



Crude oil, it's products and other fuels



174 minutes



174 marks

Q1. Crude oil is a mixture of long-chain hydrocarbons. It is cracked to produce a mixture of smaller alkanes and alkenes. Among the gases formed are ethane and ethene.

(a) Write the structural formula for:

(i) ethane

(1)

(ii) ethene

(1)

(iii) Give an example of **one** chemical reaction which both ethane and ethene undergo.

.....

(1)

(iv) Describe how to distinguish between ethane and ethene. Include a description of the practical method you would use and what you would expect to observe.

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(3)

(b) Ethene may be polymerised to form a polymer. Give the name of the polymer and a use for it.

Name Use

(1)

(Total 7 marks)

Q2. Useful fuels can be produced from crude oil. Crude oil is a mixture of hydrocarbons.

(a) The table shows the boiling points of four of these hydrocarbons.

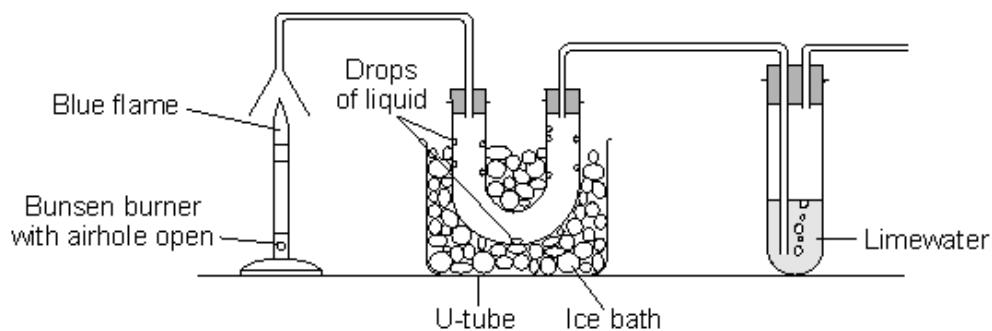
Hydrocarbon	Boiling point in °C
methane, CH ₄	-162
butane, C ₄ H ₁₀	0
pentane, C ₅ H ₁₂	+36
decane, C ₁₀ H ₂₂	+175

Tick (✓) **two** statements that are correct about these hydrocarbons.

Statement	Tick (✓)
decane has the largest molecules	
pentane is a liquid at 40°C	
methane and butane are gases at 20°C	
methane has the highest boiling point	
butane does not boil	

(2)

(b) Natural gas supplied to homes and schools is mainly methane. The diagram shows an apparatus to investigate the two substances produced when natural gas burns completely in air.



(i) Name the liquid that collects in the U-tube.

(1)

(ii) Name the gas that turns the limewater cloudy

(1)

- (c) Some crude oil contains sulfur. Petrol and diesel fuels are produced from crude oil. The sulfur must be removed from these fuels before they are burned. Explain why.

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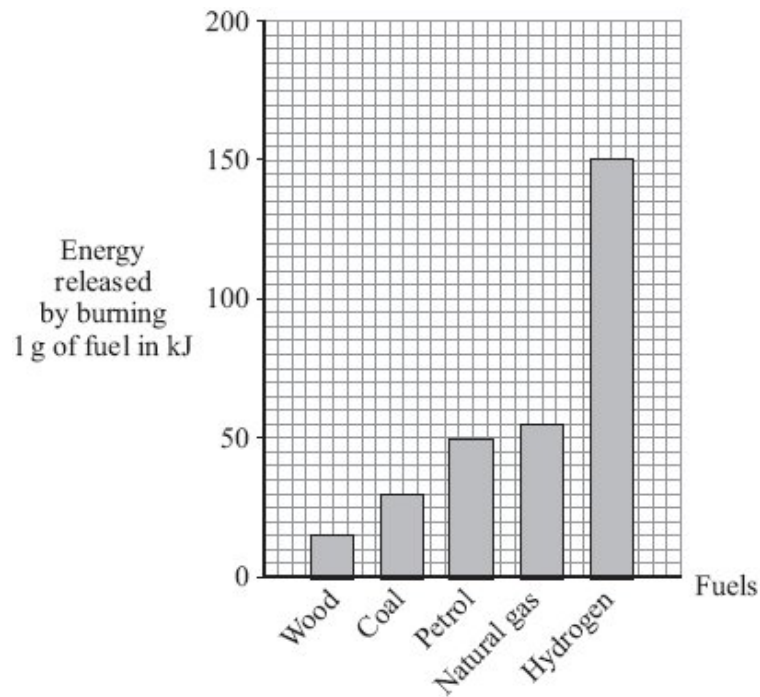
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(2)
(Total 6 marks)

Q3. 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 ₂ O
Sulfur dioxide	SO ₂

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

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(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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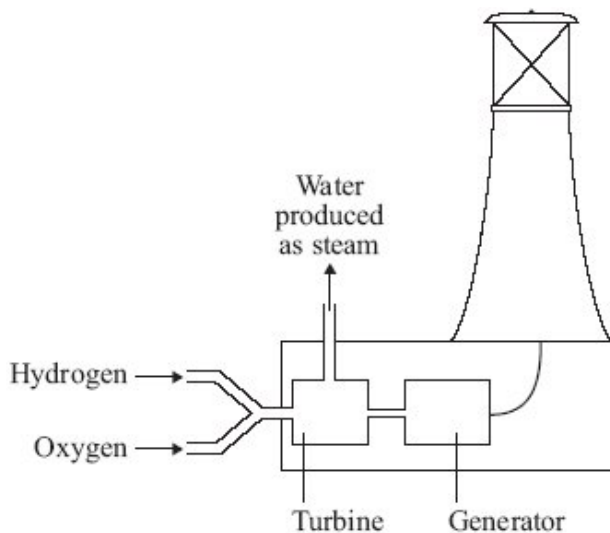
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Mass = g

(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.

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(1)

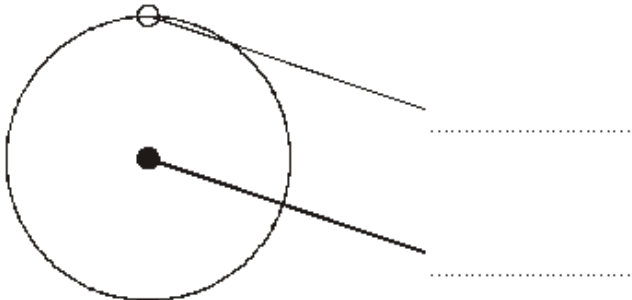
(Total 7 marks)

Q4. Hydrogen is an element.

(a) The diagram shows the parts of a hydrogen atom.

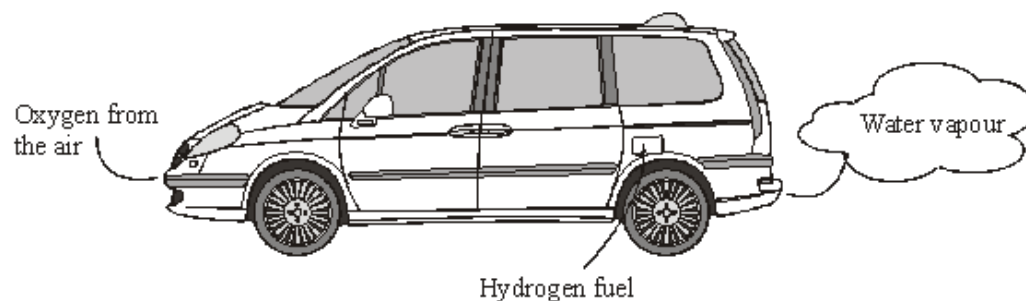
Use words from the box to label the diagram.

electron	group	nucleus	symbol
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(2)

(b) Hydrogen can be used as a *clean fuel* for cars.



(i) When hydrogen burns in air, it reacts with another element.

Complete the word equation for this reaction.



(1)

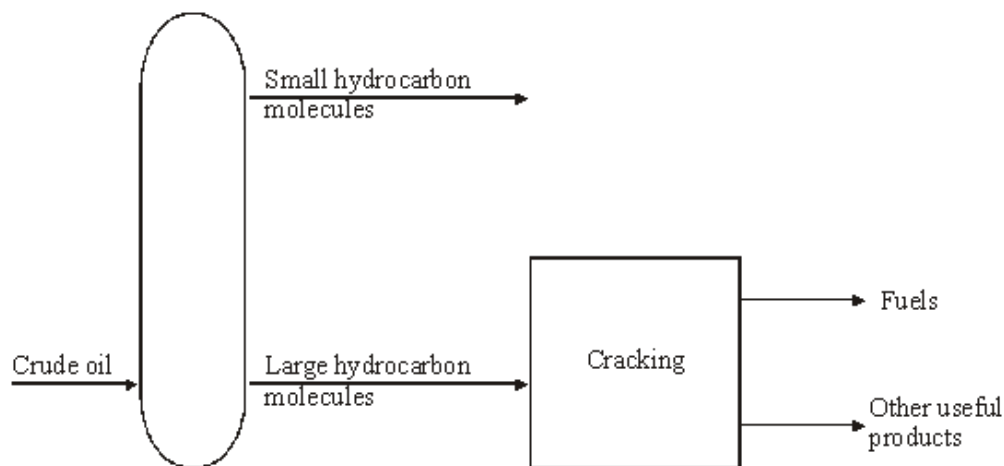
(ii) Suggest **one** reason why hydrogen is called a *clean fuel*.

