



C7 ORGANIC CHEMISTRY

Question Practice

Name: _____

Class: _____

Date: _____

Time: **181 minutes**

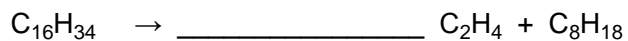
Marks: **180 marks**

Comments: **HIGHER TIER**

1

(a) The hydrocarbon $C_{16}H_{34}$ can be cracked.

Balance the equation for cracking $C_{16}H_{34}$



(1)

(b) Describe the differences between cracking and distillation.

(2)

(c) What type of reaction is cracking?

Tick **one** box.

Combustion

Decomposition

Neutralisation

Precipitation

(1)

(d) Ethene is used to make poly(ethene).

Poly(ethene) is used to make plastic bags.

the table below shows data from a Life Cycle Assessment (LCA) for a plastic bag and a paper bag.

	Plastic bag	Paper bag
Raw materials	Crude oil or natural gas	Wood
Energy used in MJ	1.5	1.7
Mass of solid waste in g	14	50
Mass of CO ₂ produced in kg	0.23	0.53
Volume of fresh water used in dm ³	255	4 520

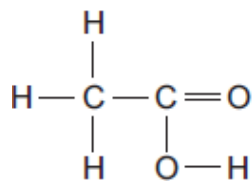
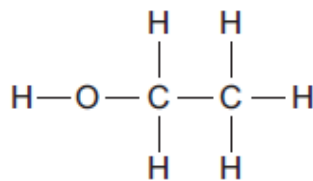
A company stated: 'A Life Cycle Assessment shows that using plastic bags has less environmental impact than using paper bags'.

Evaluate this statement. Use your knowledge and the information from above the table above.

(6)
(Total 10 marks)

2

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

Compound A**Compound B**

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

Name compound **B**.

(1)

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

burned	decomposed	oxidised
--------	------------	----------

To form compound **A**,

compound **B** is _____

(1)

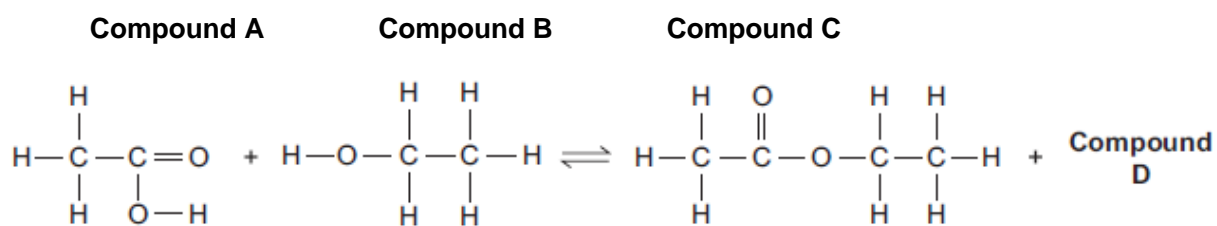
- (iii) Compounds **A** and **B** are both colourless liquids.

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.

(2)

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



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

(1)

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

Name compound **C**.

(1)

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

(1)

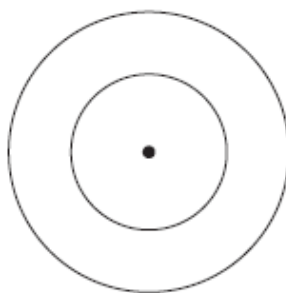
(Total 7 marks)

3

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?

(4)

(Total 6 marks)

4

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.

(3)

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

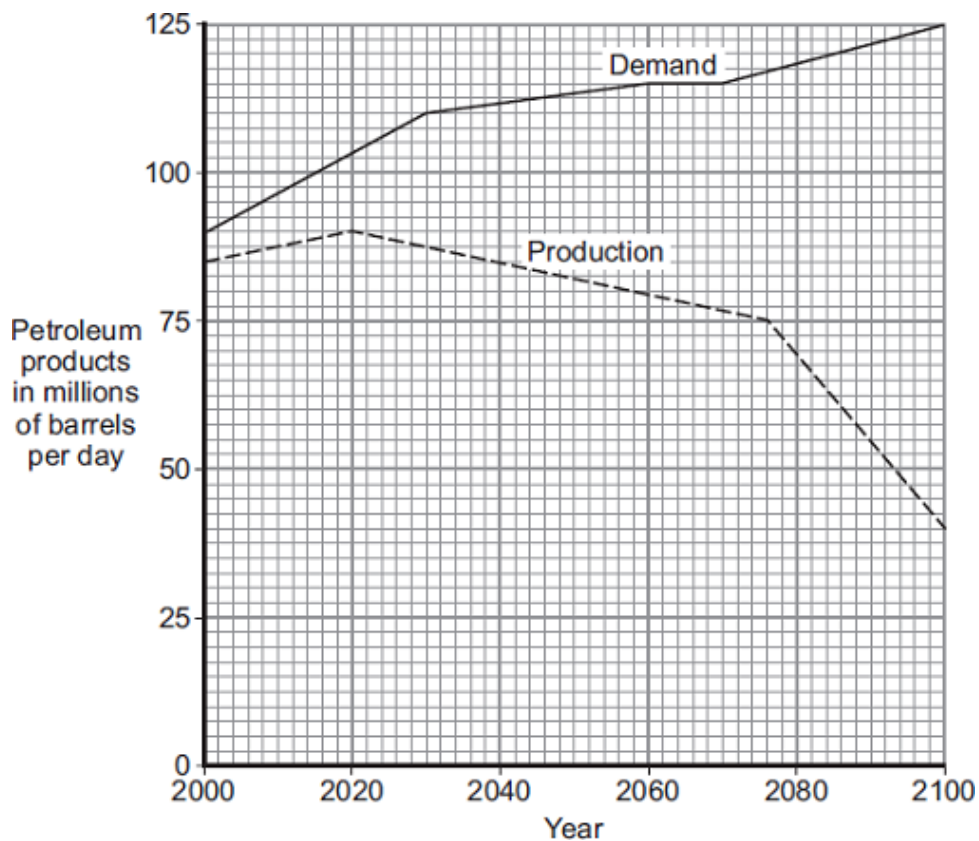
What are *alkanes*?

(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.

(6)
(Total 11 marks)

5

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.

