AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.7.1 CARBON COMPOUNDS AS FUELS AND FEEDSTOCK (PACK 2)

SCORE	PERCENTAGE
/263	%

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Q1.

Ethanol (C_2H_5OH) can be made from ethene or from sugar.

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

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

Element	Symbol	Number of atoms in the formula C_2H_5OH
Carbon	C	2
Hydrogen	H	_____
_____	O	1

(2)

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

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

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

(2)

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

H H

C C

H H

(1)

(iii) Name the substance added to ethene (C_2H_4) to produce ethanol (C_2H_5OH).

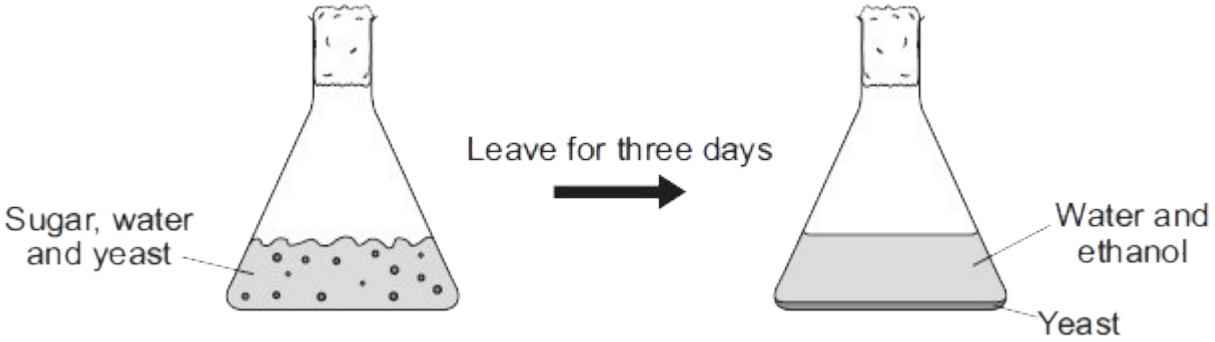
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(1)

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

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

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(i) Name the gas produced during this reaction.

_____

(1)

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

_____

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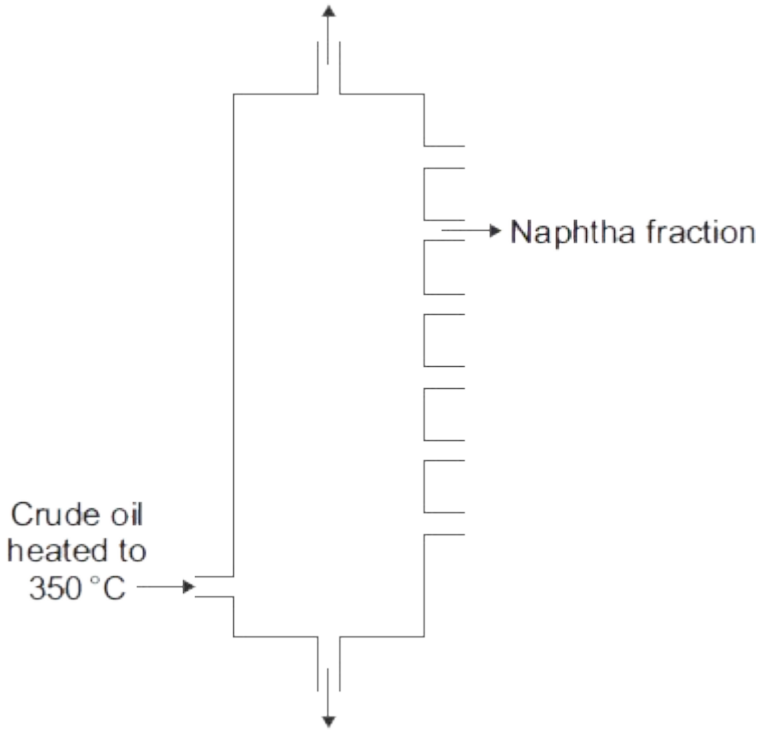
(2)

(Total 9 marks)

Q2.

Crude oil is used to produce poly(ethene).

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



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

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

(2)

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

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

1. _____

2. _____

(2)

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

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

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

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

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

_____

_____

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_____

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_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 10 marks)

Q3.

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

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

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

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

C_6H_{14} ⟶ _____ + _____

(2)

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

_____

_____

(1)

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

_____

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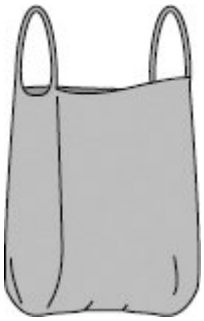
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(5)

(Total 8 marks)

Q4.

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



(a) Complete each sentence.

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(i) The compounds of hydrogen and carbon

in crude oil are called _____

(1)

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

fractional _____

(1)

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

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

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

distilling.
filtering.
vaporising.

(1)

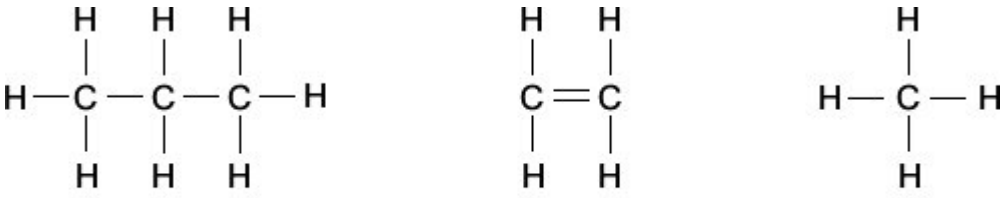
(ii) The naphtha gas is then passed over a hot catalyst.

This process is called

boiling.
bonding.
cracking.

(1)

(c) The displayed formulas of three molecules are:



Molecule A **Molecule B** **Molecule C**

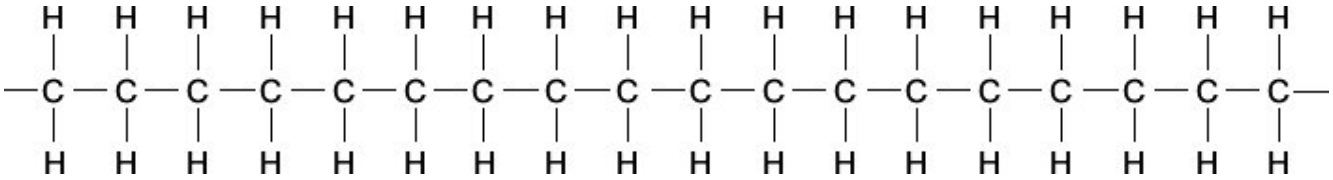
Which molecule, **A**, **B** or **C**, is an alkene? ☐

(1)

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

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

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

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

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

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

(1)

(ii) Complete the sentence.

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

(1)

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

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

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

(2)

(Total 9 marks)

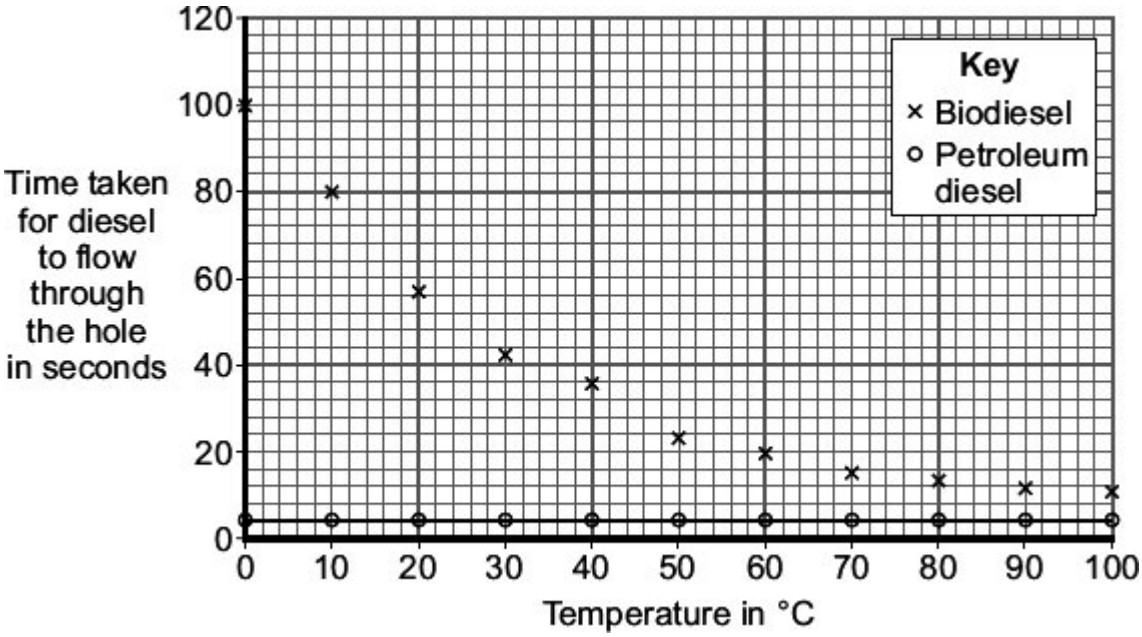
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Q5.

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.

