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Level 1 Chemistry, 2016

90932 Demonstrate understanding of aspects of carbon chemistry

2.00 p.m. Monday 21 November 2016
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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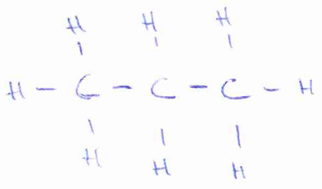
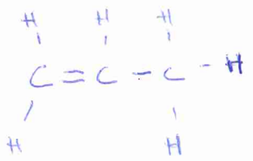
(a) Draw the structural formulae of propane and propene in the boxes below.

Propane	Propene
	

(b) (i) What is the type of bonding present in a molecule of propane?

Co-valent bonding.

Give a reason for your answer.

Both carbon and hydrogen are non-metals. ~~Oxygen~~ Hydrogen needs 1 electron to gain a full valance shell and become stable, whereas carbon needs 4. To do this they bond co-valently and share electrons to become stable.

(ii) How does the structure of propene differ to propane?

Propene has a double bond between carbon atoms. Propane does not. Propane is saturated by hydrogen atoms, but because of its double bond, Propene is not saturated.

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(c) Alkanes can be used as fuels. Compare and contrast: the complete combustion of alkanes, which produces carbon dioxide; and the incomplete combustion, which produces carbon monoxide and carbon in addition to carbon dioxide.

In your answer, you should:

- use butane as an example to illustrate your answer
- give an explanation of an effect on the environment for TWO combustion products
- include balanced symbol equations for the reactions occurring, in the labelled boxes below.

When butane is burned as a feul, it is mixed with oxygen to form carbon monoxide, carbon dioxide, water and carbon. When complete combustion occurs, there is a plentiful amount of oxygen, meaning that carbondioxide is formed. Carbon dioxide causes acidification of oceans, as it turns sea water into carbonic acid. This acid reacts with the shells of some sea creatures, and can kill them. Incomplete combustion occurs when there is a lack of oxygen. The products of incomplete combustion are carbon (soot), and carbon monoxide. Carbon monoxide is poisonous, and latches onto the hemoglobin in the blood stream and causes cell death, and ultimatly death. The complete combustion of Butane releases much more energy than incomplete combustion, and complete combustion burns cleaner to a blue flame. Incomplete combustion burns to a dirty yellow flame with soot.

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

$C_4H_{10} + 6\frac{1}{2}O_2 \rightarrow 4CO_2 + 5H_2O$

Balanced symbol equation for the **incomplete** combustion of butane:

$C_4H_{10} + 4\frac{1}{2}O_2 \rightarrow 4CO + 5H_2O$

$C_4H_{10} + 2\frac{1}{2}O_2 \rightarrow 4C + 5H_2O$

M4

QUESTION TWO

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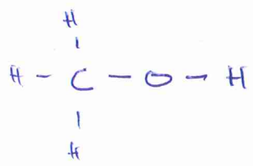
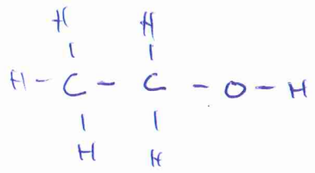
(a) Draw the structural formulae of methanol and ethanol in the boxes below.

Methanol	Ethanol
	

(b) (i) The boiling point for methanol is 65°C and ethanol is 78°C.

Why does ethanol have a higher boiling point than methanol?

Ethanol has more carbons in it than methanol. By increasing the amount of carbons, the boiling point increases. This is due to the intermolecular forces now being stronger as more carbons are present. More energy is required to break these forces, increasing the overall boiling point.

(ii) Why are both methanol and ethanol soluble in water?

Both are soluble because they have a greater attraction for water molecules than for methanol/ethanol molecules. When water molecules react with methanol/ethanol molecules, they are just pairing together.

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(c) How does the industrial preparation of methanol from natural gas differ from the process of fermentation to form ethanol?

In your answer, you should include:

- a description of the two processes
- explanations of any conditions required
- balanced symbol equations for any reactions occurring, in the labelled boxes below.

