AQA GCSE Chemistry | 8462

SPECIFICATION POINT 4.7.1.3

Properties of hydrocarbons

Past-paper questions

Tier	**Higher**
Question groups	**63**
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.

4.7.1.3 Properties of hydrocarbons

Question 01

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

4.7.1.3 Properties of hydrocarbons

Question 01 · 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.

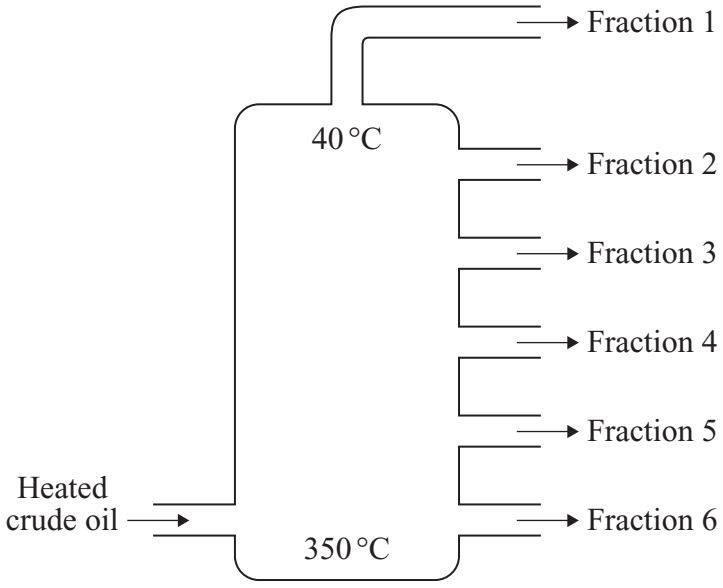
4.7.1.3 Properties of hydrocarbons

Question 02

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.

4.7.1.3 Properties of hydrocarbons

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

4.7.1.3 Properties of hydrocarbons

Question 03

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.

4.7.1.3 Properties of hydrocarbons

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

4.7.1.3 Properties of hydrocarbons

Question 04

June 2007 | CHY1B | Original Q7 | Legacy

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

4.7.1.3 Properties of hydrocarbons

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

4.7.1.3 Properties of hydrocarbons

Question 05

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)

4.7.1.3 Properties of hydrocarbons

Question 05 · continued

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(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

4.7.1.3 Properties of hydrocarbons

Question 06

November 2007 | CHY1A | Original Q5 | Legacy

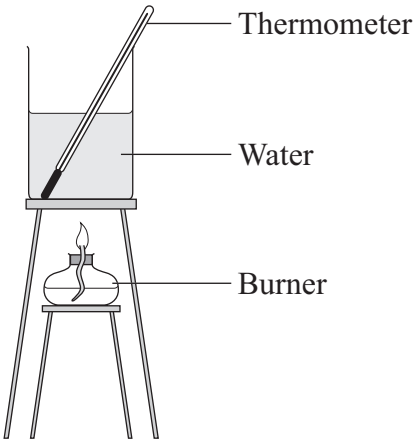
QUESTION FIVE

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			

4.7.1.3 Properties of hydrocarbons

Question 06 · 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.

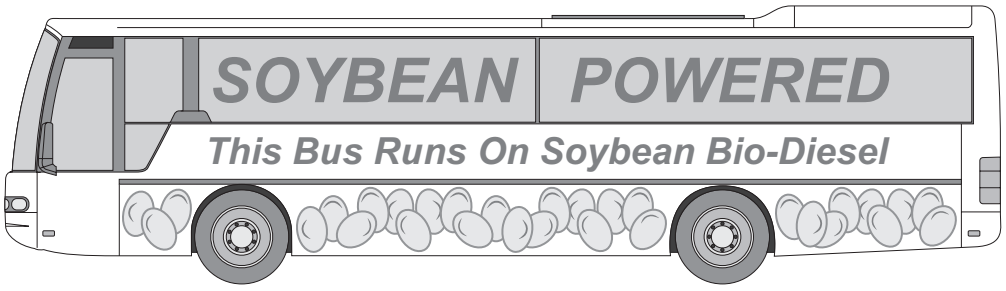
4.7.1.3 Properties of hydrocarbons

Question 07

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.

4.7.1.3 Properties of hydrocarbons

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.

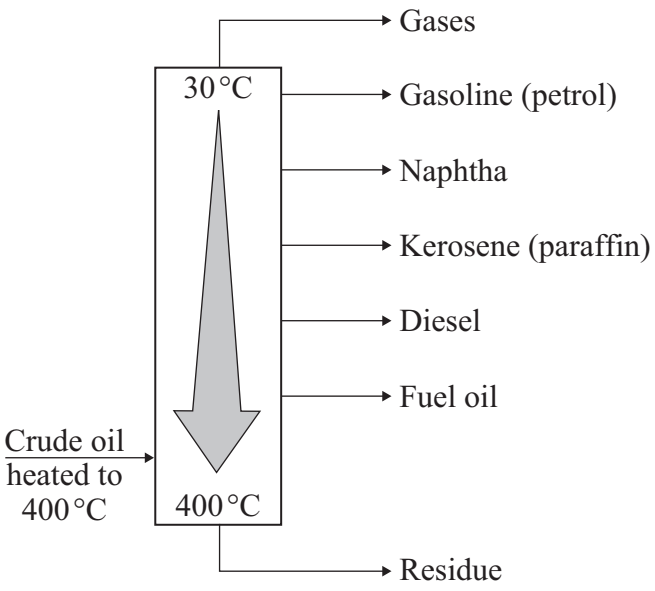
END OF TEST

4.7.1.3 Properties of hydrocarbons

Question 08

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.

.....

.....

.....

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(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)

4.7.1.3 Properties of hydrocarbons

Question 08 · continued

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(ii) Describe how cracking is carried out.

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.....

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(2 marks)

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

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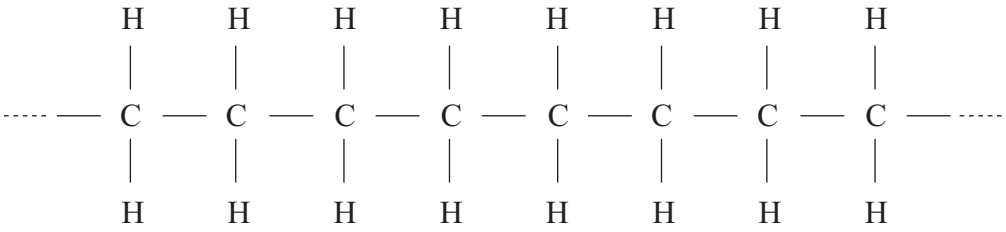
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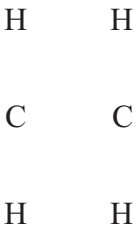
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(2 marks)

(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

4.7.1.3 Properties of hydrocarbons

Question 08 · 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.

4.7.1.3 Properties of hydrocarbons

Question 08 · 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)

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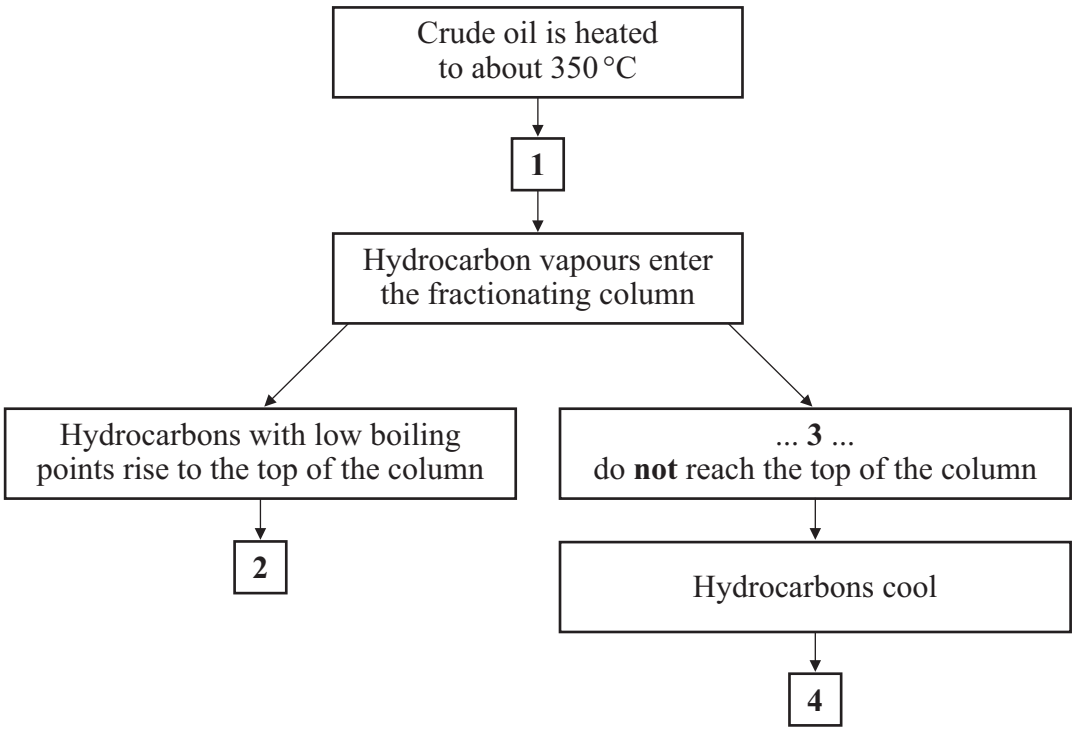
4.7.1.3 Properties of hydrocarbons

Question 09

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

4.7.1.3 Properties of hydrocarbons

Question 10

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.

