

1

This question is about hydrocarbons.

- (a) The names and formulae of three hydrocarbons in the same homologous series are:

Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}

The next member in the series is pentane.

What is the formula of pentane?

.....

(1)

- (b) Which homologous series contains ethane, propane and butane?

Tick **one** box.

Alcohols

☐

Alkanes

☐

Alkenes

☐

Carboxylic acids

☐

(1)

- (c) Propane (C_3H_8) is used as a fuel.

Complete the equation for the complete combustion of propane.



(2)

- (d) Octane (C_8H_{18}) is a hydrocarbon found in petrol.

Explain why octane is a hydrocarbon.

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(2)

- (e) The table below gives information about the pollutants produced by cars using diesel or petrol as a fuel.

Fuel	Relative amounts of pollutants		
	Oxides of Nitrogen	Particulate matter	Carbon dioxide
Diesel	31	100	85
Petrol	23	0	100

Compare the pollutants from cars using diesel with those from cars using petrol.

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(3)

- (f) Pollutants cause environmental impacts.

Draw **one** line from each pollutant to the environmental impact caused by the pollutant.

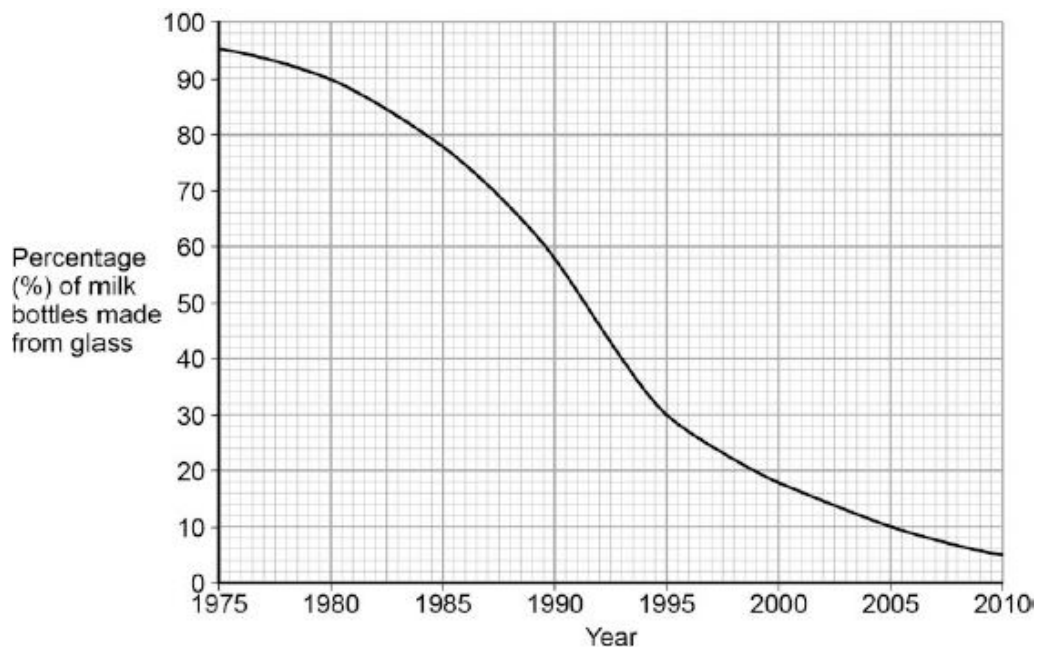
Pollutant	Environmental impact caused by the pollutant
	Acid rain
Oxides of nitrogen	Flooding
	Global dimming
Particulate matter	Global warming
	Photosynthesis

(2)
(Total 11 marks)

2

Plastic and glass can be used to make milk bottles.

The figure below shows the percentage of milk bottles made from glass between 1975 and 2010.



- (a) Plot the points and draw a line on the figure above to show the percentage of milk bottles made from materials **other** than glass between 1975 and 2010.

(3)

- (b) The table below gives information about milk bottles.

	Glass milk bottle	Plastic milk bottle
Raw materials	Sand, limestone, salt	Crude oil
Bottle material	Soda-lime glass	HD poly(ethene)
Initial stage in production of bottle material	Limestone and salt used to produce sodium carbonate.	Production of naphtha fraction.
Maximum temperature in production process	1600 °C	850 °C
Number of times bottle can be used for milk	25	1
Size(s) of bottle	0.5 dm ³	0.5 dm ³ , 1 dm ³ , 2 dm ³ , 3 dm ³
Percentage (%) of recycled material used in new bottles	50 %	10 %

Evaluate the production and use of bottles made from soda-lime glass and those made from HD poly(ethene).

Use the information given and your knowledge and understanding to justify your choice of material for milk bottles.

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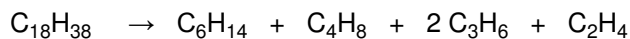
(6)
(Total 9 marks)

3

This question is about organic compounds.

Hydrocarbons can be cracked to produce smaller molecules.

The equation shows the reaction for a hydrocarbon, $C_{18}H_{38}$



(a) Which product of the reaction shown is an alkane?

Tick **one** box.

C_2H_4

☐

C_3H_6

☐

C_4H_8

☐

C_6H_{14}

☐

(1)

(b) The table below shows the boiling point, flammability and viscosity of $C_{18}H_{38}$ compared with the other hydrocarbons shown in the equation.

	Boiling point	Flammability	Viscosity
A	highest	lowest	highest
B	highest	lowest	lowest
C	lowest	highest	highest
D	lowest	highest	lowest

Which letter, **A**, **B**, **C** or **D**, shows how the properties of $C_{18}H_{38}$ compare with the properties of C_2H_4 , C_3H_6 , C_4H_8 and C_6H_{14} ?

Tick **one** box.

A

☐

B

☐

C

☐

D

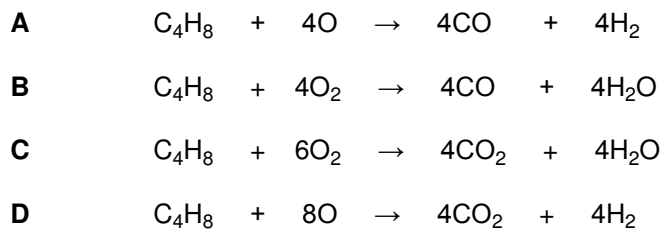
☐

(1)

- (c) The hydrocarbon C_4H_8 was burnt in air.

Incomplete combustion occurred.

Which equation, **A**, **B**, **C** or **D**, correctly represents the incomplete combustion reaction?



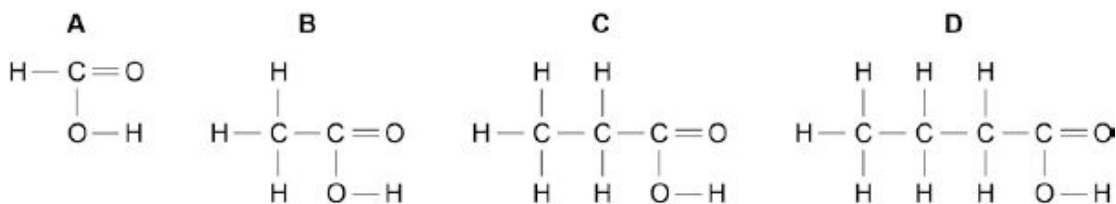
Tick **one** box.

A	<input type="checkbox"/>
B	<input type="checkbox"/>
C	<input type="checkbox"/>
D	<input type="checkbox"/>

(1)

- (d) Propanoic acid is a carboxylic acid.

Which structure, **A**, **B**, **C** or **D**, shows propanoic acid?



Tick **one** box.

A	<input type="checkbox"/>
B	<input type="checkbox"/>
C	<input type="checkbox"/>
D	<input type="checkbox"/>

(1)

(e) Propanoic acid is formed by the oxidation of which organic compound?

Tick **one** box.

Propane

☐

Propene

☐

Propanol

☐

Polyester

☐

(1)
(Total 5 marks)

4

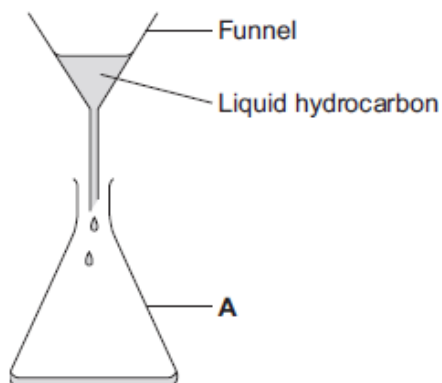
A student investigated the viscosity of liquid hydrocarbons.

A viscous liquid is a liquid that flows slowly.

The student used this method.

- Measure 50 cm³ of the liquid hydrocarbon.
- Pour the liquid hydrocarbon into the funnel, as shown in **Figure 1**.

Figure 1



- Time how long it takes for all of the liquid hydrocarbon to run out of the funnel.
- Repeat the experiment for other liquid hydrocarbons.

(a) (i) Give the name of apparatus **A** in **Figure 1**.

.....

(1)

(ii) Name the apparatus that could be used to measure 50 cm³ of liquid hydrocarbon.

.....

(1)

- (b) The student's results for six liquid hydrocarbons are shown in **Table 1**.

Table 1

Formula of liquid hydrocarbon	Time for liquid hydrocarbon to run out of the funnel in seconds			Mean time in seconds
	Experiment 1	Experiment 2	Experiment 3	
C_5H_{12}	12	11	13	12
C_6H_{14}	14	15	15	15
C_7H_{16}	19	20	18	
C_8H_{18}	27	26	28	27
$C_{10}H_{22}$	46	48	24	47
$C_{12}H_{26}$	65	67	69	67

- (i) The student did the experiment three times with each liquid hydrocarbon.

Give **two** reasons why.

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(2)

- (ii) Use the data in **Table 1** to calculate the mean time, in seconds, for C_7H_{16}

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Mean time = seconds

(1)

- (iii) Complete the sentence.

As the number of carbon atoms in a molecule of liquid hydrocarbon increases, the time taken for the liquid hydrocarbon to run out of the funnel

.....

(1)

- (iv) A ring has been drawn around one result in **Table 1**.

This result has **not** been used to calculate the mean time for $C_{10}H_{22}$

Suggest why this result was not used.

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(1)

- (v) Suggest **one** error the student may have made to get the ringed result.

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(1)

- (c) The student investigated the effect of temperature on the viscosity of one of the liquid hydrocarbons.

The liquid hydrocarbon he was using had the hazard symbols shown in **Figure 2**.

Figure 2



- (i) Suggest why the student warmed the liquid hydrocarbon using warm water and **not** a Bunsen flame.

.....

(1)

- (ii) The student wore safety glasses.

Give **one** other safety precaution the student should take, and give a reason for this safety precaution.

Safety precaution

Reason

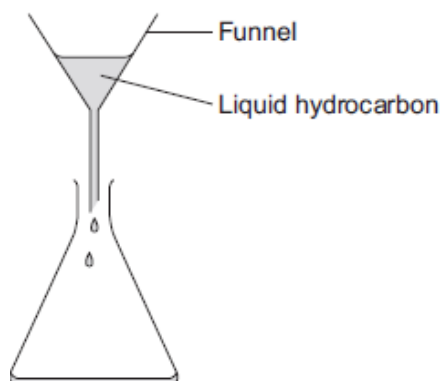
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(2)

- (d) This is the method the student used to investigate the effect of temperature on the viscosity of one of the liquid hydrocarbons.

- Measure 50 cm³ of the liquid hydrocarbon and pour it into a beaker.
- Stand the beaker of liquid hydrocarbon in a heated water bath.
- Leave for a few minutes.
- Measure the temperature of the liquid hydrocarbon.
- Pour the liquid hydrocarbon into the funnel, as shown in **Figure 3**.

Figure 3



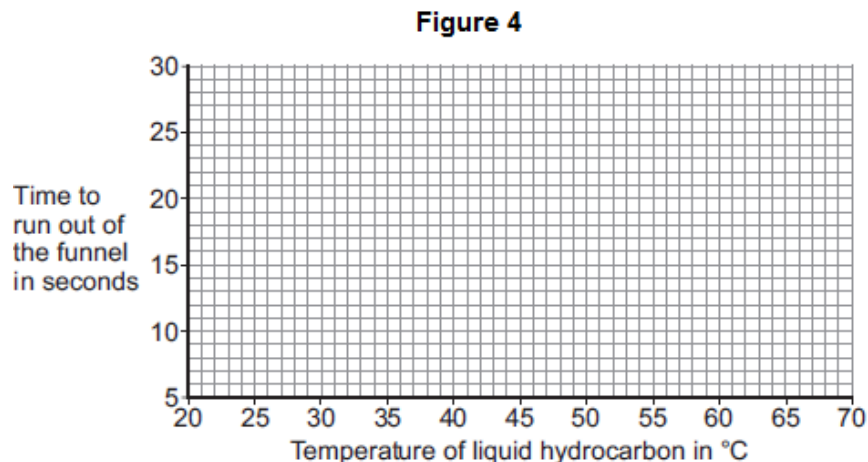
- Time how long it takes for all of the liquid hydrocarbon to run out of the funnel.
 - Repeat the experiment at different temperatures.
- (i) The student's results are shown in **Table 2**.

Table 2

Temperature of liquid hydrocarbon in °C	Time to run out of the funnel in seconds
23	27
30	21
37	17
46	16
55	11
65	9

Plot the results shown in **Table 2** on the graph in **Figure 4**.

Draw a curve of best fit.



(3)

- (ii) One of the points is anomalous.

Draw a ring around the anomalous point on your graph.

(1)

- (iii) Predict how long it will take the liquid hydrocarbon to run through the funnel at 70 °C.

Show your working on your graph.

Time = seconds

(2)

- (iv) Describe the relationship between the temperature of the liquid hydrocarbon and the viscosity of the liquid hydrocarbon.

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(3)

- (v) The apparatus the student used in **Figure 2** could lead to a systematic error in the results.

Identify **one** source of systematic error, and describe how the student could avoid or reduce the error.

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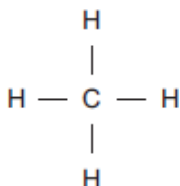
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(2)
(Total 22 marks)

5

Methane (CH_4) is used as a fuel.

(a) The displayed structure of methane is:



Draw a ring around a part of the displayed structure that represents a covalent bond.

(1)

(b) Why is methane a compound?

Tick (✓) **one** box.

Methane contains atoms of two elements, combined chemically.

☐

Methane is not in the periodic table.

☐

Methane is a mixture of two different elements.

☐

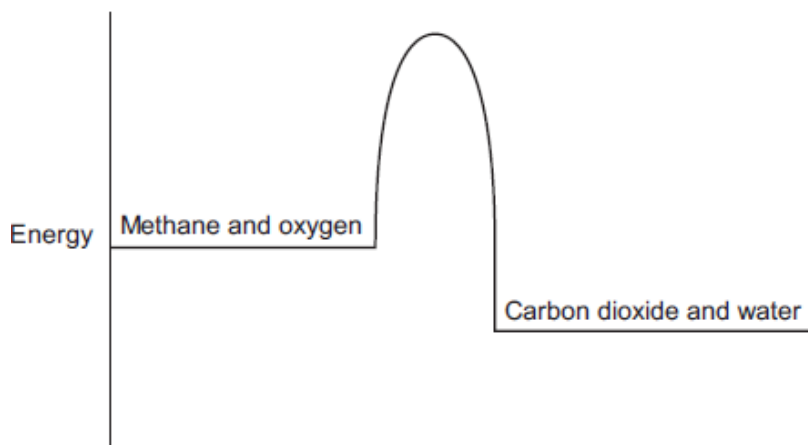
(1)

(c) Methane burns in oxygen.

(i) The diagram below shows the energy level diagram for the complete combustion of methane.

Draw and label arrows on the diagram to show:

- the activation energy
- the enthalpy change, ΔH .



(2)

- (ii) Complete and balance the symbol equation for the complete combustion of methane.



(2)

- (iii) Explain why the **incomplete** combustion of methane is dangerous.

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(2)

- (iv) Explain why, in terms of the energy involved in bond breaking and bond making, the combustion of methane is exothermic.

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(3)

- (d) Methane reacts with chlorine in the presence of sunlight.

The equation for this reaction is:



Some bond dissociation energies are given in the table.

Bond	Bond dissociation energy in kJ per mole
C-H	413
C-Cl	327
Cl-Cl	243
H-Cl	432

- (i) Show that the enthalpy change, ΔH , for this reaction is -103 kJ per mole.

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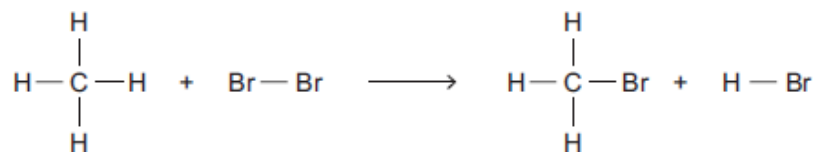
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(3)

- (ii) Methane also reacts with bromine in the presence of sunlight.



This reaction is less exothermic than the reaction between methane and chlorine.

The enthalpy change, ΔH , is -45 kJ per mole.

What is a possible reason for this?

Tick (✓) **one** box.

CH_3Br has a lower boiling point than CH_3Cl

☐

The C-Br bond is weaker than the C-Cl bond.

☐

The H-Cl bond is weaker than the H-Br bond.

☐

Chlorine is more reactive than bromine.

☐

(1)
(Total 15 marks)

6

Crude oil is a fossil fuel.

- (a) To make crude oil more useful it is separated into fractions.

Use the correct word from the box to complete each sentence.

boiling	compound	decomposition	distillation
	filtration	mixture	molecule

- (i) Crude oil is a of different substances.