Methanol can be produced from natural gases. By heating up the natural methane gas and reacting it with water, syngas is produced. This syngas is then ~~condensed to form methanol and water~~. reacted with a catalyst at high temperature to form methanol and water.

The fermentation of ethanol requires anaerobic conditions (no oxygen), warmth, and a sugar. When yeast begins to ferment, it is eating the sugars. This sugar is then turned from $C_6H_{12}O_6$ into ethanol C_2H_5OH and carbondioxide. This is how alcoholic beverages are made. The CO_2 (carbondioxide) is why they are slightly fizzy.

Balanced symbol equation(s) for the industrial preparation of methanol:

$$2CH_4 + 3H_2O \xrightarrow{\text{catalyst}} CO_2 + CO + 7H_2$$

$$CO_2 + CO + 7H_2 \xrightarrow{\text{catalyst}} 2CH_3OH + 2H_2O$$

Balanced symbol equation for preparation of ethanol using fermentation:

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

QUESTION THREE

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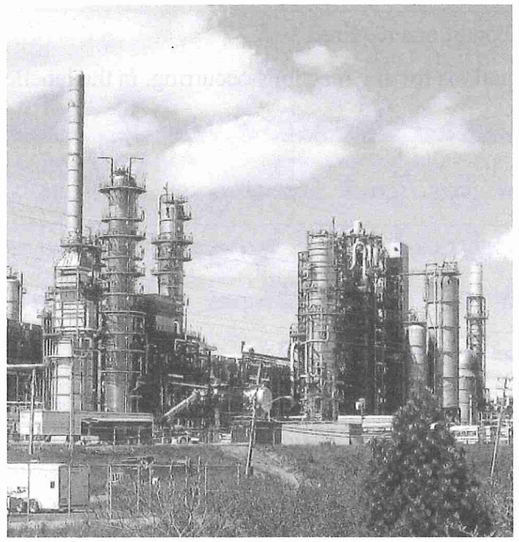
Crude oil undergoes fractional distillation in tall towers, like the ones shown in the photograph below. The different fractions produced have many uses.



http://photoartforums.com/forums/uploads/1277616145/gallery_85_17_924301.jpg

(a) Name TWO of the fractions obtained from a fractional distillation tower, and describe ONE use for each.

Fraction	Name	Use
1	fuels	fuels - petrol
2	longchain carbons	bichum - making roads.

(b) (i) Why does crude oil need to undergo fractional distillation before it can be used?

Crude oil is a mixture of lots of different carbon chain lengths. This means that it is unpredictable and useless. By putting crude oil through fractional distillation, the different chain lengths are put together and are more useable.

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(ii) Explain why fractional distillation is carried out in tall towers.

In your answer you should link the process of fractional distillation to the physical properties and chemical structure of the hydrocarbons in crude oil.

There are many different carbon chain lengths. The tower is tall to have many layers, and room for all the carbon chains fractions. The short chain carbons condense at the top of the tower after being heated to past 500°c. The longchain carbons condense at the bottom, as they have many carbons, strong intermolecular forces and high boiling points. This means that they also condense at high temperatures. The different fractions in the tower catch all the different carbon chain lengths as they condense, short at the top medium in the middle, and long at the bottom. They all condense due to their boiling points.

Question Three continues on the following page.

(c) Octane can be used to produce the polymer, polyethene. Octane undergoes Reaction 1 to form hexane and Product 2. Product 2 can be used to produce polyethene.