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(1)

(Total 4 marks)

Q5. Crude oil is a mixture of hydrocarbons. These hydrocarbons can be separated and some of them can be used to make other useful products.



(a) Complete the sentence.

Hydrocarbons are made up of atoms and atoms.

(2)

(b) How are the small and large hydrocarbon molecules in crude oil separated?

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(2)

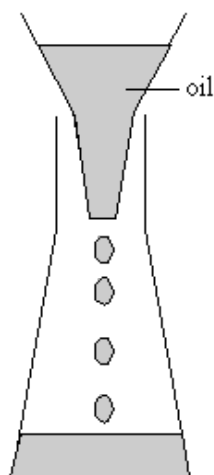
(c) The diagram shows that one useful product of cracking is fuels.
Name **one** of the other useful products.

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(1)

(Total 5 marks)

Q6. A teacher carried out an experiment to study car engine oil. The experiment was carried out in a fume cupboard and the teacher wore plastic gloves. The oil was poured through a funnel. The time taken for all the oil to go through the funnel was measured. The experiment was repeated with the oil at different temperatures.



(a) What **two** safety precautions were taken in the experiment?

1

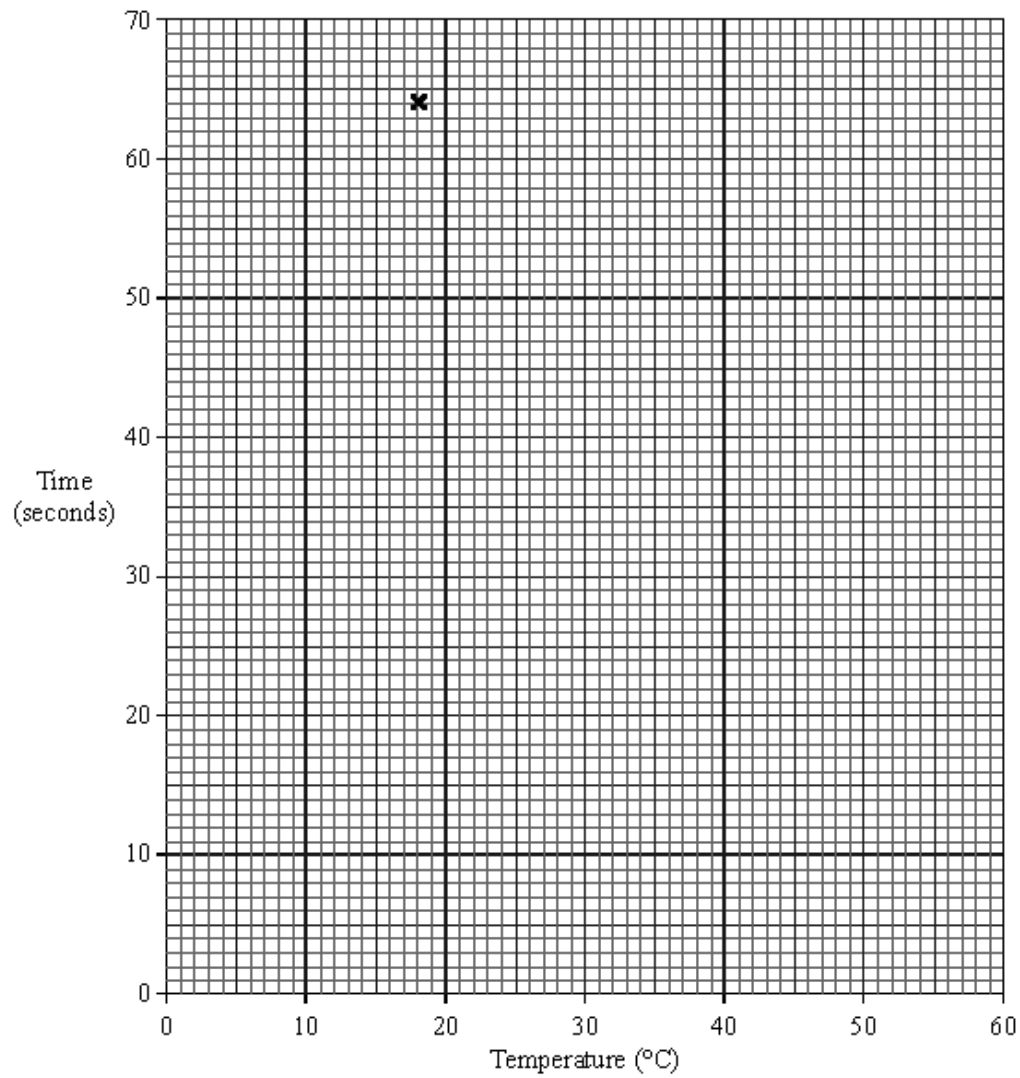
2

(1)

(b) The results of the experiment are shown in the table below.

TEMPERATURE (°C)	TIME (seconds)
18	64
25	43
32	28
42	19
52	15

(i) Plot the results on the graph paper. One of the results has been plotted for you. Join the points in a smooth curve.



(3)

- (ii) Use your graph to find the time it would take the oil to travel through the funnel at 37 °C.

Time = seconds (1)

- (iii) How does the time taken for the oil to go through the funnel change when the temperature is increased?

.....
..... (1)

- (c) An engine oil must be viscous enough to stop the metal parts of the engine from rubbing against each other. It must not be too viscous or the parts cannot move freely.

- (i) Complete the sentences below.

The more viscous a liquid is, the less easily it

As the liquid gets hotter it gets viscous.

(2)

- (ii) Why should the oil in a car engine **not** be allowed to get too hot?

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.....
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(1)

(Total 9 marks)

Q7. Since 2000 there has been a lot more research into alternative, environmentally-friendly fuels for road transport.

Several pollutants are found in the exhaust emissions produced when fossil fuels are used for road transport.

Carbon monoxide (CO) interferes with the way that red blood cells carry oxygen. Carbon dioxide (CO₂) increases the level of carbon dioxide in the atmosphere and causes global warming.

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

Sulfur dioxide (SO₂) is produced when sulfur impurities in the fuel combine with oxygen in the atmosphere.

Tiny particles of solids are produced when the fuel does not burn completely.

This increases the level of particulates (PM10) in the atmosphere.

(a) Name the environmental effect caused by:

(i) oxides of nitrogen (NO_x) and sulfur dioxide (SO₂)

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(1)

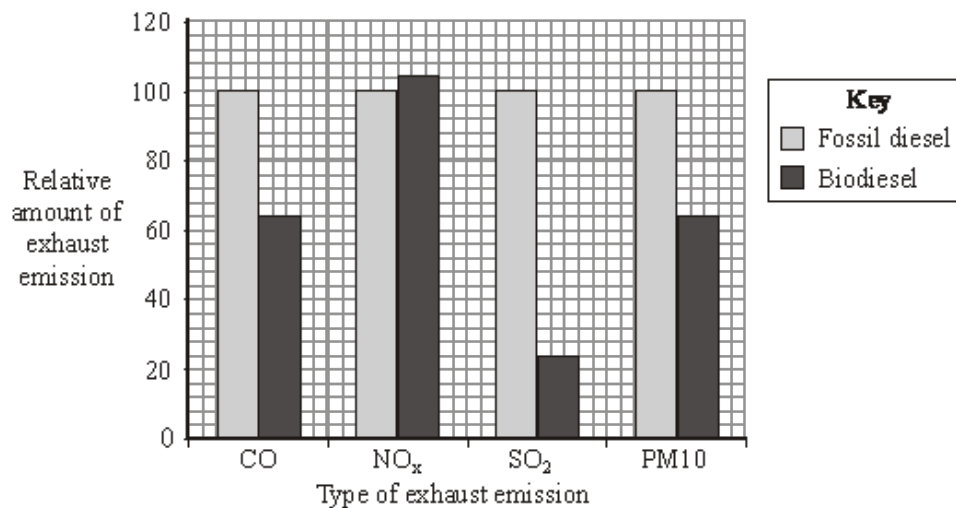
(ii) the increased level of particulates (PM10).

.....

(1)

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

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



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

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(3)

- (ii) Biodiesel is called a green fuel.

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

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

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(3)

(Total 8 marks)

Q8. The table shows some information about alkanes.

Name	Formula	Relative formula mass	Boiling point in °C
methane	CH_4	16	-160
ethane	C_2H_6	30	-90
propane		44	-40
butane	C_4H_{10}	58	
pentane	C_5H_{12}	72	36
hexane	C_6H_{14}	86	68

(a) Give the formula of propane.