(1)

- (ii) The substances in crude oil have different
..... points.

(1)

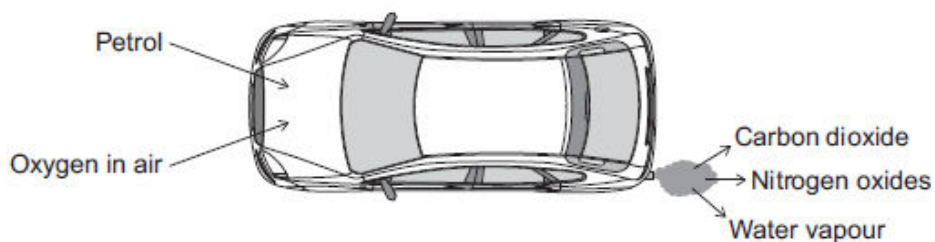
- (iii) Crude oil is separated by fractional

(1)

- (b) Petrol is one of the fractions produced from crude oil.

Car engines use a mixture of petrol and air.

The diagram shows some of the gases produced.



- (i) What type of reaction happens to petrol in a car engine?

Tick (✓) **one** box.

combustion

☐

decomposition

☐

neutralisation

☐

(1)

- (ii) Petrol contains octane (C_8H_{18}).

Complete the word equation for the reaction of octane with oxygen.

octane + \longrightarrow +

(2)

- (iii) Cars use sulfur-free petrol as a fuel.

Describe why sulfur should be removed from petrol.

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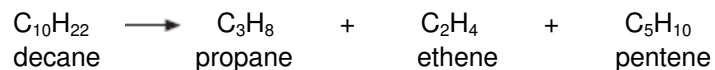
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(2)

- (c) Some fractions from crude oil contain large hydrocarbon molecules.

These molecules can be cracked to produce smaller, more useful molecules.

An equation for cracking decane is:



- (i) Why is propane useful?

Tick (✓) **one** box.

Propane is a polymer.

☐

Propane is an alloy.

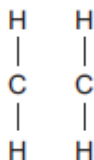
☐

Propane is a fuel.

☐

(1)

- (ii) Draw bonds to complete the displayed structure of ethene.



(1)

- (iii) What is the colour change when bromine water reacts with ethene?

Tick (✓) **one** box.

Orange to colourless

☐

Orange to green

☐

Orange to red

☐

(1)

- (iv) Complete the sentence.

Pentene is useful because many pentene molecules can join together
to form

(1)

(Total 12 marks)

7

Crude oil is a fossil fuel.

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

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(4)

- (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.

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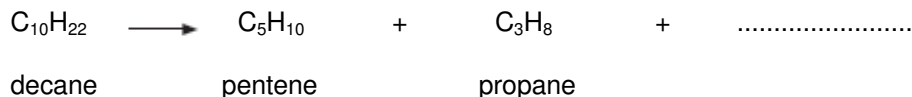
(3)

(c) Some fractions from crude oil contain large hydrocarbon molecules.

- (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.

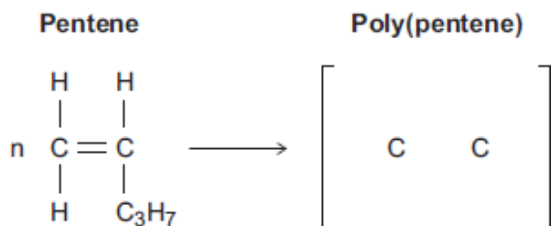
You do not need to give the name of this product.



(1)

- (ii) Pentene is used to produce poly(pentene).

Complete the equation and the displayed structure of poly(pentene).



(3)

- (iii) Some polymers are described as smart polymers.

Suggest **one** property of a smart polymer that is different to that of an ordinary polymer.

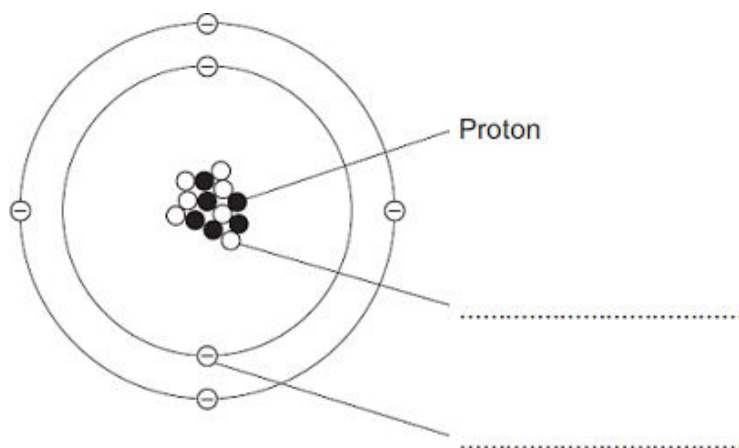
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(1)

(Total 12 marks)

8

The diagram shows a carbon atom.



- (a) (i) A proton is labelled.

Use the correct answer from the box to label each of the other sub-atomic particles.

electron	ion	molecule	neutron
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(2)

- (ii) The atom of carbon is represented as:



What is the mass number of this carbon atom?

Draw a ring around the correct answer.

6 13 19

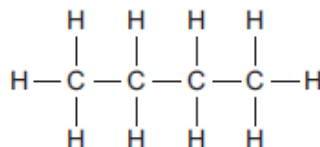
(1)

- (iii) Complete the sentence.

Atoms of carbon have no overall electrical charge because the number of protons is the same as the number of

(1)

- (b) Butane is represented as:



- (i) Use the correct answer from the box to complete each sentence.

bond	compound	helium	hydrogen	mixture	oxygen
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Butane is a

Butane contains atoms of carbon and

Each line between the atoms in butane represents a chemical

.....

(3)

- (ii) Which is the correct formula for butane?

Tick (✓) **one** box.

C₄H₄

☐

C₄H₈

☐

C₄H₁₀

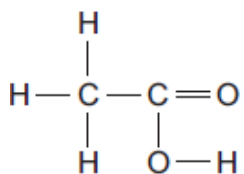
☐

(1)
(Total 8 marks)

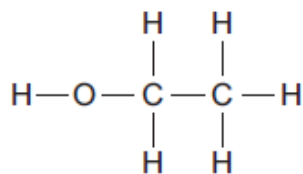
9

The diagrams represent two compounds, **A** and **B**.

Compound A



Compound B



- (a) (i) Compound **B** is an alcohol.

Name compound **B**.

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(1)

- (ii) Use the correct answer from the box to complete the sentence.

burned	decomposed	oxidised
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To form compound **A**,

compound **B** is

(1)

- (iii) Compounds **A** and **B** are both colourless liquids.

A test tube contains a colourless liquid, which could be either compound **A** or compound **B**.

Describe a simple **chemical** test to show which compound, **A** or **B**, is in the test tube.

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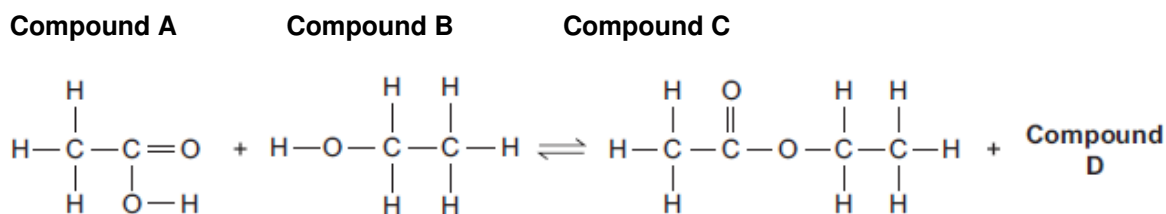
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(2)

- (b) Compounds **A** and **B** react to produce compound **C** and compound **D**.



- (i) What is the formula of compound **D**?

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(1)

- (ii) Compound **C** is an ester.

Name compound **C**.

.....

(1)

- (iii) State **one** use of esters.

.....

(1)

(Total 7 marks)

10

Sulfur is a non-metal.

Sulfur burns in the air to produce sulfur dioxide, SO_2

- (a) Why is it important that sulfur dioxide is **not** released into the atmosphere?

Tick (✓) **one** box.

Sulfur dioxide causes acid rain.

☐

Sulfur dioxide causes global dimming.

☐

Sulfur dioxide causes global warming.

☐

(1)

- (b) Sulfur dioxide dissolves in water.

What colour is universal indicator in a solution of sulfur dioxide?

Give a reason for your answer.

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(2)

- (c) Sulfur dioxide is a gas at room temperature.

The bonding in sulfur dioxide is covalent.

Explain, in terms of its structure and bonding, why sulfur dioxide has a low boiling point.

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(3)

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

Sulfur dioxide is produced when fossil fuels are burned.

It is important that sulfur dioxide is not released into the atmosphere.

Three of the methods used to remove sulfur dioxide from gases produced when fossil fuels are burned are:

- wet gas desulfurisation (**W**)
- dry gas desulfurisation (**D**)
- seawater gas desulfurisation (**S**).

Information about the three methods is given in the bar chart and in **Table 1** and **Table 2**.

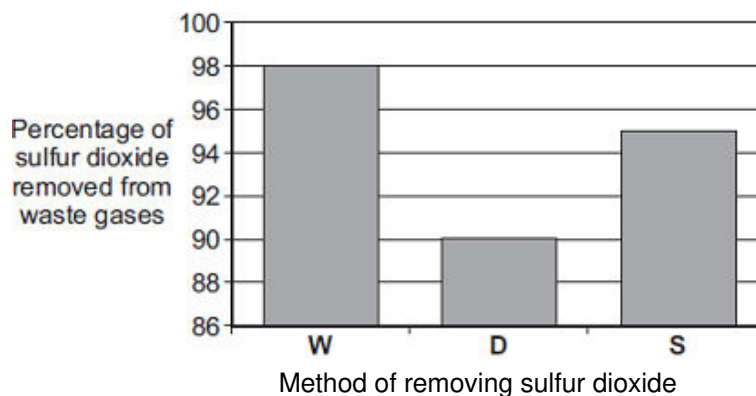


Table 1

Method	Material used	How material is obtained
W	Calcium carbonate, CaCO_3	Quarrying
D	Calcium oxide, CaO	Thermal decomposition of calcium carbonate: $\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$
S	Seawater	From the sea

Table 2

Method	What is done with waste material
W	Solid waste is sold for use in buildings. Carbon dioxide is released into the atmosphere.
D	Solid waste is sent to landfill.
S	Liquid waste is returned to the sea.

Evaluate the three methods of removing sulfur dioxide from waste gases.

Compare the three methods and give a justified conclusion.

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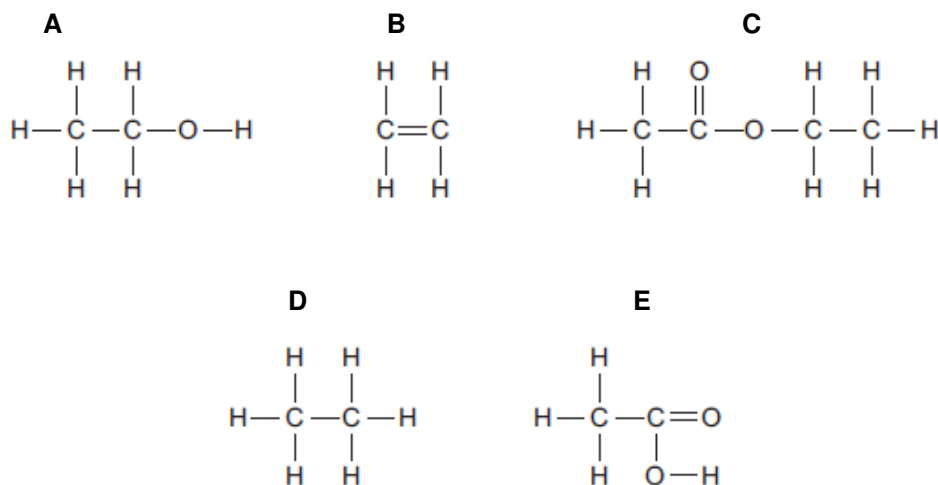
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(6)
(Total 12 marks)



- (a) Choose which organic compound, **A**, **B**, **C**, **D** or **E**, matches the descriptions.

You may choose each compound once, more than once or not at all.

Write the letter of the compound that:

- (i) is a saturated hydrocarbon

(1)

- (ii) comes from a homologous series with the general formula C_nH_{2n}

(1)

- (iii) has the empirical formula $\text{C}_2\text{H}_6\text{O}$

(1)

- (iv) reacts with calcium carbonate to produce carbon dioxide

(1)

- (v) reacts with compound **A** to produce compound **C**.

(1)

- (b) Compound **B** (C_2H_4) and C_8H_{18} are produced by cracking $\text{C}_{14}\text{H}_{30}$



- (i) Give **two** conditions for cracking.

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(2)

- (ii) Explain why C_8H_{18} has a lower boiling point than $C_{14}H_{30}$

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(2)

- (c) Compound **B** is a colourless gas.

Give a chemical test and its result to show that compound **B** is unsaturated.

Test

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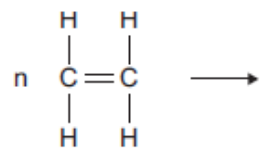
Result

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(2)

- (d) Compound **B** is ethene.

Complete the equation to show the formation of poly(ethene) from ethene.



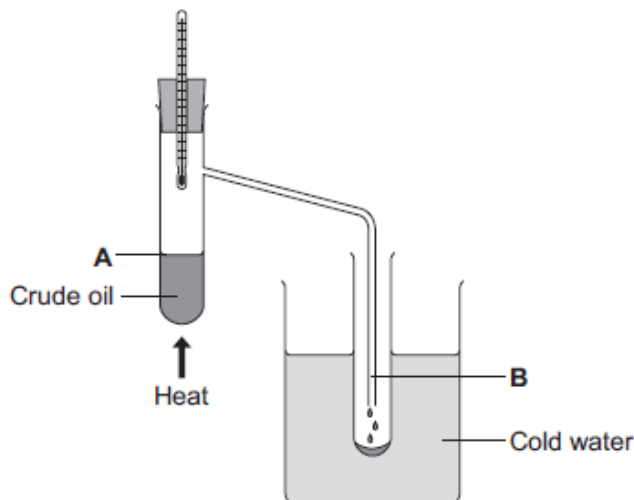
(3)

(Total 14 marks)

Crude oil is a mixture of a very large number of compounds.

Figure 1 shows a laboratory experiment to separate crude oil.

Figure 1



- (a) Complete the sentence.

The name for compounds that contain only hydrogen and carbon is

(1)

- (b) Use the correct word from the box to complete each sentence.

condensation	decomposition	distillation
evaporation	reduction	

- (i) The process of separating crude oil is fractional

(1)

- (ii) The process taking place at **A** is

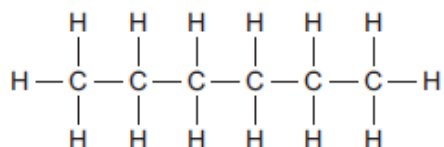
(1)

- (iii) The process taking place at **B** is

(1)

- (c) One of the compounds in crude oil is hexane. The displayed structure of hexane is shown in **Figure 2**.

Figure 2

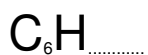


Complete the sentences.

- (i) Each line between the atoms in hexane represents a covalent

(1)

- (ii) Complete the chemical formula for hexane.



(1)

- (iii) Hexane can be broken down into smaller molecules by a process called

.....

(1)

- (d) Small molecules, called alkenes, are used to make polymers.

- (i) Name the polymer made from butene.

.....

(1)

- (ii) Incinerators are used to burn waste polymers, such as plastic bags.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of burning plastic bags.

	Advantage Tick (✓)	Disadvantage Tick (✓)
Energy is released.		
More recycling is needed.		
Carbon dioxide is produced.		

(2)

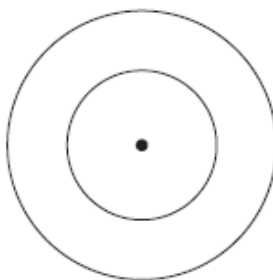
(Total 10 marks)

13

Fossil fuels contain carbon and hydrogen.

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

Complete the figure below to show the electronic structure of a carbon atom.



(1)

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

hydrogen + oxygen \longrightarrow

(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?

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(4)
(Total 6 marks)

14

This question is about compounds produced from crude oil.

The table below shows four of these compounds.

Compound	Melting point in °C	Boiling point in °C
methane (CH ₄)	-183	-164
ethene (C ₂ H ₄)	-169	-104
decane (C ₁₀ H ₂₂)	-30	+174
icosane (C ₂₀ H ₄₂)	+37	+343

- (a) Tick (✓) **two** correct statements about the four compounds.

Statement	Tick (✓)
Methane has the lowest melting point and icosane has the highest boiling point.	
Ethene and methane are alkanes.	
Methane and decane are gases at room temperature (20°C).	
Decane and icosane are liquid at 100°C.	

(2)

- (b) Petrol contains a mixture of compounds, including octane (C_8H_{18}).

