AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.7.1.1

Crude oil, hydrocarbons and alkanes

Past-paper questions

Tier	**Higher**
Question groups	**124**
Available paper years	**2007–2025**

Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

Name: _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 01

January 2007 | CHY1H | Original Q5 | Legacy

5 Crude oil is a mixture of mostly alkanes.

(a) Crude oil is separated into useful fractions by fractional distillation.

(i) Describe and explain how the mixture of alkanes is separated by fractional distillation.

.....

.....

.....

.....

.....

.....

.....

(3 marks)

(ii) The table gives the name and formula for each of the first three alkanes.

Complete the table to show the formula of butane.

Name of alkane	Formula
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	

(1 mark)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 01 · continued

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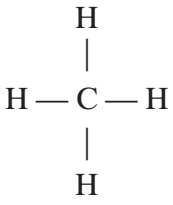
(b) The structural formula of methane, CH_4, is:



Draw the structural formula of propane, C_3H_8

(1 mark)

Question 5 continues on the next page

Question 01 · continued

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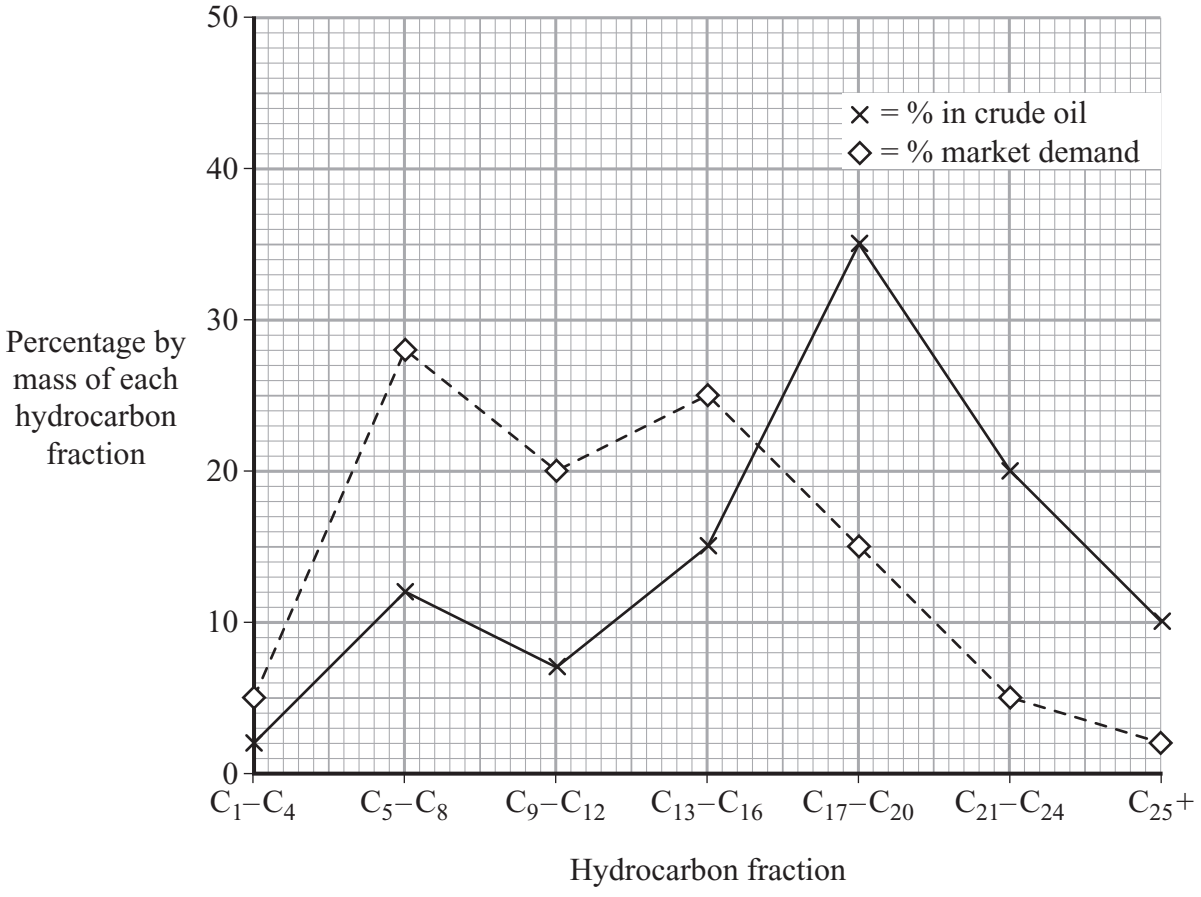
(c) The relative amounts of and the market demand for some hydrocarbons from the fractional distillation of crude oil are shown in the graph.



(i) Why is the market demand for the $C_5–C_8$ fraction higher than the market demand for the $C_{21}–C_{24}$ fraction?

.....

.....

(1 mark)

(ii) Cracking is used to break down large hydrocarbon molecules into smaller hydrocarbon molecules.

Complete the symbol equation by writing in the formula of the other hydrocarbon.

$C_{20}H_{42} \rightarrow C_{16}H_{34} + 2$ .....

(1 mark)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 01 · continued

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(iii) The C_5-C_8 fraction has low supply and high market demand.

Suggest **three** ways in which the oil industry could overcome this problem.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

10

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 02

March 2007 | CHY1A | Original Q3 | Legacy

QUESTION THREE

Crude oil is a non-renewable energy source. Petrol is a fuel obtained from the fractional distillation of crude oil.

Gasohol is also a fuel. It is a mixture of 90 % petrol and 10 % ethanol. The ethanol can be produced from the waste stems and leaves when crops have been harvested. So ethanol is a renewable energy source.

	Mass in grams of gas produced by completely burning 10 cm^3 of fuel		
Fuel	Carbon dioxide from petrol	Carbon dioxide from ethanol	Water vapour
Petrol	26.4	0	12.6
Gasohol	23.8	1.5	12.2

3A What is the total mass of carbon dioxide produced when 10 cm^3 of gasohol is burned?

1 22.3 g

2 23.8 g

3 25.3 g

4 26.4 g

3B How much more carbon dioxide is produced when 10 cm^3 of petrol is burned than when 10 cm^3 of gasohol is burned?

1 0.4 g

2 1.1 g

3 1.6 g

4 24.9 g

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 02 · continued

3C Why is the water vapour produced by burning fuels not a problem?

1 It condenses to a liquid.

2 It does not cause corrosion.

3 It is not a pollutant.

4 Very little is produced.

3D Carbon dioxide causes environmental problems.

Why is carbon dioxide from burning ethanol thought to be less of a problem than carbon dioxide from burning petrol?

1 Not as much carbon dioxide is produced.

2 The carbon dioxide produced has different chemical properties.

3 It is just recycling carbon dioxide removed from the air by plants.

4 The ethanol is not produced from crude oil.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 03

March 2007 | CHY1A | Original Q7 | Legacy

QUESTION SEVEN

In the engine cylinders of petrol-driven cars, a mixture of petrol and air is ignited.

- Petrol consists mainly of alkanes in the $C_5 - C_{10}$ range.
- Air consists of nitrogen (79 %), oxygen (20 %) and small amounts of other gases.

The petrol/air mixture is ignited by an electrical spark causing an explosive reaction to drive the pistons in the cylinders.

Some of the elements in the petrol/air mixture combine with oxygen at the very high temperatures reached.

Modern engines are very efficient but are still not capable of complete combustion. The gases produced during combustion are released as exhaust gases.

The table shows some of the exhaust gases from a typical petrol engine.

Gas	Percentage
carbon dioxide	15.0
carbon monoxide	1.0
oxygen	0.7
hydrocarbons	0.05
nitrogen oxides	0.2
sulfur dioxide	0.007

7A The gases in the table make up less than 20 % of the exhaust gases.

Which substance will make up most of the remainder of the exhaust gases?

1 hydrogen

2 methane

3 nitrogen

4 water vapour

Question 03 · continued

7B One piece of evidence that suggests there is incomplete combustion is . . .

1 the high percentage of carbon dioxide.

2 the presence of carbon monoxide.

3 the presence of nitrogen oxides.

4 the low percentage of sulfur dioxide.

Nitrogen oxides are acidic oxides.
The equation shows how nitrogen monoxide is formed in the cylinders.

$$N_2 + O_2 \rightarrow 2NO$$

7C Nitrogen monoxide reacts with more oxygen to produce nitrogen dioxide.

Which is the correct equation for this reaction?

1 $N_2 + O_2 \rightarrow NO_2$

2 $NO + O_2 \rightarrow NO_2$

3 $2NO + O_2 \rightarrow 2NO_2$

4 $2NO + 2O_2 \rightarrow 2NO_2$

7D Why is it important to remove nitrogen oxides from the exhaust gases?

1 They are brown gases.

2 They can cause global dimming.

3 They can cause acid rain.

4 They cause carbon deposits in the exhaust pipe.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 04

March 2007 | CHY1A | Original Q8 | Legacy

QUESTION EIGHT

This question is about crude oil.
Crude oil is separated into fractions by fractional distillation.

8A In the fractionating column, the crude oil separates into fractions because . . .

1 it evaporates.

2 the vapour condenses at 100 °C.

3 the vapour condenses at different temperatures.

4 thermal decomposition occurs.

8B Fractional distillation is possible because the hydrocarbons in the crude oil have . . .

1 different boiling points.

2 different chemical properties.

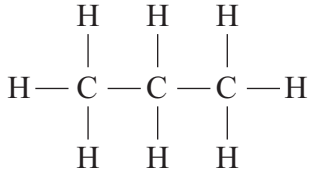
3 exactly the same boiling points.

4 the same ignition temperature.

The simplest alkane in crude oil is methane, CH_4
Another alkane is propane, C_3H_8

8C A molecule of propane can be represented by . . .

1



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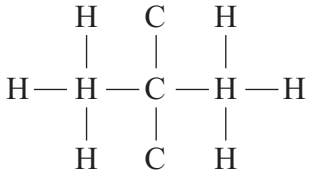

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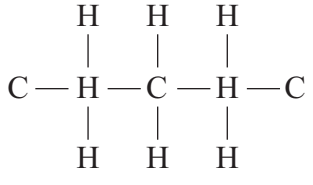

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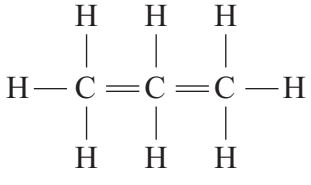


Question 04 · continued

8D Compared with methane, propane will . . .

1 ignite more easily.

2 boil at a lower temperature.

3 have a higher boiling point.

4 be less saturated.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 05

March 2007 | CHY1B | Original Q1 | Legacy

QUESTION ONE

The flow chart shows the stages in the breakdown of large hydrocarbon molecules.

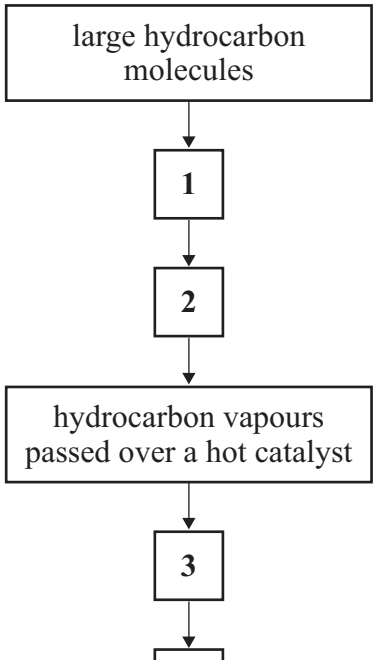
Match phrases, **A**, **B**, **C** and **D**, with the numbers **1–4** in the flow chart.

A hydrocarbons undergo thermal decomposition

B hydrocarbons are heated

C hydrocarbons vaporise

D small hydrocarbon molecules



4.7.1.1 Crude oil, hydrocarbons and alkanes

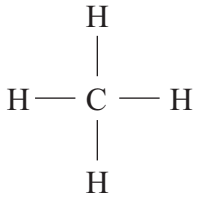
Question 06

March 2007 | CHY1B | Original Q2 | Legacy

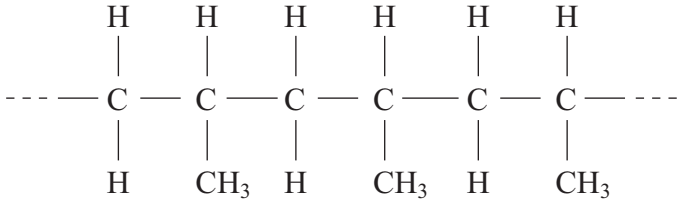
QUESTION TWO

This question is about the formulae for four hydrocarbon compounds.

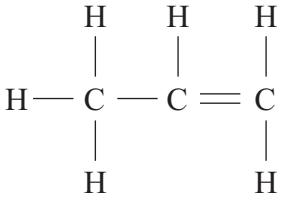
Match formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.



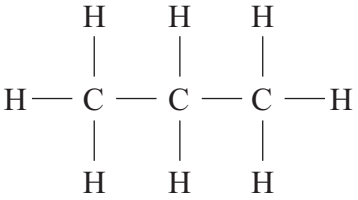
A



B



C



D

Hydrocarbon compound	Description
1	It has the molecular formula C_3H_8
2	It is the hydrocarbon with the smallest molecules.
3	It is an unsaturated hydrocarbon.
4	It is part of a polymer.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 07

March 2007 | CHY1B | Original Q6 | Legacy

QUESTION SIX

Large hydrocarbon molecules can be broken down, by cracking, to produce smaller molecules.

An example of cracking is shown below:

$$C_{14}H_{30} \longrightarrow C_7H_{16} + C_3H_6 + 2C_2H_4$$

large hydrocarbon molecule — small hydrocarbon molecules

6A Which of the products of the cracking reaction could form polymers?

1 C_7H_{16} and C_3H_6

2 C_7H_{16} and C_2H_4

3 C_3H_6 and C_2H_4

4 C_7H_{16} only

6B The hydrocarbon with the formula C_2H_4 is . . .

1 ethane.

2 ethene.

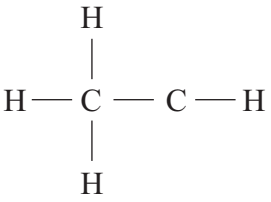
3 ethanol.

4 propene.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 07 · continued

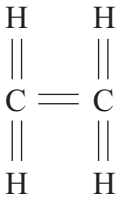
6C The hydrocarbon C_2H_4 can be represented as . . .



1



2



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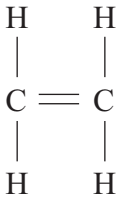


4

6D The general formula for the alkenes is . . .

1 C_nH_n

2 C_nH_{2n}

3 C_nH_{2n+2}

4 $C_{2n}H_n$

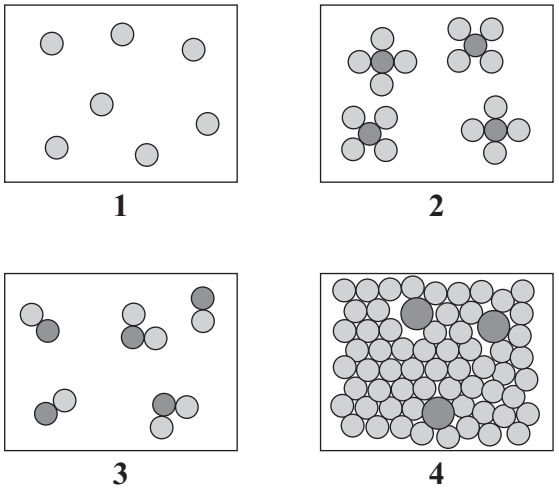
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 08

June 2007 | CHY1A | Original Q2 | Legacy

QUESTION TWO

The diagrams show the atoms in four different substances.



Match the substances, **A**, **B**, **C** and **D**, with the diagrams **1–4**.

A an alloy

B an element

C a hydrocarbon

D a mixture of compounds

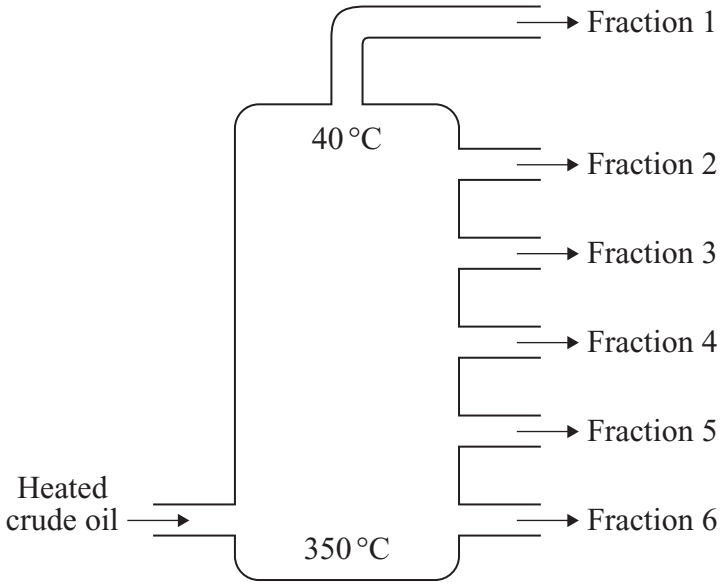
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 09

June 2007 | CHY1A | Original Q6 | Legacy

QUESTION SIX

In a fractionating column, crude oil is separated into a number of fractions.



6A Crude oil can be separated into fractions in this way because . . .

1 it contains liquid and gaseous hydrocarbons.

2 it vaporises at about 350 °C.

3 it is a mixture of only two elements.

4 it is a mixture of hydrocarbons.

6B Each fraction has a range of boiling points because . . .

1 a hydrocarbon does not have a fixed boiling point.

2 not all fractions contain the same number of hydrocarbons.

3 not all fractions contain solid hydrocarbons.

4 each fraction is a mixture of hydrocarbons.

4.7.1.1 Crude oil, hydrocarbons and alkanes

6C Which row in the table correctly describes the hydrocarbons in Fraction 1?

1	molecules are large	ignite with difficulty
2	liquids at room temperature	ignite easily
3	molecules are small	ignite easily
4	molecules are small	ignite with difficulty

6D Which of these compounds will make up the largest percentage of Fraction 1?

1 C_2H_4

2 C_3H_6

3 C_3H_8

4 $C_{12}H_{26}$

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 10

June 2007 | CHY1A | Original Q8 | Legacy

QUESTION EIGHT

Exhaust fumes from petrol-driven cars contain harmful gases, particularly acidic nitrogen oxide, poisonous carbon monoxide and unburned hydrocarbons.

Catalytic converters are fitted to these cars to help to reduce the quantities of these gases released into the atmosphere. The reaction in the converter can be summarised by this equation:

carbon monoxide + nitrogen oxide → carbon dioxide + nitrogen

The catalysts in the converters usually contain a mixture of two transition metals, platinum and rhodium.

These metals occur in the Earth's crust mainly with copper and nickel sulfide ores.
To extract the metals, the ores are roasted in air which produces sulfur dioxide.

8A The balanced, symbol equation for the reaction between carbon monoxide and nitrogen oxide is . . .

1 $2CO + 2NO \rightarrow 2CO_2 + N_2$

2 $CO + NO \rightarrow CO_2 + N_2$

3 $2CO + 2NO \rightarrow CO_2 + N_2$

4 $2CO + 2NO \rightarrow CO_2 + 2N_2$

8B Which substance is reduced in this reaction?

1 carbon monoxide

2 carbon dioxide

3 nitrogen oxide

4 nitrogen

8C Why do some environmental organisations question the benefits of catalytic converters?

1 They are expensive to manufacture and make cars more expensive.

2 Polluting gases are released both in producing them and in using them.

3 They do not remove any of the harmful gases from the exhaust fumes.

4 Nitrogen is a poisonous gas.

4.7.1.1 Crude oil, hydrocarbons and alkanes

8D What conclusion about the use of catalytic converters can safely be made from the information in this question?

1 Transition metals are good conductors of heat and electricity.

2 There are no harmful gases in the exhaust fumes from a car fitted with a catalytic converter.

3 A catalytic converter reduces the amount of carbon monoxide in the exhaust fumes from a petrol-driven car.

4 Catalytic converters work equally well in both diesel-driven and petrol-driven cars.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 11

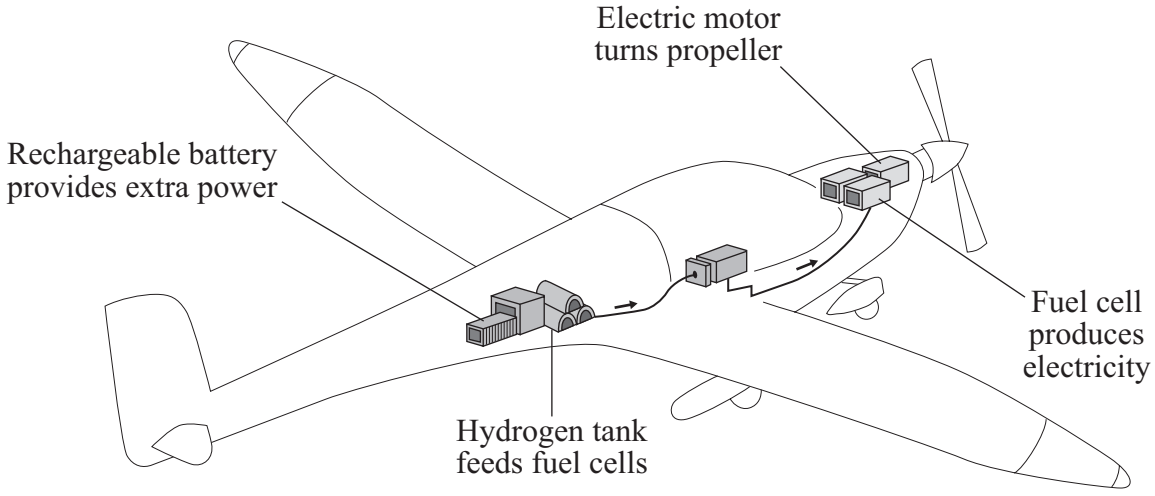
June 2007 | CHY1A | Original Q9 | Legacy

QUESTION NINE

This information is an edited newspaper article about aircraft research.

Greening the skies

'Emission-free aircraft'



Conventional aircraft use very large volumes of kerosene fuel which is a mixture of hydrocarbons. Research is being carried out into the use of hydrogen as a fuel.

In the fuel cell, hydrogen is chemically combined with oxygen to produce electricity, to drive a motor which turns the propeller. Fuel cells are bulky and expensive but have no moving parts and run silently.

Most commercially produced hydrogen is obtained from natural gas, and carbon dioxide is generated as a by-product. It has been called 'black hydrogen' by some groups.

As an aircraft fuel, mass for mass, hydrogen will deliver about three times as much energy as kerosene; however, the volume of the hydrogen is much greater.

One problem with kerosene fuel is that aircraft sometimes have to dump large volumes of fuel, if, for example, they are turned back to the take-off airport.

Question 11 · continued June 2007 | CHY1A | Original Q9 | Legacy

9A There are several reasons why this research is being carried out.

Which of the following is **not** one of those reasons?

1 There could be a shortage of kerosene in the future.

2 There is political pressure to reduce air travel.

3 Kerosene is obtained from a non-renewable source.

4 There is political pressure to reduce emission of gases which may cause global warming.

9B In this article, 'emission free' means . . .

1 there are no waste products when hydrogen is used in a fuel cell.

2 the fuel cell only produces carbon dioxide and water as waste.

3 there are no harmful gases produced by the fuel cell.

4 the fuel cell reduces noise pollution from aircraft.

9C One reason why some groups refer to the commercially produced hydrogen as 'black hydrogen' is that . . .

1 the hydrogen is impure.

2 the hydrogen is made from a fossil fuel.

3 the hydrogen burns to produce more carbon dioxide.

4 sulfur dioxide is a by-product of the process.

9D Even if hydrogen-powered aircraft are used commercially in the future, there will probably still be pressure groups against increased air travel.

One reason for objection to increased air travel could be that . . .

1 hydrogen-powered aircraft are too noisy.

2 hydrogen is a dangerous fuel to use in an aircraft.

3 agricultural land will be lost to the building of new runways.

4 dumping large volumes of hydrogen is dangerous.

END OF TEST

4.7.1.1 Crude oil, hydrocarbons and alkanes

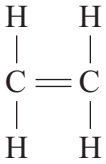
Question 12

June 2007 | CHY1B | Original Q2 | Legacy

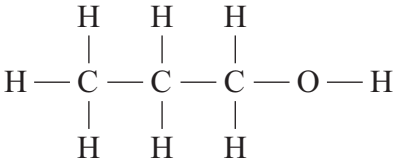
QUESTION TWO

This question is about the formulae for four compounds.

Match formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.



A



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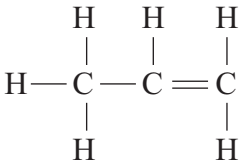

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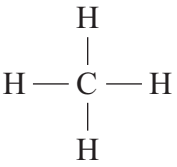


D

	Description
1	It is an unsaturated hydrocarbon with three carbon atoms in each molecule.
2	It is the monomer from which poly(ethene) is made.
3	It is the alkane that was present in Earth's early atmosphere.
4	It is not a hydrocarbon.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 13

QUESTION SEVEN

A compound, C_4H_{10}, was decomposed by passing it over a hot catalyst.

Analysis showed the product to be a mixture of two different hydrocarbons, hydrocarbon **A** (an alkane) and hydrocarbon **B**.
Both hydrocarbon **A** and hydrocarbon **B** had two carbon atoms in each molecule.

7A Which row in the table shows the correct formulae for these two hydrocarbons?

	Hydrocarbon A	Hydrocarbon B
1	C_2H_6	C_2H_4
2	C_2H_2	C_2H_8
3	C_2H_4	C_2H_6
4	C_2H_5	C_2H_5

7B The boiling point of hydrocarbon **A** is –89 °C and that of hydrocarbon **B** is –104 °C.

They could probably be separated and collected by . . .

1 thermal decomposition.

2 cracking.

3 condensation.

4 polymerisation.

7C Each of the two hydrocarbons was tested with bromine water.

Which row in the table correctly shows what happens to the bromine water?

	With hydrocarbon A	With hydrocarbon B
1	turns green	turns colourless
2	turns colourless	stays yellow-brown
3	stays yellow-brown	turns colourless
4	stays yellow-brown	turns green

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 13 · continued

7D Of these two hydrocarbons, only hydrocarbon **B** can form polymers.

This is because . . .

1 it has a higher boiling point.

2 its molecule has a double carbon carbon bond.

3 its molecule is saturated.

4 it has smaller molecules.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 14

June 2007 | CHY1B | Original Q9 | Legacy

QUESTION NINE

This passage is about biodiesel.

- Petroleum diesel is made from crude oil.
- Biodiesel is made from a variety of vegetable oils, eg soybean, palm and rapeseed.
- Biodiesel can be used in diesel cars without modification to the engine.

The use of biodiesel will reduce a country's dependency on crude oil, particularly if the technology involved in the production of biodiesel is improved.
However, large areas of agricultural land will be needed to grow the crops from which to extract the vegetable oils.

Palm oil produces better yields of fuel per hectare of land than other crops. Indonesia plans to increase the amount of land used to produce palm oil by 50%. 1.8 million hectares of rainforest in Borneo would be cut down to produce the world's largest palm oil plantation.

9A One reason why there is research and development into the use of biodiesel is that . . .

1 biodiesel does not produce any harmful waste gases when it burns.

2 there are large areas of unused agricultural land.

3 in some countries, manufacturers do not know how to make petroleum diesel.

4 crude oil is non-renewable.

9B On what basis can those who support the increased use of biodiesel claim that, when compared with petroleum diesel, it reduces the **net** greenhouse gas emissions?

1 Plants used to make biodiesel take up carbon dioxide for photosynthesis.

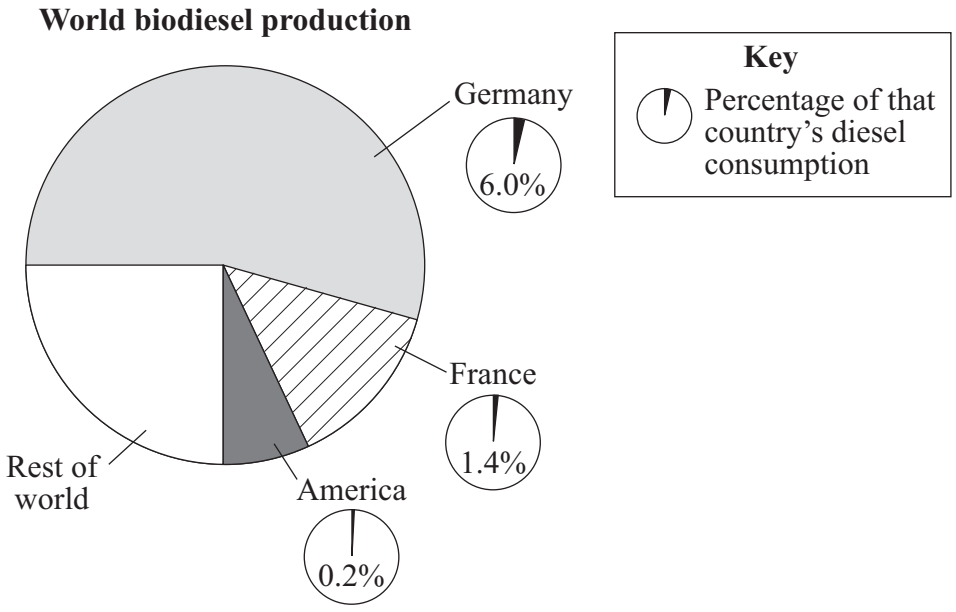
2 Biodiesel does not produce greenhouse gases when it burns.

3 Biodiesel produces more carbon dioxide when it burns.

4 Biodiesel does not produce water vapour when it burns.

Question 14 · continued

9C The pie chart shows information on the world biodiesel production and percentage of diesel consumption in 2005.



The pie chart shows that in 2005, . . .

1 France used seven times more biodiesel than America.

2 America produced less biodiesel than any other country in the world.

3 three countries produced about 75 % of the world's biodiesel.

4 Germany was the largest user of biodiesel.

9D Some pressure groups argue against the increased use of biodiesel.

Which of the following is **not** an argument that they could reasonably use?

1 It could result in the loss of some animal and plant species.

2 It could create food shortages in some parts of the world.

3 It could cause water shortages in some countries.

4 It could cause petroleum diesel prices to rise sharply.

END OF TEST

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 15

June 2007 | CHY1H | Original Q5 | Legacy

5 Known crude oil reserves are being used up rapidly. Crude oil is used to produce many useful fuels, such as petrol. One way to conserve crude oil reserves would be to increase the production of bio-fuels.

(a) Ethanol can be produced for use as a bio-fuel. Cars can be powered by ethanol or ethanol–petrol mixtures.

Sugar cane can be fermented to give a mixture of water (boiling point 100 °C) and ethanol (boiling point 78 °C).

(i) How can ethanol be separated from water?

.....

.....

(1 mark)

(ii) Ethanol, C_2H_5OH, burns to release heat energy.

Complete the balanced symbol equation by writing in the formulae of the two products.

$C_2H_5OH + 3O_2 \rightarrow 2..... + 3.....$

(2 marks)

Question 15 · continued

BLANK

(b) The cost of producing a bio-fuel, such as ethanol, by fermentation, is at least three times higher than the production cost of petrol. It costs less to produce ethanol from alkanes. In the production, the vapour of an alkane is passed over a hot catalyst.

$$\underset{\text{hexane}}{C_6H_{14}} \xrightarrow{\text{Hot catalyst}} \underset{\text{ethane}}{C_2H_6} + \underset{\text{ethene}}{2C_2H_4}$$

Ethene is then converted into ethanol.

(i) What has happened to the hexane to produce ethene?

.....

(1 mark)

(ii) Complete the structural formula for ethene, C_2H_4.

C C

(1 mark)

(iii) Name the compound that is added to ethene to produce ethanol, C_2H_5OH.

.....

(1 mark)

(c) As explained in parts (a) and (b), ethanol can be made using either sugar or alkanes as the starting material.

Evaluate the advantages and disadvantages of using these two starting materials to produce ethanol.

.....

.....

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.....

(4 marks)

10

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 16

November 2007 | CHY1A | Original Q1 | Legacy

QUESTION ONE

This question is about fractional distillation of crude oil.