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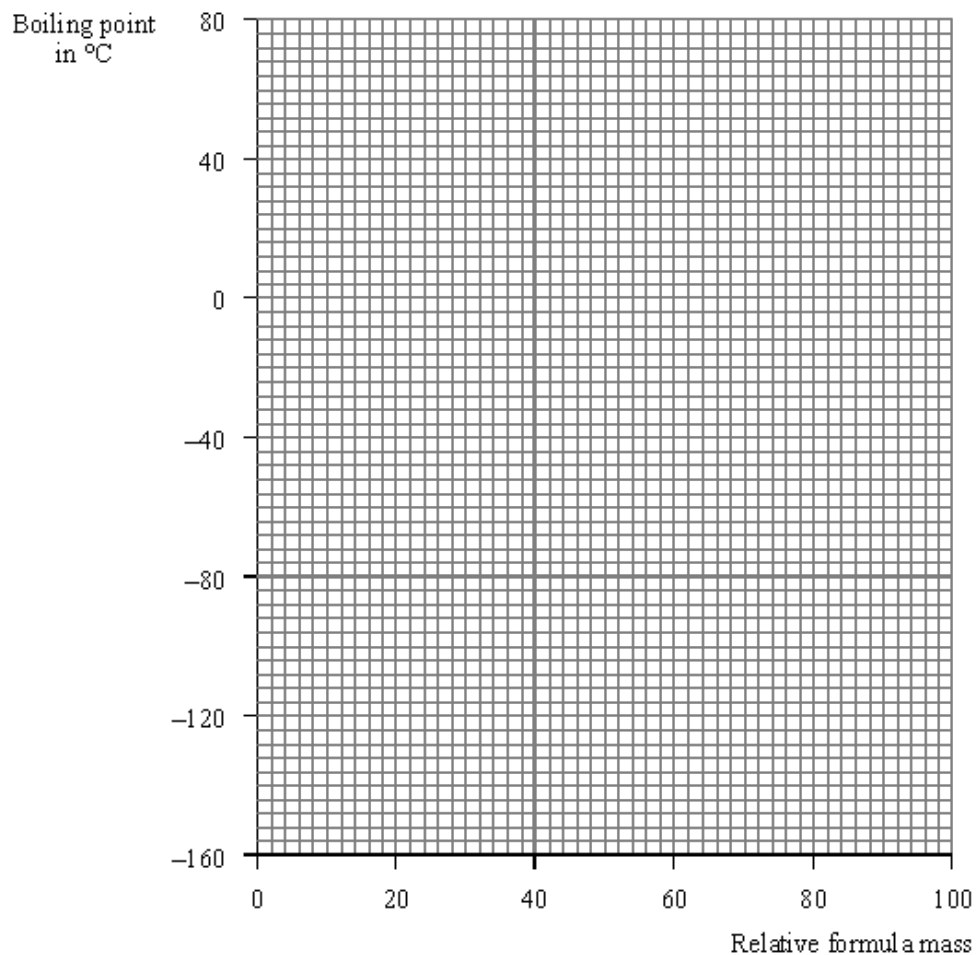
(1)

(b) (i) What happens to the boiling points of the alkanes as the relative formula mass increases?

.....

(1)

(ii) Draw a graph. Plot the points and draw a best fit line.



(3)

(iii) What is the boiling point of butane?

.....

(1)

(iv) Show clearly on the graph how you found the boiling point of butane.

(1)

(c) Circle which of the following is **not** an alkane.



(1)
(Total 8 marks)

Q9. Natural gas is mainly a hydrocarbon called methane.

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

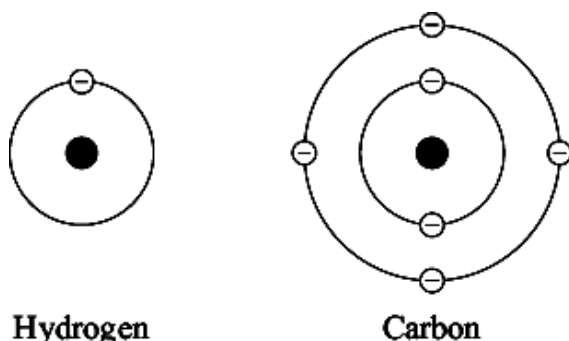
compounds	elements	molecules
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Hydrocarbons contain hydrogen and carbon only.

Hydrogen and carbon are

(1)

(b) The diagrams represent atoms of hydrogen and 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)

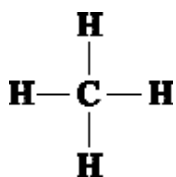
(ii) The hydrogen atom has one electron and the carbon atom has

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

CH₄

C₄H₄

(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 (H₂) can be used as a fuel.

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

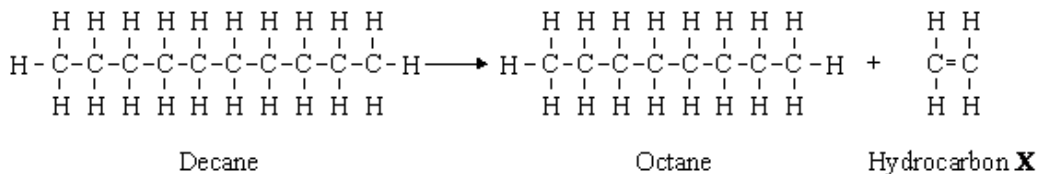
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(1)

(Total 7 marks)

Q10. The high demand for petrol (octane) can be met by breaking down longer hydrocarbons, such as decane, by a process known as cracking.



(a) Apart from heat, what is used to make the rate of this reaction faster?

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(1)

(b) Octane is a *hydrocarbon*.

(i) What does *hydrocarbon* mean?

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(1)

(ii) Give the molecular formula of octane.

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(1)

(c) The hydrocarbon **X** is used to make poly(ethene).

(i) What is the name of **X**?

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(1)

(ii) What is the name of the process in which **X** is changed into poly(ethene)?

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(1)

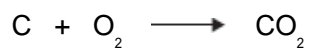
(Total 5 marks)

Q11. 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:



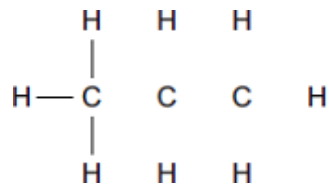
Complete the word equation for this reaction.

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.	

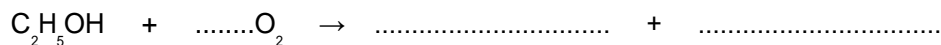
(2)

(Total 6 marks)

Q12. Most petrol used in cars contains about 5% ethanol (C₂H₅OH).

(a) The complete combustion of ethanol produces carbon dioxide and water.

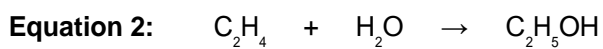
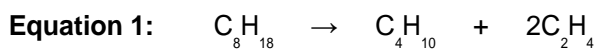
Complete and balance the symbol equation for the complete combustion of ethanol.



(2)

(b) Ethanol can be produced from octane (C_8H_{18}).

The two chemical equations represent the production of ethanol from octane.



(i) In **Equation 1** the products are a mixture of two gases.

Describe a chemical test that would indicate the presence of ethene (C_2H_4) in the mixture.

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(2)

(ii) Describe, as fully as you can, the conditions used for the two reactions to produce ethanol from octane.

Use **Equation 1** and **Equation 2** to help you with your answer.

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(4)
(Total 8 marks)

Q13. Read the article and then answer the questions.

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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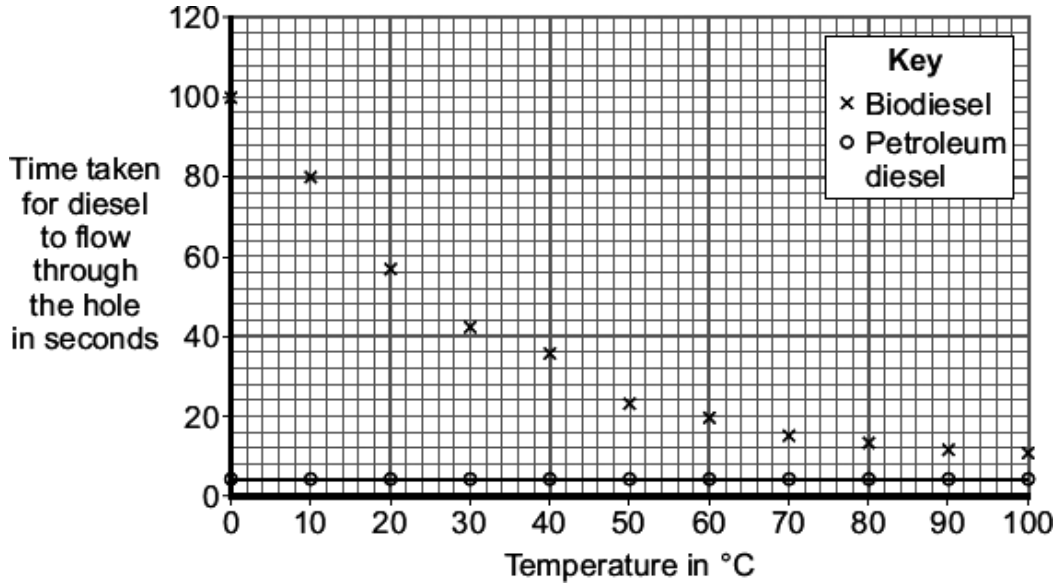
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(4)
(Total 7 marks)