4.7.1.3 Properties of hydrocarbons

Question 10 · 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.

4.7.1.3 Properties of hydrocarbons

Question 11

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

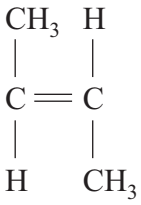
4 $C_nH_{2n} + 3nO_2 \rightarrow nCO_2 + 2nH_2O$

4.7.1.3 Properties of hydrocarbons

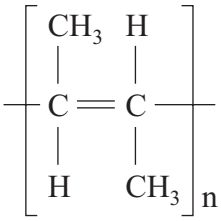
Question 11 · continued

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

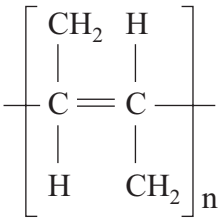
Which polymer would be produced from this alkene?



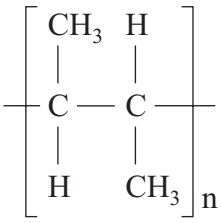
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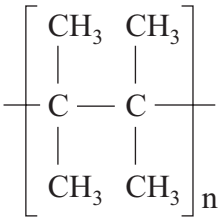
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4



END OF TEST

4.7.1.3 Properties of hydrocarbons

Question 12

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.

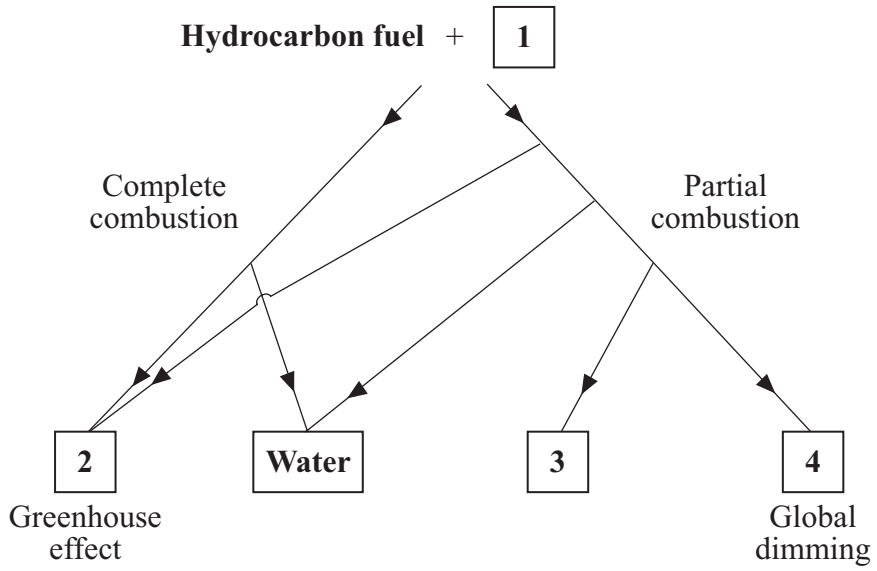
Match substances, **A**, **B**, **C** and **D**, with the numbers **1–4** in the flow chart.

A carbon monoxide

B carbon particles

C oxygen

D carbon dioxide



4.7.1.3 Properties of hydrocarbons

Question 13

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.

4.7.1.3 Properties of hydrocarbons

Question 13 · 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

4.7.1.3 Properties of hydrocarbons

Question 14

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** . . . .

4.7.1.3 Properties of hydrocarbons

Question 15

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

4.7.1.3 Properties of hydrocarbons

Question 16

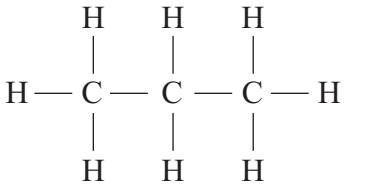
November 2008 | CHY1AP | Original Q1 | Legacy

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** . . . .

4.7.1.3 Properties of hydrocarbons

Question 17

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**.

4.7.1.3 Properties of hydrocarbons

Question 17 · 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.

4.7.1.3 Properties of hydrocarbons

Question 18

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

4.7.1.3 Properties of hydrocarbons

Question 19

November 2008 | CHY1BP | Original Q6 | Legacy

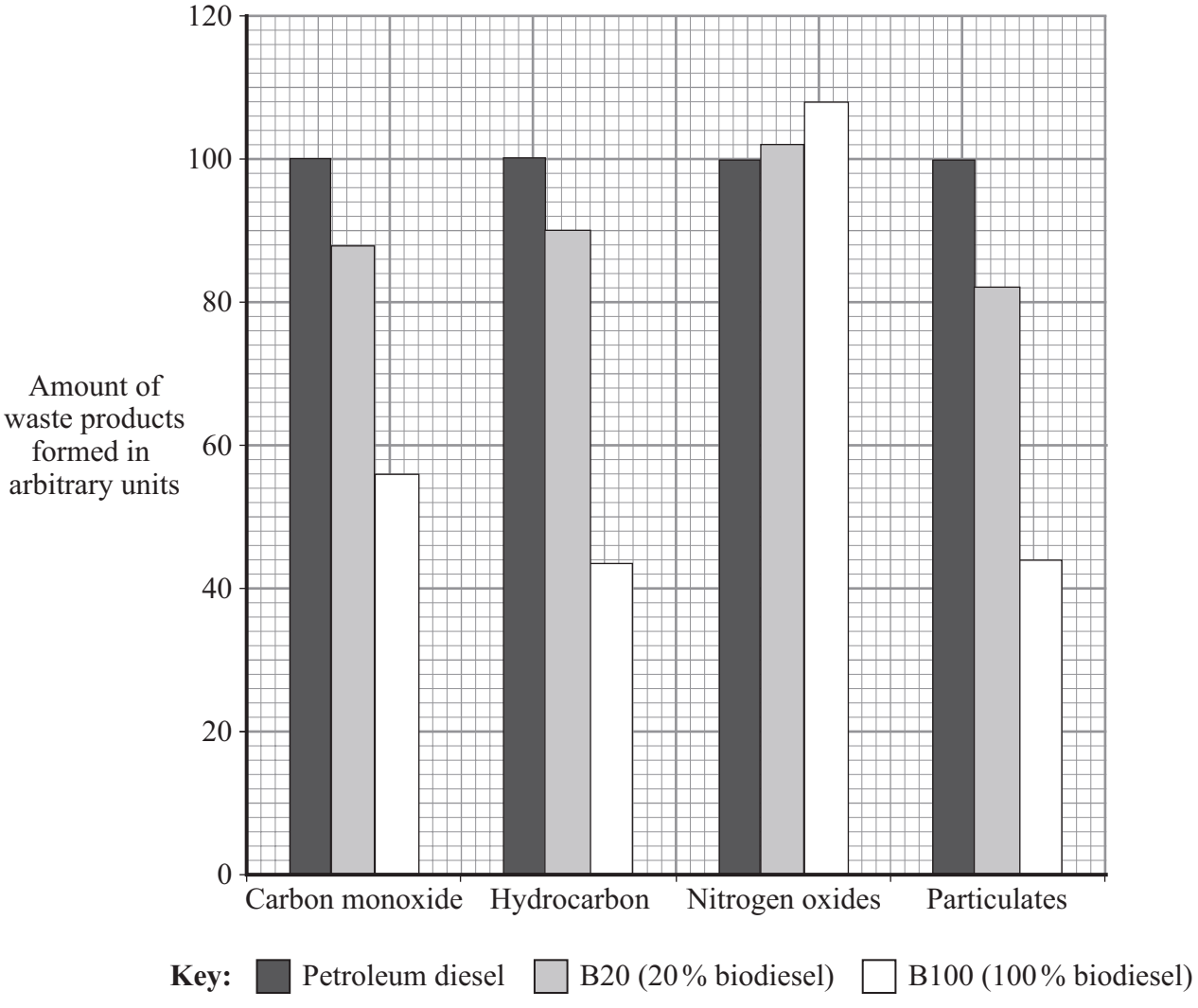
QUESTION SIX

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.



4.7.1.3 Properties of hydrocarbons

Question 19 · continued November 2008 | CHY1BP | Original Q6 | Legacy

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.

4.7.1.3 Properties of hydrocarbons

Question 20

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.

4.7.1.3 Properties of hydrocarbons

Question 21

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.

4.7.1.3 Properties of hydrocarbons

Question 21 · continued March 2009 | CHY1AP | Original Q8 | Legacy

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.

4.7.1.3 Properties of hydrocarbons

Question 22

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

4.7.1.3 Properties of hydrocarbons

Question 22 · 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

4.7.1.3 Properties of hydrocarbons

Question 23

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.

