AQA GCSE CHEMISTRY (HIGHER) · 8462

CHEMISTRY



EXAM QUESTION PACK

4.7.1 CARBON COMPOUNDS AS FUELS AND FEEDSTOCK (PACK 1)

SCORE	PERCENTAGE
/359	%

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Q1.

This question is about fuels.

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

(a) Cracking breaks down large hydrocarbon molecules into smaller hydrocarbon molecules.

Which hydrocarbon molecule can be cracked to produce octane, C_8H_{18}?

Tick **one** box.

C_4H_8 ☐

C_4H_{10} ☐

C_8H_{16} ☐

$C_{12}H_{26}$ ☐

(1)

(b) What type of carbon compound is octane, C_8H_{18}?

Tick **one** box.

Alcohol ☐

Alkane ☐

Carboxylic acid ☐

Ester ☐

(1)

(c) Oxygen is needed to burn fuels.

Name the source of the oxygen needed to burn fuels.

_____

_____

(1)

(d) Particulates and sulfur dioxide are pollutants produced when some fuels burn.

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Draw **one** line from each pollutant to the polluting effect.

Pollutant	Polluting effect
	Acid rain
Particulates	Global dimming
	Global warming
Sulfur dioxide	Landfill
	Sewage sludge

(2)

(e) Which **two** gases are produced when fuels burn in car engines?

Tick **two** boxes.

- Ammonia ☐
- Carbon dioxide ☐
- Carbon monoxide ☐
- Nitrogen ☐
- Oxygen ☐

(2)

(f) Vehicles produce most of the atmospheric pollution in cities.

How could the atmospheric pollution in cities be reduced?

Tick **two** boxes.

- Build more roads in cities ☐
- Build new car factories ☐
- Develop fuel efficient engines ☐

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Make car tax cheaper ☐

Use electric cars ☐

(2)

(Total 9 marks)

Q2.

This question is about hydrocarbons.

The table gives information about four hydrocarbons.

The hydrocarbons are four successive members of a homologous series.

Hydrocarbon	Formula	Boiling point in °C
A	C_4H_{10}	0
B		36
C	C_6H_{14}	69
D	C_7H_{16}	98

(a) What is the formula of hydrocarbon **B**?

Tick (✔) **one** box.

C_4H_{12} ☐

C_5H_{12} ☐

C_5H_{12} ☐

C_6H_{12} ☐

(1)

(b) What is the simplest ratio of carbon : hydrogen atoms in a molecule of hydrocarbon **A**?

Ratio = 2 : _____

(1)

(c) Which hydrocarbon is a gas at room temperature (25 °C)?

Tick (✔) **one** box.

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A ☐ B ☐ C ☐ D ☐

(1)

(d) Which hydrocarbon is most flammable?

Tick (✔) **one** box.

A ☐ B ☐ C ☐ D ☐

(1)

(e) Which **two** substances are produced when a hydrocarbon **completely** combusts in air?

Tick (✔) **two** boxes.

Carbon ☐

Carbon dioxide ☐

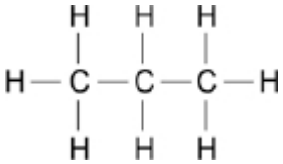
Hydrogen ☐

Sulfur dioxide ☐

Water ☐

(2)

The diagram shows the displayed structure of a hydrocarbon molecule.



(f) What is the name of the hydrocarbon in the diagram above?

Tick (✔) **one** box.

Butane ☐

Ethane ☐

Methane ☐

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Propane ☐

(1)

(g) Calculate the relative formula mass (M_r) of the hydrocarbon in the diagram above.

Relative atomic masses (A_r): H = 1 C = 12

_____

_____

Relative formula mass (M_r) = _____

(2)

(Total 9 marks)

Q3.

This question is about alkenes and crude oil.

(a) Pentene is an alkene molecule containing five carbon atoms.

Complete the formula for pentene.

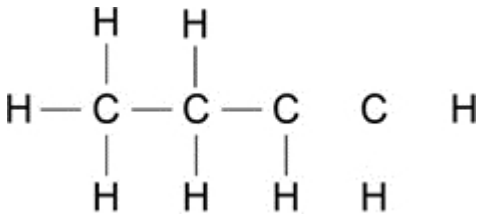
C _____ H _____

(1)

(b) Butene is an alkene molecule containing four carbon atoms.

