

1

This question is about hydrocarbons.

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

Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}

The next member in the series is pentane.

What is the formula of pentane?

.....

(1)

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

Tick **one** box.

Alcohols

☐

Alkanes

☐

Alkenes

☐

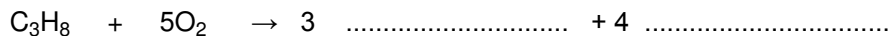
Carboxylic acids

☐

(1)

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

Complete the equation for the complete combustion of propane.



(2)

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

Explain why octane is a hydrocarbon.

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(2)

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

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

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

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(3)

- (f) Pollutants cause environmental impacts.

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

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

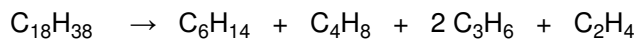
(2)
(Total 11 marks)

2

This question is about organic compounds.

Hydrocarbons can be cracked to produce smaller molecules.

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



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

Tick **one** box.

C_2H_4

☐

C_3H_6

☐

C_4H_8

☐

C_6H_{14}

☐

(1)

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

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

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

Tick **one** box.

A

☐

B

☐

C

☐

D

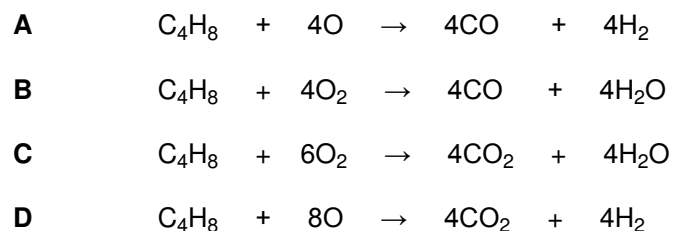
☐

(1)

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

Incomplete combustion occurred.

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



Tick **one** box.

A

☐

B

☐

C

☐

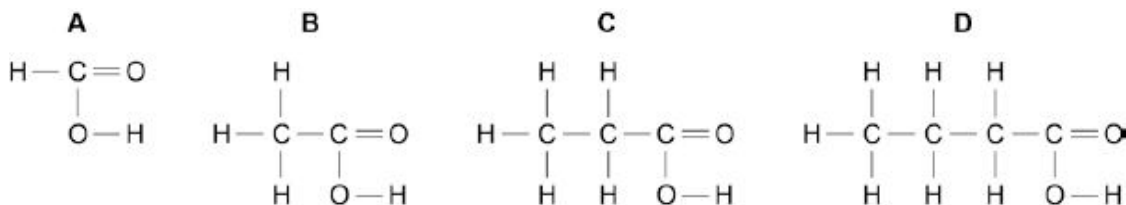
D

☐

(1)

- (d) Propanoic acid is a carboxylic acid.

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



Tick **one** box.

A

☐

B

☐

C

☐

D

☐

(1)

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

Tick **one** box.

Propane

☐

Propene

☐

Propanol

☐

Polyester

☐

(1)
(Total 5 marks)

3

This question is about copper.

- (a) Copper can be extracted by smelting copper-rich ores in a furnace.

The equation for one of the reactions in the smelting process is:



Explain why there would be an environmental problem if sulfur dioxide gas escaped into the atmosphere.

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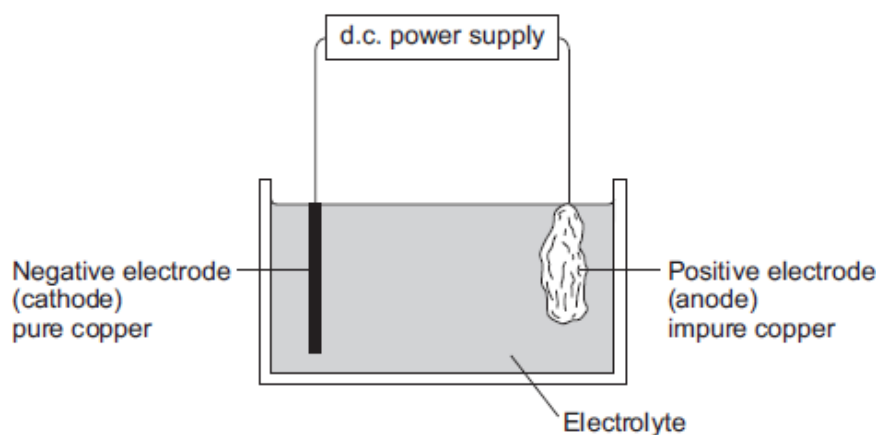
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(2)

- (b) The impure copper produced by smelting is purified by electrolysis, as shown below.



Copper atoms are oxidised at the positive electrode to Cu^{2+} ions, as shown in the half equation.



- (i) How does the half equation show that copper atoms are oxidised?

.....

(1)

- (ii) The Cu^{2+} ions are attracted to the negative electrode, where they are reduced to produce copper atoms.

Write a balanced half equation for the reaction at the negative electrode.

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(1)

- (iii) Suggest a suitable electrolyte for the electrolysis.

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(1)

- (c) Copper metal is used in electrical appliances.

Describe the bonding in a metal, and explain why metals conduct electricity.

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(4)

- (d) Soil near copper mines is often contaminated with low percentages of copper compounds.

Phytomining is a new way to extract copper compounds from soil.

Describe how copper compounds are extracted by phytomining.

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(3)

- (e) A compound in a copper ore has the following percentage composition by mass:

55.6% copper, 16.4% iron, 28.0% sulfur.

Calculate the empirical formula of the compound.

Relative atomic masses (A_r): S = 32; Fe = 56; Cu = 63.5

You must show all of your working.

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Empirical formula =

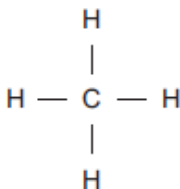
(4)

(Total 16 marks)

4

Methane (CH_4) is used as a fuel.

- (a) The displayed structure of methane is:



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

(1)

- (b) Why is methane a compound?

Tick (✓) **one** box.

Methane contains atoms of two elements, combined chemically.

☐

Methane is not in the periodic table.

☐

Methane is a mixture of two different elements.

☐

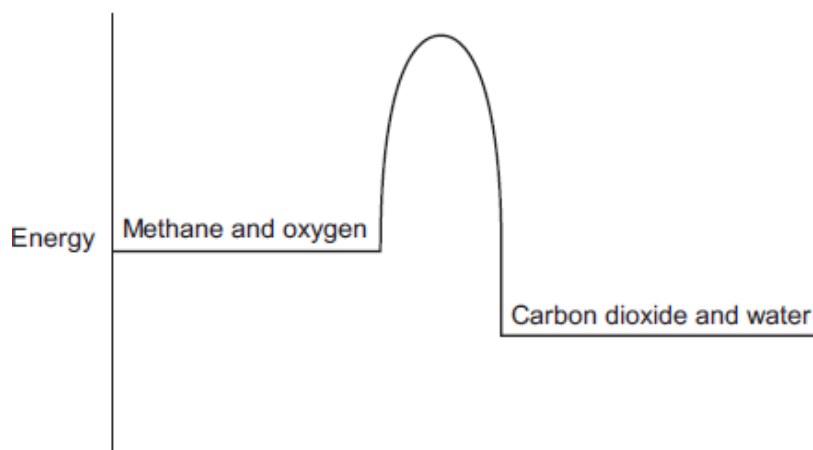
(1)

(c) Methane burns in oxygen.

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

Draw and label arrows on the diagram to show:

- the activation energy
- the enthalpy change, ΔH .



(2)

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



(2)

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

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(2)

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

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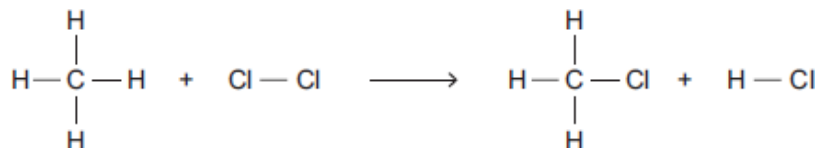
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(3)

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

The equation for this reaction is:



Some bond dissociation energies are given in the table.

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

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

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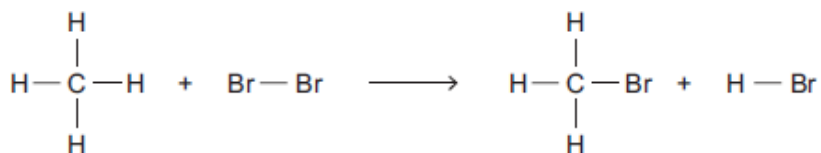
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(3)

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



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

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

What is a possible reason for this?

Tick (✓) **one** box.

CH_3Br has a lower boiling point than CH_3Cl

☐

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

☐

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

☐

Chlorine is more reactive than bromine.

☐

(1)
(Total 15 marks)

5

Crude oil is a fossil fuel.

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

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

boiling	compound	decomposition	distillation
	filtration	mixture	molecule

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

(1)

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

(1)

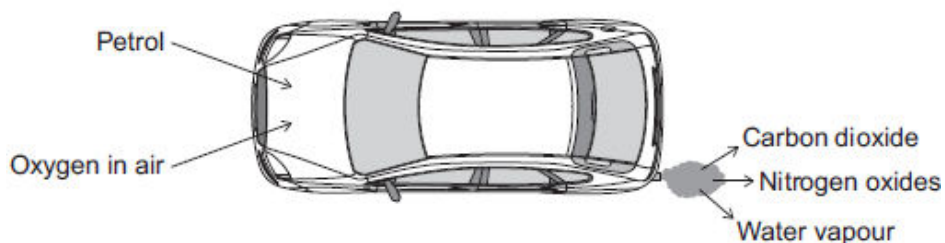
- (iii) Crude oil is separated by fractional

(1)

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

Car engines use a mixture of petrol and air.

The diagram shows some of the gases produced.



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

Tick (✓) **one** box.

combustion

☐

decomposition

☐

neutralisation

☐

(1)

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

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

octane + \longrightarrow +

(2)

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

Describe why sulfur should be removed from petrol.

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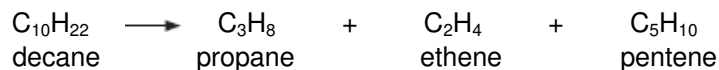
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(2)

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

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

An equation for cracking decane is:



- (i) Why is propane useful?

Tick (✓) **one** box.

Propane is a polymer.

☐

Propane is an alloy.

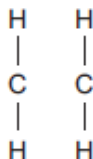
☐

Propane is a fuel.

☐

(1)

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



(1)

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

Tick (✓) **one** box.

Orange to colourless

☐

Orange to green

☐

Orange to red

☐

(1)

(iv) Complete the sentence.

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

(1)

(Total 12 marks)

6

Crude oil is a fossil fuel.

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

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(4)

(b) Fuel oil is one of the fractions from crude oil.

Power stations burn fuel oil to generate electricity. The waste gases from the combustion of fuel oil contain carbon dioxide, water vapour, sulfur dioxide and oxides of nitrogen.

The waste gases are passed through a suspension of limestone in water. Limestone is mainly calcium carbonate.

Suggest how the use of a suspension of limestone decreases one of the environmental impacts that the waste gases would cause.

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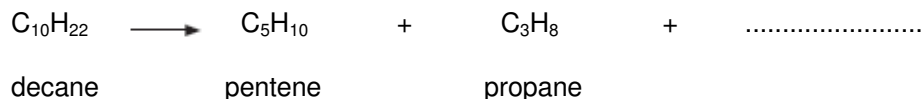
(3)

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

- (i) Hydrocarbon molecules, such as decane, can be cracked to produce smaller, more useful molecules.