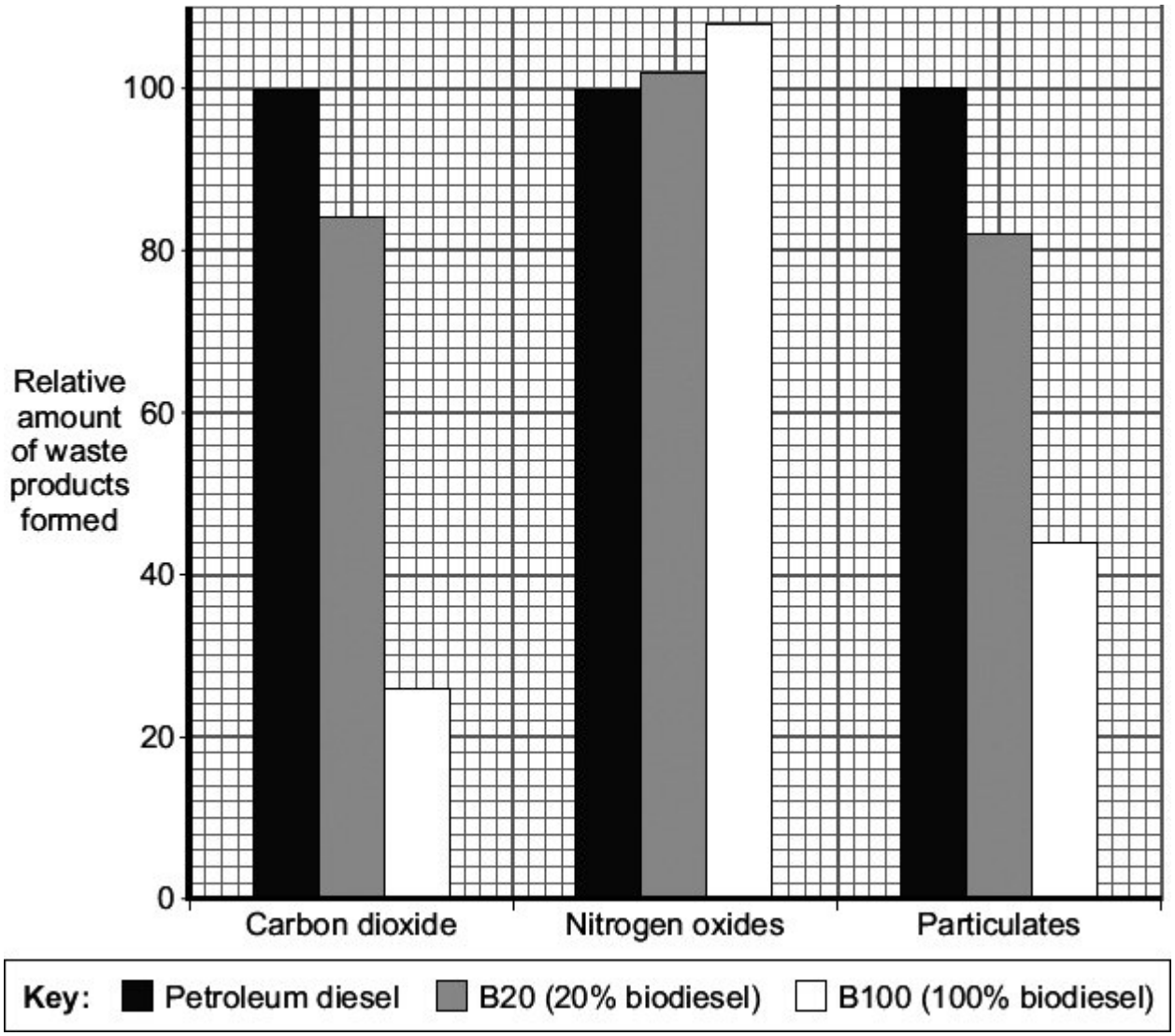
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_____

(1)

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(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.

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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.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q6.

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

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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)

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

Do you agree with this claim?

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

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_____

_____

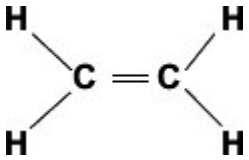
(4)

(Total 7 marks)

Q7.

Supermarkets in the UK have been advised by the Government to stop giving plastic bags to customers.
Plastic bags are made from a polymer.
The polymer is made from ethene.

The structural formula of ethene is shown.



Ethene is made by cracking hydrocarbons.
These hydrocarbons come from crude oil.

(a) Complete these sentences about ethene.

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

_____

(2)

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

(1)

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

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

(1)

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

1. _____

_____

2. _____

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_____

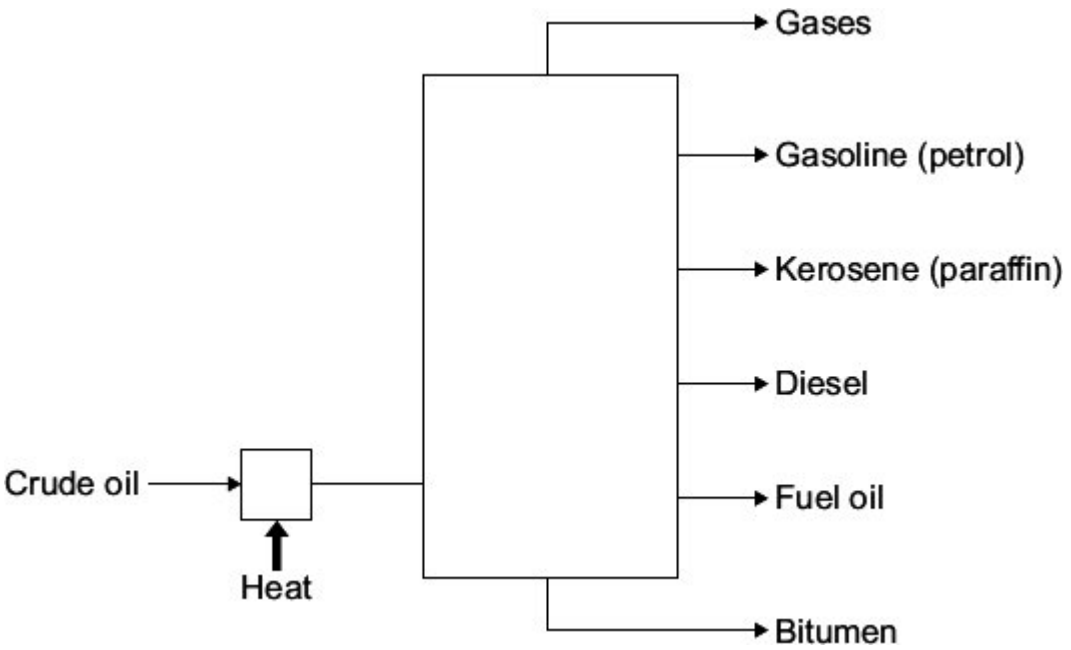
(2)

(Total 6 marks)

Q8.

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

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		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)

Q9.

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.

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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)

Q10.

This information about diesel was printed in a magazine.

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

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

_____

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_____

_____

_____

(2)

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

Remember to give a conclusion to your evaluation.

_____

_____

_____

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_____

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_____

_____

(5)

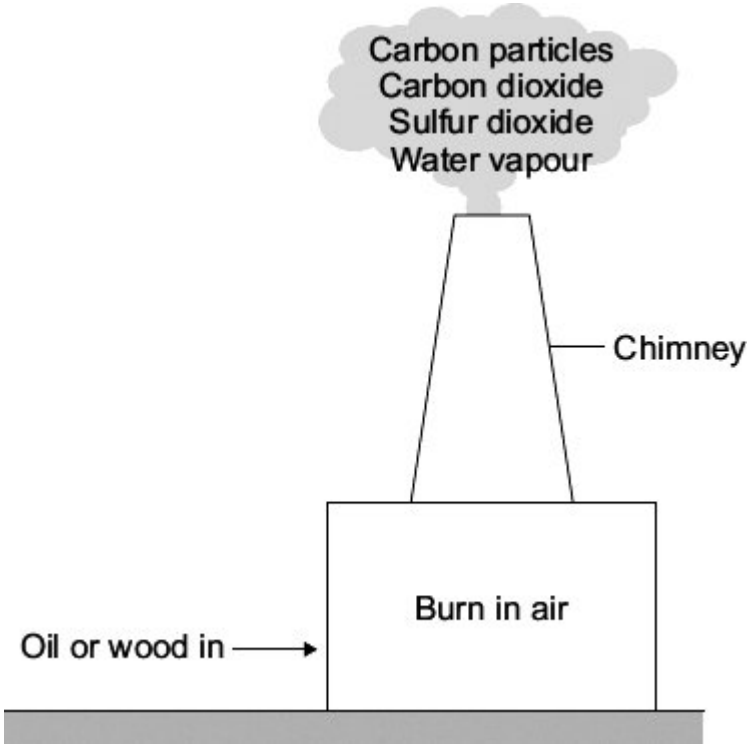
(Total 7 marks)

Q11.

In the future:

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

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

_____

(1)

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

Carbon particles in the Earth's atmosphere cause

acid rain.
global dimming.
global warming.

(1)

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

_____

(1)

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

_____

_____

(1)

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

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

_____

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_____

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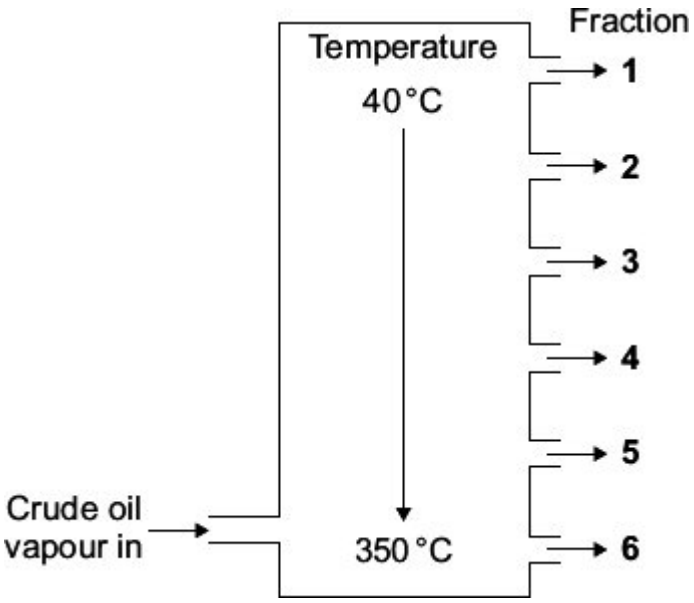
_____

(2)

(Total 6 marks)

Q12.