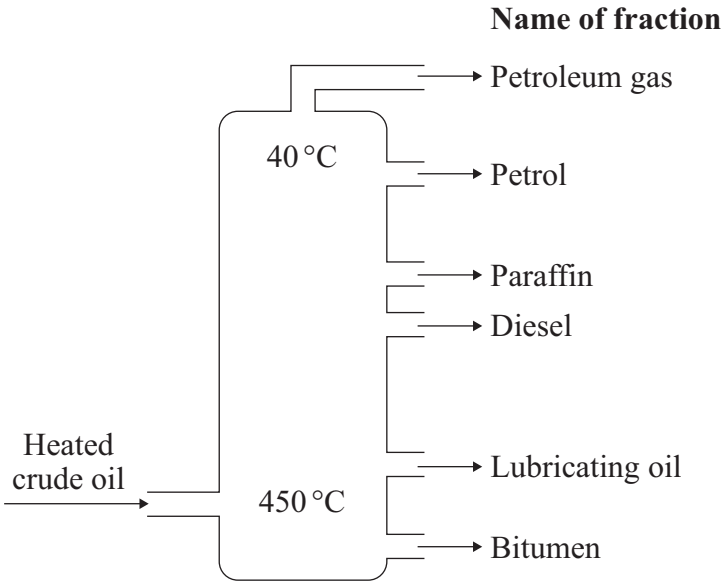
4.7.1.3 Properties of hydrocarbons

Question 24

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.

4.7.1.3 Properties of hydrocarbons

Question 24 · 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.

4.7.1.3 Properties of hydrocarbons

Question 25

November 2009 | CHY1AP | Original Q9 | Legacy

QUESTION NINE

Hydrogen is used as a fuel. Some of its properties are listed below.

K – There is a plentiful supply in water and natural gas.
L – On combustion, it forms water only.
M – It requires a lot of energy to make.
N – It is highly flammable.
P – Because of its very low density, large volumes are needed.
Q – It is difficult to liquefy because its boiling point is –253 °C.

9A Which pair of properties shows that hydrogen is a useful fuel?

1 **K** and **M**

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

3 **N** and **P**

4 **M** and **Q**

9B Which pair of properties might hold back the use of hydrogen as a fuel?

1 **M** and **P**

2 **K** and **Q**

3 **L** and **P**

4 **N** and **K**

9C Which of the following events would delay the development of hydrogen as a fuel?

1 the discovery of large deposits of crude oil

2 global warming becoming much worse

3 the cost of hydrogen manufacture decreasing

4 a safe way of storing hydrogen being discovered

9D The very rare and expensive metal palladium is capable of storing many hundreds of times its own volume of hydrogen.

Which statement would be true if palladium was used in hydrogen-powered cars?

1 The increased demand for palladium will cause its price to fall.

2 Hydrogen that has been stored in palladium will have a lower density.

3 Hydrogen that has been stored in palladium is hard to burn.

4 The cars would be safer than those that store hydrogen in pressurised cylinders.

END OF TEST

4.7.1.3 Properties of hydrocarbons

Question 26

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.

4.7.1.3 Properties of hydrocarbons

Question 27

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}

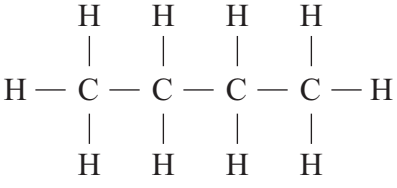
4 $C_{2n}H_{2n-2}$

The table shows information about four alkanes.

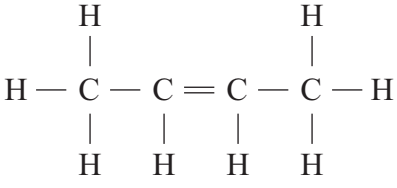
Alkane	Number of carbon atoms in each molecule
Methane	1
Butane	4
Octane	8
Dodecane	12

4B The structural formula for butane is . . .

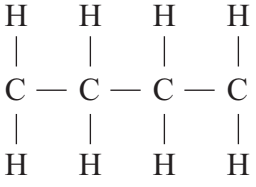
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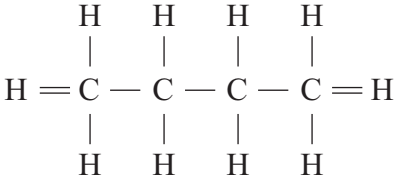
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3



4



4.7.1.3 Properties of hydrocarbons

Question 27 · 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

4.7.1.3 Properties of hydrocarbons

Question 28

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

4.7.1.3 Properties of hydrocarbons

Question 28 · continued

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

4.7.1.3 Properties of hydrocarbons

Question 29

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** . . . .

4.7.1.3 Properties of hydrocarbons

Question 30

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.

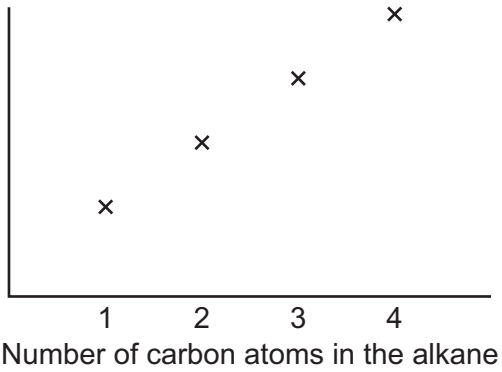
2 By cooling to –170 °C and then warming, it is possible to separate methane from petroleum gas.

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

4.7.1.3 Properties of hydrocarbons

Question 30 · 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

4.7.1.3 Properties of hydrocarbons

Question 31

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.

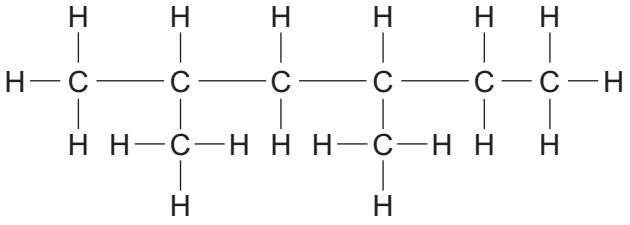
4 It is a continuous process that could go on for ever.

4.7.1.3 Properties of hydrocarbons

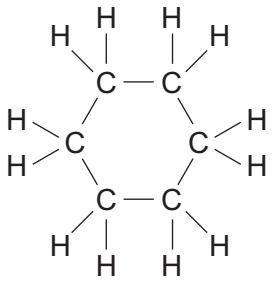
Question 31 · continued

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

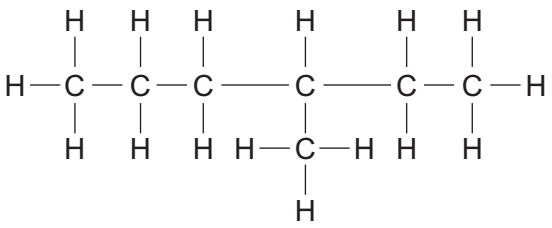
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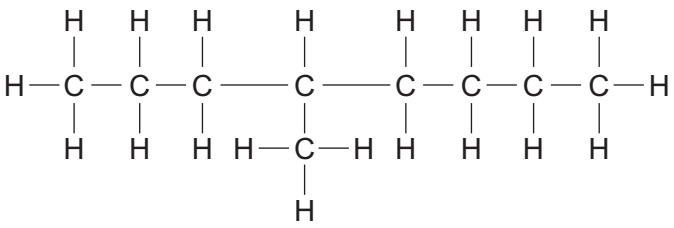
2



3



4



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

4.7.1.3 Properties of hydrocarbons

Question 32

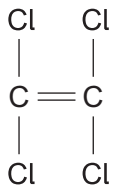
November 2010 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

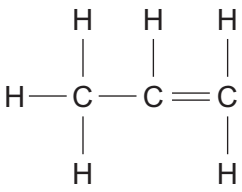
Plastic waste was taken to a recycling centre. At the recycling centre, the plastic was sorted and treated chemically. The chemical treatment broke down the plastic.

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

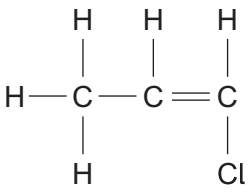
A



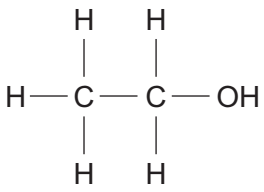
B



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.