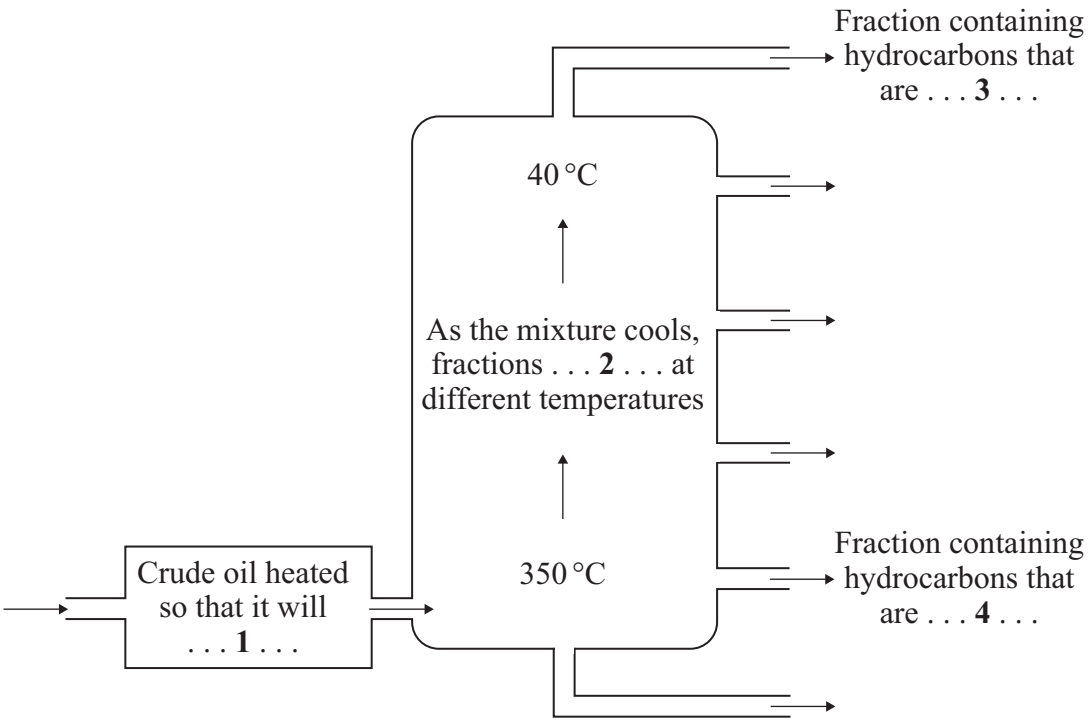
Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences on the diagram.

A condense

B vaporise

C viscous

D volatile



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 17

November 2007 | CHY1A | Original Q5 | Legacy

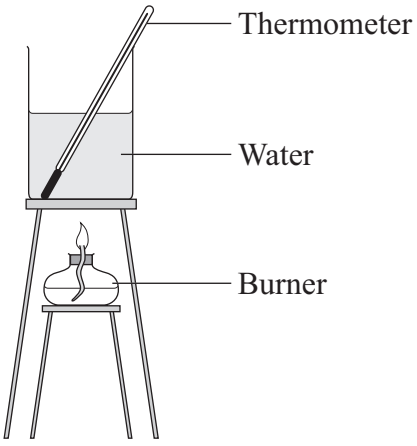
QUESTION FIVE

A student carried out an experiment to find out how much energy is given off when one gram of the alkane called pentane is burned.

The student heated some water with the burning pentane. The temperature rise was recorded.

The student repeated the experiment with pentane two more times.

The student then repeated the whole experiment using three other alkanes, hexane, heptane and octane.



The results are shown in the table.

Name of alkane	Number of carbon atoms in a molecule	Test number	Temperature rise (°C)	Average temperature rise (°C)	Energy given off in kJ per g	
					From experiment	Correct value
Pentane	5	1	8.5	8.8	2.8	48.6
		2	9.0			
		3	9.0			
Hexane	6	1	8.5			48.3
		2	8.9			
		3	14.0			
Heptane	7	1	9.0	9.2	3.6	
		2	9.5			
		3	9.0			
Octane	8	1	8.5	9.0	3.5	47.9
		2	9.0			
		3	9.5			

Question 17 · continued

5A Which one of the following values is the most sensible to use for the average temperature rise for hexane?

1 8.5

2 8.7

3 8.9

4 10.5

5B Which is the best estimate for the correct value for the energy given off when heptane is burned?

1 47.9 kJ/g

2 48.1 kJ/g

3 48.4 kJ/g

4 48.5 kJ/g

5C Which one of the following changes will **not** improve the accuracy of the results?

1 burning the fuel for longer to get a large temperature rise

2 enclosing the apparatus in a tube to exclude draughts

3 using a thermometer that measures to the nearest degree

4 weighing the burner on a more sensitive balance

5D When the fuel is burning, the flame is yellow. This is because the fuel is not completely burned.

What effect does this have on the accuracy of the results of the experiment?

1 It makes no difference to the results.

2 Some results are too high and some are too low.

3 The results are all too high.

4 The results are all too low.

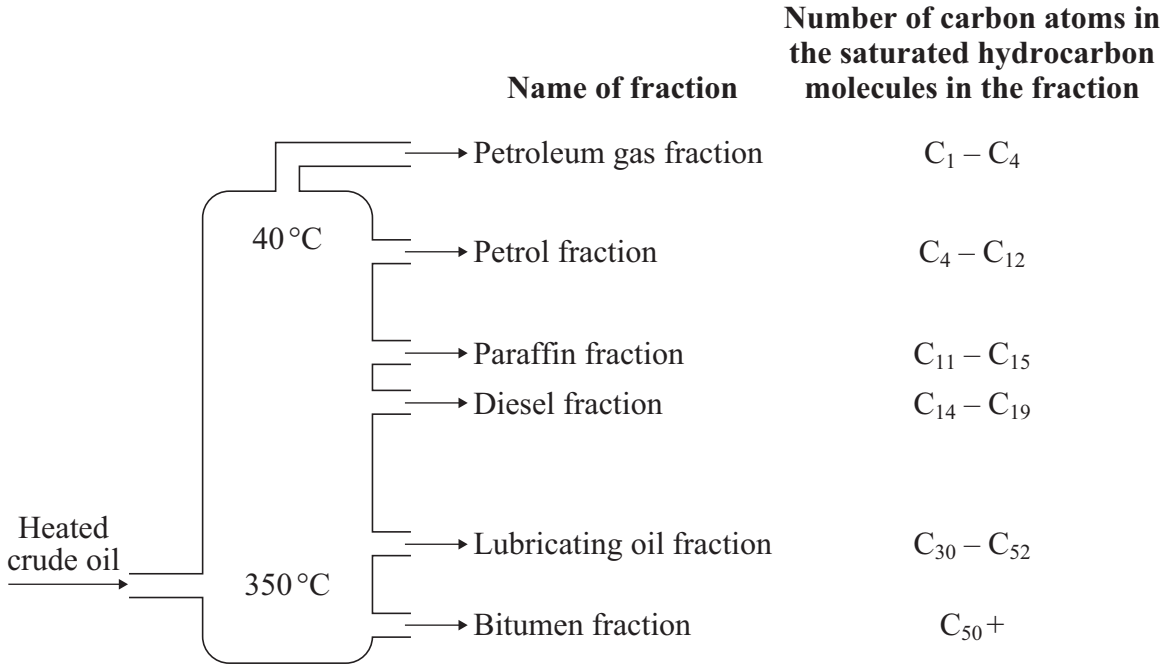
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 18

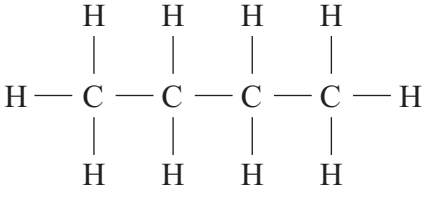
November 2007 | CHY1A | Original Q8 | Legacy

QUESTION EIGHT

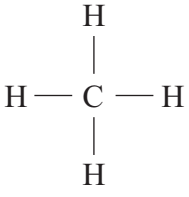
Crude oil can be separated into fractions.
Each fraction contains several different saturated hydrocarbons.



8A One of the hydrocarbons in the petrol fraction can be represented by . . .



1



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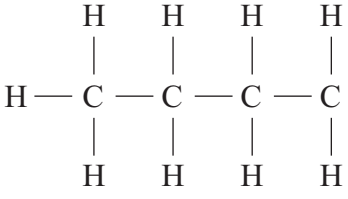

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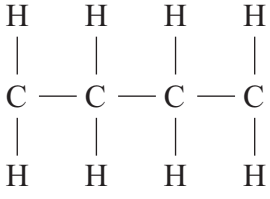

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4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 18 · continued

November 2007 | CHY1A | Original Q8 | Legacy

8B Which statement is **not** true of saturated hydrocarbons?

1 When burned completely, they produce carbon dioxide and water.

2 They have the general formula C_nH_{2n+1}

3 They can be solids, liquids or gases.

4 Those with a small number of carbon atoms in each molecule are useful as fuels.

8C When compared with diesel, petrol . . .

1 is more difficult to ignite.

2 is more volatile.

3 has a higher boiling point.

4 is more viscous.

8D Which one of these statements about ethanol is **false**?

1 Ethanol is a renewable resource.

2 Ethanol does not release carbon dioxide when it burns.

3 Ethanol, produced from plant material, can be carbon-neutral.

4 Ethanol does not release sulfur dioxide when it burns.

4.7.1.1 Crude oil, hydrocarbons and alkanes

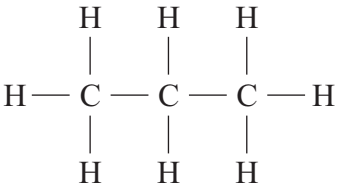
Question 19

November 2007 | CHY1B | Original Q2 | Legacy

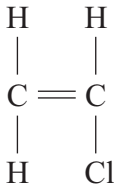
QUESTION TWO

This question is about the formulae of four organic compounds.

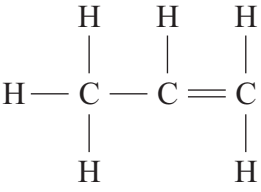
Match the formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.



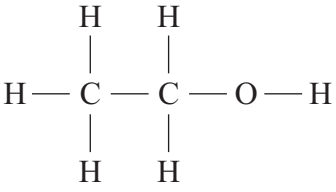
A



B



C



D

	What we can say about the organic compound
1	It is a saturated hydrocarbon useful as a fuel.
2	It is a monomer from which the polymer, polyvinylchloride, can be made.
3	It is the formula for ethanol.
4	It belongs to a group of hydrocarbons with the general formula C_nH_{2n}

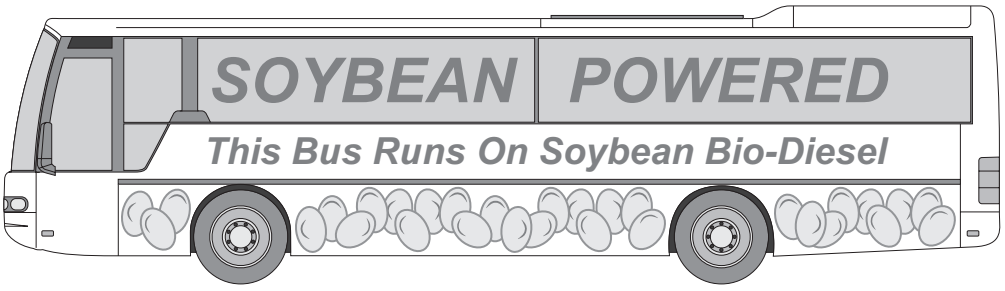
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 20

November 2007 | CHY1B | Original Q9 | Legacy

QUESTION NINE

Petroleum diesel fuel is made from crude oil.
Biodiesel fuel is made from vegetable oils. In America, soybean and rapeseed oil are used.



Biodiesel biodegrades in about a quarter of the time required for petroleum diesel to do so.
Biodiesel, when burned, emits more acidic nitrogen oxides but fewer particulates than petroleum diesel.

Three types of fuel containing biodiesel are available in America:

- B100 (100% biodiesel)
- B20 (20% biodiesel)
- B2 (2% biodiesel).

In a diesel engine, the fuel flows from the fuel tank, along fuel pipes, to the combustion chamber where it is ignited by glow plugs.
There are some operating problems with B100. Biodiesel is much thicker than petroleum diesel and is more difficult to ignite (has a lower cetane number than petroleum diesel). In most engines, the biodiesel needs to be pre-heated.
Biodiesel also has a higher melting point than petroleum diesel and so, in winter, can solidify in pipes and filters.
Using B20 gives few problems, and little or no modification to engines is required.

9A The availability of B2 and B20 may persuade motorists to use biodiesel instead of petroleum diesel.

This could be important because . . .

1 crude oil is non-renewable.

2 biodiesel emissions are less likely to cause acid rain.

3 B100 does not ignite as easily as petroleum diesel.

4 biodiesel does not produce any waste gases when it burns.

Question 20 · continued

9B Ideally, the vegetable oil used for biodiesel should have all these properties **except** . . .

1 a low viscosity.

2 a high melting point.

3 a high cetane number.

4 a good flow rate.

9C Why are **net** carbon dioxide emissions lower for biodiesel than for petroleum diesel?

1 The carbon dioxide is reused to make fossil fuels.

2 Some vegetable oils produce very little carbon dioxide when they burn.

3 The carbon dioxide is recycled as it is used by plants for photosynthesis.

4 The carbon dioxide formed from burning biodiesel is very soluble in water.

9D Spills of fuels from oil tankers cause considerable damage to the marine environment. Spills of biodiesel could be less harmful than those of petroleum diesel.

This is because biodiesel . . .

1 will float more easily on the water.

2 could be burned more easily on the surface of the water.

3 would not spread over the water as easily.

4 would break down into less harmful substances more quickly.

END OF TEST

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 21

January 2008 | CHY1H | Original Q5 | Legacy

5 Since 2000 there has been a lot more research into alternative, environmentally-friendly fuels for road transport.
Several pollutants are found in the exhaust emissions produced when fossil fuels are used for road transport.

Carbon monoxide (CO) interferes with the way that red blood cells carry oxygen.
Carbon dioxide (CO_2) increases the level of carbon dioxide in the atmosphere and causes global warming.

Oxides of nitrogen (NO_x) are produced at high temperatures when nitrogen and oxygen from the atmosphere combine.

Sulfur dioxide (SO_2) is produced when sulfur impurities in the fuel combine with oxygen in the atmosphere.

Tiny particles of solids are produced when the fuel does not burn completely.
This increases the level of particulates (PM10) in the atmosphere.

(a) Name the environmental effect caused by:

(i) oxides of nitrogen (NO_x) and sulfur dioxide (SO_2)

.....

(1 mark)

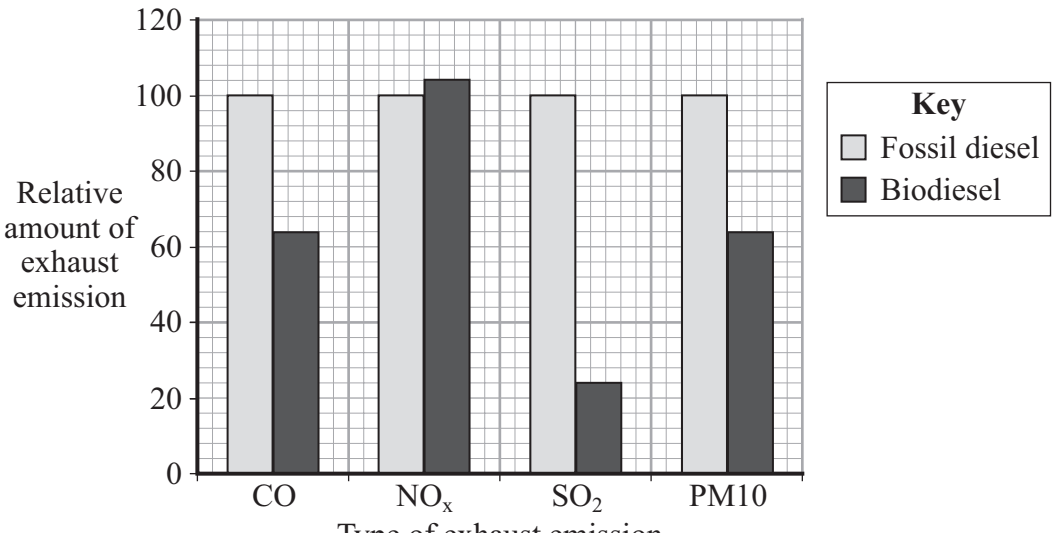
(ii) the increased level of particulates (PM10).

.....

(1 mark)

(b) Diesel obtained from crude oil is often called fossil diesel.
Biodiesel can be made from many vegetable oils.
One research project compared the exhaust emissions when fossil diesel or biodiesel were used as fuels.

Some of the relative amounts of these exhaust emissions are shown in the bar chart.



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 21 · continued

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(i) Use your knowledge and the information opposite to explain the environmental benefits of using biodiesel as a sustainable, low pollution fuel.

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(3 marks)

(ii) Biodiesel is called a green fuel.

This is because the life-cycle emission of carbon dioxide from biodiesel is less than that from fossil diesel.

Use your knowledge and the information opposite to explain why biodiesel's contribution to global warming is considered to be much less than that of fossil diesel.

.....

.....

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.....

.....

.....

(3 marks)

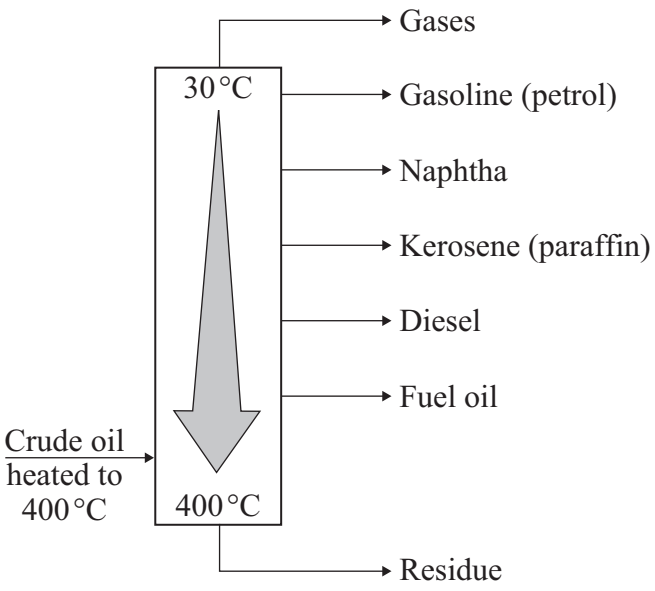
8

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 22

January 2008 | CHY1H | Original Q6 | Legacy

6 Crude oil is the source of many useful materials. Crude oil is separated into fractions by fractional distillation.



(a) Describe how the naphtha fraction separates from the other fractions.

.....

.....

.....

.....

(2 marks)

(b) The naphtha fraction is often used to make other useful materials.
This involves the cracking of hydrocarbons in the naphtha fraction.

For example:

decane → hexane + ethene

$C_{10}H_{22} \rightarrow C_6H_{14} + C_2H_4$

(i) Balance the symbol equation given above.

(1 mark)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 22 · continued

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(ii) Describe how cracking is carried out.

.....

.....

.....

(2 marks)

(iii) Why does ethene have different chemical properties from decane and hexane?

.....

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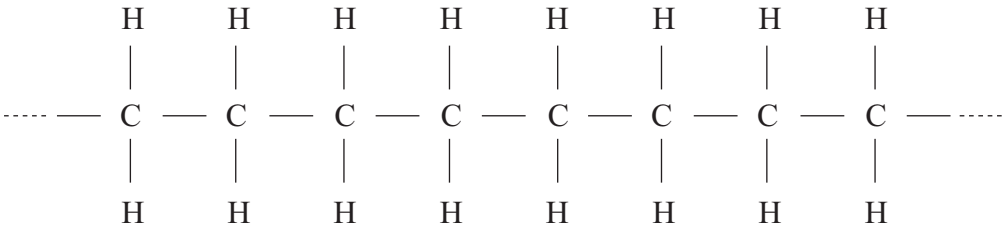
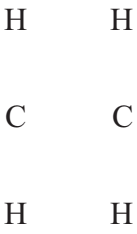
(2 marks)

(c) Ethene is used as the starting material for many polymers. The most common polymer is poly(ethene). One hydrocarbon molecule in poly(ethene) will contain thousands of carbon atoms.



Complete the diagram to show the bonds in ethene.



(1 mark)

Question 6 continues on the next page

Question 22 · continued

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(d) Read the following information.

Landfill, Incineration, Recycling and Re-use of Poly(ethene)

People could be encouraged to re-use their poly(ethene) bags and containers.

Recycling poly(ethene) saves raw materials and energy needed to make new plastic. When polymers are recycled the plastics must be collected, transported, sorted into different types by hand and washed. This requires the use of fossil fuels and is expensive.

Poly(ethene) can be burnt in an incinerator with other household waste. The heat released could be used to make steam to drive an electric generator. Surplus heat could be used to heat greenhouses used for growing vegetables. Incineration at too low a temperature can produce harmful substances. The residue (ash) has to go to landfill.

Landfill is probably the easiest way to dispose of polymers and it is cheap. Polymers are often mixed in with other household rubbish. Household waste does not get sorted into different materials because it is disposed of in the same hole in the ground. When the hole is eventually full, the waste is covered by a layer of soil to stop it smelling. The waste gets compressed under its own weight. Most polymers, such as poly(ethene), are not biodegradable so will remain in the ground forever.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 22 · continued

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You are asked to decide which option for the disposal of poly(ethene) will be put forward in your area. You decide that recycling is the best option.

Suggest **one** economic argument and **one** environmental argument that will be made against recycling.

For each argument made, how will you persuade those making the argument to accept your option?
(You must use only one sentence for each argument made against your decision and only one sentence for your response to it.)

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(4 marks)

12

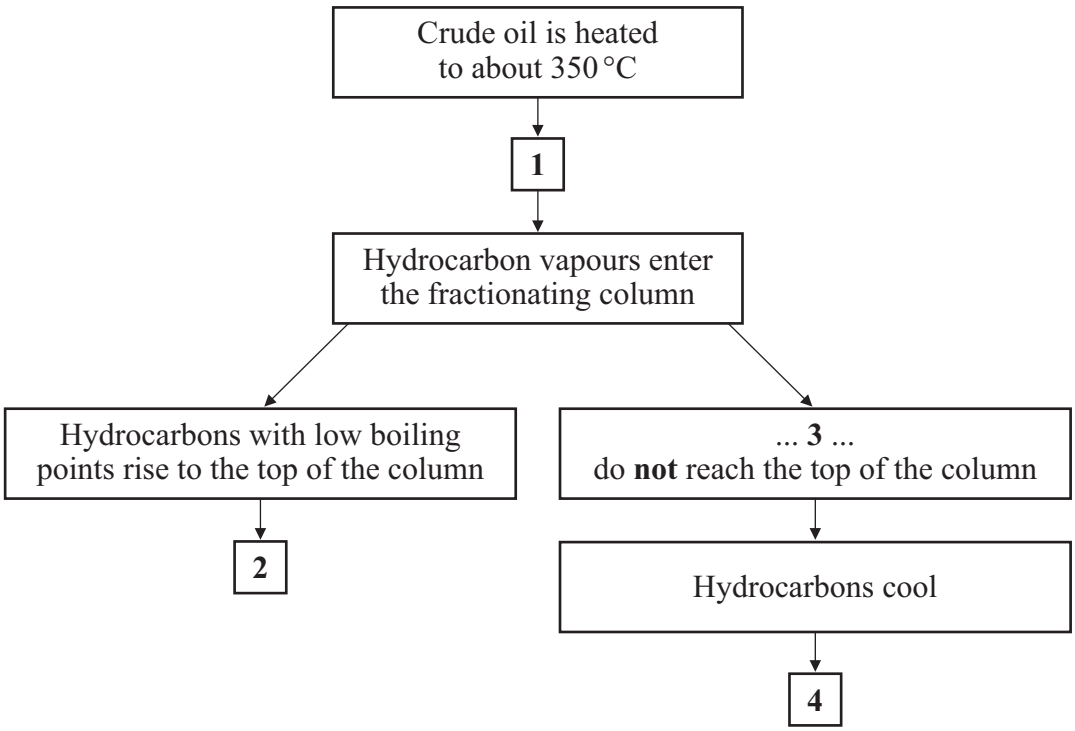
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 23

March 2008 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

The flow chart shows stages in the fractional distillation of crude oil.



Match statements, **A**, **B**, **C** and **D**, with the numbers **1–4** in the flow chart.

A Hydrocarbons in the crude oil turn to vapour

B Hydrocarbons collected as gases

C Hydrocarbons with high boiling points

D Hydrocarbons condense to form liquids

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 24

March 2008 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The table gives some information about the boiling points and combustion products of the first six alkanes.

			When one molecule of the alkane is completely burned	
Name	**Formula**	**Boiling point in °C**	**Number of molecules of CO_2 formed**	**Number of molecules of H_2O formed**
Methane	CH_4	–168	1	2
Ethane	C_2H_6	– 89	2	3
Propane	C_3H_8	– 42	3	4
Butane	C_4H_{10}	– 0.5		
Pentane	C_5H_{12}	+ 36		
Hexane	C_6H_{14}	+ 69		

8A Which one of the following statements is true about the fractional distillation of a mixture of the alkanes in the table?

1 Each of the fractions collected would contain just **one** alkane.

2 Hexane would be in the fraction selected at the highest temperature.

3 The hottest part of the column would be at the top.

4 Methane would be separated out at the bottom of the column.

8B Which one of the following is true about burning the alkanes?

1 As the size of the alkane molecules increases, the ratio of $CO_2 : H_2O$ molecules formed will eventually be 1:1

2 As the size of the alkane molecules increases, more and more oxygen molecules will be required to completely burn one molecule of the alkane.

3 The amount of water and carbon dioxide formed suggests that the alkanes with larger molecules will ignite more easily.

4 Since only water and carbon dioxide are formed on burning, the alkanes are environmentally-friendly fuels.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 24 · continued

8C Burning the alkanes that have larger molecules tends to produce carbon monoxide along with carbon dioxide and water.

This suggests that these alkanes . . .

1 do **not** undergo complete combustion.

2 would make better fuels.

3 contain dissolved carbon monoxide gas.

4 can never be made totally pure.

8D To estimate the boiling point of heptane (C_7H_{16}) it would be best to use the boiling points from the table to plot . . .

1 a line graph with the number of carbon atoms as the independent, discrete variable.

2 a line graph with the number of carbon atoms as the categoric variable.

3 a bar chart with the number of carbon atoms as the independent, discrete variable.

4 a bar chart with the number of carbon atoms as the categoric variable.

4.7.1.1 Crude oil, hydrocarbons and alkanes

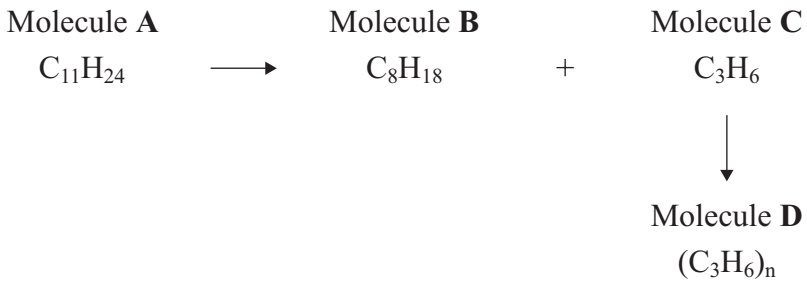
Question 25

March 2008 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

This question is about cracking.

Match molecules, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.



Molecule . . . **1** . . . has been cracked.

Molecule . . . **2** . . . is an alkene.

Molecule . . . **3** . . . is a polymer.

Molecule . . . **4** . . . is the smallest alkane in the reaction.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 26

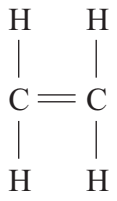
March 2008 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

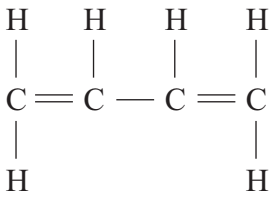
This question is about the formulae for four hydrocarbon compounds.

Match formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

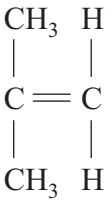
A



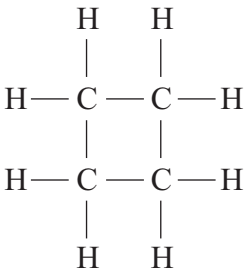
B

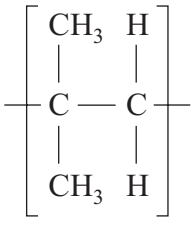


C



D



Hydrocarbon compound	Description
1	It does **not** fit the general formula C_nH_{2n}
2	It could be produced by cracking any of the other three.
3	It cannot be polymerised without further treatment.
4	It would produce a polymer with the repeating unit: 

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 27

March 2008 | CHY1BP | Original Q9 | Legacy

QUESTION NINE

The general equation for the complete combustion of an alkane is:

$$2C_nH_{2n+2} + (3n+1)O_2 \rightarrow 2nCO_2 + 2(n+1)H_2O$$

Use this information to help you to answer the following questions.

9A Why are alkanes with few carbon atoms likely to be better fuels?

1 They require less oxygen so are less likely to be completely burned.

2 They require less oxygen so are more likely to be completely burned.

3 They require more oxygen so are less likely to be completely burned.

4 They require more oxygen so are more likely to be completely burned.

9B The formula of hexane is C_6H_{14}

How many molecules of oxygen are needed to burn one molecule of hexane?

1 $9\frac{1}{2}$

2 19

3 $21\frac{1}{2}$

4 43

9C What is the general equation for the combustion of an alkene (C_nH_{2n})?

1 $C_nH_{2n} + 1\frac{1}{2}nO_2 \rightarrow nCO_2 + nH_2O$

2 $C_nH_{2n} + 1\frac{1}{2}nO_2 \rightarrow nCO_2 + 2nH_2O$

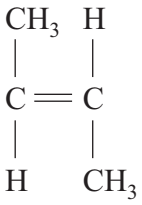
3 $C_nH_{2n} + 3nO_2 \rightarrow nCO_2 + nH_2O$

4 $C_nH_{2n} + 3nO_2 \rightarrow nCO_2 + 2nH_2O$

Question 27 · continued

9D Alkene molecules can be bonded together to form polymers.

Which polymer would be produced from this alkene?



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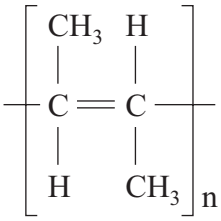

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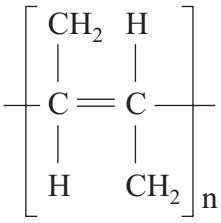

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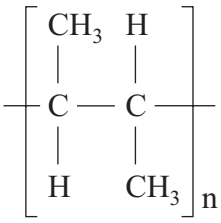

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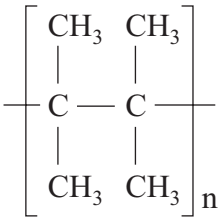


END OF TEST

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 28

June 2008 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

This question is about hydrocarbons and fuels.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A C_2H_5OH

B C_3H_8

C C_2H_4

D S

1	a hydrocarbon that is **not** an alkane
2	an alkane
3	a compound that is **not** a hydrocarbon
4	an element that may be found in a fuel

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 29

June 2008 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

The flow chart below gives information about some of the substances involved in the combustion of a hydrocarbon fuel.

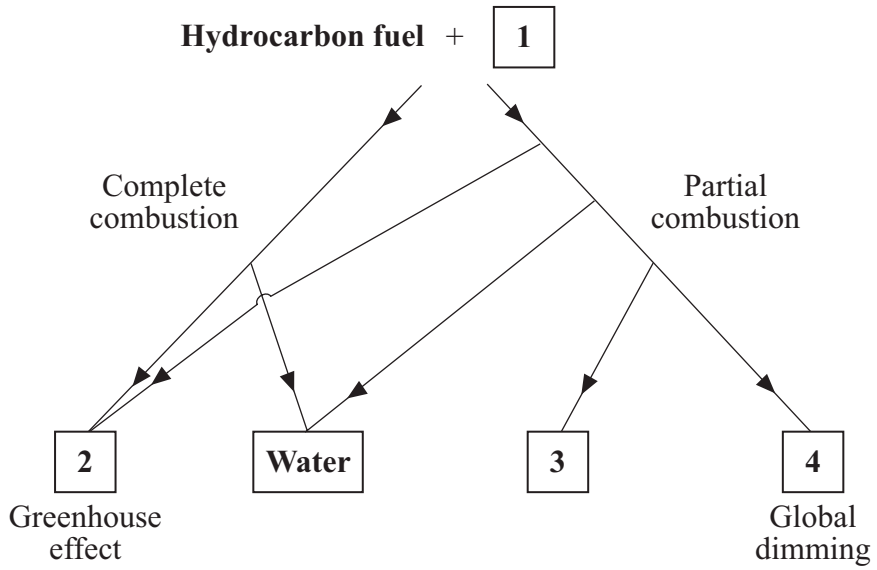
Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the flow chart.

A carbon monoxide

B carbon particles

C oxygen

D carbon dioxide



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 30

June 2008 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

Scientists are researching new catalysts to convert compounds in coal into small hydrocarbon molecules.

These small molecules can be used to make liquid fuels such as petrol.

4A Scientists are trying to develop processes that convert coal into liquid fuels, such as petrol, because . . .

1 they have found new supplies of catalysts.

2 oil reserves are running out quickly.

3 there is no alternative to using coal.

4 catalysts are being used up.

4B Petrol is made from small molecules and **not** large molecules because hydrocarbons with small molecules . . .

1 have a higher boiling point.

2 are more viscous.

3 are darker in colour.

4 ignite more easily.

4C Both petrol and coal produce carbon dioxide when burned.

To compare the volume of the gas produced by a sample of coal with the volume of gas produced by a sample of petrol, a control variable would be . . .

1 how much carbon dioxide is produced.

2 the amount of coal and petrol used.

3 the speed at which each fuel is set alight.

4 the time taken to burn all the fuel.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 30 · continued June 2008 | CHY1AP | Original Q4 | Legacy

4D Ethanol, made from plant material, is another liquid fuel used in cars.

Ethanol and petrol produce similar amounts of carbon dioxide when they burn.

Burning ethanol made from plant material, in cars, is thought to be less of an environmental problem than burning petrol.

This is because . . .

1 ethanol does **not** produce water when it burns.

2 using ethanol made from plants as a fuel does **not** change the amount of carbon dioxide in the atmosphere.