Q14. 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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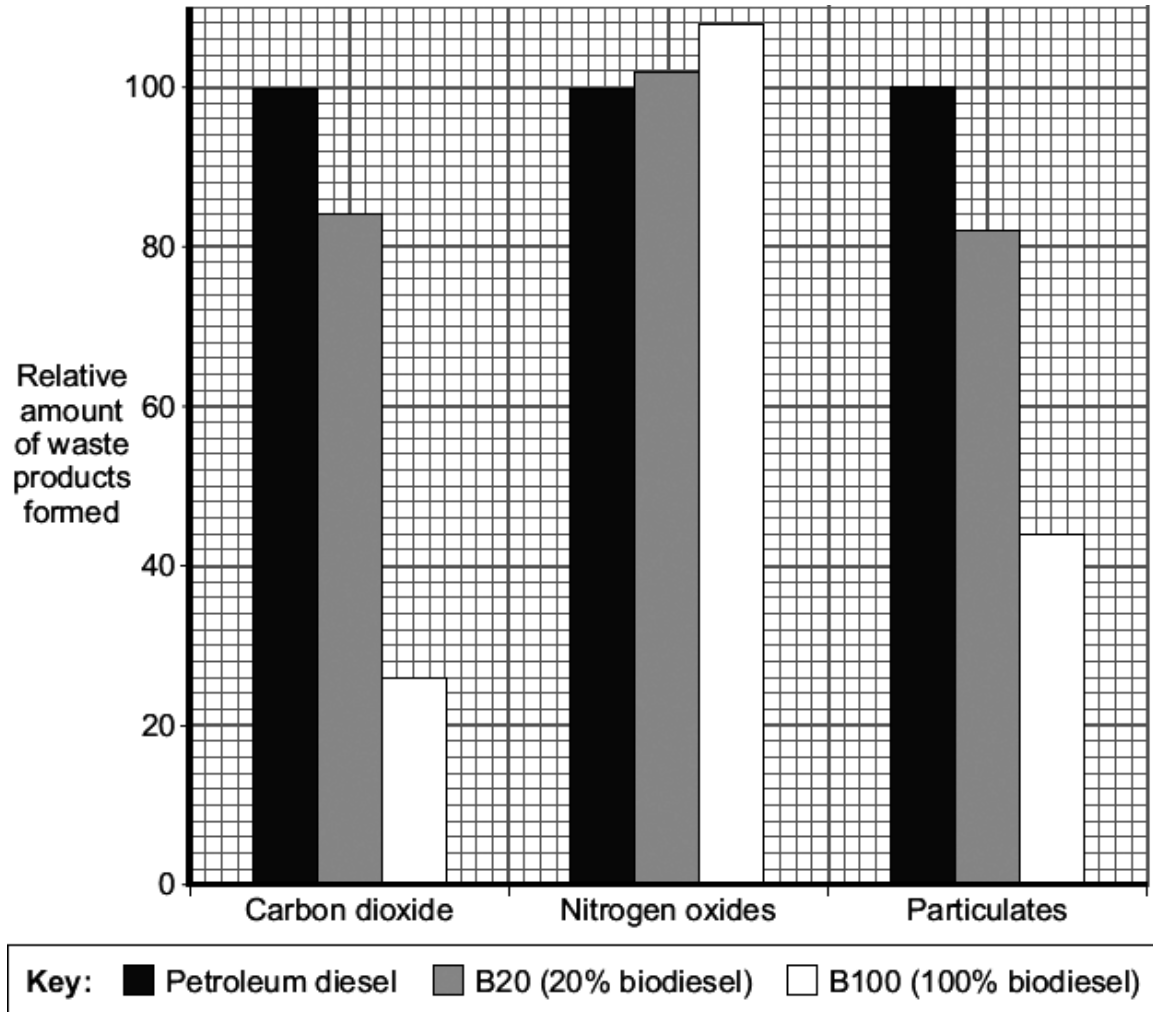
(2)

(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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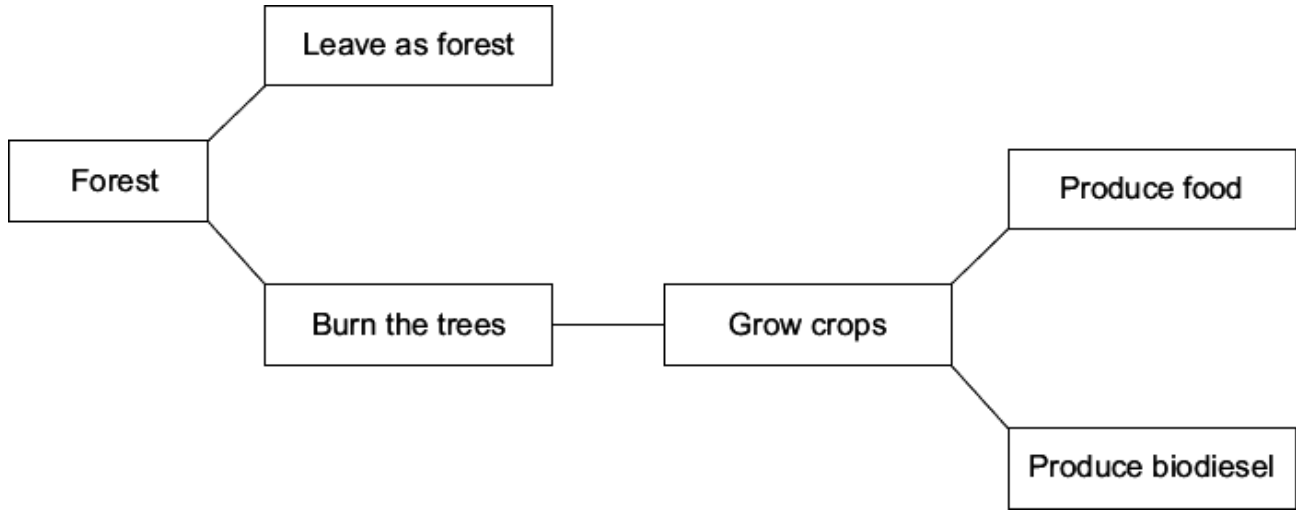
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(2)

(Total 10 marks)

Q15. 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.

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(1)

(Total 7 marks)

Q16. (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

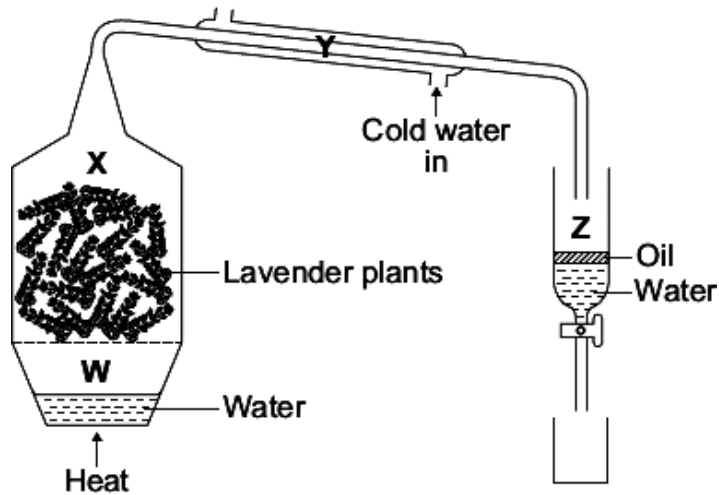
burn
condense
decompose

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
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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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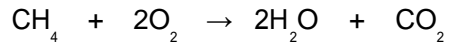
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(2)
(Total 10 marks)

Q17. Cement is made by heating a mixture of clay and limestone in a kiln.

(a) Many kilns are heated by burning natural gas (methane) in air.

A chemical equation for the burning of methane is:



Describe this reaction in words.

Give the names of the molecules **and** the numbers of each molecule in this chemical equation.

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.....

(2)

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

Limestone contains calcium carbonate.

There is a large deposit of limestone under an area of natural beauty.

A company wants to quarry this limestone and build a kiln near to the quarry to make cement.

Area of natural beauty



Evelyn Simak [CC-BY-SA-2.0], via Wikimedia Commons

A quarry



By Thomas Bjørkan (Own work) [CC-BY-SA-3.0], via Wikimedia Commons

Explosives will be used to extract the limestone out of the ground.
Heavy machinery will be used to lift and crush the limestone.
Lorries will be used to transport the limestone to the kiln to make cement.
The lorries and the heavy machinery will use diesel fuel.

Quarrying limestone and making cement will have an impact on everything near the area.

Describe the positive and the negative impacts of quarrying limestone and making cement.