The diagram shows all of the atoms and some of the bonds in the displayed formula for butene.

Complete the displayed formula by adding the remaining bonds.



(1)

Pentene and butene are produced from crude oil.

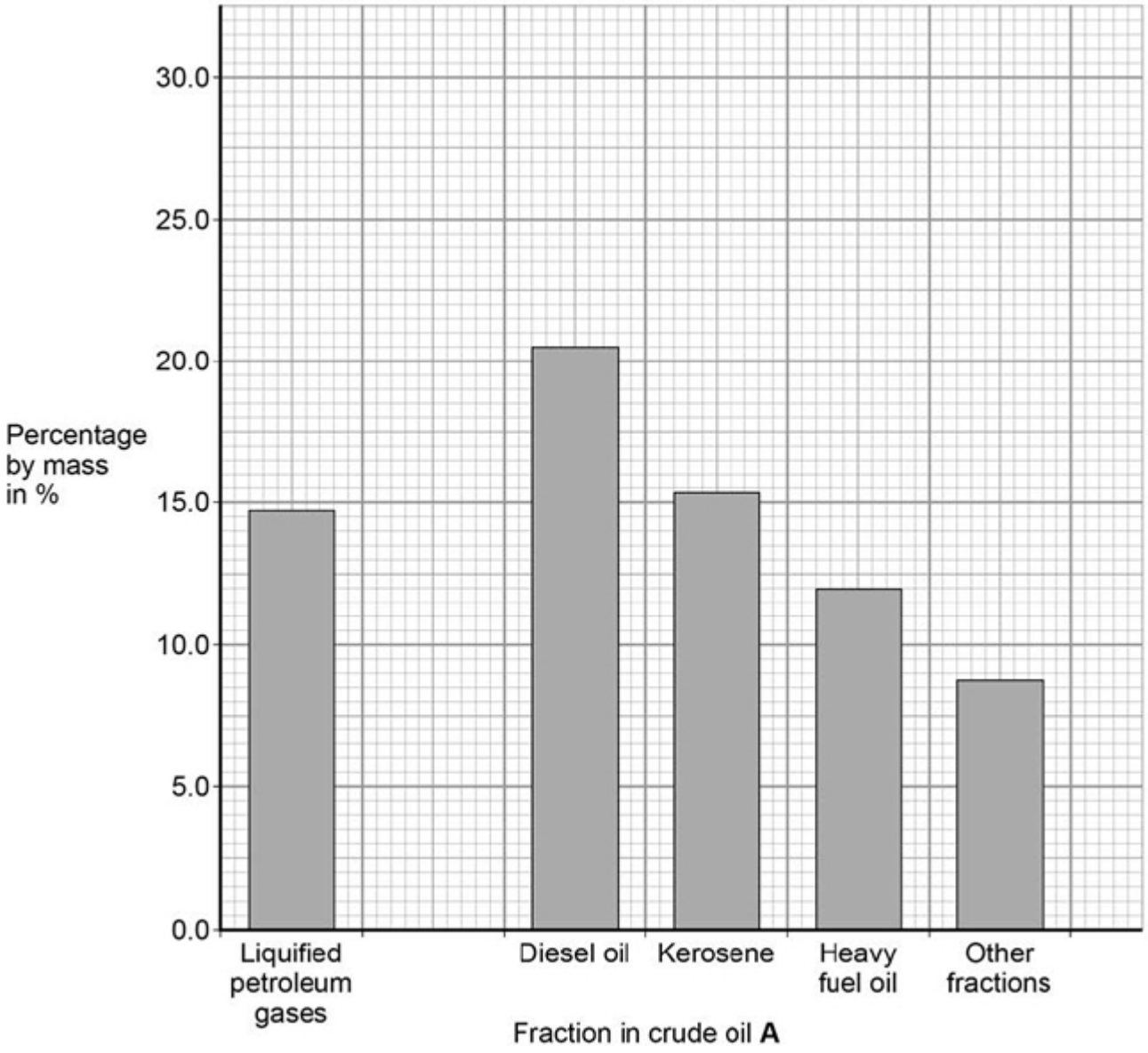
The table shows the percentages of different fractions in two samples of crude oil.

Fraction	**Percentages by mass in %**	
	Crude oil A	**Crude oil B**
Liquefied petroleum gases	14.7	7.1
Petrol	28.6	11.1
Diesel oil	20.5	17.2

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Kerosene	15.4	38.5
Heavy fuel oil	12.0	16.0
Other fractions	8.8	10.1

The graph shows the percentages of different fractions in crude oil **A**.