3 ethanol will burn without using oxygen.

4 in the car engine, only partial combustion of the ethanol occurs.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 31

June 2008 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Crude oil contains a large number of alkanes, which have the general formula C_nH_{2n+2}

Crude oil can be separated into a number of fractions by fractional distillation.

6A Crude oil can be separated into fractions in this way because . . .

1 the alkanes it contains have different boiling points.

2 the alkanes it contains have different densities.

3 alkanes are compounds which are made up of more than one element.

4 all alkanes vaporise easily when they are heated.

6B Each fraction from the crude oil will contain . . .

1 a single alkane.

2 a mixture of several alkanes.

3 alkanes that have the same boiling point.

4 alkanes that have the same density.

The alkanes are a series of compounds.

The first ten alkanes in the series range from methane, CH_4 to decane, $C_{10}H_{22}$

6C The difference between the formulae of successive alkanes is . . .

1 C

2 H_2

3 CH

4 CH_2

4.7.1.1 Crude oil, hydrocarbons and alkanes

6D Which of the following changes in the alkane series, from methane to decane?

1 the general formula

2 the number of bonds on each carbon atom

3 the ratio of carbon atoms to hydrogen atoms

4 the number of elements present

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 32

June 2008 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

This question is about unsaturated hydrocarbons.

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A catalysis

B polymerisation

C combustion

D thermal decomposition

Heating large hydrocarbon molecules so that they break down into smaller molecules, such as ethene, is an example of . . . **1** . . . .

Ethanol is formed when ethene reacts with steam. The reaction is speeded up using phosphoric acid. This reaction is an example of . . . **2** . . . .

Individual ethene molecules can be made to link together to form very long chains in a process called . . . **3** . . . .

Ethene reacts with oxygen to produce carbon dioxide and water. This reaction is an example of . . . **4** . . . .

4.7.1.1 Crude oil, hydrocarbons and alkanes

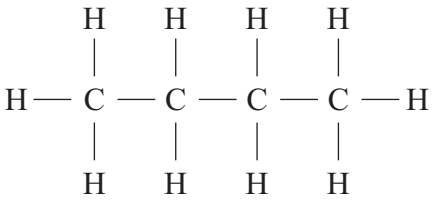
Question 33

June 2008 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

This question is about carbon compounds.

A



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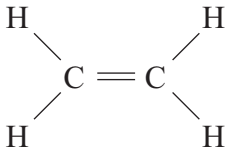
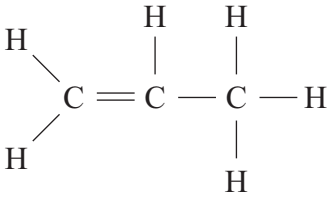
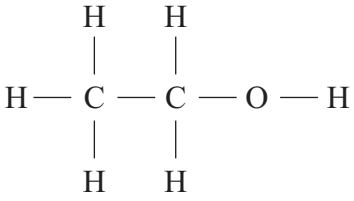


C



D



Match carbon compounds, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

	What we can say about the carbon compound
1	It is **not** a hydrocarbon.
2	It has the molecular formula C_2H_4
3	It is the monomer from which poly(propene) is made.
4	It can be cracked to produce propene.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 34

June 2008 | CHY1H | Original Q2 | Legacy

2 The hydrocarbons in crude oil can be separated into useful fractions.

Fraction	Boiling point in °C	Carbon chain length	Relative % in crude oil	Relative % demand
Naphtha	20–180	5–9	10	20
Gasoline (petrol)	20–200	5–10	10	20
Kerosene (paraffin)	180–260	10–16	15	23
Diesel	260–340	14–20	20	25
Fuel oil	370–600	20–70	45	12

2 (a) Why does gasoline (petrol) have a lower boiling point than fuel oil?

.....

.....

(1 mark)

2 (b) Suggest why gasoline (petrol) costs more than fuel oil.

.....

.....

.....

.....

(2 marks)

2 (c) Describe how fuel oil can be changed into gasoline (petrol).

.....

.....

.....

.....

(2 marks)

5

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 35

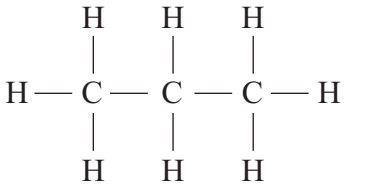
November 2008 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

This question is about four alkanes, **A**, **B**, **C** and **D**.

Alkane	Formula	Boiling point in °C
A	C_2H_6	−89
B	C_3H_8	−42
C	C_4H_{10}	0
D	C_5H_{12}	+36

Match alkanes, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

The alkane with the structural formula  is . . . **1** . . . .

The alkane with the highest boiling point is . . . **2** . . . .

The alkane that boils at the same temperature as ice melts is . . . **3** . . . .

The alkane that is a gas at −50 °C is . . . **4** . . . .

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 36

November 2008 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

Hydrocarbon fuels, **K**, **L**, **M** and **N**, were burned and the products were collected and identified.

The results are shown in the table below.

	Hydrocarbon fuels			
Products of burning	**K**	**L**	**M**	**N**
Carbon monoxide	✓	✓	✓	✗
Carbon dioxide	✓	✓	✓	✓
Water vapour	✓	✓	✓	✓
Soot	✓	✓	✗	✗
Sulfur dioxide	✗	✗	✓	✓

Key:
✓ indicates that the substance is one of the products
✗ indicates that the substance is **not** one of the products.

3A The results show that combustion was **only** complete for . . .

1 hydrocarbon fuel **K**.

2 hydrocarbon fuel **L**.

3 hydrocarbon fuel **M**.

4 hydrocarbon fuel **N**.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 36 · continued

3B The table of results shows that the hydrocarbon fuels that do **not** contain sulfur are . . .

1 **M** and **N**.

2 **K** and **L**.

3 **L** and **M**.

4 **K** and **M**.

3C When hydrocarbon fuels are burned, some of the products cause problems.

Which one of the following statements correctly describes a problem that is caused by the products of burning?

1 Sulfur dioxide in the air causes heavier rainfall.

2 Releasing large amounts of carbon dioxide into the atmosphere produces ‘acid rain’.

3 A build-up of particles in the air causes ‘global dimming’.

4 Releasing large amounts of carbon dioxide into the atmosphere causes ‘global dimming’.

3D Ethanol is a compound of carbon, hydrogen and oxygen.
Ethanol can be used as a fuel in vehicles together with, or in place of, hydrocarbon fuels.

An advantage of ethanol as a fuel is that when it burns . . .

1 no carbon dioxide is produced.

2 carbon dioxide and water are produced.

3 no sulfur dioxide is produced.

4 only water is produced.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 37

November 2008 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

Benzene is a chemical which used to be obtained from whale oil. It is now mainly manufactured from crude oil, but it can also be obtained from coal. It is an extremely useful substance in the chemical industry, but it is very toxic. The chemical formula for benzene is C_6H_6

9A Which of the following statements about benzene is true?

1 It is a hydrocarbon.

2 It is an alkane.

3 It is a mixture.

4 It is safe to use as a fuel.

9B The equation below for the combustion of benzene is **not** balanced.

$$2C_6H_6 + \ldots\ldots O_2 \rightarrow 12CO_2 + 6H_2O$$

How many oxygen molecules would be required to balance the equation?

1 12

2 15

3 18

4 30

9C Benzene burns with a very smoky flame, producing lots of soot.

This is because . . .

1 it is manufactured from crude oil.

2 it has very large molecules.

3 it has a high ratio of carbon to hydrogen atoms.

4 it is very toxic.

9D The price of benzene is increasing.

This could be because . . .

1 whales are harder to catch.

2 there is no demand for benzene.

3 it is obtained from a renewable resource.

4 the costs of crude oil and coal are rising.

END OF TEST

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 38

November 2008 | CHY1BP | Original Q6 | Legacy

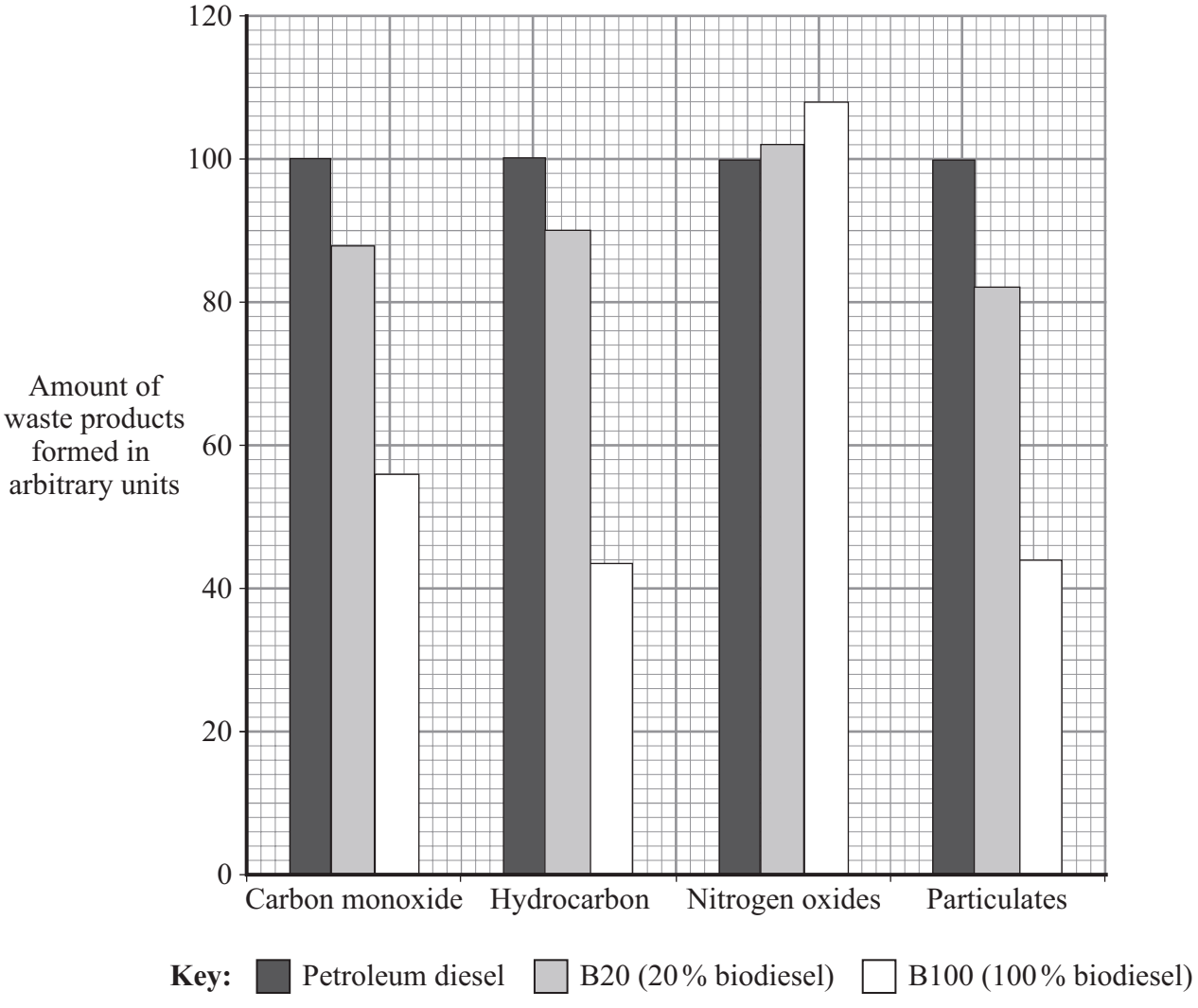
QUESTION SIX

Biodiesel is a fuel made from vegetable oils. It can be mixed with or it can entirely replace petroleum diesel fuel in vehicles.
B20 is petroleum diesel with 20 % biodiesel.
B100 is 100 % biodiesel.

Petroleum diesel is made from crude oil.

In a car engine, the fuel ignites and burns in air. The waste products formed leave the engine through the exhaust system.

The bar graph compares the quantities of four different waste products formed by burning B20 and B100 with the quantities formed by burning petroleum diesel.



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 38 · continued

6A From the information on the chart, the use of B100 instead of B20 will reduce particulates by about . . .

1 5 times.

2 half.

3 20%

4 35%

6B Which of the following is a correct statement about the waste products formed by burning these fuels?

1 They are all oxides.

2 They are all reduced when B20 is used instead of petroleum diesel.

3 Water vapour is also produced.

4 No carbon dioxide is produced with B100.

6C The main advantage of B100 over petroleum diesel is that B100 . . .

1 is non-biodegradable.

2 is renewable.

3 is unsaturated.

4 is hydrogenated.

6D Why are net carbon dioxide emissions lower for biodiesel than for petroleum diesel?

1 Plants use carbon dioxide for photosynthesis.

2 There are fewer alkanes in biodiesel.

3 Biodiesel does **not** contain any hydrocarbons.

4 Plants produce carbon dioxide in respiration.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 39

November 2008 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

Large hydrocarbon molecules can be broken down to produce smaller molecules.

An example is shown in the equation below:

$$\underset{\text{Hexane}}{C_6H_{14}} \longrightarrow \underset{\text{Substance } \mathbf{K}}{C_3H_8} + \underset{\text{Substance } \mathbf{L}}{C_3H_6}$$

7A What are the conditions needed for this breakdown of hexane?

1 heat at 60 °C

2 heat the vapour with hydrogen

3 heat with hydrogen in the presence of a nickel catalyst

4 heat and pass the vapour over a hot catalyst

7B The mixture of substances **K** and **L** could be separated by condensation if they . . .

1 were of different density.

2 ignited at different temperatures.

3 had different boiling points.

4 were both gases.

7C Substance **L** is . . .

1 a saturated hydrocarbon.

2 an alkane.

3 an alkene.

4 a polymer.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 39 · continued

7D One difference between the molecules of substances **K** and **L** is that . . .

1 in **K** there is a higher ratio of carbon to hydrogen atoms.

2 in **L** the carbon atoms have fewer bonds.

3 in **K** there are fewer single bonds.

4 in **L** there is a double bond.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 40

March 2009 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

Fuels burn in air to form oxides of the elements they contain.
When fuel molecules contain a large number of carbon atoms, combustion is not always complete.
With incomplete combustion, carbon particles may be produced.

Match molecules, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A H_2

B CO

C C_4H_{10}

D $C_{14}H_{28}$

1	It will burn to form carbon dioxide only.
2	It will burn to form water only.
3	It is an alkane.
4	It will probably contribute to global dimming when burned.

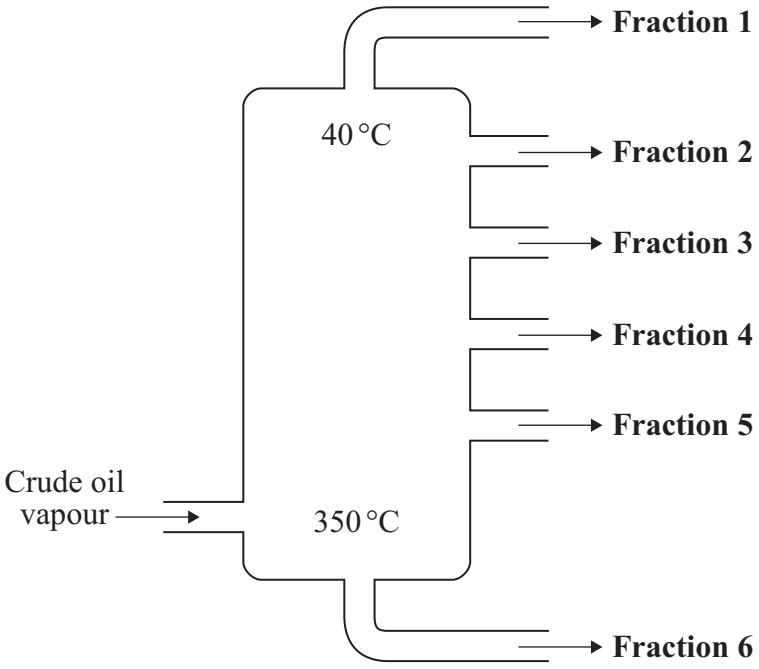
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 41

March 2009 | CHY1AP | Original Q6 | Legacy

QUESTION SIX

Crude oil vapour can be separated into a number of fractions.



6A Crude oil vapour enters the fractionating column.

What happens as the vapour cools?

1 The fractions separate because they have different densities.

2 The fractions condense at 40 °C.

3 The fractions condense at different temperatures.

4 The fractions condense at 350 °C.

6B **Fraction 6** will contain . . .

1 alkanes with high boiling points.

2 alkanes with a small number of carbon atoms in each molecule.

3 only hydrocarbons that are unsaturated.

4 only hydrocarbons with low boiling points.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 41 · continued

March 2009 | CHY1AP | Original Q6 | Legacy

6C **Fraction 1** contains the alkanes called methane, ethane, propane and butane.

By what process could pure methane be obtained from this fraction?

1 evaporation

2 electrolysis

3 thermal decomposition

4 fractional distillation

6D Which of these statements is correct for the alkanes?

1 They are a series of compounds with the general formula C_nH_{2n+1}

2 They are saturated compounds.

3 Most are gases at room temperature (20 °C), some are liquids, none are solids.

4 Their molecules have a carbon : hydrogen ratio of 1 : 4

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 42

March 2009 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

This question is about cyclic alkanes. Cyclic alkanes have similar chemical properties to straight chain alkanes.

The table below gives the energy released by burning the first four cyclic alkanes.

Cyclic alkane	Formula	Energy released by burning 1 g of the cyclic alkane
Cyclopropane	C_3H_6	46.6 kJ
Cyclobutane	C_4H_8	45.9 kJ
Cyclopentane	C_5H_{10}	44.3 kJ
Cyclohexane	C_6H_{12}	43.9 kJ

8A The cyclic alkanes listed in the table all fit the general formula . . .

1 CH_2

2 C_nH_{2n}

3 C_nH_{2n+2}

4 C_nH_{n+2}

8B Burning cyclic alkanes could **not** produce . . .

1 carbon.

2 hydrogen.

3 carbon dioxide.

4 water.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 42 · continued

8C A graph of the energy released by burning cyclic alkanes (*y*-axis) against the number of carbon atoms they contain (*x*-axis), would involve plotting . . .

1 an independent variable against a discrete variable.

2 a continuous variable against a continuous variable.

3 a discrete variable against a control variable.

4 a continuous variable against a discrete variable.

8D A graph of the energy released by burning cyclic alkanes (*y*-axis) against the number of carbon atoms they contain (*x*-axis), would show . . .

1 negative correlation.

2 no clear pattern.

3 positive correlation.

4 direct proportionality.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 43

March 2009 | CHY1BP | Original Q6 | Legacy

QUESTION SIX

This question is about cracking large hydrocarbon molecules.

Cracking is achieved by using either a high temperature and pressure without a catalyst, or a low temperature and pressure with a catalyst.

Whichever method is chosen:

- the energy for cracking is provided by burning fossil fuels;
- the zeolite catalysts used are not very expensive;
- the catalyst is not used up in the process;
- the cracking plant is often built near the oil refinery.

6A Which of the following occurs during cracking?

1 Small hydrocarbon molecules join together.

2 The hydrocarbon molecules become saturated.

3 The hydrocarbon molecules react together.

4 The hydrocarbon molecules are decomposed.

6B In which equation do the products include two different alkenes?

1 $C_{15}H_{32} \rightarrow 2C_2H_4 + C_3H_6 + C_8H_{18}$

2 $C_{15}H_{32} \rightarrow C_2H_2 + C_5H_{10} + C_8H_{18} + H_2$

3 $C_{15}H_{32} \rightarrow C_8H_{18} + C_7H_{14}$

4 $C_{15}H_{32} \rightarrow C_7H_{16} + C_8H_{16}$

6C Which of the following shows only products that could be directly obtained by cracking $C_{10}H_{22}$?

1 alkanes up to $C_{20}H_{44}$, hydrogen and ethene

2 alkanes up to C_8H_{18}, carbon dioxide and ethene

3 propene, poly(ethene) and hydrogen

4 alkanes up to C_8H_{18}, ethene and propene

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 43 · continued

6D These are the formulae for three hydrocarbons:

C_2H_4 C_2H_6 C_3H_6

Which row in the table shows the hydrocarbons that could form polymers, and gives the correct reason why they can polymerise?

	Hydrocarbons	Reason
1	C_2H_4 and C_2H_6	their molecules are saturated
2	C_2H_4 and C_3H_6	their molecules have a double carbon carbon bond
3	C_2H_4 and C_3H_6	their molecules are saturated
4	C_2H_4 and C_2H_6	their molecules have a double carbon carbon bond

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 44

June 2009 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

This question is about substances that can be burned in air.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A C_2H_5SH

B C_2H_6

C C_2H_2

D C

1	It would contribute to the formation of acid rain when burned.
2	It is an alkane.
3	It corresponds to the general formula C_nH_{2n-2}
4	It forms only carbon dioxide when burned in air.

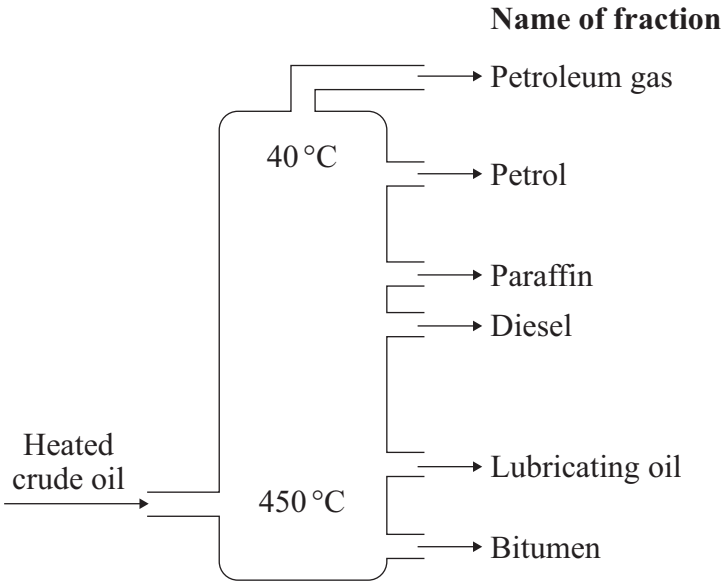
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 45

June 2009 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

In a fractionating column, crude oil is separated into a number of fractions.



5A The crude oil separates into fractions in the fractionating column because . . .

1 it changes from a liquid to a vapour.

2 crude oil vapour condenses at 100 °C.

3 crude oil vapour condenses at different temperatures.

4 decomposition of the crude oil occurs.

5B The diesel fraction boils over a range of temperatures from about 250 °C to 340 °C.

The fraction does **not** have a fixed boiling point because . . .

1 the temperature in the fractionating column is **not** constant.

2 the hydrocarbons in the fraction have different chemical properties.

3 the fraction contains a mixture of hydrocarbons.

4 liquid hydrocarbons boil at temperatures above 250 °C.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 45 · continued

5C The hydrocarbons from the bitumen fraction will . . .

1 be difficult to ignite at room temperature.

2 have small molecules.

3 be gases or liquids at room temperature.

4 have a small number of carbon atoms in each molecule.

5D A hydrocarbon from the lubricating oil fraction burns, in air, with a smoky flame.

This suggests that . . .

1 the hydrocarbon contains sulfur as an impurity.

2 there is only partial combustion of the hydrocarbon.

3 the hydrocarbon has small molecules.

4 when the hydrocarbon burns, it is oxidised.

4.7.1.1 Crude oil, hydrocarbons and alkanes

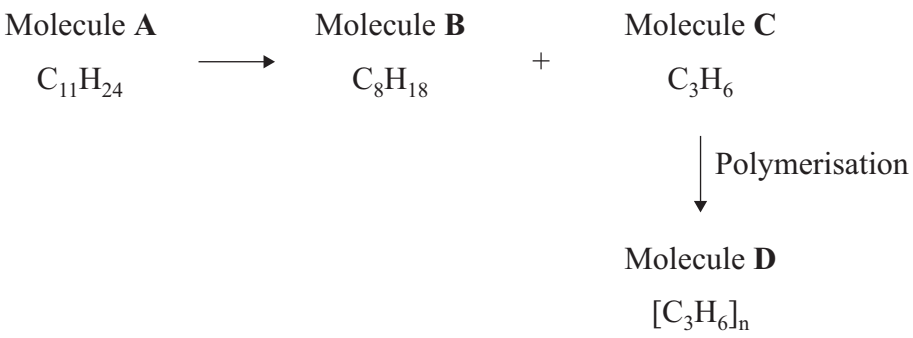
Question 46

June 2009 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

This question is about reactions of some hydrocarbon molecules.

Match molecules, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.



The molecule that has been cracked is . . . **1** . . . .

The molecule that is an alkene is . . . **2** . . . .

The molecule that is a plastic is . . . **3** . . . .

The molecule that is the smallest alkane in these reactions is . . . **4** . . . .

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 47

June 2009 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

This question is about obtaining useful substances from crude oil fractions.

Match words, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A polymerisation

B thermal decomposition

C unsaturation

D hydration (addition of water)

Alkenes can be made from oil fractions by . . . **1** . . . .

Bromine can be used to test for . . . **2** . . . in any alkenes formed.

Ethene formed from oil fractions can be made into ethanol by . . . **3** . . . .

Alkene molecules can be joined together into long-chain molecules in the process called . . . **4** . . . .

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 48

June 2009 | CHY1H | Original Q6 | Legacy

6 (a) PEX is a material that is used as an alternative to copper for hot water pipes. PEX is made from poly(ethene).

6 (a) (i) Describe how ethene forms poly(ethene).

.....

.....

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.....

(2 marks)

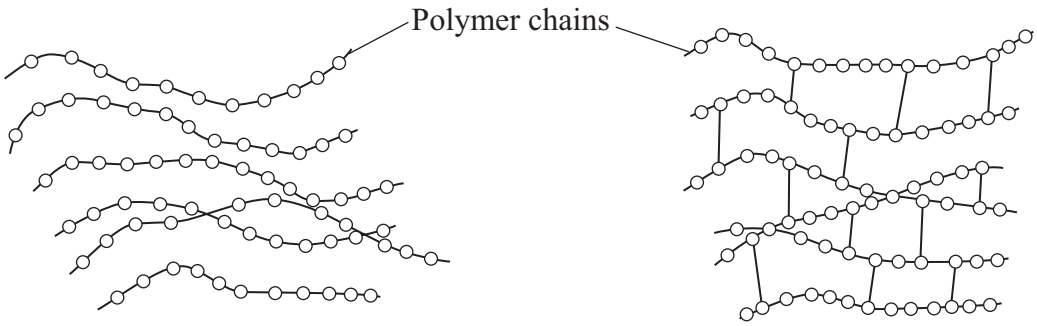
6 (a) (ii) PEX is a shape memory polymer. What property does a shape memory polymer have?

.....

.....

(1 mark)

6 (a) (iii) The simplified structures of poly(ethene) and PEX are shown.



Poly(ethene) **PEX**

Poly(ethene) is a thermoplastic that softens easily when heated.

Suggest and explain how the structure of PEX changes this property.

.....

.....

.....

.....

.....

(3 marks)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 48 · continued

for mark

6 (b) Copper was considered to be the most suitable material to use for hot water pipes. PEX is now used as an alternative material for hot water pipes.

Copper is extracted from its ore by a series of processes.

1 The low-grade ore is powdered and concentrated.
2 Smelting is carried out in an oxygen flash furnace. This furnace is heated to 1100 °C using a hydrocarbon fuel. The copper ore is blown into the furnace with air, producing impure, molten copper.
3 Oxygen is blown into the impure, molten copper to remove any sulfur. The copper is cast into rectangular slabs.
4 The final purification of copper is done by electrolysis.

PEX is made from crude oil by a series of processes.

1 Fractional distillation
2 Cracking
3 Polymerisation
4 Conversion of poly(ethene) into PEX

Suggest the possible environmental advantages of using PEX instead of copper for hot water pipes.

.....

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(4 marks)

10

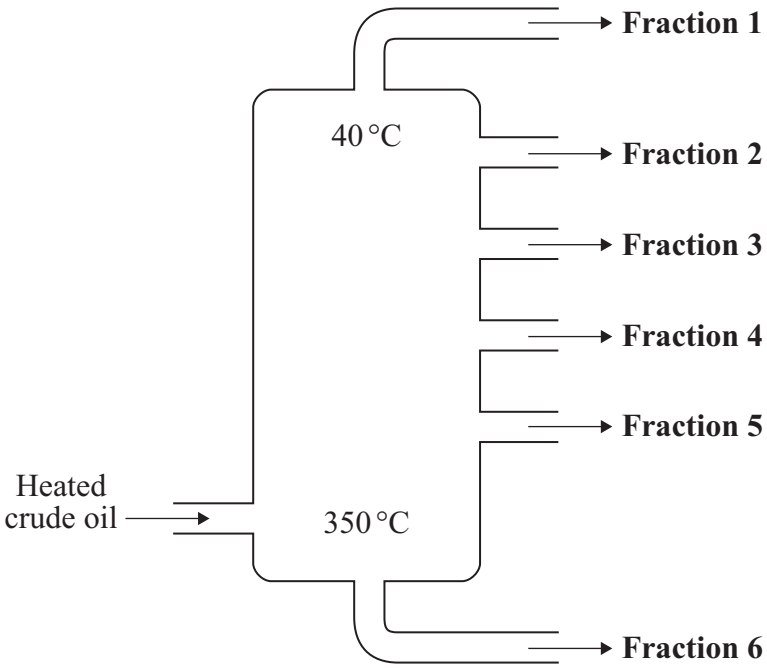
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 49

November 2009 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

In a fractionating column, crude oil is separated into a number of fractions.



3A Each fraction contains . . .

1 only alkanes that are liquids.

2 only alkanes that condense at temperatures above 40 °C.

3 alkanes with similar boiling points.

4 alkanes with the same chemical formula.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 49 · continued November 2009 | CHY1AP | Original Q3 | Legacy

3B Which statement is true for the alkanes in **Fraction 1**?

1 They burn to produce carbon dioxide and sulfur dioxide only.

2 They have the general formula C_nH_{2n-2}

3 They are saturated compounds.

4 They are compounds of carbon, hydrogen and oxygen.

3C When compared with the alkanes in **Fraction 6**, the alkanes in **Fraction 1** . . .

1 will ignite more easily.

2 will be more viscous.

3 will have higher boiling points.

4 will have larger molecules.

3D In a molecule of the alkane called propane, there are eight hydrogen atoms.

The formula for propane is . . .

1 C_2H_8

2 C_3H_8

3 C_4H_8

4 C_3H_8O

4.7.1.1 Crude oil, hydrocarbons and alkanes

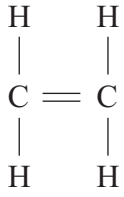
Question 50

November 2009 | CHY1BP | Original Q4 | Legacy

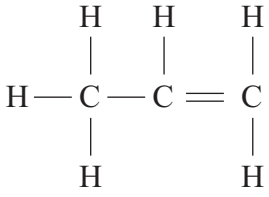
QUESTION FOUR

The diagram shows three compounds.

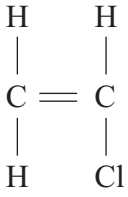
Compound W



Compound X



Compound Y



4A Which of the compounds are hydrocarbons?

1 **W** and **X**

2 **W** and **Y**

3 **X** and **Y**

4 **W**, **X** and **Y**

4B Which row in the table correctly describes the bonding in Compound **X**?

	Number of bonds to each carbon atom	Number of bonds to each hydrogen atom
1	1	1
2	1	4
3	4	1
4	4	4

4C All three compounds can form polymers because . . .

1 they have saturated molecules.

2 their molecules contain two or more carbon atoms.

3 their molecules have a double carbon carbon bond.

4 they have small molecules.

4.7.1.1 Crude oil, hydrocarbons and alkanes

4D Disposal of polymer waste can be a problem.

The main reason that it causes problems in a landfill site is that . . .

1 it is very light.

2 it is not easily broken down by microorganisms.

3 it is difficult to bury.

4 it burns easily, releasing toxic gases.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 51

November 2009 | CHY1BP | Original Q6 | Legacy

QUESTION SIX

This question is about heating oil fractions.

$C_{20}H_{42}$ is found in one of the oil fractions. On heating, it can break down as shown in the equation:

$$C_{20}H_{42} \rightarrow C_8H_{16} + 2\mathbf{X} + \mathbf{Y}$$

6A Which row in the table correctly identifies **X** and **Y** in the equation?

	X	**Y**
1	C_2H_4	C_8H_{14}
2	C_3H_6	C_6H_{14}
3	C_4H_8	C_3H_8
4	C_5H_{10}	CH_4

6B From the information in the table, substance **X** is . . .

1 a saturated hydrocarbon.

2 an alkane.

3 an alkene.

4 a polymer.

6C In the reaction shown in the equation, which of the following is occurring?

1 Polymer chains are being cracked.

2 Only alkenes are produced.

3 Long-chain hydrocarbons are being emulsified.

4 Long-chain hydrocarbons are being changed into alkane fuels and alkenes.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 51 · continued

6D The process of heating certain oil fractions is carried out continuously night and day because . . .

1 this will provide more work for local people.

2 there is more demand for products at night.

3 extra fuel would be used if the process was restarted every day.

4 this will help to dispose of unwanted oil fractions.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 52

November 2009 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

This question is about ethanol. Some ethanol is used as a fuel to replace petrol.

The table compares two different industrial processes for making ethanol.