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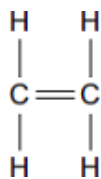
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(6)
(Total 8 marks)

Q18. 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(ethenol)	
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.

.....
.....

(1)

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

.....
.....

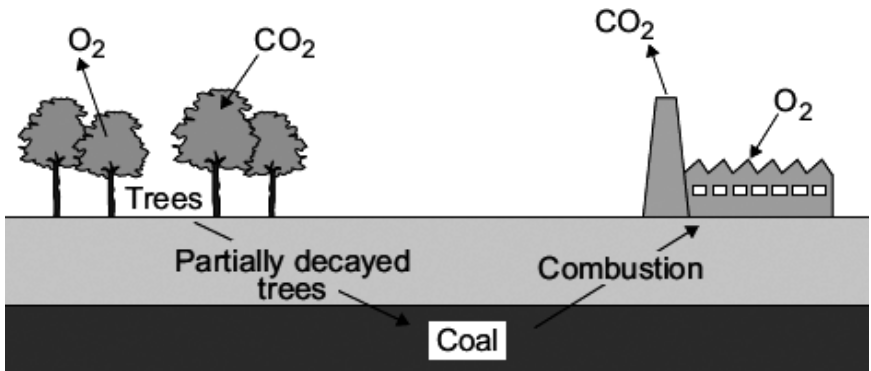
(1)

(Total 5 marks)

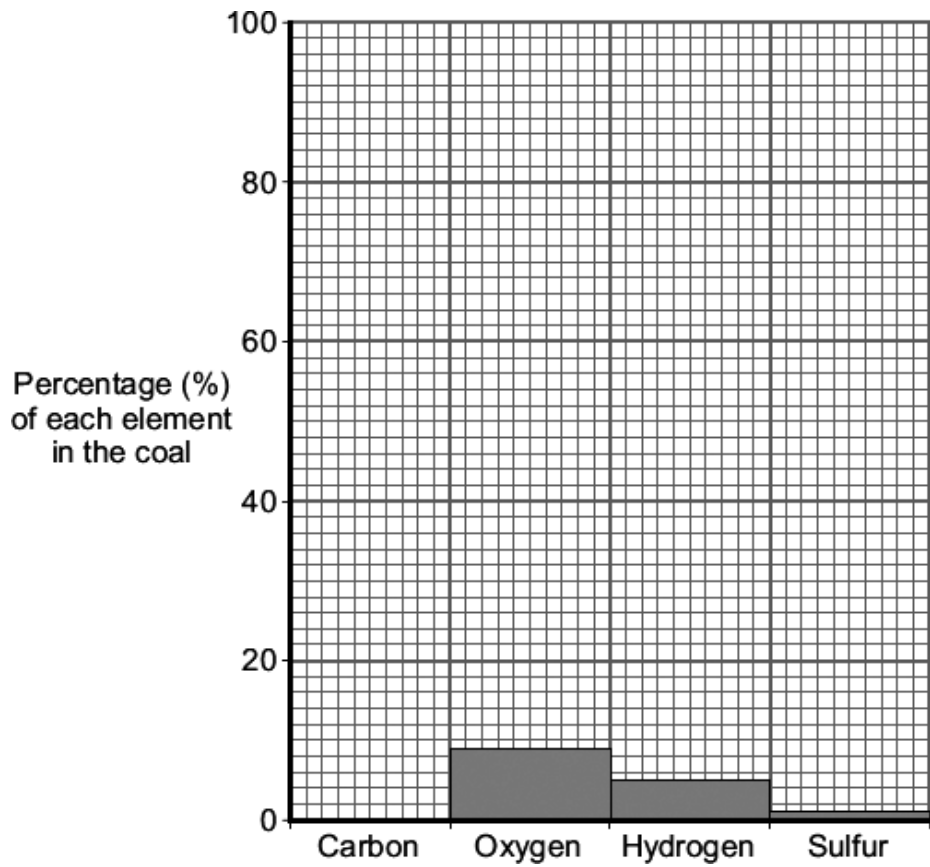
Q19. About 3000 million years ago carbon dioxide was one of the main gases in the Earth's early atmosphere.

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.

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
Sulfur dioxide	Acid rain
Carbon particles	Global dimming
	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?

.....
.....

(1)

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

.....
.....
.....
.....

(2)

(Total 6 marks)

Q20. 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*?

.....

.....

.....

.....

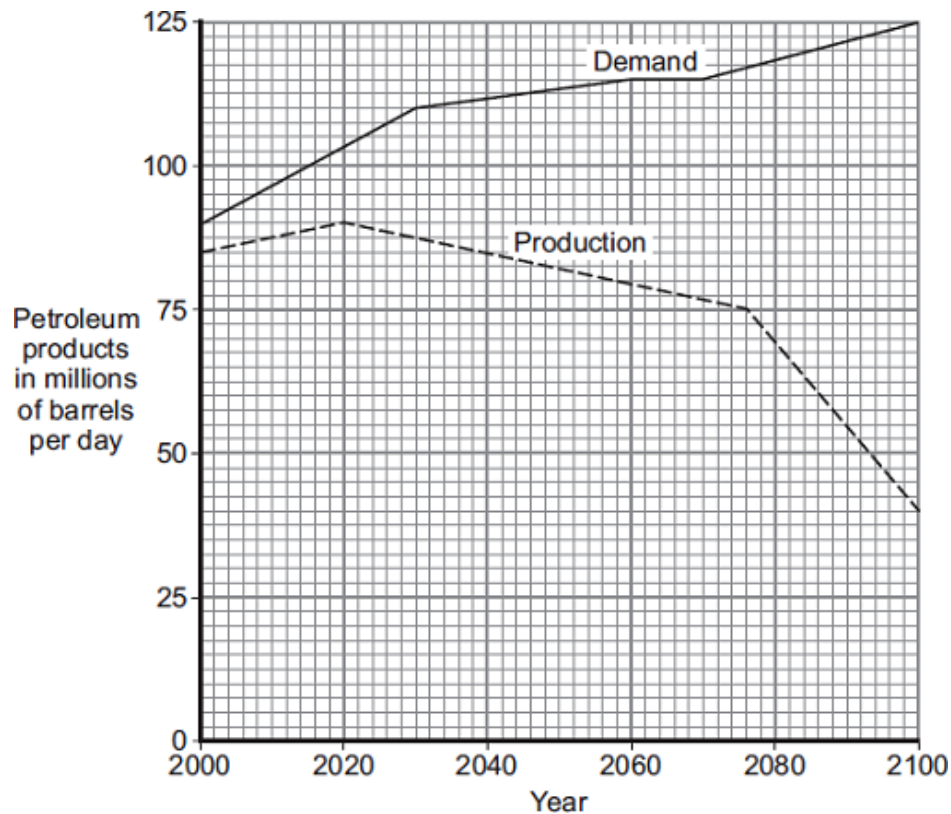
.....

(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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(6)
(Total 11 marks)

Q21. 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 (C₈H₁₈).

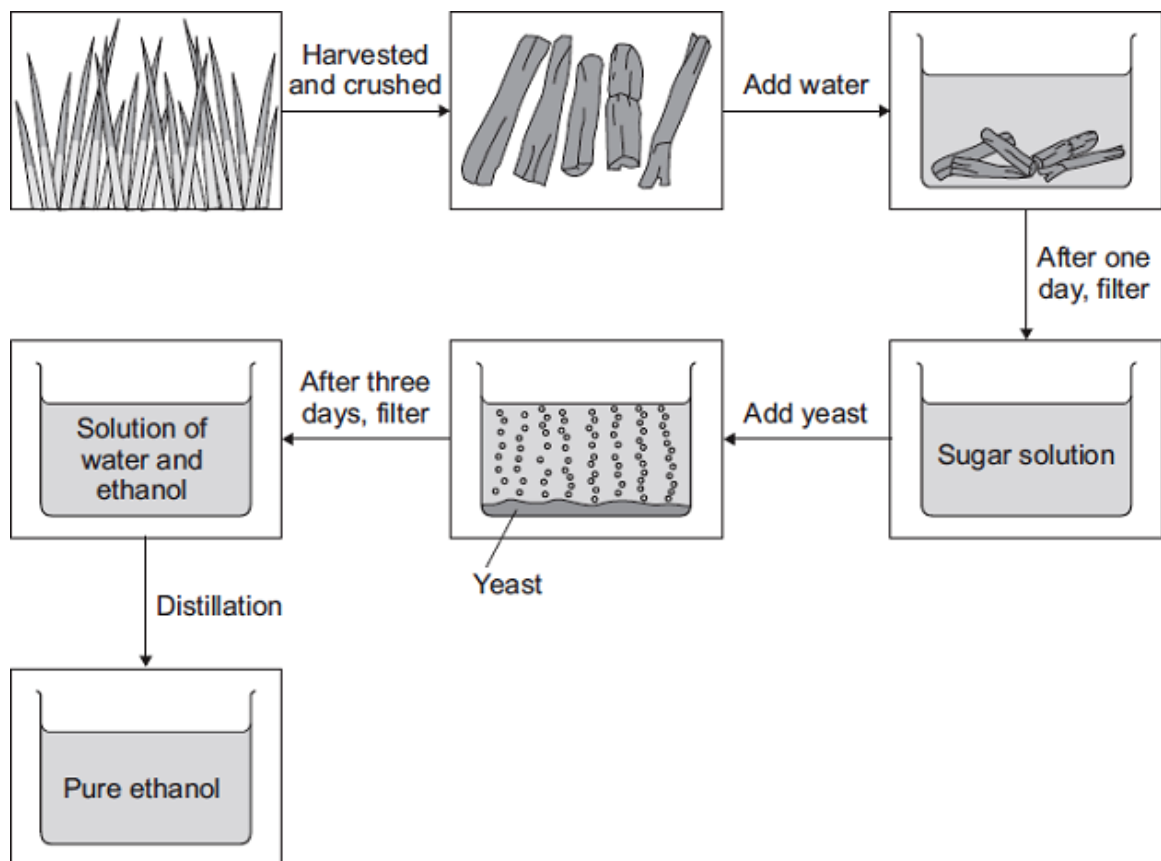
Complete the word equation for the complete combustion of octane.

octane + oxygen → +

(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
-
-
- 2
-
-

(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

.....