Write the correct formula of the third product to complete the chemical equation.

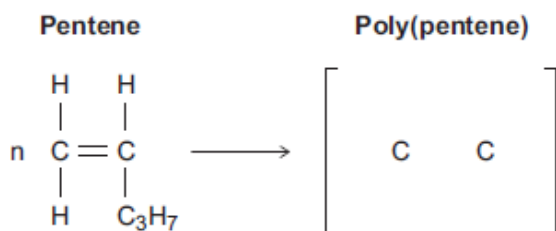
You do not need to give the name of this product.



(1)

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

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



(3)

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

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

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.....

(1)

(Total 12 marks)

7

Sulfur is a non-metal.

Sulfur burns in the air to produce sulfur dioxide, SO_2

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

Tick (✓) **one** box.

Sulfur dioxide causes acid rain.

☐

Sulfur dioxide causes global dimming.

☐

Sulfur dioxide causes global warming.

☐

(1)

- (b) Sulfur dioxide dissolves in water.

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

Give a reason for your answer.

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(2)

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

The bonding in sulfur dioxide is covalent.

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

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(3)

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

Sulfur dioxide is produced when fossil fuels are burned.

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

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

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

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

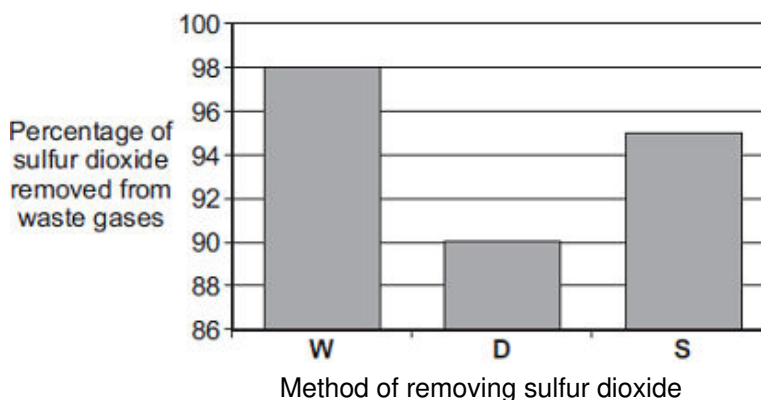


Table 1

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

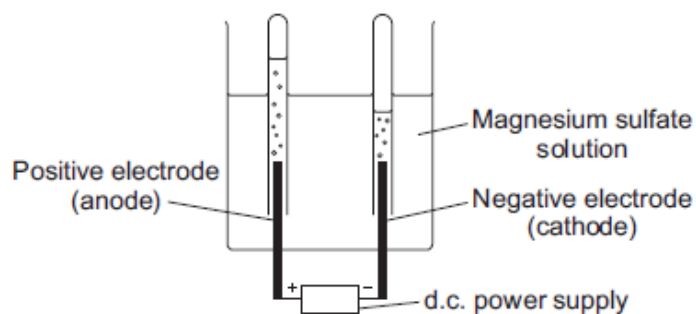
Table 2

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

[illegible]

8

Diagram 1



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- (a) The gas collected at the anode was oxygen.

Draw **one** line from the test for oxygen to the correct result.

Test	Result
	The splint relights
Place a glowing splint in the tube of the gas	The splint goes out
	There is a squeaky pop

(1)

- (b) (i) The gas collected at the cathode was hydrogen.

Describe how to test the gas to show that it is hydrogen.

Test

.....

Result

.....

(2)

- (ii) Why is hydrogen, and **not** magnesium, produced at the cathode?

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(1)

- (c) A student wanted to use electrolysis to silver plate a metal spoon.

- (i) Give **one** reason why metal spoons are sometimes silver plated.

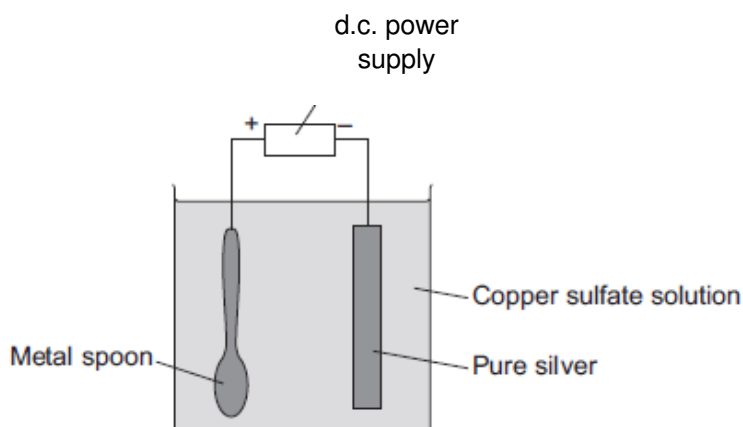
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(1)

- (ii) **Diagram 2** shows the apparatus the student used. The student did **not** set the apparatus up correctly.

Diagram 2



The student found that the metal spoon eroded and a thin layer of copper formed on the pure silver electrode.

Suggest **two** changes that the student must make to his apparatus to be able to silver plate the metal spoon. Give a reason for each change.

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(4)

- (iii) Why is it difficult to electroplate plastic spoons?

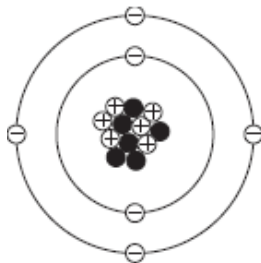
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(1)

(Total 10 marks)

- (a) The figure below represents a carbon atom.



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

- (i) The name of the particle with a positive charge is

an electron.
a neutron.
a proton.

(1)

- (ii) The centre of the atom is called the

energy level.
molecule.
nucleus.

(1)

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

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

4

6

8

10

12

The mass number of this carbon atom is

In the periodic table, carbon is in Group

- (b) Coal is a fossil fuel.

A piece of coal contains:

- 80% carbon
- 9% oxygen
- 1% sulfur
- 5% hydrogen.

The rest of the coal is other elements.

- (i) What is the percentage of other elements in this piece of coal?

..... %

(1)

- (ii) Coal burns in air to produce carbon dioxide, sulfur dioxide and water.

Draw **one** line from each product to the type of pollution caused by each product.

Product	Type of pollution
Carbon dioxide	Acid rain
Sulfur dioxide	Global dimming
Water	Global warming
	No pollution

(3)

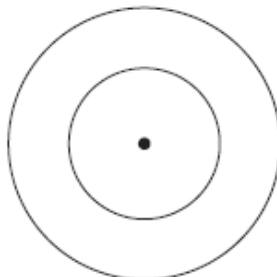
(Total 8 marks)

10

Fossil fuels contain carbon and hydrogen.

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

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



(1)

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

hydrogen + oxygen \longrightarrow

(1)

- (b) Coal is a fossil fuel.

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

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

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

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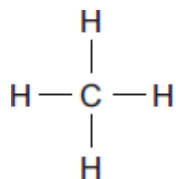
(4)

(Total 6 marks)

11

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.

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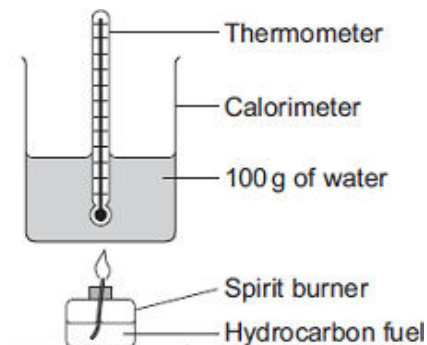
(1)

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

Her hypothesis was:

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

The apparatus the student used is shown in the diagram.



She burned each hydrocarbon fuel for 2 minutes.

Her results are shown in the table.

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

The student investigated only hydrocarbons.

Look carefully at her results.

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

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

Give reasons for your answer.

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(4)

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

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

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

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

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Moles of carbon dioxide =

(2)

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

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

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Moles of hydrogen atoms =

(1)

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

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

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

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Formula =

(2)

(Total 19 marks)

12

Crude oil is a mixture of many different chemical compounds.

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

- (i) Fuels react with oxygen to release energy.

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

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(1)

- (ii) Fuels react with oxygen to produce carbon dioxide.
The reaction of a fuel with oxygen can produce a different oxide of carbon.

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

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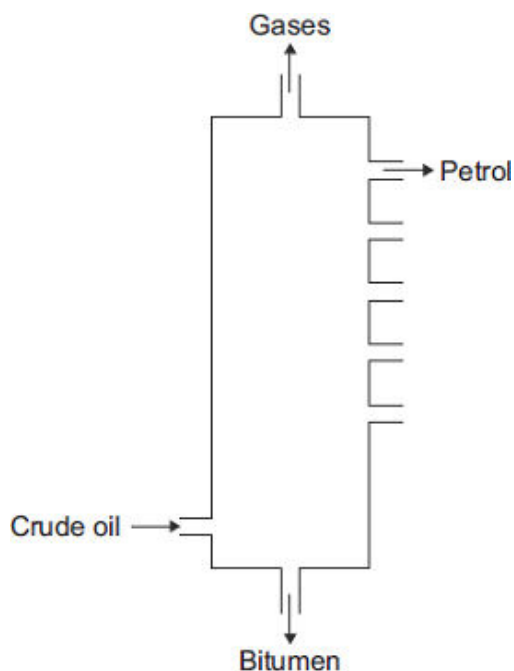
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(2)

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



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

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

Use the diagram and your knowledge to answer this question.

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(6)
(Total 9 marks)

13

A mixture of petrol and air is burned in a car engine.
Petrol is a mixture of alkanes. Air is a mixture of gases.

The tables give information about the composition of petrol and the composition of air.

Petrol	
Alkane	Formula
hexane	C_6H_{14}
heptane	
octane	C_8H_{18}
nonane	C_9H_{20}
decane	$C_{10}H_{22}$

Air	
Gas	Percentage (%)
nitrogen	78
oxygen	21
carbon dioxide	0.035
Small amounts of other gases and water vapour	

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

(i) Give the formula for heptane

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(1)

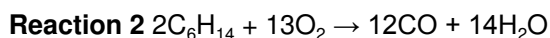
(ii) Complete the general formula of alkanes.
n = number of carbon atoms

C_nH

(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.

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(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.

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(1)

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

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(2)

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

Explain why.