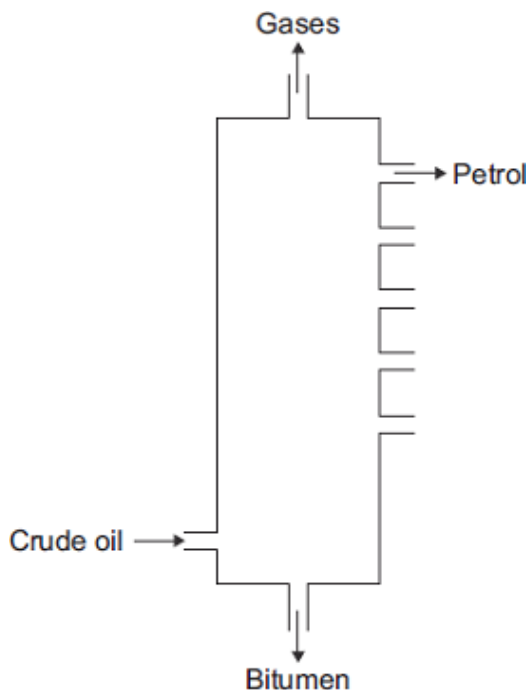
The reaction of a fuel with oxygen can produce a different oxide of carbon.

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

(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.

(6)

(Total 9 marks)

6

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

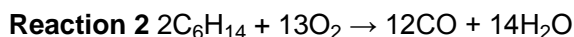
(1)

- (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.

(2)

(Total 11 marks)

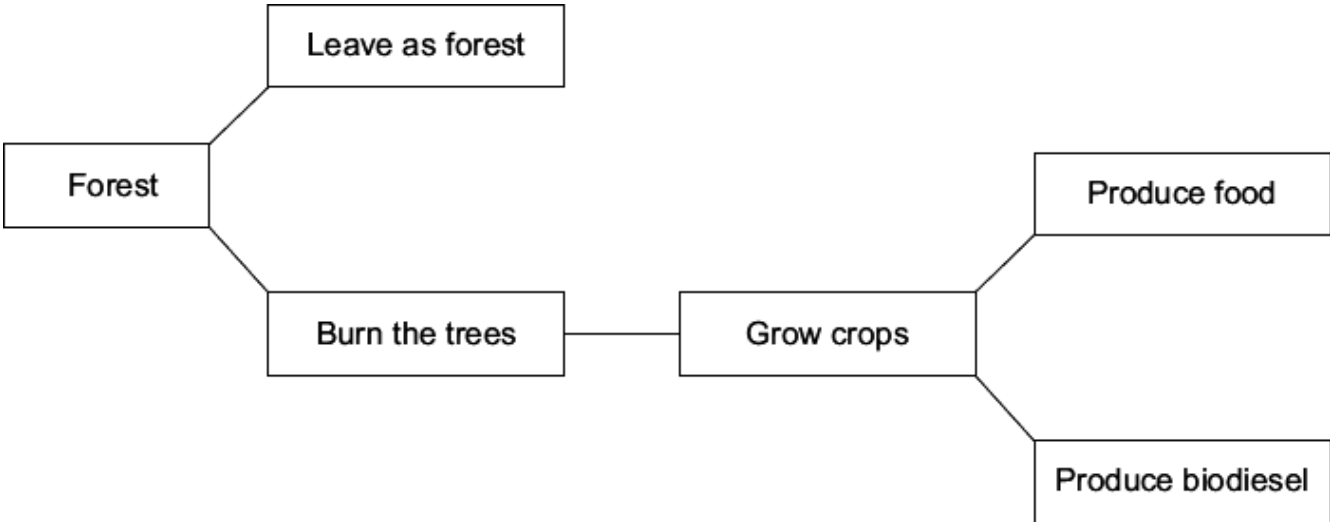
7

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.

(2)

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

(2)

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

(1)

- (c) Suggest why producing biodiesel from crops:

- (i) causes ethical concerns

(1)

- (ii) causes economic concerns.

(1)

(Total 7 marks)

8

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.

(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.

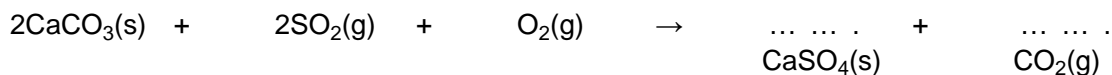
Name **three** elements that are in this coal.

(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

decreases atmospheric pollution.

(4)

(Total 10 marks)

9

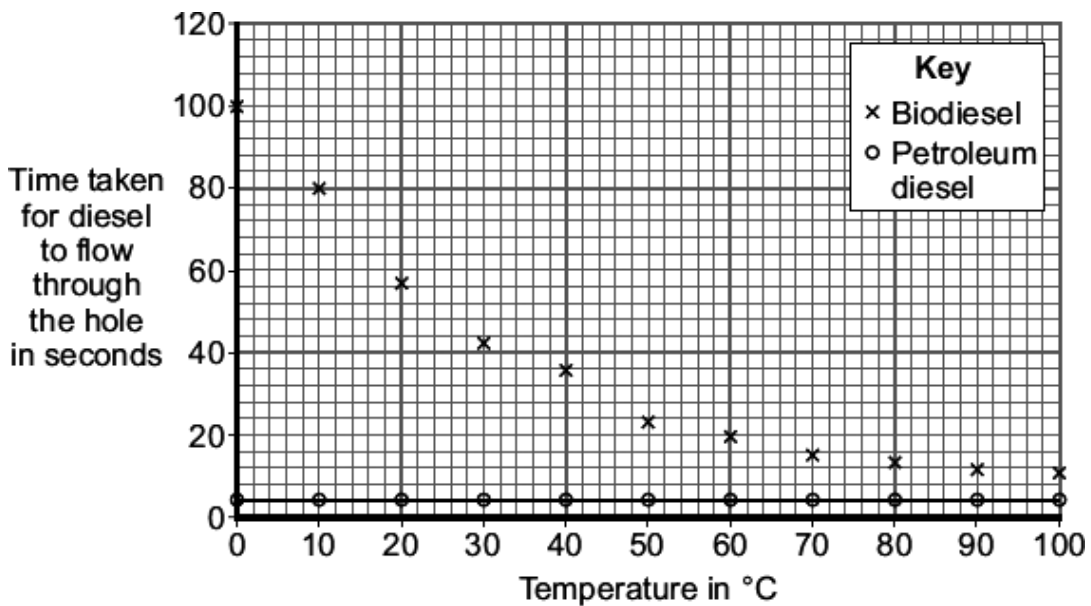
There are two main types of diesel fuel used for cars:

- 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)