.....

2

.....

.....

(2)
(Total 9 marks)

Q22. 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.

.....

(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.

.....

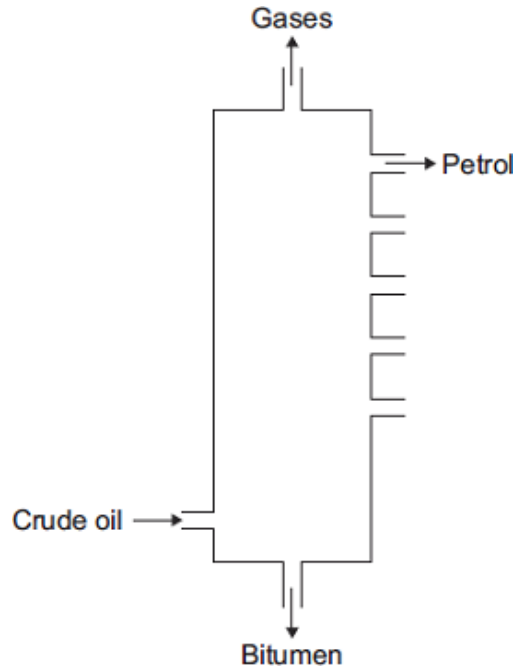
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(2)

- (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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(6)
(Total 9 marks)

Q23. 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.

.....
.....
.....

(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.

.....
.....
.....
.....

(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.

.....
.....
.....
.....

(2)

- (c) When any fuel from the table is used in a car engine, the exhaust gases contain nitrogen oxides.

Explain why.

.....
.....
.....
.....

(2)

- (d) Evaluate replacing petrol with ethanol as a fuel for cars.

To gain full marks you should give a justified conclusion.

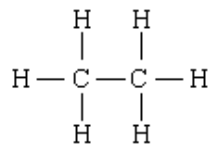
Use the information from the table and your knowledge to answer this question.

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(4)

(Total 12 marks)

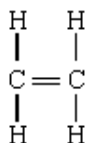
M1. (a) (i)



do not credit CH₃CH₃

1

(ii)



do not credit C₂H₄

1

(iii) burn **or** react with oxygen **or** combustion **or** oxidation
accept react with chlorine

1

(iv) bubble each gas through (test tube containing) bromine water
accept add bromine (water to gas collected) or burn

1

ethene decolourises it **or** turns the brown colourless
accept ethene burns with smoky flame
do not accept makes it go clear

1

ethane does not affect it **or** leaves it brown
accept ethane burns with clear flame
note carefully the spelling of ethene and ethane

1

(b) *both the correct name and use are required for the mark*

poly (ethene) **or** polythene; any soft or pliable plastic article **or** any suitable harder plastic item

accept polyethene or polyethylene

1

[7]

M2. (a) decane has the largest molecules

1

methane and butane are gases at 20 °C

1

- (b) (i) water 1
- (ii) carbon dioxide 1
- (c) sulfur dioxide is produced when sulfur burns 1
- therefore sulfur must be removed from these fuels because sulfur dioxide causes acid rain 1

[6]

- M3.** (a) (i) wood 1
- (ii) 30 (kJ) 1
- (iii) carbon / C
or hydrogen / H
or sulfur / S
or oxygen / O 1
- (iv) 3 / three (g) 1
- (b) (i) releases most energy
accept releases a lot of energy / burns rapidly
ignore references to cost 1
- no harmful gases / no or less pollution formed / no global warming /
no climate change / no greenhouse gas
accept produces water (only) / steam
*accept does **not** produce sulfur dioxide / carbon dioxide / carbon monoxide / particles / smoke* 1

(ii) any **one** from:

- expensive
- difficult to produce
accept large volume needed
- not available in large quantities
- explosive / dangerous
- not a natural fuel / resource
allow will run out / non-renewable
- made from fossil fuels
- difficult to store

1

[7]

M4. (a) electron

words must be in correct position

1

nucleus

1

(b) (i) oxygen / O₂

ignore air

1

(ii) any **one** from:

- (water) does not pollute
accept no harmful gas(es)
- (only) water is produced
- no carbon dioxide (is produced)
accept no greenhouse gas(es) / effect
- no sulfur dioxide (is produced)
accept no acid rain
- no nitrogen oxides (are produced)
- no carbon / no particles (are produced)

1

[4]

M5.	(a)	carbon	1	
		hydrogen		
		<i>any order</i>	1	
	(b)	fractional	1	
		distillation		
		<i>accept description</i>		
		• <i>heat or evaporate / boil (1mark)</i>		
		• <i>separated when they condense</i>		
		<i>or by boiling points (1 mark)</i>	1	
	(c)	alkenes		
		<i>accept names or unsaturated hydrocarbons</i>	1	[5]

##

(a)	fume cupboard			
	plastic gloves (only one tick)			
	<i>for 1 mark</i>		1	
(b)	(i)	plotting points (allow ± 0.5 units either vertically or horizontally)		
		(all correct = 2) (3 correct =1)		
		curve (not joined with straight lines. Must be very close		
		to all points. One line only) (1 mark)		
		<i>gains 3 marks</i>	3	
	(ii)	as read from graph (± 0.5 units) –		
		points must be joined		
		<i>for 1 mark</i>	1	
	(iii)	decreases, gets less, quicker		
		<i>for 1 mark</i>	1	
(c)	(i)	flows, moves, passes through (not rubbing/moving of		
		engine parts)		
		<i>for 1 mark</i>		
		less etc		
		<i>for 1 mark</i>	2	

- (ii) parts rub against each other
 increases wear of engine parts
 damages the oil
 engine seizes
 overheating of engine
 (not burns or blows up)
 (not just 'damage')
any 1 for 1 mark

1

[9]

- M7.** (a) (i) acid rain
accept consequences of acid rain
allow asthma / bronchitis
ignore toxic gas

1

- (ii) global dimming
accept dimming alone

1

- (b) (i) **sustainable:**

maximum **two** from:

- crops (that produce oil) can be grown in most places owtte
- renewable
- use less fossil fuels / diesel
- use (refined) waste oils

low pollution:

maximum **two** from:

ignore references to CO₂ here

- most emissions are lower **or** any two named emissions from CO / SO₂ / PM₁₀ are lower
- much / lot less SO₂ emissions (than the others) owtte
- accept spillages / waste is biodegradable
- less new CO₂ **or** (more) carbon neutral

3

- (ii) plants / photosynthesis use carbon (dioxide) from the air* 1
- it / biodiesel releases carbon (dioxide) from plants / crops / photosynthesis*
(* allow 1 mark for biodiesel is (more) carbon neutral) 1
- (fossil) diesel releases 'locked up' / new carbon (dioxide) / doesn't
absorb CO₂ / absorbed it millions of years ago 1

