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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.

Excellence

TOTAL

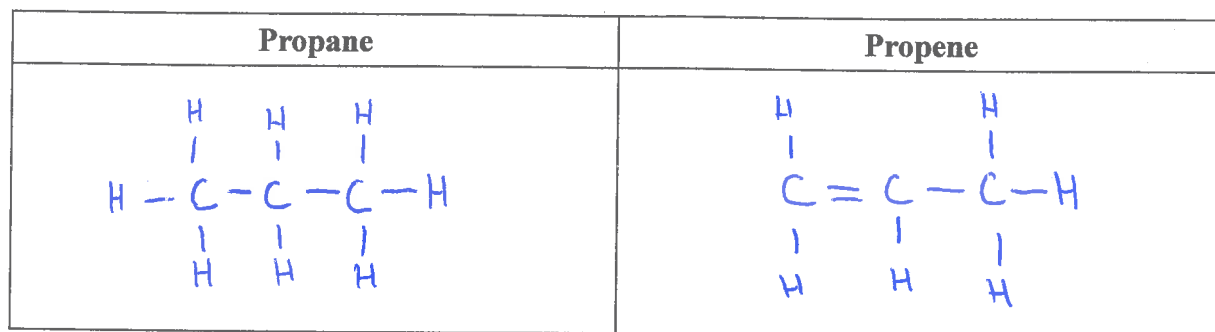
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QUESTION ONE

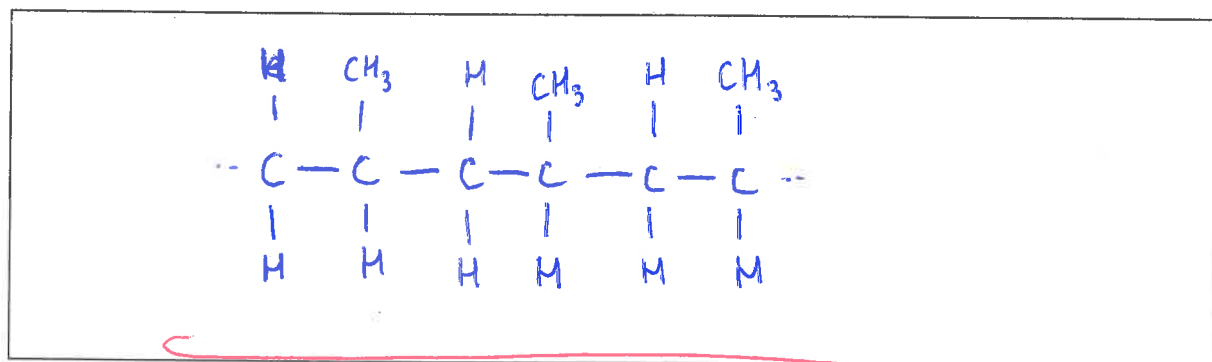
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- (a) Draw the structural formulae of propane and propene in the boxes below.



- (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.

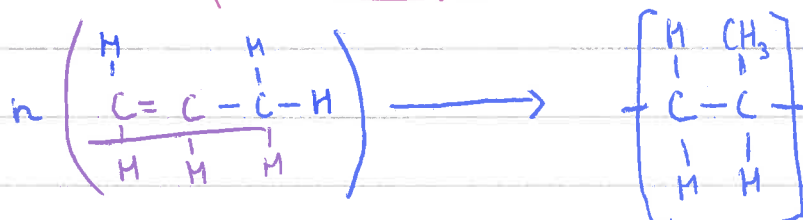
Ethene has two carbon atoms whereas propene has 3 carbon atoms. This means that the intermolecular forces between propene molecules are stronger than those between ethene, so more energy is required to overcome this forces and allow propene to change state.

- (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.