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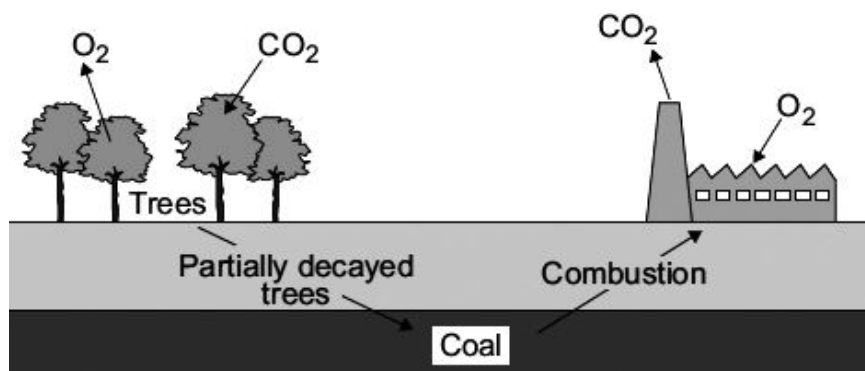
(2)
(Total 11 marks)

14

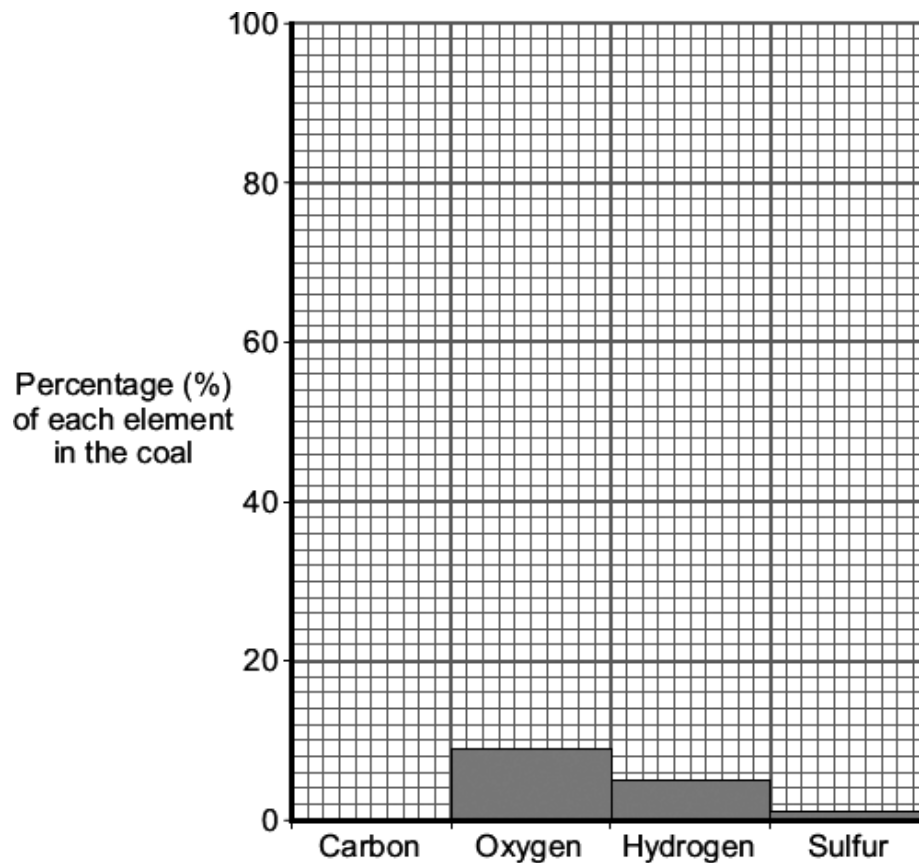
About 3000 million years ago carbon dioxide was one of the main gases in the Earth's early atmosphere.

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

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



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



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

(1)

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

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

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

(2)

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

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

.....

(1)

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

.....

(2)

(Total 6 marks)

15

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

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

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

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(3)

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

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

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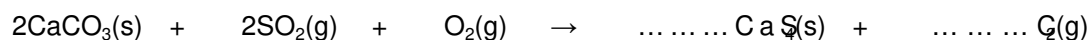
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(2)

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

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

Balance the chemical equation.



(1)

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

increases atmospheric pollution

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decreases atmospheric pollution.

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(4)
(Total 10 marks)

16

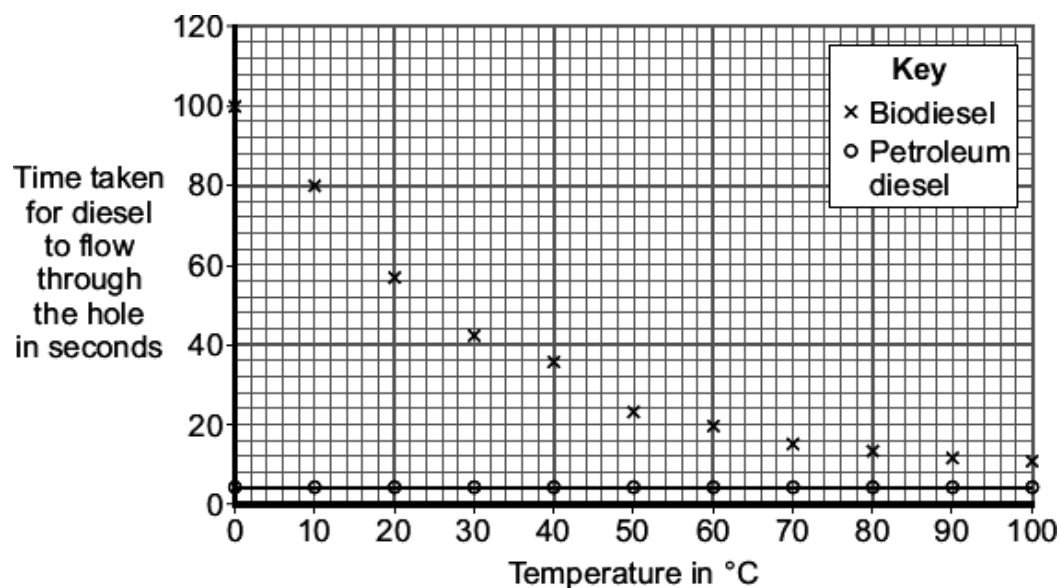
There are two main types of diesel fuel used for cars:

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

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

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

The scientist's results are plotted on the grid.



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

(1)

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

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(2)

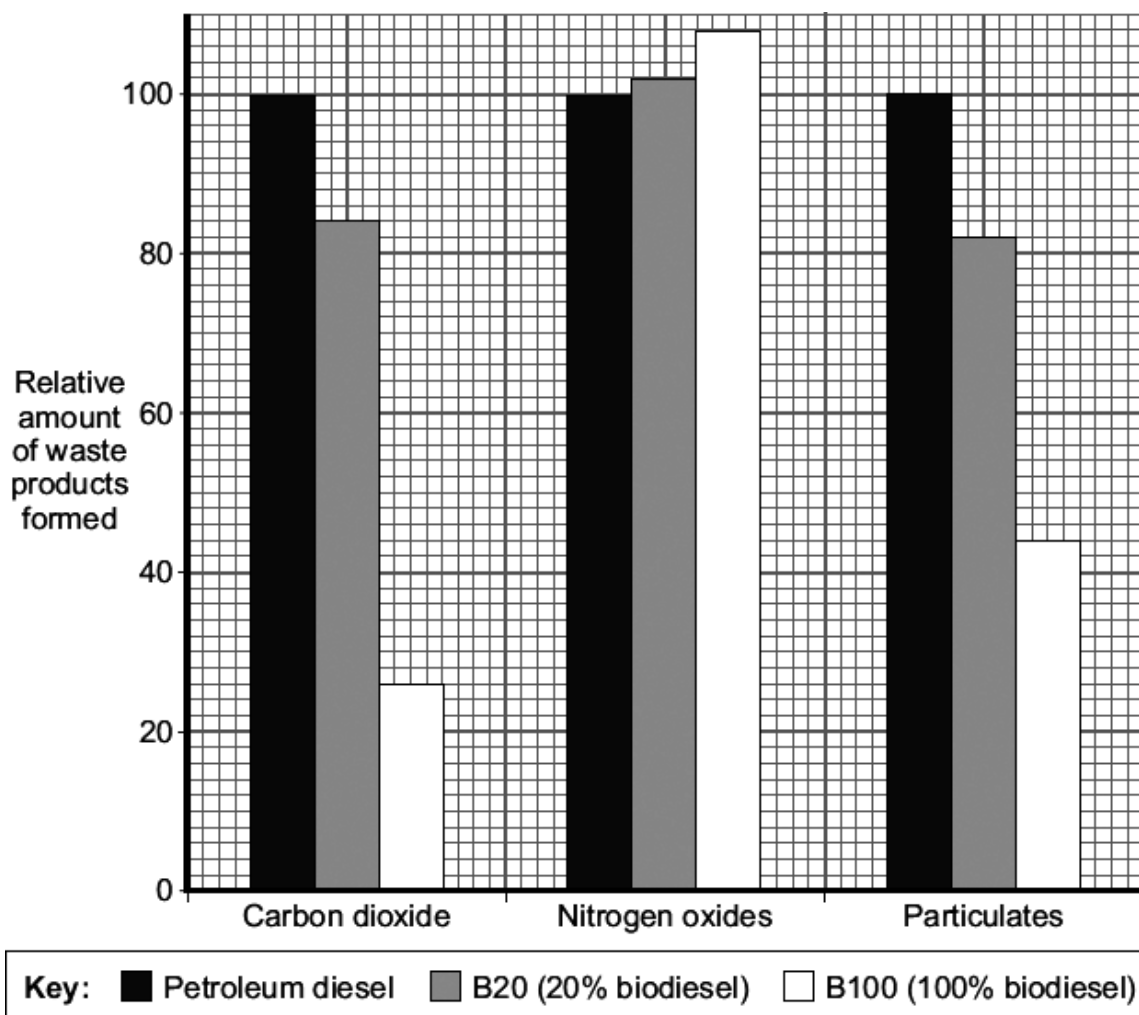
- (iii) Biodiesel may be less suitable than petroleum diesel as a fuel for cars. Use these results to suggest **one** reason why.

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(1)

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



Nitrogen oxides and sulfur dioxide cause a similar environmental impact.

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

.....

(1)

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

..... %

(1)

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

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

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(2)

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

Is biodiesel a carbon neutral fuel?

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

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(2)

(Total 10 marks)

17

This information about diesel was printed in a magazine.

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

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

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

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

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

.....

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(2)

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

Remember to give a conclusion to your evaluation.

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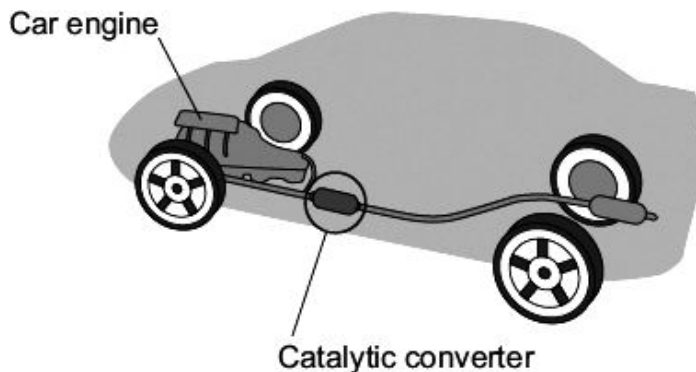
(5)
(Total 7 marks)

Read the information about car engines.

Burning petrol in air is an exothermic reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

A catalytic converter stops these harmful substances being released into the air.



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

(i) The exothermic reaction makes the temperature of the engine

decrease.

increase.

stay the same.

(1)

(ii) This is because during exothermic reactions

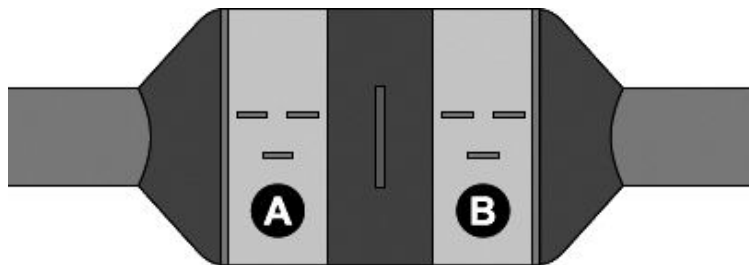
energy is taken in from the surroundings.

energy is given out to the surroundings.

there is no energy change.