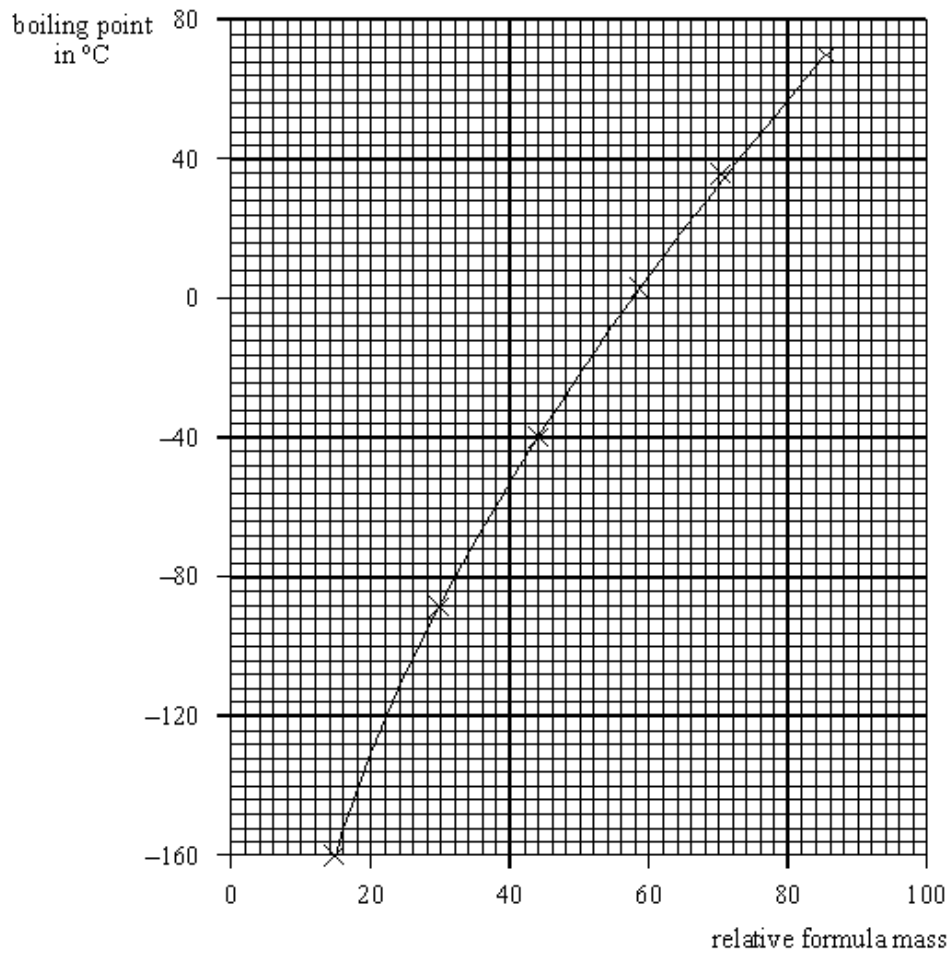
[8]

- M8.** (a) C₃H₈ 1
- (b) (i) increases / gets larger 1

- (ii) all 5 points plotted correctly
 deduct 1 mark for each incorrectly plotted point
 but **ignore** -90, 30
 allow error of one square in any direction

2

smooth line graph



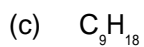
1

- (iii) boiling point estimate from their graph
 allow ± 2 °C

1

- (iv) shown clearly on graph
 allow just one construction line drawn

1



1

[8]

M9. (a) elements

1

- (b) (i) nucleus 1
- (ii) six 1
- (c) (i) CH₄ 1
- (ii) bond 1
- (d) (i) oxygen 1
- (ii) any **one** from:
- (water) does not pollute
accept no harmful gas(es)
allow less pollution
 - (only) water is produced
 - no carbon dioxide / monoxide (is produced)
*accept no greenhouse gas(es) / effect **or** no global warming*

1

[7]

- M10.** (a) catalyst 1
- (b) (i) made up of **only** carbon and hydrogen 1
- (ii) C₈H₁₈ 1
- (c) (i) ethene 1
- (ii) polymerisation 1

[5]

- M11.** (a) oxygen 1
- must be name*
- do **not** accept oxide or dioxide*

1

- (b) (i) 2 x C–C
and
5 x C–H
all single (line) bonds 1
- (ii) C₃ H₈
must be formula
*do **not** accept lower case h* 1
- (iii) water 1
- (c) ethane and butane boil at temperatures less than 20°C 1
- ethene and hexene each have a carbon-carbon double bond 1
- [6]**

- M12.** (a) CO₂ (+) H₂O
correct products 1
- 3 (O₂) 2 (CO₂) 3 (H₂O)
correct balancing 1
- (b) (i) add bromine water
allow iodine 1
- changes (from orange) to colourless / decolourised
ignore clear 1
- (ii) octane vapours
ignore any references to butane (C₄H₁₀) 1
- are passed over a catalyst (to produce ethene)
ignore incorrect names of catalysts 1

OR

octane mixed with steam (1)

at a (very) high temperature (1)

for steam cracking, second mark is conditional on 'steam'

steam is added (to ethene)

ignore the formula H_2O / water

1

in the presence of a catalyst (to produce ethanol)

*if no other marks awarded then allow 1 mark for cracking of octane
or hydration of ethene*

1

[8]

M13.

(a)

*allow answers referring
specifically to the naphtha fraction*

crude oil is evaporated/vaporised (by heating)

1

the vapours are condensed (by cooling)

1

(fractions condense) / boil at different temperatures

allow fractions have different boiling points

1

(b) any **four** from:

answer yes or no does not gain credit

ignore references to volume of milk held / number of bottles used / biodegradability / habitats / pollution / mining / dust

each marking point must be a comparison

milk bag points

- uses (75%) less **crude oil** to make (than a plastic milk bottle)
allow eg uses 75% less
poly(ethene) which is made from crude oil
- uses less **energy** / fuel to make (than a plastic / glass milk bottle)
- produces less **carbon dioxide** to manufacture (than a plastic / glass milk bottle)
allow produces less greenhouse gases / causes less global warming
allow produces less CO₂ on burning
- produces less **waste** (than a plastic / glass milk bottle)
allow takes up less landfill (space)
allow an argued case for more waste eg milk bags are discarded / cannot be reused
- less fuel used for **transport** than glass milk bottles
- (produces waste because) milk bags are only used once whereas glass bottles can be **re-used**
allow milk bags are discarded but glass bottles can be reused (24 / many times)
allow glass bottles can be reused but milk bags can't

poly(ethene) points

- uses a limited **raw material** / crude oil whereas the raw materials for glass are almost unlimited
- **less** (5%) poly(ethene) is **recycled** (compared to glass (35%))
allow (35%) glass is recycled or (5%) poly(ethene) (bottles) recycled BUT milk bags aren't / are discarded
or
recycled poly(ethene) is not used to make new bags whereas recycled glass is used to make new bottles

4

[7]

M14. (a) (i) a reasonable attempt at a smooth curve

allow a curve which is close to but does not necessarily touch all points

1

- (ii) any **two** from:
- allow thicker / thinner / runny for viscous*
 - biodiesel is more viscous than petroleum diesel at all / lower temperatures
 - biodiesel – as the temperature increases the viscosity decreases or vice versa
 - petroleum diesel – the viscosity does not change
if no other mark awarded
allow 1 mark for any correct conclusion based on time or rate of flow
- 2

- (iii) does not flow as easily (through pipes / engine)
allow could form a solid / block pipes / engine at low temperatures
- or**
- needs a high temperature to flow
allow more difficult to vaporise / ignite
ignore burning
ignore references to viscosity
- 1

- (b) (i) global dimming
allow correct description
- 1

- (ii) 56 (%)
- 1

- (iii) (increases) acid rain
- 1

- because there is more nitrogen oxide(s)
ignore sulfur dioxide
if no other mark awarded
allow 1 mark for nitrogen oxide(s) given
- 1

- (iv) *answer yes or no does not gain credit because the marks are for an explanation*
ignore references to petroleum diesel
allow carbon for carbon dioxide
- no
- because carbon dioxide (26%) is released / produced
- 1

this will not all be absorbed by photosynthesis / growing plants for biodiesel
*accept growing plants / farming uses machinery / fossil fuels
releases carbon dioxide*

OR

yes

because although carbon dioxide (26%) is released / produced (1)

this was absorbed by photosynthesis / growing plants (for biodiesel) (1)
*allow this will be absorbed by photosynthesis / growing plants for
biodiesel*

1

[10]

M15. (a) (i) *use of carbon throughout = **max 1***

burning biodiesel releases CO₂

ignore burning trees

1

CO₂ is absorbed / used by the crops/plants (used to produce the biodiesel)

allow CO₂ absorbed / used by trees

1

(ii) *allow use of carbon for carbon dioxide throughout*

increases CO₂ / greenhouse effect

accept causes global warming

OR

allow causes climate change

less CO₂ is absorbed (from atmosphere)

ignore other correct effects

1

because burning trees releases CO₂

accept fewer trees to absorb CO₂

or *crops / plants do not absorb as much CO₂ as trees*

OR

because there is less photosynthesis

ignore habitats / biodiversity

*if no other mark awarded global dimming because of smoke /
particles gains 1 mark*

1

- (b) any **one** from:
- ignore carbon neutral / cost / less harmful / environmentally friendly*
 - crude oil / fossil fuel is running out / non-renewable
allow biodiesel is renewable / sustainable
 - demand for fuels / energy is increasing
ignore demand for biodiesel is increasing
 - new legislation / protocols
- 1

- (c) (i) uses crops / land that could be used for food
*allow destroys habitats **or** reduces biodiversity*
ignore cost
- 1

- (ii) increases the cost of food / land
ignore cost of machinery / process
ignore cheaper to produce biodiesel
- 1

[7]

- M16.** (a) (i) hydrocarbons
- 1

- (ii) ethane has the smallest molecules
- 1

heptadecane has the highest boiling point

1

- (iii) evaporating
- 1

condense

1

- (b) (i) **W**
- 1

Y

1

- (ii) floats
if no answer written on line, allow correct answer indicated in the box
- 1

- (iii) open the tap
allow let the water out
ignore remove water
- 1

stop the flow of liquid when the water has run out
allow until oil is left behind
ignore filter

1

[10]

M17. (a) • one / 1 (molecule of) methane (reacts with) two / 2 (molecules of) oxygen

1

• two / 2 (molecules of) water / steam / hydrogen oxide and one / 1 (molecule of) carbon dioxide (are produced)

if no other marks awarded all four names correct

or

*correct number **and** name for two molecules*

or

4 correct numbers gains 1 mark

*allow all four names correct **and** correct number of atoms in each substance for 2 marks*

1

- (b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks

No relevant content

Level 1 (1-2 marks)

There is a simple description of a positive **and / or** a negative impact caused by the plan to quarry limestone and / or make cement.