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



(a) (i) Complete the sentence.

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

fractional _____ .

(1)

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

_____

_____

(1)

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

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

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has a high boiling point	

(2)

(c) Fraction **1** contains hydrocarbons called alkanes.
The general formula of an alkane is: C_nH_{2n+2}

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

Draw a ring around the correct answer.

C_5H_9 **C_5H_{10}** **C_5H_{11}** **C_5H_{12}**

(1)
(Total 5 marks)

Q13.

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

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

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

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

How are hydrocarbons cracked?

_____

_____

_____

_____

(2)

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

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

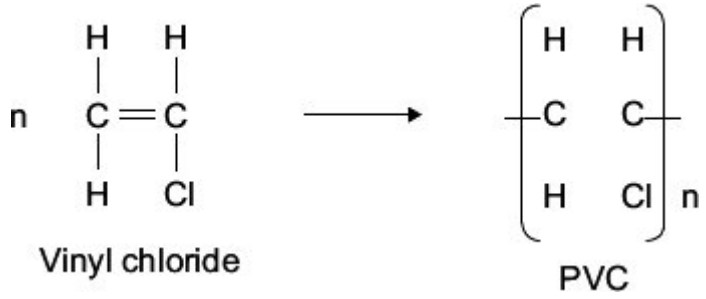
$$C_2H_4 + Cl_2 \longrightarrow \text{_____} + HCl$$

(1)

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

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

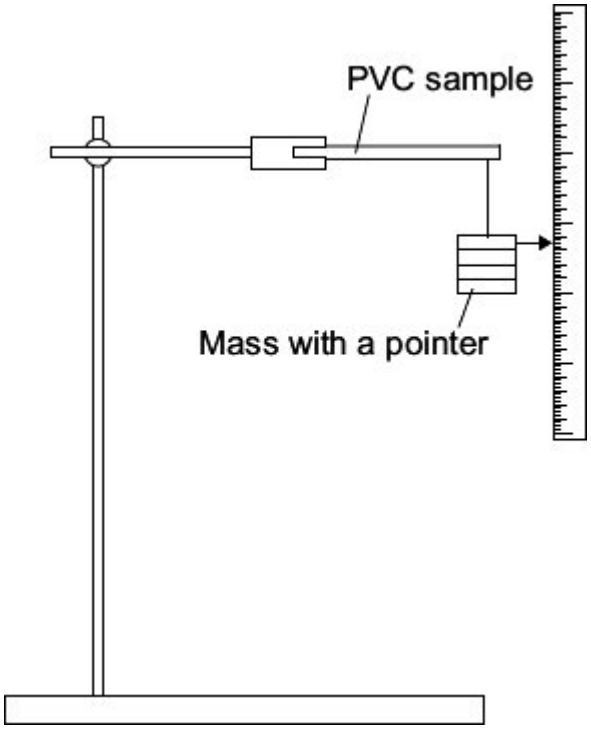
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(1)

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

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



The student's results are shown in the table.

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

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D	**15**	34	35	35	36	35

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

_____

_____

(1)

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

_____

_____

(1)

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

_____

_____

_____

_____

(2)

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

_____

_____

(1)

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

_____

_____

(1)

(Total 10 marks)

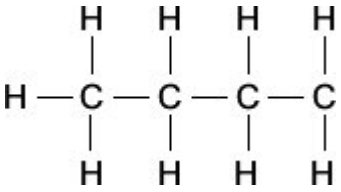
Q14.

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

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

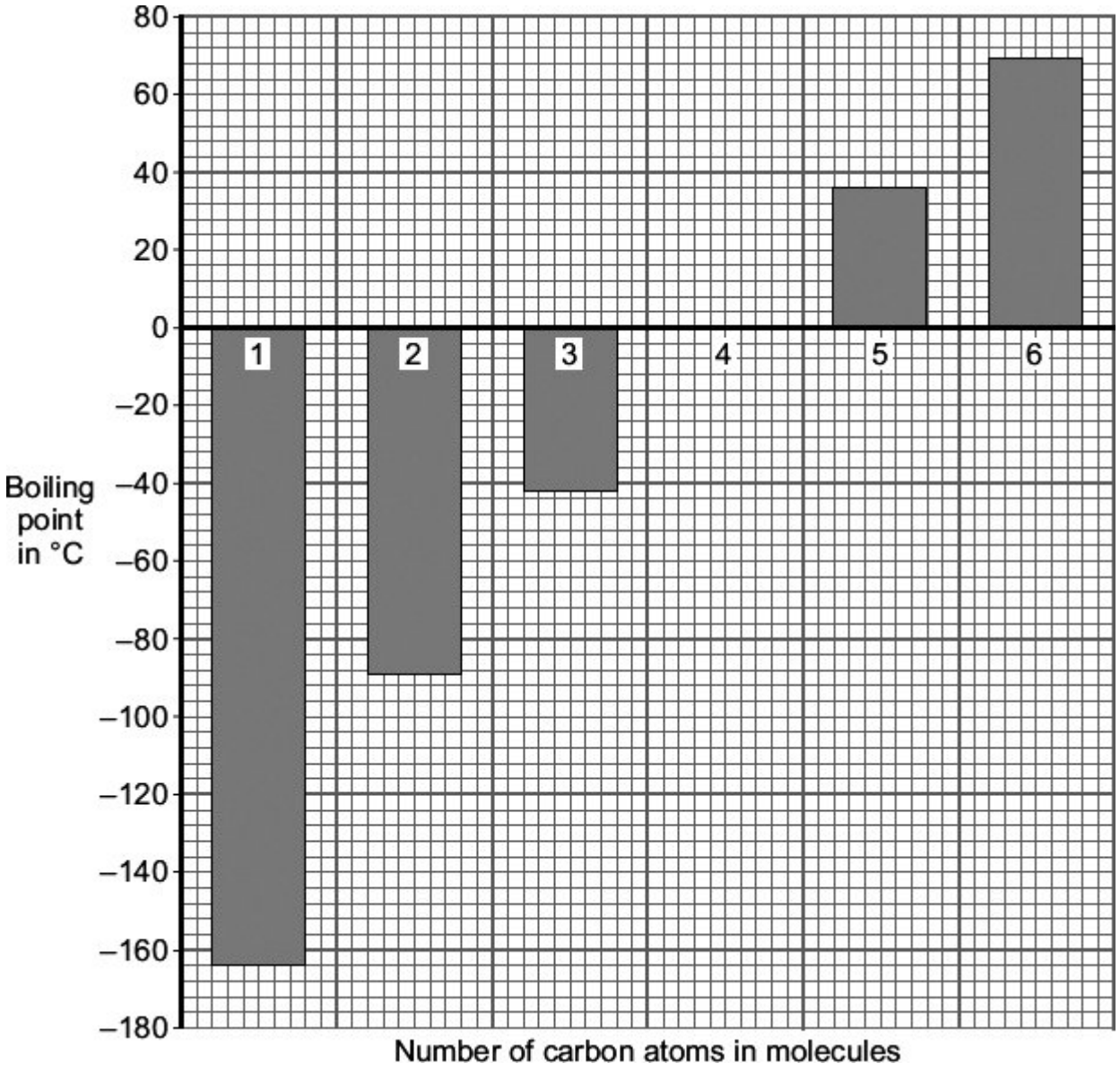
Complete the structural formula for the alkane that has **six** carbon atoms in its molecules.

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(1)

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



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

_____

_____

(1)

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

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1. _____

_____

2. _____

_____

(2)

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

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

$2\ C_8H_{18} + 25\ O_2 \longrightarrow ____\ CO_2 + ____\ H_2O$

(1)

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

_____

_____

(1)

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

_____

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q15.

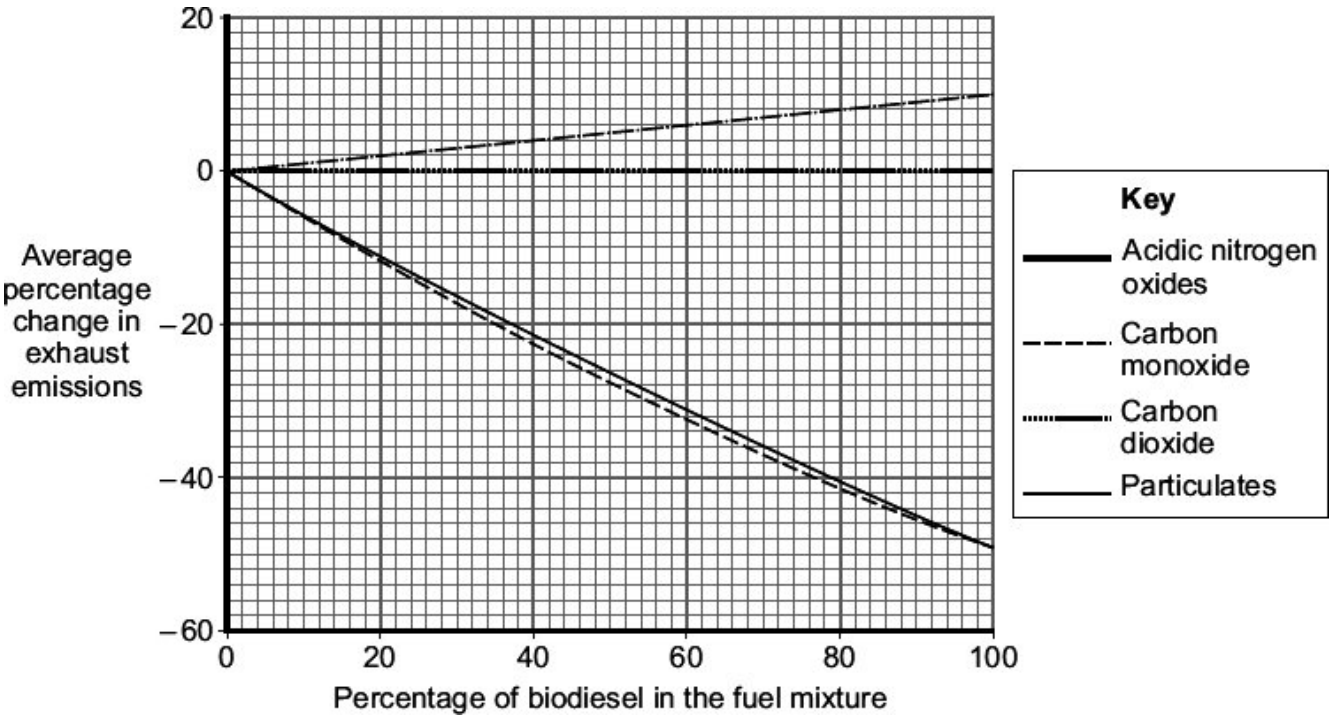
Petroleum diesel is produced from crude oil.

