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Level 1 Chemistry, 2017

90932 Demonstrate understanding of aspects of carbon chemistry

9.30 a.m. Tuesday 14 November 2017
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 17

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QUESTION ONE

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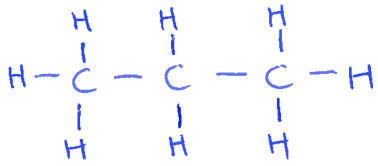
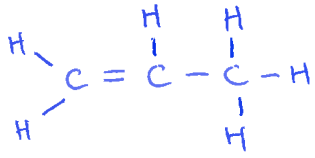
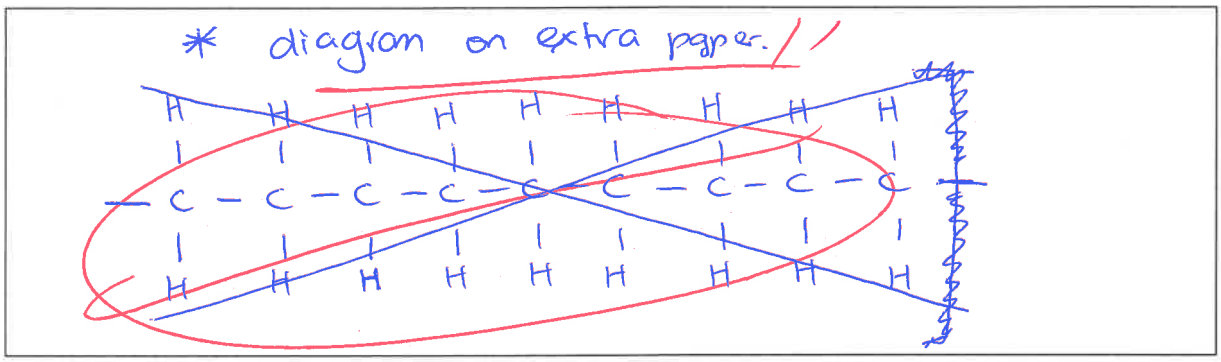
(a) Draw the structural formulae of propane and propene in the boxes below.

Propane	Propene
	

(b) Propene is used to make the polymer polypropene.

In the box below, draw a section of the polymer polypropene with THREE repeating units.



(c) The boiling point for ethene is –104°C and propene is –48°C.

Why does propene have a higher boiling point than ethene?

Explain your answer.

Propene ~~Propenene~~ has a higher boiling point than ethene because propene has a longer length carbon chain which means that the forces of attraction between propene molecules are stronger than the forces of attraction between ethene molecules. This means that more energy is required to break the forces of attraction between propene molecules than is required to break the forces of attraction between ethene molecules.

(d) Explain why **propene** can be used to make polymers, but **propane** cannot.

In your answer, you should explain the chemical reaction that occurs between propene molecules to form the polymer, polypropene.

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Propene can be used to make polymers however propane cannot, this is because propene contains a double where as propane ~~cant~~ doesn't. When a polymere is formed the double bond breaks allowing the monomer in this case propene to bond to other propene molecules forming a chain of propene monomers which is called a polymer in this case poly - propene.