Process	Raw material	Type of process	Purity of product	Rate of ethanol production
Fermentation using yeast	Sugar	Batch – one tank of sugar solution is fermented at a time	Dilute solution of ethanol	Slow
Hydration using steam	Ethene	Continuous – ethene and steam flow steadily into the reaction vessel and ethanol flows steadily out	Almost pure ethanol	Fast

8A Ethene is obtained from the hydrocarbons in crude oil by . . .

1 thermal decomposition.

2 hydration.

3 fractional distillation.

4 polymerisation.

8B In some countries, very little ethanol for fuel is produced by fermentation because . . .

1 ethene is obtained from a non-renewable resource.

2 they have a hot climate suitable for growing sugar cane.

3 they are wealthy enough to import oil from abroad.

4 the ethanol from fermentation produces more carbon dioxide when burnt.

8C Which of the following is **not** a reason why an ethanol factory using sugar takes longer to produce ethanol than a factory using ethene?

1 A fermentation tank has to be emptied and cleaned after each batch.

2 After fermentation, the ethanol needs to be separated from water.

3 Sugar cane plants take a long time to grow.

4 Yeast takes several days to convert sugar into ethanol.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 52 · continued

8D Who would benefit economically if ethanol was made by hydration of ethene rather than by fermentation?

1 investors in the fermentation industry

2 oil companies

3 environmental pressure groups

4 sugar cane farmers

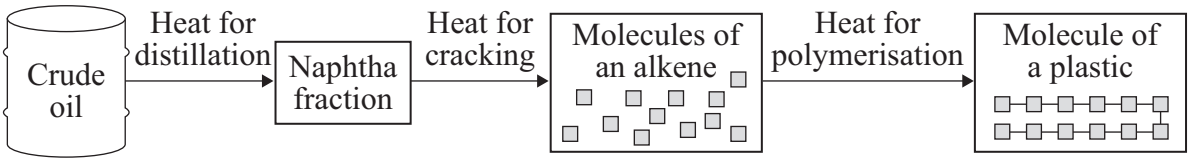
Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 53

January 2010 | CHY1H | Original Q6 | Legacy

6 To make a plastic, such as poly(ethene), from crude oil involves many processes.



6 (a) Describe how crude oil is separated into fractions.

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.....

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.....

.....

(2 marks)

6 (b) Ethene is produced by cracking the hydrocarbons in the naphtha fraction.

6 (b) (i) Balance the symbol equation for this reaction.

$C_{10}H_{22}$	→	C_4H_{10}	+	C_2H_4
decane		butane		ethene

(1 mark)

6 (b) (ii) Describe how cracking is carried out.

.....

.....

.....

.....

.....

(2 marks)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 53 · continued

for mark

6 (c) Alkanes, such as butane (C_4H_{10}), do **not** form polymers.

Alkenes, such as ethene (C_2H_4), do form polymers.

Explain these statements.

.....

.....

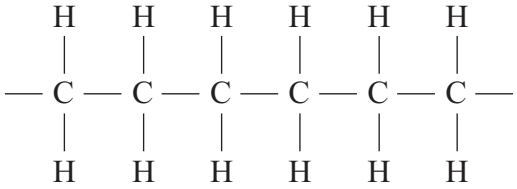
.....

.....

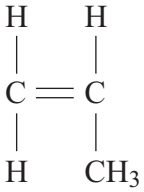
.....

(2 marks)

6 (d) Ethene molecules form the polymer poly(ethene). One molecule in poly(ethene) will contain thousands of carbon atoms. The diagram represents part of a poly(ethene) molecule.



Propene molecules form the polymer poly(propene).



Propene molecule

Draw a diagram to represent part of a poly(propene) molecule.

(2 marks)

9

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 54

March 2010 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

Anaesthetics are used to put patients to sleep before an operation.

Many new anaesthetics are based on alkanes in which some of the hydrogen atoms are replaced by fluorine (F), chlorine (Cl) and bromine (Br).

The temperature in an operating theatre is usually above 30 °C.

	Formula of the anaesthetic	Boiling point in °C	Additional information
A	$CF_3CHClBr$	50	Unstable in light
B	$CHF_2OCHClCF_3$	49	Very few side-effects
C	$(CF_3)_2CHOCH_2F$	59	High cost
D	$CF_3CHFOCHF_2$	24	Large amount needed to put patients to sleep

Match anaesthetics, **A**, **B**, **C** and **D**, with the numbers **1–4** below.

1 It does **not** require warming in the operating theatre to turn it into a gas.

2 It has to be stored in a dark bottle.

3 It contains the most fluorine atoms in its formula.

4 It would cause least harm to patients.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 55

March 2010 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

The alkanes are a series of hydrocarbons.

4A What is the general formula for the alkane series?

1 C_nH_n

2 C_nH_{2n}

3 C_nH_{2n+2}

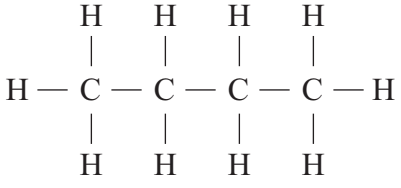
4 $C_{2n}H_{2n-2}$

The table shows information about four alkanes.

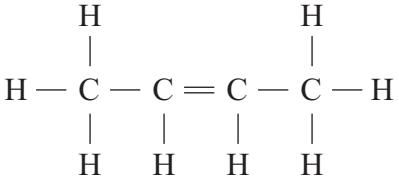
Alkane	Number of carbon atoms in each molecule
Methane	1
Butane	4
Octane	8
Dodecane	12

4B The structural formula for butane is . . .

1



2



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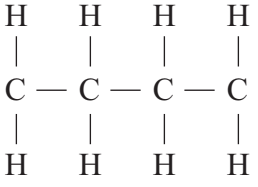

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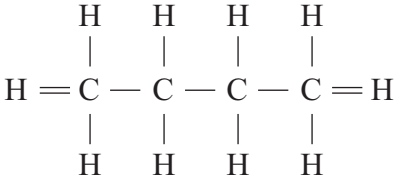


4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 55 · continued March 2010 | CHY1AP | Original Q4 | Legacy

4C When compared with octane, dodecane . . .

1 has a lower boiling point.

2 is easier to ignite.

3 evaporates less easily.

4 is less viscous.

4D When pure methane burns in plenty of oxygen, the only products are . . .

1 carbon dioxide and hydrogen.

2 carbon, carbon dioxide and water.

3 carbon dioxide, sulfur dioxide and water.

4 carbon dioxide and water.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 56

March 2010 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

Fuel oil is a mixture of compounds, mainly hydrocarbons.

Fuel oil is obtained from crude oil by fractional distillation.

5A Which of the following hydrocarbons is an alkane?

1 CH_6

2 C_3H_6

3 C_2H_6

4 C_2H_4

5B Which of the following describes how fuel oil is obtained from crude oil during fractional distillation?

1 boiling followed by evaporation

2 evaporation followed by boiling

3 evaporation followed by condensation

4 condensation followed by evaporation

5C Which of the following is a correct list of gases that might be produced by burning fuel oil?

1 carbon dioxide, water vapour, sulfur dioxide, carbon monoxide

2 hydrogen, carbon dioxide, sulfur dioxide, carbon monoxide

3 sulfur dioxide, carbon dioxide, water vapour, hydrogen

4 carbon, water vapour, sulfur dioxide, carbon monoxide

4.7.1.1 Crude oil, hydrocarbons and alkanes

5D Which row in the table correctly describes the type of combustion **and** a substance produced when fuel oil is burned?

	Type of combustion	Substance produced
1	Incomplete	Hydrogen
2	Complete	Carbon particles
3	Incomplete	Carbon particles
4	Complete	Carbon monoxide

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 57

March 2010 | CHY1BP | Original Q3 | Legacy

QUESTION THREE

The two equations below show reactions involving hydrocarbons.

$$C_{11}H_{24} \rightarrow C_2H_4 + C_4H_8 + C_5H_{12}$$

$$C_4H_{10} \rightarrow 2C_2H_4 + H_2$$

3A The reactions are examples of . . .

1 condensation.

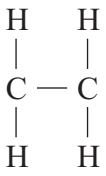
2 polymerisation.

3 cracking.

4 hydrogenation.

3B The hydrocarbon C_2H_4 can be represented by . . .

1



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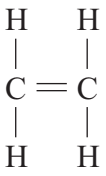

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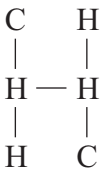


4



3C In the equations, the two hydrocarbons that are alkenes are . . .

1 C_2H_4 and C_4H_8

2 C_2H_4 and C_4H_{10}

3 C_2H_4 and C_5H_{12}

4 $C_{11}H_{24}$ and C_4H_{10}

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 57 · continued March 2010 | CHY1BP | Original Q3 | Legacy

3D Which of the hydrocarbons is used to make poly(ethene)?

1 C_2H_4

2 C_4H_8

3 C_4H_{10}

4 C_5H_{12}

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

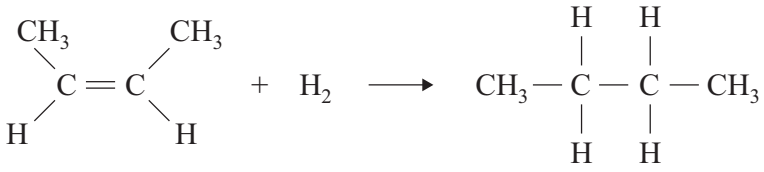
Question 58

March 2010 | CHY1BP | Original Q9 | Legacy

QUESTION NINE

Unsaturated oils contain double carbon carbon bonds. If an unsaturated hydrocarbon is heated with hydrogen gas and a nickel catalyst, the following reaction takes place.

Unsaturated hydrocarbon **Saturated hydrocarbon**



9A What is this process called?

1 cracking

2 polymerisation

3 hydrogenation

4 combustion

9B An unsaturated oil is made into a saturated compound.

The saturated compound . . .

1 contains fewer hydrogen atoms in its molecules.

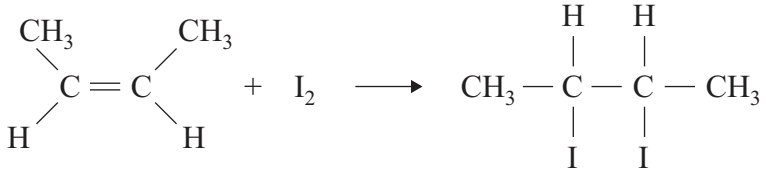
2 has a higher melting point.

3 feels softer but has the same melting point.

4 would be more useful as a fuel for vehicles.

Question 58 · continued

9C Iodine (I_2) reacts with unsaturated hydrocarbons as shown in the equation.



The iodine number is the number of grams of iodine that will react with 100 g of the unsaturated hydrocarbon. The higher the iodine number, the more unsaturated the hydrocarbon is.

3 g of iodine are added to 1 g of a vegetable oil. When the reaction has finished, 1.2 g of iodine are left unreacted.

What is the iodine number of the oil?

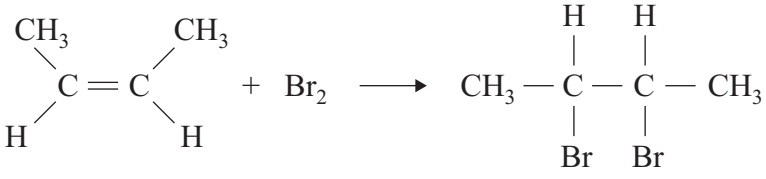
1 120

2 180

3 240

4 300

9D Bromine (Br_2) reacts with unsaturated hydrocarbons in the same way as iodine.



If bromine water is added drop-by-drop to a sample of vegetable oil, the bromine will be decolourised until all the double carbon carbon bonds have reacted.

A sample of an oil with an iodine number of 150 decolourises 25 drops of bromine water. The same amount of another vegetable oil decolourises 6 drops of the same bromine water.

What is the iodine number of the second oil?

1 30

2 36

3 40

4 45

END OF TEST

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 59

June 2010 | CHY1AP | Original Q1 | Legacy

QUESTION ONE

Petrol is a hydrocarbon fuel that burns in air. Air is mainly nitrogen.

In a car engine:

- not all of the petrol burns completely
- after burning, the products pass into the exhaust pipe.

Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

A nitrogen dioxide

B carbon monoxide

C carbon dioxide

D soot (carbon)

The black solid seen inside the exhaust pipe is . . . **1** . . . .

The gas in the exhaust fumes formed by the complete combustion of petrol is . . . **2** . . . .

The poisonous gas in the exhaust fumes formed by incomplete combustion of petrol is . . . **3** . . . .

The gas in the exhaust fumes formed by combining two gases from the air is . . . **4** . . . .

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 60

June 2010 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

The table gives some data on four alkanes.

Name of alkane	Formula of alkane	Melting point in °C	Boiling point in °C	Amount of oxygen in cm^3 needed to completely burn 100 cm^3 of the alkane	Amount of air in cm^3 needed to completely burn 100 cm^3 of the alkane
Methane	CH_4	−182	−164	200	1000
Ethane	C_2H_6	−183	−89	350	1750
Propane	C_3H_8	−190	−42	500	2500
Butane	C_4H_{10}	−138	−1	650	3250

8A Petroleum gas contains the four alkanes in the table.

Which statement correctly describes what happens if petroleum gas is cooled?

1 By cooling to –150 °C, only methane would turn to liquid.

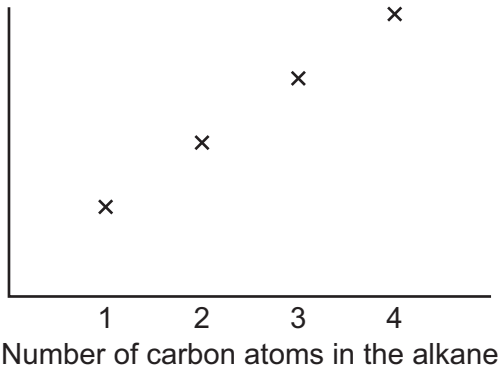
2 By cooling to –170 °C and then warming, it is possible to separate methane from petroleum gas.

3 By cooling to –100 °C, two liquid alkanes would be formed.

4 By cooling to –170 °C, all the alkanes would be solids.

8B The graph makes use of some of the data in the table.

The label on the vertical (*y*) axis has been omitted.



Which of the following could be the correct label for the *y*-axis?

1 either melting point or boiling point

2 either boiling point or the amount of oxygen required to burn the alkane

3 either boiling point or the amount of air required to burn the alkane

4 either the amount of oxygen or the amount of air required to burn the alkane

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 60 · continued

8C The graph in part **B** shows points plotted. This is not the best way to represent this data.

Which type of graph or chart should be used?

1 a bar chart because the number of carbon atoms is a continuous variable

2 a bar chart because the number of carbon atoms is a discrete variable

3 a line graph because the number of carbon atoms is a continuous variable

4 a line graph because the number of carbon atoms is a discrete variable

8D The equation below shows the reaction when methane burns completely in oxygen.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

Which row in the table below shows how many molecules of carbon dioxide and molecules of water will be produced when a molecule of **propane** (C_3H_8) burns completely?

	Molecules of carbon dioxide	Molecules of water
1	2	4
2	3	4
3	4	8
4	3	6

4.7.1.1 Crude oil, hydrocarbons and alkanes

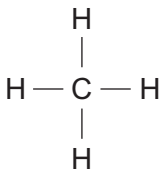
Question 61

June 2010 | CHY1BP | Original Q2 | Legacy

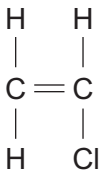
QUESTION TWO

This question is about the formulae of four carbon compounds, **A**, **B**, **C** and **D**.

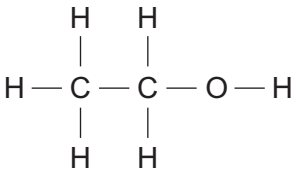
A



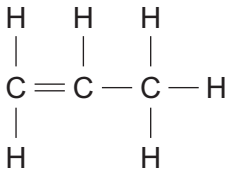
B



C



D



Match formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

1	It is an unsaturated hydrocarbon.
2	It is the alkane that was present in Earth's early atmosphere.
3	It is made by reacting ethene with steam.
4	It is the monomer from which the polymer, poly(chloroethene) is made.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 62

June 2010 | CHY1BP | Original Q3 | Legacy

QUESTION THREE

This equation shows the thermal decomposition of a hydrocarbon.

$$C_8H_{18} \longrightarrow \text{an alkane} + \text{an alkene}$$

3A What is the name of this process?

1 polymerisation

2 cracking

3 combustion

4 hydrogenation

3B In this decomposition, . . .

1 the hydrocarbon vapour is heated with iodine.

2 the hydrocarbon is mixed with hydrogen and heated.

3 the hydrocarbon vapour is passed over a hot catalyst.

4 the hydrocarbon is liquefied, then passed over a catalyst.

3C The alkene produced . . .

1 is an unsaturated compound.

2 has molecules in which each carbon atom has two bonds.

3 is unreactive.

4 will burn to produce carbon dioxide and hydrogen.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 62 · continued

3D Poly(ethene) is a polymer that is made from an alkene.

The polymer is . . .

1 produced by thermal decomposition.

2 a thermosoftening polymer.

3 produced by cracking.

4 biodegradable.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 63

June 2010 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Four hydrocarbons, **K**, **L**, **M** and **N**, were each analysed to measure their carbon and hydrogen content.

The results are shown in the table.

	Hydrocarbon			
	K	**L**	**M**	**N**
Number of hydrogen atoms in each molecule	8	20	8	12
Number of carbon atoms in each molecule	4	10	16	5

8A From the table we can deduce that . . .

1 none of the four is an alkene.

2 **K** and **L** are alkenes.

3 only **M** is an alkene.

4 only **N** is an alkene.

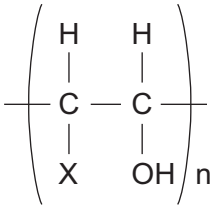
8B Hydrocarbon **N** cannot be used to make a polymer because its molecules . . .

1 are too short.

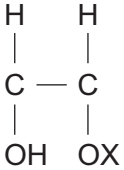
2 have an odd number of carbon atoms.

3 have fewer carbon atoms than hydrogen atoms.

4 do not have a carbon carbon double bond.

8C The polymer with the formula  where 'n' is a large number, could be made from the monomer . . .

1



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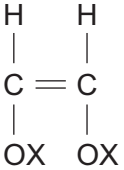

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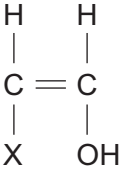

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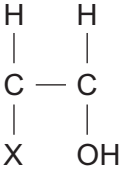
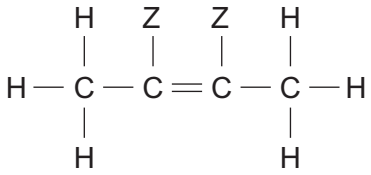


4.7.1.1 Crude oil, hydrocarbons and alkanes

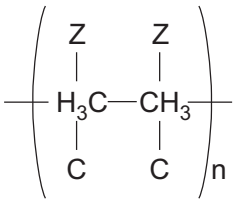
Question 63 · continued

8D The monomer  is made into a polymer.

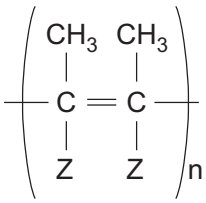
In the formulae below, 'n' is a large number.

The polymer may be represented as . . .

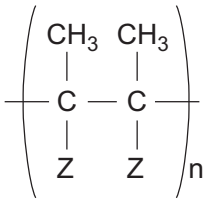
1



2



3



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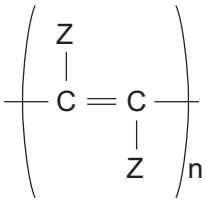


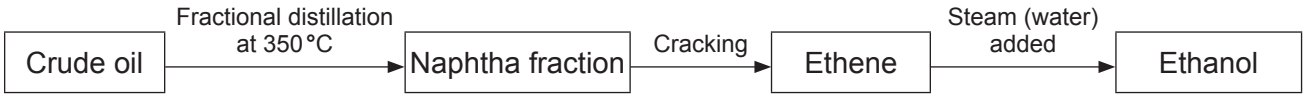
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 64

June 2010 | CHY1H | Original Q6 | Legacy

6 Petrol sold in most countries now contains at least 5% ethanol.
The production of ethanol, for use as a fuel, is being increased.

The flow diagram shows how ethanol can be produced from crude oil.



6 (a) Why does crude oil need to be fractionally distilled?

.....

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(1 mark)

6 (b) Hydrocarbons, such as decane, in the naphtha fraction are cracked to produce ethene.
The balanced chemical equation shows the cracking of decane.

$C_{10}H_{22}$	$\rightarrow$	C_8H_{18}	+	C_2H_4
decane		octane		ethene

6 (b) (i) Describe how cracking is done.

.....

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.....

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(2 marks)

6 (b) (ii) Complete the structural formula of ethene by drawing lines to represent each covalent bond.

H H

C C

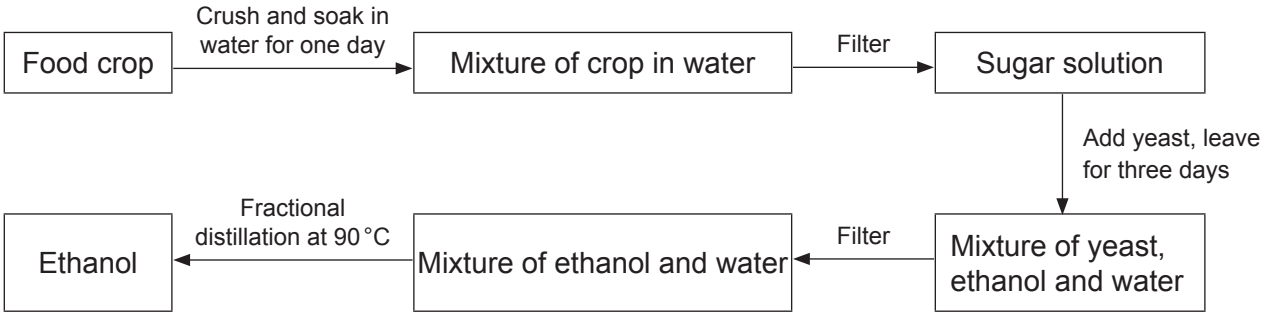
H H

(1 mark)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 64 · continued

6 (c) The flow diagram below shows how ethanol, for use as a fuel, can also be produced from food crops.



Use the information in the two flow diagrams and your own knowledge and understanding to evaluate whether more of this ethanol should be produced from food crops or from crude oil.

Remember to give a conclusion to your evaluation.

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(5 marks)

9

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 65

November 2010 | CHY1AP | Original Q7 | Legacy

QUESTION SEVEN

This question is about crude oil and some of the alkanes that it contains.

The table shows information about four of the fractions obtained from the distillation of crude oil.

Fraction	Boiling point in °C	Number of carbon atoms in the molecules of the alkanes in the fraction
Gases	Lower than 25	1–4
Petrol	25–60	4–11
Naphtha	60–180	7–14
Kerosene	180–222	11–15

7A Which of the following is the likely boiling point for the alkane with twelve **hydrogen** atoms?

1 −16 °C

2 36 °C

3 76 °C

4 186 °C

7B Which of the following statements about the distillation of crude oil is correct?

1 It produces more alkanes than were in the original mixture.

2 It will not use up the world's fuel supplies.

3 It will contribute to global warming.

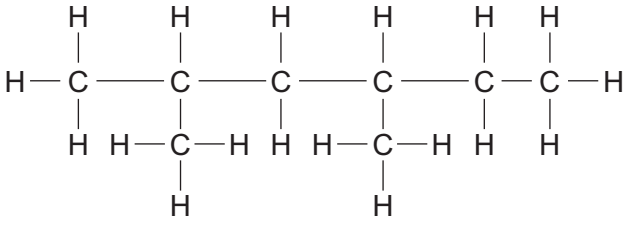
4 It is a continuous process that could go on for ever.

4.7.1.1 Crude oil, hydrocarbons and alkanes

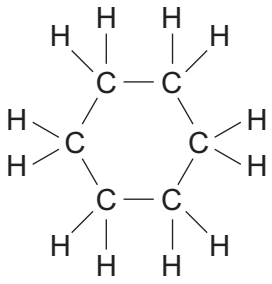
Question 65 · continued

7C Which of the following hydrocarbons would give the same number of molecules of carbon dioxide on complete combustion as octane C_8H_{18}?

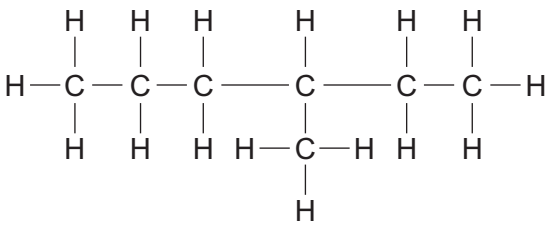
1



2



3



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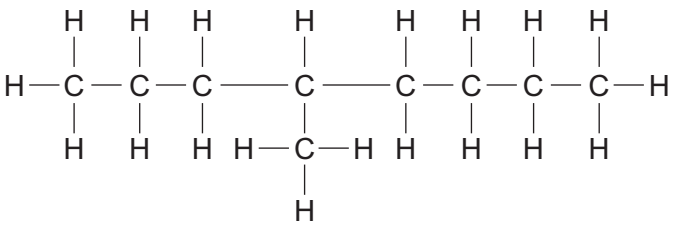


7D Hexane is the **sixth** member of the alkanes.

Which of the following could **not** be calculated from this information about its position in the alkane series?

1 its chemical formula

2 the number of water molecules produced by burning one molecule of hexane

3 the number of bonds in one molecule of hexane

4 the number of carbon monoxide molecules produced by the incomplete combustion of one molecule of hexane

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 66

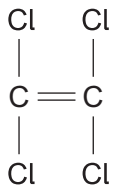
November 2010 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

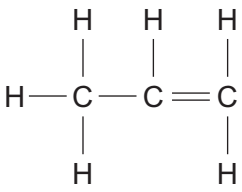
Plastic waste was taken to a recycling centre. At the recycling centre, the plastic was sorted and treated chemically. The chemical treatment broke down the plastic.

Breaking down the plastic produced new substances. The formulae for some of the substances produced are shown below.

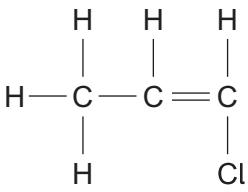
A



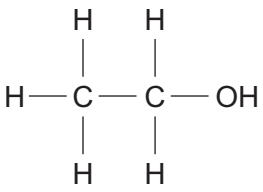
B



C



D



Match formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

1	It is a hydrocarbon.
2	It could be made from propene, C_3H_6
3	It is formed by reacting ethene with steam, H_2O
4	It would not produce water vapour if burnt in air.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 67

November 2010 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

The equation shows the thermal decomposition of a hydrocarbon.

$$C_6H_{14} \longrightarrow \underset{\text{Ethene}}{C_2H_4} + \text{Substance } \mathbf{K}$$

4A What is the formula for substance **K**?

1 CH_4

2 C_2H_6

3 C_4H_{10}

4 C_8H_{18}

4B Ethene, C_2H_4 is . . .

1 an alkane.

2 an alkene.

3 a saturated hydrocarbon.

4 a polymer.

4C Ethene, C_2H_4 can form polymers because . . .

1 it contains both carbon atoms and hydrogen atoms.

2 it contains twice as many carbon atoms as hydrogen atoms.

3 the carbon atoms and hydrogen atoms are linked by single bonds.

4 there is a double bond between the carbon atoms.

4D Poly(ethene) is used to make shopping bags.

A problem with poly(ethene) is that . . .

1 it is not waterproof.

2 it cannot be coloured.

3 it is not broken down by microorganisms.

4 it is a thermosetting polymer.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 68

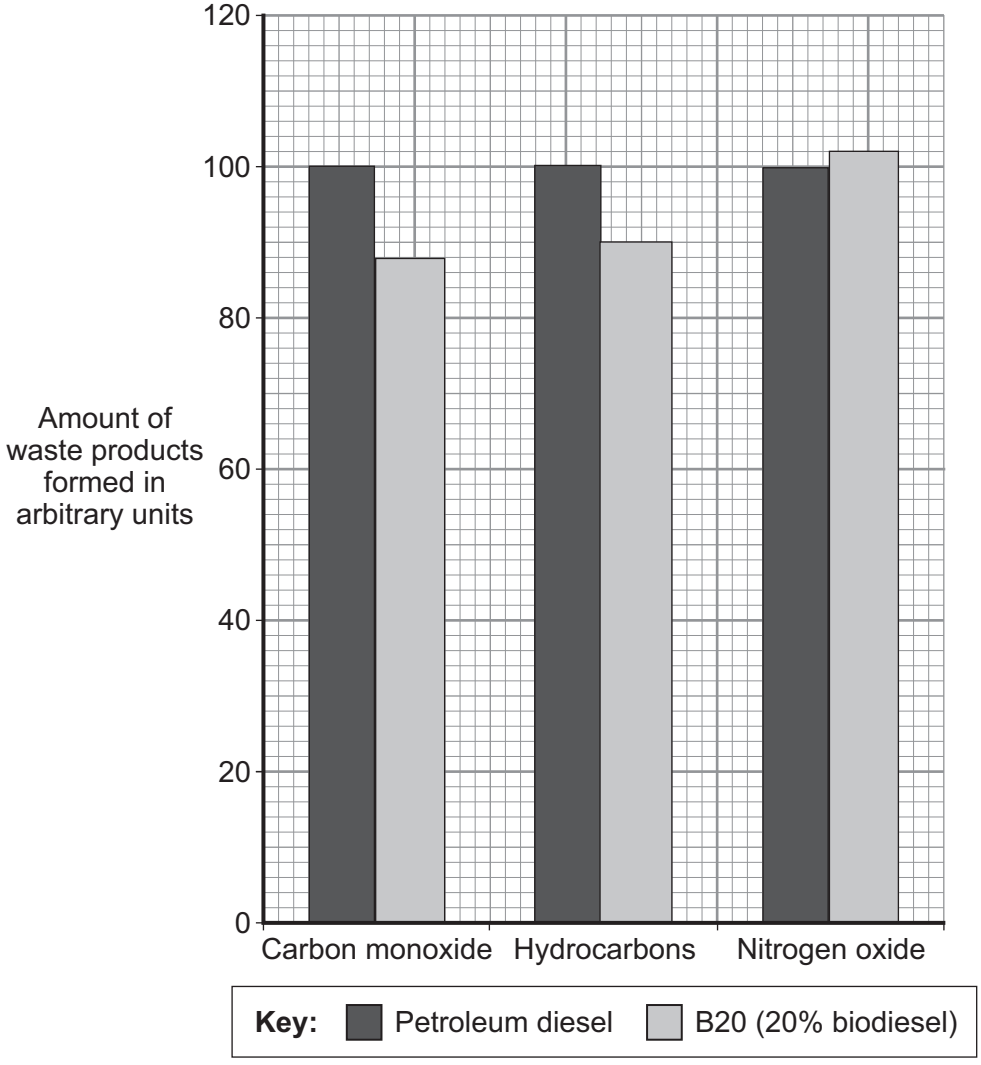
November 2010 | CHY1BP | Original Q6 | Legacy

QUESTION SIX

Petroleum diesel fuel is made from crude oil. Biodiesel fuel is made from vegetable oils.

Some diesel cars can use petroleum diesel mixed with different amounts of biodiesel.
For example, B20 is 20 % biodiesel and 80 % petroleum diesel.

The bar chart shows the waste products from burning petroleum diesel and B20. The amounts of the three waste products are shown for each fuel.



6A Which of the following is a correct statement about these waste products?

1 They are all oxides.

2 They all contain carbon.

3 They are all elements.

4 They are all compounds.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 68 · continued

6B When B20 burns in a diesel engine, the other waste products are likely to be . . .

1 carbon dioxide, oxygen and water vapour.

2 nitrogen, water vapour and sulfur dioxide.

3 carbon dioxide, water vapour and sulfur dioxide.

4 oxygen, water vapour and sulfur dioxide.

6C Which row in the table shows a correct advantage and a correct disadvantage of using B20 instead of petroleum diesel?

	Advantage of using B20	Disadvantage of using B20
1	It is partly renewable.	It produces a greater amount of all harmful waste products.
2	It is unsaturated.	It is non-biodegradable.
3	It is partly renewable.	It produces an increased amount of nitrogen oxide.
4	It is hydrogenated.	It produces more carbon monoxide.

6D B100 is 100 % biodiesel. Net carbon dioxide emissions are lower for B100 than for petroleum diesel.

This is because . . .

1 the carbon dioxide is used by plants for photosynthesis.

2 vegetable oils produce very little carbon dioxide when they burn.

3 biodiesel does not contain any hydrocarbons.

4 carbon dioxide dissolves in the oceans.