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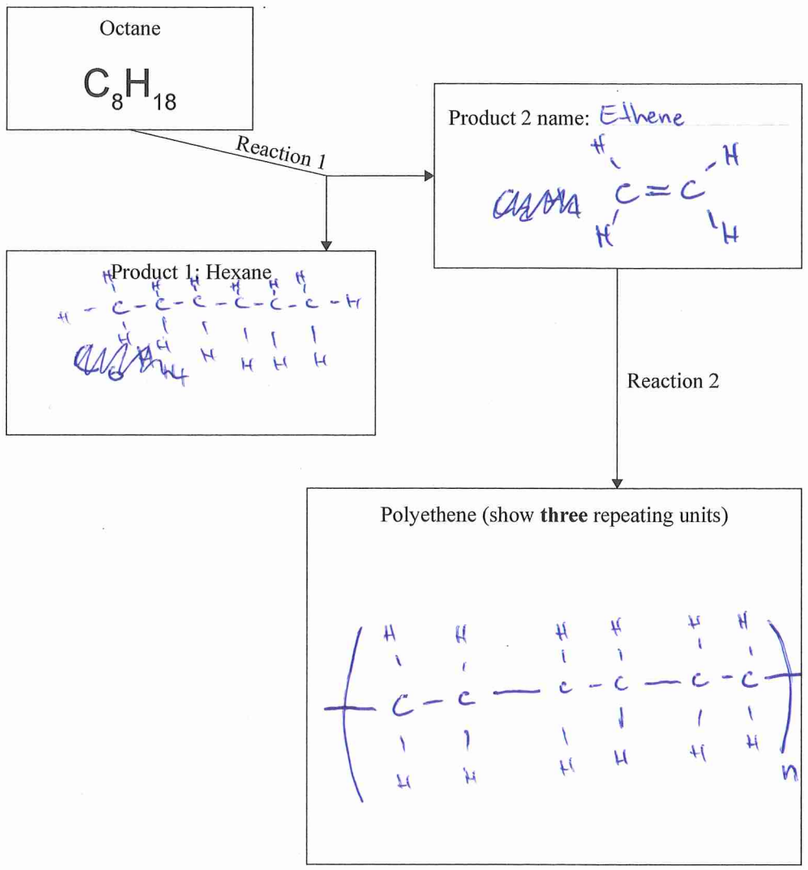
(i) Complete the reaction scheme by filling in the boxes to show all structural formulae, as well as the name for Product 2.



(ii) Elaborate on Reaction 1 and Reaction 2.

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In your answer, you should:

- name the types of reactions occurring
- give the conditions required for each reaction
- explain how polyethene can be made from Product 2.

Reaction 1 is referred to as cracking. This is when an alkane or alkene is split under pressure, heat, and the presence of a catalyst. Cracking creates two or more products from breaking down one larger hydro carbon, to form smaller ones.

Reaction 2 is polymerisation. This is where many monomers (single alkenes) are melted down under heat, and put together to form a carbon chain.

Polyethene is made from reaction 2, when many ethene monomers are heated up to beyond their melting point. This breaks the double bond, leaving ethene with 2 spare bonds. The bonds are then filled up with 2 more ethene molecules forming a chain. This is the polymerisation of ethene, to form polyethene.

M5

Merit exemplar 2016

Subject:	Chemistry	Standard:	90932	Total score:	17

Q	Grade score	Annotation
1	M6	The candidate has 2 correctly balanced symbol equations, one for complete and one for incomplete combustion. However, the response does not reach excellence because it only referenced one environmental effect (ocean acidification) and this explanation is lacking in detail. Their second product is CO, but this is linked to health issues rather than environmental issues. The response correctly compares the availability of oxygen and the release of energy for both types of combustion, thus meeting merit criteria. To secure the M6, they correctly explain that the atoms C and H share electrons to attain stability by covalent bonding.
2	M6	The candidate has a correctly balanced symbol equation for the production of ethanol from glucose, but an incorrectly balanced equation for the production of methanol from methane. In addition, the candidate explains the process of ethanol production including the conditions required. To secure the M6, they correctly explain the relative boiling points of ethanol and methanol by linking the length of the carbon chain to the strength of the intermolecular forces.
3	M5	The candidate explains that the fractions are separated based on boiling points and link these to the molecular mass of the hydrocarbon chain and the size of the intermolecular forces. However, the candidate does not explain the process of fractional distillation and so do not get to excellence level. They also clearly explain the process of polymerisation including the conditions, the breaking of the C to C double bond (from the diagram on page 8) and that the polymer chain formed from many individual monomers. They do not clearly show the forming of new single covalent bonds between adjacent monomers. The candidate also explains that crude oil is a mixture of different hydrocarbons, but did not link fractional distillation to the separation of fractions in question (b)(i).