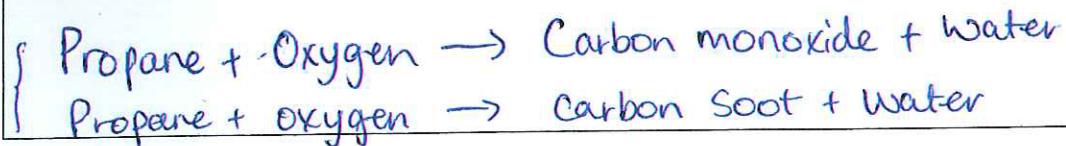
In your answer, you should:

- ✓ 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.

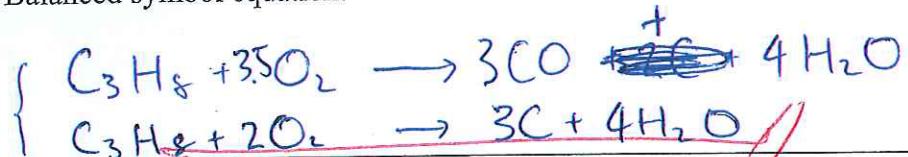
- When the oxygen supply is not sufficient, incomplete combustion occurs, which produces Carbon soot and/or carbon monoxide gas and water.
- When propane is burning without sufficient energy, it undergoes incomplete combustion and it can be observed as burning in a yellow-orange flame. The carbon solids glow a orange hue, so the sooty flame (contains Carbon soot) has the orange colour. The orange colour is also less hot compared to the blue flame which is seen during complete combustion, as incomplete combustion is not energy efficient, therefore cannot produce the maximum amount of energy.

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

Word equation:



Balanced symbol equation:

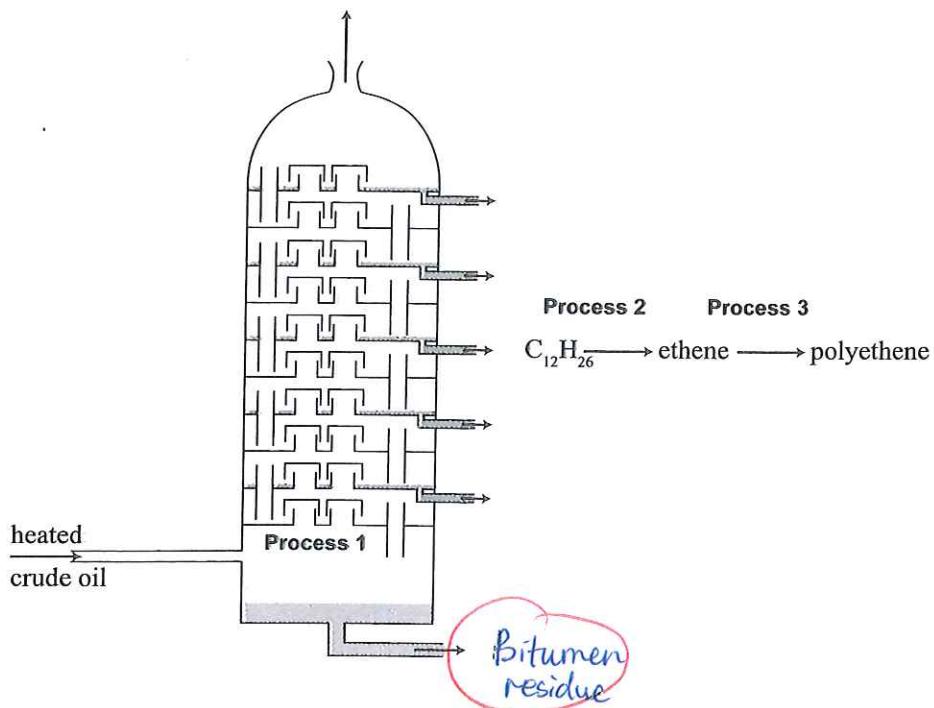


- The products of incomplete combustion, especially Carbon soot and carbon monoxide gas are harmful to human health. (continued on Pg 9)