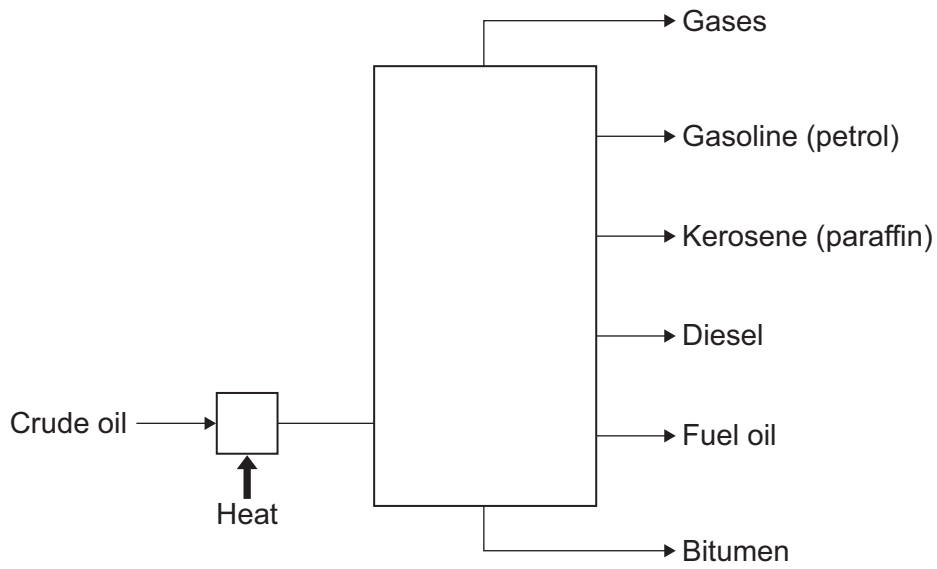
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 69

January 2011 | CHY1H | Original Q2 | Legacy

2 Crude oil is used to produce many useful materials.

2 (a) The diagram shows some of the fractions produced from crude oil by fractional distillation.



Use the diagram to help you to explain how crude oil is separated into fractions.

You should use the words evaporated and condensed in your answer.

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(3 marks)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 69 · continued

2 (b) The table shows some information about four of the fractions from crude oil that are used as fuels.

Fraction	Boiling point in °C	Number of carbon atoms found in the molecules
Gasoline (petrol)	20 – 200	5 – 10
Kerosene (paraffin)	180 – 260	10 – 16
Diesel	260 – 340	14 – 20
Fuel oil	370 – 600	20 – 70

Use the information in the table to help you to answer these questions.

2 (b) (i) How can you tell that each of the fractions is a mixture?

.....

.....

(1 mark)

2 (b) (ii) How does the number of carbon atoms in a molecule affect its boiling point?

.....

.....

(1 mark)

2 (c) Fuels are substances that release energy.

2 (c) (i) Name the reaction that releases energy from a fuel such as gasoline (petrol).

.....

(1 mark)

2 (c) (ii) Describe how fuel oil is broken down into smaller, more useful molecules such as gasoline (petrol).

.....

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.....

.....

(2 marks)

8

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 70

January 2011 | CHY1H | Original Q6 | Legacy

6 This information about diesel was printed in a magazine.

Almost all of the crops that we eat can be converted into fuel for cars.
Vegetable oils can be used as biodiesel. Diesel from crude oil is called fossil diesel.
When either biodiesel or fossil diesel burn they both produce similar amounts of carbon dioxide.
Both types of diesel produce carbon monoxide. However, biodiesel produces fewer carbon particles and less sulfur dioxide.

6 (a) Carbon monoxide can be produced when diesel burns in a car engine. Explain how.

.....

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(2 marks)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 70 · continued

6 (b) Use the information at the start of this question and your knowledge and understanding to evaluate the use of biodiesel compared with fossil diesel as a fuel for cars.

Remember to give a conclusion to your evaluation.

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(5 marks)

7

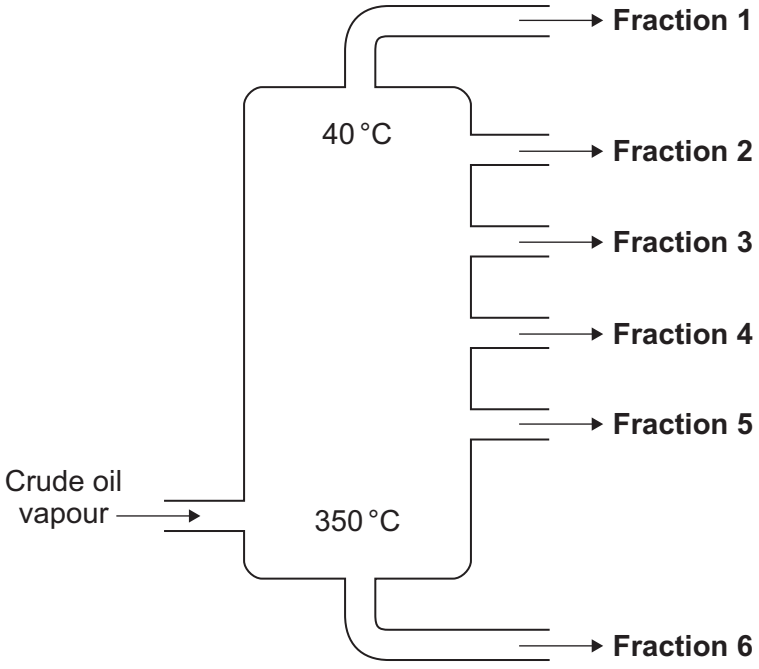
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 71

March 2011 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

Crude oil can be separated into fractions by fractional distillation.



5A The fractions can be separated in this way because the hydrocarbons in the crude oil . . .

1 have different chemical properties.

2 are compounds containing only two elements.

3 are gases, liquids and solids.

4 have different boiling points.

5B Each fraction will contain . . .

1 a single alkane.

2 alkanes with the same chemical formula.

3 a mixture of alkanes.

4 alkanes with the same number of carbon atoms in each molecule.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 71 · continued

5C When compared with **Fraction 5**, **Fraction 3** . . .

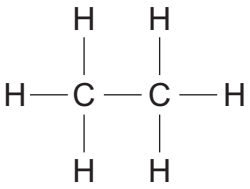
1 will be more difficult to ignite.

2 will be more volatile.

3 will be more viscous.

4 will have boiling points in a higher range.

5D The diagram shows a molecule of an alkane.



In which fraction will most of this alkane be found?

1 **Fraction 1**

2 **Fraction 2**

3 **Fraction 4**

4 **Fraction 6**

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 72

March 2011 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

Haloalkanes are alkanes which have one or more hydrogen atoms replaced by halogen atoms.

The table shows properties of some haloalkanes.

Haloalkane	Formula	Density in g per cm^3	Boiling point in °C
Chloromethane	CH_3Cl	0.916	-24.1
Bromomethane	CH_3Br	1.676	3.7
Iodomethane	CH_3I	2.279	42.5
Chloroethane	CH_3CH_2Cl	0.898	12.4
Bromoethane	CH_3CH_2Br	1.461	38.5
Iodoethane	CH_3CH_2I	1.936	72.4
Dichloromethane	CH_2Cl_2	1.30	40.1
Trichloromethane	$CHCl_3$	1.50	61.8

9A From the information in the table, increasing the length of the carbon chain . . .

1 increases density but decreases boiling point.

2 increases density and boiling point.

3 decreases density but increases boiling point.

4 decreases density and boiling point.

9B From the information in the table, replacing more hydrogen atoms with halogen atoms causes . . .

1 no effect on the boiling point or the density.

2 an increase in boiling point and density.

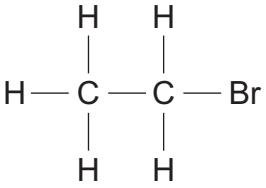
3 an increase in boiling point only.

4 an increase in density only.

Question 72 · continued

9C Which is the correct structural formula for bromoethane?

1



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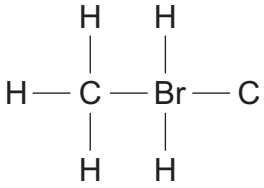

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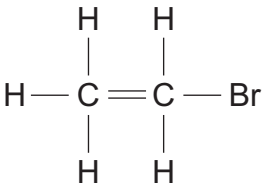

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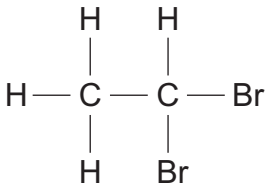


9D The order of the halogens in Group 7 of the periodic table is shown.

Group 7
Fluorine (F)
Chlorine (Cl)
Bromine (Br)
Iodine (I)

Which row in the table below shows the properties that fluoromethane might have?

	Density in g per cm^3	Boiling point in °C
1	0.6	15
2	1.8	−100
3	1.1	−30
4	0.6	−80

END OF TEST

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 73

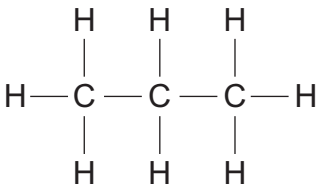
March 2011 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

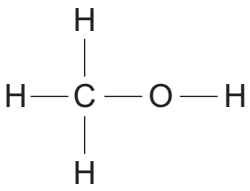
This question is about the formulae of four compounds.

Match formulae, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

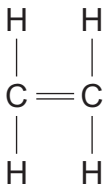
A



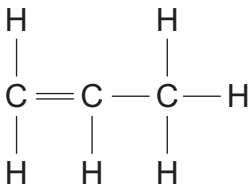
B



C



D



1	It is the alkene used to make ethanol.
2	It is a saturated hydrocarbon useful as a fuel.
3	It is not a hydrocarbon but burns to produce carbon dioxide and water vapour.
4	It belongs to the group with the general formula C_nH_{2n} where n = 3.

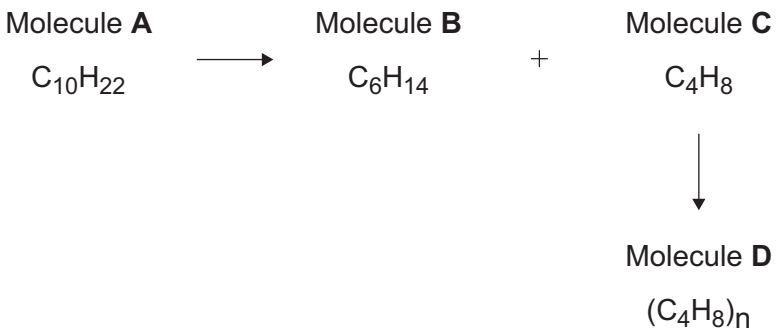
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 74

March 2011 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

This question is about hydrocarbons.



Match molecules, **A**, **B**, **C** and **D**, with the numbers **1–4** in the sentences.

Molecule . . . **1** . . . has been cracked.

Molecule . . . **2** . . . is an alkene.

Molecule . . . **3** . . . is a polymer.

Molecule . . . **4** . . . is the alkane in the reactions with the smallest molecules.

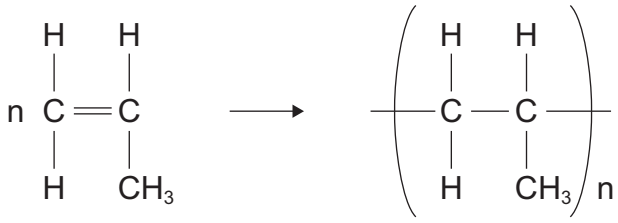
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 75

March 2011 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

The equation shows a chemical reaction.



Small molecules of hydrocarbon **X**

Large molecule of hydrocarbon **Y**

4A Hydrocarbon **X** is . . .

1 an alkane.

2 a polymer.

3 an alkene.

4 a catalyst.

4B Hydrocarbon **Y** is . . .

1 an unsaturated compound.

2 a polymer.

3 an alkene.

4 a monomer.

4C Poly(propene) is a thermosoftening polymer so it **cannot** be used to make . . .

1 buckets.

2 food containers.

3 non-stick coating for frying pans.

4 washing-up bowls.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 75 · continued

4D Putting poly(propene) and other polymer waste into landfill creates a problem because this type of waste . . .

1 is very lightweight and blows about.

2 is not biodegradable.

3 does not dissolve in water.

4 is very dense and sinks deep underground.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 76

March 2011 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Some vehicles which normally use petroleum diesel fuel can also use a mixture of biodiesel and petroleum diesel.

Petroleum diesel is made from crude oil.
Biodiesel is made from a variety of vegetable oils: for example, soybean, palm and rapeseed.
This means that large areas of land are needed to grow crops from which to extract the vegetable oils for the production of biodiesel.

8A Research into the production and use of biodiesel continues.

The main reason for this is that . . .

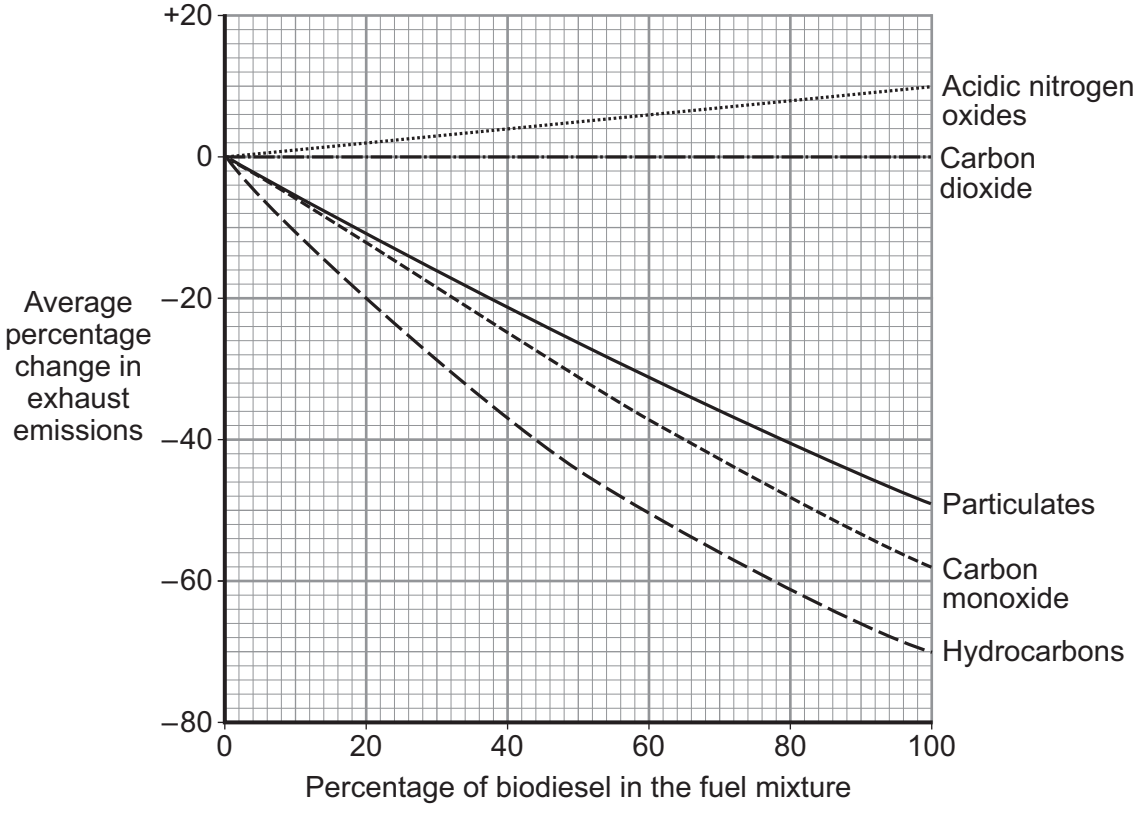
1 unused food crops are being wasted in some developing countries.

2 large, new oilfields have been discovered in Europe.

3 crude oil is a non-renewable energy source.

4 car manufacturers are making cars that run only on biodiesel.

The graph shows the average percentage change in exhaust emissions from vehicles using different mixtures of petroleum diesel and biodiesel.



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 76 · continued

8B Some scientists claim that net carbon dioxide emissions are lower for biodiesel than for petroleum diesel.

What is the basis for this argument?

1 Biodiesel produces less carbon dioxide when it burns.

2 Plants take up carbon dioxide as they grow.

3 Biodiesel is not a carbon compound.

4 Plants release carbon dioxide in respiration.

8C The graph indicates that when compared with 100 % petroleum diesel, a fuel mixture of equal volumes of petroleum diesel and biodiesel will . . .

1 reduce nitrogen oxides by about 5 %.

2 increase both particulates and carbon monoxide by about 25 %.

3 reduce hydrocarbons by about 45 %.

4 reduce carbon dioxide by about 5 %.

8D One possible disadvantage of using fuel with a high percentage of biodiesel is that . . .

1 it is non-biodegradable.

2 it could increase the amount of acid rain.

3 it is non-renewable.

4 it could increase global dimming.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 77

June 2011 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

This question is about four carbon compounds that burn in air.

Match compounds, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A CO

B CS_2

C C_2H_4

D C_3H_8

1	It burns to form carbon dioxide only.
2	It is a hydrocarbon but it is not an alkane.
3	It is in the series with the general formula C_nH_{2n+2}
4	It burns to form carbon dioxide and sulfur dioxide.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 78

June 2011 | CHY1AP | Original Q4 | Legacy

QUESTION FOUR

Crude oil is a mixture made up mainly of alkanes.

4A The alkanes are a series of hydrocarbons . . .

1 all of which are gases at room temperature (20 °C).

2 that have the general formula C_nH_{2n}.

3 in which the molecules have a carbon : hydrogen ratio of 1 : 4.

4 that are saturated.

Crude oil can be separated into fractions by fractional distillation.

4B In the fractionating column, the crude oil separates into fractions because . . .

1 the crude oil changes from a liquid into a vapour.

2 the alkanes condense at different temperatures.

3 the crude oil decomposes when it is heated.

4 the alkanes have different densities.

4C The petrol fraction has a boiling range from 40 °C to 70 °C.

The fraction does not have a fixed boiling point because it . . .

1 contains only one alkane.

2 contains several alkanes.

3 collects near the top of the column.

4 decomposes at 40 °C.

4D The petrol fraction is used as a fuel. Ethanol (C_2H_5OH), made from plant material, can be used as a fuel instead of petrol.

One advantage of ethanol over petrol is that ethanol . . .

1 does not produce carbon dioxide when it burns.

2 is a renewable fuel.

3 produces only water when it burns.

4 is a compound, not a mixture.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 79

June 2011 | CHY1AP | Original Q8 | Legacy

QUESTION EIGHT

This question is about alkanes.

Alkane	Melting point in °C	Boiling point in °C
Methane, CH_4	−183	−164
Ethane, C_2H_6	−183	−89
Propane, C_3H_8	−190	−42
Butane, C_4H_{10}	−138	−0.5
Pentane, C_5H_{12}	−130	+36

8A Which of the following is correct?

1 Butane is liquid at room temperature (20 °C).

2 These alkanes will be collected separately during the fractional distillation of crude oil.

3 The boiling points of the alkanes decrease as the size of their molecules increases.

4 Pentane is liquid over the greatest range of temperature.

8B In the alkane series, which one of the following changes from one alkane to the next?

1 the general formula

2 the number of bonds on each carbon atom

3 the ratio of carbon atoms to hydrogen atoms in each molecule

4 the number of double carbon carbon bonds in each molecule

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 79 · continued June 2011 | CHY1AP | Original Q8 | Legacy

8C The general equation below represents the burning of an alkane in excess of oxygen.

$$C_wH_x + (w + \frac{x}{y})O_2 \rightarrow wCO_2 + (\frac{x}{2})H_2O$$

The value of y is . . .

1 1

2 2

3 4

4 8

8D The complete combustion of a molecule of propane . . .

1 produces less carbon dioxide than the complete combustion of a molecule of butane.

2 requires more oxygen than the complete combustion of a molecule of pentane.

3 produces the same ratio of carbon dioxide molecules to water molecules as pentane.

4 requires less oxygen than the complete combustion of a molecule of methane.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 80

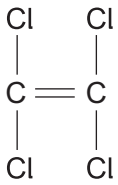
June 2011 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

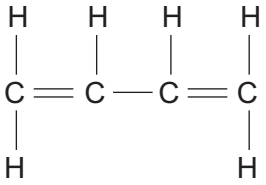
This question is about four carbon compounds.

Match compounds, **A**, **B**, **C** and **D**, with the numbers **1–4** in the table.

A



B



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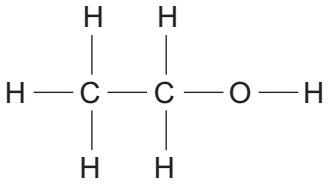
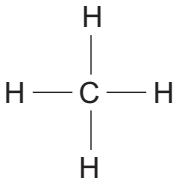


D



	Description
1	It is not a hydrocarbon but burns to give carbon dioxide and water.
2	It is a saturated hydrocarbon used as a fuel.
3	It will not produce water vapour if it burns.
4	It belongs to a group of compounds with the general formula C_nH_{2n-2}

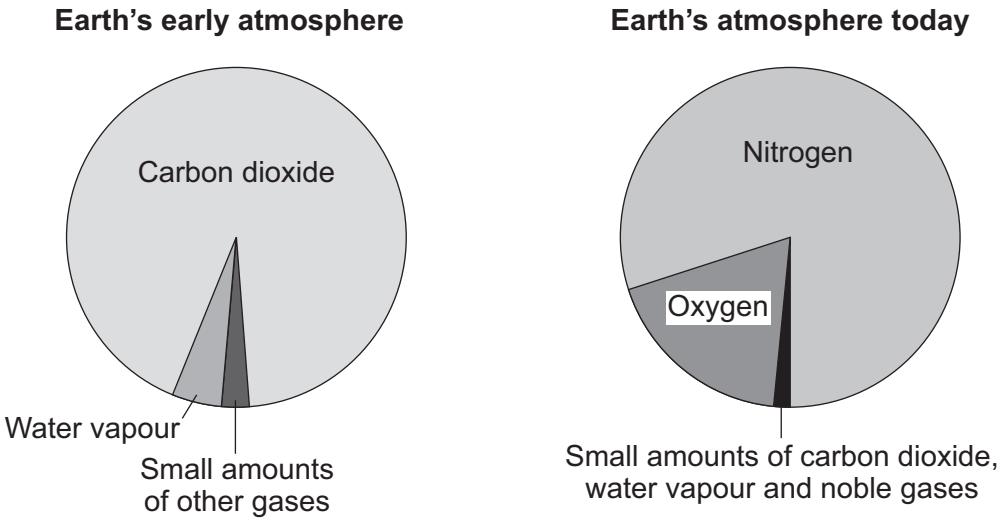
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 81

June 2011 | CHY1BP | Original Q3 | Legacy

QUESTION THREE

The pie charts show the amounts of gases in the Earth's early atmosphere and in the Earth's atmosphere today.



3A Very small amounts of a hydrocarbon gas are thought to have been in the Earth's early atmosphere.

This gas is . . .

1 ammonia, NH_3

2 helium, He

3 methane, CH_4

4 oxygen, O_2

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 81 · continued

3B As the Earth's early atmosphere was forming, it contained water vapour.

Which row in the table shows where the water vapour came from **and** why the quantity in the atmosphere reduced?

	Water vapour came from	Water vapour reduced because
1	evaporation from the ground.	it condensed to form the oceans.
2	evaporation from the ground.	there was less rainfall.
3	volcanic activity.	it condensed to form the oceans.
4	volcanic activity.	there was less rainfall.

3C Why was there no oxygen in the Earth's early atmosphere?

1 There was no carbon dioxide for the plants to use to make oxygen.

2 Living organisms had used up the oxygen.

3 There were no plants on Earth.

4 Oxygen is a very reactive gas.

3D The quantity of carbon dioxide in the Earth's atmosphere today is very different from the quantity that was in the Earth's early atmosphere.

One of the reasons why it is very different is that . . .

1 there are a lot of cars on our roads today.

2 it is locked up as carbon in fossil fuels.

3 most homes use fossil fuels for central heating.

4 plants produce carbon dioxide by photosynthesis.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 82

June 2011 | CHY1BP | Original Q7 | Legacy

QUESTION SEVEN

About 90 % of the world's supply of ethanol is produced by using yeast for the fermentation of sugars obtained from plants. A solution of about 8 % ethanol in water is obtained.
Ethanol can be used to produce ethene.

Reaction **P** shows carbon dioxide being removed from the atmosphere by plants to make sugar.
Reaction **Q** shows carbon dioxide being released by yeast into the atmosphere during respiration.
Reaction **R** shows the formation of ethene from ethanol.

Reaction **P** $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

Reaction **Q** $C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$

Reaction **R** $C_2H_5OH \rightarrow C_2H_4 + H_2O$

7A In these reactions, what is the net change in the number of molecules of carbon dioxide in the atmosphere during the production of one molecule of ethene?

1 1

2 2

3 4

4 6

Ethanol can also be produced by the reaction of ethene with steam.

This is a continuous process because the reactants flow steadily into the reactor and the ethanol flows out.

7B How is the ethene for this process obtained?

1 by fractional distillation of crude oil

2 by cracking fractions from crude oil

3 by polymerisation of crude oil

4 by vaporisation of crude oil

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 82 · continued

7C An advantage of producing ethanol from ethene rather than by fermentation is that . . .

1 higher temperatures are required.

2 catalysts are used.

3 the ethanol is purer.

4 the reaction is slower.

7D It may be better to obtain ethene from biologically-produced ethanol rather than from crude oil.

One reason for this is that . . .

1 ethene can be produced in unlimited quantities.

2 crude oil is a non-renewable resource.

3 poly(ethene) made from biologically produced ethanol will be biodegradable.

4 the fermentation of sugar is done in batches, whereas production of ethene from crude oil is continuous.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 83

June 2011 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

This question is about the cracking of hydrocarbons.

8A Which of the following is a correctly balanced equation for the cracking of $C_{15}H_{32}$ in which two different alkenes are produced?

1 $C_{15}H_{32} \rightarrow 2C_2H_4 + C_3H_6 + C_8H_{18}$

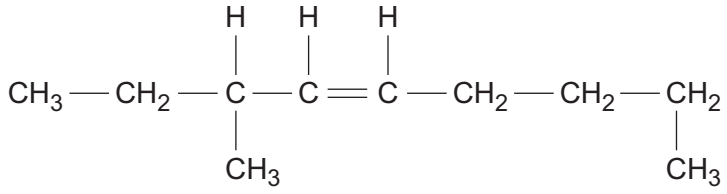
2 $C_{15}H_{32} \rightarrow 2CH_4 + C_3H_6 + C_4H_{10} + C_6H_{12}$

3 $C_{15}H_{32} \rightarrow 2C_3H_6 + C_9H_{20}$

4 $C_{15}H_{32} \rightarrow C_4H_{10} + C_5H_{10} + C_6H_{14}$

8B Which of the following hydrocarbons that could be produced by the cracking of C_9H_{20} has the general formula C_nH_{2n} and decolourises bromine water?

1



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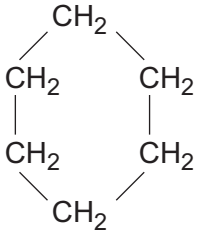

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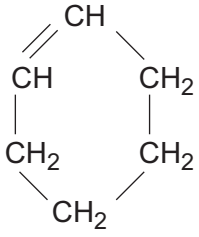

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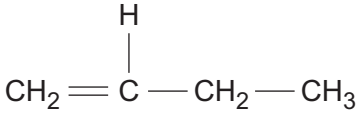
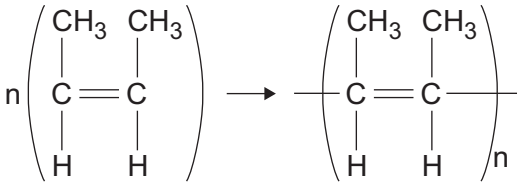


4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 83 · continued

8C Which of the following equations represents the polymerisation of butene?

1



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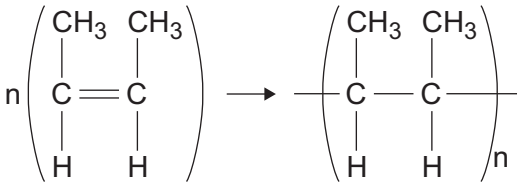

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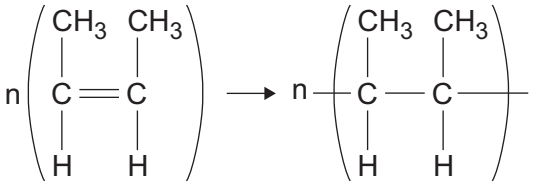

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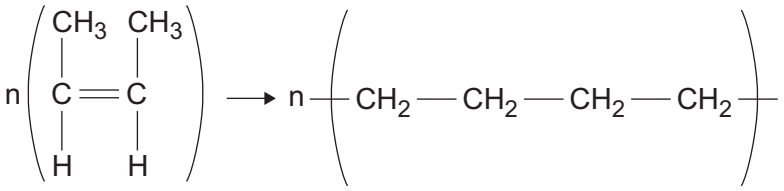


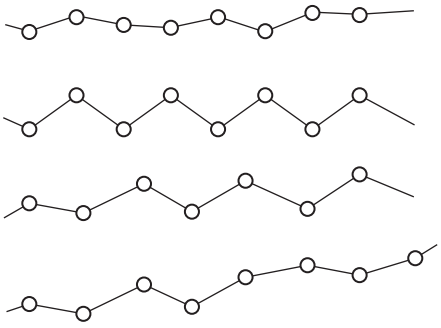
Question 8 continues on the next page

4.7.1.1 Crude oil, hydrocarbons and alkanes

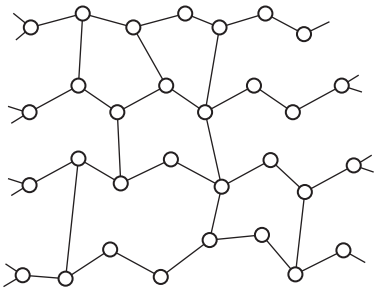
Question 83 · continued

8D The diagram shows the structures of a thermosoftening polymer and a thermosetting polymer.

Thermosoftening polymer



Thermosetting polymer



Which row in the table describes the properties of the two types of polymer?

	Thermosoftening polymer		Thermosetting polymer	
	Property 1	**Property 2**	**Property 1**	**Property 2**
1	Polymer molecules able to slide	Chemical bonds between the chains	Melt on heating	Short chain lengths
2	Long chain lengths	No chemical bonds between the chains	Chemical bonds between the chains	Polymer molecules able to slide
3	Long chain lengths	No chemical bonds between the chains	Do not melt on heating	Chemical bonds between the chains
4	Chemical bonds between the chains	Melt on heating	No chemical bonds between the chains	Long chain lengths

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 84

June 2011 | CHY1H | Original Q2 | Legacy

2 The raw materials used to make the polymer polyvinyl chloride (PVC) are crude oil and sea salt (sodium chloride).

2 (a) There are three main stages in the production of PVC.

2 (a) (i) **Stage 1** Cracking of hydrocarbons from crude oil produces ethene, C_2H_4

$$C_{10}H_{22} \longrightarrow C_8H_{18} + C_2H_4$$

How are hydrocarbons cracked?

.....

.....

.....

.....

(2 marks)

2 (a) (ii) **Stage 2** Electrolysis of sodium chloride solution produces chlorine.
Ethene from **Stage 1** is then reacted with this chlorine.
One of the hydrogen atoms in each ethene molecule is replaced by a chlorine atom to produce vinyl chloride.

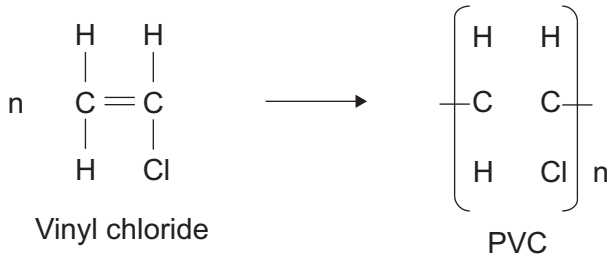
Complete the chemical equation by writing in the formula of the product vinyl chloride.

$$C_2H_4 + Cl_2 \longrightarrow \text{.....} + HCl$$

(1 mark)

2 (a) (iii) **Stage 3** Polymerisation of vinyl chloride produces polyvinyl chloride (PVC).

Complete the chemical equation by drawing in the missing bonds of the product, PVC.



(1 mark)

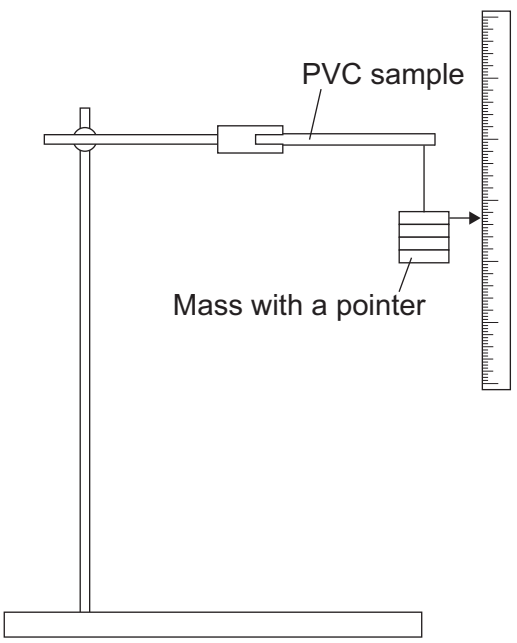
Question 2 continues on the next page

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 84 · continued

2 (b) Unplasticised polyvinyl chloride (uPVC) is used to make door and window frames.
PVC with a plasticiser added is used to make cling film for wrapping food.
A plasticiser is a chemical compound.

A student investigated how the percentage of plasticiser added to PVC affected its flexibility.
The student measured the bending of PVC samples when a mass was added.



The student's results are shown in the table.

Sample of PVC	Percentage (%) of plasticiser added	Bending of PVC sample in mm				
		Test 1	Test 2	Test 3	Test 4	Mean
A	**0**	2	3	3	4	3
B	**5**	22	15	23	24	
C	**10**	27	27	29	29	28
D	**15**	34	35	35	36	35

2 (b) (i) Each PVC sample should be the same size to make it a fair test.
Explain why.

.....

.....

(1 mark)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 84 · continued

2 (b) (ii) The student repeated the test four times for each sample.
Explain why.

.....

.....