Level 2 (3-4 marks)

There is a clear description of both a positive **and** a negative impact caused by the plan to quarry limestone and / or make cement.

Level 3 (5-6 marks)

There is a detailed description of both positive impacts **and** negative impacts caused by the plan to quarry limestone and / or make cement.

examples of the chemistry points made in the response

Positive impacts:

- Limestone / cement is used for building
- Limestone needed for industrial processes
- Company landscapes / provides recreation facilities in the quarry after use
- Provides employment
- Improves local economy
- Improved transport links

Negative impacts:

- Destruction of habitats
- Fewer plants / trees to absorb carbon dioxide
- Example of visual pollution
- Example of noise pollution
- Example of atmospheric pollution
- More traffic

6

[8]

M18.

(a) (i) C_2H_4

1

(ii) poly(ethene)

1

	(b) (i)	is not biodegradable	1	
	(ii)	not enough landfill sites / space <i>accept landfill sites are filling up or plastics remain for years or plastics not broken down</i> <i>ignore cost / waste of resources / not biodegradable / wildlife</i>	1	
	(iii)	recycle / burn <i>accept reduce the amount of packaging used</i> <i>ignore reused</i>	1	[5]
M19.	(a) (i)	bar drawn between 84 and 86	1	
	(ii)	sulfur dioxide linked to acid rain	1	
		carbon particles linked to global dimming	1	
	(b) (i)	any one from:		
		• plants / trees <u>absorb</u> (carbon dioxide)		
		• coal ' <u>locks up</u> ' (carbon dioxide)	1	
	(ii)	it <u>increases</u> the amount (of CO ₂)	1	
		because carbon in coal (forms carbon dioxide) <i>accept because carbon / coal burns / reacts <u>with oxygen</u> (to produce CO₂)</i>	1	[6]
M20.	(a)	heat to vaporise (the crude oil) <i>do not accept cracking / burning</i>	1	
		vapours condense	1	
		at different temperatures <i>allow they have different boiling points</i>	1	

- (b) (alkanes) are hydrocarbons **or** are compounds of hydrogen and carbon only

1

alkanes are saturated **or** have only (carbon-carbon) single bonds

accept have no (carbon-carbon) double bonds

accept general formula is C_nH_{2n+2} for 2 marks

1

- (c) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

0 marks

No relevant content.

Level 1 (1-2 marks)

There is a basic description of at least one advantage or one disadvantage of extracting petroleum products from oil sands.

Level 2 (3-4 marks)

There is a clear description of an advantage and a disadvantage of extracting petroleum products from oil sands.

Level 3 (5-6 marks)

There is a detailed description of both advantages and disadvantages of extracting petroleum products from oil sands.

Examples of the chemistry/environmental/economic/social points made in the response

Advantages:

- the oil sands are needed because crude oil is running out
- this crude oil is needed because demand is increasing
- the oil sands contain a large amount of crude oil
- the oil sands could improve Canada's economy
- the oil sands provide employment for a lot of people
- the trees / forest are used for wood products / fuel

Disadvantages:

- destruction of environment / habitats
- fewer trees / forests to absorb carbon dioxide
- specified pollution, for example, visual, noise, atmospheric (including dust), water (including river or drinking) with cause, e.g. gases / particulates from burning diesel
- large amounts of methane (natural gas) are used to provide energy
- energy / fuel needed for cracking and fractional distillation
- burning fuel releases carbon dioxide
- crude oil / natural gas contains locked up carbon
- crude oil is non-renewable

6
[11]

M21. (a) Methane has the lowest melting point and icosane has the highest boiling point

1

Decane and icosane are liquid at 100°C

1

(b) water / H₂O

either order

1

carbon dioxide / CO₂

allow hydrogen oxide

1

(c) (i) fermentation

1

(ii) any **two** from:

- sugar cane / plants absorb carbon dioxide
ignore oxygen released
- growing sugar cane / plants reduces global warming
allow ethanol from plants is carbon neutral
- renewable resource / sustainable
accept conserves fossil fuels / petrol

2

(iii) any **two** from:

- destruction of habitats / forests (to grow sugar cane/crops)
- fermentation releases carbon dioxide
- production plants cause visual pollution
- pollution from the transportation of sugar cane / Ethanol
- growing sugar cane / plants uses a lot of land

2

[9]

M22.

(a) (i) exothermic

accept combustion
*allow burning **or** oxidation **or***
redox

1

(ii) carbon monoxide / CO (is produced)

allow monoxide (is produced) ignore carbon oxide

1

because there is incomplete / partial combustion (of the fuel)

accept because there is insufficient oxygen / air (to burn the fuel)

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the [Marking guidance](#).

0 marks

No relevant content.

Level 1 (1-2 marks)

There is a statement that crude oil is heated **or** that substances are cooled. However there is little detail and any description may be confused or inaccurate.

Level 2 (3-4 marks)

There is some description of heating / evaporating crude oil **and either** fractions have different boiling points **or** there is an indication of a temperature difference in the column.

Level 3 (5-6 marks)

There is a reasonable explanation of how petrol is or fractions are separated from crude oil using evaporating **and** condensing.

If cracking is given as a preliminary or subsequent process to fractional distillation then ignore.

However, if cracking / catalyst is given as part of the process, maximum is **level 2**.

Examples of chemistry points made in the response could include:

- Some / most of the hydrocarbons (or petrol) evaporate / form vapours or gases
- When some of / a fraction of the hydrocarbons (or petrol) cool to their boiling point they condense
- Hydrocarbons (or petrol) that have (relatively) low boiling points and are collected near the top of the fractionating column or hydrocarbons with (relatively) high boiling points are collected near the bottom of the fractionating column
- The process is fractional distillation
- Heat the crude oil / mixture of hydrocarbons or crude oil / mixture is heated to about 350°C
- Some of the hydrocarbons remain as liquids
- Liquids flow to the bottom of the fractionating column
- Vapours / gases rise up the fractionating column
- Vapours / gases cool as they rise up the fractionating column
- The condensed fraction (or petrol) separates from the vapours / gases and flows out through a pipe
- Some of the hydrocarbons remain as vapours / gases
- Some vapours / gases rise out of the top of the fractionating column
- There is a temperature gradient in the fractionating column or the fractionating column is cool at the top and hot at the bottom

6

[9]

- M23.** (a) ethanol is made up of only one type of molecule **or** ethanol is a compound
allow ethanol is pure

1

diesel / petrol / rapeseed oil are mixtures

accept composition of diesel / petrol / rapeseed oil varies / changes

allow different hydrocarbons have different melting points

ignore diesel, petrol and rapeseed oil are impure

1

(b) (i) sugar is mixed with / dissolved in water

accept sugar cane for sugar

1

yeast (is added)

allow enzymes are added

if no other mark awarded, allow correct word or chemical equation for 1 mark

1

(ii) (growing sugar cane / rapeseed) plants absorbs carbon dioxide

accept carbon for carbon dioxide

accept carbon dioxide is used for photosynthesis

1

which is released (when the biofuel burns)

*do **not** accept no carbon dioxide is released (when biofuels burn)*

1

(c) nitrogen / N₂ **and** oxygen / O₂ (in the air)

*do **not** accept fuels contain nitrogen*

1

react in the hot engine / at high temperature

1

(d) any **three** from:

ignore references to melting point

3

- ethanol needs a higher temperature to burn than petrol **or** ethanol has a higher flashpoint than petrol
- ethanol releases less energy (per litre) than petrol
- sugar is renewable **or** crude oil is non-renewable / will run out
- sugar cane growth is unreliable / slow **or** crude oil is a reliable supply
*allow ethanol is not readily available **or** petrol is readily available*
- ethanol is made by a batch / slow process **or** petrol is made by a continuous / fast process
- ethanol is carbon neutral **or** petrol contains 'locked up' carbon dioxide
- sugar / sugar cane should be used for food not for fuels
accept idea of food shortages

a justified conclusion that adds value

*accept one **additional** point from the list above as long as one comparison of replacing petrol with ethanol is made*

1

[12]