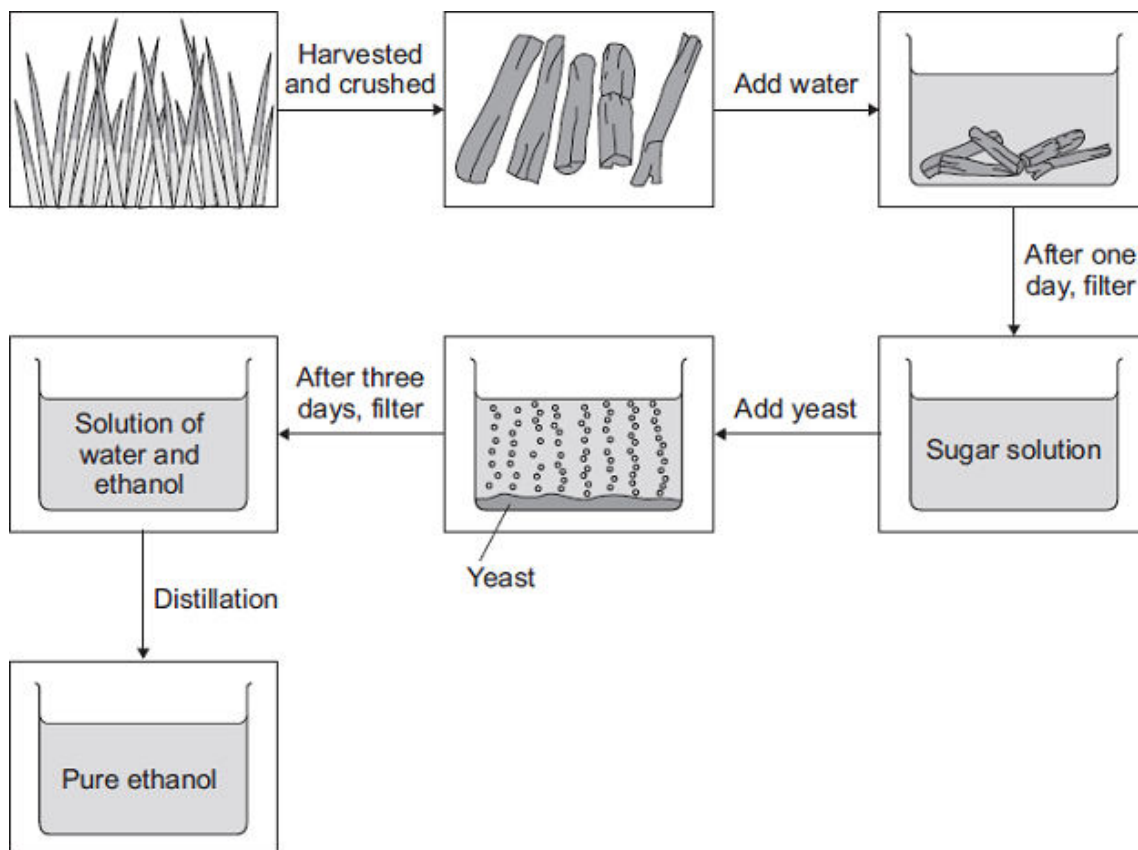
Complete the word equation for the complete combustion of octane.

octane + oxygen \rightarrow +

(2)

- (c) Most petrol used in cars contains about 5% ethanol (C_2H_5OH).

Ethanol can be produced from sugar cane.



- (i) Draw a ring around the correct answer to complete the sentence.

The reaction to produce ethanol from sugar solution is

combustion.
displacement.
fermentation.

(1)

- (ii) Some people say that increasing the production of ethanol from sugar cane will be **good** for the environment.

Suggest **two** reasons why.

1

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2

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(2)

- (iii) Other people say that increasing the production of ethanol from sugar cane will be **bad** for the environment.

Suggest **two** reasons why.

1

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2

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(2)

(Total 9 marks)

15

This question is about oil reserves.

- (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)

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

What are *alkanes*?

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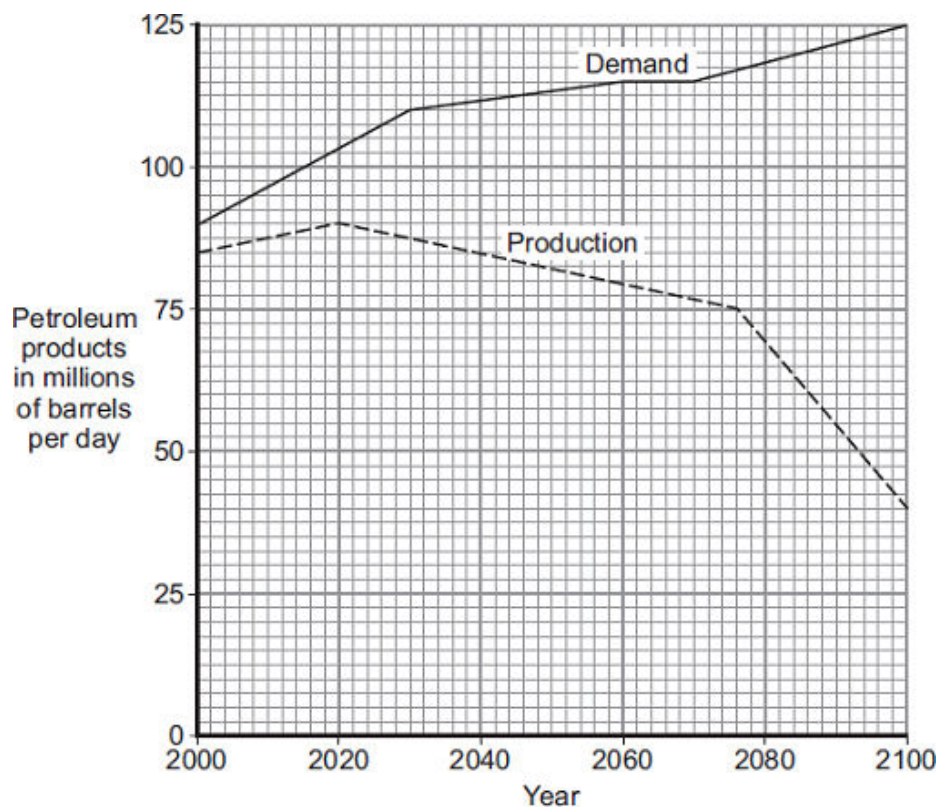
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(2)

- (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.

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

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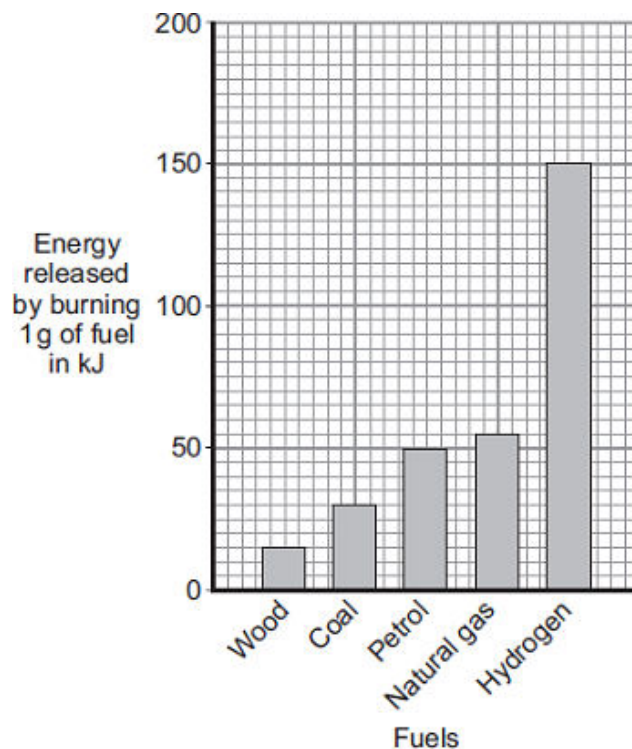
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(6)
(Total 11 marks)

- (a) The bar chart shows the energy in kilojoules, kJ, released by burning 1 g of five different fuels.



- (i) Which fuel releases least energy by burning 1 g?

.....

(1)

- (ii) How much energy is released by burning 1 g of coal?

Energy =kJ

(1)

- (iii) Calculate the mass of petrol that will release the same amount of energy as 1 g of hydrogen.

Use information from the bar chart to help you.

.....

.....

Mass = g

(1)

- (b) Coal burns in oxygen and produces the gases shown in the table.

Name	Formula
Carbon dioxide	CO ₂
Water vapour	H ₂ O
Sulfur dioxide	SO ₂

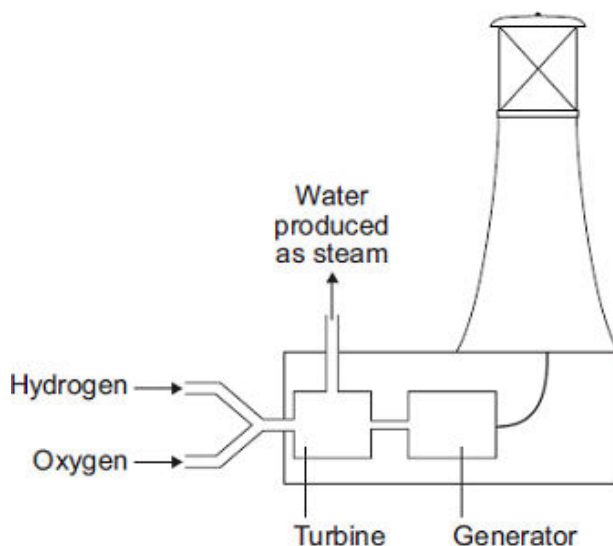
Use information from the table to name **one** element that is in coal.

.....

(1)

- (c) Hydrogen can be made from fossil fuels.
Hydrogen burns rapidly in oxygen to produce water only.

A lighthouse uses electricity generated by burning hydrogen.



Suggest **two** advantages of using hydrogen as a fuel.

Use information from the bar chart and the diagram above to help you.

1

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2

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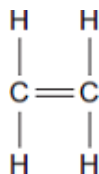
(2)

(Total 6 marks)

17

Crude oil is used to make useful substances such as alkenes and plastics.

(a) The alkene shown is ethene.



(i) Tick (✓) the correct formula for ethene.

Formula	Tick (✓)
CH ₄	
C ₂ H ₄	
C ₂ H ₆	

(1)

(ii) Tick (✓) the name of the plastic formed when many ethene molecules join together.

Name of plastic	Tick (✓)
Poly(ethene)	
Poly(ethanol)	
Poly(propene)	

(1)

- (b) Read the article about plastics and then answer the questions.

THE PROBLEM WITH PLASTIC WASTE

Millions of tonnes of plastics are made from crude oil every year.

Most of the litter found on beaches is plastic waste.

80 % of plastics produced end up in landfill sites.

- (i) Draw a ring around the correct answer in the box to complete the sentence.

Plastic waste needs to be removed from beaches because it

decomposes.

is reactive.

is not biodegradable.

(1)

- (ii) Suggest a problem caused by 80 % of plastics going to landfill sites.

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(1)

- (iii) Suggest **one** way of reducing the amount of plastics going to landfill sites.

.....

.....

(1)

(Total 5 marks)

18

Scientists study the atmosphere on planets and moons in the Solar System to understand how the Earth's atmosphere has changed.

- (a) Millions of years ago the Earth's atmosphere was probably just like that of Mars today.

The table shows data about the atmosphere of Mars and Earth today.

Mars today		Earth today	
nitrogen	3%	nitrogen	78%
oxygen	trace	oxygen	21%
water	trace	water	trace
Carbon dioxide	95%	Carbon dioxide	trace
Average surface temperature -23°C		Average surface temperature 15°C	

The percentages of some gases in the Earth's atmosphere of millions of years ago have changed to the percentages in the Earth's atmosphere today.

For **two** of these gases describe how the percentages have changed **and** suggest what caused this change.

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(2)

- (b) Titan is the largest moon of the planet Saturn.
Titan has an atmosphere that contains mainly nitrogen.
Methane is the other main gas.

Main gases in Titan's atmosphere	Percentage (%)	Boiling point in °C
Nitrogen	95	-196
Methane	5	-164
Average surface temperature -178°C		

When it rains on Titan, it rains methane!

Use the information above and your knowledge and understanding to explain why.

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(2)

- (c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene (C_2H_4) and propene (C_3H_6) from methane in Titan's atmosphere.

State the general formula for alkenes.

.....

(1)

(Total 5 marks)

19

Alkanes are hydrocarbons found in crude oil.

- (a) (i) Complete the sentence.

Hydrocarbons contain the elements and only.

(1)

- (ii) Ethane is an alkane with the formula C_2H_6

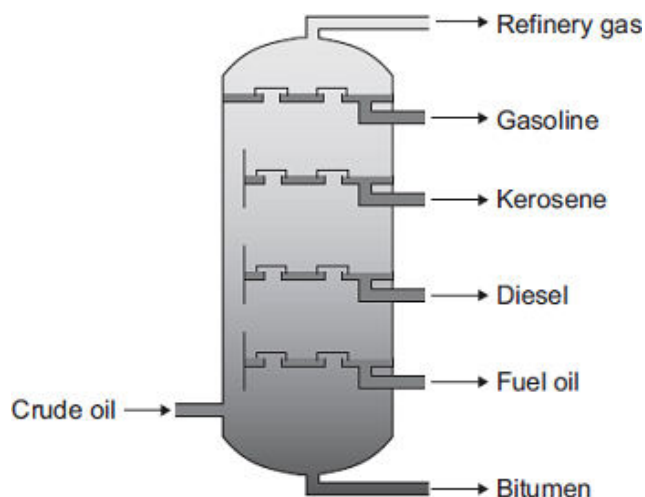
Draw a ring around the correct answer to complete the sentence.

Alkanes are hydrocarbons with the general formula

C_nH_n
C_nH_{2n}
C_nH_{2n+2}

(1)

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



Describe and explain how crude oil is separated into fractions by fractional distillation.

Use the diagram to help you answer the question.

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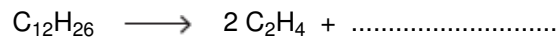
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(4)

- (c) Dodecane ($C_{12}H_{26}$) from crude oil is cracked to produce ethene (C_2H_4).

- (i) Complete the equation for this reaction.



(1)

- (ii) Give **two** conditions needed for cracking.

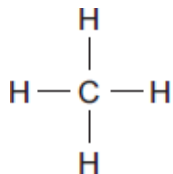
1

2

(2)

(Total 9 marks)

- (a) Methane can be represented as:



- (i) The formula of methane is

(1)

- (ii) Draw a ring around the correct answer to complete the sentence.

In a saturated hydrocarbon molecule all of the bonds are

double.
ionic.
single.

(1)

- (iii) Draw a ring around the correct answer to complete the sentence.

The homologous series that contains methane and octane is called the

alcohols.
alkanes.
alkenes.

(1)

- (b) (i) The complete combustion of petrol produces carbon dioxide, water vapour and sulfur dioxide.

Name **three** elements petrol must contain.

1

2

3

(3)

- (ii) The exhaust gases from cars can contain oxides of nitrogen.

Complete the sentence.

Nitrogen in the oxides of nitrogen comes from

(1)

- (iii) The sulfur dioxide and oxides of nitrogen from cars cause an environmental problem.

Name the problem and describe **one** effect of the problem.

Name of problem

Effect of problem

.....

(2)

- (c) When a fuel burns without enough oxygen, there is incomplete combustion.

One gaseous product of incomplete combustion is carbon monoxide.

Name **one** solid product of incomplete combustion.

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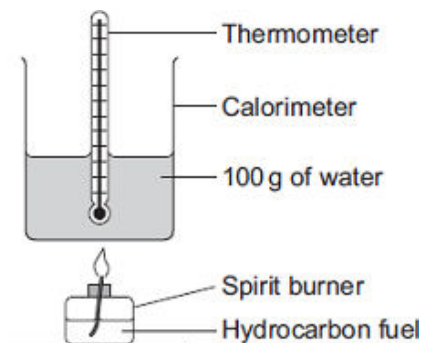
(1)

- (d) A student investigated how well different hydrocarbon fuels would heat up 100 g of water.

Her hypothesis was:

The more carbon atoms there are in a molecule of any fuel, the better the fuel is.

The apparatus the student used is shown in the diagram.



She burned each hydrocarbon fuel for 2 minutes.

Her results are shown in the table.

Name of hydrocarbon fuel	Number of carbon atoms in a molecule of hydrocarbon fuel	Temperature change of water in °C after 2 minutes	Temperature change per g of fuel burned	Observations
Pentane	5	30	60	no smoke
Hexane	6	40	57	very small amount of smoke
Octane	8	55	55	small amount of smoke
Decane	10	57	52	large amount of smoke
Dodecane	12	60	43	very large amount of smoke

The student investigated only hydrocarbons.

Look carefully at her results.

How well do the student's results support her hypothesis?

The more carbon atoms there are in a molecule of any fuel, the better the fuel is.

Give reasons for your answer.

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(4)

- (e) A 0.050 mol sample of a hydrocarbon was burned in excess oxygen.

The products were 3.60 g of water and 6.60 g of carbon dioxide.

- (i) Calculate the number of moles of carbon dioxide produced.

Relative atomic masses: C = 12; O = 16.

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Moles of carbon dioxide =

(2)

- (ii) When the hydrocarbon was burned 0.20 mol of water were produced.

How many moles of hydrogen atoms are there in 0.20 mol of water?

.....

Moles of hydrogen atoms =

(1)

- (iii) The amount of hydrocarbon burned was 0.050 mol.

Use this information and your answers to parts **(e) (i)** and **(e) (ii)** to calculate the molecular formula of the hydrocarbon.

If you could not answer parts **(e) (i)** or **(e) (ii)** use the values of 0.20 moles carbon dioxide and 0.50 moles hydrogen. These are **not** the answers to parts **(e) (i)** and **(e) (ii)**.

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Formula =

(2)

(Total 19 marks)

21

- (a) A student had a colourless solution.

The student thought the solution was dilute hydrochloric acid.

- (i) The student added universal indicator to this solution.

What colour would the universal indicator change to if the solution is hydrochloric acid?

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(1)

- (ii) Describe how the student could show that there are chloride ions in this solution.