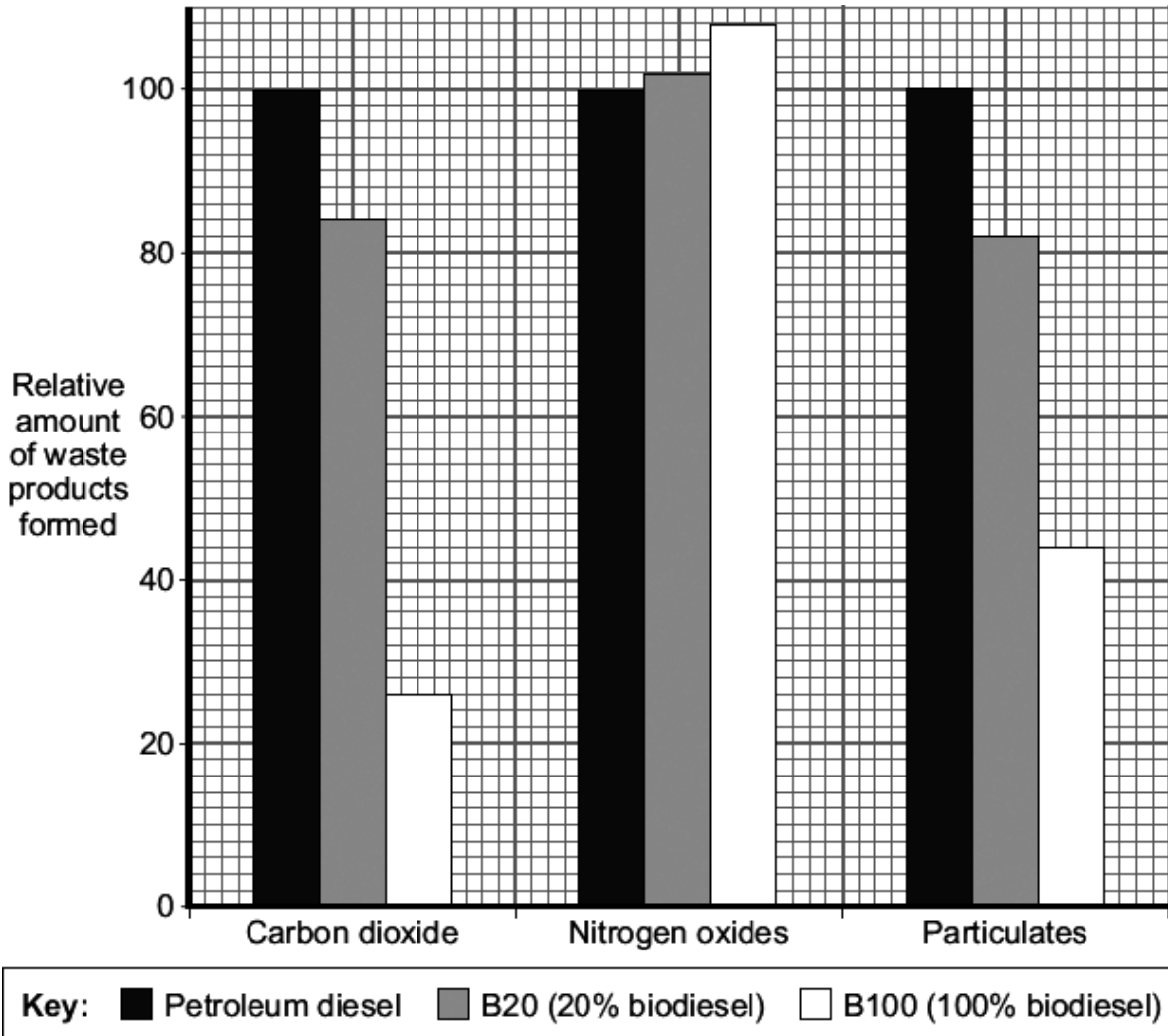
- (ii) What conclusions can the scientist make about the viscosity of biodiesel compared with the viscosity of petroleum diesel at different temperatures?

(2)

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

(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?

(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.

(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.

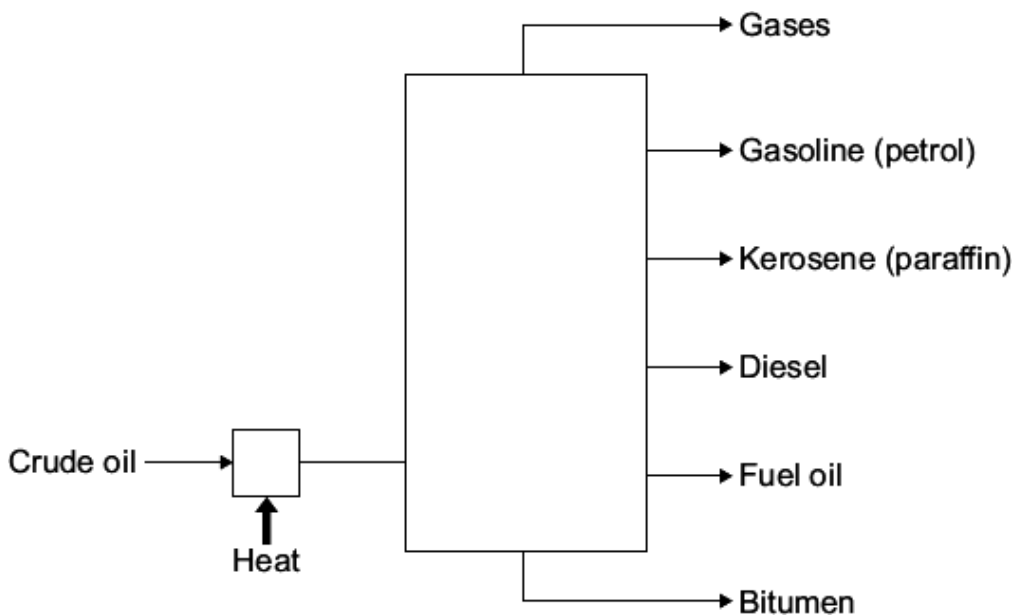
(2)

(Total 10 marks)

10

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.

(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).

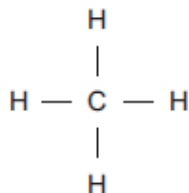
(2)

(Total 8 marks)

11

Methane (CH₄) 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.

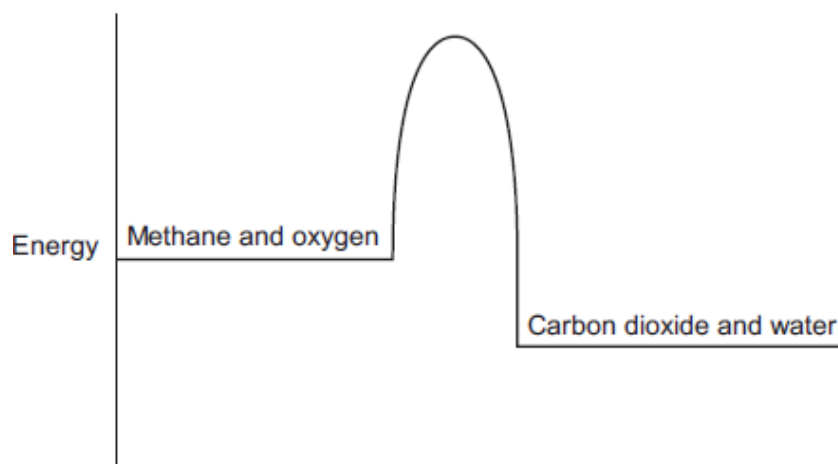
(1)

(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.