(c) Plot the data for petrol in the table above on the graph.

(1)

(d) What mass of crude oil **A** is needed to obtain 12 tonnes of heavy fuel oil?.

Use the table above.

10 tonnes ☐

100 tonnes ☐

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1000 tonnes ☐

10 000 tonnes ☐

(1)

(e) What mass of crude oil **A** is needed to obtain 12 tonnes of heavy fuel oil?.

Calculate the total mass of car fuel that can be produced from 2000 kg of crude oil **B**.

Use the table above.

_____

_____

_____

_____

Mass of car fuel = _____ kg

(3)

(f) Crude oil **B** is a better source of hydrocarbons for cracking than crude oil **A**.

Suggest why.

Use the table above.

_____

_____

(1)

(g) Alkenes are obtained from crude oil using fractional distillation followed by cracking.

Explain how alkenes are produced using fractional distillation followed by cracking.

(6)

(Total 14 marks)

Q4.

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?

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_____

(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.

$C_3H_8 + 5O_2 \rightarrow 3$ _____ + 4 _____

(2)

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

Explain why octane is a hydrocarbon.

_____

_____

(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)

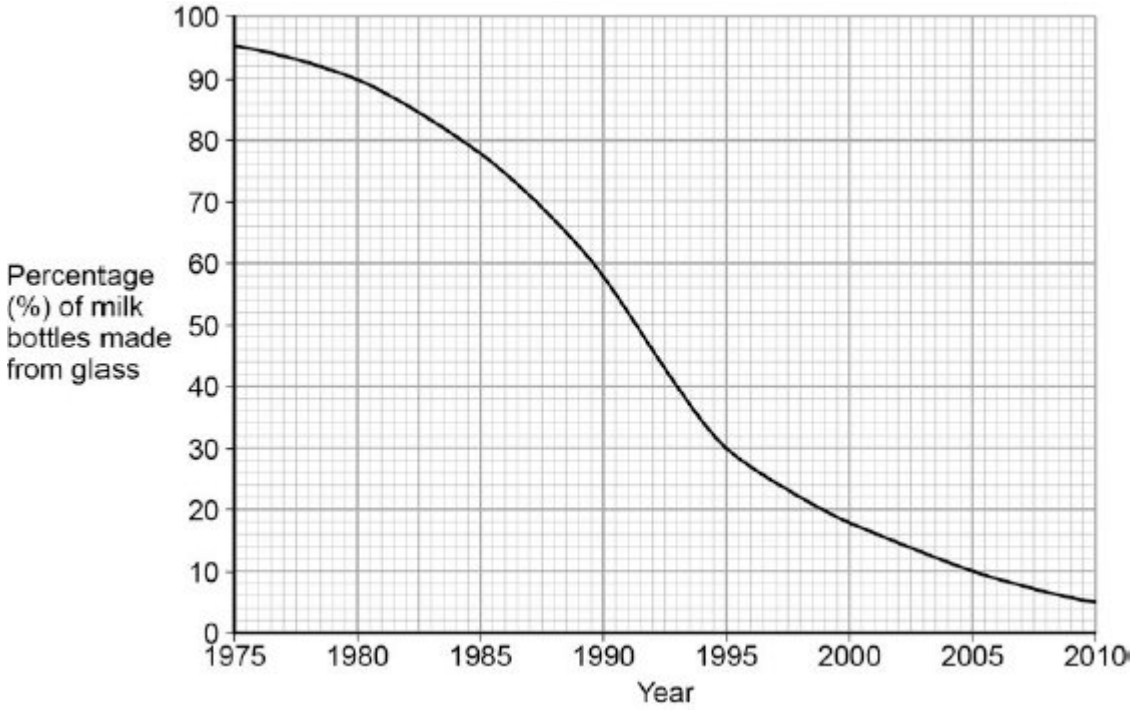
(Total 11 marks)

Q5.

Plastic and glass can be used to make milk bottles.

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

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

(3)

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

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

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

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

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(Total 9 marks)

Q6.

This question is about organic compounds.

Hydrocarbons can be cracked to produce smaller molecules.

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

$C_{18}H_{38} \rightarrow C_6H_{14} + C_4H_8 + 2\,C_3H_6 + C_2H_4$

(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

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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?