M6

QUESTION TWO

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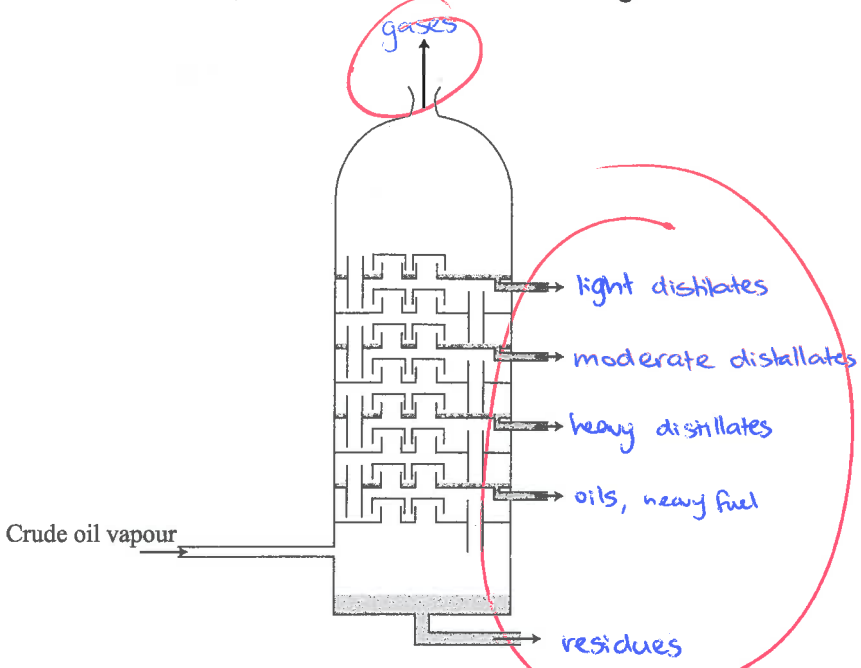
Crude oil is fractionally distilled in tall towers, like the one shown in the diagram below.



(a) (i) Why must crude oil be fractionally distilled before it can be used?
Explain your answer.

Because crude oil is a combination of different length hydrocarbons and isn't very useful but by ~~separating~~ using fractional distillation the crude oil can be separated into hydrocarbons of similar length and that are much more useful.

(ii) Explain why smaller hydrocarbons are collected at the top of the tower.

Smaller hydrocarbons are collected at the top of the tower because they have lower boiling points and the temperature at the top of the tower is much cooler than the temperature at the bottom of the tower. Some of the smallest hydrocarbons are collected as gases because they still haven't reached a low enough boiling point in order to change state back into a liquid.

(b) Complete the equation for the cracking of decane, $C_{10}H_{22}$, to produce pentane and two other products.

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$$C_{10}H_{22} \rightarrow C_5H_{12} + C_2H_4 + C_3H_6$$

pentane ethene propene

(c) Contrast the processes of fractional distillation and cracking.

In your answer, you should refer to relevant physical and/or chemical properties of hydrocarbons.

In fractional distillation crude oil containing a mixture of hydrocarbons is pumped into a tall tower as a gas which then vises up through the tower where the temperature cools the higher up the tower you get. The different hydrocarbons get separated according to their boiling points with the longer hydrocarbons with the higher boiling points such as nonane and decane collected close to the bottom and the shorter hydrocarbons with the lower boiling points such as methane and ethane collected as gases at the top of the tower. Cracking however is using pressure and heat to break the longer less useful hydrocarbons such as decane into smaller more useful hydrocarbons. The process of cracking however produces alkenes as well as alkanes while the process of distilling separates out only alkanes and no alkenes are produced. Both ~~forms~~ processes produce smaller and more useful hydrocarbons alkenes which are used for fuel and cracking produces alkenes which can be used for making polymers or plastics

There is more space for your answer to this question on the following page.

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QUESTION THREE

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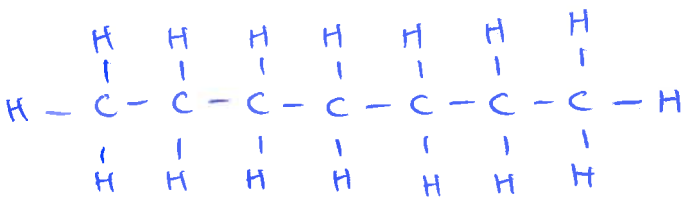
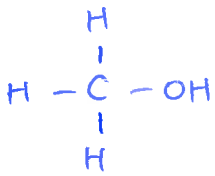
(a) (i) Draw the structural formulae of heptane and methanol in the boxes below.

Heptane



Methanol



(ii) Explain why heptane is classified as a hydrocarbon, while methanol is not.