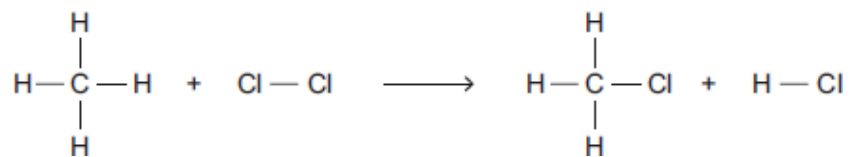
(2)

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

(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.

(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.

CH₃Br has a lower boiling point than CH₃Cl

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)

12

Sulfur is a non-metal.

Sulfur burns in the air to produce sulfur dioxide, SO₂

(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.

(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.

(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**.

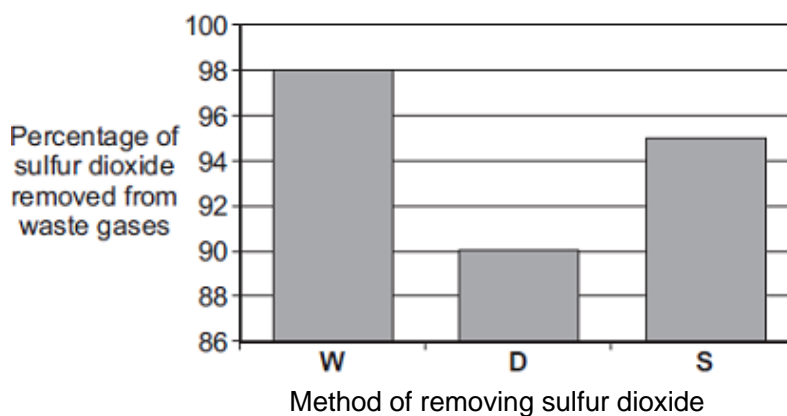


Table 1

Method	Material used	How material is obtained
W	Calcium carbonate, CaCO ₃	Quarrying
D	Calcium oxide, CaO	Thermal decomposition of calcium carbonate: CaCO ₃ → CaO + 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.

13

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.

(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.

(2)

- (c) Ultraviolet radiation from the Sun produces simple alkenes, such as ethene (C₂H₄) and propene (C₃H₆) from methane in Titan's atmosphere.

State the general formula for alkenes.

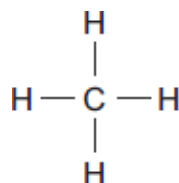
(1)

(Total 5 marks)

14

Saturated hydrocarbons, for example methane and octane, are often used as fuels.

- (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.

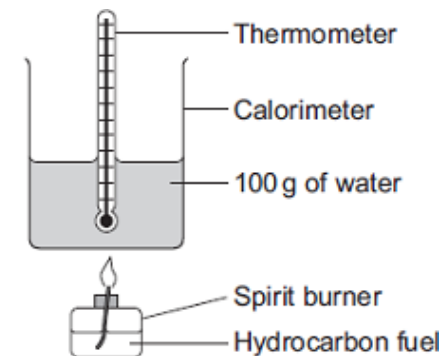
(1)

(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.

(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)**.

Formula = _____

(2)

(Total 19 marks)

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.

(3)

16

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 _____

Recycled _____

Burned _____

Dumped _____

(4)
(Total 4 marks)

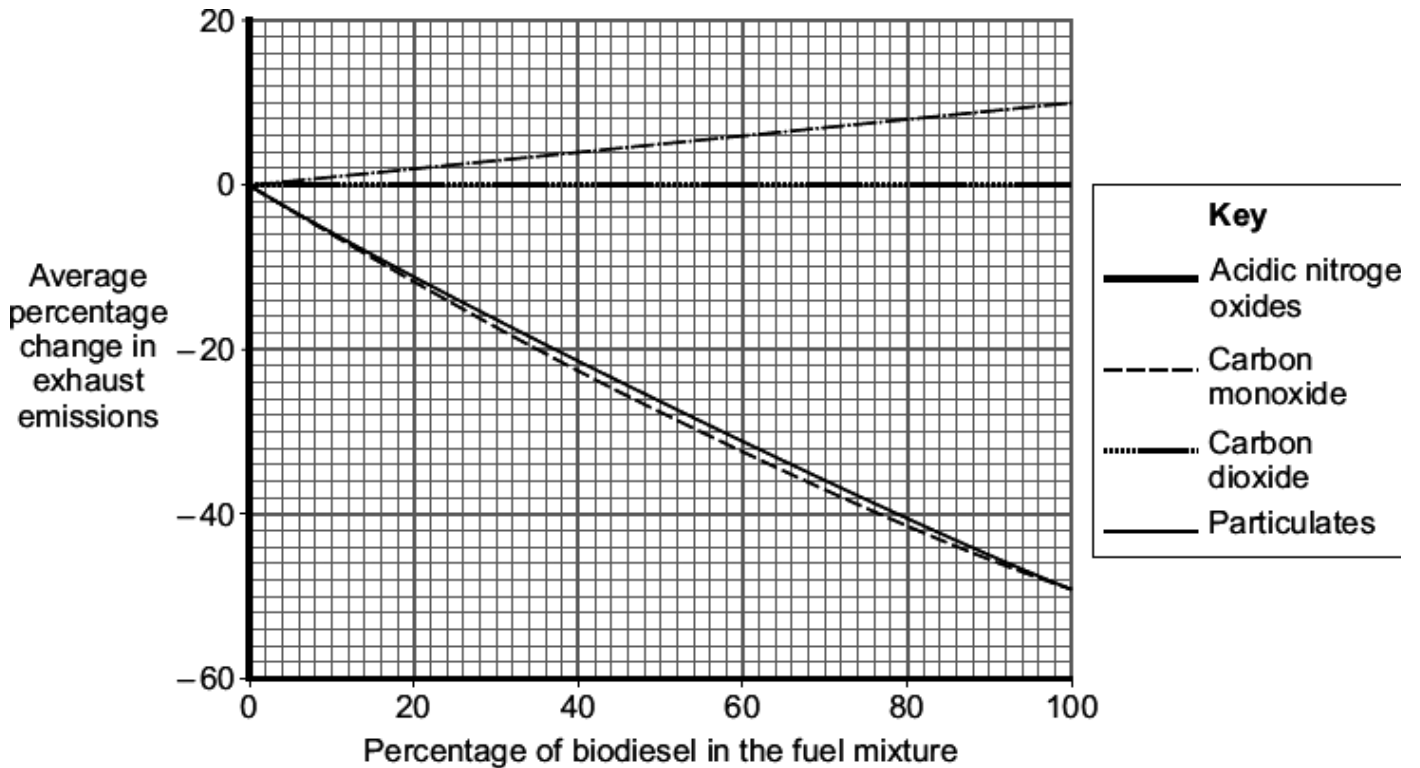
18

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.