A $C_4H_8 + 4O \rightarrow 4CO + 4H_2$

B $C_4H_8 + 4O_2 \rightarrow 4CO + 4H_2O$

C $C_4H_8 + 6O_2 \rightarrow 4CO_2 + 4H_2O$

D $C_4H_8 + 8O \rightarrow 4CO_2 + 4H_2$

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

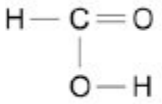
(1)

(d) Propanoic acid is a carboxylic acid.

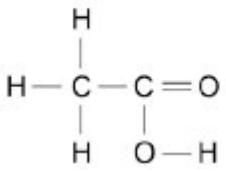
Which structure, **A**, **B**, **C** or **D**, shows propanoic acid?

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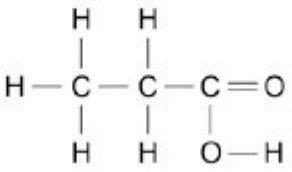
A



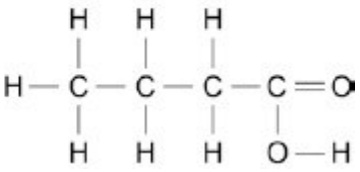
B



C



D



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)

Q7.

This question is about hydrocarbons.

(a) Most of the hydrocarbons in crude oil are alkanes.

(i) Large alkane molecules can be cracked to produce more useful molecules.

The equation shows the cracking of dodecane.

$$\underset{\text{dodecane}}{C_{12}H_{26}} \longrightarrow \underset{\text{butane}}{C_4H_{10}} + \underset{\text{hexene}}{C_6H_{12}} + \underset{\text{ethene}}{C_2H_4}$$

Give **two** conditions used to crack large alkane molecules.

1. _____

2. _____

(2)

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(ii) The products hexene and ethene are alkenes.

Complete the sentence.

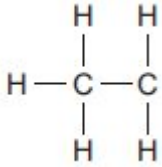
When alkenes react with bromine water the colour changes

from orange to _____ .

(1)

(iii) Butane (C_4H_{10}) is an alkane.

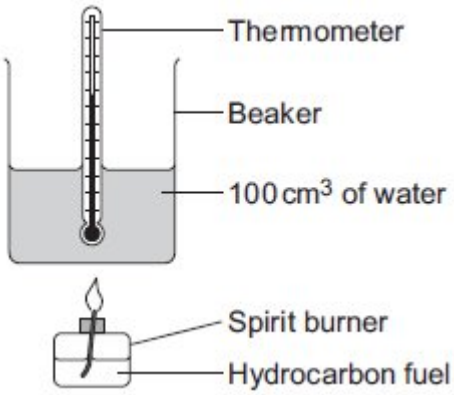
Complete the displayed structure of butane.



(1)

(b) A group of students investigated the energy released by the combustion of four hydrocarbon fuels.

The diagram below shows the apparatus used.



Each hydrocarbon fuel was burned for two minutes.

Table 1 shows the students' results.

Table 1

	After two minutes				
Name and formula of hydrocarbon fuel	**Mass of fuel used in g**	**Temperature increase of water in °C**	**Energy released by fuel in kJ**	**Energy released by 1.0 g of fuel in kJ**	**Relative amount of smoke in the flame**
Hexane, C_6H_{14}	0.81	40	16.80	20.74	very little smoke
Octane, C_8H_{18}	1.10	54	22.68	20.62	some smoke
Decane, $C_{10}H_{22}$	1.20	58	24.36		smoky

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Dodecane, $C_{12}H_{26}$	1.41	67	28.14	19.96	very smoky

(i) Calculate the energy released by 1.0 g of decane in kJ.

_____

_____

Energy released = _____ kJ

(2)

(ii) Suggest **one** improvement to the apparatus, or the use of the apparatus, that would make the temperature increase of the water for each fuel more accurate.

Give a reason why this is an improvement.

_____

_____

_____

(2)

(iii) The students noticed that the bottom of the beaker became covered in a black substance when burning these fuels.

Name this black substance.

Suggest why it is produced.

_____

_____

_____

_____

(2)

(iv) A student concluded that hexane is the best of the four fuels.

Give **two** reasons why the results in **Table 2** support this conclusion.

1. _____

_____

2. _____

_____

(2)

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

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Most car engines use petrol as a fuel.