Heptane is a hydrocarbon as it is made up of only carbon and hydrogen while methanol isn't because it isn't made up of only hydrogen and carbon as it contains the OH functional group.

(b) Heptane and methanol are both colourless liquids at room temperature (25°C).

How could water be used to distinguish between separate samples of heptane and methanol?

In your answer, you should include any observations that would be made, and explain the physical properties of BOTH compounds that allow this identification.

Mix both samples with water and the sample that forms layers is heptane and the sample that mixes with the water is methanol. This happens because methanol is an alcohol and alcohols are soluble in water whereas heptane is an alkane and alkanes aren't soluble in water and would therefore form layers.

Question Three continues on the following page.

(c) Both heptane and methanol can be used as fuels and can undergo both complete and incomplete combustion.

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Analyse the combustion reactions of the two fuels – heptane and methanol.

In your answer, you should include:

- a description of the observations that would be made for both complete and incomplete combustion of EITHER heptane OR methanol
- an explanation of the effect on human health for TWO combustion products from the **incomplete** combustion of EITHER heptane OR methanol
- an explanation of the advantages of using methanol as a fuel compared to heptane
- a balanced symbol equation for the **complete** combustion of each fuel.

8+14 = 22

Balanced symbol equation for the **complete** combustion of heptane:

$2C_7H_{16} + 22O_2 \rightarrow 14CO_2 + 16H_2O$

Balanced symbol equation for the **complete** combustion of methanol:

$2CH_3OH + 2O_2 \rightarrow 2H_2O + 2CO_2$

If heptane under went complete combustion an almost invisible blue flame would be seen however if it under went incomplete combustion then a dirty yellow flame and smoke would be observed. In incomplete combustion of heptane carbon monoxide and carbon are produced. Carbon monoxide can caused carbon monoxide poisoning and can lead to a person becoming dizzy and disorientated and eventually dying if to much carbon monoxide is inhaled. Carbon can get inhaled and ~~blood~~ get caught in the lungs and airways causing the person to cough and choke. ~~Methanol~~ Using methanol instead of heptane is advantageous because methanol burns with a cleaner flame and requires less oxygen to combust completely.