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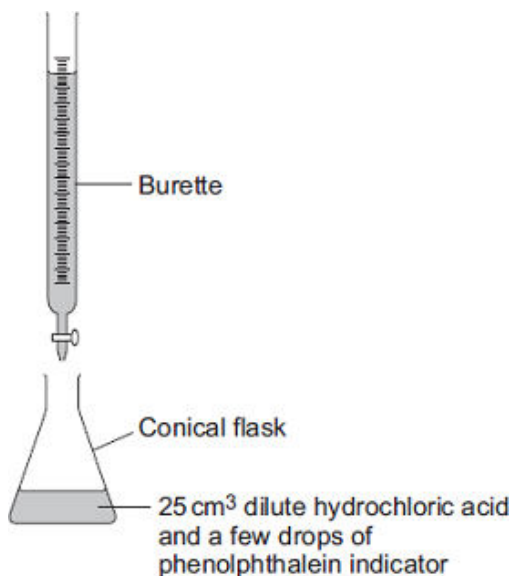
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(2)

- (b) The results of a titration can be used to find the concentration of an acid.



Describe how to use the apparatus to do a titration using 25 cm³ of dilute hydrochloric acid.

In your answer you should include:

- how you will determine the end point of the titration
- how you will make sure the result obtained is accurate.

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(4)

- (c) Hydrochloric acid is a strong acid.

Ethanoic acid is a *weak acid*.

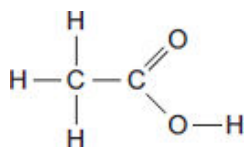
What is meant by the term *weak acid*?

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(1)

- (d) The displayed formula of ethanoic acid is:



- (i) On the formula, draw a circle around the functional group in ethanoic acid. (1)
- (ii) Ethanoic acid and ethanol react together to make the ester ethyl ethanoate.
Draw the **displayed** formula of ethyl ethanoate.

(2)
(Total 11 marks)

22

Barbecues are heated by burning charcoal or burning hydrocarbons.



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

The chemical equation for charcoal burning is:



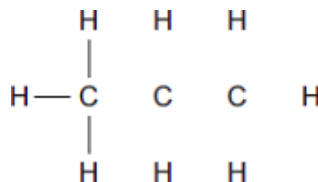
Complete the word equation for this reaction.

carbon + \longrightarrow carbon dioxide

(1)

(b) Propane is a hydrocarbon.

(i) Complete the displayed structure of propane. Draw in the missing bonds.



(1)

(ii) Write the chemical formula of propane.

(1)

(iii) Draw a ring around the correct answer to complete the sentence.

Propane burns in air to produce carbon dioxide and

hydrogen.

hydroxide.

water.

(1)

(c) The table shows information about six hydrocarbons.

Hydrocarbon	State at room temperature (20°C)	Boiling point in °C
Ethane (C ₂ H ₆)	gas	-89
Ethene (C ₂ H ₄)	gas	-104
Butane (C ₄ H ₁₀)	gas	-1
Butene (C ₄ H ₈)	gas	-6
Hexane (C ₆ H ₁₄)	liquid	+69
Hexene (C ₆ H ₁₂)	liquid	+64

Tick (✓) **two** correct statements about the six hydrocarbons.

Statement	Tick (✓)
Ethane and butane boil at temperatures less than 20°C.	
Hexene and butene are alkanes.	
Butane and hexane are liquid at 0°C.	
Ethene and hexene each have a carbon-carbon double bond.	

(2)

(Total 6 marks)

23

Crude oil is a mixture of many different chemical compounds.

(a) Fuels, such as petrol (gasoline), can be produced from crude oil.

(i) Fuels react with oxygen to release energy.

Name the type of reaction that releases energy from a fuel.

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(1)

(ii) Fuels react with oxygen to produce carbon dioxide.

The reaction of a fuel with oxygen can produce a different oxide of carbon.

Name this different oxide of carbon and explain why it is produced.

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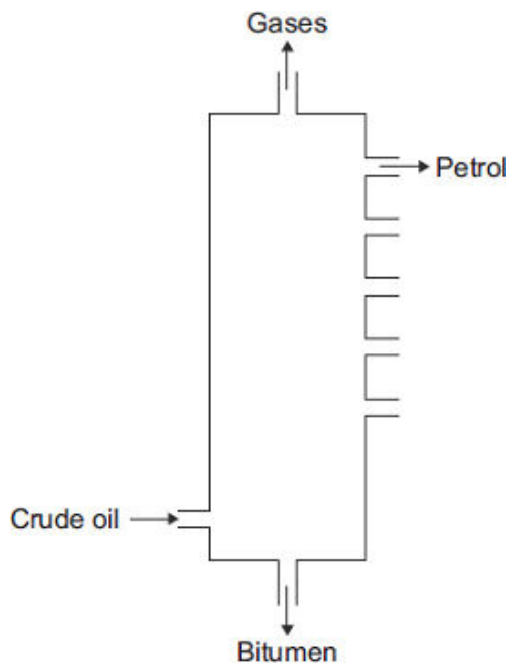
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(2)

(b) Most of the compounds in crude oil are hydrocarbons.
Hydrocarbons with the smallest molecules are very volatile.



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

Describe and explain how **petrol** is separated from the mixture of hydrocarbons in crude oil.

Use the diagram and your knowledge to answer this question.

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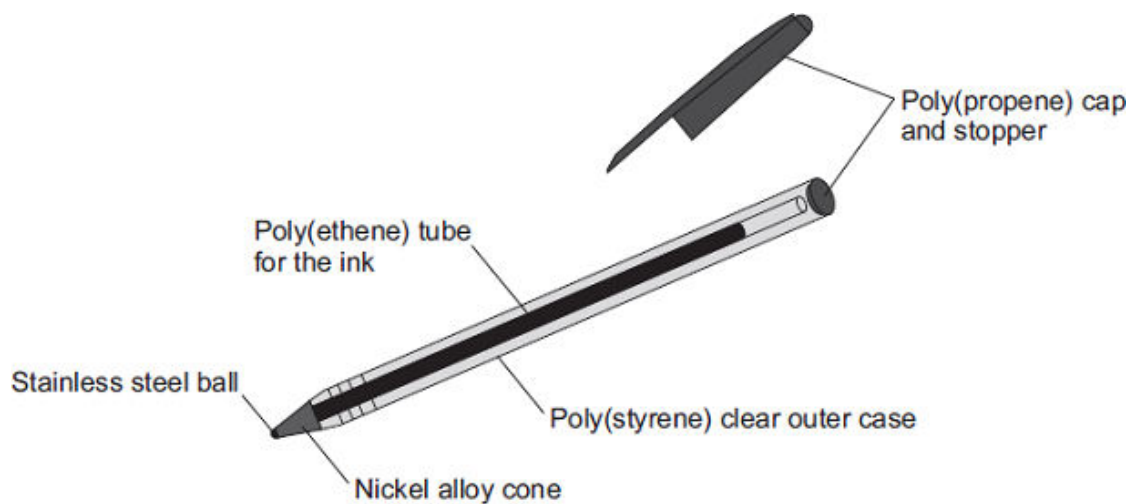
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(6)
(Total 9 marks)

24

The diagram shows a ballpoint pen.



- (a) Give **one** advantage and **one** disadvantage of recycling the materials from this type of ballpoint pen.

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(2)

- (b) Alloys are used to make the ballpoint pen.

Give **two** reasons why alloys are used in the ballpoint pen.

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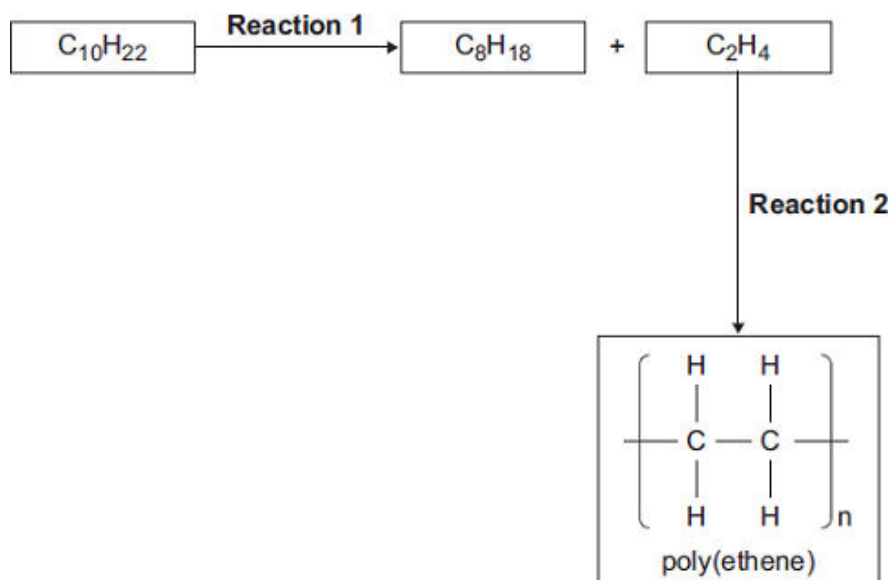
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(2)

- (c) Decane ($C_{10}H_{22}$) can be used to produce poly(ethene).



- (i) Describe the conditions needed for **Reaction 1**.

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(2)

- (ii) Describe, in terms of molecules, how poly(ethene) is produced in **Reaction 2**.

.....

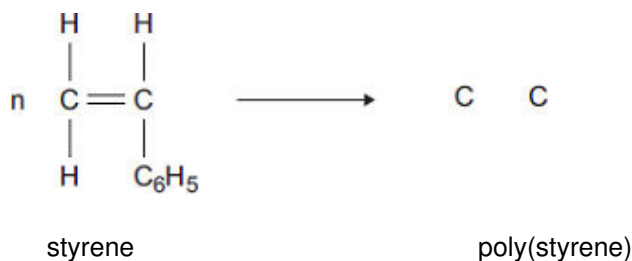
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(2)

(d) Complete the displayed structure of the product in the equation.



(2)
(Total 10 marks)

25

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 ₂ H ₅ OH	-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.

(a) The melting point of ethanol is precise but the other melting points are approximate.

Suggest why.

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(2)

(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.

(i) Describe how the process of fermentation is done.

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(2)

- (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)

- (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)

- (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)

(Total 12 marks)

26

- (a) Crude oil is a mixture of compounds.
These compounds are made up of hydrogen and carbon atoms only.

- (i) Draw a ring around the correct answer to complete the sentence.

Compounds made up of carbon and hydrogen atoms only are called

alcohols.
hydrocarbons.
vegetable oils.

(1)

- (ii) The table shows five of these compounds.

Compound	State at room temperature (20 °C)	Boiling point in °C
ethane, C ₂ H ₆	gas	– 89
butane, C ₄ H ₁₀	gas	0
hexane, C ₆ H ₁₄	liquid	+69
pentadecane, C ₁₅ H ₃₂	liquid	+270
heptadecane, C ₁₇ H ₃₆	solid	+302

Tick (✓) **two** correct statements about the five compounds.

Statement	Tick (✓)
ethane has the smallest molecules	
hexane and pentadecane are liquid at 100 °C	
heptadecane has the highest boiling point	
butane boils at 100 °C	

(2)

- (iii) Draw a ring around the correct answer to complete each sentence.

Fractional distillation is used to separate the compounds in crude oil.

The first step in fractional distillation is

cracking
displacing
evaporating

the crude oil.

During fractional distillation the compounds

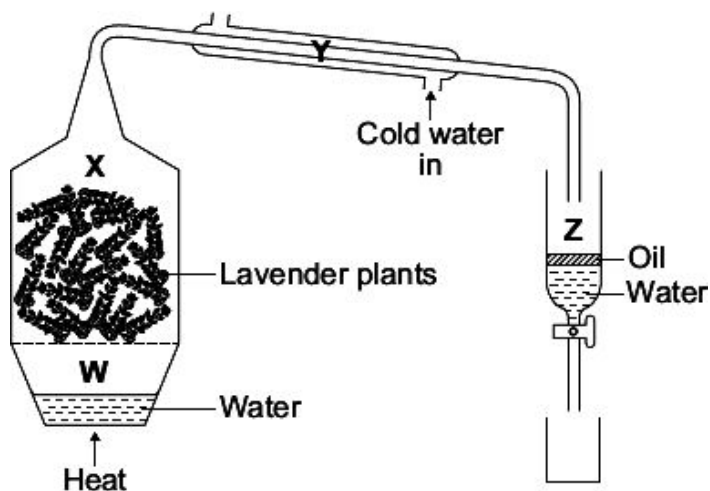
burn
condense
decompose

at different temperatures.

(2)

- (b) Steam distillation is used to separate oils from plants.

The diagram shows some apparatus that can be used to separate oil from lavender plants. Four parts of the apparatus are labelled **W**, **X**, **Y** and **Z**.



- (i) In which part, **W**, **X**, **Y** or **Z**, of the apparatus:

is steam produced

are steam and oil condensed?

(2)

- (ii) Use the correct word from the box to complete the sentence.

dissolves floats sinks

When the oil separates from the water, the oil

(1)

- (iii) Describe how part **Z** of the apparatus can be used to remove the water from the oil.

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(2)
(Total 10 marks)

27

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	

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

- (i) Give the formula for heptane

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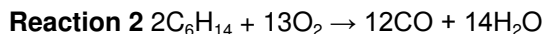
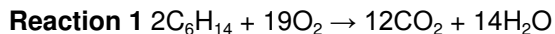
(1)

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



(1)

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



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

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

.....

(1)

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

.....

.....

(1)

- (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	

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

.....

(1)

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

.....

(1)

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

.....

(1)

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

.....

(2)

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

Explain why.

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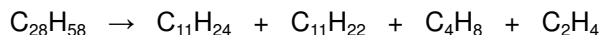
(2)

(Total 11 marks)

28

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

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



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

Complete the sentences.

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

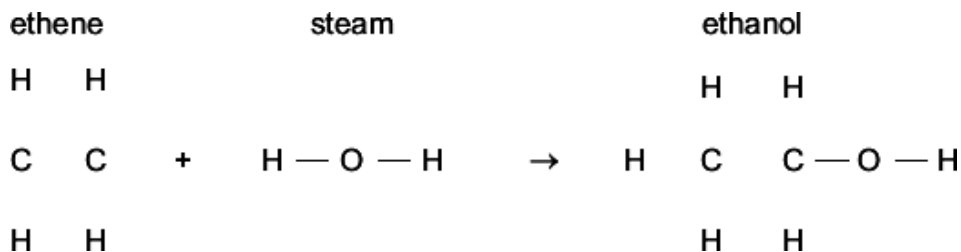
The chemical structure of this product is different to the other products because

.....

(2)

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

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



(2)

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

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

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

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

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

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

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

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

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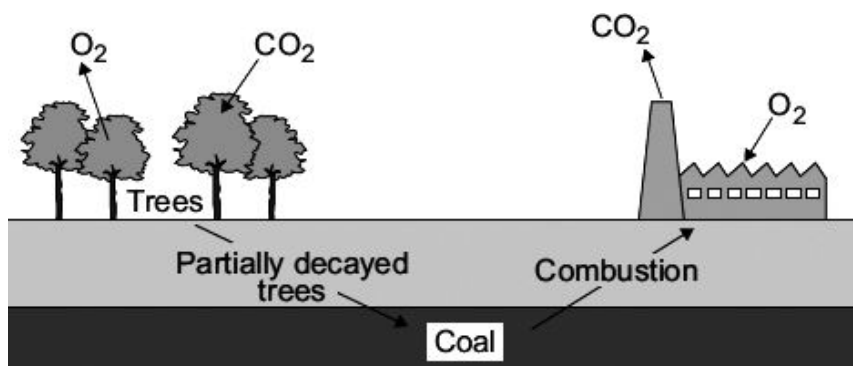
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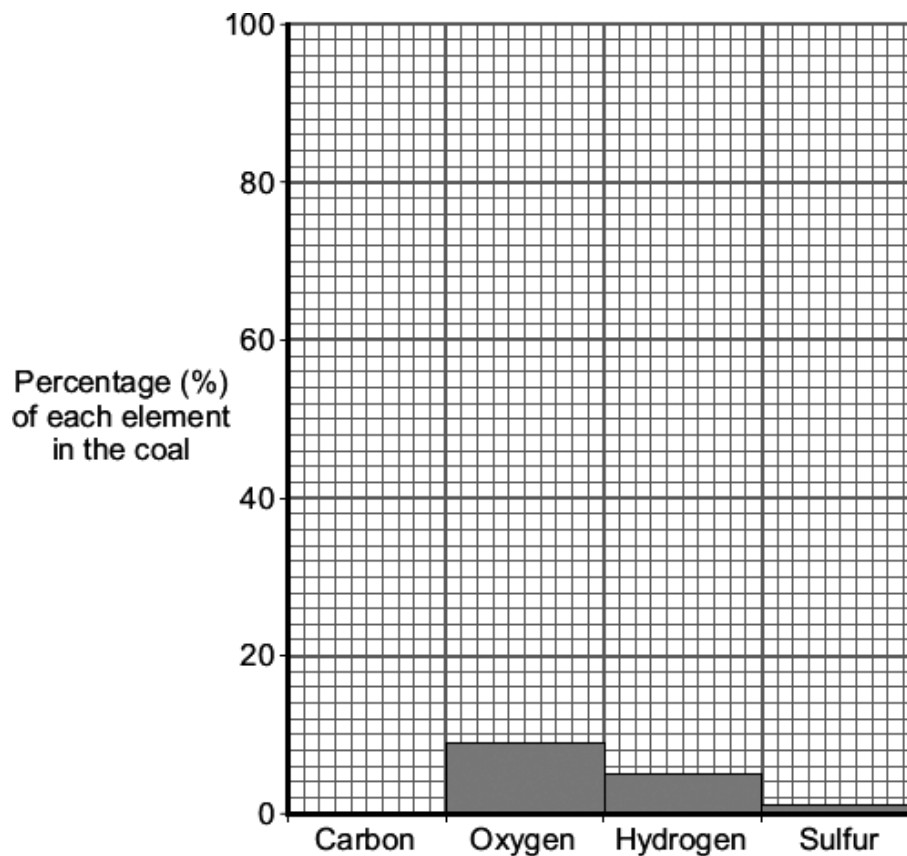
(6)
(Total 10 marks)

About 400 million years ago plants and trees grew on most of the land. When the plants and trees died they were covered by sand and slowly decayed to form coal.