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.

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

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



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

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

Remember to give a conclusion to your evaluation.

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_____

_____

_____

_____

_____

_____

(5)

(Total 5 marks)

Q16.

Natural gas is mainly a hydrocarbon called methane.

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

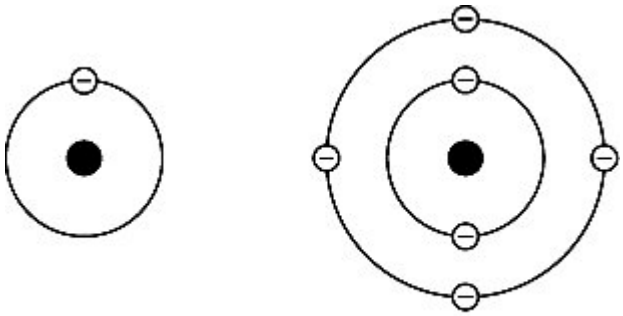
compounds	**elements**	**molecules**

Hydrocarbons contain hydrogen and carbon only.

Hydrogen and carbon are _____ .

(1)

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



Hydrogen Carbon

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

(i) The centre of each atom is called the

bond.

nucleus.

symbol.

(1)

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

three

four

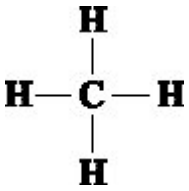
electrons.

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six

(1)

(c) A molecule of methane can be represented as



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

(i) The formula of methane is

CH

CH_4

C_4H_4

(1)

(ii) The line between C—H is called a

bond.

molecule.

nucleus.

(1)

(d) Methane burns to produce carbon dioxide (CO_2) and water (H_2O).

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

When methane burns it reacts with

carbon.

nitrogen.

oxygen.

(1)

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

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

_____

_____

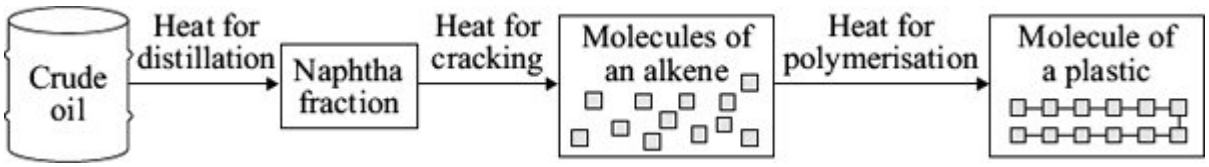
(1)

(Total 7 marks)

Q17.

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

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

_____

_____

_____

_____

_____

(2)

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

(i) Balance the symbol equation for this reaction.

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

(1)

(ii) Describe how cracking is carried out.

_____

_____

_____

_____

_____

(2)

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

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

Explain these statements.

_____

_____

_____

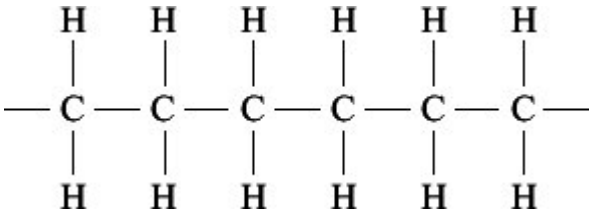
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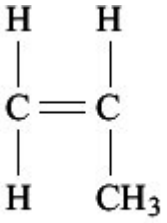
(2)

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



Propene molecules form the polymer poly(propene).



Propene molecule

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

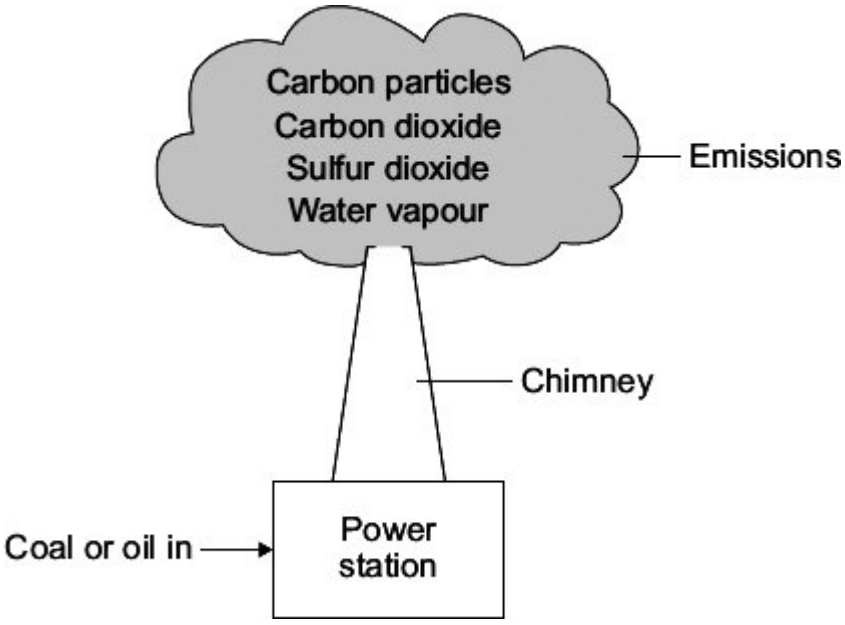
(2)

(Total 9 marks)

Q18.

In the future more coal-fired and fewer oil-fired power stations will be used to generate electricity.

When coal and oil are burned they produce the same types of emissions which can cause environmental problems.



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

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Possible environmental problem	Emission that causes it
acid rain	carbon particles
global warming	carbon dioxide
global dimming	sulfur dioxide
	water vapour

(3)

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

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

carbon dioxide.
nitrogen.
oxygen.

(1)

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

carbon monoxide.
hydrogen.
oxygen.

(1)

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

The world production figures after 2000 are predicted.

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

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

_____

_____

(1)

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

1. _____

_____

2. _____

_____

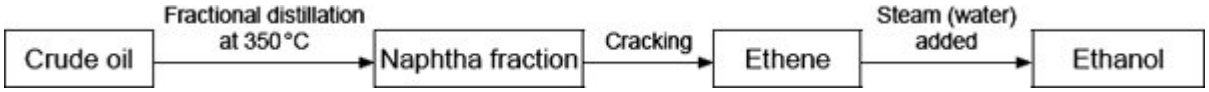
(2)

(Total 8 marks)

Q19.

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

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



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

_____

_____

(1)

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

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

(i) Describe how cracking is done.

_____

_____

_____

_____

(2)

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

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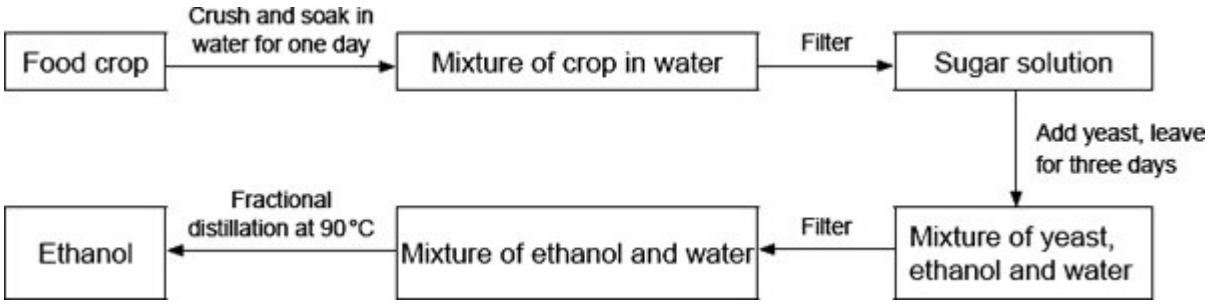
H H

C C

H H

(1)

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



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

Remember to give a conclusion to your evaluation.