(5)
(Total 5 marks)

19 Crude oil is a mixture of mostly alkanes.

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

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

(3)

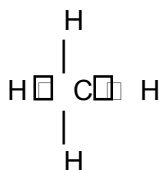
(ii) The table gives the name and formula for each of the first three alkanes.

Complete the table to show the formula of butane.

Name of alkane	Formula
Methane	CH ₄
Ethane	C ₂ H ₆
Propane	C ₃ H ₈
Butane	

(1)

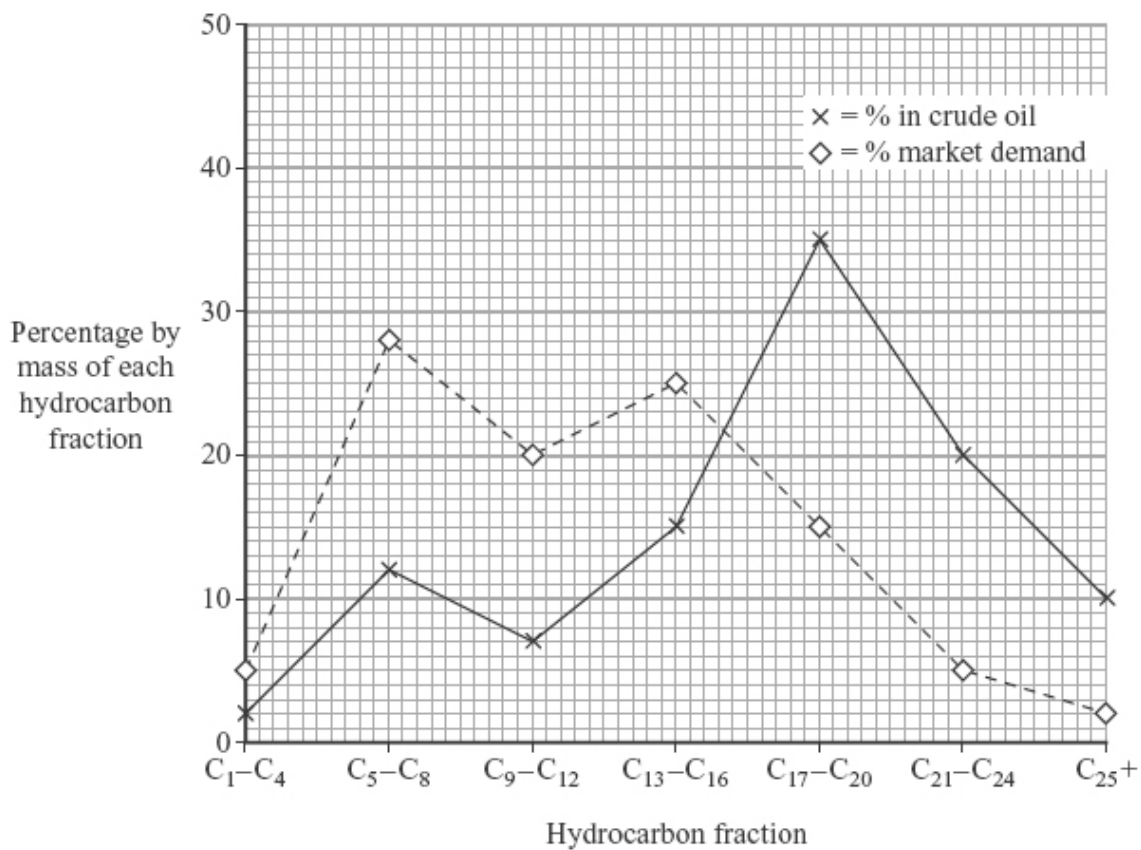
(b) The structural formula of methane, CH₄, is:



Draw the structural formula of propane, C₃H₈

(1)

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

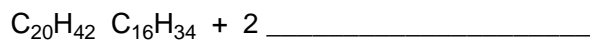


- (i) Why is the market demand for the C₅ – C₈ fraction higher than the market demand for the C₂₁ – C₂₄ fraction?

(1)

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

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



(1)

- (iii) The C₅ – C₈ fraction has low supply and high market demand.

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

1. _____

2. _____

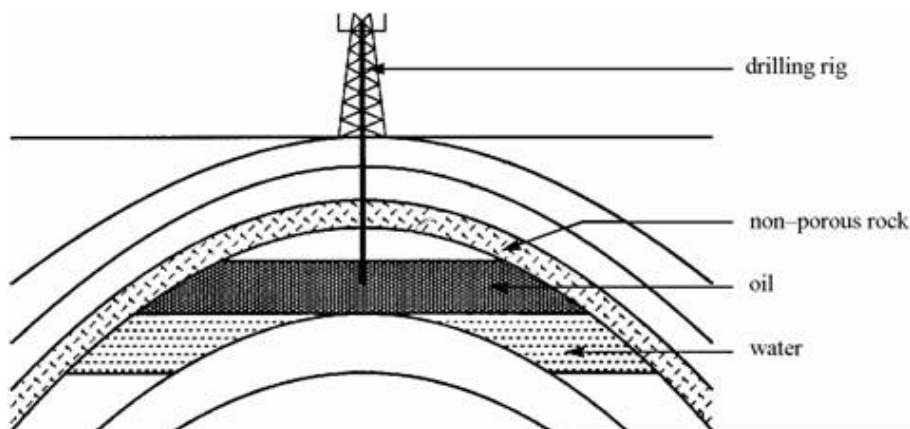
3. _____

(3)

(Total 10 marks)