Today coal is burned in power stations to release the energy needed by industry.



(a) The bar chart shows the percentage of some of the elements in this coal.



(i) This coal contains 85 % carbon. Draw the bar for carbon on the chart.

(1)

- (ii) Coal is burned in the atmosphere to release energy.
Two of the products of burning coal are shown.

Draw **one** line from each product to its environmental impact.

Product	Environmental impact
	Acid rain
Sulfur dioxide	
	Global dimming
Carbon particles	
	Global warming

(2)

- (b) Use the information above and your knowledge and understanding to answer these questions.

- (i) How did the formation of coal decrease the amount of carbon dioxide in the Earth's early atmosphere?

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(1)

- (ii) How does burning coal affect the amount of carbon dioxide in the Earth's atmosphere?
Explain your answer.

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(2)

(Total 6 marks)

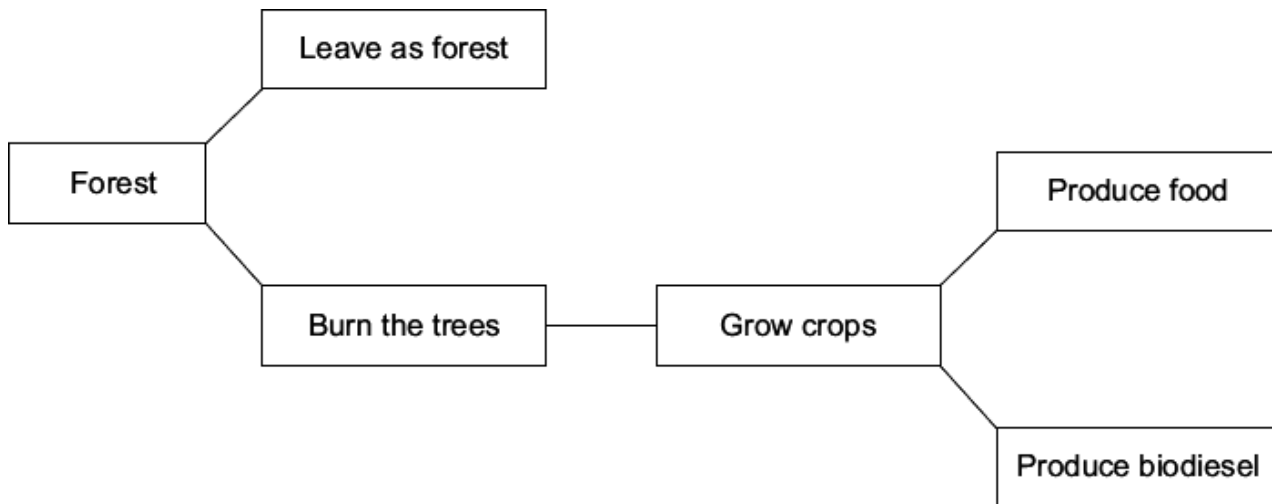
30

Petroleum diesel is a fuel made from crude oil.

Biodiesel is a fuel made from vegetable oils.

To make biodiesel, large areas of land are needed to grow crops from which the vegetable oils are extracted.

Large areas of forest are cleared by burning the trees to provide more land for growing these crops.



(a) Use this information and your knowledge and understanding to answer these questions.

- (i) Carbon neutral means that there is no increase in the amount of carbon dioxide in the atmosphere.

Suggest why adverts claim that using biodiesel is carbon neutral.

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(2)

- (ii) Explain why clearing large areas of forest has an environmental impact on the atmosphere.

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(2)

- (b) Why is there an increasing demand for biodiesel?

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(1)

- (c) Suggest why producing biodiesel from crops:

- (i) causes ethical concerns

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(1)

- (ii) causes economic concerns.

.....
.....

(1)

(Total 7 marks)

31

About 3000 million years ago, carbon dioxide was one of the main gases in the Earth's atmosphere.

About 400 million years ago, plants and trees grew on most of the land. When the plants and trees died they were covered by sand and slowly decayed to form coal.

- (a) Describe and explain how the composition of the Earth's atmosphere was changed by the formation of coal.

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(3)

- (b) Today, coal is burned in power stations to release the energy needed by industry. Carbon dioxide, water and sulfur dioxide are produced when this coal is burned.

Name **three** elements that are in this coal.

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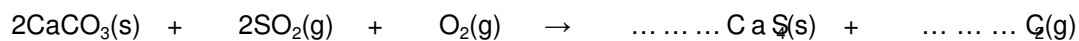
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(2)

- (c) In some power stations coal is mixed with calcium carbonate (limestone). The mixture is crushed before it is burned.

- (i) Many chemical reactions happen when this mixture is burned. The chemical equation represents one of these reactions.

Balance the chemical equation.



(1)

- (ii) Explain how the use of calcium carbonate in the mixture:

increases atmospheric pollution

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decreases atmospheric pollution.

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(4)

(Total 10 marks)

Ethanol ($\text{C}_2\text{H}_5\text{OH}$) can be made from ethene or from sugar.

- (a) Complete the table which shows the number of atoms of each element in the formula of ethanol.

Use the Chemistry Data Sheet to help you to complete the table.

Element	Symbol	Number of atoms in the formula $\text{C}_2\text{H}_5\text{OH}$
Carbon	C	2
Hydrogen	H
.....	O	1

(2)

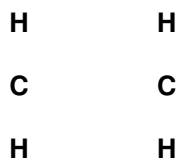
- (b) Ethene (C_2H_4) is produced when hydrocarbons are cracked.

- (i) Tick (✓) **two** conditions needed to crack a hydrocarbon.

Condition	Tick (✓)
The presence of an emulsifier.	
Heating the hydrocarbon to a high temperature.	
Adding oxygen to the hydrocarbon.	
The presence of a catalyst.	

(2)

- (ii) Draw the missing bonds to complete the displayed structure of ethene.



(1)

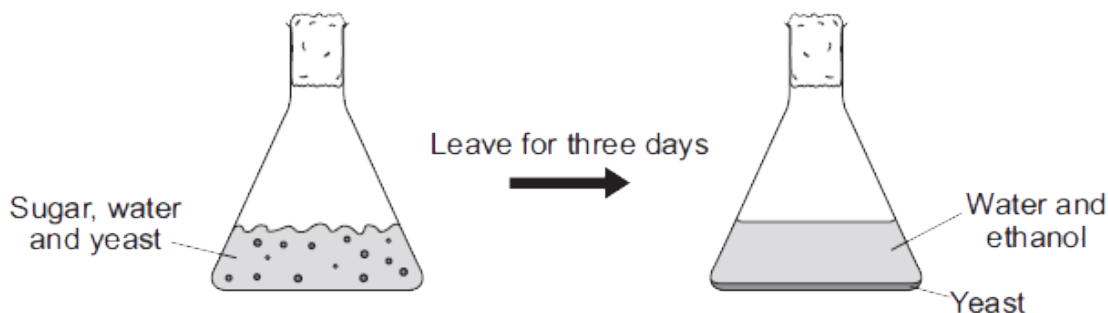
- (iii) Name the substance added to ethene (C_2H_4) to produce ethanol ($\text{C}_2\text{H}_5\text{OH}$).

.....

(1)

- (c) The diagram shows how a solution of ethanol is made from sugar dissolved in water.

The boiling point of ethanol is 78°C and the boiling point of water is 100°C .



- (i) Name the gas produced during this reaction.

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(1)

- (ii) What are the main steps needed to obtain pure ethanol from the mixture produced after three days?

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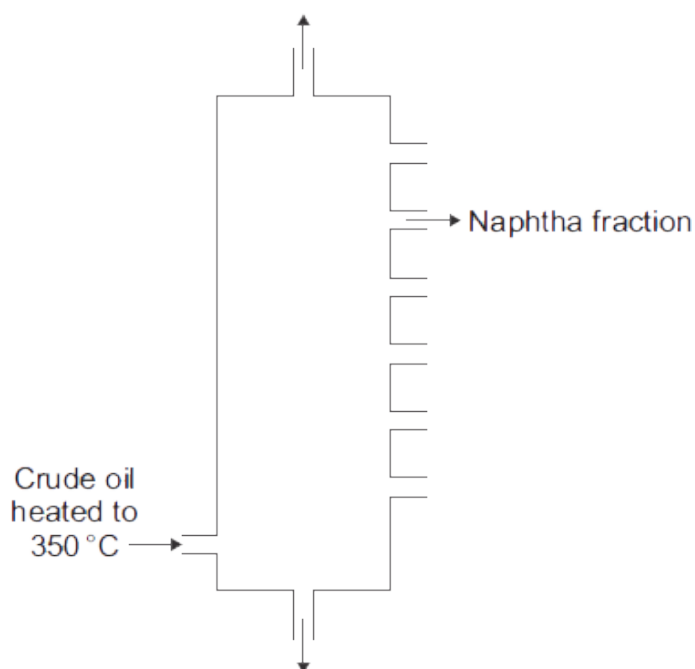
(2)

(Total 9 marks)

33

Crude oil is used to produce poly(ethene).

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



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

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

(2)

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

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

1

2

(2)

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

Each year in the UK, billions of plastic bags are given free to shoppers. These bags are made from poly(ethene) and are often used only once.

After being used many of these plastic bags are either thrown away as litter or buried in landfill sites.

In 2006 over 10 billion of these plastic bags were given free to shoppers.

In 2009 the number of plastic bags given to shoppers had decreased to 6.1 billion.

One reason for the decrease was because some supermarkets made people pay for their plastic bags.

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

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

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(6)
(Total 10 marks)

34

Ethanol ($\text{C}_2\text{H}_5\text{OH}$) is produced from ethene or from sugar cane.

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

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

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

**(2)**

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

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(1)

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

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(5)
(Total 8 marks)

35

The plastic used for shopping bags is made from crude oil.



- (a) Complete each sentence.

(i) The compounds of hydrogen and carbon
in crude oil are called

(1)

(ii) Crude oil is separated into fractions, such as naphtha, using
fractional

(1)

- (b) Plastics are made from alkenes.
The alkenes are made from naphtha.

Draw a ring around the correct answer to complete each sentence.

- (i) First the liquid naphtha is made into a gas. This process is called

distilling.
 filtering.
 vaporising.

(1)

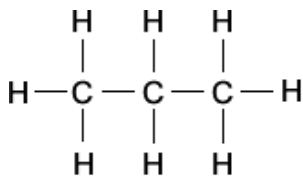
- (ii) The naphtha gas is then passed over a hot catalyst.

This process is called

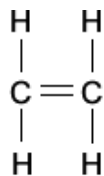
boiling.
 bonding.
 cracking.

(1)

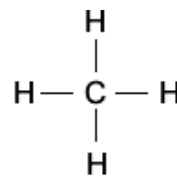
- (c) The displayed formulas of three molecules are:



Molecule A



Molecule B



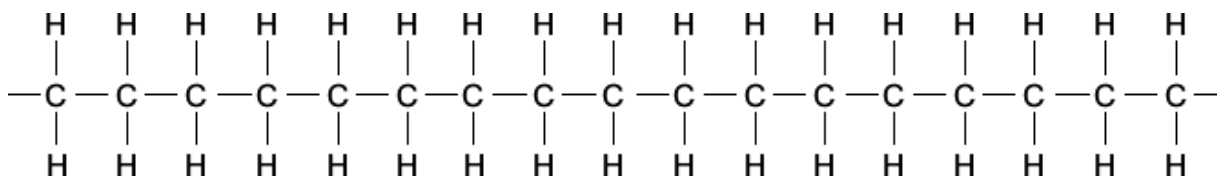
Molecule C

Which molecule, **A**, **B** or **C**, is an alkene?

(1)

- (d) The plastic for the bag is made when many alkene molecules are joined together to make the polymer called poly(ethene).

Part of a very large poly(ethene) molecule is shown below.



After plastic bags have been used for shopping, the bags can be reused, recycled, buried in landfill sites or burned.

- (i) Reusing and recycling used plastic bags is good for the environment because this conserves crude oil.

Tick (✓) another reason why recycling used plastic bags is good for the environment.

Reason	Tick (✓)
energy is used to transport and melt the used plastic bags	
new plastic products are made from the used plastic bags	
new plastic bags made from crude oil are cheap to produce	

(1)

- (ii) Complete the sentence.

One reason why burying used plastic bags in landfill sites is not good for the environment is that poly(ethene)

(1)

(iii) Some statements about burning used plastic bags are given below.

Tick (✓) **one** advantage and tick (✓) **one** disadvantage of burning used plastic bags.

	Advantage Tick (✓)	Disadvantage Tick (✓)
new plastic bags can be produced		
carbon dioxide is produced		
water is one of the products		
energy is released		

(2)
(Total 9 marks)

36

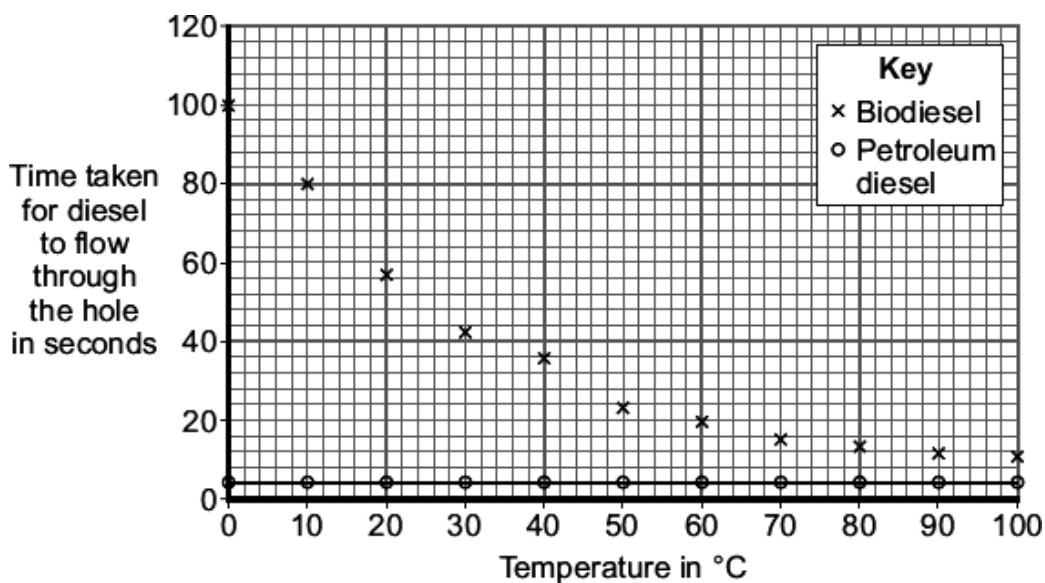
There are two main types of diesel fuel used for cars:

- biodiesel, made from vegetable oils
- petroleum diesel, made from crude oil.

(a) A scientist compared the viscosity of biodiesel with petroleum diesel at different temperatures.

The scientist measured the time for the same volume of diesel to flow through a small hole in a cup.

The scientist's results are plotted on the grid.



(i) Draw a line of best fit for the biodiesel results.

(1)

- (ii) What conclusions can the scientist make about the viscosity of biodiesel compared with the viscosity of petroleum diesel at different temperatures?

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(2)

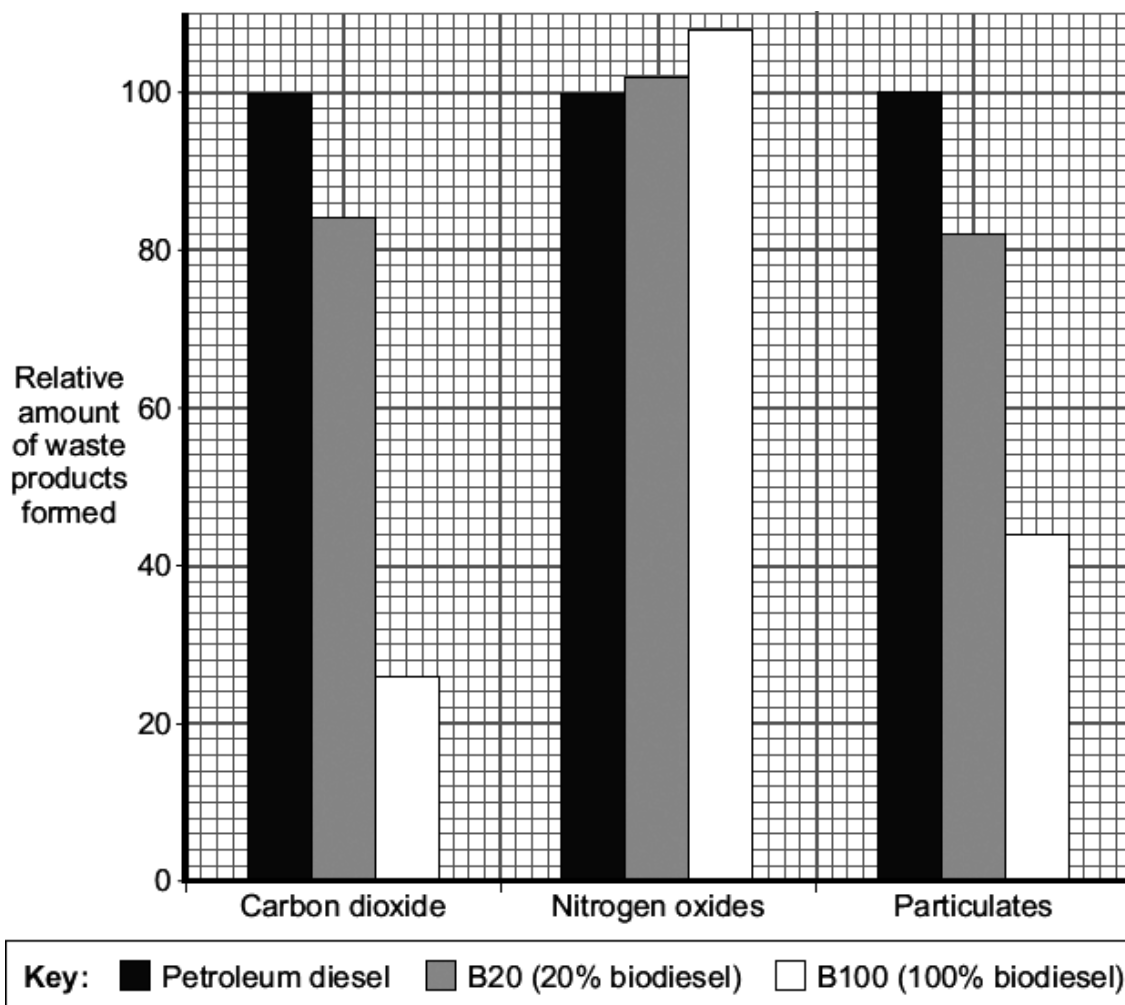
- (iii) Biodiesel may be less suitable than petroleum diesel as a fuel for cars. Use these results to suggest **one** reason why.