(1 mark)

2 (b) (iii) Calculate the mean value for sample **B**.

.....

.....

.....

.....

(2 marks)

2 (b) (iv) Each of the samples bent the most in test **4**.
Suggest a possible reason for this.

.....

.....

(1 mark)

2 (c) Suggest why unplasticised polyvinyl chloride (uPVC) is used to make door and window frames.

.....

.....

(1 mark)

10

4.7.1.1 Crude oil, hydrocarbons and alkanes

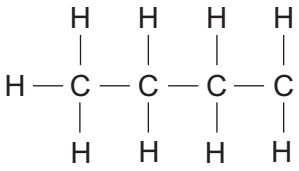
Question 85

June 2011 | CHY1H | Original Q5 | Legacy

5 Crude oil is a mixture of hydrocarbons. Most of these hydrocarbons are alkanes.

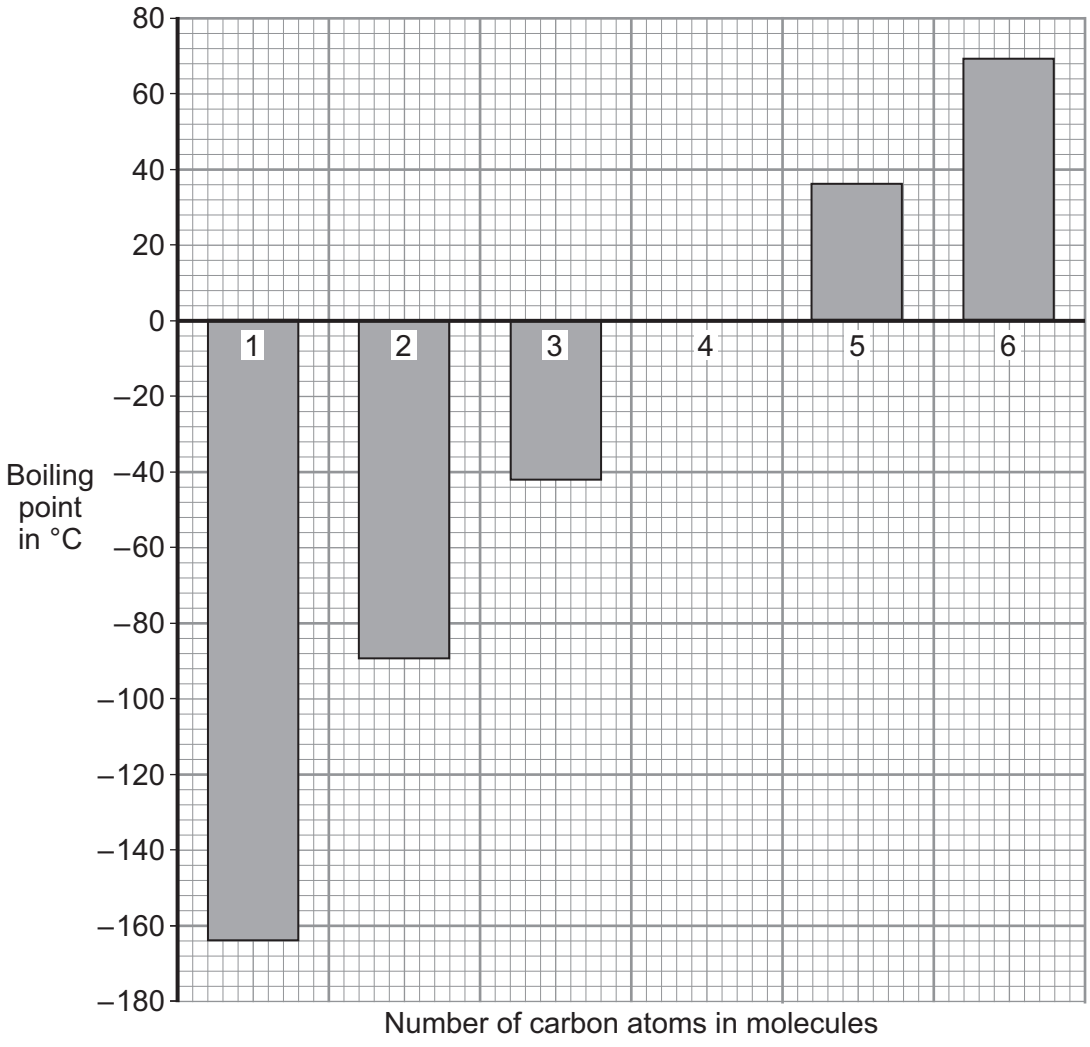
5 (a) The general formula of an alkane is C_nH_{2n+2}

Complete the structural formula for the alkane that has **six** carbon atoms in its molecules.



(1 mark)

5 (b) The boiling points of alkanes are linked to the number of carbon atoms in their molecules.



5 (b) (i) Describe the link between the number of carbon atoms in an alkane molecule and its boiling point.

.....

.....

(1 mark)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 85 · continued

5 (b) (ii) Suggest **two** reasons why all of the alkanes in the bar chart are better fuels than the alkane with the formula $C_{30}H_{62}$

1 .....

.....

2 .....

.....

(2 marks)

5 (c) During the last 200 million years the carbon cycle has maintained the percentage of carbon dioxide in the atmosphere at about 0.03 %.
Over the last 100 years the percentage of carbon dioxide in the atmosphere has increased to about 0.04 %.
Most of this increase is caused by burning fossil fuels to heat buildings, to generate electricity and to power our transport.
Fossil fuels contain carbon that has been locked up for millions of years.

5 (c) (i) Burning fossil fuels, such as petrol, releases this locked up carbon. Balance the chemical equation for the combustion of one of the alkanes in petrol.

$$2\,C_8H_{18} + 25\,O_2 \longrightarrow \text{.....}\ CO_2 + \text{.....}\ H_2O$$

(1 mark)

5 (c) (ii) Where did the carbon that is locked up in fossil fuels come from?

.....

.....

(1 mark)

5 (c) (iii) The burning of fossil fuels has caused the percentage of carbon dioxide in the atmosphere to increase to above 0.03 %.
Explain why.

.....

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(2 marks)

8

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 86

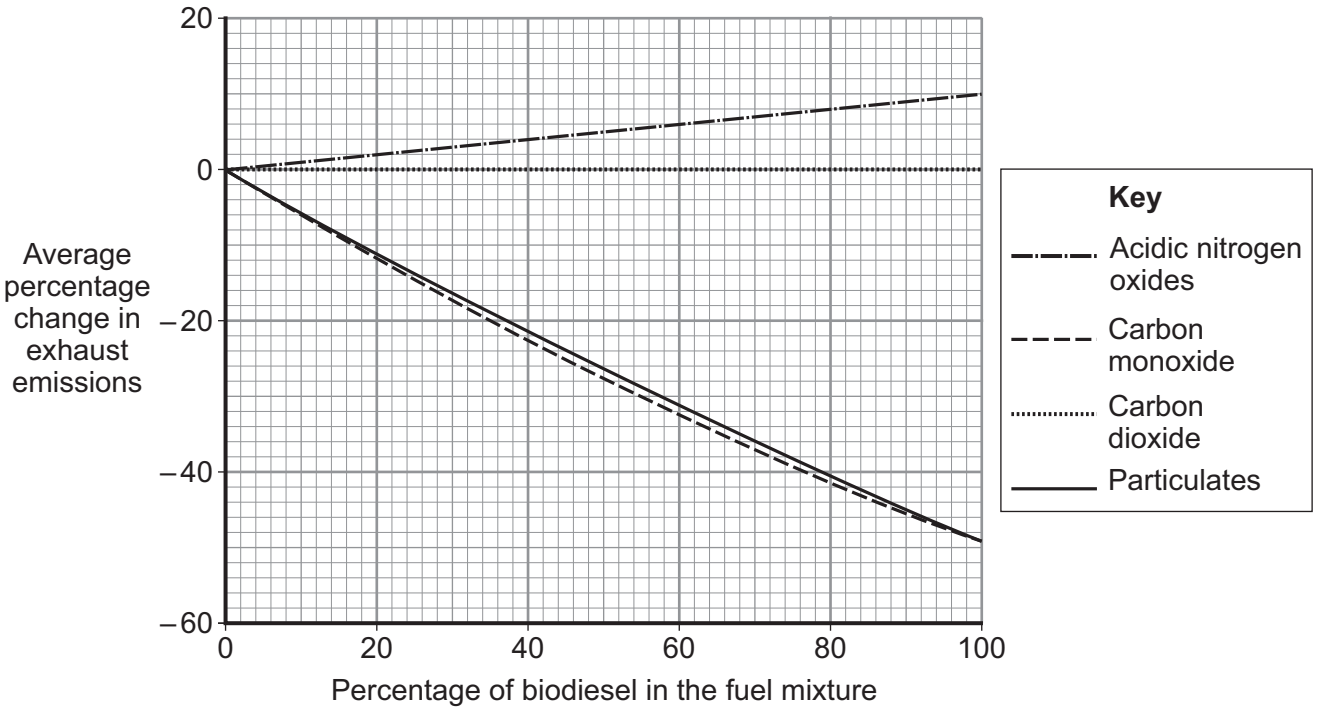
June 2011 | CHY1H | Original Q6 | Legacy

6 Petroleum diesel is produced from crude oil.

Most vehicles that use petroleum diesel as fuel can also use biodiesel or a mixture of these two fuels. In the UK (in 2010) there must be 5% biodiesel in all petroleum diesel fuel.

Biodiesel is produced from plant oils such as soya. The crops used to produce biodiesel can also be used to feed humans. The benefit that biodiesel is 'carbon neutral' is outweighed by the increasing demand for crops. This increasing demand is causing forests to be burnt to provide land for crops to produce biodiesel. Only a huge fall in the price of petroleum diesel would halt the increasing use of biodiesel.

The graph shows the average percentage change in exhaust emissions from vehicles using different mixtures of petroleum diesel and biodiesel.



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 86 · continued

There is no difference in carbon dioxide emissions for all mixtures of petroleum diesel and biodiesel.

Use the information and your knowledge and understanding to evaluate the use of plant oils to produce biodiesel.

Remember to give a conclusion to your evaluation.

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(5 marks)

5

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 87

June 2011 | CHY3H | Original Q6 | Legacy

6 *Unsaturated* organic compounds are used to make polymers.

6 (a) (i) Describe what you would **see** when bromine water reacts with an *unsaturated* organic compound.

.....

.....

(1 mark)

6 (a) (ii) In terms of structure, what makes an organic compound *unsaturated*?

.....

.....

(1 mark)

6 (b) When 2.1 g of an unsaturated hydrocarbon were completely burned in oxygen, 6.6 g of carbon dioxide and 2.7 g of water were the only products.

Relative formula masses: CO_2 = 44; H_2O = 18.

Use this information to calculate the number of moles of carbon dioxide and of water produced in this reaction. Use your answer to calculate the empirical formula of the hydrocarbon.

You must show your working to gain full marks.

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.....

Empirical formula = ...

(3 marks)

5

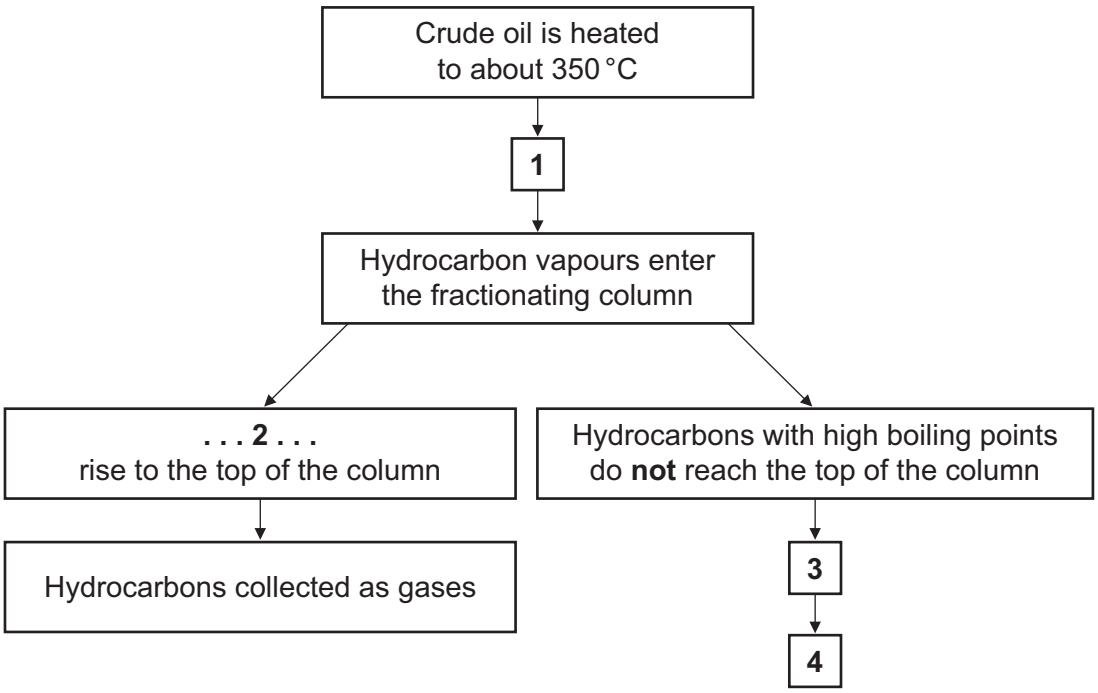
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 88

November 2011 | CHY1AP | Original Q2 | Legacy

QUESTION TWO

The flow chart shows stages in the fractional distillation of crude oil.



Match statements, **A**, **B**, **C** and **D**, with the numbers **1–4** in the flow chart.

A Hydrocarbons turn to vapour

B Hydrocarbons cool

C Hydrocarbons with low boiling points

D Hydrocarbons condense to form liquids

4.7.1.1 Crude oil, hydrocarbons and alkanes

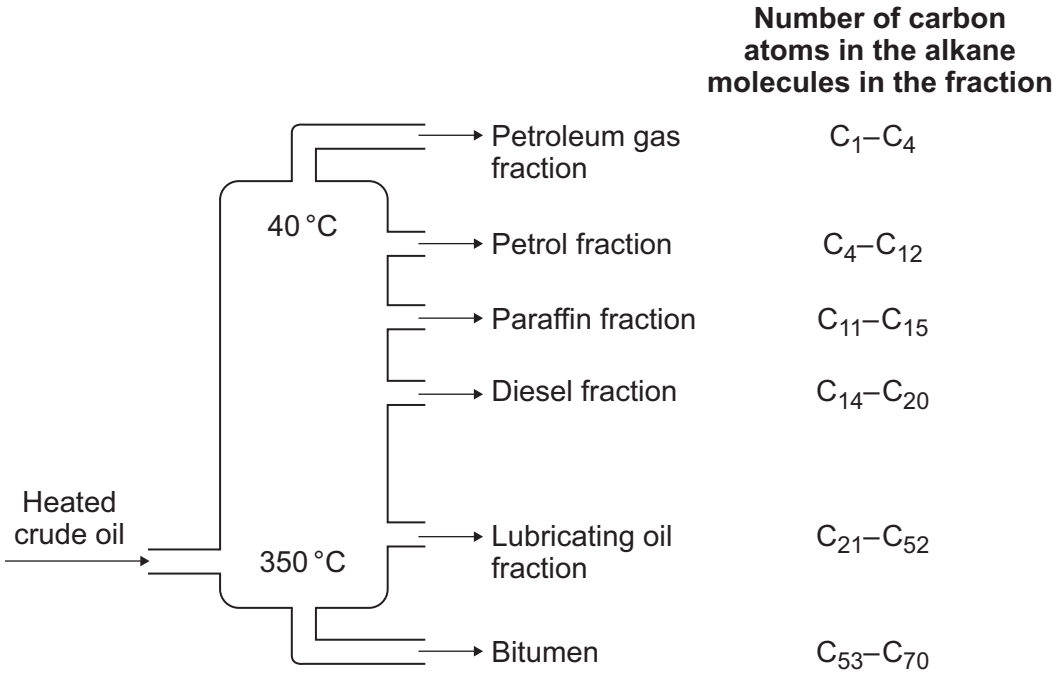
Question 89

November 2011 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

Crude oil can be separated into fractions.

Each fraction contains several alkanes.

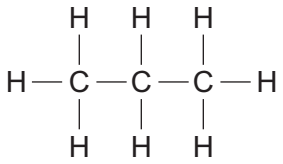


4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 89 · continued

3A One of the alkanes in the petrol fraction can be represented by . . .

1



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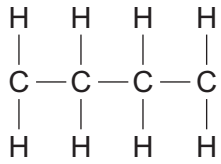

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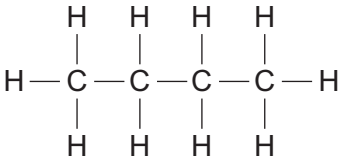
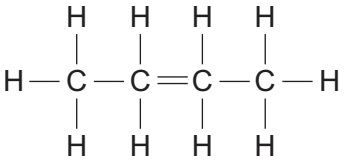


4



3B When compared with the alkanes in the petrol fraction, the alkanes in the lubricating oil fraction . . .

1 will be more difficult to ignite.

2 will burn with a cleaner flame.

3 will have lower boiling points.

4 will have smaller molecules.

3C The alkane called nonane has 20 hydrogen atoms in each molecule.

In which fraction will it be mainly collected?

1 Petroleum gas fraction

2 Petrol fraction

3 Diesel fraction

4 Lubricating oil fraction

3D Which of these gases **cannot** be produced when a pure alkane burns?

1 carbon monoxide

2 carbon dioxide

3 sulfur dioxide

4 water vapour

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 90

November 2011 | CHY1AP | Original Q5 | Legacy

QUESTION FIVE

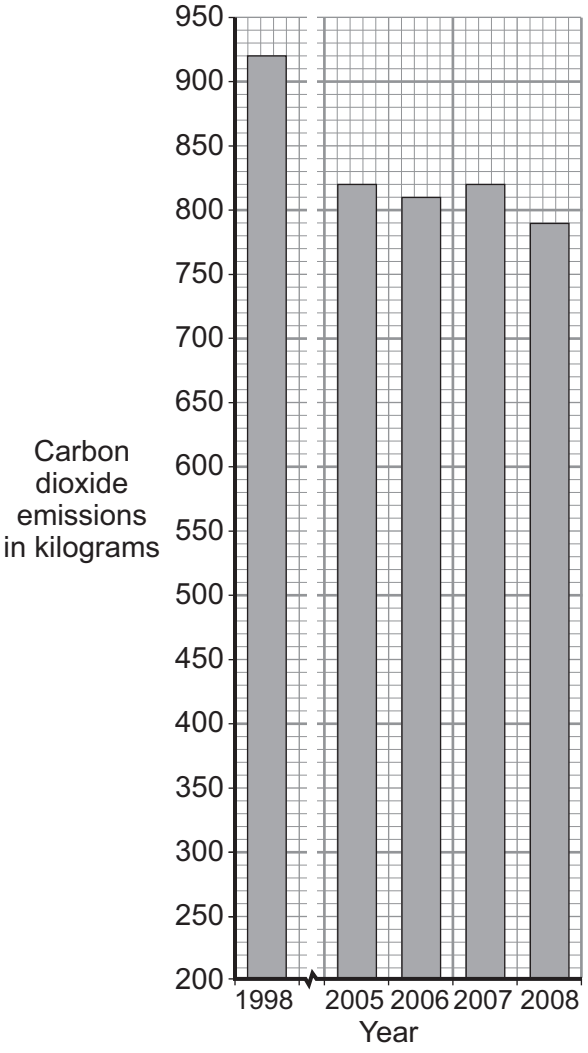
Cement is made in a rotary kiln, from a mixture of limestone and clay. The kiln is heated by burning a hydrocarbon fuel in air.

The cement industry needs to reduce carbon dioxide emissions.

Graphs 1 and **2** show carbon dioxide emissions from cement manufacture in Britain, between 1998 and 2008.

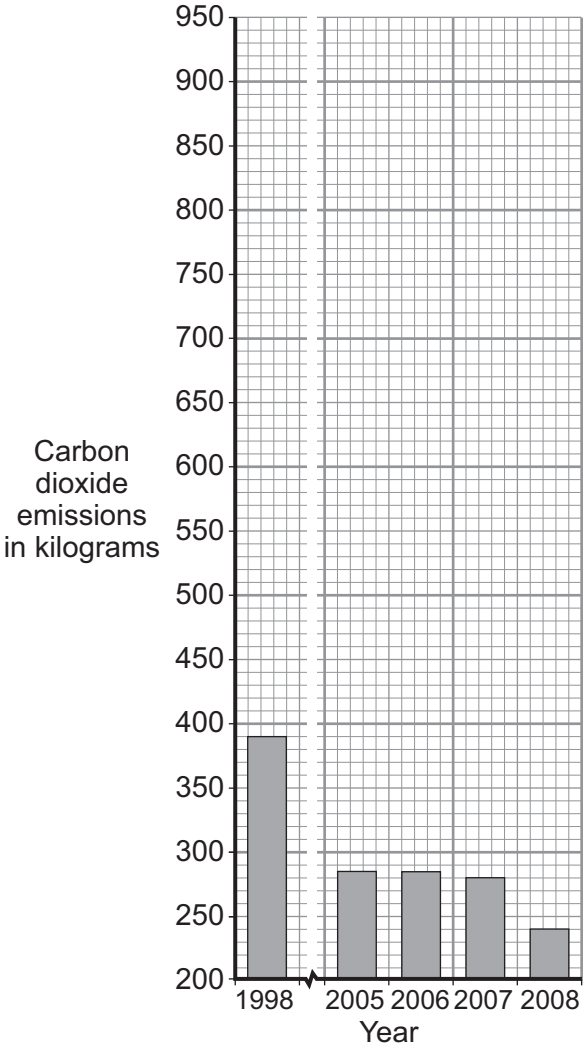
Graph 1

Total carbon dioxide emissions from factories per tonne of cement manufactured



Graph 2

Carbon dioxide emissions from combustion of hydrocarbon fuels per tonne of cement manufactured



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 90 · continued

5A A correct conclusion from the information in the graphs is that . . .

1 the largest reduction in total emissions of carbon dioxide was from 1998 to 1999.

2 the largest reduction in emissions of carbon dioxide from combustion of hydrocarbon fuels was from 2007 to 2008.

3 from 2007 to 2008, total emissions of carbon dioxide, per tonne of cement manufactured, reduced by 40 kilograms.

4 from 2007 to 2008, emissions of carbon dioxide from combustion of hydrocarbon fuels, per tonne of cement manufactured, reduced by 40 kilograms.

5B What was the percentage reduction in emissions of carbon dioxide from combustion of hydrocarbon fuels at cement factories between 1998 and 2008?

1 16.2 %

2 38.5 %

3 61.5 %

4 84.4 %

5C What proportion of the carbon dioxide released during cement manufacture in 2006 came from combustion of hydrocarbon fuels?

1 0.23

2 0.35

3 0.61

4 0.85

5D Most of the carbon dioxide released during cement manufacture comes from . . .

1 hydrocarbons.

2 limestone.

3 quicklime.

4 slaked lime.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 91

November 2011 | CHY1BP | Original Q4 | Legacy

QUESTION FOUR

Large hydrocarbon molecules can be broken down to produce smaller molecules.

An example is shown below.

Hydrocarbon **K** (large molecule) $\rightarrow$ C_6H_{12} + C_3H_6 + C_3H_8

4A What are the conditions needed for this reaction to take place most successfully?

1 heat hydrocarbon **K** vapour over a hot catalyst

2 heat hydrocarbon **K** vapour with hydrogen

3 heat hydrocarbon **K** with a dilute acid

4 heat hydrocarbon **K** at 40 °C

4B The formula for hydrocarbon **K** is . . .

1 C_9H_{18}

2 $C_{12}H_{24}$

3 $C_{12}H_{26}$

4 $C_{26}H_{12}$

4C Which row in the table shows the products that react with bromine water and the colour change seen when they react?

	Product(s)	Colour change
1	C_6H_{12} and C_3H_6	from yellow-brown to colourless
2	C_3H_6 and C_3H_8	from yellow-brown to colourless
3	C_6H_{12} and C_3H_6	from colourless to yellow-brown
4	C_3H_8 only	from yellow-brown to colourless

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 91 · continued

4D Two of the products can form polymers because . . .

1 they are obtained from crude oil by fractional distillation.

2 they are saturated compounds.

3 their molecules have a double carbon carbon bond.

4 they vaporise at temperatures below 20 °C.

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 92

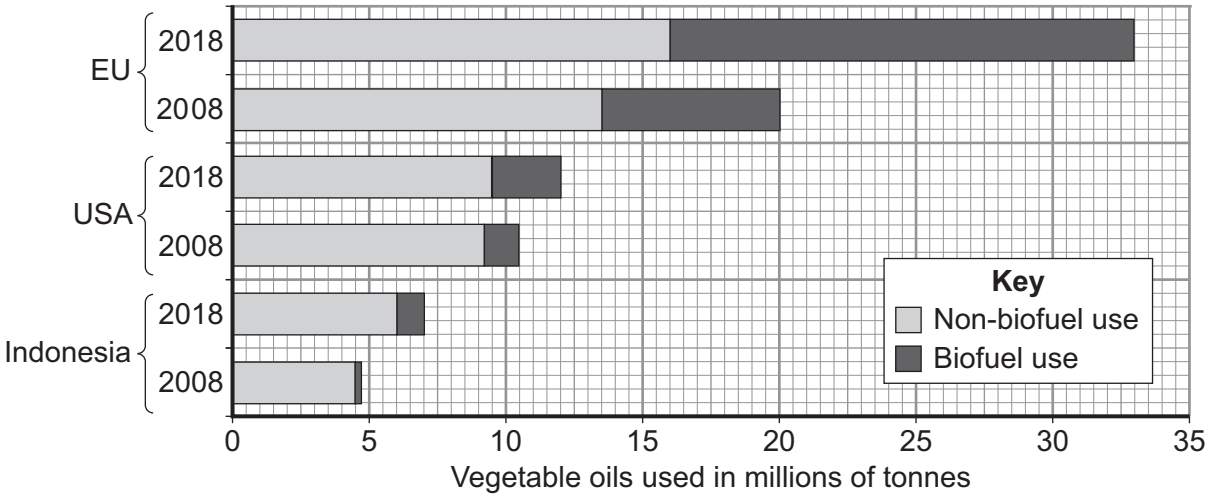
November 2011 | CHY1BP | Original Q8 | Legacy

QUESTION EIGHT

Vegetable oils are an important raw material for the production of biofuels.
An increase in the proportion of vegetable oils used for biofuels will reduce a country's dependence on crude oil.

However, large areas of agricultural land will be needed to grow the crops from which the oils are extracted.

The bar chart shows the use of vegetable oils in the European Union (EU), the USA and Indonesia in 2008. It also shows the projected use of vegetable oils in 2018. Indonesia is a country in south-east Asia.



8A What is the projected proportion of vegetable oils that will be used in the USA in 2018 to produce biofuels?

1 0.21

2 0.29

3 0.36

4 0.48

8B What is the projected percentage increase in the use of biofuels in the EU between 2008 and 2018?

1 22 %

2 75 %

3 162 %

4 250 %

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 92 · continued

8C The main environmental reason for the projected increase in the use of biofuels is . . .

1 the increase in the price of crude oil.

2 pressure to meet targets for reduced carbon dioxide emissions.

3 the discovery of large areas of unused agricultural land.

4 that biofuels do not produce any harmful waste gases when they burn.

8D Some pressure groups argue against the increased use of biofuels. They make many statements in support of their cause.

Which of the following is probably a false statement?

Increased use of biofuels will . . .

1 result in the loss of some animal and plant species.

2 create food shortages in some parts of the world.

3 cause water shortages in some countries.

4 cause petroleum diesel prices to rise.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 93

January 2012 | CH1HP | Original Q2 | Legacy

2 A mixture of petrol and air is burned in a car engine.
Petrol is a mixture of alkanes. Air is a mixture of gases.

The tables give information about the composition of petrol and the composition of air.

Petrol	
Alkane	**Formula**
hexane	C_6H_{14}
heptane	
octane	C_8H_{18}
nonane	C_9H_{20}
decane	$C_{10}H_{22}$

Air	
Gas	**Percentage (%)**
nitrogen	78
oxygen	21
carbon dioxide	0.035
Small amounts of other gases and water vapour	

2 (a) Use the information above to answer these questions.

2 (a) (i) Give the formula for heptane.

.....

(1 mark)

2 (a) (ii) Complete the general formula of alkanes.
n = number of carbon atoms

$$C_nH$$

(1 mark)

2 (b) Alkanes in petrol burn in air.
The equations represent two reactions of hexane burning in air.

Reaction 1 $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$

Reaction 2 $2C_6H_{14} + 13O_2 \rightarrow 12CO + 14H_2O$

Reaction 2 produces a different carbon compound to **Reaction 1**.

2 (b) (i) Name the carbon compound produced in **Reaction 2**.

.....

(1 mark)

2 (b) (ii) Give a reason why the carbon compounds produced are different.

.....

.....

(1 mark)

Question 2 continues on the next page

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 93 · continued

2 (c) The table shows the percentages of some gases in the exhaust from a petrol engine.

Name of gas	Percentage (%)
nitrogen	68
carbon dioxide	15
carbon monoxide	1.0
oxygen	0.75
nitrogen oxides	0.24
hydrocarbons	0.005
sulfur dioxide	0.005
other gases	

2 (c) (i) What is the percentage of the other gases in the table?

.....

(1 mark)

2 (c) (ii) What is the name of the compound that makes up most of the other gases?

.....

(1 mark)

2 (c) (iii) Give a reason why sulfur dioxide is produced in a petrol engine.

.....

.....

(1 mark)

2 (c) (iv) State how nitrogen oxides are produced in a petrol engine.

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.....

.....

(2 marks)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 93 · continued

2 (d) Many scientists are concerned about the carbon dioxide released from burning fossil fuels such as petrol.

Explain why.

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(2 marks)

11

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 94

January 2012 | CH1HP | Original Q7 | Legacy

7 Ethene is used as a starting material for the production of many other substances, including ethanol.

7 (a) Ethene is produced when hydrocarbons are cracked. To do this hydrocarbons are heated to vaporise them. The vapours are then passed over a hot catalyst. The symbol equation shows the reaction for one hydrocarbon.

$$C_{28}H_{58} \rightarrow C_{11}H_{24} + C_{11}H_{22} + C_4H_8 + C_2H_4$$

7 (a) (i) One of the products is a different type of hydrocarbon to the other products.

Complete the sentences.

The formula of the product that is a different type of hydrocarbon is ..... .

The chemical structure of this product is different to the other products because

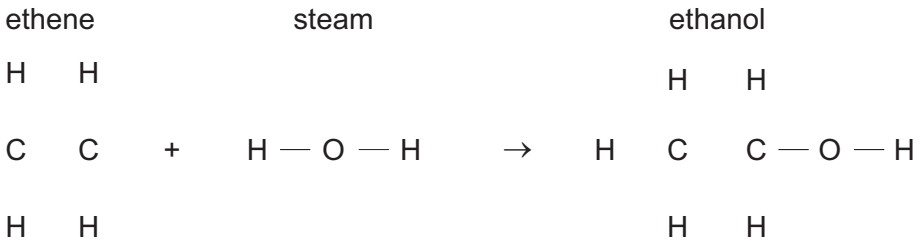
.....

.....

(2 marks)

7 (a) (ii) Ethanol is produced when ethene reacts with steam in the presence of a hot catalyst.

Draw the missing bonds to complete the displayed structures in the equation.



(2 marks)

7 (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

In 1970, the Brazilian Government had stated that all petrol must contain more than 25 % ethanol. The reasons for this statement in 1970 were:

- the oilfields in Brazil at that time only supplied 20 % of the crude oil needed to make petrol
- Brazil has a climate suitable for growing sugar cane.

To produce ethanol the sugar cane plants are crushed and soaked in water for one day. The sugar solution is separated from the plant material by filtration. Yeast is added to the sugar solution and fermented for three days. The yeast is separated from the solution of water and ethanol by filtration. Ethanol is separated from water by fractional distillation.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 94 · continued

In 2011, the Brazilian Government decided to reduce the amount of ethanol in petrol to 18%. The reasons were that in 2011:

- the demand for ethanol and the price of ethanol had greatly increased
- very large offshore oilfields had been discovered. These offshore oilfields would make Brazil one of the biggest crude oil producers in the world.

Use the information above and your own knowledge and understanding to evaluate whether Brazil should in future produce ethanol from crude oil or produce ethanol from sugar cane.

You should include environmental and economic or social factors in your evaluation.

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(6 marks)

10

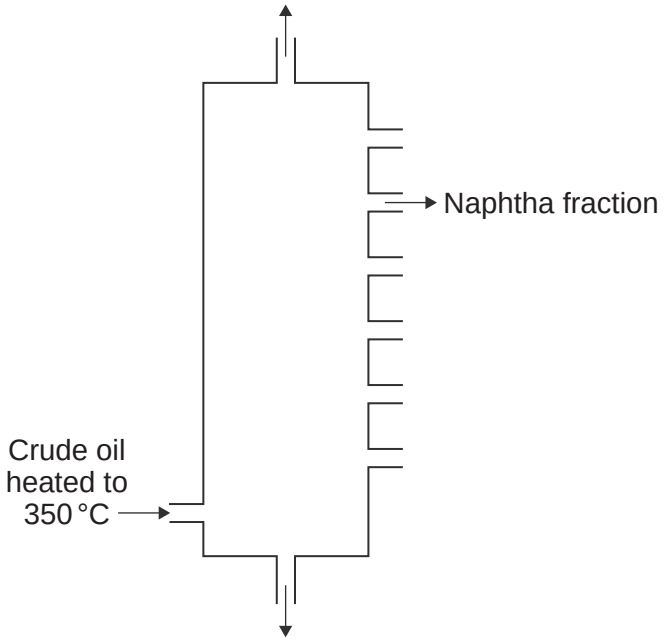
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 95

June 2012 | CH1HP | Original Q3 | Legacy

3 Crude oil is used to produce poly(ethene).

3 (a) Fractional distillation is used to separate crude oil into fractions.