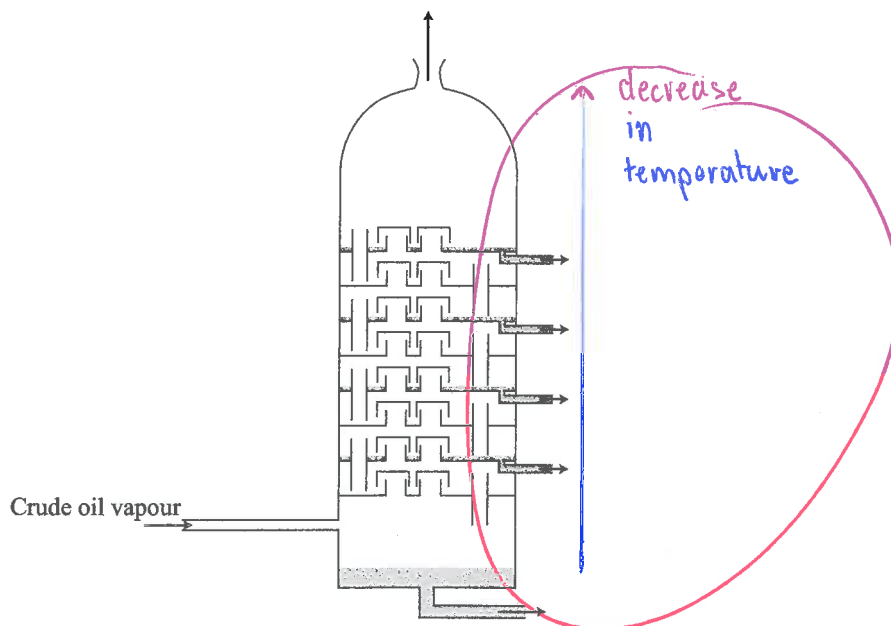
Propane is saturated (all carbon atoms are bonded to 4 other atoms) and all the bonds are single bonds, so propane cannot be used to make polymers as it is unreactive.

Propene is unsaturated and has a double bond, and is therefore reactive. The double bond can easily be broken during polymerisation (which requires heat, high pressure and a catalyst) and the adjacent carbon atoms can form a single covalent bond with the adjacent carbon of other monomers. That forms long chains of carbon, polypropene.



QUESTION TWO

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.

Crude oil is a mixture of hydrocarbons of different sizes which all have different uses. They undergo fractional distillation in order to be separated in useful fractions.

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

smaller hydrocarbons have a lower boiling point than bigger hydrocarbons because the intermolecular forces are weaker so they will condense at lower temperatures at the top of the tower. ~~because less energy is applied.~~ Small hydrocarbons (with 1 carbon to 4 carbon) are gases at room temperature so are recolled as gases at the very top of the tower.

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



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

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

~~Cracking and fractional distillation are both processes used to separate hydrocarbons.~~

Cracking is a thermal decomposition reaction that requires heat and a catalyst. A long alkane is broken down into a smaller alkane and alkenes. Fractional distillation is the process of separating different hydrocarbons into useful fraction. Different sizes of hydrocarbons have different boiling points and can therefore being separated, because long molecules with a high boiling point will condense first at the bottom and smaller hydrocarbons with a lower boiling point will condense higher up. The boiling point of a hydrocarbon depend on the length of this hydrocarbon. The longer the molecule is, the stronger the intermolecular forces are so the more energy is required to overcome them so the boiling point is higher.

The small alkanes are then used for fuels, but long alkanes are not good fuels as they are difficult to ignite and don't flow easily. ^(because they need a lot of energy to break the intermolecular forces) This is why they then undergo cracking that break the molecules into a smaller alkane.

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

that can be used as a fuel and an alkene which can be used to make polymers.