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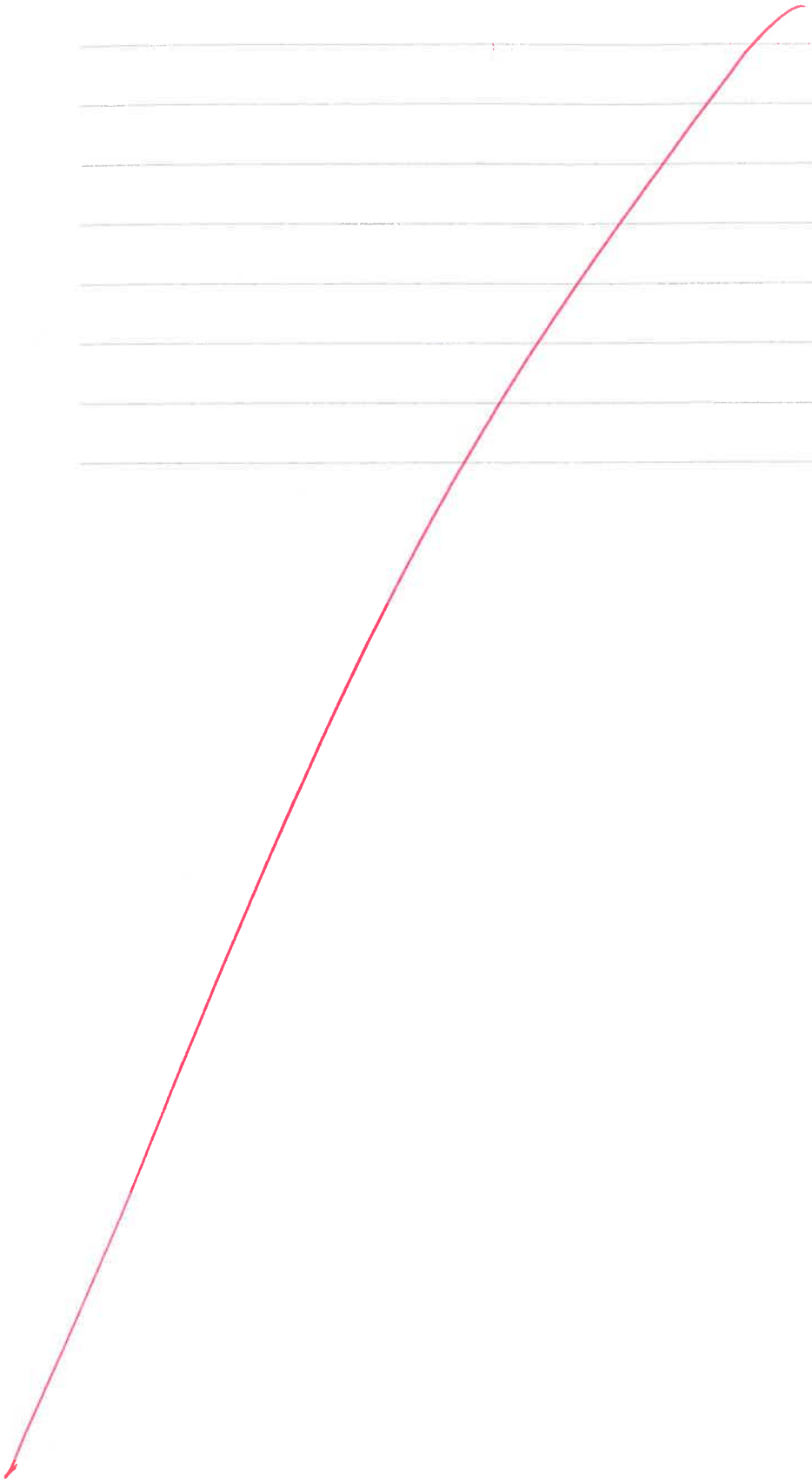

M6

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

QUESTION NUMBER

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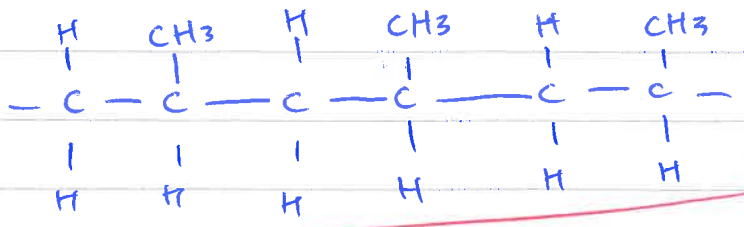
1b



Subject:	Chemistry	Standard:	90932	Total score:	17

Q	Grade score	Annotation
1	M6	The candidate has correctly linked having a longer carbon chain to stronger intermolecular bonds, which then require more energy to break. They secure the M6 by explaining how the double bond in an alkene can break which allows other monomers to bond with it to form a chain. To get E8 the candidate needed to clearly explain that a single bond is forming between the carbon atoms in adjacent monomers.
2	M5	The candidate has correctly balanced the cracking equation of decane and explained how fractional distillation separates the different hydrocarbons in crude oil. To secure M5 they have stated that smaller hydrocarbons have a lower boiling point and linked this to the top of the distillation tower being cooler. To get E7 the candidate needed to link the smaller hydrocarbons to a weaker intermolecular force.
3	M6	The candidate has clearly explained why heptane is a hydrocarbon and methanol is not with reference to the atoms in the molecules. They have linked the observations when adding methanol and heptane to water to their solubilities but have not explained in terms of intermolecular forces why one is soluble but the other is not. To secure the M6 the candidate has also written a correct symbol equation for one of the complete combustion equations, explained how one incomplete combustion product can cause a health effect and linked the type of combustion to the amount of oxygen needed. The response does not reach excellence as they have only stated a second health effect, rather than explaining how it is caused.