4.7.1.3 Properties of hydrocarbons

Question 33

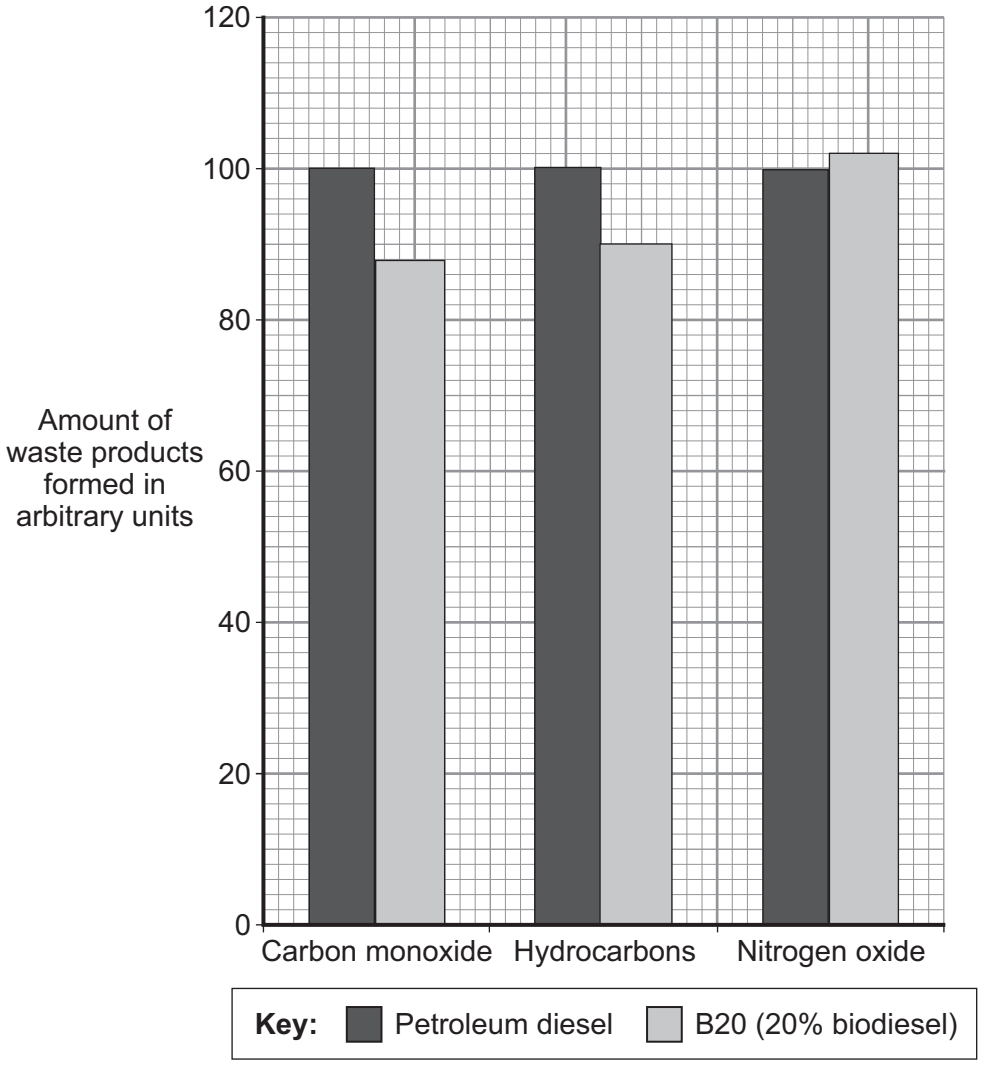
November 2010 | CHY1BP | Original Q6 | Legacy

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.

4.7.1.3 Properties of hydrocarbons

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.

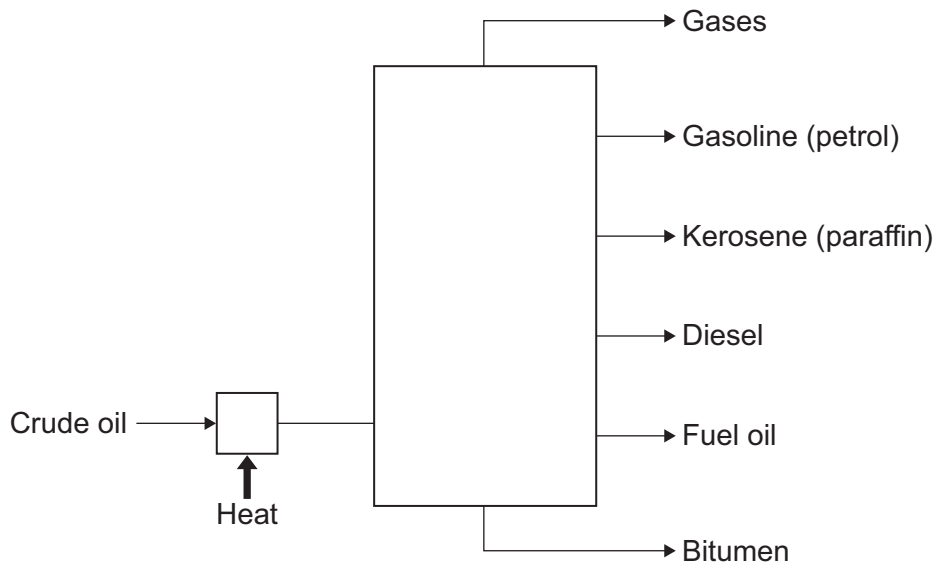
4 carbon dioxide dissolves in the oceans.

4.7.1.3 Properties of hydrocarbons

Question 34

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.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

4.7.1.3 Properties of hydrocarbons

Question 34 · 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).

.....

.....

.....

.....

(2 marks)

8

4.7.1.3 Properties of hydrocarbons

Question 35

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.

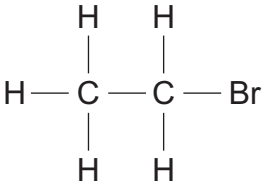
3 an increase in boiling point only.

4 an increase in density only.

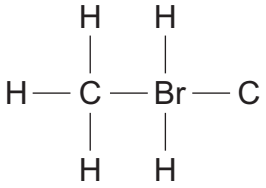
Question 35 · continued

9C Which is the correct structural formula for bromoethane?

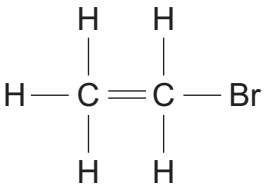
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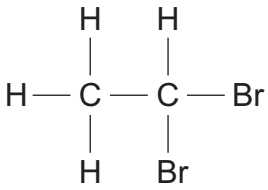
2



3



4



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

4.7.1.3 Properties of hydrocarbons

Question 36

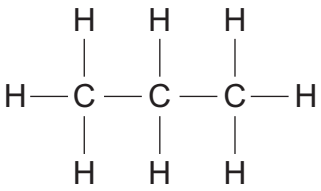
March 2011 | CHY1BP | Original Q1 | Legacy

QUESTION ONE

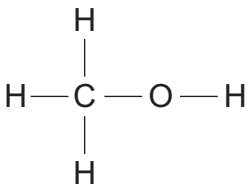
This question is about the formulae of four compounds.

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

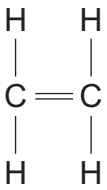
A



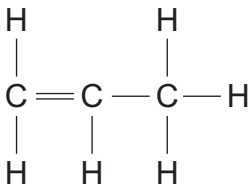
B



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.

4.7.1.3 Properties of hydrocarbons

Question 37

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.

4.7.1.3 Properties of hydrocarbons

Question 38 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.

4.7.1.3 Properties of hydrocarbons

Question 39

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

4.7.1.3 Properties of hydrocarbons

Question 39 · 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.

4.7.1.3 Properties of hydrocarbons

Question 40

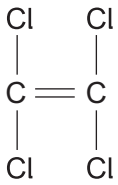
June 2011 | CHY1BP | Original Q2 | Legacy

QUESTION TWO

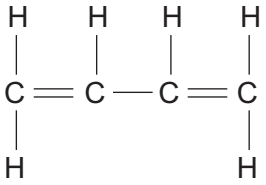
This question is about four carbon compounds.

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

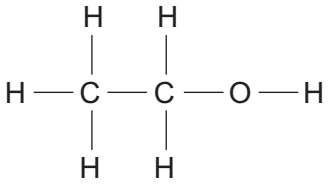
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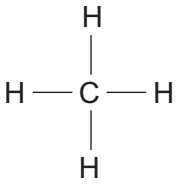
B