(5)

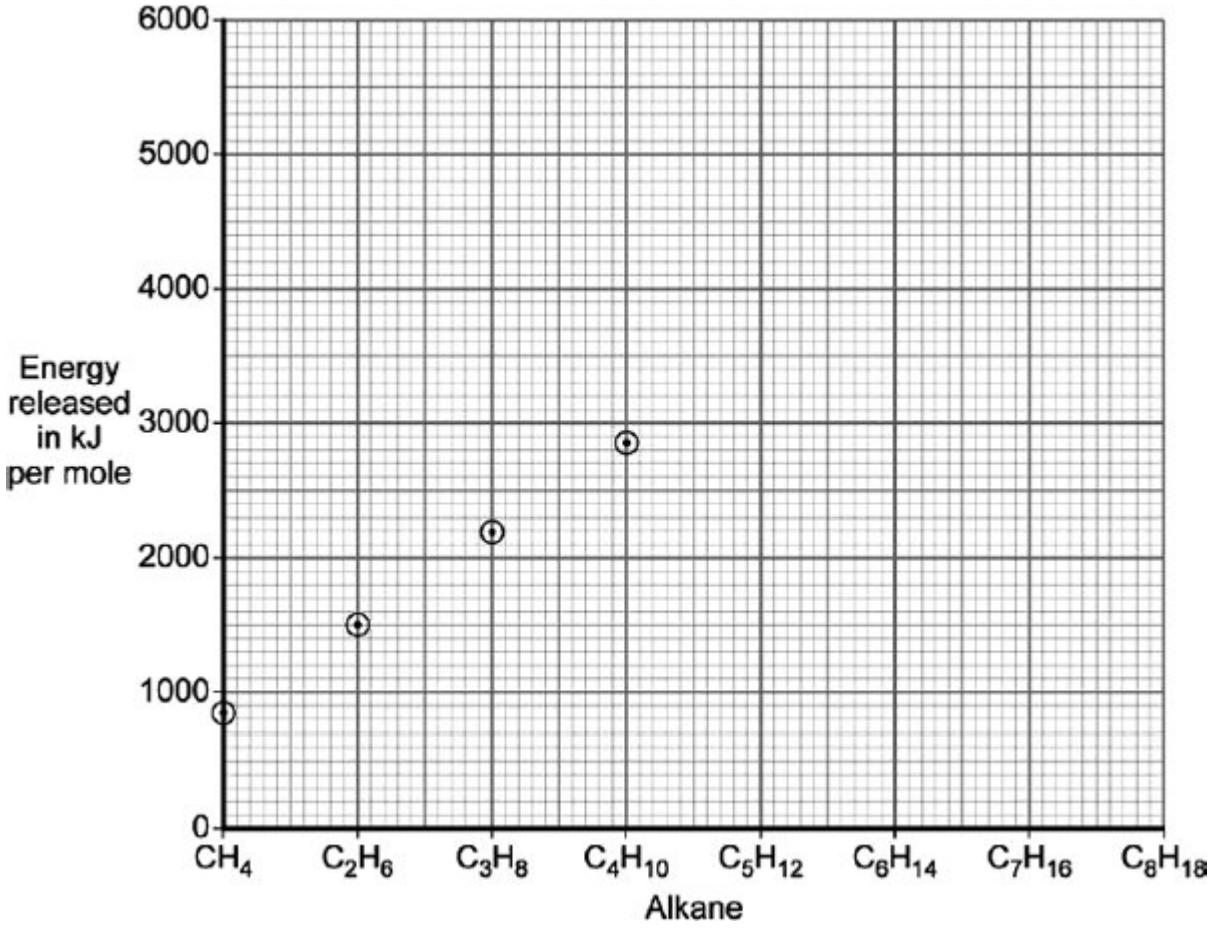
(Total 9 marks)

Q20.

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

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



(i) Draw a line through the points and extend your line to the right-hand edge of the graph.

(1)

(ii) Use the graph to estimate the amount of energy released when 1 mole of octane (C_8H_{18}) is burned.

Energy released = _____ kJ

(1)

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

_____

_____

(1)

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

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

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

_____

_____

_____

_____

(2)

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

			Combustion products			
Fuel	**Type**	**Heat released in kJ per g**	**CO_2**	**SO_2**	**H_2O**	**Type of flame**
Bio-ethanol	Renewable	29	✓		✓	Not smoky
Coal	Non-renewable	31	✓	✓	✓	Smoky
Hydrogen	Renewable	142			✓	Not smoky
Natural gas	Non-renewable	56	✓		✓	Not smoky

From this information a student made two conclusions.

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

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

_____

_____

_____

_____

(2)

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

_____

_____

_____

_____

_____

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_____

_____

(2)

(Total 9 marks)

Q21.

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

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

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

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

(i) Name the polymer made from ethene.

_____

(1)

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

$$C_5H_{12} \rightarrow C_2H_4 + C_3H_8$$

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

_____

_____

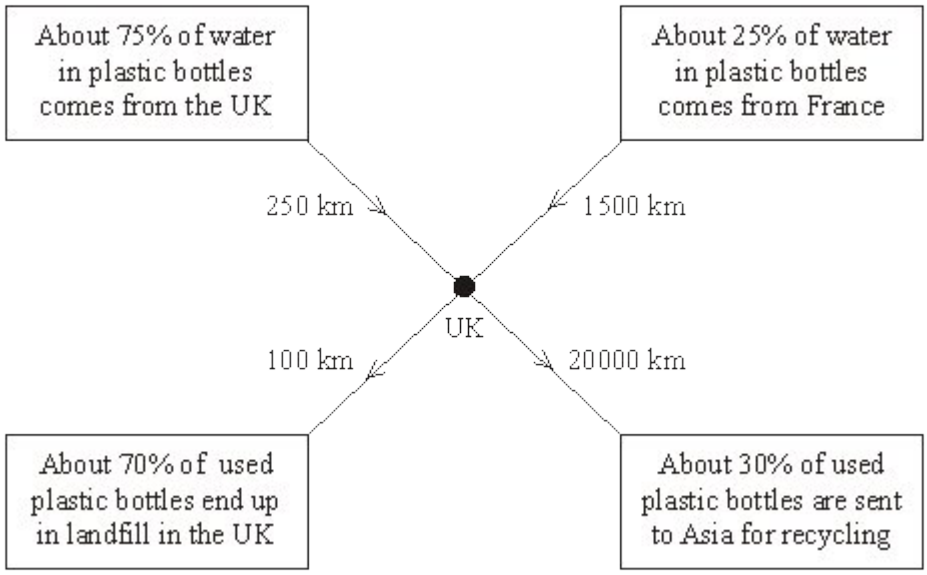
_____

_____

(2)

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

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

_____

_____

_____

_____

_____

_____

(3)

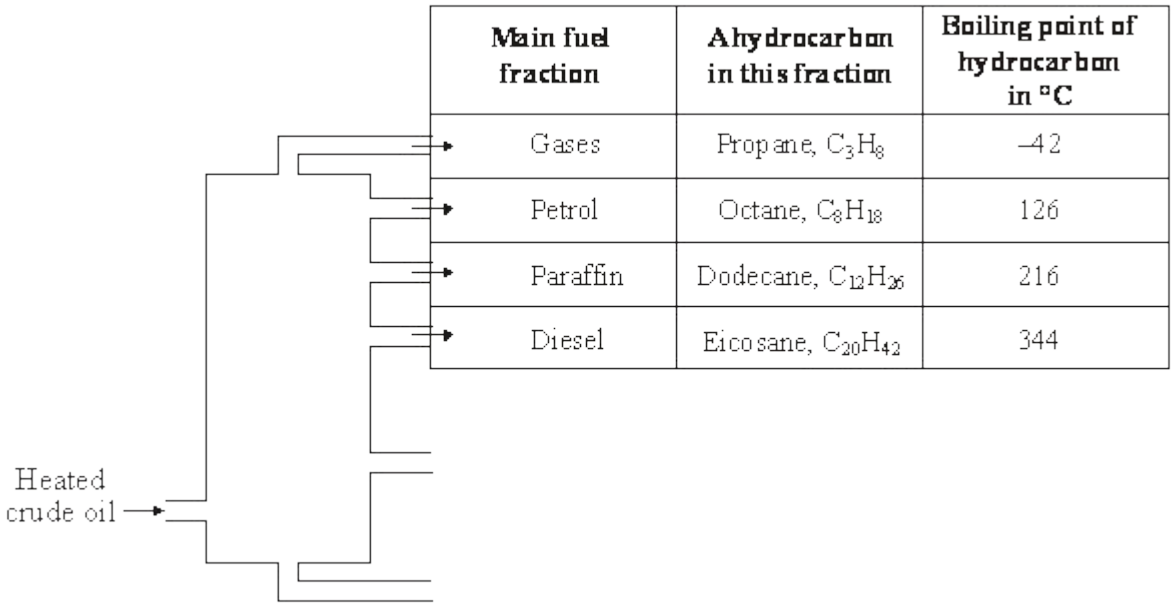
(Total 6 marks)

Q22.