(1)

- (b) The diagram shows a catalytic converter which removes harmful substances. The catalytic converter has two parts, **A** and **B**, which contain different catalysts.



- (i) The equation for the reaction that takes place in part **A** is:



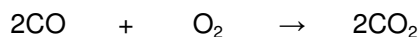
Which **one** of the substances shown in the equation is a compound?

Give the formula of this compound.

.....

(1)

- (ii) The equation for the reaction that takes place in part **B** is:



Why is it important to stop carbon monoxide (CO) from being released into the air?

.....

.....

(1)

- (c) The table lists some statements about catalysts. Only **two** statements are correct.

Tick (✓) the **two** correct statements.

Statement	Tick (✓)
A catalyst can speed up a chemical reaction.	
A catalyst is used up in a chemical reaction.	
Different reactions need different catalysts.	
A catalyst does not change the rate of a chemical reaction.	

(2)

- (d) Modern catalytic converters contain nanosized particles of catalyst. Less catalyst is needed when nanosized catalyst particles are used.

- (i) Complete the sentence.

The size of nanosized particles is than normal sized particles.

(1)

- (ii) The catalysts contain platinum.

Suggest why a manufacturer of catalytic converters would want to use less catalyst.

.....

(1)

(Total 8 marks)

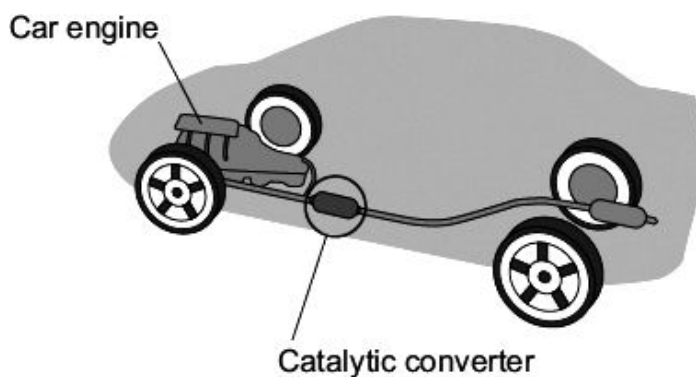
19

Read the information about car engines.

Burning petrol in air is an *exothermic* reaction. This reaction is used in car engines.

When petrol burns it produces harmful substances such as nitrogen oxides and carbon monoxide.

A catalytic converter stops these harmful substances being released into the air.

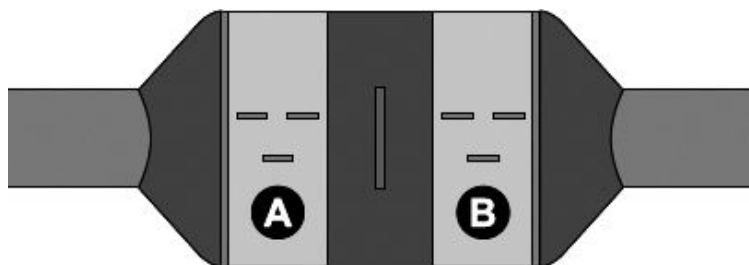


- (a) The reaction is *exothermic*. What is the meaning of *exothermic*?

.....

(1)

- (b) The catalytic converter has two parts shown as **A** and **B** in the diagram.



Part **A** contains a catalyst made from platinum and rhodium.

Part **B** contains a catalyst made from platinum and palladium.

- (i) Why are catalysts used in chemical reactions?

.....

(1)

- (ii) One reaction in part **A** is shown by this equation.



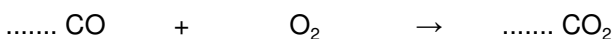
Suggest why this reaction helps the environment.

.....

(1)

- (iii) The equation for one of the reactions in part **B** is shown below.

Balance this equation.



(1)

- (iv) The catalytic converter works for many years without replacing the catalyst.

Explain why the catalyst does not need to be replaced.

.....

(1)

- (v) Suggest why different catalysts are used in parts **A** and **B**.

.....

(1)

- (c) Modern catalytic converters contain nanosized particles of catalyst. Using nanosized particles reduces the cost of the catalytic converter.

Suggest and explain why the use of nanosized catalyst particles reduces the cost of the catalytic converter.

Your answer should include information about the size and surface area of the particles.

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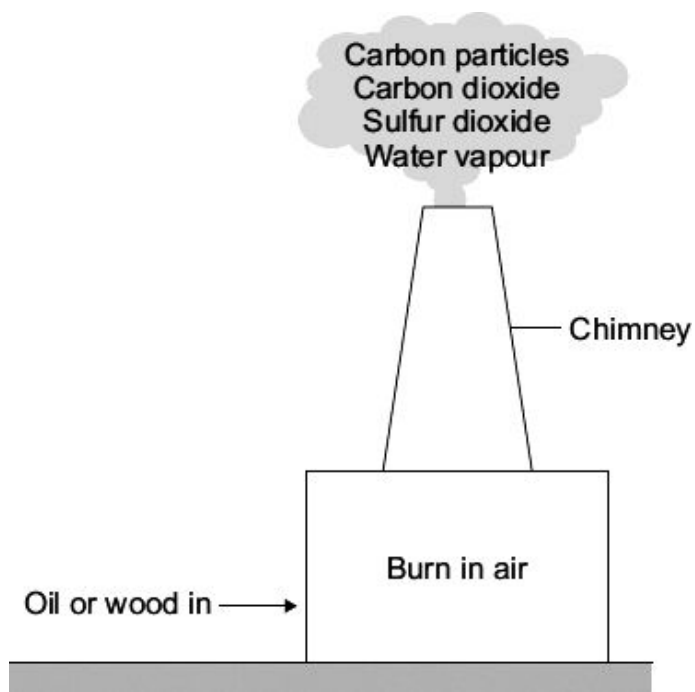
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(3)
(Total 9 marks)

20

In the future:

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



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

.....

(1)

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

Carbon particles in the Earth's atmosphere cause

acid rain.

global
dimming.

global
warming.

(1)

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

.....

(1)

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

.....

.....

(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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(2)

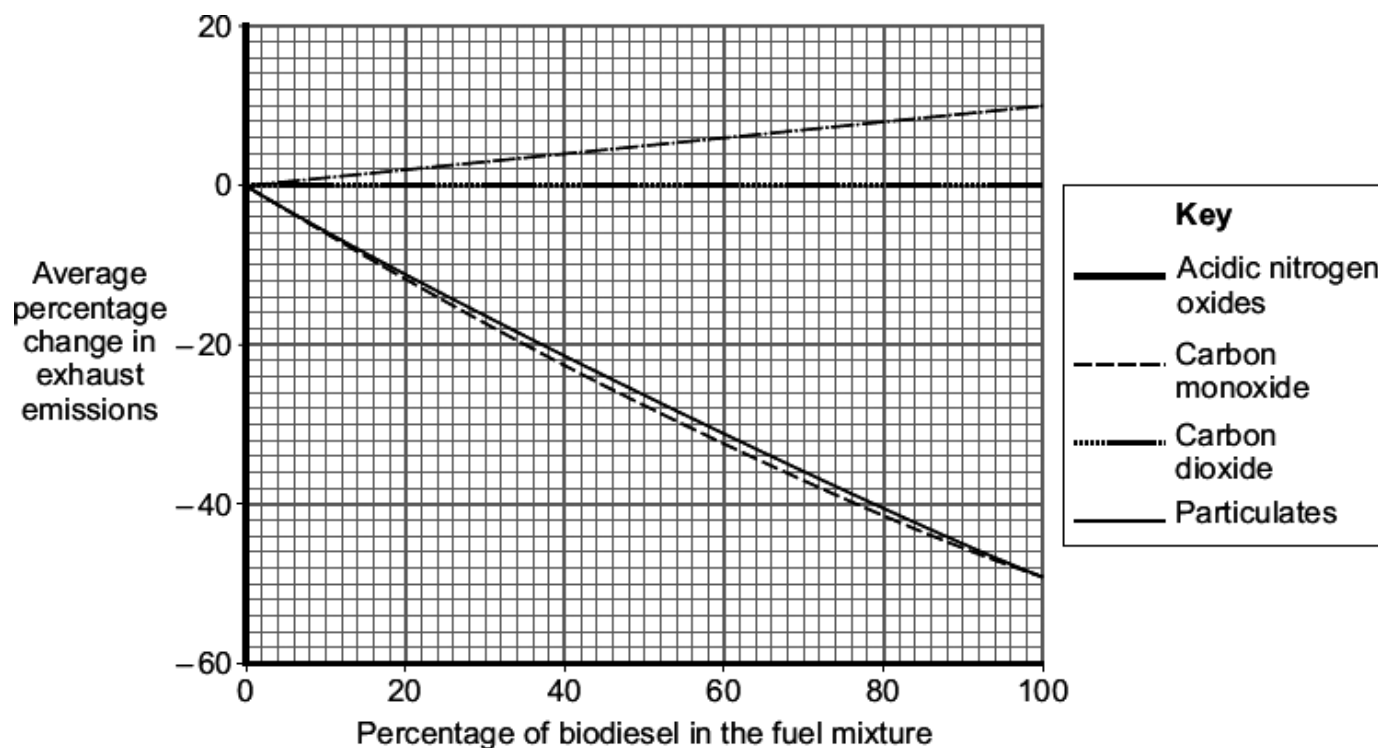
(Total 6 marks)

Petroleum diesel is produced from crude oil.

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

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

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



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

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

Remember to give a conclusion to your evaluation.

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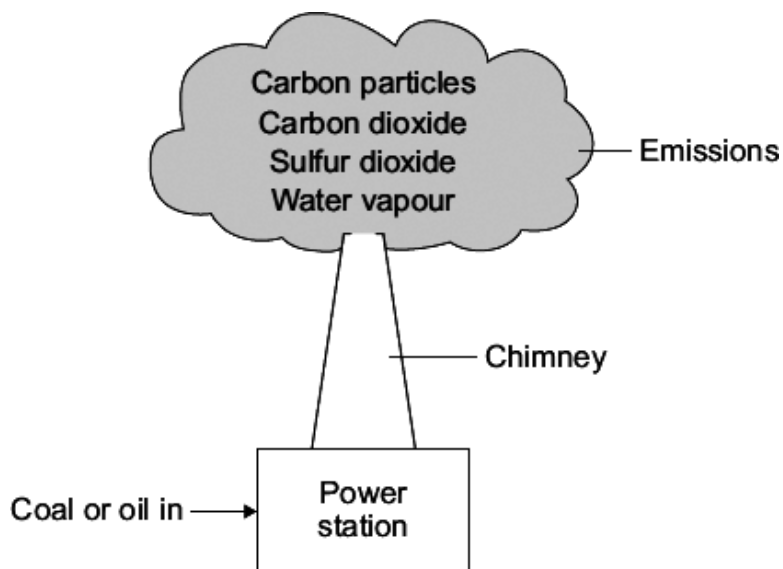
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(5)
(Total 5 marks)

22

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



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

Possible environmental problem

Emission that causes it

acid rain

carbon particles

global warming

carbon dioxide

global dimming

sulfur dioxide

water vapour

(3)

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

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

carbon dioxide.
nitrogen.
oxygen.

(1)

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

carbon monoxide.
hydrogen.
oxygen.

(1)

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

The world production figures after 2000 are predicted.