20

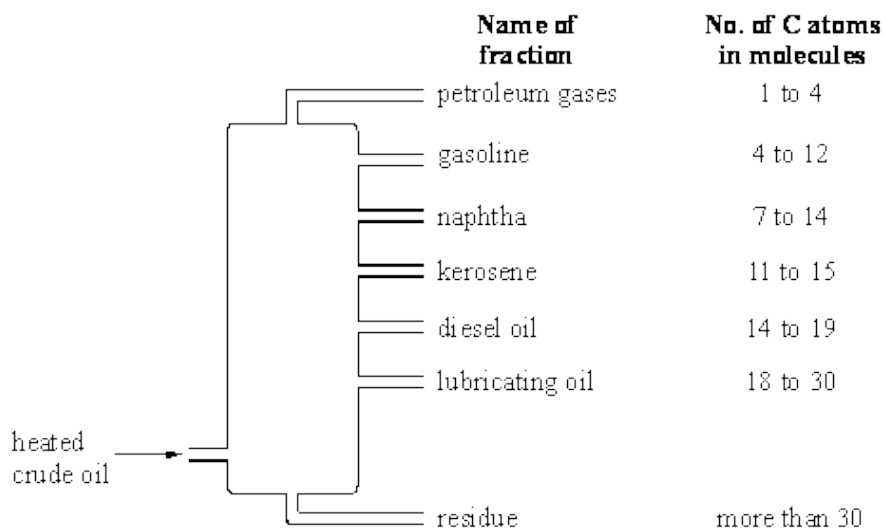
Crude oil is obtained by drilling into the Earth's crust. The diagram shows a section through the Earth's crust to show how this is done.



- (a) Crude oil contains many hydrocarbons. Which elements do hydrocarbons contain?

(1)

- (b) The crude oil is separated by fractional distillation. The diagram shows a column used for this.



- (i) Explain, as fully as you can, how fractional distillation works.

(3)

- (ii) Naphtha burns more easily than diesel oil. Explain why.

(1)

- (iii) Naphtha contains a saturated hydrocarbon with the formula C_7H_{16} . Draw the structural formula of this compound.

(2)

(Total 7 marks)

Mark schemes

1	(a)	4 (C ₂ H ₄)	1
	(b)	cracking involves a catalyst	1
		distillation does not	
		or	
		distillation does not involve a chemical change	
		but cracking does	1
	(c)	Decomposition	1
	(d)	Level 3 (5–6 marks): A logically structured evaluation with links involving several comparisons. Nearly all points made are relevant and correct.	
		Level 2 (3–4 marks): Some valid comparisons made between the two types of bag. There may be some incorrect or irrelevant points.	
		Level 1 (1–2 marks): A vague response with few correct and relevant points and with no direct comparisons.	
	0 marks: No relevant content		
	Indicative content		
	Accept converse in terms of plastic bags for all statements		
	<ul style="list-style-type: none">• Paper bags are made from a renewable resource• Plastic bags are made from a finite resource• Paper bags require more energy to manufacture• Paper bags produce more waste• Paper bags are biodegradable• Paper bags create more CO₂• CO₂ created by paper bags offset by photosynthesis in growing wood• Paper bag requires much more fresh water• Paper bags cannot be recycled• Agree because non-renewability less important than other factors or disagree because of converse or can't say because data inconclusive / incomplete	6	
		[10]	
2	(a)	(i) ethanol	1
		(ii) oxidised	1

(iii) **Test**

add any named carbonate or hydrogen carbonate
*the first mark is for the test; the second is for the result
if the test is incorrect award 0 marks.*

1

Result

A will effervesce (carbon dioxide) **or B** will not effervesce.
if the result is incorrect, award the first mark only

1

or

*candidates do not have to name a gas but penalise an incorrect
gas.*

Test

add a named (magnesium, aluminium, zinc, iron or tin) metal
give credit to any test that will work.

Result

A will effervesce (hydrogen), **B** will not
allow a test that would identify B.

or

Test

add an acid-base indicator

Result

credit any acid colour for that indicator eg for universal indicator allow red,
yellow or orange

give credit for the neutral colour for **B**

or

Test

add an alcohol (+ acid catalyst)

Result

sweet or fruity smell of esters.

(b) (i) H₂O

1

(ii) ethyl ethanoate

1

(iii) any **one** from:

- flavourings
- perfumes
- solvents
- plasticisers

allow any correct use of esters

1

[7]

3

(a) (i) 2,4 drawn (as dots / crosses / e⁻)

1

(ii) Water (vapour) / steam

allow hydrogen oxide / H₂O

*do **not** accept hydroxide*

1

(b) any **two** pairs from:

carbon dioxide (1)

causes global warming (1)

allow greenhouse effect / climate change / sea level rise / melting of polar ice caps

or

carbon (particles) / soot (1)

allow particulates

causes global dimming (1)

allow blocks out sunlight / smog / prevents plant growth / causes breathing difficulties

or

carbon monoxide (1)

is toxic (1)

or

sulfur dioxide (1)

causes acid rain (1)

allow kills plants / erosion / acidifies water

4

[6]

4

(a) heat to vaporise (the crude oil)

*do **not** accept cracking / burning*

1

vapours condense

1

at different temperatures

allow they have different boiling points

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]

5

(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]

6

(a) (i) C_7H_{16}

mark answer line first

answer may be given in the table

1

(ii) C_nH_{2n+2}

1

(b) (i) carbon monoxide

*do **not** accept carbon oxide*

*do **not** accept water*

ignore CO

1

(ii) because of partial / incomplete combustion (in reaction 2) **or** complete combustion (in reaction 1)

*allow because there is less / insufficient oxygen (in reaction 2) **or** sufficient oxygen (in reaction 1) allow different amounts of oxygen used (in the reactions) **or** 19O₂ (in reaction 1) **and** 13O₂ (in reaction 2)*

ignore air

1

(c) (i) 15 (%)

ignore units

1

(ii) water (vapour)/steam

allow H₂O / OH₂ / hydrogen oxide

1

(iii) sulfur in petrol / crude oil (reacts with oxygen)

it = sulfur dioxide

1

(ii) because nitrogen **and** oxygen (are in the air and) react

*allow nitrogen **and** oxygen burn*

*accept nitrogen + oxygen → nitrogen oxide **or** symbol equation*

ignore air

1

at high temperature (inside a petrol engine)

allow heat / hot (engine)

1

(d) because carbon dioxide / it causes global warming **or**

allow because carbon dioxide / it causes greenhouse effect / climate change

1

because carbon dioxide / it has an impact on oceans

because this carbon dioxide / carbon / it was 'locked up' (in fossil fuels) **or**

because the percentage/amount of carbon dioxide / it in the atmosphere is increasing

1

[11]

7

(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]

8

(a) carbon dioxide decreased (by plants / trees)

allow plants / trees absorbed carbon dioxide

1

oxygen increased (by plants / trees)
allow plants / trees released oxygen
if neither of these marks awarded
allow plants / trees
photosynthesise for 1 mark

1

because coal 'locks up' / traps / stores carbon dioxide / carbon
allow trees 'locked up' carbon dioxide / carbon