3 (a) (i) Write a number, **2**, **3**, **4** or **5**, next to each stage so that the description of fractional distillation is in the correct order. Numbers **1** and **6** have been done for you.

Number	Stage
1	The crude oil is heated to 350 °C.
	When a fraction in the vapours cools to its boiling point, the fraction condenses.
	Any liquids flow down to the bottom of the column and the hot vapours rise up the column.
6	The condensed fraction is separated and flows out through a pipe.
	When the hot vapours rise up the column, the vapours cool.
	Most of the compounds in the crude oil evaporate.

(2 marks)

3 (a) (ii) The naphtha fraction is cracked to produce ethene (C_2H_4).
Ethene is used to make the polymer called poly(ethene).

Name **two** substances produced when poly(ethene) burns in air.

1 .....

2 .....

(2 marks)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 95 · continued

June 2012 | CH1HP | Original Q3 | Legacy

3 (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Each year in the UK, billions of plastic bags are given free to shoppers. These bags are made from poly(ethene) and are often used only once.
After being used many of these plastic bags are either thrown away as litter or buried in landfill sites.

In 2006 over 10 billion of these plastic bags were given free to shoppers.
In 2009 the number of plastic bags given to shoppers had decreased to 6.1 billion.
One reason for the decrease was because some supermarkets made people pay for their plastic bags.

From 2011 a new type of plastic shopping bag made mainly from poly(ethene) had a use-by date of only one year printed on the bag.

Use the information above and your knowledge and understanding to describe advantages and disadvantages of using plastic shopping bags made from poly(ethene).

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(6 marks)

10

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 96

June 2012 | CH1HP | Original Q7 | Legacy

7 Ethanol (C_2H_5OH) is produced from ethene or from sugar cane.

The two different methods to produce ethanol are summarised in the table.

Ethanol from sugar cane is a batch process	Ethanol from crude oil is a continuous process
Sugar cane plants are crushed and soaked in water for one day.	Crude oil is distilled to separate the naphtha fraction.
The sugar solution is separated by filtration.	The naphtha fraction is cracked when the vaporised hydrocarbons are passed over a hot catalyst.
Yeast is added to the sugar solution and fermented for three days.	The ethene produced is separated by distillation.
The solution of water and ethanol produced is separated by filtration.	Ethene is reacted with steam in the presence of a catalyst.
Distillation of this solution produces a 50% solution of ethanol.	This hydration reaction produces 100% ethanol.

7 (a) Complete and balance an equation for the cracking of the hydrocarbon C_6H_{14} to produce ethene.

C_6H_{14} ⟶ ..... + ...

(2 marks)

7 (b) What is **seen** when the sugar solution and yeast are fermented?

.....

.....

(1 mark)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 96 · continued

7 (c) Evaluate the issues involved with the production of ethanol from sugar cane compared with the production of ethanol from crude oil.
You should explain why each issue you describe is important.

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(5 marks)

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4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 97

January 2013 | CH1HP | Original Q3 | Legacy

3 This question is about oil reserves.

3 (a) Diesel is separated from crude oil by fractional distillation.

Describe the steps involved in the fractional distillation of crude oil.

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(3 marks)

3 (b) Diesel is a mixture of lots of different *alkanes.*

What are *alkanes*?

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.....

.....

(2 marks)

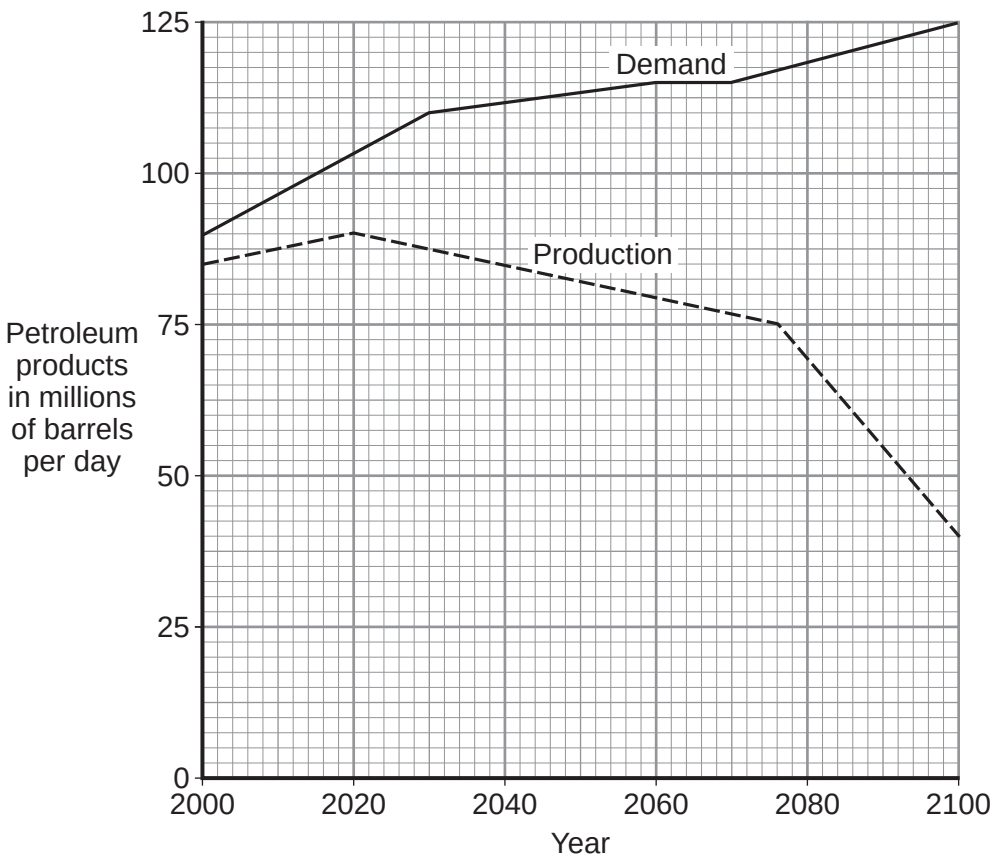
Question 3 continues on the next page

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 97 · continued

3 (c) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Petroleum products, such as petrol, are produced from crude oil.
The graph shows the possible future production of petroleum products from crude oil and the expected demand for petroleum products.



Canada's oil sands hold about 20% of the world's known crude oil reserves.

The oil sands contain between 10 to 15% of crude oil. This crude oil is mainly bitumen.

In Canada the oil sands are found in the ground underneath a very large area of forest. The trees are removed. Then large diggers and trucks remove 30 metres depth of soil and rock to reach the oil sands. The oil sands are quarried. Boiling water is mixed with the quarried oil sands to separate the bitumen from the sand. Methane (natural gas) is burned to heat the water.

The mixture can be separated because bitumen floats on water and the sand sinks to the bottom of the water. The bitumen is cracked and the products are separated by fractional distillation.

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 97 · continued

Use the information on page 8 and your knowledge and understanding to suggest the advantages and disadvantages of extracting petroleum products from oil sands.

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(6 marks)

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4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 98

8 Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere may have evolved.

Titan is the largest moon of Saturn.

The table shows data about some substances in the atmosphere of Titan.

Substance	Melting point in °C	Boiling point in °C
Nitrogen	–210	–196
Methane	–183	–164
Argon	–189	–186
Hydrogen	–259	–253
Carbon monoxide	–205	–192

8 (a) There is no water on Titan. The average surface temperature on Titan is –179 °C.

Which of the substances in the table would form oceans on Titan?

Explain your answer.

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(2 marks)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 98 · continued

8 (b) Amino acids are essential to life.

In the 1950s the Miller-Urey experiment showed that simple amino acids, such as glycine (NH_2CH_2COOH), could have been produced from the Earth's early atmosphere.

The Miller-Urey experiment showed that simple amino acids could be produced by reactions between hydrocarbons, ammonia and water.

Explain how the Miller-Urey experiment suggests that reactions between the substances in Titan's atmosphere could also produce simple amino acids.

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(4 marks)

6

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 99

June 2013 | CH1HP | Original Q3 | Legacy

3 Crude oil is a mixture of many different chemical compounds.

3 (a) Fuels, such as petrol (gasoline), can be produced from crude oil.

3 (a) (i) Fuels react with oxygen to release energy.

Name the type of reaction that releases energy from a fuel.

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(1 mark)

3 (a) (ii) Fuels react with oxygen to produce carbon dioxide.
The reaction of a fuel with oxygen can produce a different oxide of carbon.

Name this different oxide of carbon and explain why it is produced.

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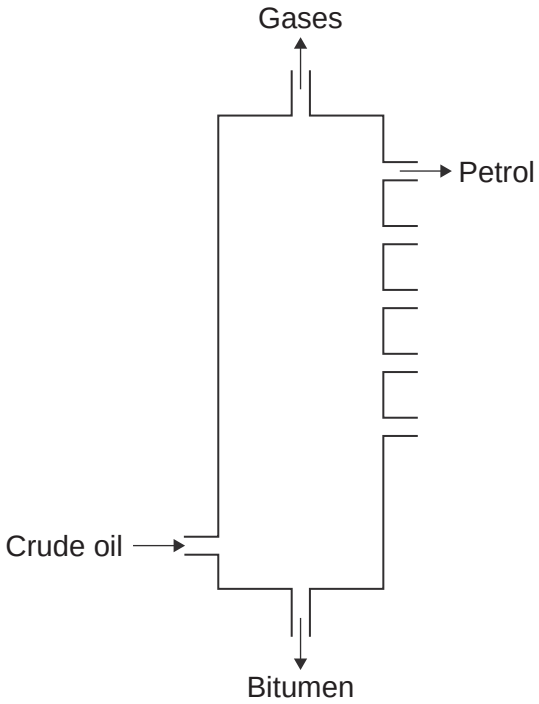
(2 marks)

3 (b) Most of the compounds in crude oil are hydrocarbons.
Hydrocarbons with the smallest molecules are very volatile.



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 99 · continued

In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

Describe and explain how **petrol** is separated from the mixture of hydrocarbons in crude oil.

Use the diagram and your knowledge to answer this question.

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(6 marks)

9

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 100

June 2013 | CH1HP | Original Q5 | Legacy

5 The amount of carbon dioxide in the Earth's atmosphere has changed since the Earth was formed.
The amount of carbon dioxide continues to change because of human activities.

5 (a) Cement is produced when a mixture of calcium carbonate and clay is heated in a rotary kiln. The fuel mixture is a hydrocarbon and air.

Hydrocarbons react with oxygen to produce carbon dioxide.
Calcium carbonate decomposes to produce carbon dioxide.

5 (a) (i) Complete each chemical equation by writing the formula of the other product.

$$CH_4 + 2O_2 \longrightarrow 2 \text{ .....} + CO_2$$

$$CaCO_3 \longrightarrow \text{.....} + CO_2$$

(2 marks)

5 (a) (ii) Hydrocarbons and calcium carbonate contain *locked up* carbon dioxide.

What is *locked up* carbon dioxide?

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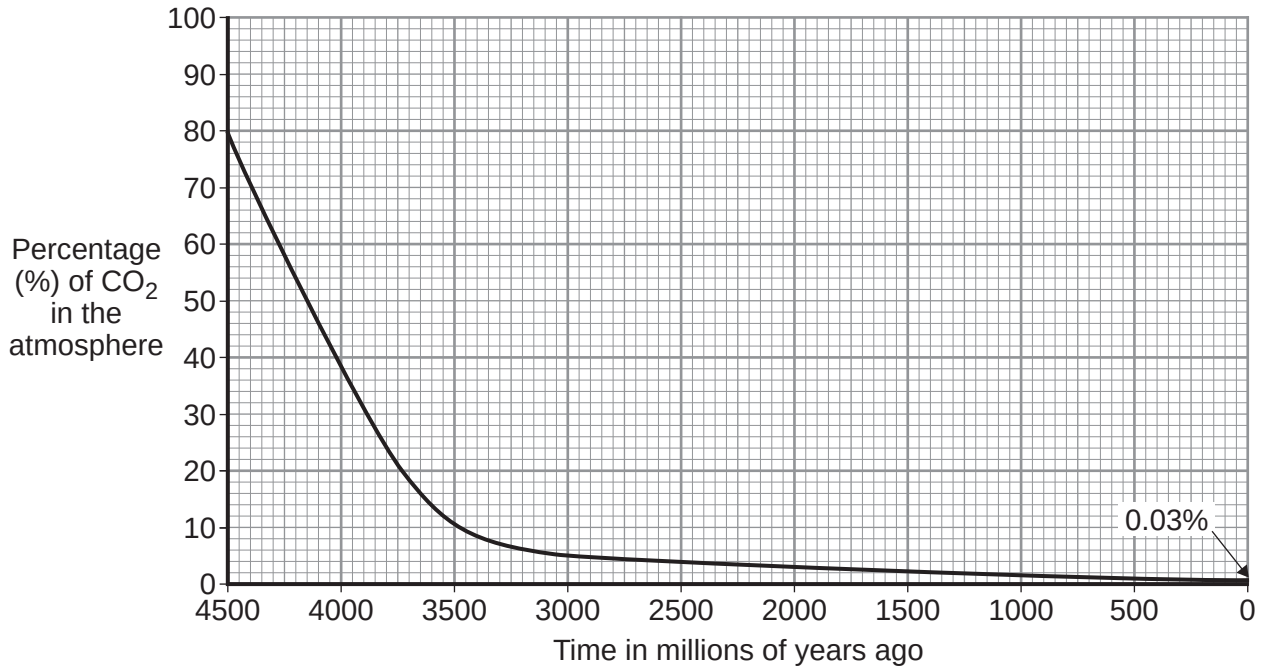
(2 marks)

Question 100 · continued

5 (b) **Graph 1** shows how the percentage of carbon dioxide in the atmosphere changed in the last 4500 million years.

Graph 1



Use information from **Graph 1** to answer these questions.

5 (b) (i) Describe how the percentage of carbon dioxide has changed in the last 4500 million years.

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(2 marks)

5 (b) (ii) Give **two** reasons why the percentage of carbon dioxide has changed.

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(2 marks)

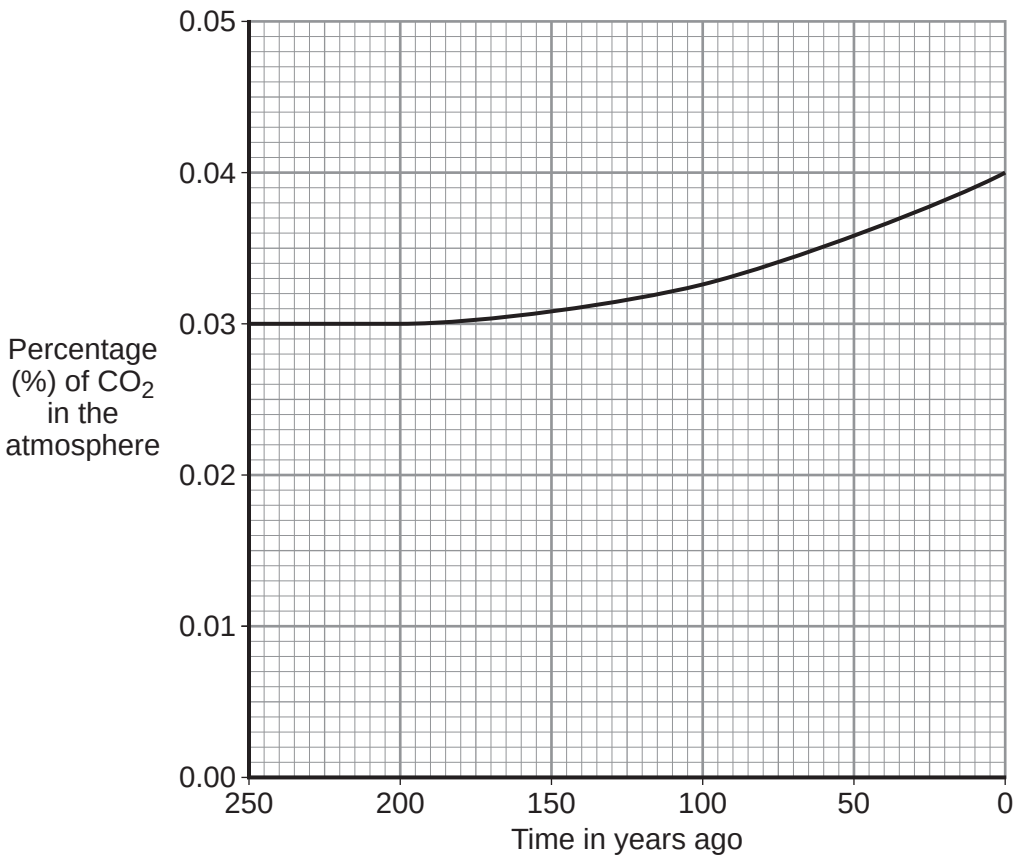
Question 5 continues on the next page

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 100 · continued

5 (c) **Graph 2** shows how the percentage of carbon dioxide in the atmosphere changed in the last 250 years.

Graph 2



Should we be concerned about this change in the percentage of carbon dioxide?

Explain your answer.

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(2 marks)

10

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 101

June 2013 | CH1HP | Original Q7 | Legacy

7 There has been research into fuels for car engines.

Fuel	Content	Melting point in °C	Flashpoint in °C	Energy released in MJ per litre
Ethanol	C_2H_5OH	–114	+14	21.2
Diesel	hydrocarbons	About –24	+64	38.6
Petrol	hydrocarbons	About –57	–45	34.8
Rapeseed oil	fats	About +5	+130	32.8

The flashpoint is the lowest temperature a fuel vapour ignites in air.

7 (a) The melting point of ethanol is precise but the other melting points are approximate. Suggest why.

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(2 marks)

7 (b) Ethanol is produced by fermentation of sugar cane. Rapeseed oil is produced by pressing rapeseeds. Waste plant material from both processes is used to feed animals.

7 (b) (i) Describe how the process of fermentation is done.

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(2 marks)

7 (b) (ii) Carbon neutral fuels do **not** increase the amount of carbon dioxide in the atmosphere.

Suggest why using a biofuel, such as ethanol or rapeseed oil, is thought to be carbon neutral.

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(2 marks)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 101 · continued

June 2013 | CH1HP | Original Q7 | Legacy

7 (c) When any fuel from the table is used in a car engine, the exhaust gases contain nitrogen oxides.

Explain why.

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(2 marks)

7 (d) Evaluate replacing petrol with ethanol as a fuel for cars.

To gain full marks you should give a justified conclusion.

Use the information from the table and your knowledge to answer this question.

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(4 marks)

12

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 102

June 2013 | CH2HP | Original Q5 | Legacy

5 Oil rigs are used to drill for crude oil.



5 (a) Drill heads are made from steel. Steel is an alloy.

Explain why alloys are harder than pure metals.

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(3 marks)

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 102 · continued

5 (b) Drill heads also contain diamonds.

Describe, as fully as you can, the structure and bonding in diamond.

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(4 marks)

5 (c) Polymers are produced from crude oil.

Describe the structure and bonding in a thermosoftening polymer and explain why thermosoftening polymers melt when heated.

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(4 marks)

11

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 103

June 2014 | CH1HP | Original Q2 | Legacy

2 Ethanol and vegetable oil are used as fuels.

2 (a) There are two different ways to produce ethanol:

- using ethene from crude oil
- using sugar from plants.

2 (a) (i) Ethanol is produced from ethene by **hydration** in the presence of a catalyst.

What is **hydration**?

[1 mark]

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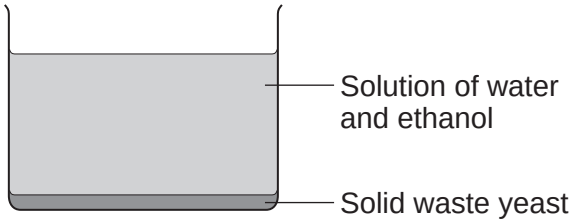
2 (a) (ii) Fermentation is used to produce ethanol from sugar by:

- dissolving the sugar in water
- adding yeast to the sugar solution
- leaving the mixture for three days.

Figure 2 shows the substances after three days.

Figure 2



Suggest:

- how the solid waste yeast is removed
- how ethanol is obtained from the solution.

[2 marks]

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4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 103 · continued

2 (b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Crude oil is separated to produce the fraction petroleum diesel.

Worries about low supplies of crude oil have led to the growing of large areas of crops to produce vegetable oil.

Vegetable oils are used to produce biodiesel.

There are economic, ethical and environmental issues about the use of biodiesel.

Biodiesel and petroleum diesel are used as a fuel for cars. In a car engine the fuel burns and releases waste products through the car exhaust system.

Table 1 shows the amount of waste products formed by biodiesel compared with the amount of waste products formed by petroleum diesel.

(Note that ppm is parts per million.)

Table 1

	Carbon dioxide in ppm	Nitrogen oxides in ppm	Sulfur dioxide in ppm	Particulates in g per m^3
Biodiesel	20 000	760	0	0.3
Petroleum diesel	80 000	700	300	0.6

Use this information and your knowledge and understanding to give advantages and disadvantages of using biodiesel instead of petroleum diesel.

[6 marks]

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4.7.1.1 Crude oil, hydrocarbons and alkanes

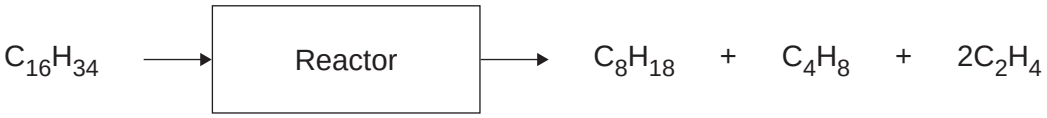
Question 104

June 2014 | CH1HP | Original Q7 | Legacy

7 Poly(butene) is a polymer made from crude oil in two stages.

7 (a) The first stage in making poly(butene) is to break down large hydrocarbon molecules from crude oil into smaller hydrocarbon molecules, as shown in **Figure 6**.

Figure 6



7 (a) (i) The products contain two types of hydrocarbon with different general formulae.

Name the two types of hydrocarbon.

[1 mark]

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7 (a) (ii) Describe the conditions in the reactor.

[2 marks]

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7 (a) (iii) Suggest why air must **not** enter the reactor.

[1 mark]

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7 (a) (iv) Suggest a method that can be used to separate butene (C_4H_8) from the other hydrocarbons.

[1 mark]

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4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 104 · continued

7 (b) The second stage is to use butene (C_4H_8) to produce poly(butene).

7 (b) (i) Draw the displayed structure of a butene (C_4H_8) molecule.

[1 mark]

7 (b) (ii) Describe how molecules of butene (C_4H_8) form poly(butene).

[2 marks]

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8

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 105

June 2015 | CH1HP | Original Q5 | Legacy

5 Crude oil is a fossil fuel.

5 (a) Describe how crude oil is separated into fractions.

[4 marks]

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5 (b) Fuel oil is one of the fractions from crude oil.

Power stations burn fuel oil to generate electricity. The waste gases from the combustion of fuel oil contain carbon dioxide, water vapour, sulfur dioxide and oxides of nitrogen.

The waste gases are passed through a suspension of limestone in water. Limestone is mainly calcium carbonate.

Suggest how the use of a suspension of limestone decreases one of the environmental impacts that the waste gases would cause.

[3 marks]

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4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 105 · continued

5 (c) Some fractions from crude oil contain large hydrocarbon molecules.

5 (c) (i) Hydrocarbon molecules, such as decane, can be cracked to produce smaller, more useful molecules.

Write the correct formula of the third product to complete the chemical equation.

You do not need to give the name of this product.

[1 mark]

$C_{10}H_{22} \longrightarrow C_5H_{10} + C_3H_8 +$ .....

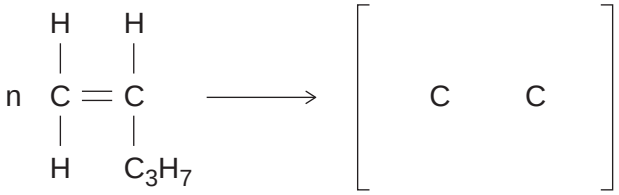
decane pentene propane

5 (c) (ii) Pentene is used to produce poly(pentene).

Complete the equation and the displayed structure of poly(pentene).

[3 marks]

Pentene **Poly(pentene)**



5 (c) (iii) Some polymers are described as smart polymers.

Suggest **one** property of a smart polymer that is different to that of an ordinary polymer.

[1 mark]

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12

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 106

June 2016 | CH1HP | Original Q2 | Legacy

2 This question is about hydrocarbons.

2 (a) Most of the hydrocarbons in crude oil are alkanes.

2 (a) (i) Large alkane molecules can be cracked to produce more useful molecules.

The equation shows the cracking of dodecane.

$$\underset{\text{dodecane}}{C_{12}H_{26}} \longrightarrow \underset{\text{butane}}{C_4H_{10}} + \underset{\text{hexene}}{C_6H_{12}} + \underset{\text{ethene}}{C_2H_4}$$

Give **two** conditions used to crack large alkane molecules.

[2 marks]

1 _____

2 _____

2 (a) (ii) The products hexene and ethene are alkenes.

Complete the sentence.

[1 mark]

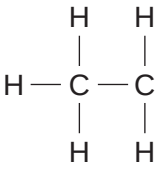
When alkenes react with bromine water the colour changes

from orange to _____ .

2 (a) (iii) Butane (C_4H_{10}) is an alkane.

Complete the displayed structure of butane.

[1 mark]



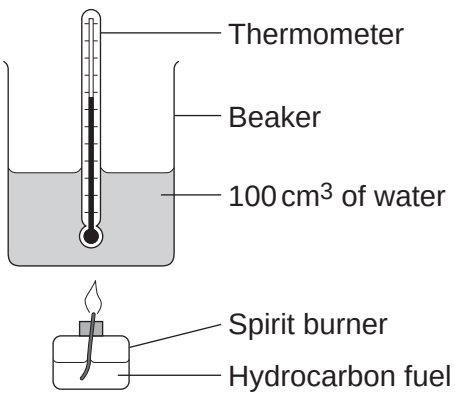
Question 2 continues on the next page

Question 106 · continued

2 (b) A group of students investigated the energy released by the combustion of four hydrocarbon fuels.

Figure 3 shows the apparatus used.

Figure 3



Each hydrocarbon fuel was burned for two minutes.

Table 1 shows the students' results.

Table 1

	After two minutes				
Name and formula of hydrocarbon fuel	**Mass of fuel used in g**	**Temperature increase of water in °C**	**Energy released by fuel in kJ**	**Energy released by 1.0 g of fuel in kJ**	**Relative amount of smoke in the flame**
Hexane, C_6H_{14}	0.81	40	16.80	20.74	very little smoke
Octane, C_8H_{18}	1.10	54	22.68	20.62	some smoke
Decane, $C_{10}H_{22}$	1.20	58	24.36		smoky
Dodecane, $C_{12}H_{26}$	1.41	67	28.14	19.96	very smoky

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 106 · continued

2 (b) (i) Calculate the energy released by 1.0 g of decane in kJ.

[2 marks]

Energy released = _____ kJ

2 (b) (ii) Suggest **one** improvement to the apparatus, or the use of the apparatus, that would make the temperature increase of the water for each fuel more accurate.

Give a reason why this is an improvement.

[2 marks]

2 (b) (iii) The students noticed that the bottom of the beaker became covered in a black substance when burning these fuels.

Name this black substance.

Suggest why it is produced.

[2 marks]

2 (b) (iv) A student concluded that hexane is the best of the four fuels.

Give **two** reasons why the results in **Table 1** support this conclusion.

[2 marks]

1 _____

2 _____

Question 2 continues on the next page

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 106 · continued

2 (c) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Most car engines use petrol as a fuel.

- Petrol is produced from the fractional distillation of crude oil.
- Crude oil is a mixture of hydrocarbons.
- Sulfur is an impurity in crude oil.

Car engines could be developed to burn hydrogen as a fuel.

- Hydrogen is produced from natural gas.
- Natural gas is mainly methane.

Table 2 shows information about petrol and hydrogen.

Table 2

	Petrol	**Hydrogen**
State of fuel at room temperature	Liquid	Gas
Word equation for combustion of the fuel	petrol + oxygen ⟶ carbon dioxide + water	hydrogen + oxygen ⟶ water
Energy released from combustion of 1 g of the fuel	47 kJ	142 kJ

Describe the **advantages** and **disadvantages** of using hydrogen instead of petrol in car engines.

Use the information given and your knowledge and understanding to answer this question.

[6 marks]

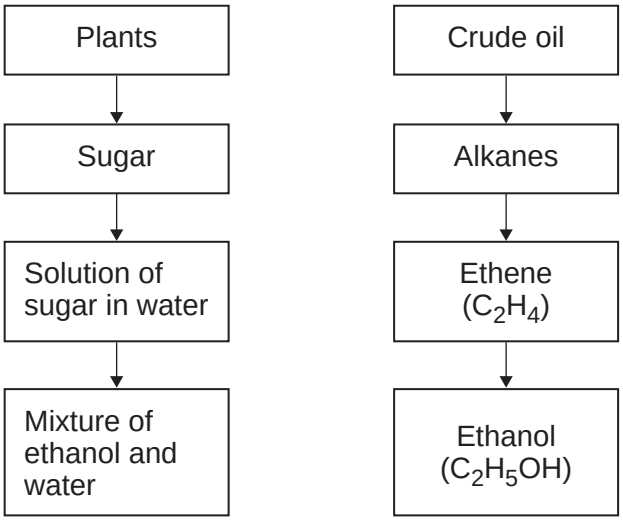
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 107

June 2016 | CH1HP | Original Q4 | Legacy

4 Ethanol can be made from plants and from crude oil as shown in **Figure 6.**

Figure 6



4 (a) (i) Describe how the solution of sugar in water is used to produce the mixture of ethanol and water.

[2 marks]

4 (a) (ii) Describe how ethanol is produced from ethene.

[2 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 107 · continued

4 (b) Explain **one** advantage and **one** disadvantage of using crude oil to make ethanol instead of using plants.

[4 marks]

4 (c) Ethanol has a boiling point of 78 °C.
Water has a boiling point of 100 °C.

Describe how distillation is used to separate a mixture of ethanol and water.

[3 marks]

11

4.7.1.1 Crude oil, hydrocarbons and alkanes

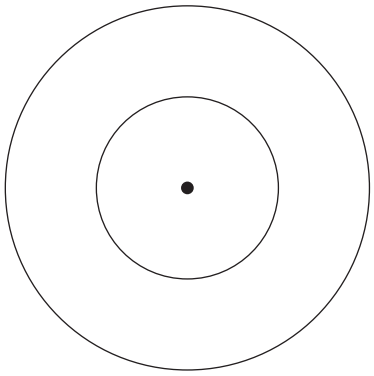
Question 108

June 2017 | CH1HP | Original Q2 | Legacy

2 This question is about compounds of carbon.

2 (a) **Figure 2** shows an atom with two energy levels (shells).

Figure 2



2 (a) (i) A carbon atom has six electrons.

Complete **Figure 2** to show the electronic structure of a carbon atom.

Use **x** to represent an electron.

[1 mark]

2 (a) (ii) Complete the following description about the central part of this carbon atom.

[3 marks]

The central part is made up of six neutrons that have no electrical charge and _____

_____

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2 (b) Crude oil is a mixture of compounds. These compounds are mainly hydrocarbons.

What does the term hydrocarbon mean?

[1 mark]

_____

_____

Question 108 · continued

2 (c) Alkanes and alkenes are hydrocarbons.

Table 2 shows the boiling points of some alkanes and alkenes.

Table 2

Alkanes

Name	Formula	Boiling point in °C
Ethane	C_2H_6	−88
Propane	C_3H_8	−42
Butane	C_4H_{10}	0
Pentane	C_5H_{12}	+36
Hexane	C_6H_{14}	+69

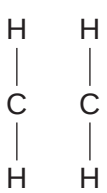
Alkenes

Name	Formula	Boiling point in °C
Ethene	C_2H_4	−104
Propene	C_3H_6	−48
Butene	C_4H_8	−6
Pentene	C_5H_{10}	+30
Hexene	C_6H_{12}	+64

2 (c) (i) Complete the displayed structure of ethane and the displayed structure of ethene.

[2 marks]

Ethane



Ethene



2 (c) (ii) Describe the relationship between the number of carbon atoms in an alkane molecule and the boiling point of the alkane molecule.

[1 mark]

4.7.1.1 Crude oil, hydrocarbons and alkanes

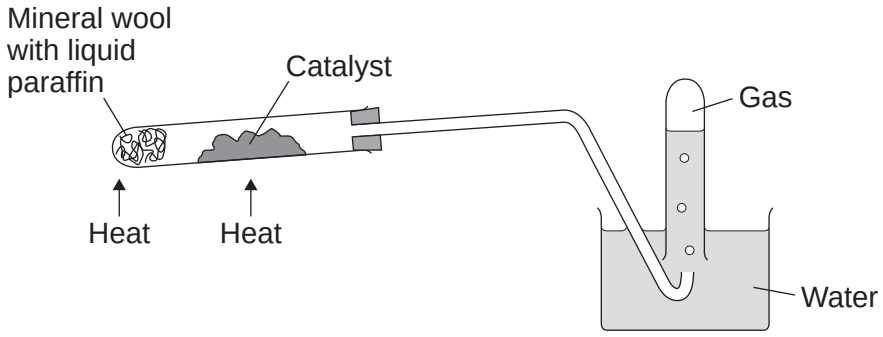
Question 108 · continued

2 (c) (iii) Use the information in **Table 2** to compare the boiling points of alkanes with the boiling points of alkenes.