- Petrol is produced from the fractional distillation of crude oil.
- Crude oil is a mixture of hydrocarbons.
- Sulfur is an impurity in crude oil.

Car engines could be developed to burn hydrogen as a fuel.

- Hydrogen is produced from natural gas.
- Natural gas is mainly methane.

Table 2 shows information about petrol and hydrogen.

Table 2

	Petrol	**Hydrogen**
State of fuel at room temperature	Liquid	Gas
Word equation for combustion of the fuel	petrol + oxygen ⟶ carbon dioxide + water	hydrogen + oxygen ⟶ water
Energy released from combustion of 1 g of the fuel	47 kJ	142 kJ

Describe the **advantages** and **disadvantages** of using hydrogen instead of petrol in car engines.

Use the information given and your knowledge and understanding to answer this question.

(6)

(Total 18 marks)

Q8.

A student investigated the viscosity of liquid hydrocarbons.

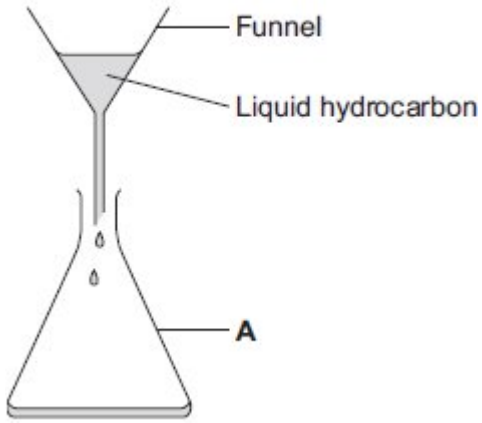
A viscous liquid is a liquid that flows slowly.

The student used this method.

- Measure 50 cm^3 of the liquid hydrocarbon.
- Pour the liquid hydrocarbon into the funnel, as shown in **Figure 1**.

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Figure 1



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

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

_____

(1)

(ii) Name the apparatus that could be used to measure 50 cm^3 of liquid hydrocarbon.

_____

(1)

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

Table 1

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

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

Give **two** reasons why.

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_____

_____

_____

_____

(2)

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

_____

_____

Mean time = _____ seconds

(1)

(iii) Complete the sentence.

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

_____ .

(1)

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

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

Suggest why this result was not used.

_____

_____

(1)

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

_____

_____

_____

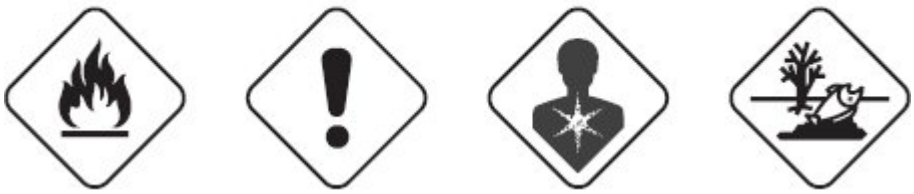
(1)

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

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

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Figure 2



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

_____

_____

(1)

(ii) The student wore safety glasses.

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

Safety precaution _____

Reason _____

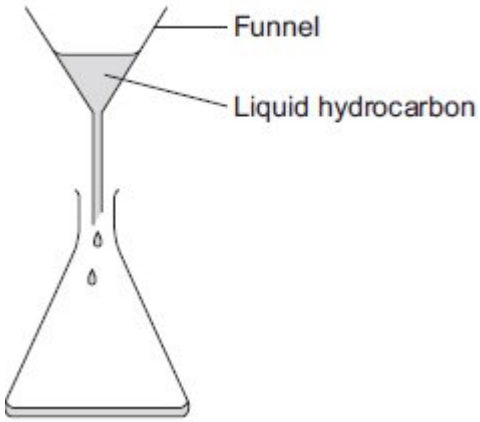
_____

(2)

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

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

Figure 3



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- Time how long it takes for all of the liquid hydrocarbon to run out of the funnel.
- Repeat the experiment at different temperatures.

(i) The student's results are shown in **Table 2**.