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

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

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Main fuel fraction	A hydrocarbon in this fraction	Boiling point of hydrocarbon in °C
Gases	Propane, C_3H_8	–42
Petrol	Octane, C_8H_{18}	126
Paraffin	Dodecane, $C_{12}H_{26}$	216
Diesel	Eicosane, $C_{20}H_{42}$	344

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

_____

_____

(1)

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

Temperature = _____ °C

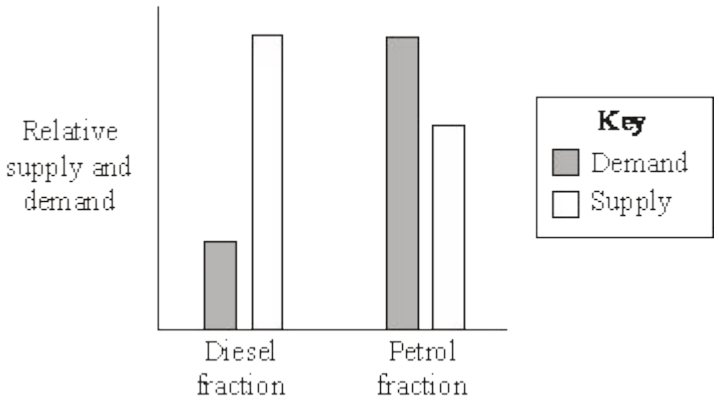
(1)

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

Temperature = _____ °C

(1)

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



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

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_____

_____

_____

_____

(2)

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

_____

_____

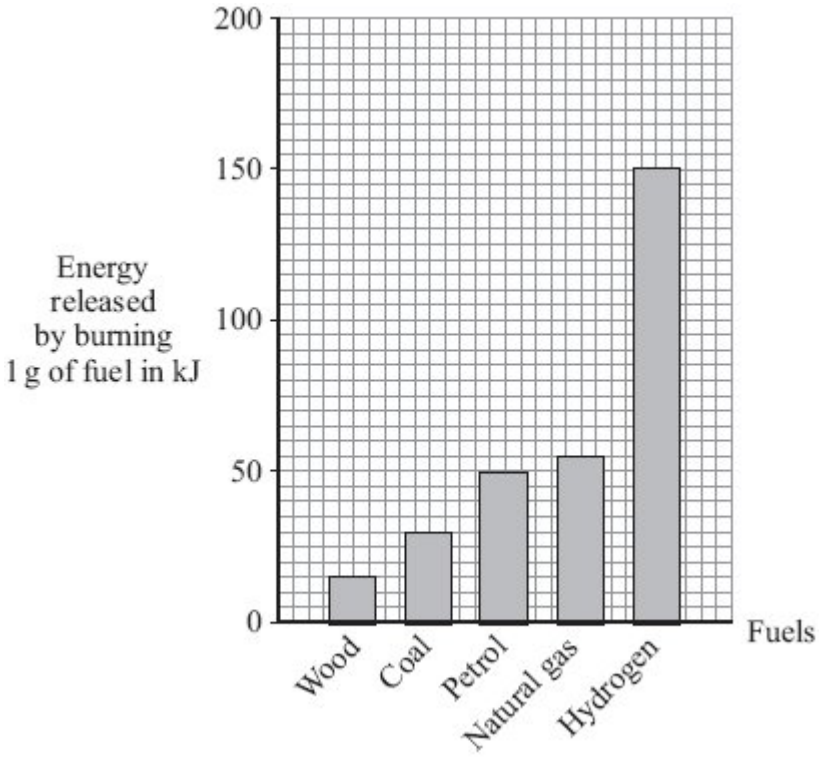
(1)

(Total 6 marks)

Q23.

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)

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

Name	Formula
Carbon dioxide	CO_2
Water vapour	H_2O
Sulfur dioxide	SO_2

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

_____

(1)

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

_____

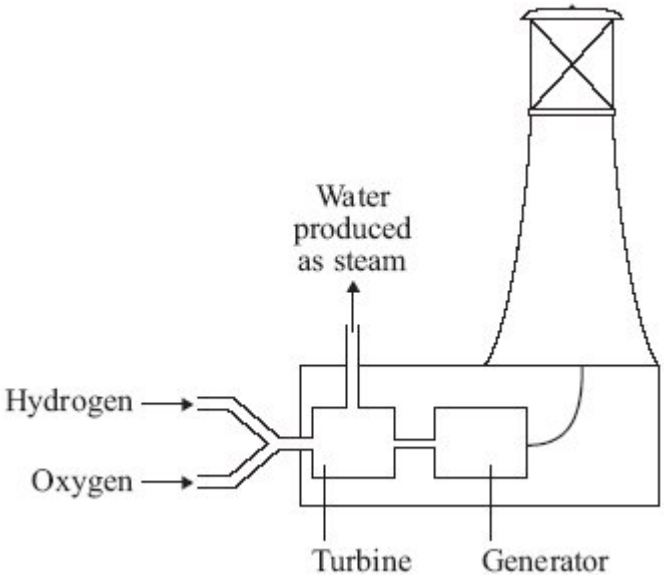
_____

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. _____

_____

2. _____

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_____

(2)

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

_____

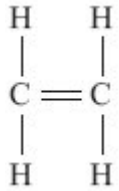
(1)

(Total 7 marks)

Q24.

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

(a) The alkene shown is ethene.



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

Formula	(✓)
CH_4	
C_2H_4	
C_2H_6	

(1)

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

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

(1)

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

THE PROBLEM WITH PLASTIC WASTE

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

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

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

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The UK recycles only 7% of plastic waste.

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

Litter that is plastic waste needs to be removed from beaches

because it | decomposes / is flammable / is not biodegradable | .

(1)

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

_____

_____

(1)

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

How are resources saved by recycling more plastics?

_____

_____

(1)

(Total 5 marks)

Q25.

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

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

_____

_____

_____

_____

(2)

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

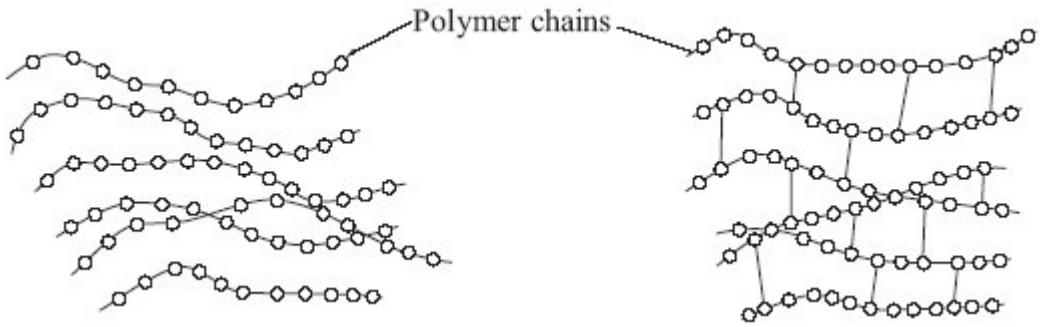
_____

_____

(1)

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

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Poly(ethene) **PEX**

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

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

_____

_____

_____

_____

_____

(3)

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

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

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

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

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

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

_____

_____

_____

_____

_____

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_____

_____

_____

_____

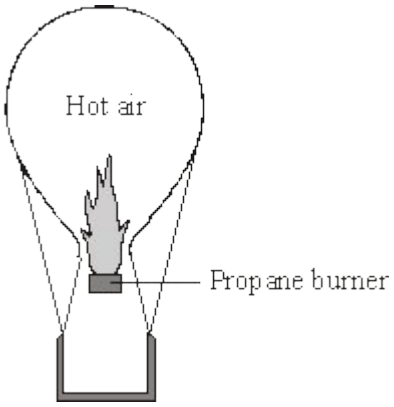
_____

(4)

(Total 10 marks)

Q26.

Hot air balloons burn hydrocarbons to heat the air.



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

(i) Argon is an *element*.

What is an *element*?

_____

_____

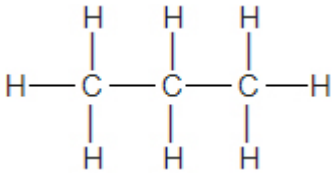
(1)

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

_____

(1)

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



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

bond	carbon	compound	element	mixture

(i) Propane is a _____ and is made up of atoms of hydrogen and _____

(2)

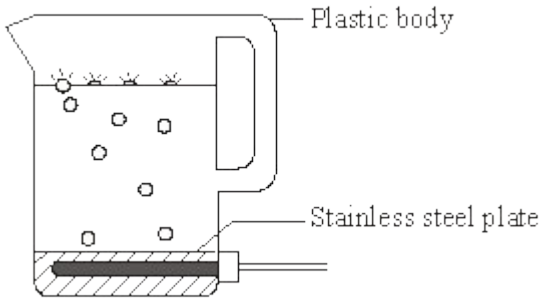
(ii) Each line between the atoms in propane represents a chemical _____

(1)

(Total 5 marks)

Q27.

Plastics are used to make many everyday items, such as the body of the kettle.



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

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

catalysts
monomers
polymers

(1)

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

crude oil
limestone
metal ores

(1)

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

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

Consider these statements.

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

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1. _____

_____

2. _____

_____

3. _____

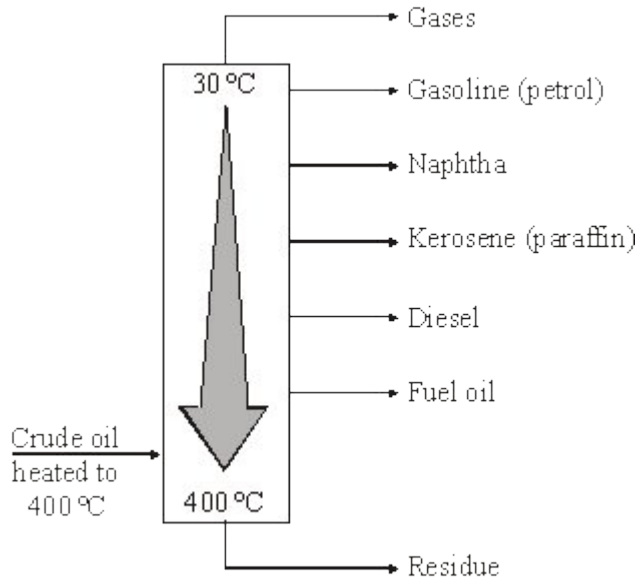
_____

(3)

(Total 5 marks)

Q28.

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



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

_____

_____

_____

_____

(2)

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

This involves the cracking of hydrocarbons in the naphtha fraction.

For example:

decane	→	hexane	+	ethene
$C_{10}H_{22}$	→	C_6H_{14}	+	C_2H_4

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(i) Balance the symbol equation given above.