[2 marks]

2 (d) A student used the apparatus in **Figure 3** to investigate what happens when liquid paraffin is heated to a high temperature.

Figure 3



Liquid paraffin contains alkanes.

Describe what happens to the alkane molecules in this investigation.

[3 marks]

13

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 109

June 2017 | CH1HP | Original Q6 | Legacy

6 Oils from plants are used in the production of fuels and foods.

6 (a) Explain **one** advantage of using biodiesel made from plant oils compared with using fossil diesel made from crude oil.

[2 marks]

6 (b) Plant oils are used in emulsions to give a consistent texture to many foods.

Explain how an emulsion of water and oil is formed.

[4 marks]

6 (c) Bromine water changes colour when shaken with some plant oils.

Describe the colour change.

[2 marks]

Question 6 continues on the next page

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 109 · continued

June 2017 | CH1HP | Original Q6 | Legacy

6 (d) Describe and explain what happens to plant oils when they react with hydrogen in the presence of a nickel catalyst at about 60 °C.

[3 marks]

11

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 110

June 2018 | 8462/2H | Original Q7

0 7 Older cars are tested each year to measure the amount of pollutants contained in exhaust fumes.

Table 4 shows the maximum allowed percentages of exhaust pollutants for petrol cars.

Table 4

Age of car in years	Maximum allowed percentage (%) of exhaust pollutant	
	Carbon monoxide	Unburned hydrocarbons
16–24	0.30	0.02
3–16	0.20	0.02

0 7 . 1 Explain how carbon monoxide is produced when petrol is burned in car engines.

[2 marks]

0 7 . 2 Suggest **two** reasons why the maximum allowed percentage of carbon monoxide has been decreased for newer cars.

[2 marks]

1

2

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 110 · continued

0 7 . 3 Give **one** reason for having a maximum allowed percentage of unburned hydrocarbons in exhaust fumes.

[1 mark]

Oxides of nitrogen are also pollutants contained in exhaust fumes.

0 7 . 4 Describe how oxides of nitrogen are produced when petrol is burned in car engines.

[2 marks]

Catalytic converters are fitted to car exhausts to reduce the amount of pollutants released into the atmosphere.

0 7 . 5 Nitrogen dioxide is an oxide of nitrogen.

Nitrogen dioxide reacts to produce nitrogen and oxygen in catalytic converters.

Complete the equation for this reaction.

The equation should be balanced.

[2 marks]

$$__\ NO_2\ (g) \rightarrow _____ + __\ O_2\ (g)$$

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 110 · continued

0 7 . 6 Give **two** effects of atmospheric pollution which are reduced by using catalytic converters.

[2 marks]

1 _____

_____

2 _____

_____

0 7 . 7 The catalyst in catalytic converters is a mixture of three elements.

Where in the periodic table are these elements most likely to be found?

[1 mark]

Tick **one** box.

- Alkali metals ☐
- Halogens ☐
- Noble gases ☐
- Transition metals ☐

12

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 111

June 2018 | 8462/2H | Original Q10

1 0 Disposable cups are made from coated paper or poly(styrene).

Table 6 shows information on the life cycle assessments (LCAs) of disposable cups.

Table 6

	Coated paper cups	Poly(styrene) cups
Raw materials	Wood	Crude oil
Mass of 1 cup in g	8.3	1.9
Energy to produce 1 cup in kJ	550	200
Energy released when 1 cup is burned in kJ	166	76
Biodegradable	Yes	No
Recyclable	No	Yes

1 0 . 1 Evaluate the use of coated paper compared with poly(styrene) to make disposable cups.

Use **Table 6** and your knowledge and understanding of LCAs.

[6 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 111 · continued

10.2 Calculate the energy needed to produce 1.00 kg of coated paper cups.

Use **Table 6**.

Give your answer in standard form.

[2 marks]

Energy = _____ kJ

10.3 Melamine is a polymer used to make non-disposable cups.

Melamine does **not** melt when it is heated.

Explain why.

[2 marks]

10

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 112

June 2019 | 8462/2H | Original Q1

0 1 This question is about crude oil and hydrocarbons.

Figure 1 shows a fractionating column used to separate crude oil into fractions.

Figure 1

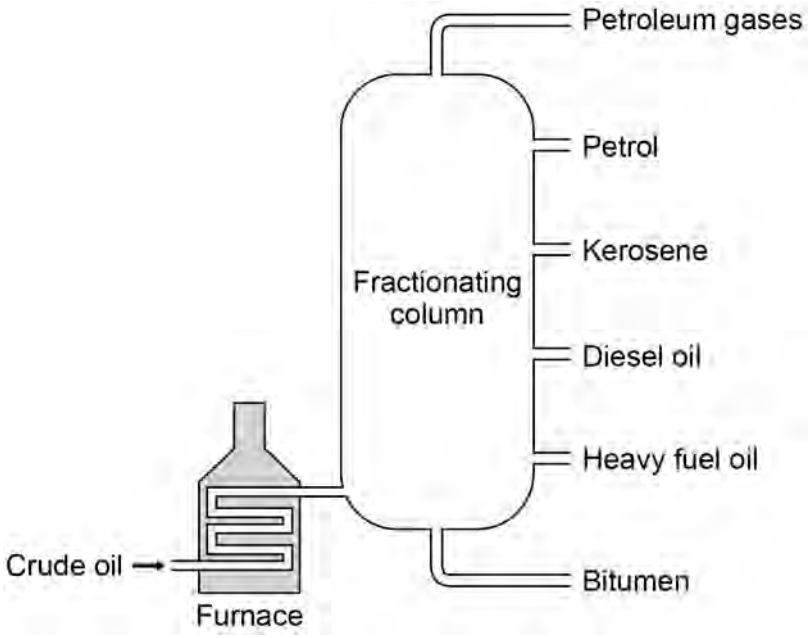


Table 1 gives information about some of the fractions.

Table 1

Fraction	Boiling point range in °C
Petroleum gases	Below 30
Petrol	40–110
Kerosene	180–260
Diesel oil	260–320
Heavy fuel oil	320–400
Bitumen	400–450

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 112 · continued

0 1 . 1 Suggest a suitable temperature for the furnace in **Figure 1**.

[1 mark]

_____ °C

0 1 . 2 Explain why diesel oil collects above heavy fuel oil but below kerosene in the fractionating column.

Use **Table 1**.

[2 marks]

_____

_____

_____

_____

0 1 . 3 Suggest **two** reasons why bitumen is **not** used as a fuel.

[2 marks]

1 _____

_____

2 _____

_____

Question 1 continues on the next page

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 112 · continued

0 1 . 4 Petrol contains mainly alkanes.

Which of the following compounds is an alkane?

[1 mark]

Tick (✓) **one** box.

C_2H_4 ☐

C_4H_8 ☐

C_6H_{14} ☐

C_8H_{16} ☐

Large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

0 1 . 5 Describe the conditions needed to crack hydrocarbon molecules from the diesel oil fraction.

[2 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 112 · continued

0 1 . 6 Explain why large hydrocarbon molecules in the diesel oil fraction are cracked to produce smaller hydrocarbon molecules.

[2 marks]

0 1 . 7 Complete the equation for the cracking of $C_{15}H_{32}$

[1 mark]

$$C_{15}H_{32} \rightarrow C_{12}H_{26} + _____$$

11

Turn over for the next question

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 113

June 2019 | 8462/2H | Original Q6

0 6 **Figure 5** shows a surfer on a surfboard.

Figure 5



Surfboards are made from polymers.

Surfboards have a poly(styrene) core and an outer skin.

0 6 . 1 **Figure 6** shows the displayed structural formula of poly(styrene).

Figure 6

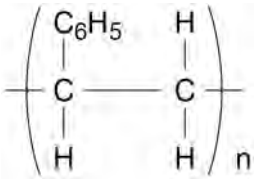
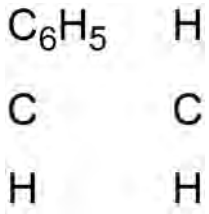


Figure 7 shows an incomplete displayed structural formula of the monomer styrene.

Complete **Figure 7**.

[2 marks]

Figure 7



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 113 · continued

The outer skin of surfboards contains a polyester.

Two monomers, **A** and **B**, are needed to make the polyester.

Figure 8 shows how these two monomers are represented.

Figure 8



Monomer **A** Monomer **B**

0 6 . 2 Name the functional group in monomer **B**.

[1 mark]

0 6 . 3 Monomers **A** and **B** join together to produce a polyester and a small molecule.

Name the small molecule.

[1 mark]

0 6 . 4 Why does this type of polyester melt when it is heated?

[2 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 113 · continued

June 2019 | 8462/2H | Original Q6

The outer skin of surfboards is a composite material.

The composite material contains glass fibres surrounded by a polyester.

0 6 . 5 Draw **one** line from each material to the description of that material.

[2 marks]

Material	Description of the material
	Hydrocarbon
Glass fibres	Matrix
	Monomer
Polyester	Polypeptide
	Reinforcement

0 6 . 6 The outer skin makes the surfboard more expensive.

Suggest **two** reasons why an outer skin is added to the poly(styrene) core.

[2 marks]

1 _____

_____

2 _____

_____

10

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 114

June 2019 | 8462/2H | Original Q8

0 8 Titan is a moon of the planet Saturn.

Table 3 shows the percentages of the gases in the atmosphere of Titan.

Table 3

Gas	Percentage of gas in atmosphere (%)
Nitrogen	98.4
Methane	1.4
Other gases	0.2

0 8 . 1 Some scientists think that living organisms could have evolved on Titan.

Explain why these organisms could **not** have evolved in the same way that life is thought to have evolved on Earth.

Use **Table 3**.

[3 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 114 · continued

0 8 . 2 Saturn has other moons.

The other moons of Saturn have no atmosphere.

Titan is warmer than the other moons of Saturn because its atmosphere contains the greenhouse gas methane.

Explain how this greenhouse gas keeps Titan warmer than the other moons of Saturn.

[3 marks]

0 8 . 3 The atmosphere of Titan contains small amounts of propene.

Describe a test to show that propene is an unsaturated hydrocarbon.

Give the result of the test.

[2 marks]

Test _____

Result _____

8

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 115

November 2020 | 8462/2H | Original Q3

0 3 This question is about hydrocarbons.

Hexane and hexene are hydrocarbons containing six carbon atoms in each molecule.

Hexane is an alkane and hexene is an alkene.

0 3 . 1 Draw **one** line from each hydrocarbon to the formula of that hydrocarbon.

[2 marks]

Hydrocarbon	Formula
	C_6H_8
Hexane	C_6H_{10}
	C_6H_{12}
Hexene	C_6H_{14}
	C_6H_{16}

0 3 . 2 Bromine water is added to hexane and to hexene.

What would be observed when bromine water is added to hexane and to hexene?

[2 marks]

Hexane _____

_____

Hexene _____

_____

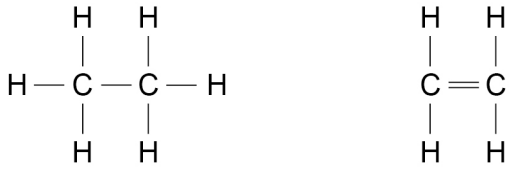
4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 115 · continued

0 3 . 3 Ethane is an alkane and ethene is an alkene.

Figure 1 shows the displayed structural formulae of ethane and of ethene.

Figure 1



Ethane **Ethene**

Compare ethane with ethene.

You should refer to:

- their structure and bonding
- their reactions.

[6 marks]

10

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 116

November 2020 | 8462/2H | Original Q5

0 5 This question is about materials used to make food plates.

Food plates are made from paper, polymers or ceramics.

Table 2 shows information about plates of the same diameter made from each of these materials.

Table 2

	Food plate material		
	Paper	**Polymers**	**Ceramics**
Raw material	Wood	Crude oil	Mined clay
Number packaged in 10 dm^3 cardboard box	500	100	50
Average number of times used	1	400	1000
Biodegradable?	Yes	No	No
Recyclable?	Yes	Yes	No

0 5 . 1 **Table 2** does **not** show information about energy usage.

Suggest **two** pieces of information about energy usage which would help to produce a complete life cycle assessment (LCA) for the three food plate materials.

[2 marks]

1 _____

_____

2 _____

_____

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 116 · continued

0 5 . 2 Evaluate the use of these materials for making food plates.

You should use features of life cycle assessments (LCAs).

Use **Table 2**.

[4 marks]

0 5 . 3 Describe how ceramic food plates are produced from clay.

[2 marks]

8

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 117

November 2021 | 8462/2H | Original Q2

0 2 This question is about alkanes.

Table 1 shows information about some alkanes.

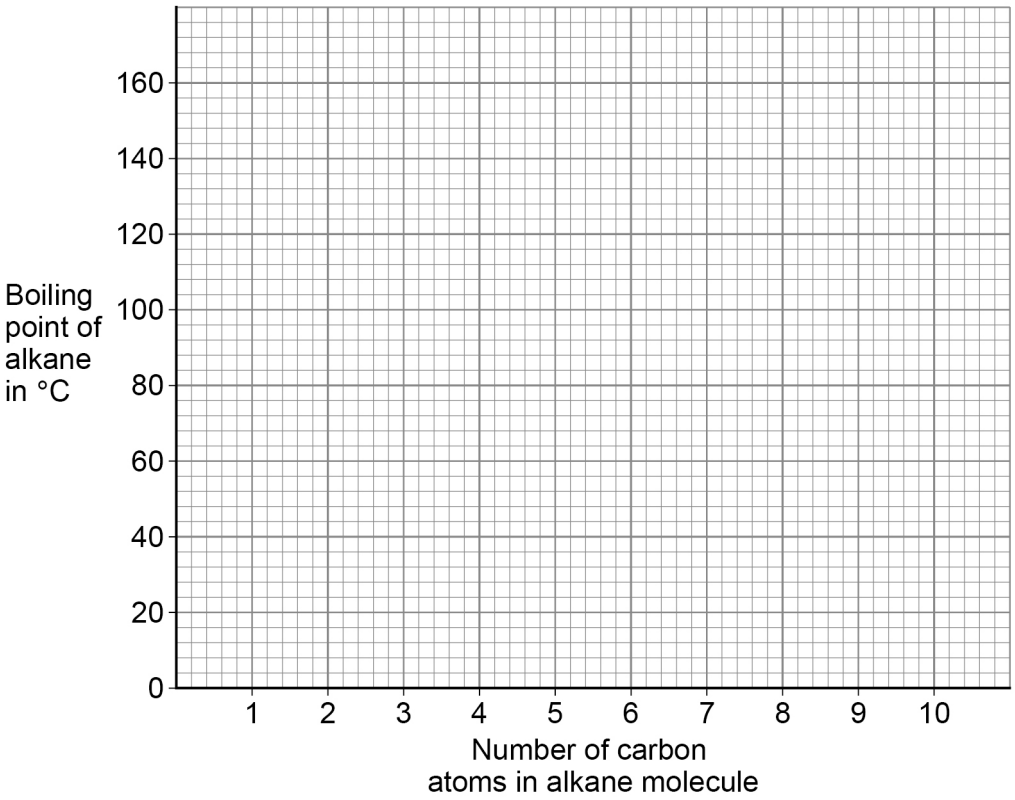
Table 1

Number of carbon atoms in alkane molecule	Boiling point of alkane in °C
4	0
5	36
6	69
7	**X**
8	126
9	151

0 2 . 1 Plot the data from **Table 1** on **Figure 2**.

[2 marks]

Figure 2



4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 117 · continued

0 2 . 2 Predict the boiling point **X** of the alkane with seven carbon atoms in a molecule.

Use **Table 1** and **Figure 2**.

[1 mark]

X = _____ °C

0 2 . 3 **Figure 2** is **not** suitable to show the boiling point of the alkane with three carbon atoms in a molecule.

Suggest **one** reason why.

[1 mark]

_____

_____

0 2 . 4 What is the state at 20 °C of the alkane with four carbon atoms in a molecule?

Use **Table 1**.

[1 mark]

_____

Question 2 continues on the next page

Question 117 · continued

Table 1 is repeated below.

Table 1

Number of carbon atoms in alkane molecule	Boiling point of alkane in °C
4	0
5	36
6	69
7	**X**
8	126
9	151

The alkane with nine carbon atoms in a molecule is called nonane.

0 2 . 5 Complete the formula of nonane.

[1 mark]

C_9H____

0 2 . 6 Nonane will condense lower in a fractionating column during fractional distillation than the other alkanes in **Table 1**.

Explain why.

You should refer to the temperature gradient in the fractionating column.

[2 marks]

8

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 118

November 2021 | 8462/2H | Original Q6

0 6 This question is about cycloalkenes.

Cycloalkenes are ring-shaped hydrocarbon molecules containing a double carbon-carbon bond.

Cycloalkenes react in a similar way to alkenes.

0 6 . 1 Describe a test for the double carbon-carbon bond in cycloalkene molecules.

Give the result of the test.

[2 marks]

Test _____

_____

Result _____

_____

0 6 . 2 **Table 3** shows the name and formula of three cycloalkenes.

Table 3

Name	Formula
Cyclobutene	C_4H_6
Cyclopentene	C_5H_8
Cyclohexene	C_6H_{10}

Determine the general formula for cycloalkenes.

[1 mark]

_____

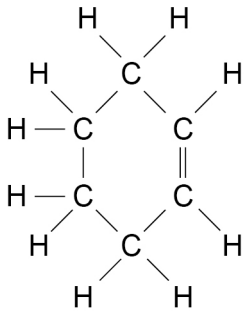
General formula = _____

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 118 · continued

Figure 6 shows the displayed structural formula of cyclohexene, C_6H_{10}

Figure 6

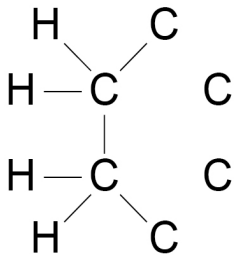


Chlorine reacts with cyclohexene to produce a compound with the formula $C_6H_{10}Cl_2$

0 6 . 3 Complete **Figure 7** to show the displayed structural formula of $C_6H_{10}Cl_2$

[2 marks]

Figure 7



0 6 . 4 Calculate the percentage by mass of chlorine in a molecule of $C_6H_{10}Cl_2$

Relative atomic masses (A_r): H = 1 C = 12 Cl = 35.5

[3 marks]

Percentage by mass = _____ %

8

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 119

November 2021 | 8462/2H | Original Q10

1 0 This question is about alkenes and alcohols.

Ethene is an alkene produced from large hydrocarbon molecules.

Large hydrocarbon molecules are obtained from crude oil by fractional distillation.

1 0 . 1 Name the process used to produce ethene from large hydrocarbon molecules.

[1 mark]

1 0 . 2 Describe the conditions used to produce ethene from large hydrocarbon molecules.

[2 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 119 · continued

10.3 Ethanol can be produced from ethene and steam.

The equation for the reaction is:

$$C_2H_4(g) + H_2O(g) \rightleftharpoons C_2H_5OH(g)$$

The forward reaction is exothermic.

Explain how the conditions for this reaction should be chosen to produce ethanol as economically as possible.

[6 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 119 · continued

10.4 Ethanol can also be produced from sugar solution by adding yeast.

Name this process.

[1 mark]

10.5 Butanol can be produced from sugar solution by adding bacteria.

Sugar solution is broken down in similar ways by bacteria and by yeast.

Suggest the reaction conditions needed to produce butanol from sugar solution by adding bacteria.

[2 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 119 · continued

Ethanol and butanol can be used as fuels for cars.

10.6 A car needs an average of 1.95 kJ of energy to travel 1 m

Ethanol has an energy content of 1300 kilojoules per mole (kJ/mol).

Calculate the number of moles of ethanol needed by the car to travel 200 km

[3 marks]

Number of moles = _____ mol

10.7 When butanol is burned in a car engine, complete combustion takes place.

Write a balanced equation for the complete combustion of butanol.

You do **not** need to include state symbols.

[2 marks]

17

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 120

June 2022 | 8462/2H | Original Q3

0 3 This question is about life cycle assessments (LCAs).

0 3 . 1 Milk bottles can be made from glass or from a polymer.

Table 2 shows information about milk bottles of equal volume.

Table 2

	Glass	Polymer
Raw materials	Limestone Sand Sodium carbonate	Crude oil
Energy needed to process raw materials in kilojoules	6750	1710
Energy needed to manufacture bottle in kilojoules	750	90
Mass of bottle in grams	200	20
Mean number of times used during lifetime of bottle	25	1
One disposal method at end of useful life	Recycled to make different glass products	Recycled to make different polymer products

Evaluate the use of glass for milk bottles compared with the use of a polymer for milk bottles.

Use features of life cycle assessments (LCAs) in your answer.

Use **Table 2**.

[6 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 120 · continued

0 3 . 2 Milk is also sold in cardboard cartons.

A carton is made using 40 cm^3 of cardboard.

The density of the cardboard is 0.40 g/cm^3.

Calculate the mass of the carton.

Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

[3 marks]

Mass = _____ g

9

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 121

June 2022 | 8462/2H | Original Q4

0 4 This question is about the fractions obtained from crude oil.

0 4 . 1 Crude oil is separated into fractions by fractional distillation.

The fractions obtained from crude oil include:

- lubricating oil
- naphtha
- petroleum gases.

Table 3 shows the boiling point range of these fractions.

Table 3

Fraction	Boiling point range in °C
Lubricating oil	300–350
Naphtha	90–200
Petroleum gases	< 25

Explain how these fractions are obtained from crude oil by fractional distillation.

[4 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 121 · continued

0 4 . 2 Fractions from crude oil can be processed to produce feedstock for the petrochemical industry.

Which **two** are useful materials produced from this feedstock?

[2 marks]

Tick (✓) **two** boxes.

- Alloys ☐
- Ceramics ☐
- Detergents ☐
- Fertilisers ☐
- Solvents ☐

Another fraction obtained from crude oil is petrol.

0 4 . 3 Petrol contains a hydrocarbon with the formula C_9H_{20}

Complete the equation for the complete combustion of C_9H_{20}

You should balance the equation.

[2 marks]

C_9H_{20} + _____ → _____ + _____

0 4 . 4 Petrol obtained from crude oil contains sulfur impurities.

Explain why sulfur impurities are removed before petrol is burned in car engines.

[2 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 121 · continued

0 4 . 5 **Table 4** shows information about two more fractions obtained from crude oil.

Table 4

Fraction	Range of number of carbon atoms in each molecule
Kerosene	11–15
Heavy fuel oil	20–40

A student predicted that heavy fuel oil is more viscous than kerosene.

The student's prediction was correct.

Justify the student's prediction.

[2 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 121 · continued

The heavy fuel oil fraction can be processed to produce smaller hydrocarbon molecules.

0 4 . 6 Name the process which produces smaller hydrocarbon molecules from heavy fuel oil.

Give the conditions used in this process.

[3 marks]

Name of process _____

Conditions _____

_____

_____

0 4 . 7 Hydrocarbon molecules containing seven and eight carbon atoms can be produced when heavy fuel oil is processed.

Which pair of hydrocarbon molecules would **both** turn bromine water colourless?

[1 mark]

Tick (✓) **one** box.

C_7H_{14} and C_8H_{16} ☐

C_7H_{14} and C_8H_{18} ☐

C_7H_{16} and C_8H_{16} ☐

C_7H_{16} and C_8H_{18} ☐

16

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 122

June 2024 | 8462/2H | Original Q5

0 5 This question is about burning fuels in central heating boilers.

In the future, gas central heating boilers may burn hydrogen rather than natural gas.

Table 2 shows information about these fuels when 1 dm^3 of the fuel is burned in a central heating boiler.

Table 2

	Fuel	
	Hydrogen	**Natural gas**
Energy released in kJ	11.9	37.1
Mass of carbon dioxide produced in grams	0.00	1.83
Mass of water vapour produced in grams	0.75	1.50
Mass of oxides of nitrogen produced in grams	6.6×10^{-4}	4.9×10^{-4}

0 5 . 1 Explain how oxides of nitrogen are produced when burning fuels.

[2 marks]

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 122 · continued

0 5 . 2 Explain **one** positive impact on the environment of burning hydrogen rather than natural gas as a fuel.

Use **Table 2**.

[2 marks]

0 5 . 3 Explain **one** negative impact on the environment of burning hydrogen rather than natural gas as a fuel.

Use **Table 2**.

[2 marks]

Question 5 continues on the next page

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 122 · continued

0 5 . 4 Air is 20% oxygen.

Calculate the volume of air needed to provide enough oxygen to react with 3.50 dm^3 of hydrogen gas.

The equation for the reaction is

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

[3 marks]

Volume of air = _____ dm^3

0 5 . 5 Central heating boilers can also burn kerosene.

Kerosene is produced from crude oil in a fractionating column using fractional distillation.

In the first step, crude oil is heated and hydrocarbon vapours are formed.

Explain how kerosene is produced from these hydrocarbon vapours.

[3 marks]

12

4.7.1.1 Crude oil, hydrocarbons and alkanes

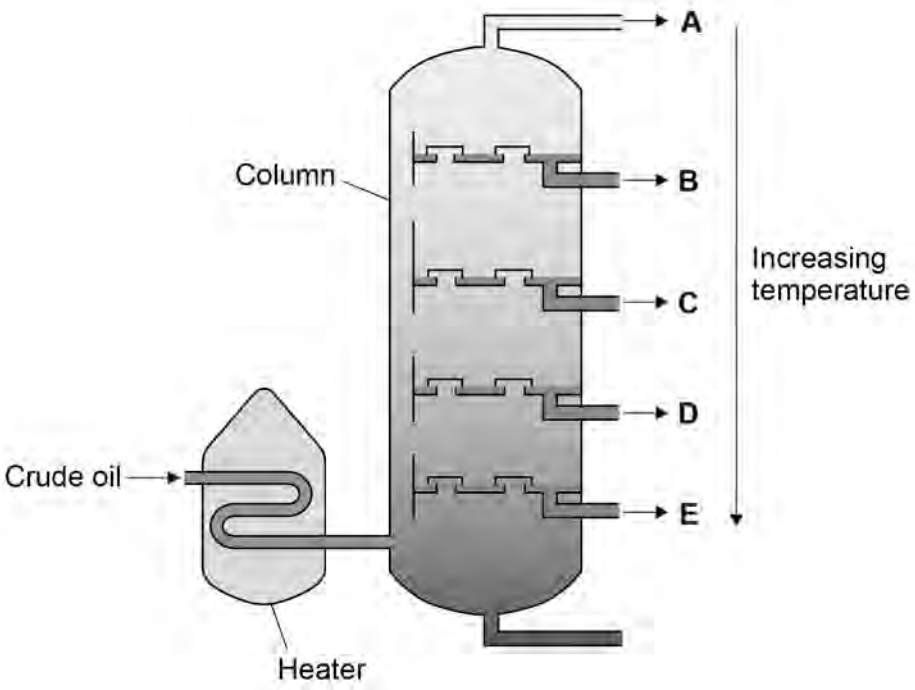
Question 123

June 2025 | 8462/2H | Original Q2

0 2 This question is about hydrocarbon fuels.

Figure 1 represents the process used to separate hydrocarbon fuels from crude oil.

Figure 1



0 2 . 1 Name the process represented by **Figure 1**.

[1 mark]

_____

0 2 . 2 Changes of state take place during the process in **Figure 1**.

Name the change of state taking place in:

- the heater
- the column.

[2 marks]

Heater _____

Column _____

Question 123 · continued

Different fuels are obtained from crude oil at the points on **Figure 1** labelled **A** to **E**.

Table 2 shows the boiling point ranges of different fuels obtained from the process in **Figure 1**.

Table 2

Fuel	Boiling point range in °C
Diesel oil	260 – 320
Heavy fuel oil	320 – 400
Kerosene	180 – 260
Petrol	40 – 110
Petroleum gases	Below 30

0 2 . 3 Which fuel is obtained at **B** in the column?

Use **Figure 1** and **Table 2**.

[1 mark]

0 2 . 4 Fuels with higher boiling point ranges contain larger molecules.

What is the order of increasing flammability of the fuels?

Use **Table 2**.

[1 mark]

Tick (✓) **one** box.

Heavy fuel oil ⟶ diesel oil ⟶ kerosene ☐

Heavy fuel oil ⟶ kerosene ⟶ diesel oil ☐

Kerosene ⟶ diesel oil ⟶ heavy fuel oil ☐

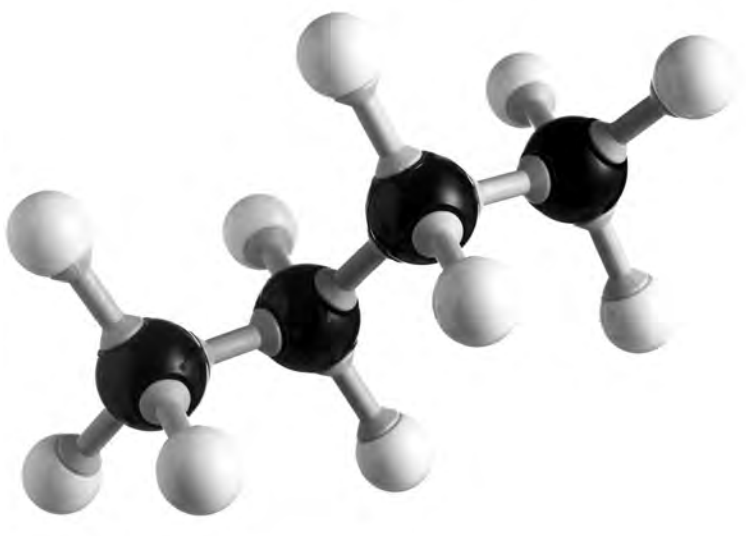
Kerosene ⟶ heavy fuel oil ⟶ diesel oil ☐

Question 123 · continued

Liquified petroleum gases are a mixture of several different hydrocarbons.

Figure 2 shows a model of one of these hydrocarbons.

Figure 2



0 2 . 5 Write the molecular formula of the hydrocarbon represented by the model in **Figure 2**.

[1 mark]

0 2 . 6 Name the hydrocarbon represented by the model in **Figure 2**.

[1 mark]

0 2 . 7 Petroleum gases also contain a hydrocarbon with the formula C_3H_8

Balance the equation for the complete combustion of C_3H_8

[2 marks]

$$C_3H_8 + 5\ O_2 \rightarrow ___\ CO_2 + ___\ H_2O$$

9

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 124

June 2025 | 8462/2H | Original Q5

0 5 This question is about unsaturated hydrocarbons.

0 5 . 1 **Table 6** shows the boiling points of some unsaturated hydrocarbons.

Table 6

Formula of unsaturated hydrocarbon	Boiling point in °C
C_2H_4	– 104
C_3H_6	– 47
C_4H_8	**X**
C_5H_{10}	30
C_6H_{12}	63

Estimate the boiling point **X** in **Table 6**.

[1 mark]

_____ °C

0 5 . 2 C_2H_4 reacts with water vapour (steam).

Name the compound produced when C_2H_4 reacts with water vapour.

[1 mark]

_____

Question 5 continues on the next page

Question 124 · continued June 2025 | 8462/2H | Original Q5

C_4H_8 reacts with chlorine (Cl_2).

0 5 . 3 Describe the test for chlorine.

Give the result of the test.

[2 marks]

Test _____

_____

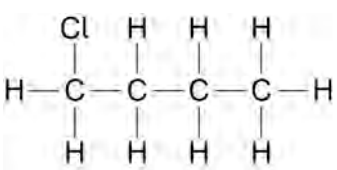
Result _____

_____

0 5 . 4 Which is the displayed formula of the organic compound produced when C_4H_8 reacts with chlorine?

[1 mark]

Tick (✓) **one** box.



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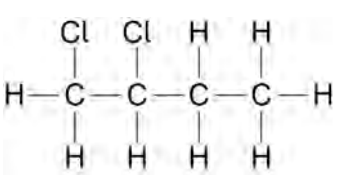

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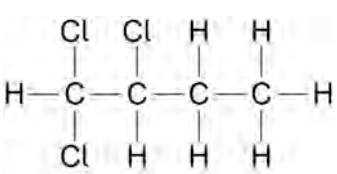

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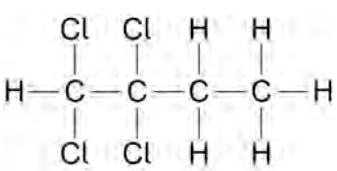

☐

4.7.1.1 Crude oil, hydrocarbons and alkanes

Question 124 · continued

0 5 . 5 Name the unsaturated hydrocarbon with the formula C_3H_6

[1 mark]

0 5 . 6 Why does C_3H_6 tend to burn in air with a smoky flame?

[1 mark]

0 5 . 7 C_3H_6 is a gas at room temperature and pressure.

Calculate the volume of 2.1 g of C_3H_6 at room temperature and pressure.

Give your answer in cm^3.

The volume of one mole of any gas at room temperature and pressure is 24 dm^3.

Relative atomic masses (A_r): H = 1 C = 12

[5 marks]

Volume = _____ cm^3

12