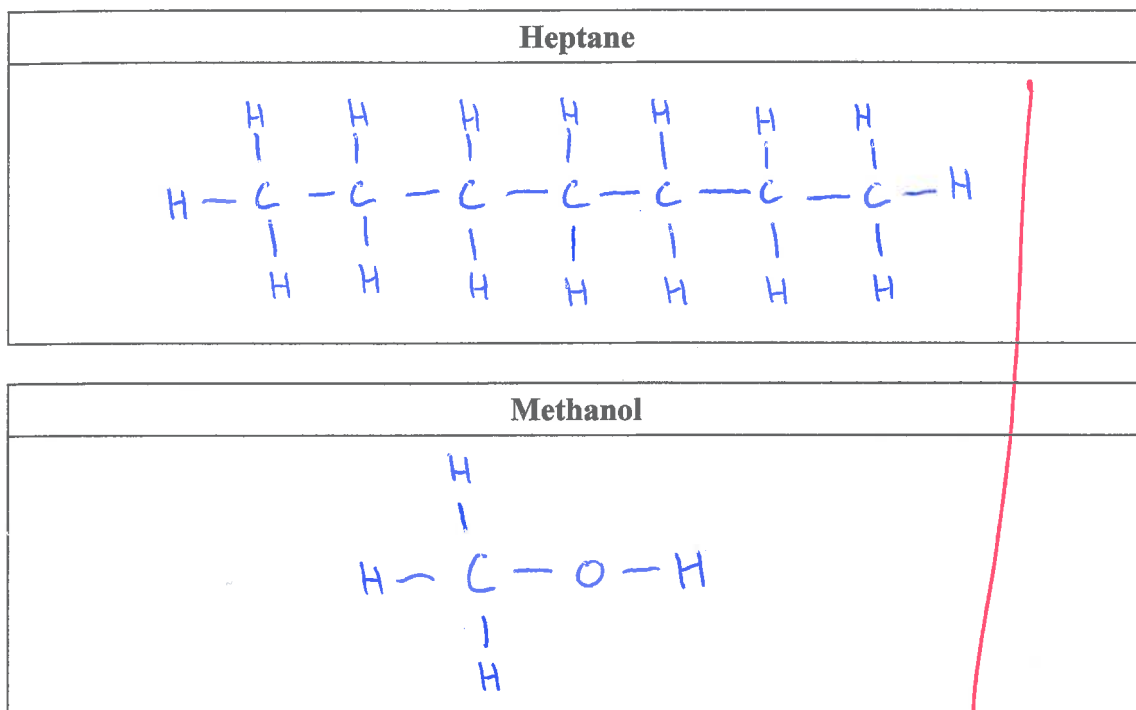
ASSESSOR'S
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E7

QUESTION THREE

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



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

Heptane is a hydrocarbon because it has only carbon and hydrogen atoms, whereas methanol is not a hydrocarbon because it has ^{also} an oxygen atom.

- (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.

Heptane will create a layer on top of the water because it is not soluble, whereas methanol will dissolve in water because it is soluble. Heptane is not soluble because the attraction between water and heptane molecules are very weak compare to the intermolecular forces between the heptane and heptane, and the forces between the water molecules, so they don't overcome them. Methanol is soluble because the OH group is soluble and the forces between methanol and

**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.

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

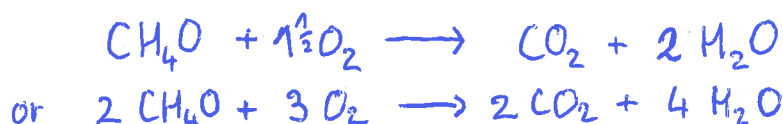
In your answer, you should include:

- 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.

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



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



When methanol undergoes complete combustion, it burns in a blue flame and carbon dioxide (colourless gas) and water vapour (colourless gas) are produced. If it undergoes incomplete combustion (lack of oxygen), it will burn in a yellow flame and produce carbon (soot), carbon monoxide (colourless gas) and water vapour. (black ash)

Carbon affects the health because the very small particles can be inhaled and they affect the respiratory system because they go in the lungs. It can cause asthma or lung cancer. Carbon monoxide is also poisonous because it links with the haemoglobins in the blood instead of oxygen so less oxygen arrives to our brain and our cells so it causes death.

Using methanol as a fuel is better than using heptane

because it is more likely to undergo complete combustion,
and complete combustion is not bad for human health
and it releases more energy. Methanol is more likely to
undergo complete combustion because of the extra oxygen
atom and because it is a smaller molecule compare
the heptane so less energy is required for the
combustion. //

Extra paper if required.

Write the question number(s) if applicable.

QUESTION
NUMBERASSESSOR'S
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Q₃ b) water are strong enough to overcome the methanol-methanol forces and the water-water forces ✓

SEEN

Subject:	Chemistry	Standard:	90932	Total score:	23
Q	Grade score	Annotation			
1	E8	This question is E8 as the candidate has correctly linked the process of polymerisation to the breaking of the carbon-carbon double bond and the formation of a new carbon-carbon single bond between monomers. It secures E8 by drawing the polymer, polypropene correctly.			
2	E7	This question is E7 as the candidate has clearly linked the size of the hydrocarbon to the strength of the intermolecular forces and hence its boiling point. They then relate this to the temperature gradient inside the fractional distillation tower. To get E8 they needed an explanation of why fractional distillation is a physical process whereas cracking is a chemical process.			
3	E8	The candidate has correctly linked the observations to the physical properties of both samples. This includes a discussion comparing the forces between the solute (methanol/heptane) and the forces between the solute and solvent (water). They have also linked products of incomplete combustion to two health effects by explaining how the products interact with the human body. Finally, they secure the E8 grade by correctly balancing one complete combustion equation.			