1

(b) carbon / C

hydrogen / H

sulfur / S

all 3 correct 2 marks

1 or 2 correct 1 mark

allow H₂

ignore oxygen

2

(c) (i) 2 2

balancing must be correct

*do **not** accept changed formulae*

1

(ii) increases atmospheric pollution

carbon dioxide / CO₂ released

1

from the (thermal) decomposition of calcium carbonate **or**

*accept causes global warming **or** CO₂ is a greenhouse gas*

description of this decomposition **or** equation

ignore sulfur dioxide and effects in this part

1

decreases atmospheric pollution

sulfur dioxide / SO₂ is removed

accept less acid rain produced

1

by reaction with calcium oxide **or** calcium carbonate

*accept neutralisation **or** forms calcium sulfate*

1

[10]

9

(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]

10

(a) crude oil / it is evaporated / vaporised

ignore heated

1

vapours / gases / fractions cool and condense

accept named fraction(s)

1

(different) vapours / gases / fractions (condense) at different temperatures

*accept (different) vapours / gases / fractions have different boiling
points*

*max 2 marks for description of laboratory method **or** mention of
cracking*

1

(b) (i) any **one** from:

- range of boiling points
- range of carbon atoms

1

(ii) greater the number (of carbon atoms) the higher the boiling point

*do **not** accept molecules / particles*

1

(c) (i) burning / combustion

allow oxidation / redox

1

(ii) any **two** from:
reaction with hydrogen gains max of 1 mark only

- cracking / (thermal) decomposition
- heat / vaporise
- catalyst / aluminium oxide

allow porous pot

ignore names of other catalysts

2

[8]

11

(a) circle round any one (or more) of the covalent bonds

any correct indication of the bond – the line between letters

1

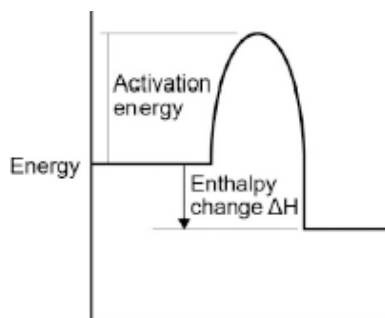
(b) Methane contains atoms of two elements, combined chemically

1

- (c) (i) activation energy labelled from level of reagents to highest point of curve
ignore arrowheads

1

enthalpy change labelled from reagents to products



*arrowhead **must** go from reagents to products only*

1

- (ii) 2 O₂

1

2 H₂O

if not fully correct, award 1 mark for all formulae correct.

ignore state symbols

1

- (iii) carbon monoxide is made

1

this combines with the blood / haemoglobin **or** prevents oxygen being carried in the blood / round body **or** kills you **or** is toxic **or** poisonous

dependent on first marking point

1

- (iv) energy is taken in / required to break bonds

accept bond breaking is endothermic

1

energy is given out when bonds are made

accept bond making is exothermic

1

the energy given out is greater than the energy taken in

this mark only awarded if both of previous marks awarded

1

- (d) (i) energy to break bonds = 1895
calculation with no explanation max = 2 1
- energy from making bonds = 1998 1
- 1895 - 1998 (= -103)
or
 energy to break bonds = 656
 energy from making bonds = 759
 656 - 759 (= -103)
allow:
bonds broken - bonds made =
413 + 243 - 327 - 432 = -103 for 3 marks. 1
- (ii) The C — Br bond is weaker than the C — Cl bond 1
- [15]
- 12** (a) Sulfur dioxide causes acid rain. 1
- (b) red / orange / yellow
*do **not** accept any other colours* 1
- because sulfur dioxide (when in solution) is an acid 1
- (c) (there are) weak forces (of attraction)
*do **not** accept any reference to covalent bonds breaking* 1
- between the molecules
*do **not** accept any other particles* 1
- (these) take little energy to overcome
award third mark only if first mark given 1

- (d) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also refer to the information on page 5 and apply a 'best-fit' approach to the marking.

0 marks

No relevant content

Level 1 (1 – 2 marks)

A relevant comment is made about the data.

Level 2 (3 – 4 marks)

Relevant comparisons have been made, and an attempt made at a conclusion.

Level 3 (5 – 6 marks)

Relevant, detailed comparisons made and a justified conclusion given.

examples of the points made in the response

effectiveness

- W removes the most sulfur dioxide
- D removes the least sulfur dioxide

material used

- Both W and D use calcium carbonate
- Calcium carbonate is obtained by quarrying which will create scars on landscape / destroy habitats
- D requires thermal decomposition, this requires energy
- D produces carbon dioxide which may cause global warming / climate change
- S uses sea water, this is readily available / cheap

waste materials

- W product can be sold / is useful
- W makes carbon dioxide which may cause global warming / climate change
- D waste fill landfill sites
- S returned to sea / may pollute sea / easy to dispose of

6

[12]

13

(a) any **two** from:

*asks for cause therefore no marks for just describing the change
must link reason to a correct change in a gas*

carbon dioxide has decreased due to:

accept idea of 'used' to indicate a decrease

- plants / microorganisms / bacteria / vegetation / trees
- photosynthesis
ignore respiration
- 'locked up' in (sedimentary) rocks / carbonates / fossil fuels
- dissolved in oceans
ignore volcanoes

oxygen has increased due to:

accept idea of 'given out / produced'

- plants / bacteria / microorganisms / vegetation / trees
- photosynthesis
ignore respiration

nitrogen increased due to:

accept idea of 'given out / produced'

- ammonia reacted with oxygen
- bacteria / micro organisms
ignore (increase in) use of fossil fuels / deforestation

2

(b) (because methane's) boiling point is greater than the average / surface temperature
or Titan's (average / surface) temperature is below methane's boiling point

*ignore references to nitrogen **or** water*

1

any methane that evaporates will condense

accept boils for evaporates

accept cooling and produce rain for condensing

1

(c) C_nH_{2n}

1

[5]

14

(a) (i) CH_4

allow H_4C

*do **not** allow lower-case h*

*do **not** allow superscript*

1

(ii)	single	1
(iii)	alkanes	1
(b) (i)	carbon / C <i>any order</i>	1
	hydrogen / H <i>allow phonetic spelling</i>	1
	sulfur / sulphur / S	1
(ii)	air / atmosphere	1
(iii)	acid rain	1
	damages trees / plants or kills aquatic organisms or damages buildings / statues or causes respiratory problems <i>allow harmful to living things</i>	1
(c)	carbon / C <i>accept soot / particulates / charcoal</i>	1
(d)	any four from: <ul style="list-style-type: none"> • (supports hypothesis) because when the fuel contained more carbon the temperature of the water went up more / faster (in 2 minutes) • (does not support hypothesis as) temperature change per gram decreases as the number of carbons increases • (does not support hypothesis) because the more carbon in the fuel the more smoke or the dirtier / sootier it is • only tested hydrocarbons / alkanes / fuels with between 5 and 12 carbon atoms • valid, justified, conclusion <i>accept converse statements</i> 	4
(e) (i)	0.15 <i>correct answer with or without working gains 2 marks</i> <i>if answer incorrect, M_r carbon dioxide = 44 gains 1 mark</i> <i>allow 0.236 / 0.24 / 0.2357142 (ecf from M_r of 28) for 1 mark</i>	2
(ii)	0.4(0)	1