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

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

.....
.....

(1)

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

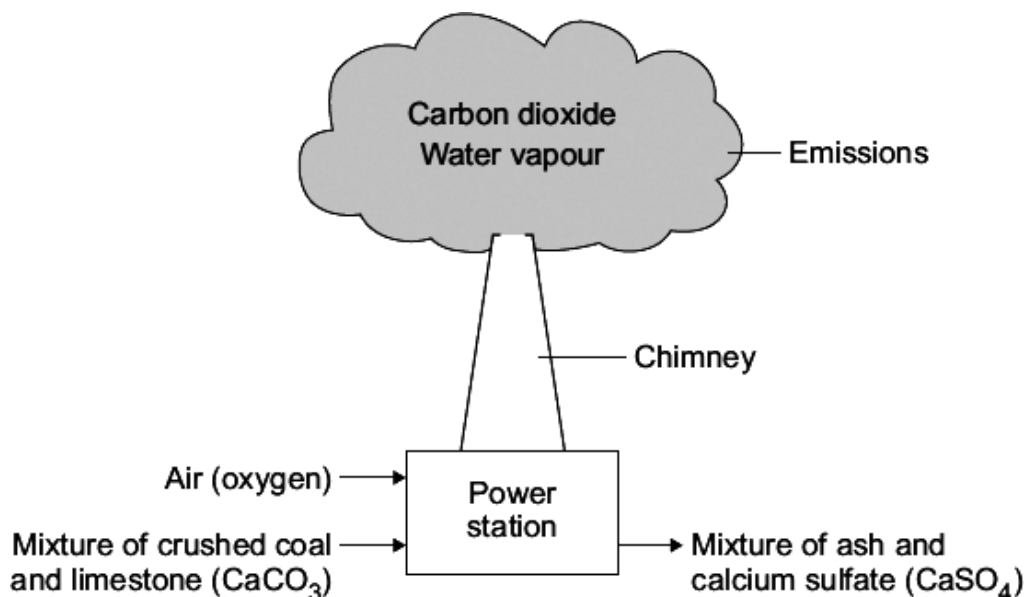
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2
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(2)

(Total 8 marks)

23

Most power stations burn coal to generate electricity. Burning coal gives off sulfur dioxide gas which can be removed from the waste gases by using limestone. This prevents sulfur dioxide from entering the atmosphere and causing acid rain. One disadvantage of using limestone in a power station is that it releases 'locked up carbon dioxide' into the atmosphere.



(a) How does the limestone used in a power station:

(i) release carbon dioxide

.....

(1)

(ii) remove sulfur dioxide?

.....

(1)

(b) The waste gases from the chimney are monitored. One toxic gas that should not be released is carbon monoxide.

Explain how carbon monoxide would be formed.

.....

(2)

(c) The use of limestone in a power station releases 'locked up carbon dioxide' into the atmosphere.

(i) Explain the meaning of 'locked up carbon dioxide'.

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(2)

(ii) Why does the release of this carbon dioxide cause an environmental problem?

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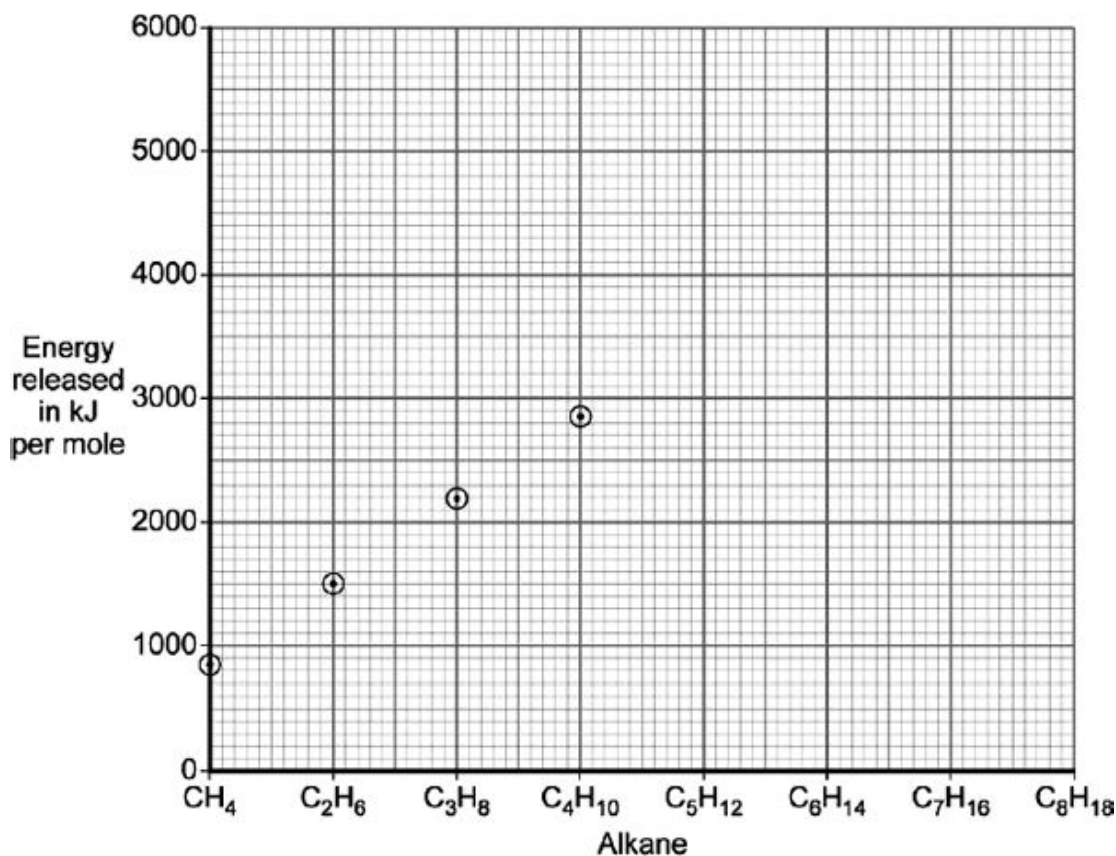
(1)

(Total 7 marks)

24

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

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



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

Energy released = kJ

(1)

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

.....

(1)

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

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

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

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(2)

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

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

From this information a student made two conclusions.

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

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

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(2)

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

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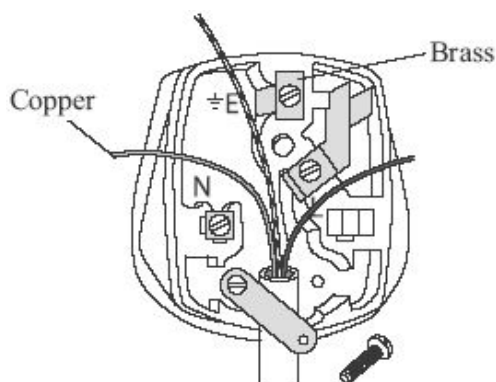
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(2)
(Total 9 marks)

25

Copper metal is used for electric wires.

An alloy of copper, called brass, is used for pins and terminals of electric plugs.



- (a) Copper metal is relatively soft and flexible.

Give another reason why copper is used for electric wires.

.....

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(1)

- (b) Brass is an *alloy*.

What is an *alloy*?

.....

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(1)

- (c) Open-cast mining of copper ore makes a very large hole.



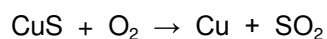
- (i) Suggest **one** environmental problem that is caused by open-cast mining of copper ore.

.....
.....

(1)

- (ii) Some copper ores contain copper sulfide, CuS.

Copper sulfide is heated in air to produce copper and sulfur dioxide.



Suggest **one** environmental problem caused by heating copper sulfide in air.

.....
.....

(1)

- (d) The amount of copper-rich ores is estimated to last only a few more years. New houses need several kilometres of copper wire.

- (i) Explain why the need to use so much copper will cause a problem in the future.

.....
.....

(1)

- (ii) Suggest **two** ways in which society could overcome this problem.

1

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2

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(2)
(Total 7 marks)

26

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

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

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

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

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

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

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

- (a) Name the environmental effect caused by:

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

.....

(1)

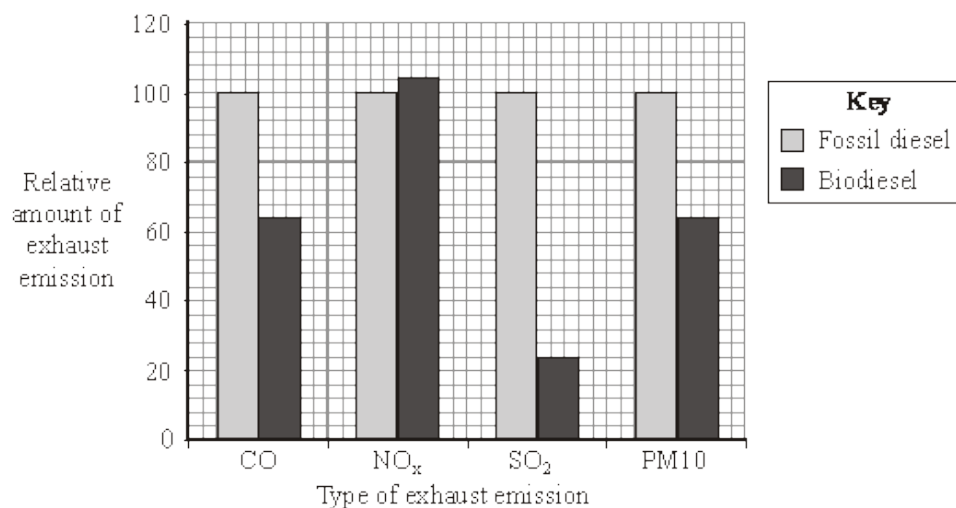
- (ii) the increased level of particulates (PM10).

.....

(1)

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

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



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

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(3)

- (ii) Biodiesel is called a green fuel.

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

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

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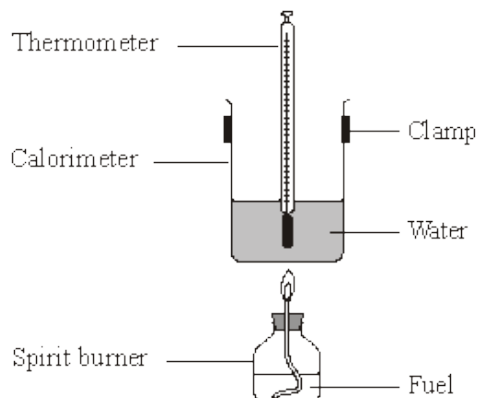
(3)

(Total 8 marks)

27

A student burned four fuels and compared the amounts of energy they produced.

The student set up the apparatus as shown in the diagram.



The heat produced when each fuel was burned was used to raise the temperature of 100 g of water. The student noted the mass of fuel burned, the increase in temperature and whether the flame was smoky.

The results are shown in the table.

Fuel	Mass of fuel burned (g)	Temperature increase ($^{\circ}\text{C}$)	Type of flame
Ethanol	4	24	Not smoky
Methanol	3	9	Not smoky
Peanut oil	2	20	Smoky
Vegetable oil	1	15	Smoky

- (a) The student suggested that the vegetable oil was the best fuel for producing heat.

Explain why.

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(2)

- (b) Suggest an environmental problem that could be caused when large amounts of vegetable oil are burned. Suggest how the problem could be overcome.