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(1)

- (b) Biodiesel can be mixed with petroleum diesel to make a fuel for cars.
 In a car engine, the diesel fuel burns in air.
 The waste products leave the car engine through the car exhaust system.
 The bar chart compares the relative amounts of waste products made when three different types of diesel fuel burn in a car engine.



Nitrogen oxides and sulfur dioxide cause a similar environmental impact.

- (i) What environmental impact do particulates from car exhaust systems cause?

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(1)

- (ii) What is the percentage reduction in particulates when using B100 instead of petroleum diesel?

..... %

(1)

- (iii) Replacing petroleum diesel with biodiesel increases one type of environmental pollution.

Use the bar chart and the information given to explain why.

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(2)

- (iv) A carbon neutral fuel does **not** add extra carbon dioxide to the atmosphere.

Is biodiesel a carbon neutral fuel?

Use the bar chart and your knowledge to explain your answer.

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(2)

(Total 10 marks)

**Supermarkets launch eco-friendly plastic milk bags.
Could this be the end of the milk bottle?**



Milk bottles are made from glass or from plastic.

Glass milk bottles contain 0.5 litres of milk. When the milk is used up the empty bottles are returned to be re-used. Glass milk bottles are re-used 24 times on average. The glass to make new milk bottles is produced when a mixture of sand, limestone, soda and recycled glass is heated to about 1600 °C in a furnace. There are almost unlimited amounts of the raw materials needed to produce this glass. About 35% of used glass is recycled.

The most common plastic milk bottles contain 2 litres of milk. When the milk is used up the empty bottles are discarded as waste. The plastic used to make these milk bottles is poly(ethene). Poly(ethene) is produced from crude oil by first using fractional distillation, then cracking the naphtha fraction and finally polymerising the ethene. About 5% of used poly(ethene) is recycled.

The new plastic milk bags contain 2 litres of milk. The milk bags are also made from poly(ethene). A milk bag uses 75% less poly(ethene) than is used to make the poly(ethene) milk bottles. When the milk is used up the empty bags are discarded as waste.

- (a) Describe what happens in fractional distillation so that fractions, such as naphtha, are separated from crude oil.

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(3)

- (b) Supermarkets claim that using milk bags instead of milk bottles would have less environmental impact.

Do you agree with this claim?

Use the information in the article and your knowledge and understanding to make appropriate comparisons to justify your answer.

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(4)
(Total 7 marks)

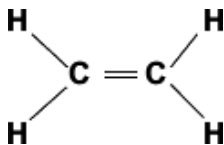
38

Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers.

Plastic bags are made from a polymer.

The polymer is made from ethene.

The structural formula of ethene is shown.



Ethene is made by cracking hydrocarbons.

These hydrocarbons come from crude oil.

(a) Complete these sentences about ethene.

- (i) Ethene is a hydrocarbon because it contains only and

(2)

- (ii) Ethene is unsaturated because it has a bond.

(1)

(b) Tick (✓) the name of the polymer formed when many ethene molecules join together.

Name of polymer	Tick (✓)
poly(chloroprene)	
poly(ethene)	
poly(propene)	

(1)

(c) Suggest **two** reasons why supermarkets should stop giving plastic bags to customers.

- 1
-
- 2
-

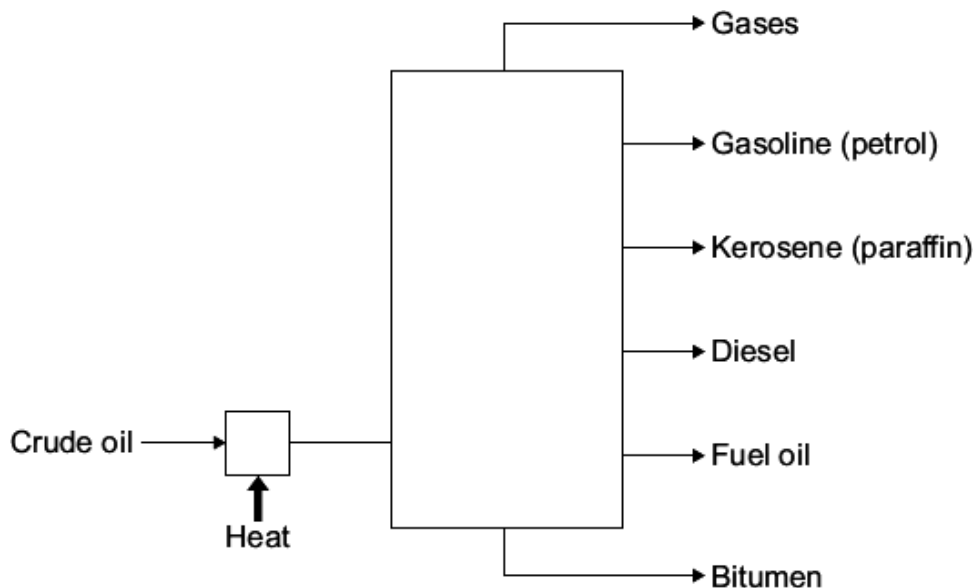
(2)

(Total 6 marks)

39

Crude oil is used to produce many useful materials.

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



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

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

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(3)

- (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.

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

.....

(1)

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

.....

(1)

- (c) Fuels are substances that release energy.

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

.....

(1)

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

.....

(2)

(Total 8 marks)

Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers. The Government states that this is because plastic bags use up resources that are not renewable and that the manufacture of plastic bags produces carbon dioxide. Most of these plastic bags are made from poly(ethene). The table shows methods to deal with large numbers of used plastic bags.

Method	Description of what happens to the plastic bag
Reused	used again by the customer
Recycled	collected, transported, washed and melted to make new plastic items
Burned	collected, transported and burnt to release heat energy
Dumped	mixed with other household waste, collected, transported and disposed of at a landfill site

Use the information and your knowledge and understanding to briefly give **one advantage and one disadvantage** for each of these methods.

Reused

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.....

Recycled

.....

.....

Burned

.....

.....

Dumped

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.....

(4)
(Total 4 marks)

41

This information about diesel was printed in a magazine.

Almost all of the crops that we eat can be converted into fuel for cars.

Vegetable oils can be used as biodiesel. Diesel from crude oil is called fossil diesel.

When either biodiesel or fossil diesel burn they both produce similar amounts of carbon dioxide.

Both types of diesel produce carbon monoxide. However, biodiesel produces fewer carbon particles and less sulfur dioxide.

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

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(2)

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

Remember to give a conclusion to your evaluation.

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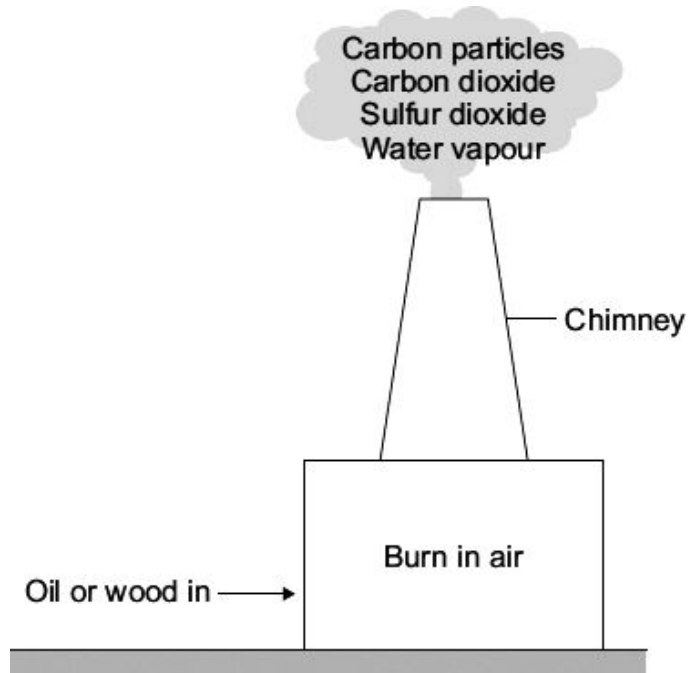
(5)

(Total 7 marks)

42

In the future:

- there will be fewer oil burning power stations
- there may be more wood burning power stations.



- (a) Which **one** of the emissions from the chimney can cause acid rain?

.....

(1)

- (b) Draw a ring around the correct answer to complete the sentence.

Carbon particles in the Earth's atmosphere cause

acid rain.

global
dimming.

global
warming.

(1)

- (c) Which gas in the air is needed for oil or wood to burn?

.....

(1)

- (d) Suggest why there will be **fewer** power stations burning oil in the future.

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(1)

- (e) Some power stations burn wood.
The wood comes from trees grown in forests.

Suggest why burning wood in power stations is said to be 'carbon-neutral'.

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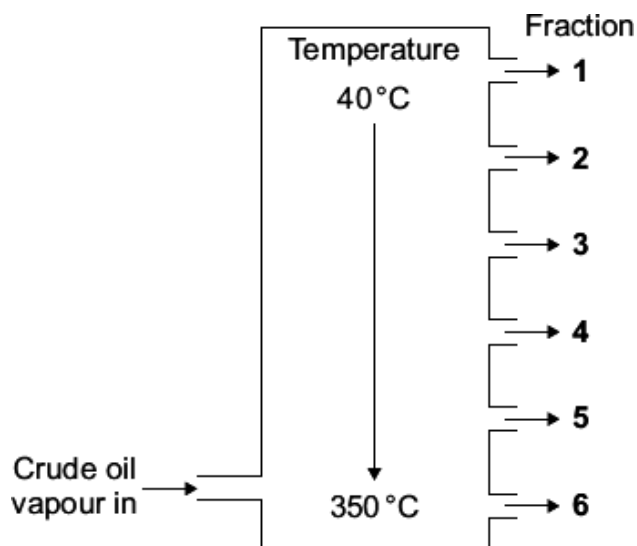
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(2)
(Total 6 marks)

43

Crude oil is a mixture of hydrocarbons.
Crude oil can be separated into fractions.



- (a) (i) Complete the sentence.

The process used to separate the crude oil into fractions is called
fractional

(1)

- (ii) Why do the fractions separate at different temperatures?

.....

.....

(1)

- (b) Tick (✓) **two** properties of fraction **6**.

Property	Tick (✓)
contains hydrocarbons	
has a small number of carbon atoms in each molecule	
is easy to ignite	
has a high boiling point	

(2)

- (c) Fraction **1** contains hydrocarbons called alkanes.

The general formula of an alkane is: C_nH_{2n+2}

What is the formula of the alkane that has 5 carbon atoms in each molecule?

Draw a ring around the correct answer.



(1)

(Total 5 marks)

44

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

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

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



How are hydrocarbons cracked?

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(2)

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

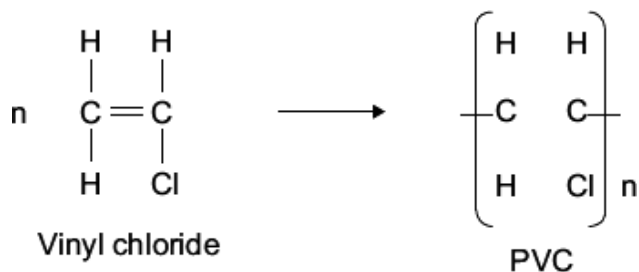
Complete the chemical equation by writing in the formula of the product vinyl chloride.



(1)

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

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

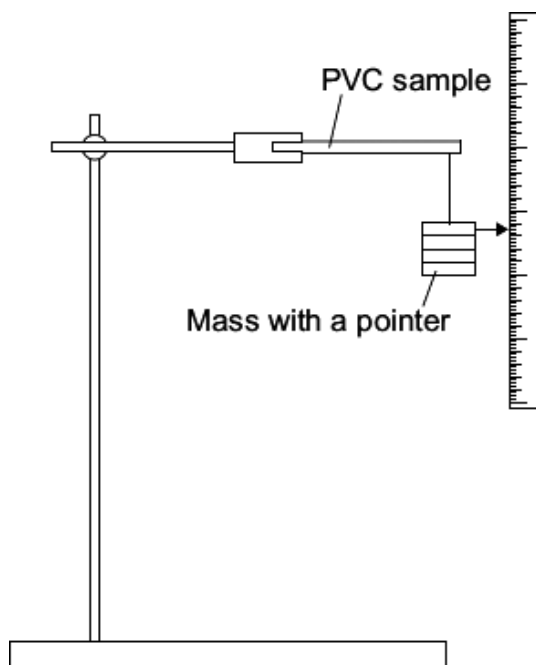


(1)

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

A student investigated how the percentage of plasticiser added to PVC affected its flexibility.

The student measured the bending of PVC samples when a mass was added.



The student's results are shown in the table.

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

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

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.....

(1)

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

.....

(1)

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

.....

(2)

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

.....

(1)

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

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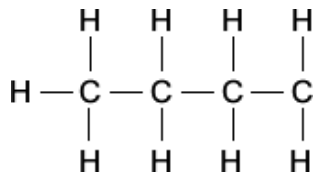
(1)

(Total 10 marks)**45**

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

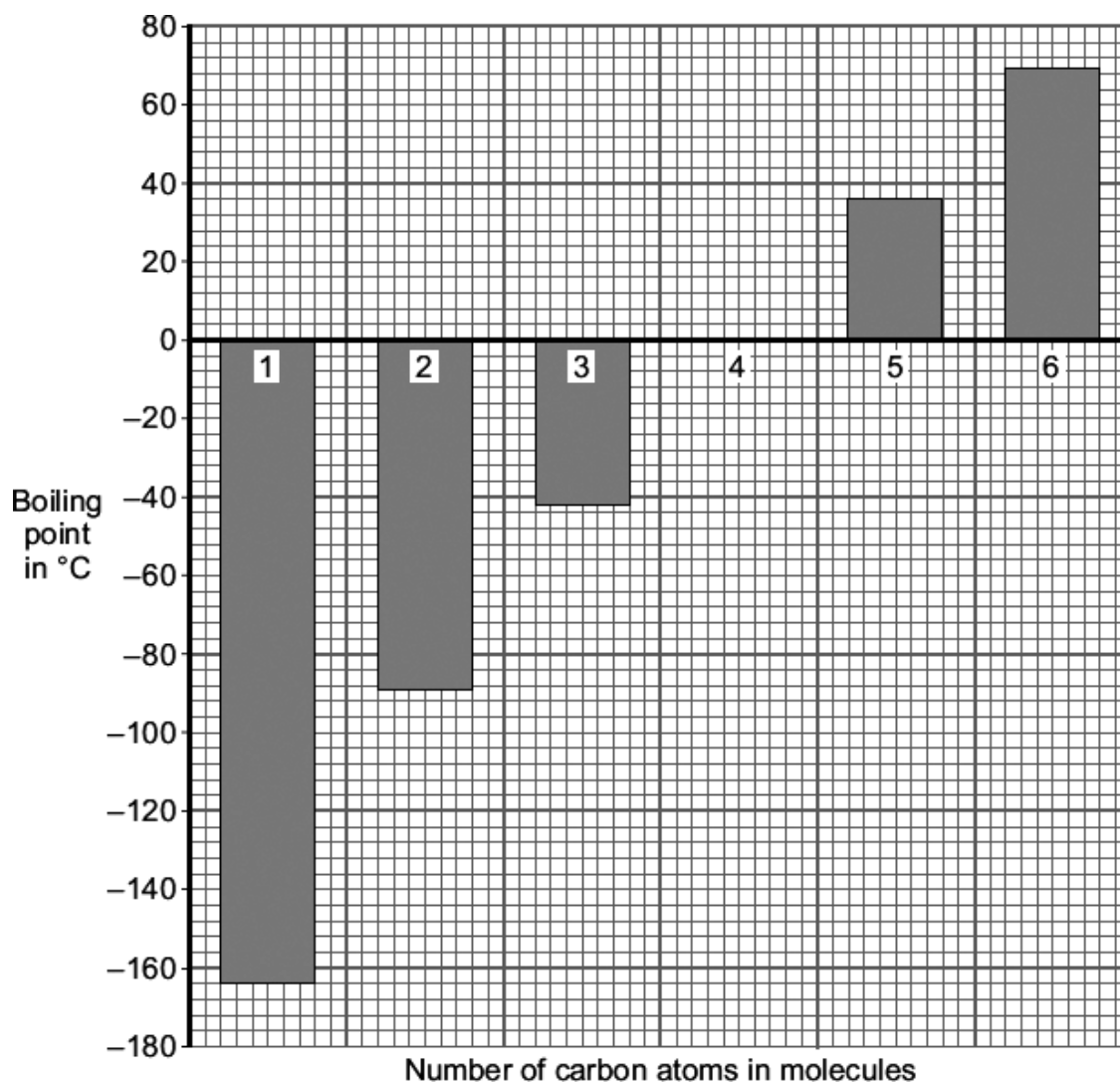
- (a) The general formula of an alkane is C_nH_{2n+2}

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



(1)

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



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

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(1)

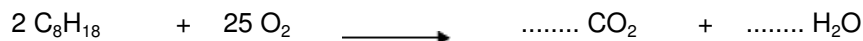
- (ii) Suggest **two** reasons why all of the alkanes in the bar chart are better fuels than the alkane with the formula $C_{30}H_{62}$

1
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2
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(2)

- (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.