(iii) C_3H_8

correct formula with or without working scores 2 marks

$$0.15 / 0.05 = 3$$

allow ecf from (e)(i)

and

$$0.4 / 0.05 = 8 (1)$$

allow ecf from (e)(ii)

allow 1 mark for correct empirical formula from their values

If use 'fall-back-values:

$$0.50 / 0.05 = 10$$

and

$$0.20 / 0.05 = 4$$

1 mark

C_4H_{10}

1 mark

if just find ratio of C to H using fall-back values, get C_2H_5 allow 1 mark

2

[19]

15

(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]

16

Reused

- saves raw materials / crude oil
 - *unable to reuse many times*
 - *bags easily split*
- saves energy / fuel / transport
- fewer bags needed / made
- reduces carbon / CO₂ emissions
- reduces use of landfill
- saves cost of a new bag
- no waste

1

Recycled

- saves raw materials / crude oil
 - *has to be collected / transported / washed / separated / melted*
- saves energy / use of fuel
- reduces carbon / CO₂ emissions
- reduces use of landfill
- can be used for new products
 - *ignore uses energy*

1

Burned

- heat / energy released can be used (for heating / generating electricity)
 - *has to be collected / transported*
- reduces use of landfill
 - *wastes the resource / plastic*
 - *releases harmful gases / toxic gases / CO₂*

1

Dumped

- collected / transported with household waste
 - *wastes the resource*
 - *plastic uses landfill*
- (slowly) biodegrades **or** produces methane which can be used as a fuel
 - *produces methane which is a greenhouse gas / could cause explosions*
- (not biodegradable so) does not release CO₂ / green house gas into the air
 - *not biodegradable / take years to decompose*

ignore cost / litter / waste / global warming / habitats unless mentioned above

1

[4]

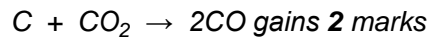
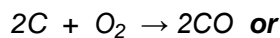
17

- (a) carbon / diesel / it reacts / burns in oxygen / air

1

limited supply (of oxygen / air)

accept incomplete combustion



1

- (b) any **four** from:

accept converse statements for fossil diesel.

ignore cost / ease of manufacture / usage issues

for biodiesel:

- less global dimming (because fewer carbon particles)
- less acid rain (because less sulfur dioxide)
 - if neither point awarded, fewer carbon particles and less sulfur dioxide = 1 mark*
- renewable resource / sustainable
 - accept fossil fuel / diesel supplies are limited*
- use waste vegetable oils / fats
- vegetables / plants absorbed carbon dioxide / carbon neutral
 - accept fossil fuel / diesel releases locked up carbon / is not carbon neutral*
- uses land which could be used to produce food
- third world countries can produce bio diesel
- biodegrades easily
- more NO_x released

4

18

any **four** from:

to gain 4 marks both pros and cons should be given

Arguments for biodiesel

max **three** from:

- sustainable / renewable
- (carbon neutral) absorbs CO₂ when growing / during photosynthesis
- burning biodiesel produces low amounts particulates / carbon monoxide
allow burning biodiesel produces little / low amount of global dimming
ignore sulfur dioxide
- can use waste vegetable oils / fats (from food industry) **or** can use waste plant material
- can be used to conserve crude oil (instead of / mixed with petroleum diesel)
- produced by a low energy / temperature process
accept produced by a low tech process
- biodegrades (easily)
ignore engine effects

Arguments against biodiesel

max **three** from:

- creates food shortages
accept price of food increases
- deforestation to plant more crops leads to loss of habitat / biodiversity **or** deforestation leads to a reduction in absorption of CO₂
allow burning trees increases CO₂
allow deforestation increases global warming
- burning biodiesel produces high amounts of nitrogen oxides
allow increases acid rain
- crops takes time to grow
allow crops can fail
- vast areas of land needed to grow crops

conclusion supported by the argument presented, which must give added value to the points for and against given above

1

[5]

19

(a) (i) heat / evaporate the crude oil / change to gas or vapour
do not accept heat with catalyst

1

cool / condense (hydrocarbons)

allow small molecules at top and / or large molecules at bottom

1

at different temperatures / boiling points

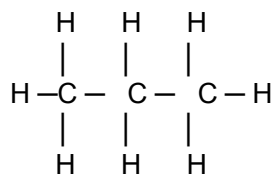
if the answer describes cracking ' no marks

1

(ii) C_4H_{10}

1

(b)



1

(c) (i) C_5 to C_8 fraction are fuels **or** easier to burn or petrol (fraction)
accept C_{21} to C_{24} fraction not useful as fuels
do not accept produce more energy

1

(ii) C_2H_4

do not accept C_4H_8

1

(iii) any **three** from:

- use different / lighter crude oils
- develop markets for low demand fractions
- develop new techniques / equipment to use low demand fractions as fuels
- cracking
- convert low demand fractions to high demand fractions or bigger molecules to smaller molecules
- develop alternative / bio fuels
do not accept price

3

[10]

20

- (a) hydrogen and carbon
for 1 mark

1

- (b) (i) the oil is evaporated / boiled / liquid converted to gas / vaporised
oil is condensed/changed back to liquid/cooled below boiling point (not just cooled)

liquids of different boiling points condense at different levels /
fractions with lower boiling points form near the top /
boiling point linked to chain length or Mr

each for 1 mark

3

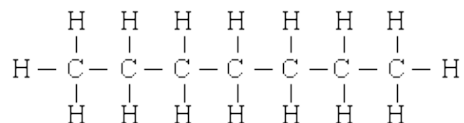
- (ii) Assume they mean naphtha unless they say otherwise.
smaller molecules
/contains less atoms
/lower boiling point
/more volatile
/less bonds to break
/lower activation energy

If the answer is given the opposite way around then diesel must
be specified.

any one for 1 mark

1

- (iii)



correct number of atoms = 1

correct number of bonds (attached to correct atoms) = 1

Accept diagrams which show electrons correctly.

$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 = 1$

for 2 marks

2

[7]