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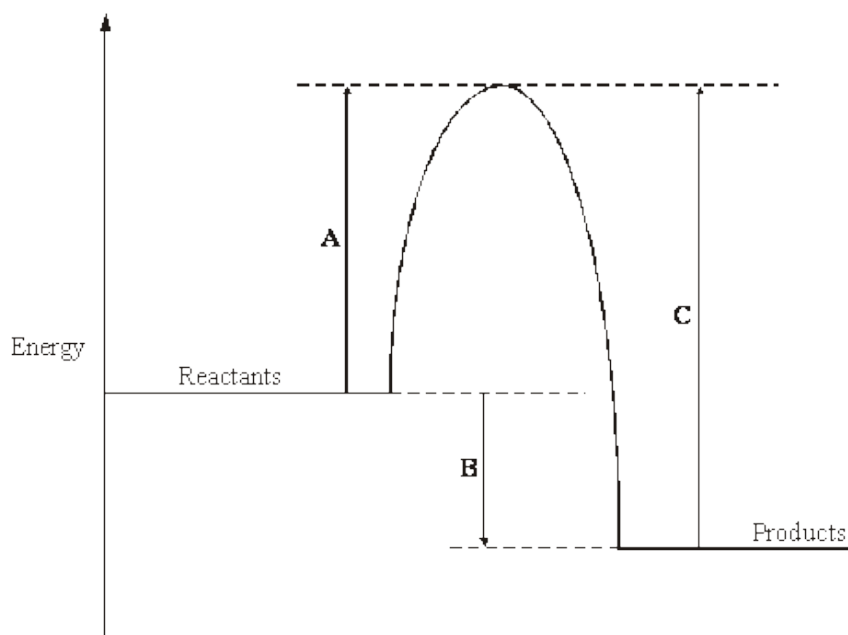
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(2)

- (c) An energy level diagram for the burning of vegetable oil is shown below.



Which of the energy changes **A**, **B** or **C**:

- (i) represents the activation energy

.....

(1)

- (ii) shows the amount of energy given out during the reaction?

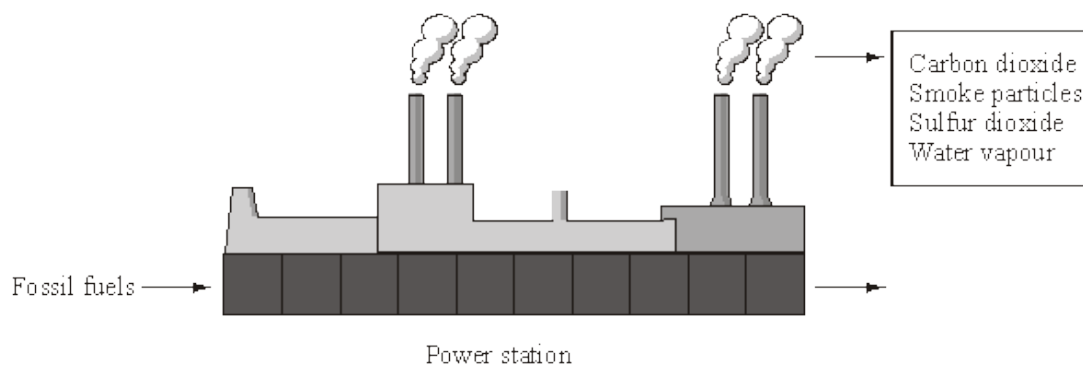
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(1)

(Total 6 marks)

28

Most electricity in the UK is generated in power stations that burn fossil fuels. The diagram lists some of the substances released into the air when fossil fuels are burned.



- (a) (i) Which **one** of the substances released into the air causes acid rain?

.....

(1)

- (ii) In the sentence below, draw a ring around the correct answer.

The type of environmental pollution caused by

smoke particle is

global dimming
global warming
rising sea levels

(1)

- (iii) Suggest how the burning of fossil fuels may cause climate change.

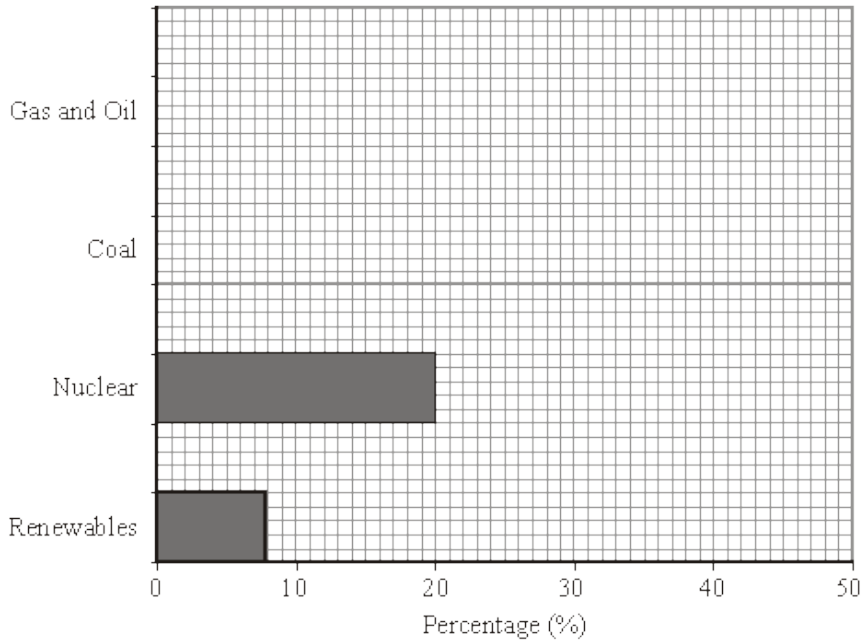
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(2)

(b) The table shows the percentage of electricity generated by different energy sources.

Energy sources	Renewables	Nuclear	Coal	Gas and Oil
Percentage (%)	8	20	32	40

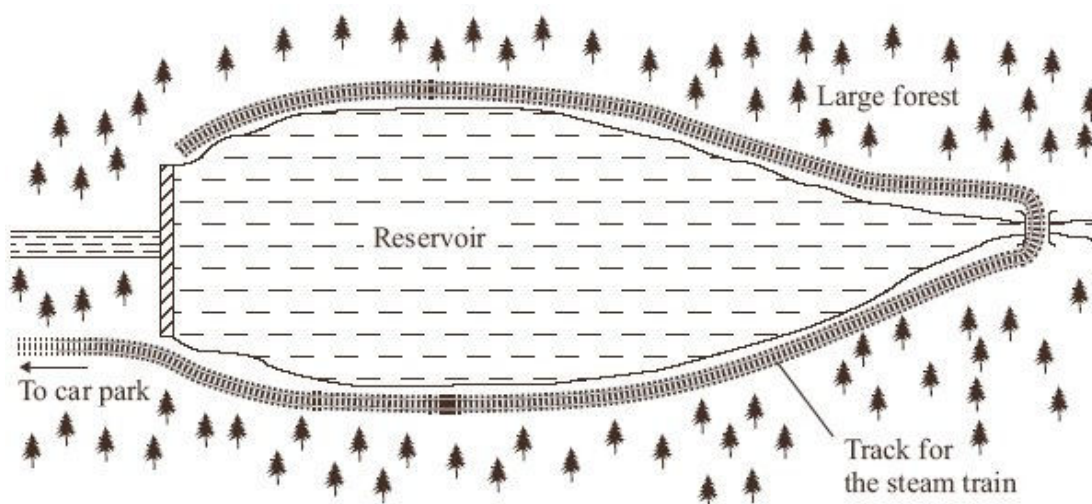
Complete the bar chart to show the percentage of electricity generated by coal and by gas and oil.



(2)
(Total 6 marks)

29

A large reservoir is surrounded by trees. Planners need to protect the environment. The distance around the reservoir is many kilometres. There will be only one road access to a car park a few kilometres from the reservoir. From the car park people would be transported to accommodation, activities or places of interest by steam train.



- (a) Coal contains carbon and small amounts of sulfur. The steam train would cause environmental problems if coal were used as the fuel.

Explain why.

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(4)

- (b) The planners have stated that, as a result of using the steam train, there must be no overall increase of carbon dioxide added to the atmosphere. The steam train would be considered as 'carbon neutral' if wood, from the surrounding forest, were used as the fuel.

Suggest why.

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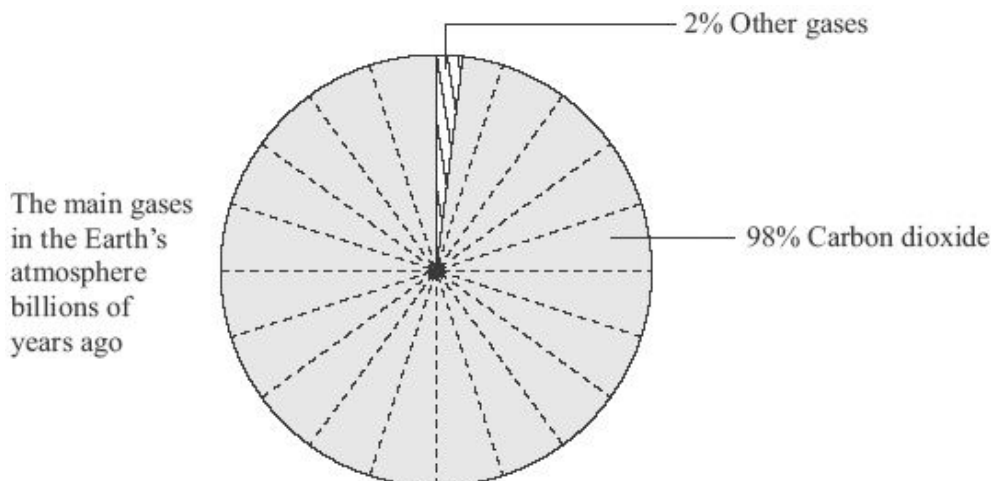
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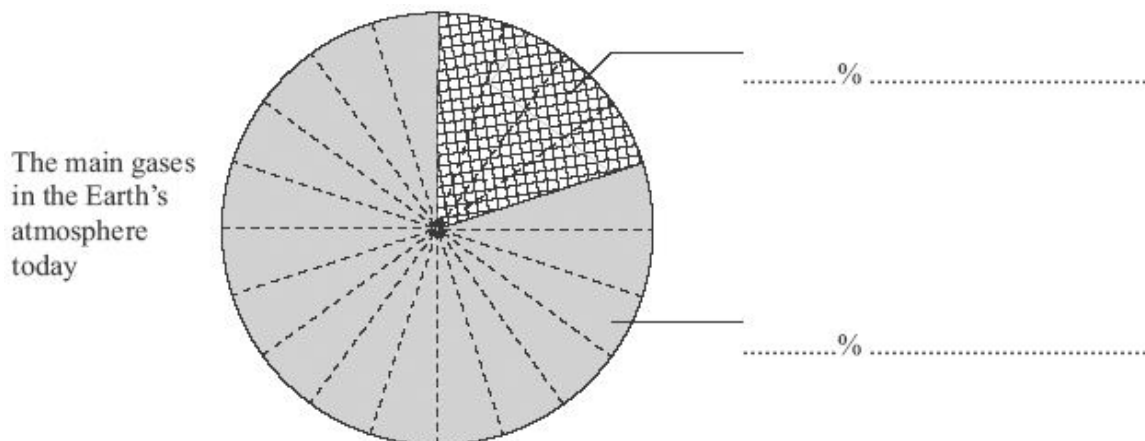
(3)
(Total 7 marks)

30

Life on Earth would not exist without the atmosphere. Billions of years ago the composition of the Earth's atmosphere was very different from the composition today.