- (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.



(1)

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

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.....

(1)

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

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(2)

(Total 8 marks)

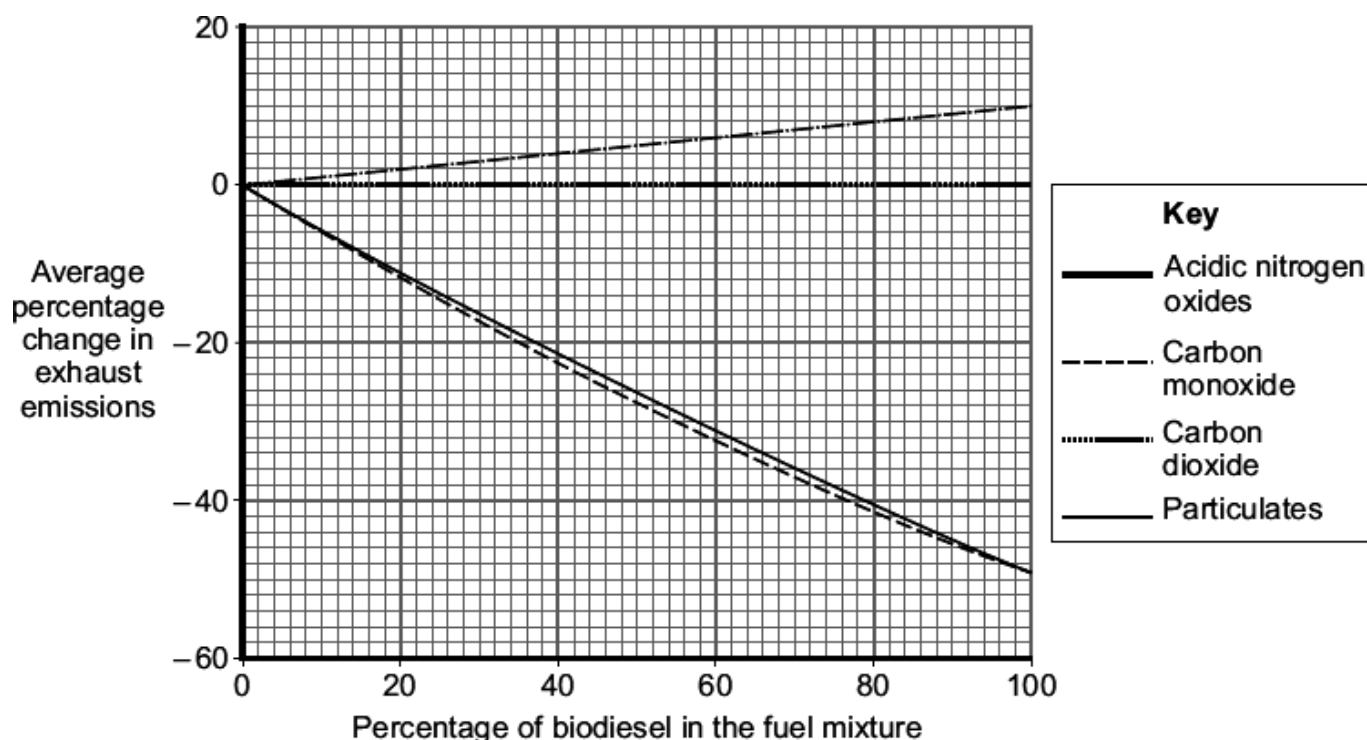
46

Petroleum diesel is produced from crude oil.

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

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

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



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

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

Remember to give a conclusion to your evaluation.

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(5)
(Total 5 marks)

47

Natural gas is mainly a hydrocarbon called methane.

- (a) Use **one** word from the box to complete the sentence.

compounds

elements

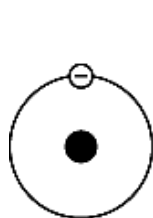
molecules

Hydrocarbons contain hydrogen and carbon only.

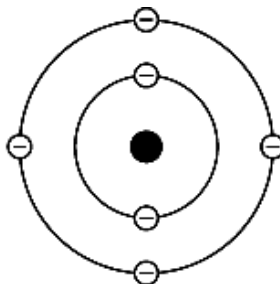
Hydrogen and carbon are

(1)

- (b) The diagrams represent atoms of hydrogen and carbon.



Hydrogen



Carbon

Draw a ring around the correct answer to complete the sentences.

- (i) The centre of each atom is called the

bond.

nucleus.

symbol.

(1)

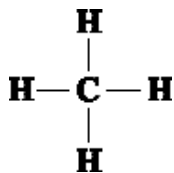
- (ii) The hydrogen atom has one electron and the carbon atom has

three
four
six

electrons.

(1)

- (c) A molecule of methane can be represented as



Draw a ring around the correct answer to complete the sentences.

- (i) The formula of methane is

CH
CH ₄
C ₄ H ₄

(1)

- (ii) The line between C—H is called a

bond.
molecule.
nucleus.

(1)

- (d) Methane burns to produce carbon dioxide (CO₂) and water (H₂O).

- (i) Draw a ring around the correct answer to complete the sentence.

When methane burns it reacts with

carbon.
nitrogen.
oxygen.

(1)

- (ii) Hydrogen (H_2) can be used as a fuel.

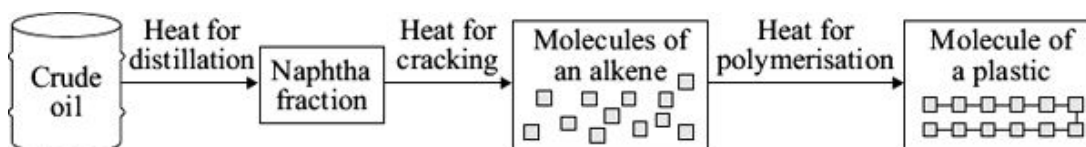
Suggest why burning hydrogen would be less harmful to the environment than burning methane.

.....

(1)
 (Total 7 marks)

48

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



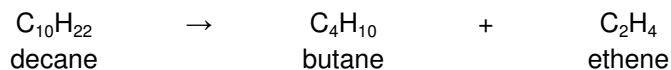
- (a) Describe how crude oil is separated into fractions.

.....

(2)

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

- (i) Balance the symbol equation for this reaction.



(1)

- (ii) Describe how cracking is carried out.

.....

(2)

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

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

Explain these statements.

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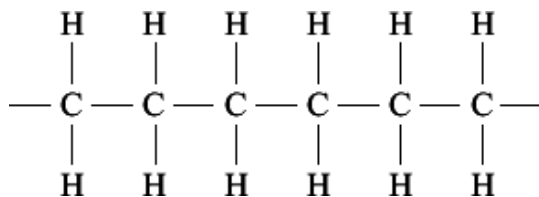
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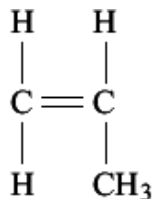
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(2)

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



Propene molecules form the polymer poly(propene).



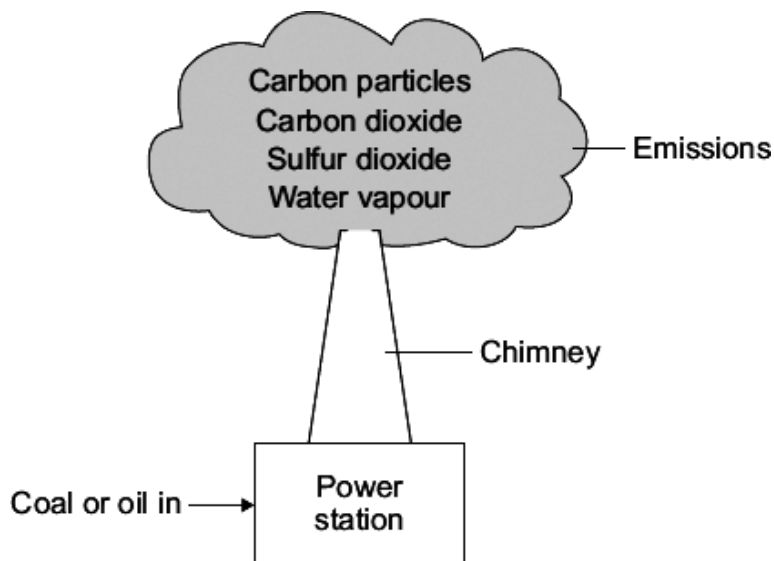
Propene molecule

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

(2)
(Total 9 marks)

49

In the future more coal-fired and fewer oil-fired power stations will be used to generate electricity. When coal and oil are burned they produce the same types of emissions which can cause environmental problems.



- (a) Emissions from the chimney can cause acid rain, global dimming and global warming. Draw **one** straight line from each possible environmental problem to the emission that causes it.

Possible environmental problem

Emission that causes it

acid rain

carbon particles

global warming

carbon dioxide

global dimming

sulfur dioxide

water vapour

(3)

- (b) Draw a ring around the correct word in the box to complete each sentence.

- (i) Incomplete combustion of coal or oil is caused by too little

carbon dioxide.
nitrogen.
oxygen.

(1)

- (ii) A gas formed by the incomplete combustion of coal or oil is

carbon monoxide.
hydrogen.
oxygen.

(1)

- (c) The table shows the world production for both coal and oil in 2000.

The world production figures after 2000 are predicted.

Year	World production of coal (billions of tonnes per year)	World production of oil (billions of barrels per year)
2000	3.5	12.5
2050	4.5	5.6
2100	5.0	1.7
2150	5.5	0.5
2200	6.0	0.0

- (i) How is the world production of oil predicted to change from 2000 to 2200?

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(1)

- (ii) Suggest **two** reasons why the world production of coal is predicted to increase.

1

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2

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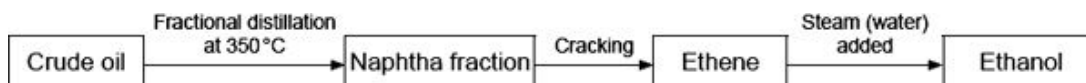
(2)

(Total 8 marks)

50

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

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

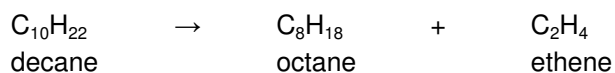


- (a) Why does crude oil need to be fractionally distilled?

.....

(1)

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

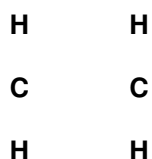


- (i) Describe how cracking is done.

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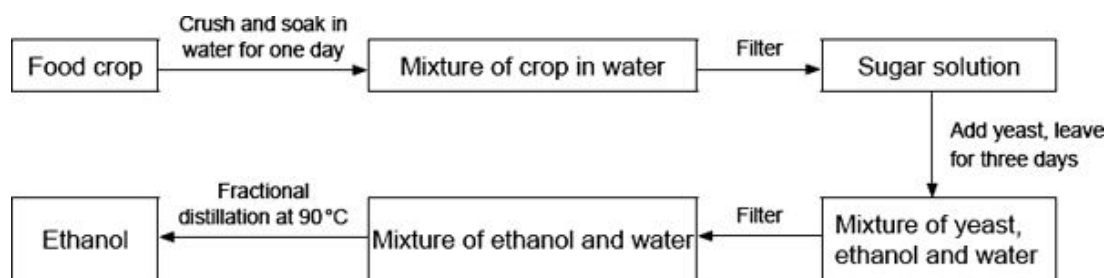
(2)

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



(1)

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



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

Remember to give a conclusion to your evaluation.

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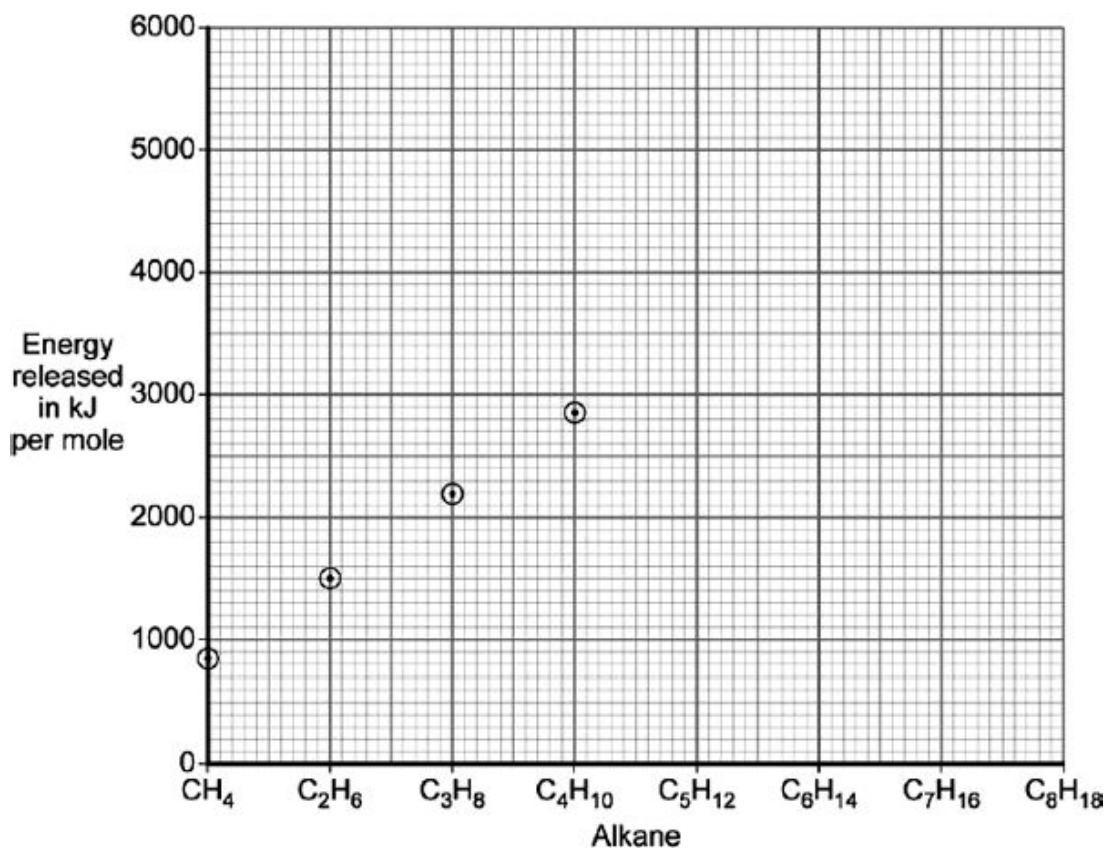
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(5)
(Total 9 marks)

51

- (a) Alkanes are important hydrocarbon fuels. They have the general formula C_nH_{2n+2}

The points on the graph show the amount of energy released when 1 mole of methane (CH_4), ethane (C_2H_6), propane (C_3H_8) and butane (C_4H_{10}) are burned separately.



- (i) Draw a line through the points and extend your line to the right-hand edge of the graph. (1)
- (ii) Use the graph to estimate the amount of energy released when 1 mole of octane (C_8H_{18}) is burned.

Energy released = kJ

(1)

- (iii) Suggest why we can make a good estimate for the energy released by 1 mole of pentane (C_5H_{12}).

.....

.....

(1)

- (iv) A student noticed that octane (C_8H_{18}) has twice as many carbon atoms as butane (C_4H_{10}), and made the following prediction:

“When burned, 1 mole of octane releases twice as much energy as 1 mole of butane.”

Use the graph to decide if the student's prediction is correct. You **must** show your working to gain credit.

.....

(2)

- (b) Some information about four fuels is given in the table.

Fuel	Type	Heat released in kJ per g	Combustion products			Type of flame
			CO ₂	SO ₂	H ₂ O	
Bio-ethanol	Renewable	29	✓		✓	Not smoky
Coal	Non-renewable	31	✓	✓	✓	Smoky
Hydrogen	Renewable	142			✓	Not smoky
Natural gas	Non-renewable	56	✓		✓	Not smoky

From this information a student made two conclusions.

For each conclusion, state if it is correct **and** explain your answer.

- (i) “Renewable fuels release more heat per gram than non-renewable fuels.”

.....

(2)

- (ii) "Non-renewable fuels are better for the environment than renewable fuels."

.....

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(2)
(Total 9 marks)

52

Water sold in plastic bottles has a high 'carbon cost'.

The 'carbon cost' depends on the amount of carbon dioxide emitted in making and transporting the product.

The more carbon dioxide emitted, the higher the 'carbon cost'.