C



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}

4.7.1.3 Properties of hydrocarbons

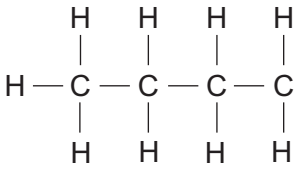
Question 41

June 2011 | CHY1H | Original Q5 | Legacy

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

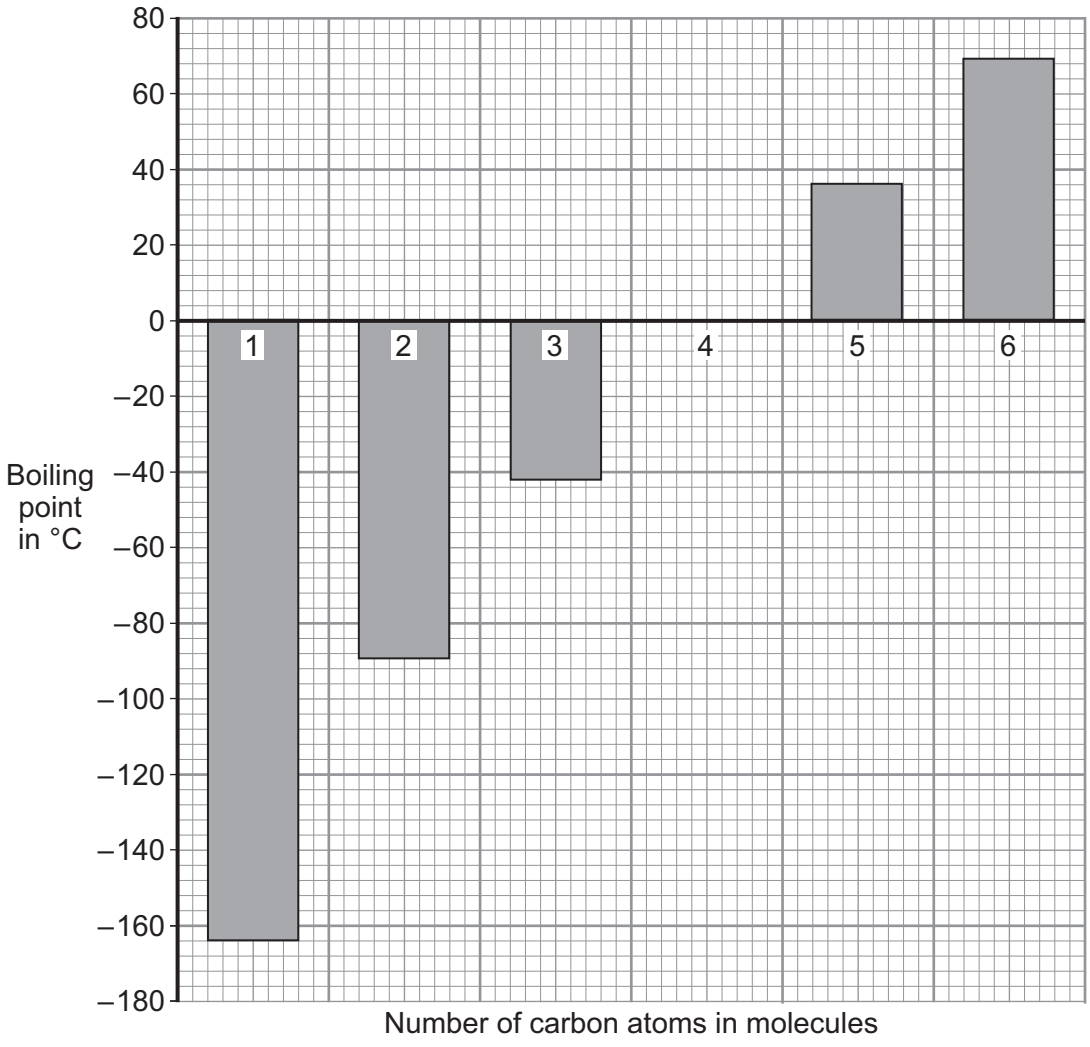
5 (a) The general formula of an alkane is C_nH_{2n+2}

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)

4.7.1.3 Properties of hydrocarbons

Question 41 · 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.

.....

.....

.....

.....

.....

.....

(2 marks)

8

4.7.1.3 Properties of hydrocarbons

Question 42

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

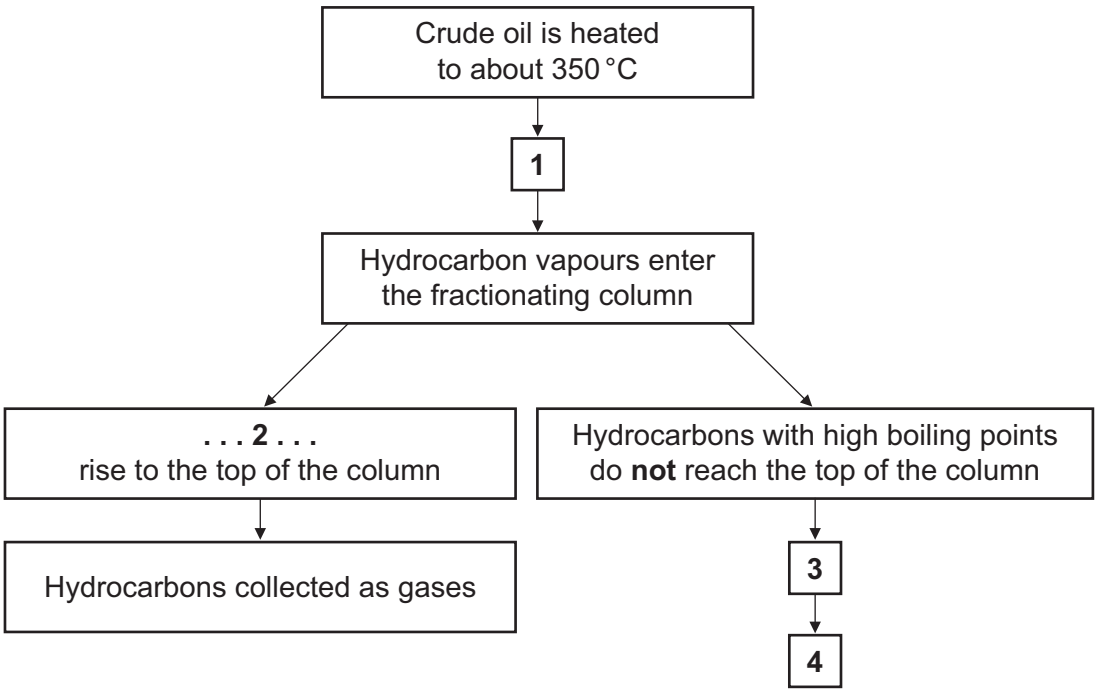
4.7.1.3 Properties of hydrocarbons

Question 43

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

4.7.1.3 Properties of hydrocarbons

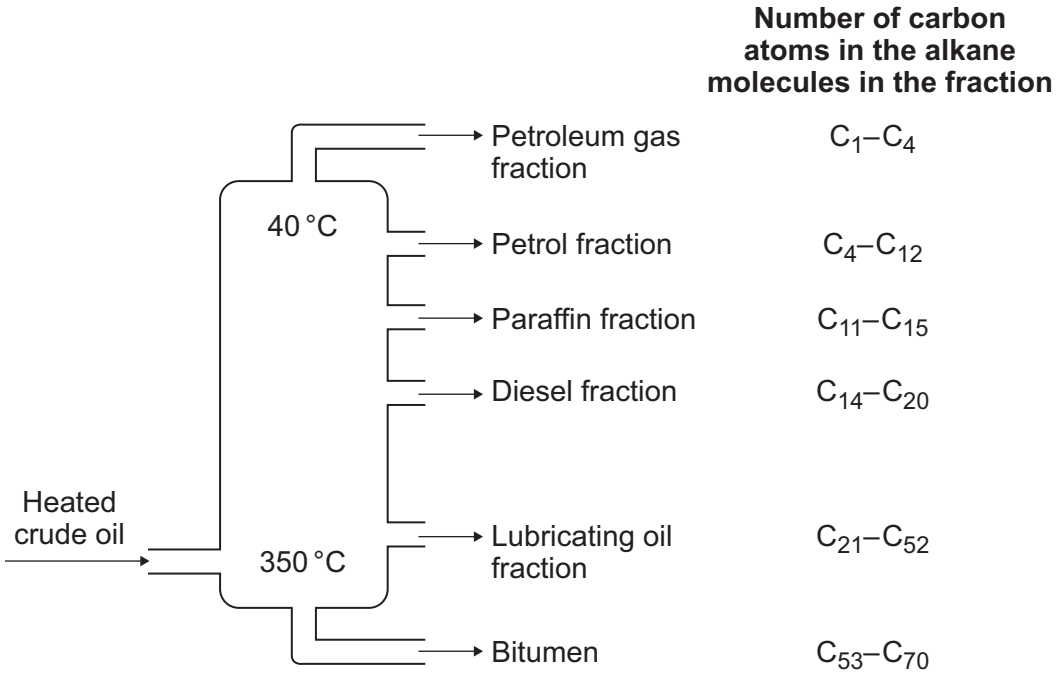
Question 44

November 2011 | CHY1AP | Original Q3 | Legacy

QUESTION THREE

Crude oil can be separated into fractions.

Each fraction contains several alkanes.