- (a) Label the pie chart below to show the percentages and names of the two main gases in the Earth's atmosphere today.



(2)

- (b) There is evidence that the composition of the Earth's atmosphere is still changing. One possible reason is that many power stations generate electricity by burning fossil fuels such as coal, oil or natural gas. Sulfur dioxide, SO_2 , is produced when coal burns in air.

(i) What environmental problem does sulfur dioxide cause?

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.....

(1)

(ii) How could this environmental problem be reduced in coal-fired power stations?

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(1)

(iii) Gas-fired power stations burn methane, CH_4 , in air.

Complete the word equation for this reaction.

methane + \rightarrow carbon dioxide +

(2)

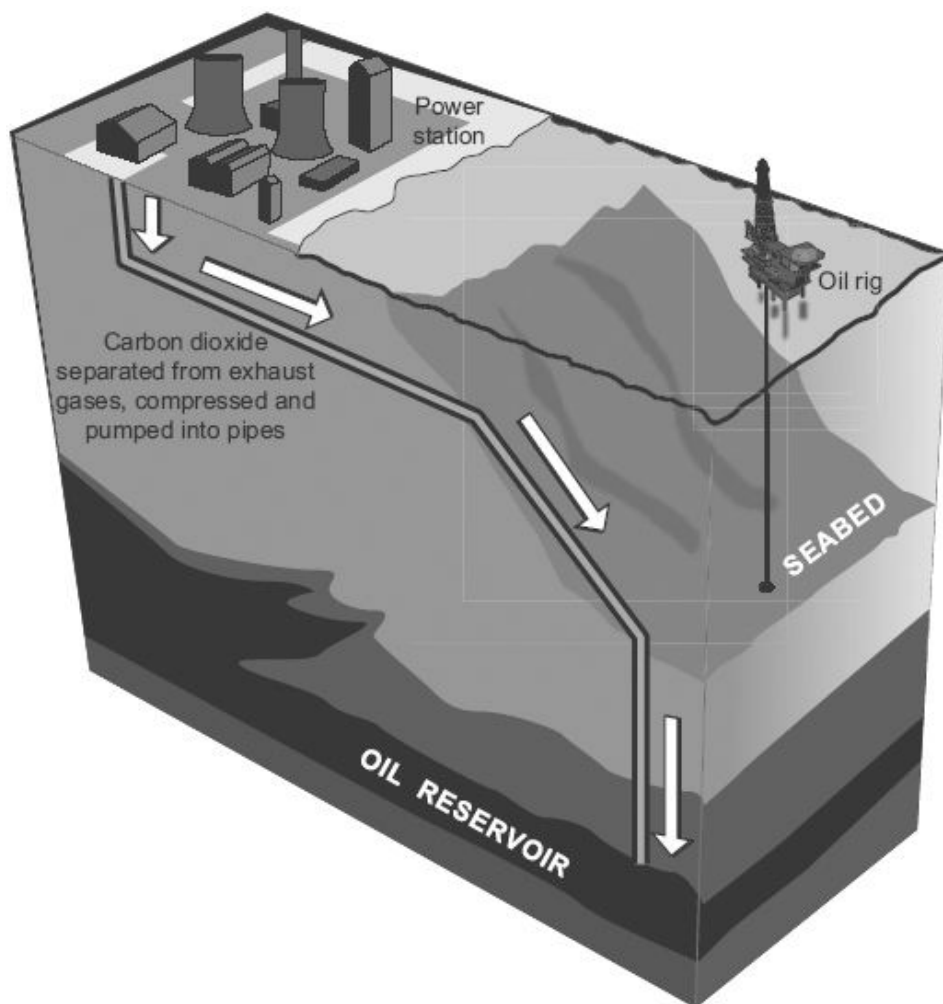
- (c) Excess carbon dioxide should be prevented from entering the atmosphere.

Explain why.

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(2)

- (d) Carbon dioxide is produced when fossil fuels burn in power stations. The diagram represents one idea to prevent excess carbon dioxide from entering the atmosphere.



Use the diagram to explain how carbon dioxide can be prevented from entering the atmosphere.

.....

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.....

.....

(2)
(Total 10 marks)

31

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

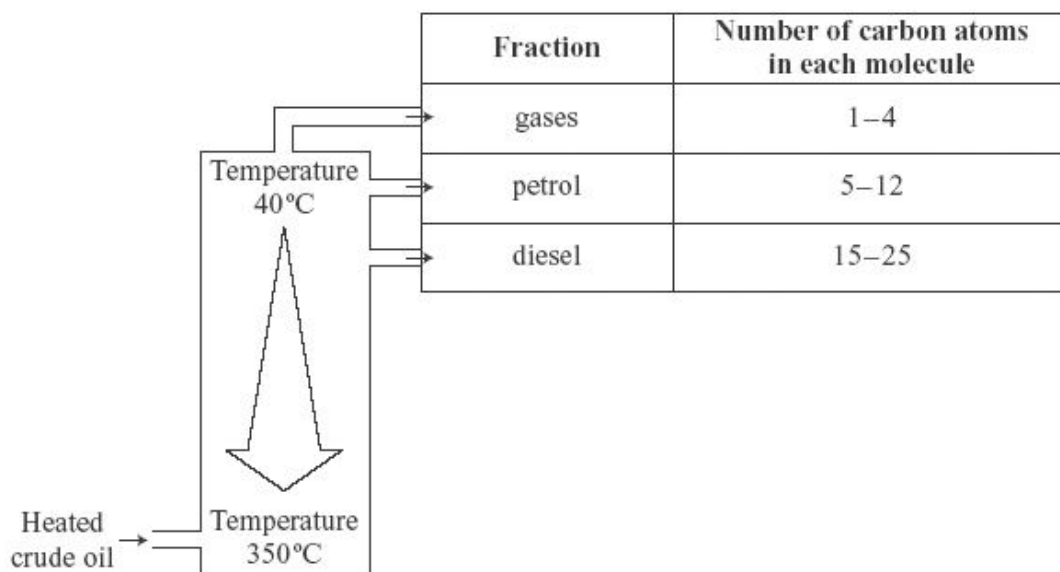
- (a) Crude oil is a mixture of hydrocarbons.

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.



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.

Substance	Possible environmental problem
Carbon dioxide	Causes global dimming
Carbon particles	Causes global warming
Crude oil	Non-polluting liquid
Water	Non-renewable resource
	Toxic gas

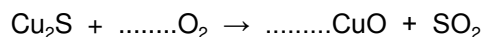
(3)
(Total 6 marks)

32

Copper is a widely used metal. The main ore of copper contains copper sulfide. Copper can be extracted from copper sulfide in a three stage process.

- (a) In the first stage of extraction the copper sulfide is heated in air.

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



(1)

- (ii) Explain why there would be an environmental problem if the gas from this reaction were allowed to escape into the atmosphere.

.....

(2)

- (b) In the second stage copper oxide, CuO , is reduced using carbon.

Describe and explain what happens during this reaction.

.....

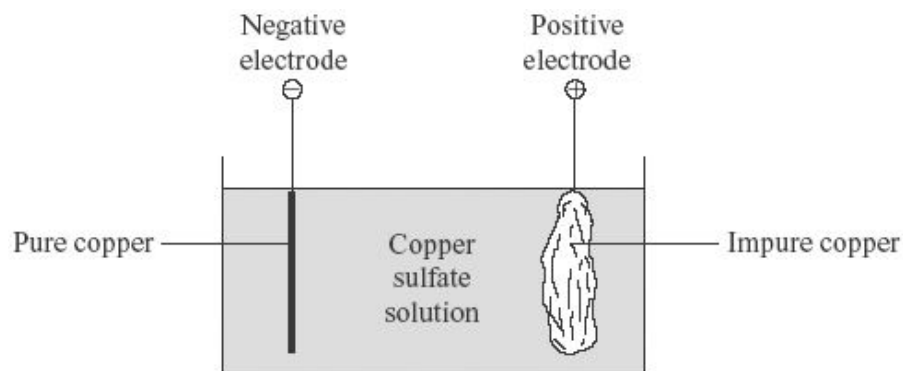
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(2)

- (c) During the third stage the copper can be purified as shown in the diagram.



- (i) What is the name of the type of process used for this purification?

.....

(1)

- (ii) Give **one** use of purified copper.

.....

(1)

- (d) Copper-rich ores are running out.

New ways of extracting copper from low grade ores are being researched.

Recycling of copper may be better than extracting copper from its ores.

Explain why.

.....

.....

.....

.....

.....

.....

(3)
(Total 10 marks)

33

The table gives some data about four fuels, **A**, **B**, **C** and **D**.

Fuel	Cost in pence per 100 g	Energy in kJ per 100 g	Energy per penny in kJ	Gas (✓) formed on burning		
				Carbon dioxide	Sulphur dioxide	Water vapour
A	6.0	4 800	800	✓		✓
B	4.0	1 200	300	✓		✓
C	3.5	2 800	800	✓	✓	✓
D	18.0	14 400	800			✓

A student was asked to use the data in the table to compare these four fuels, and then place the fuels in an order.

The order that the student chose was:

D best fuel
 ↑
A
C
 ↓
B worst fuel

Use the information in the table to suggest reasons why the student chose this order.

To gain full marks in this question you should write down your ideas in good English. Put them into a sensible order and use the correct scientific words.

.....

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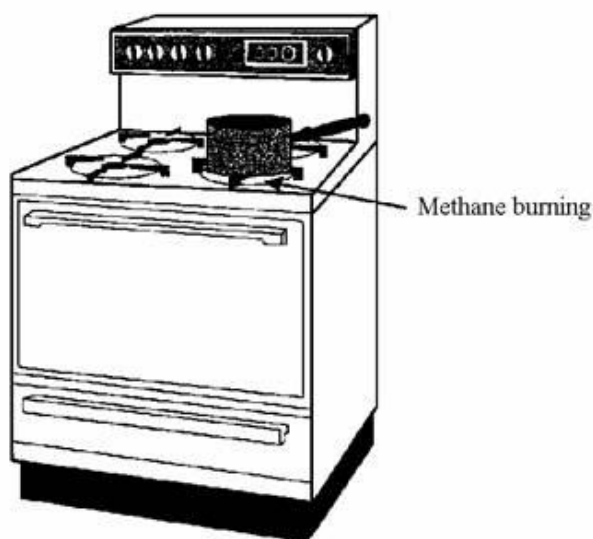
.....

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(Total 4 marks)

34

Some gas cookers burn natural gas, methane. Methane, CH_4 , is a *hydrocarbon*.



(a) What is meant by *hydrocarbon*?

.....

.....

(2)

(b) When methane burns there must be a good supply of air.

(i) Complete the word equation by choosing the correct **two** chemicals from the box.

carbon dioxide	hydrogen	oxygen	water
----------------	----------	--------	-------

methane + oxygen → +

(2)

(ii) Without a good supply of air, carbon monoxide is formed. Why is carbon monoxide a dangerous gas?

.....

(1)

(Total 5 marks)

35

This question is about hydrocarbons.

(a) Use **two** of the words in the box to complete the sentence.