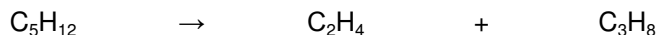
- (a) Plastic water bottles are made from a polymer.
The polymer is made from ethene.
Ethene is made by cracking hydrocarbons.

- (i) Name the polymer made from ethene.

.....

(1)

- (ii) Ethene can be made by cracking the hydrocarbon pentane, C_5H_{12} .



Explain why there is a 'carbon cost' for the process of cracking a hydrocarbon.

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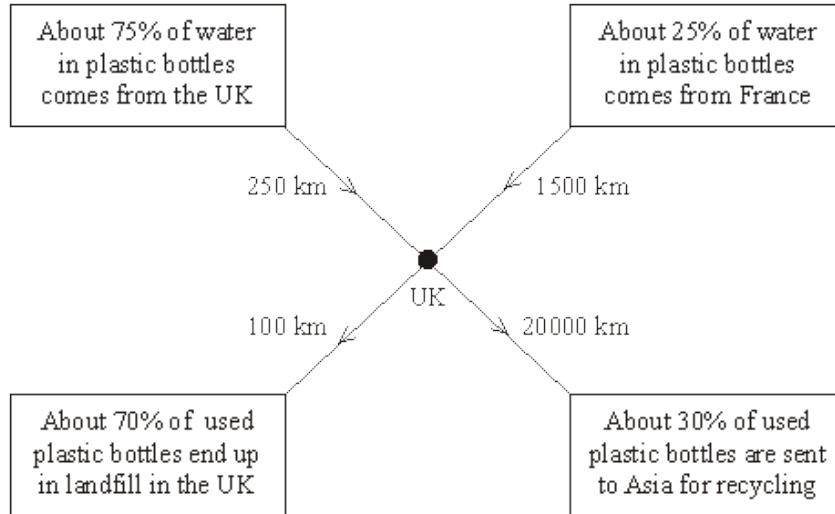
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(2)

- (b) The diagram shows information about water sold in plastic bottles in the UK. The diagram also shows the average distances that water and plastic bottles are transported.



Suggest how the high 'carbon cost' of water sold in plastic bottles could be reduced.

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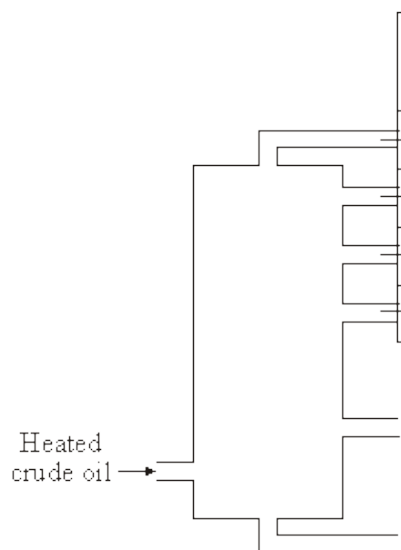
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(3)
(Total 6 marks)

Crude oil is a resource from which fuels can be separated.

- (a) The name of the main fuel fractions and one of the hydrocarbons in each fraction are shown in the table.



Main fuel fraction	A hydrocarbon in this fraction	Boiling point of hydrocarbon in °C
Gases	Propane, C ₃ H ₈	-42
Petrol	Octane, C ₈ H ₁₈	126
Paraffin	Dodecane, C ₁₂ H ₂₆	216
Diesel	Eicosane, C ₂₀ H ₄₂	344

- (i) How does the number of carbon atoms in a hydrocarbon affect its boiling point?

.....

(1)

- (ii) Suggest the lowest temperature to which crude oil needs to be heated to vaporize all the hydrocarbons in the table.

Temperature = °C

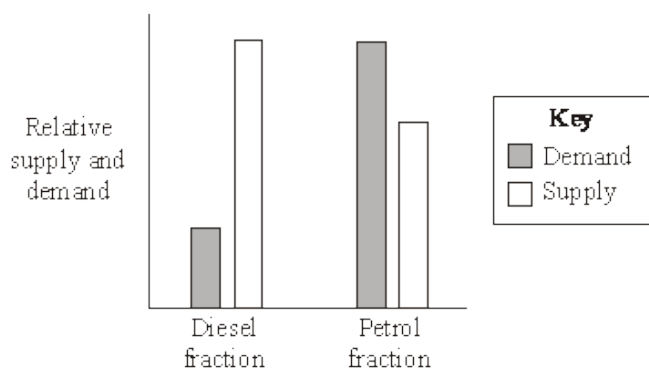
(1)

- (iii) Dodecane boils at 216 °C. At what temperature will dodecane gas condense to liquid?

Temperature = °C

(1)

- (b) The bar chart shows the relative supply and demand for the petrol and diesel fractions.



- (i) How does the relative supply and demand for petrol and diesel fractions cause problems for an oil company?

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(2)

- (ii) Suggest **one** way an oil company could solve these problems.

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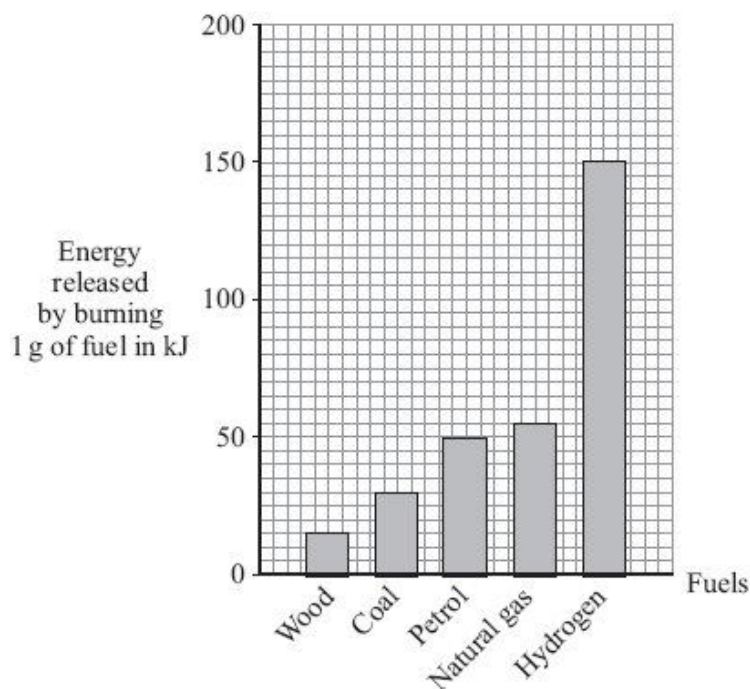
(1)

(Total 6 marks)

54

Energy is released by burning fuels.

- (a) The bar chart shows the energy in kilojoules, kJ, released by burning 1 g of five different fuels.



- (i) Which fuel releases the least energy from 1 g?

.....

(1)

- (ii) How much energy is released by burning 1 g of coal?

Energy = kJ

(1)

- (iii) Coal burns in oxygen and produces the gases shown in the table.

Name	Formula
Carbon dioxide	CO_2
Water vapour	H_2O
Sulfur dioxide	SO_2

Use information from the table to name **one** element that is in coal.

.....

(1)

- (iv) Use information from the bar chart to calculate the mass of petrol that will release the same amount of energy as 1 g of hydrogen.

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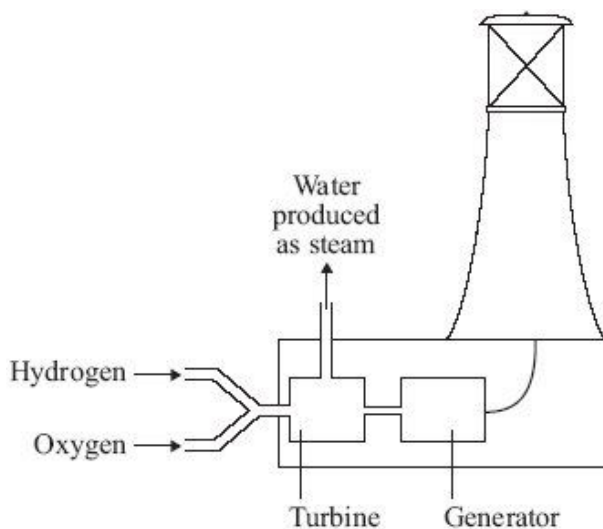
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Mass = g

(1)

- (b) Hydrogen can be made from fossil fuels.
Hydrogen burns rapidly in oxygen to produce water only.

A lighthouse uses electricity generated by burning hydrogen.



- (i) Use information from the bar chart and the diagram above to suggest **two** advantages of using hydrogen as a fuel.

1

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2

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(2)

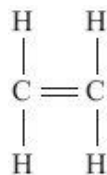
- (ii) Suggest **one** disadvantage of using hydrogen.

(1)
(Total 7 marks)

55

Crude oil is used to make useful substances such as alkenes and plastics.

- (a) The alkene shown is ethene.



- (i) Tick (✓) the correct formula for ethene.

Formula	(✓)
CH ₄	
C ₂ H ₄	
C ₂ H ₆	

(1)

- (ii) Tick (✓) the name of the plastic formed when many ethene molecules join together.

Name of plastic	(✓)
Poly(ethene)	
Poly(ethanol)	
Poly(propene)	

(1)

- (b) Read the article about plastics and then answer the questions.

THE PROBLEM WITH PLASTIC WASTE

The UK produces about 3 million tonnes of plastics from crude oil every year.

Most of the litter found on UK beaches is plastic waste.

80% of the plastics produced end up in landfill sites.

The UK recycles only 7% of plastic waste.

- (i) Draw a ring around the correct answer in the box to complete the sentence.

Litter that is plastic waste needs to be removed from beaches

because it

decomposes is flammable is not biodegradable
--

(1)

- (ii) Suggest a problem caused by 80% of the plastics going to landfill sites.

.....
.....

(1)

- (iii) The UK government has set a target to recycle 30% of plastic waste.

How are resources saved by recycling more plastics?

.....
.....

(1)

(Total 5 marks)

56

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

- (i) Describe how ethene forms poly(ethene).

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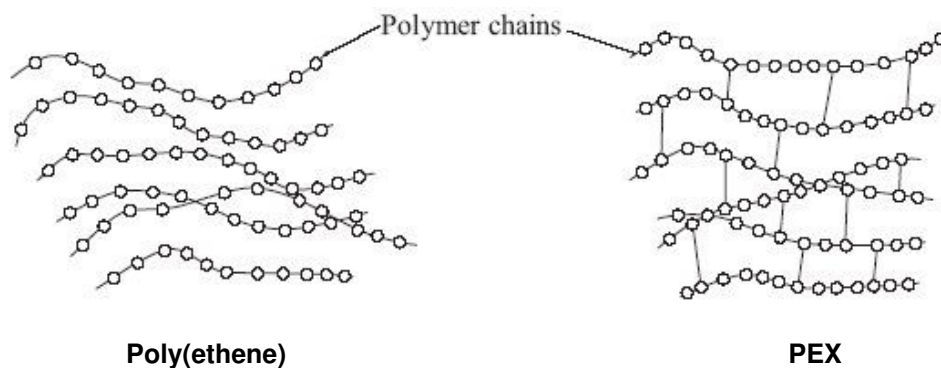
(2)

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

.....
.....

(1)

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



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

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

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.....

(3)

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

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

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

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

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

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

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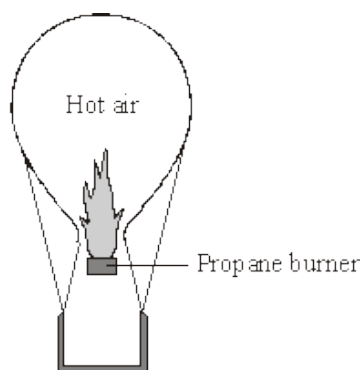
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(4)
(Total 10 marks)



- (a) The hot air contains these gases: nitrogen, N_2
 oxygen, O_2
 argon, Ar
 carbon dioxide, CO_2
 water vapour, H_2O

- (i) Argon is an *element*.

What is an *element*?

.....

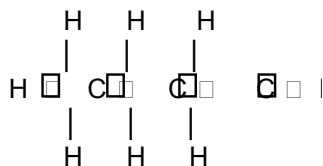
(1)

- (ii) Name **one** other gas in the hot air that is also an element.

.....

(1)

- (b) Propane, C_3H_8 , can be represented as:



Use the correct words from the box to complete the sentences.

bond	carbon	compound	element	mixture
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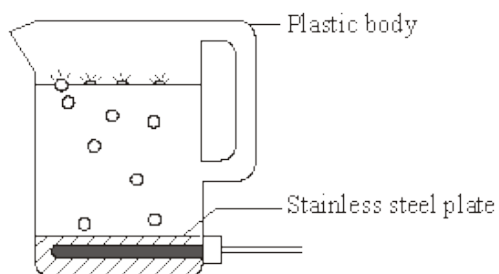
- (i) Propane is a and is made up of atoms of hydrogen
 and

(2)

- (ii) Each line between the atoms in propane represents a chemical

(1)

(Total 5 marks)



(a) Complete the sentences by drawing a ring around the correct words.

(i) The plastic is made from many small molecules called

catalysts
monomers
polymers

(1)

(ii) Propene is produced by cracking some of the fractions that are

separated from

crude oil
limestone
metal ores

(1)

(b) After a few years the kettle no longer worked.

- Some parts of the kettle are made of plastic.
- Some parts of the kettle are made of stainless steel.
- The owner of the kettle disposed of it in a landfill site.

Consider these statements.

Suggest **three** reasons why the kettle should **not** be disposed of in a landfill site.

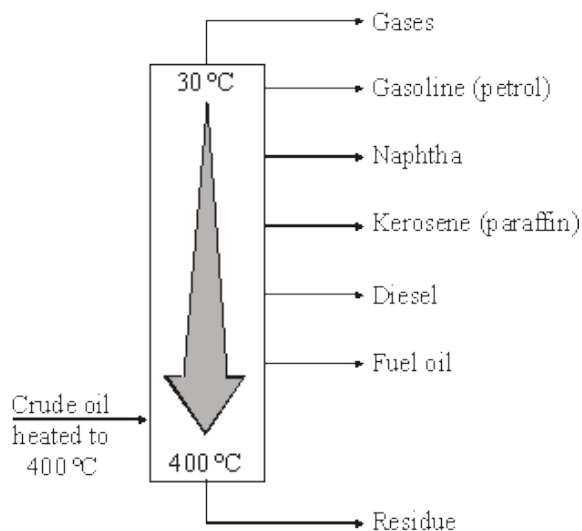
- 1
- 2
- 3

(3)

(Total 5 marks)

59

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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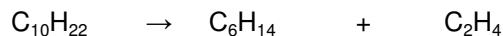
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(2)

- (b) The naphtha fraction is often used to make other useful materials.

This involves the cracking of hydrocarbons in the naphtha fraction.

For example:



- (i) Balance the symbol equation given above.

(1)

- (ii) Describe how cracking is carried out.

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(2)

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

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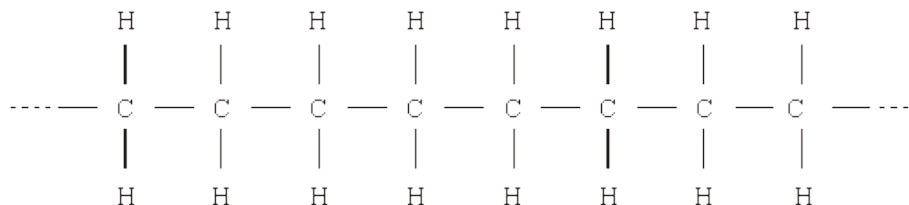
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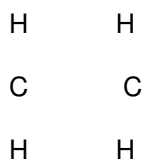
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(2)

- (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)

(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.

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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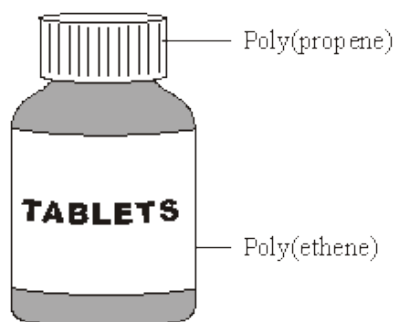
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(4)
(Total 12 marks)

60

Tablet containers are often made from two different polymers.



(a) Ethene, C_2H_4 , and propene, C_3H_6 , can be made from crude oil.

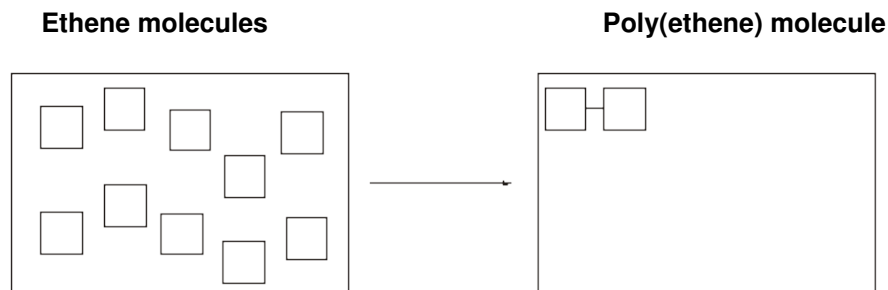
(i) Complete the following sentence.

Ethene and propene are called hydrocarbons because they are made up of carbon and atoms only.

(1)

- (ii) Ethene molecules are used to form poly(ethene) molecules.

Complete the diagram to show the poly(ethene) molecule.



(2)

- (b) The tablet containers could be disposed of in a landfill site or could be recycled.

- (i) Suggest **two** reasons why disposing of the tablet containers in a landfill site could cause problems.

1

.....

2

.....

(2)

- (ii) Suggest **one** reason why recycling the tablet containers would be difficult.

.....

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(1)

(Total 6 marks)