(1)

(ii) Describe how cracking is carried out.

_____

_____

_____

(2)

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

_____

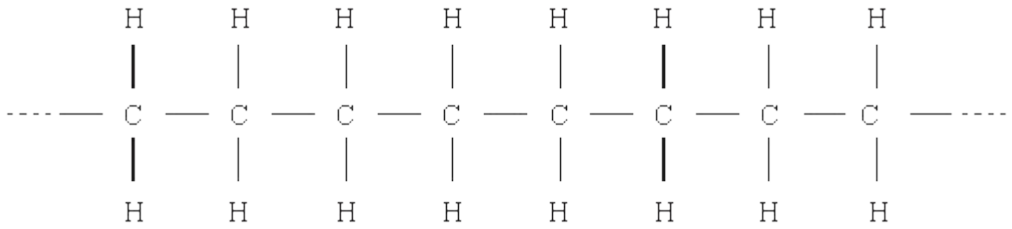
_____

_____

_____

(2)

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



Complete the diagram to show the bonds in ethene.

H H

C C

H H

(1)

(d) Read the following information.

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

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

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

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the use of fossil fuels and is expensive.

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

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

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

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

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

_____

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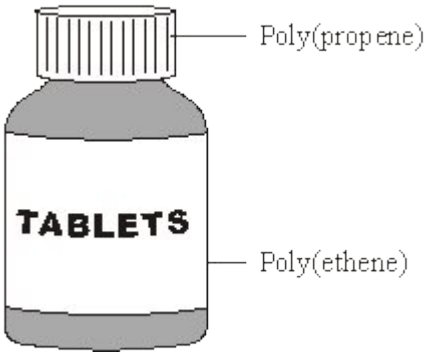
(4)

(Total 12 marks)

Q29.

Tablet containers are often made from two different polymers.

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

(i) Complete the following sentence.

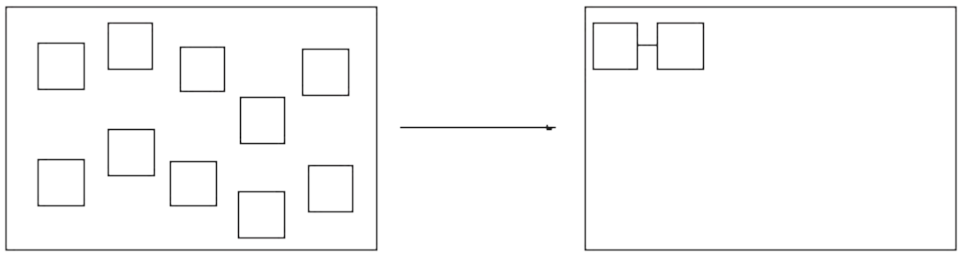
Ethene and propene are called hydrocarbons because they are made up of carbon and _____ atoms only.

(1)

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

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

Ethene molecules **Poly(ethene) molecule**



(2)

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

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

1. _____

_____

2. _____

_____

(2)

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

_____

_____

(1)

(Total 6 marks)

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Q30.

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

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

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

_____

_____

(1)

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

_____

_____

_____

_____

(2)

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

_____

_____

_____

_____

(2)

(Total 5 marks)

Q31.

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.

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_____

_____

_____

_____

_____

_____

_____

(3)

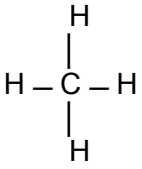
(ii) The table gives the name and formula for each of the first three alkanes.

Complete the table to show the formula of butane.

Name of alkane	**Formula**
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	

(1)

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

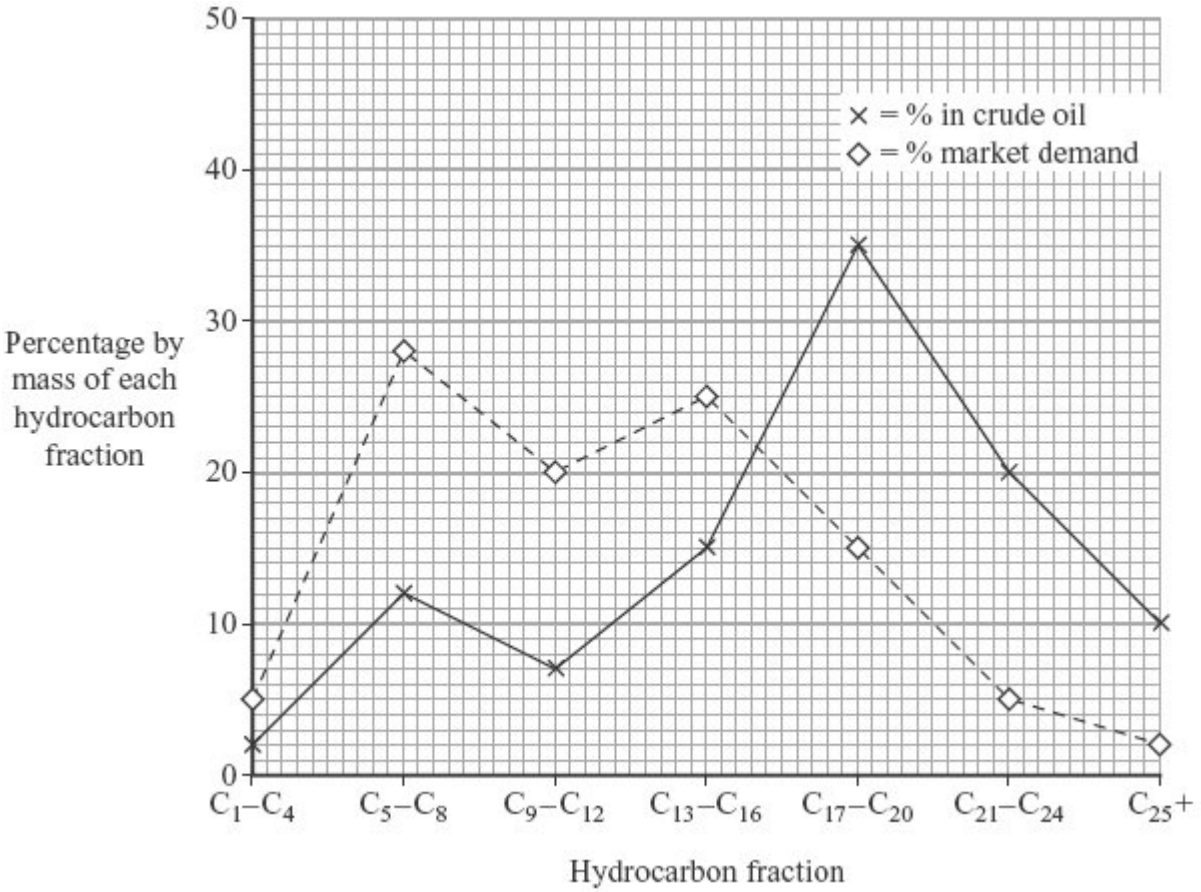


Draw the structural formula of propane, C_3H_8

(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.

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

_____

_____

(1)

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

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

$C_{20}H_{42}$ $C_{16}H_{34}$ + 2 _____

(1)

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

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

1. _____

_____

2. _____

_____

3. _____

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_____

(3)

(Total 10 marks)

Q32.

Polymers are used to make many materials that people need.

(a) Plastic bags are used to carry, protect and store food. Plastic bags are made from polymers.



Plastic bag made from a polymer

(i) Ethene is the small molecule (the monomer) used to make the polymer for this plastic bag.

Name the polymer that is made from ethene.

_____

(1)

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

condensing	**corroding**	**cracking**

Ethene is made by breaking down large hydrocarbon molecules into smaller hydrocarbon molecules by a process called _____

(1)

(iii) The hydrocarbon ethene has the formula C_2H_4

Complete the sentence about ethene.

Ethene is a hydrocarbon made up of carbon and _____ atoms.

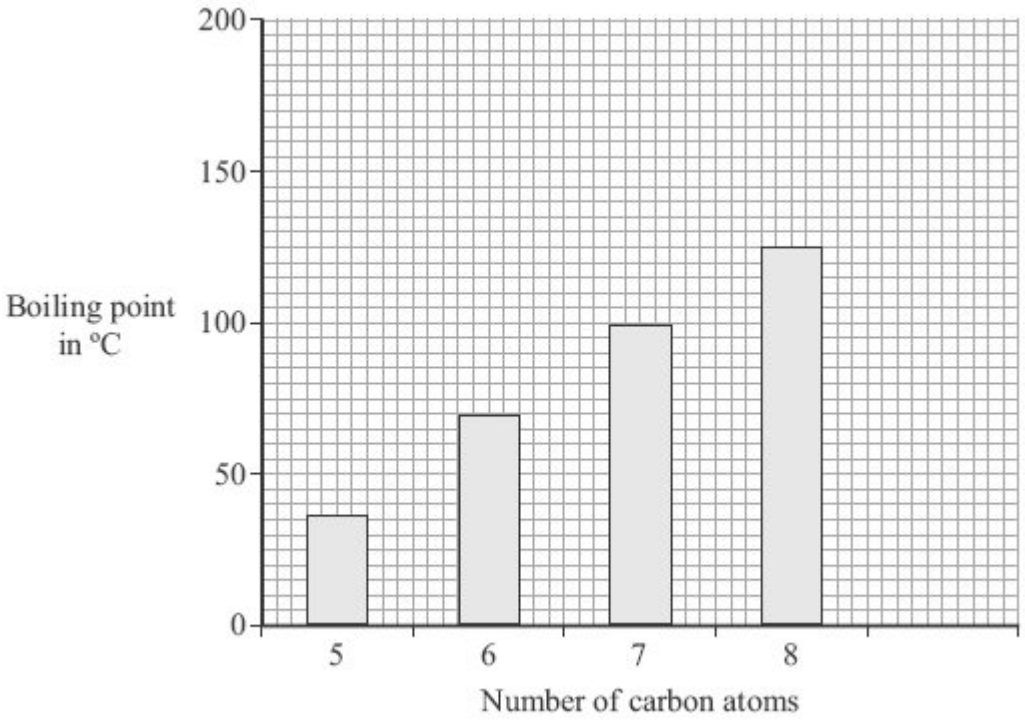
(1)

(b) The hydrocarbons used to make ethene come from crude oil. The properties of hydrocarbons are linked to the number of carbon atoms in their molecules.