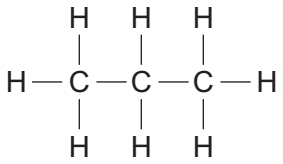


4.7.1.3 Properties of hydrocarbons

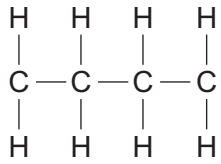
Question 44 · continued

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

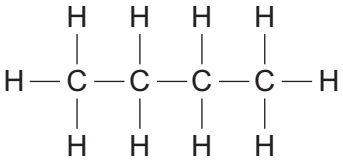
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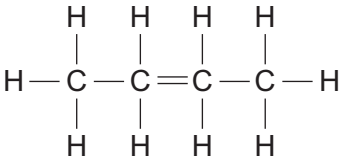
2



3



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

4.7.1.3 Properties of hydrocarbons

Question 45

November 2011 | CHY1AP | Original Q5 | Legacy

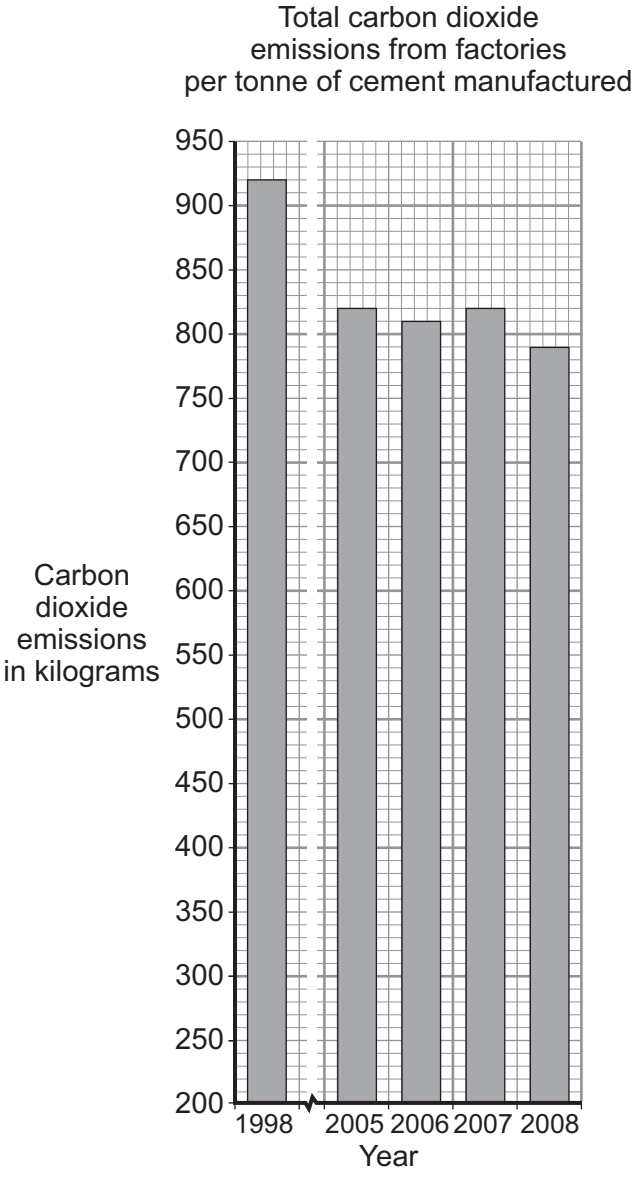
QUESTION FIVE

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.

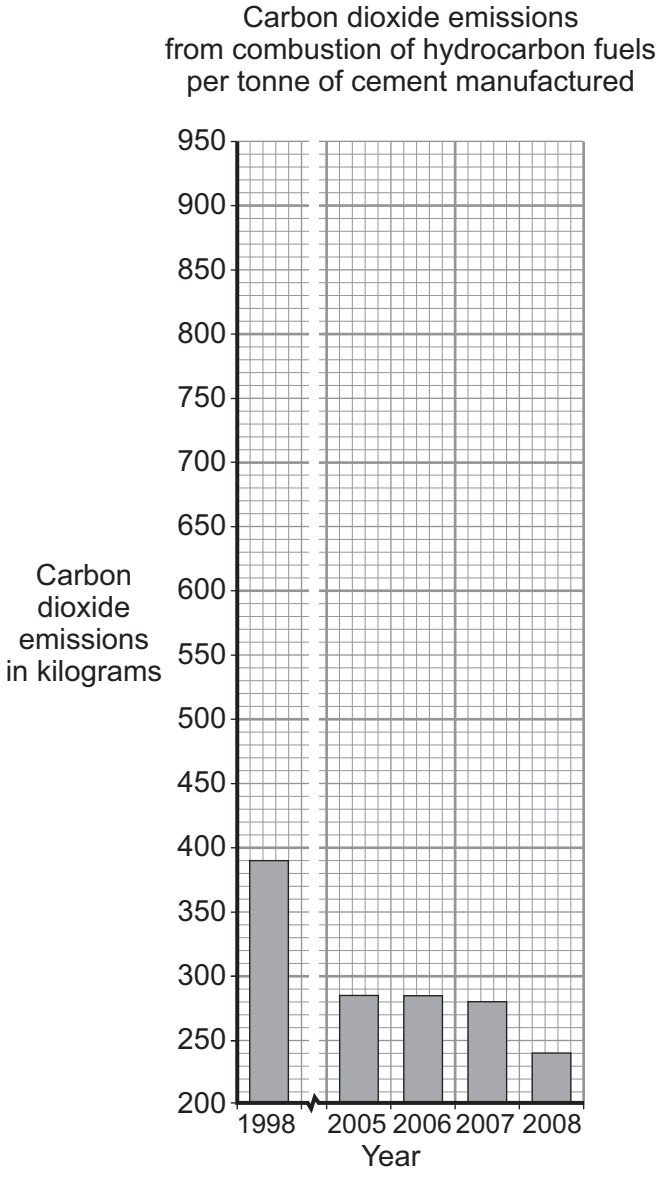
The cement industry needs to reduce carbon dioxide emissions.

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

Graph 1



Graph 2



4.7.1.3 Properties of hydrocarbons

Question 45 · 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.

4.7.1.3 Properties of hydrocarbons

Question 46

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

4.7.1.3 Properties of hydrocarbons

Question 46 · 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.

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(1 mark)

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

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(2 marks)

4.7.1.3 Properties of hydrocarbons

Question 46 · 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

4.7.1.3 Properties of hydrocarbons

Question 47

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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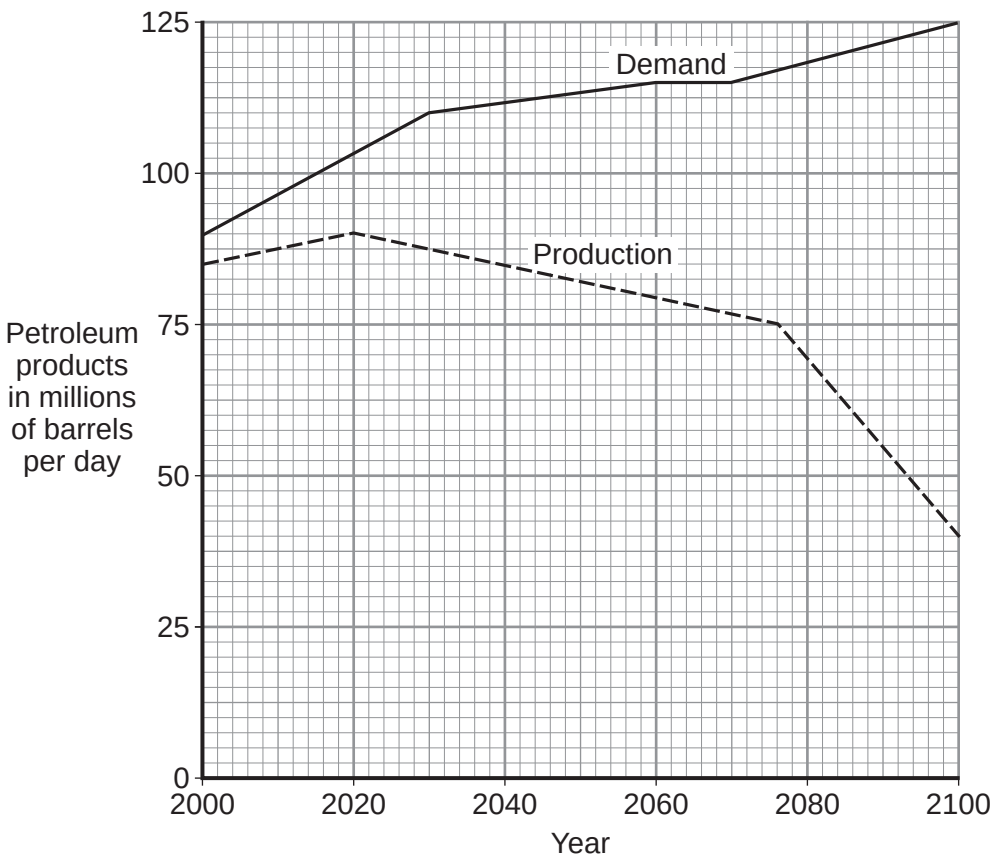
(2 marks)

Question 3 continues on the next page

Question 47 · 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.

4.7.1.3 Properties of hydrocarbons

Question 47 · 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)

11

4.7.1.3 Properties of hydrocarbons

Question 48

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)

4.7.1.3 Properties of hydrocarbons

Question 48 · 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

4.7.1.3 Properties of hydrocarbons

Question 49

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)

4.7.1.3 Properties of hydrocarbons

Question 49 · continued

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

4.7.1.3 Properties of hydrocarbons

Question 50

June 2014 | CH1HP | Original Q1 | Legacy

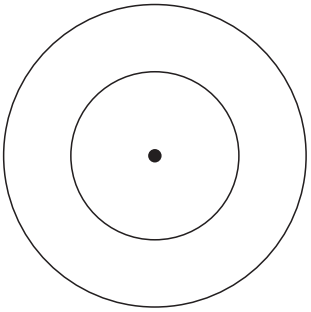
1 Fossil fuels contain carbon and hydrogen.