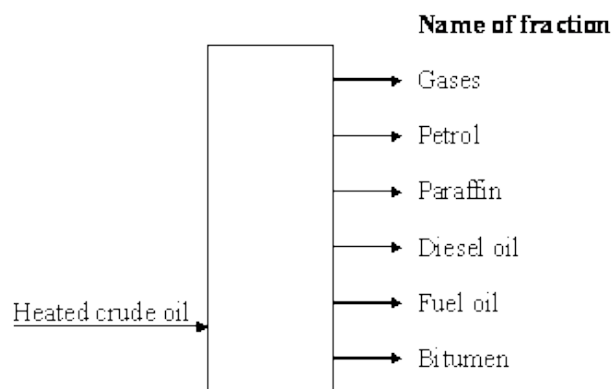
air	finite	organic	renewable	sediment	water
-----	--------	---------	-----------	----------	-------

Crude oil is a mixture of hydrocarbons. It was formed from

..... materials that were trapped in
 over a very long period of time.

(2)

(b) Petrol is separated from crude oil by fractional distillation.



(i) Which fraction has the lowest boiling point?

.....

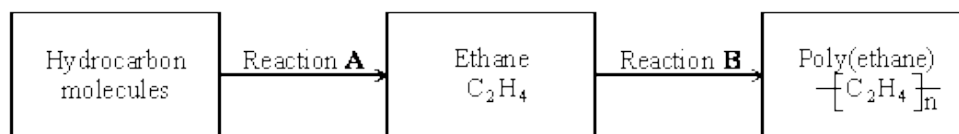
(1)

(ii) Which fraction has the highest density?

.....

(1)

- (c) Some of the fractions containing larger hydrocarbon molecules are used to make plastics, such as poly(ethene).



- (i) What type of chemical change is Reaction **A**?

.....

(1)

- (ii) Explain what happens in Reaction **B**.

.....

.....

.....

.....

(2)

- (d) Natural gas contains the hydrocarbon called methane. Some water heaters use methane as a fuel. People could die from breathing the fumes produced by heaters that have not been checked and serviced. Explain how these fumes are produced and why they are dangerous.

.....

.....

.....

.....

.....

.....

.....

(3)

(Total 10 marks)

36

- (a) Burning fuels changes the Earth's atmosphere. The new substances produced are mainly gases.
The following is a list of types of reaction.

combustion

cracking

electrolysis

fermentation

neutralisation

reduction

Choose, from the list, the word which has the same meaning as burning.

.....

(1)

- (b) The table shows the gases formed when four fuels, **A** to **D**, are completely burned in air.

FUEL	GAS FORMED ON BURNING		
	CARBON DIOXIDE CO ₂	WATER VAPOUR H ₂ O	SULPHUR DIOXIDE SO ₂
A	✓	✓	✗
B	✗	✓	✗
C	✓	✗	✗
D	✓	✓	✓

Which fuel, **A** to **D**, is hydrogen, H₂?

(1)

(Total 2 marks)

37

Crude oil and natural gas are mixtures of hydrocarbons. They are obtained from wells drilled into rocks where they are trapped.

- (a) (i) What is the name of the process used to separate the different hydrocarbons in crude oil?

.....

(1)

- (ii) Methane is one of the gases obtained when crude oil is separated.

Give the name of another hydrocarbon gas obtained from this process.

.....

(1)

- (b) A fuel used in gas cookers is natural gas. It is mainly methane, CH₄.

- (i) Complete the word equation for the complete combustion of methane.

methane + oxygen → +

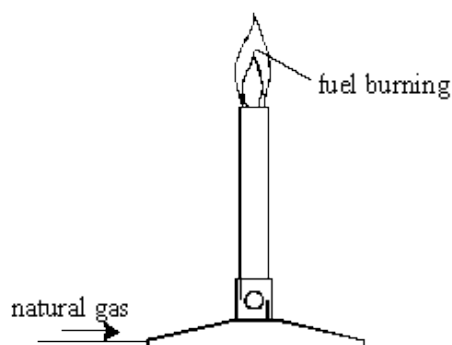
(2)

- (ii) What different gas is produced by the incomplete combustion of methane?

.....

(1)

(Total 5 marks)



- (a) Complete these sentences.

When the fuel burns completely, we cannot see the new substances produced because they are mainly colourless

The energy of the fuel is released as

(3)

- (b) Choose words from this list to complete the sentence below.

carbon	carbon dioxide	hydrogen	nitrogen
oxygen	sulphur dioxide	water vapour	

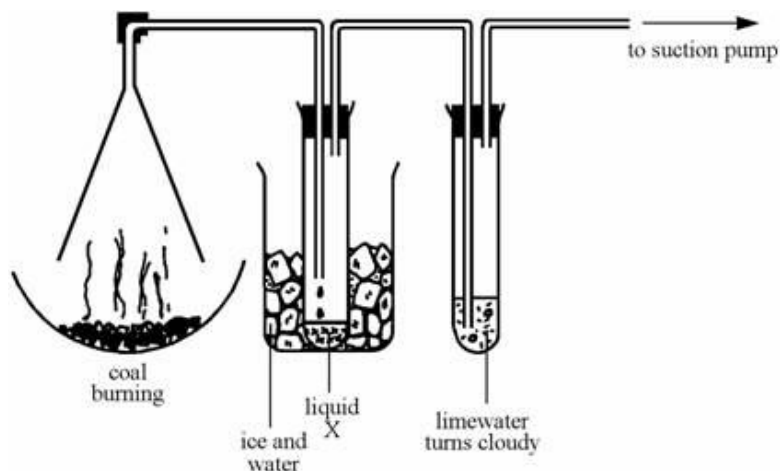
Three gases which can be produced when fuels burn are:

1.
2.
3.

(3)

(Total 6 marks)

The gases produced when coal burns are cooled by ice and then bubbled through limewater.



(a) Complete these sentences.

- (i) The coal is reacting with when it burns.
- (ii) During burning, elements in the coal are converted to compounds
called

(2)

(b) Choose words from this list to complete the sentences.

carbon

carbon dioxide

sulphur

sulphur dioxide

sodium

water

- (i) Liquid X is a compound made from hydrogen and oxygen.
It is called
- (ii) Sulphur dioxide is an acidic gas. It is given off when coal burns, because coal
contains the element
- (iii) Most fuels are compounds of hydrogen and

(3)

(c) Burning coal is an exothermic reaction.

Explain what "exothermic" means.

.....
.....

(1)

(d) (i) Which gas turns limewater cloudy?

.....

(ii) Which element in the coal is oxidised to form this gas?

.....

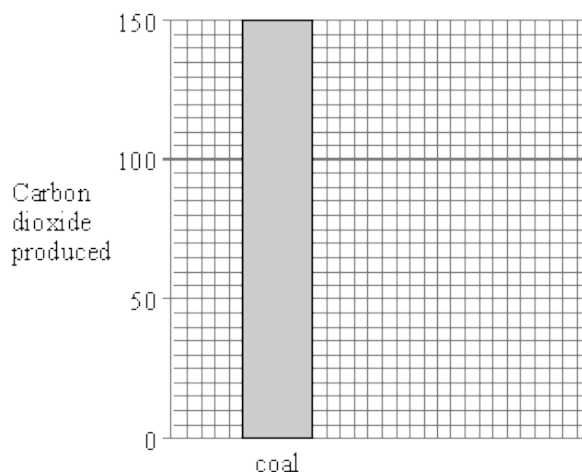
(2)

(Total 8 marks)

40

The table shows how much carbon dioxide is produced when you transfer the same amount of energy by burning coal, gas and oil.

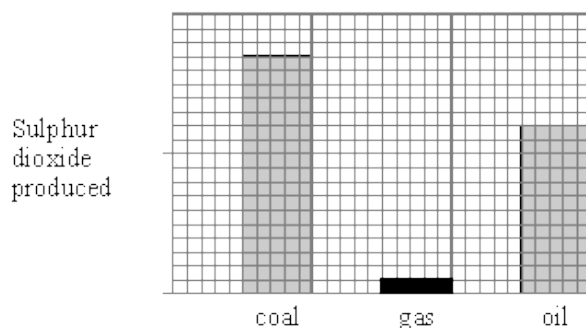
	Carbon dioxide (based on oil = 100)
coal	150
gas	75
oil	100



(a) Use the information from the table to complete the bar-chart.

(3)

(b) The second bar-chart shows how much sulphur dioxide is produced by burning the same three fuels.



Compare the amount of sulphur produced by burning gas with the amount produced by burning coal.

.....

(2)

(c) (i) Coal and oil produce carbon dioxide and sulphur dioxide when they burn. What elements must they contain?

.....

(2)

- (ii) Burning fuels also produce nitrogen oxides, even though the fuels contain no nitrogen. Explain why this happens.

.....

.....

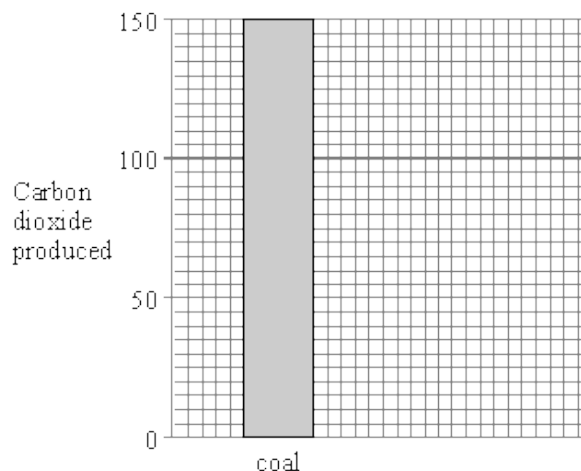
(2)

(Total 9 marks)

41

The table shows how much carbon dioxide is produced when you transfer the same amount of energy by burning coal, gas and oil.

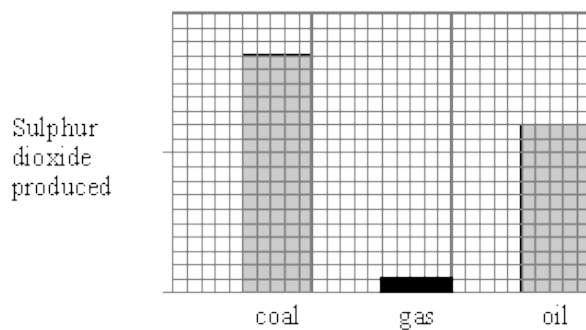
	Carbon dioxide (based on oil = 100)
coal	150
gas	75
oil	100



- (a) Use the information from the table to complete the bar-chart.

(2)

- (b) The second bar-chart shows how much sulphur dioxide is produced by burning the same three fuels.



Compare the amount of sulphur produced by burning gas with the amount produced by burning coal.

.....

.....

(1)

- (c) Burning fuels also produces nitrogen oxides, even though the fuels contain no nitrogen.
Explain why this happens.

.....

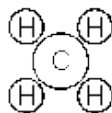
(2)

- (d) When you release the same amount of energy from coal, gas and oil, different amounts of carbon dioxide are produced.
Use the information below to explain why.

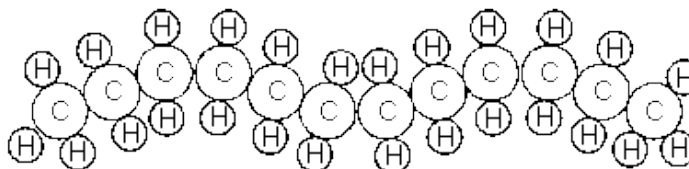
Coal is mainly
carbon



North Sea gas is
mainly methane



Oil is made from molecules similar to
the one shown



(3)

- (e) What other element do coal and oil usually contain?

.....

(1)

(Total 9 marks)