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Number of carbon atoms	5	6	7	8	9
Boiling point in °C	36	69	99	125	151

(i) Use the data in the table to complete the bar chart.



(2)

(ii) What happens to the boiling point of a hydrocarbon as the number of carbon atoms increases?

_____

(1)

(iii) All the hydrocarbons in the table are found in petrol. Petrol is one of the fractions separated from crude oil.

Describe how the fractions are separated from crude oil.

_____

_____

_____

_____

_____

(2)

(c) Most plastic bags that are made of hydrocarbons are not biodegradable.

Used plastic bags can be:

- dumped into large holes, which is called landfill

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- burned to give out heat energy, which would produce large amounts of gases.

Would burning used plastic bags be better for the environment than dumping them in landfill?

Explain your answer.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q33.

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

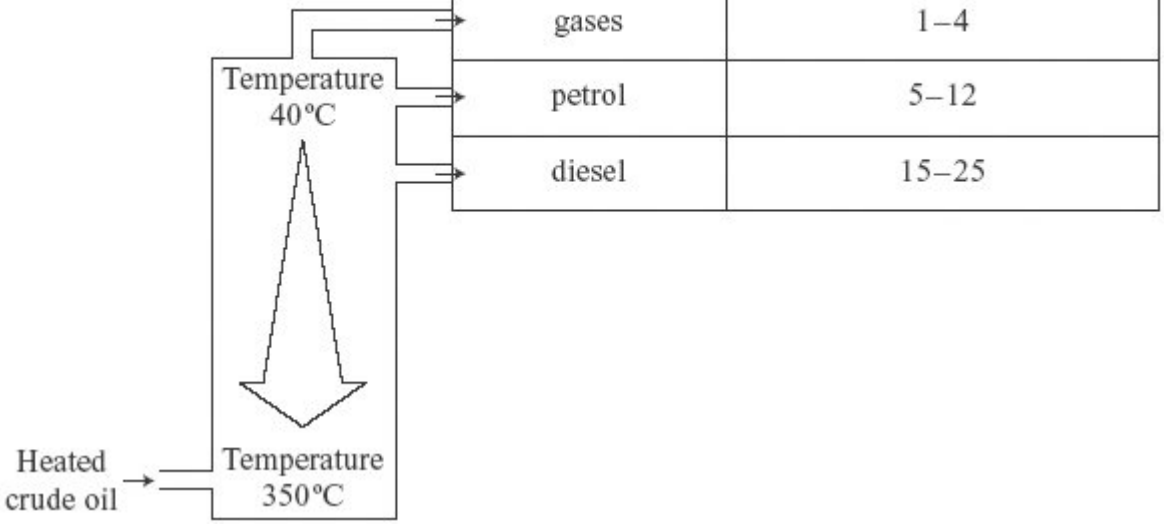
(a) Crude oil is a mixture of hydrocarbons.

Complete the sentence about a hydrocarbon molecule.

A hydrocarbon molecule is made up of _____ and carbon atoms only.

(1)

(b) Many fuels come from crude oil. Some of these fuels are shown in the diagram.



Fraction	Number of carbon atoms in each molecule
gases	1–4
petrol	5–12
diesel	15–25

Suggest **two** properties of these fuels that allow them to be separated from crude oil.

_____

_____

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_____

_____

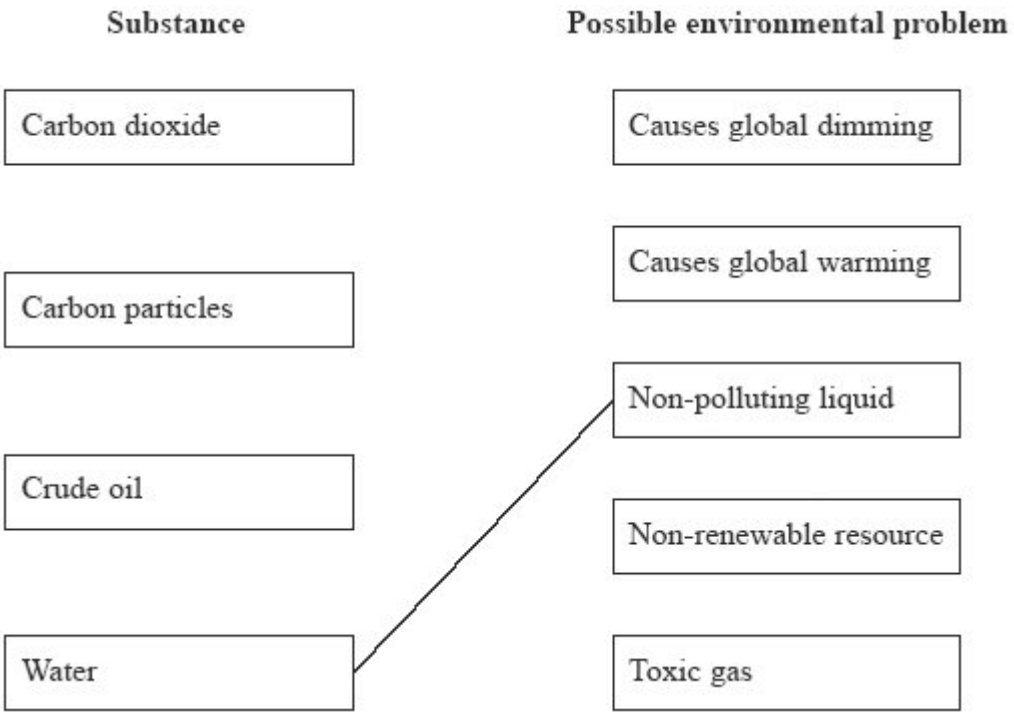
(2)

(c) Fuels from crude oil burn to provide heat energy.

When a fuel burns, it combines with oxygen in the air and produces carbon dioxide and water. When there is not enough oxygen, the fuel burns and also produces carbon monoxide and carbon particles.

Draw a straight line from each substance that links it to a possible environmental problem.

One has been done for you.



(3)

(Total 6 marks)

Q34.

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

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

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

(i) How can ethanol be separated from water?

_____

_____

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(1)

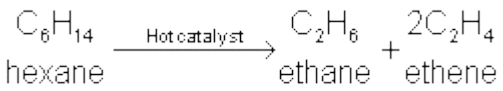
(ii) Ethanol, C_2H_5OH, burns to release heat energy.

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

C_2H_5OH + $3O_2$ 2_____ + 3_____

(2)

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



Ethene is then converted into ethanol.

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

_____

(1)

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

C C

(1)

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

_____

(1)

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

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

_____

_____

_____

_____

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_____

_____

_____

_____

(4)

(Total 10 marks)

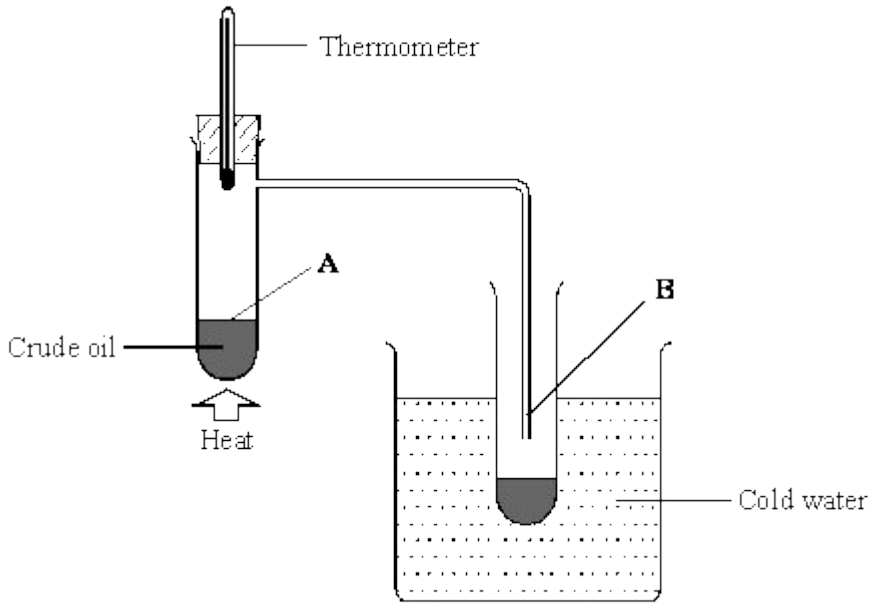
Q35.

(a) Complete this sentence about crude oil.

Crude oil is mainly a mixture of compounds called _____ which contain carbon and hydrogen only.

(1)

(b) The diagram shows a laboratory experiment used to separate crude oil.



Complete each sentence by choosing the correct words from the box.

condensation	**distillation**	**evaporation**
melting	**sublimation**	

The main process taking place at **A** is _____

The main process taking place at **B** is _____

This method of separating crude oil is called _____

(3)

(c) Complete this sentence by crossing out the word in each box that is wrong. The first one has been done for you.

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This method of separating crude oil works because the [smaller / larger] the molecules are,

the [higher / lower] their boiling point and the [more / less] volatile they are.

(1)

(Total 5 marks)

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