1 (a) (i) Use the Chemistry Data Sheet to help you to answer this question.

Complete **Figure 1** to show the electronic structure of a carbon atom.

[1 mark]

Figure 1



1 (a) (ii) Complete the word equation for the oxidation of hydrogen.

[1 mark]

hydrogen + oxygen ⟶ .....

1 (b) Coal is a fossil fuel.

Coal contains the elements hydrogen, sulfur, oxygen and carbon.

Name **two** products of burning coal that have an impact on the environment.

What impact does each of the products you named have on the environment?

[4 marks]

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6

4.7.1.3 Properties of hydrocarbons

Question 51

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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4.7.1.3 Properties of hydrocarbons

Question 51 · continued June 2015 | CH1HP | Original Q5 | Legacy

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]

$C_{10}H_{22} \longrightarrow C_5H_{10} + C_3H_8 +$ .....

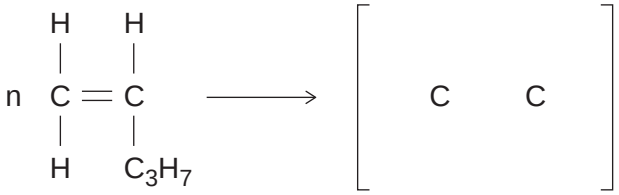
decane pentene propane

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]

.....

.....

12

4.7.1.3 Properties of hydrocarbons

Question 52

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]

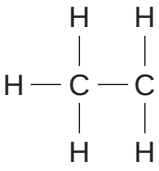
When alkenes react with bromine water the colour changes

from orange to _____ .

2 (a) (iii) Butane (C_4H_{10}) is an alkane.

Complete the displayed structure of butane.

[1 mark]



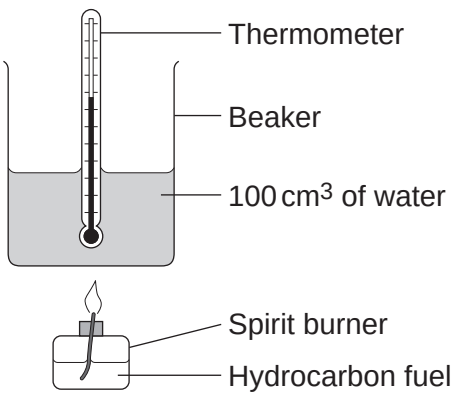
Question 2 continues on the next page

Question 52 · 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

4.7.1.3 Properties of hydrocarbons

Question 52 · 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

4.7.1.3 Properties of hydrocarbons

Question 52 · 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]

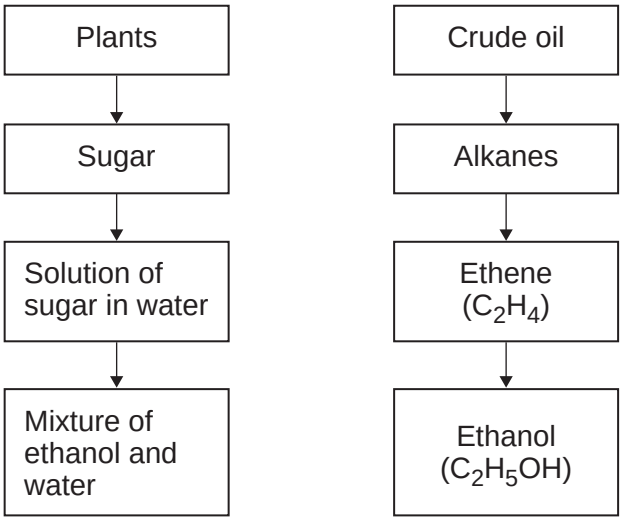
4.7.1.3 Properties of hydrocarbons

Question 53

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]

4.7.1.3 Properties of hydrocarbons

Question 53 · 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

4.7.1.3 Properties of hydrocarbons

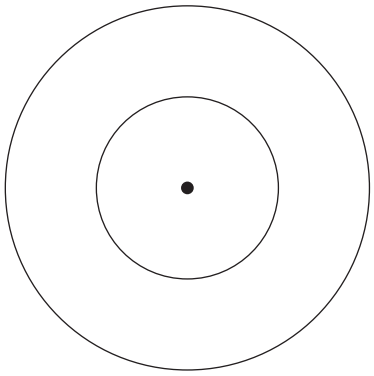
Question 54

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 _____

_____

_____

_____

_____

2 (b) Crude oil is a mixture of compounds. These compounds are mainly hydrocarbons.

What does the term hydrocarbon mean?

[1 mark]

_____

_____

Question 54 · 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

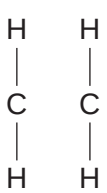
Alkenes

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]

4.7.1.3 Properties of hydrocarbons

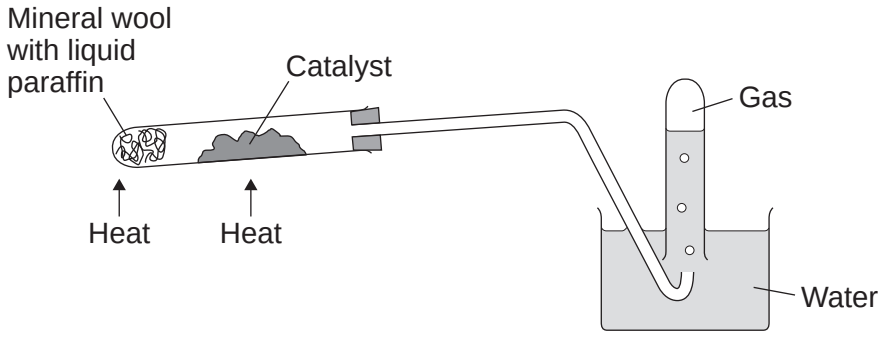
Question 54 · continued

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

4.7.1.3 Properties of hydrocarbons

Question 55

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

4.7.1.3 Properties of hydrocarbons

Question 55 · 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]

$$__\ NO_2\ (g) \rightarrow _____ + __\ O_2\ (g)$$

4.7.1.3 Properties of hydrocarbons

Question 55 · 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

4.7.1.3 Properties of hydrocarbons

Question 56

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

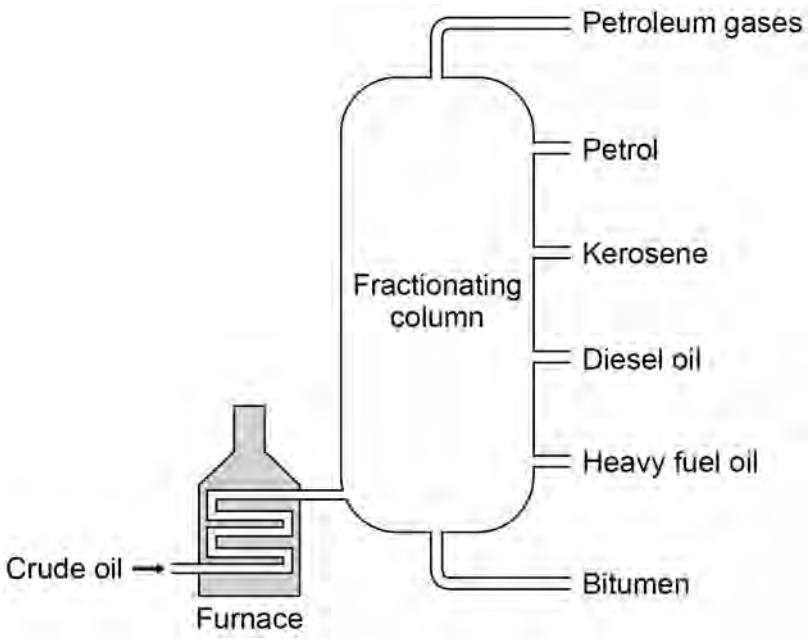


Table 1 gives information about some of the fractions.

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

4.7.1.3 Properties of hydrocarbons

Question 56 · 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

4.7.1.3 Properties of hydrocarbons

Question 56 · 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]

4.7.1.3 Properties of hydrocarbons

Question 56 · 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

4.7.1.3 Properties of hydrocarbons

Question 57

June 2019 | 8462/2H | Original Q5

0 5 This question is about combustion of fuels.

0 5 . 1 Some central heating boilers use wood as a fuel.

Suggest **two** reasons why wood is more sustainable than natural gas as a fuel for central heating boilers.

[2 marks]

1 _____

_____

2 _____

_____

Natural gas is mainly methane.

When methane burns it can produce both carbon monoxide and carbon dioxide.

0 5 . 2 Explain the process by which carbon monoxide can be produced when methane is burned.

[2 marks]

_____

_____

_____

_____

0 5 . 3 Balance the equation for the combustion of methane to produce carbon monoxide.

[1 mark]

$$___\ CH_4(g) + ___\ O_2(g) \rightarrow ___\ CO(g) + ___\ H_2O(l)$$

4.7.1.3 Properties of hydrocarbons

Question 57 · continued

0 5 . 4 Propane burns to form carbon dioxide and water.