E8

## 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	<u>Fractional distillation</u>
2	<u>Cracking</u>
3	<u>Polymerisation</u>

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

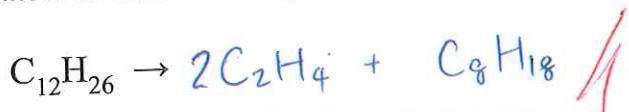
Ethene is an alkene, so it's unsaturated as it contains 1 C to C double bond. (Each Carbon atom is not bonded to the maximum number of hydrogen atoms). The double bond can be broken under high pressure, high temperature and the presence of a catalyst through the process of cracking to form ethene monomers. The pairs of electrons freed by cracking allows ethene monomers to covalently bond together, forming extremely long molecules called polymers, and in this case polyethene.

- (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.

high temperature

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



- (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.

• Process 1 is fractional distillation. It allows the mixture of hydrocarbons of different carbon chain length to be separated into fractions. Crude oil contains a mixture of hydrocarbons of different chain length and these hydrocarbons have different boiling points, so crude oil is not a useful fuel for combustion as some long molecules are hard to ignite. By fractional distillation, these hydrocarbons are separated into similar chain lengths so they can become more useful fuels.

- The fractional distillation column is arranged in a gradient temperature with the hottest on the bottom and cooler towards the top.
- So when the <sup>heated</sup> crude oil vapour into the column, hydrocarbons may condense at different fractions in the column where the temperature is no longer hot enough/the heat energy is not enough to overcome the intermolecular forces of attraction between neighbouring molecules.

\* For example, bitumen residue is collected at the very bottom of the fractional distillation column, because it is comprised of hydrocarbons with a large number of carbon atoms ( $C > 70$ ). The mass of these hydrocarbons is very large and the extremely strong intermolecular forces of attraction between neighbouring molecules results in its very high boiling point.

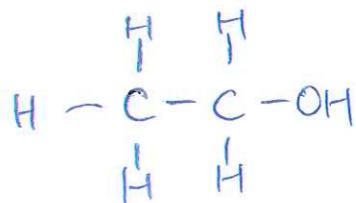
(continue on Pg 9)

E8

### 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.

Alkanes and alkenes contain hydrogen atoms and carbon atoms  
Only. But alcohols contain additional oxygen atom (a hydroxyl group)  
so they're not hydro-carbons

- (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.

We can use the solubility of ethanol and octane:

\* Ethanol is soluble in water (miscible) so ~~it will form no separate layers~~  
will be observed when ethanol is mixed with water. This is  
because ethanol and water both contain the hydroxyl group (-OH)

which are attracted to each other, and that attraction is strong  
enough to overcome the intermolecular forces of attraction  
between neighbouring ethanol molecules, and neighbouring  
water molecules ( $\text{H}_2\text{O}$ ).

\* Octane is insoluble in water (immiscible) as there is  
no or very weak attraction between water molecules and  
octane molecules. So Octane can be identified when  
it forms a separate layer when mixed with water

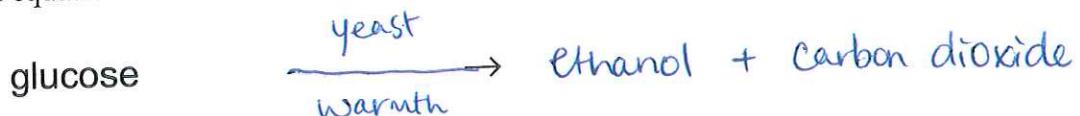
- (b) One method of producing ethanol is by fermentation.

Explain how ethanol is produced by fermentation.