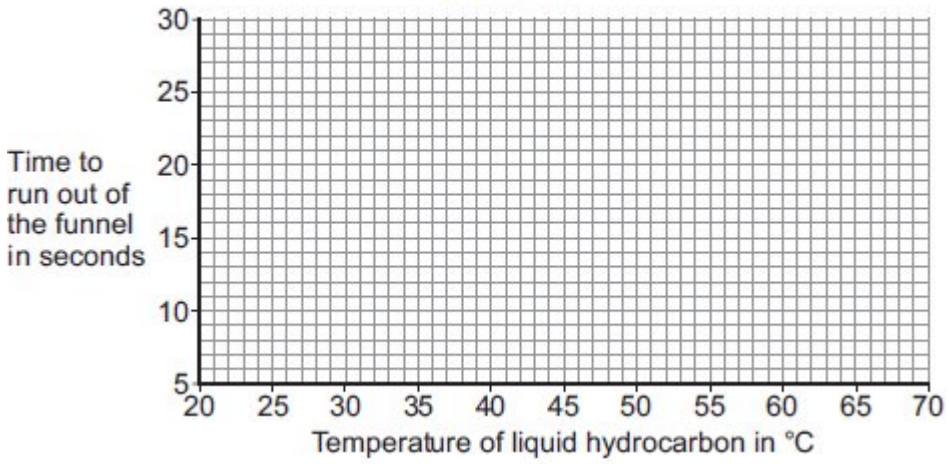
Table 2

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

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

Draw a curve of best fit.

Figure 4



(3)

(ii) One of the points is anomalous.

Draw a ring around the anomalous point on your graph.

(1)

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

Show your working on your graph.

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Time = _____ seconds

(2)

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

_____

_____

_____

_____

_____

_____

(3)

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

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

_____

_____

_____

_____

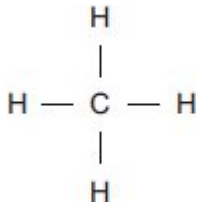
(2)

(Total 22 marks)

Q9.

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.

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Methane contains atoms of two elements, combined chemically. ☐

Methane is not in the periodic table. ☐

Methane is a mixture of two different elements. ☐

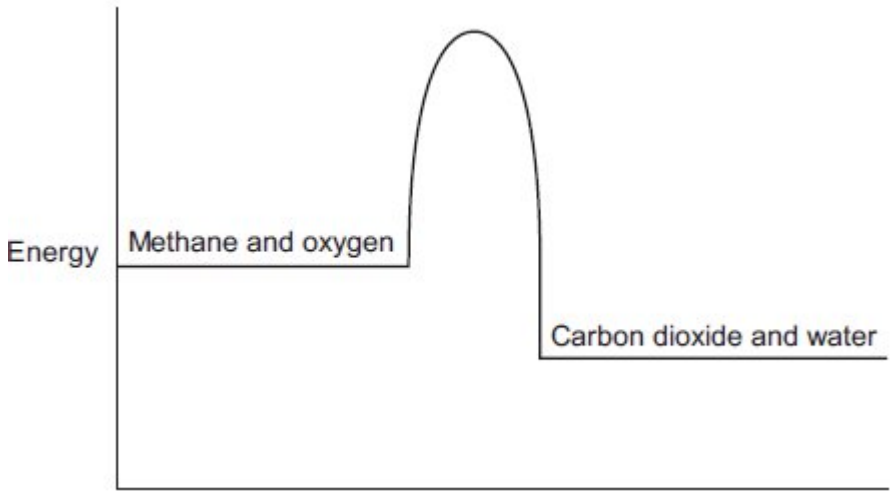
(1)

(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.

$$CH_4 + _____ \longrightarrow CO_2 + _____$$

(2)

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

_____

_____

_____

_____

(2)

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

_____

_____

_____

_____

_____

_____

(3)

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

The equation for this reaction is:



Some bond dissociation energies are given in the table.

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

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

_____

_____

_____

_____

_____

_____

(3)

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

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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)

Q10.

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 _____ .

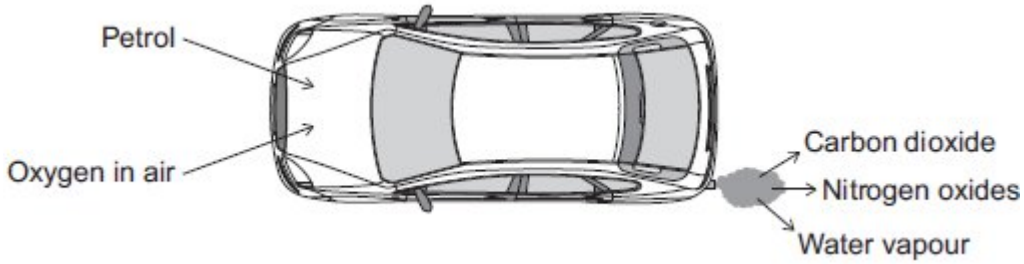
(1)

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(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 + _____ → _____ + _____

(2)

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

Describe why sulfur should be removed from petrol.