The equation for the reaction is:

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$$

3.60 dm^3 carbon dioxide is produced when a sample of propane is burned in 7.25 dm^3 oxygen.

Calculate the volume of unreacted oxygen.

Give your answer in cm^3

[4 marks]

Volume of unreacted oxygen = _____ cm^3

9

4.7.1.3 Properties of hydrocarbons

Question 58

November 2021 | 8462/2H | Original Q2

0 2 This question is about alkanes.

Table 1 shows information about some alkanes.

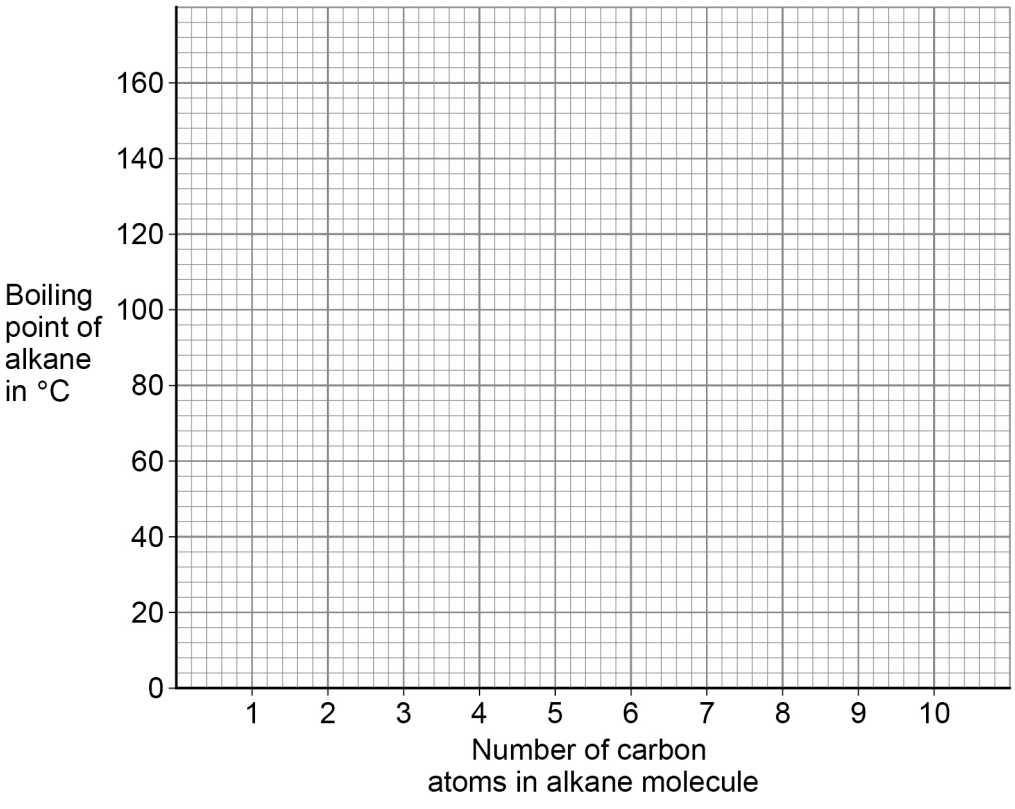
Table 1

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



4.7.1.3 Properties of hydrocarbons

Question 58 · 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

4.7.1.3 Properties of hydrocarbons

Question 58 · 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

4.7.1.3 Properties of hydrocarbons

Question 59

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]

4.7.1.3 Properties of hydrocarbons

Question 59 · continued

1 0 . 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]

4.7.1.3 Properties of hydrocarbons

Question 59 · 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]

4.7.1.3 Properties of hydrocarbons

Question 59 · 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

4.7.1.3 Properties of hydrocarbons

Question 60

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]

4.7.1.3 Properties of hydrocarbons

Question 60 · 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]

4.7.1.3 Properties of hydrocarbons

Question 60 · 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]

4.7.1.3 Properties of hydrocarbons

Question 60 · 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

4.7.1.3 Properties of hydrocarbons

Question 61

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]

4.7.1.3 Properties of hydrocarbons

Question 61 · 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

4.7.1.3 Properties of hydrocarbons

Question 61 · 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

4.7.1.3 Properties of hydrocarbons

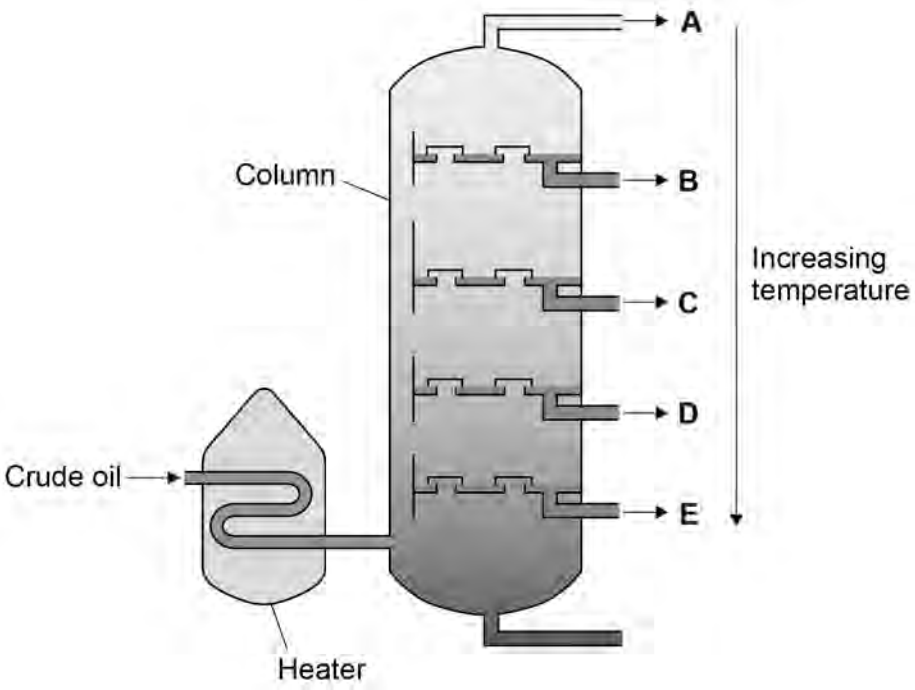
Question 62

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 62 · 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 ☐

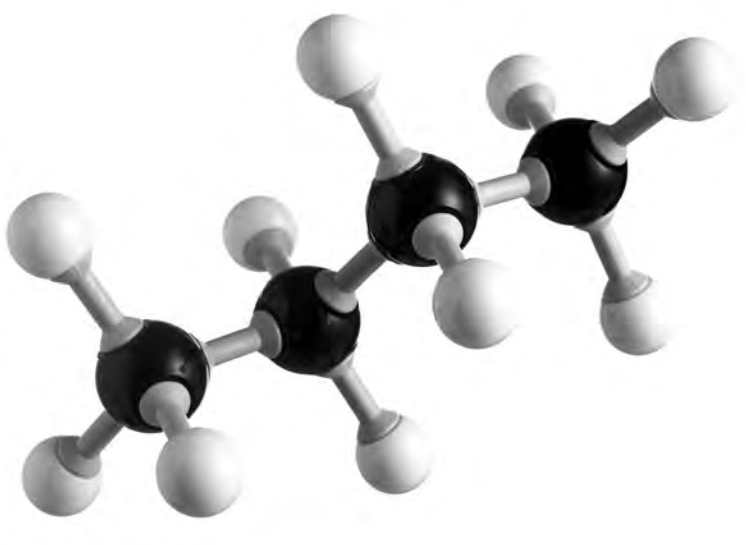
4.7.1.3 Properties of hydrocarbons

Question 62 · 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

4.7.1.3 Properties of hydrocarbons

Question 63

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

4.7.1.3 Properties of hydrocarbons

Question 63 · continued

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 _____

_____

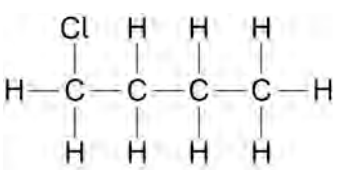
Result _____

_____

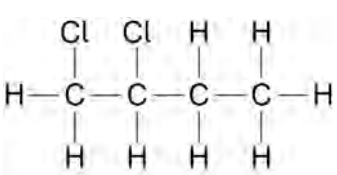
0 5 . 4 Which is the displayed formula of the organic compound produced when C_4H_8 reacts with chlorine?

[1 mark]

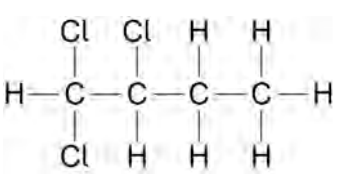
Tick (✓) **one** box.



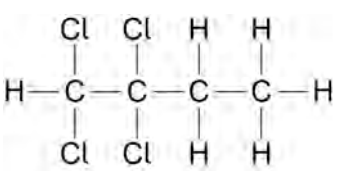
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4.7.1.3 Properties of hydrocarbons

Question 63 · 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