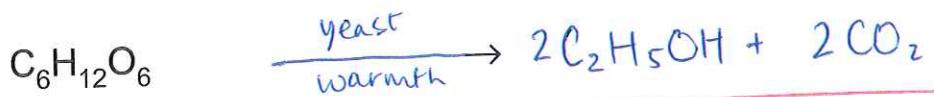
In your answer, you should:

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

Word equation:



Balanced symbol equation:



Fermentation is an enzyme-controlled reaction where bacteria or fungi eg. yeast is used to break down carbohydrates ie. glucose, into ethanol and a colourless gas Carbon dioxide.

- This reaction also requires a warm temperature at around  $40^{\circ}\text{C}$  and an anaerobic condition where oxygen is prevented from contacting the reactant

- (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,  $C_7H_{16}$ .

Evaluate the use of ethanol in biofuels for cars.

[www.renewablegreenenergypower.com/biofuel-101/](http://www.renewablegreenenergypower.com/biofuel-101/)

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.

Ethanol usually undergoes complete combustion and it produces ~~at~~ carbon dioxide gas and water.

\* Carbon dioxide is a colourless gas and if its concentration is too high it may cause <sup>①</sup> global warming and <sup>②</sup> ocean acidification.

①  $CO_2$  found ~~for~~ outside the atmosphere is able to reflect the sun's infra-red light back to the Earth's Surface, making the temperature of the Earth's Surface warmer, causing global warming which can lead to melting of ice bergs and ~~is~~ thus rise in sea level.

②  $CO_2$  can also be absorbed by the ocean, and ~~the~~ high concentrations of  $CO_2$  in the ocean produces carbonic acid:



The carbonic acid may react with the skeletons & shells of marine animals which is made up of calcium carbonate and hence ocean acidification caused by high concentration of  $CO_2$  cause damage in marine lives.

\* However using ethanol as a bio-fuel has its advantages when compared to petrol, e.g. heptane. Heptane is a long molecule, (continue on Pg 10)

Balanced symbol equation:



Extra paper if required.

Write the question number(s) if applicable.

- Q1 c) Carbon soot is a black soot, and if it's inhaled by a human, it can cause damage in the respiratory tissues eg. lungs, making humans have breathing problems, eg. Asthma. If Carbon Soot enters the blood stream, it can also cause blockages in the arteries, which is very dangerous as this can lead to heart diseases. /
- Carbon monoxide is a colourless, odourless but very toxic gas. When inhaled it binds with the haemoglobins in the blood forming carboxyhaemoglobins. This prevents oxygen gas from further bonding with haemoglobins, causing an oxygen shortage in the body. As a result, blood becomes deoxygenated and cells die, the person may feel dizzy and might eventually die. //

- Q2 c) So bitumen condenses at the very bottom of the column, as even though the temperature is the hottest there, the heat energy is still not enough to fully overcome the <sup>intermolecular</sup> forces of attraction between neighbouring molecules. Bitumen is later collected and used for construction of roads. /

Another example would be gases that are collected at the upper most layer of the column, eg. LPG used for cooking. These are very short carbon-chain hydrocarbons ( $C < 4$ ) and therefore they have very low boiling point as not a lot of heat energy is required to overcome the <sup>intermolecular</sup> forces of attraction between neighbouring molecules.

So at the coolest part of the fractional distillation column, the temperature/heat energy is enough to fully overcome the attractive forces, so the LPG is collected as a gas <sup>at the top</sup>. //

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

Q3 c) and contains many carbon atoms. This means that it tends to undergo incomplete combustion when the supply of oxygen isn't sufficient. Incomplete combustion produces water, soot (C) and CO<sub>2</sub> and very little energy. So heptane is not very efficient when compared to ethanol, which has a low boiling point due to its short chain length and its high hydrogen to carbon ratio, which enables ethanol to be more likely to undergo complete combustion. Complete combustion is more energy efficient so ethanol is better suited to be used as a bio-fuel. ~~as~~  
Also ethanol can be produced from sugar-cane, which is a renewable resource, whereas heptane is separated from crude oil - fossoil fuels, which is non-renewable and costs more as it must go through fractional distillation //