_____

_____

_____

_____

(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:

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$C_{10}H_{22}$ ⟶ C_3H_8 + C_2H_4 + C_5H_{10}

decane — propane — ethene — pentene

(i) Why is propane useful?

Tick (✓) **one** box.

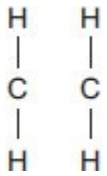
Propane is a polymer. ☐

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)

Q11.

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Crude oil is a fossil fuel.

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

(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.

(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.

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

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

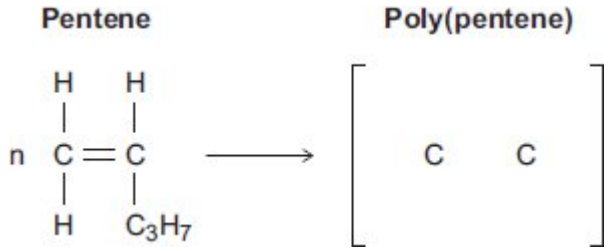
$C_{10}H_{22} \longrightarrow C_5H_{10} + C_3H_8 +$ _____

decane pentene propane

(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.

_____

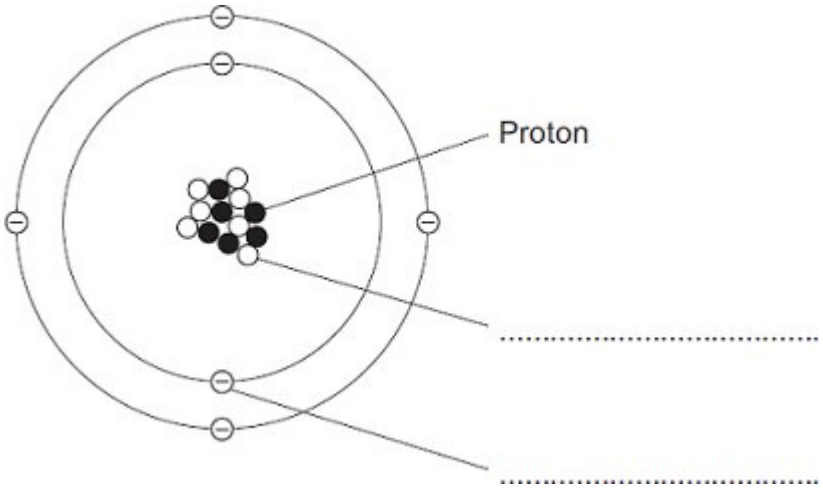
_____

(1)

(Total 12 marks)

Q12.

The diagram shows a carbon atom.



(a) (i) A proton is labelled.

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

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electron	ion	molecule	neutron

(2)

(ii) The atom of carbon is represented as:

$$^{13}_{6}C$$

What is the mass number of this carbon atom?

Draw a ring around the correct answer.

6 **13** **19**

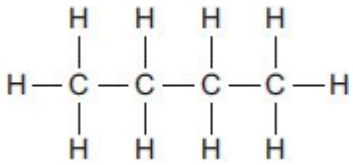
(1)

(iii) Complete the sentence.

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

(1)

(b) Butane is represented as:



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

bond	compound	helium	hydrogen	mixture	oxygen

Butane is a _____ .

Butane contains atoms of carbon and _____ .

Each line between the atoms in butane represents a chemical

_____ .

(3)

(ii) Which is the correct formula for butane?

Tick (✔) **one** box.

C_4H_4 ☐

C_4H_8 ☐

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C_4H_{10} ☐

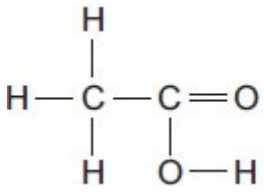
(1)

(Total 8 marks)

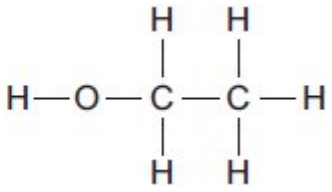
Q13.

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

Compound A



Compound B



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

Name compound **B**.

_____

(1)

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

burned	**decomposed**	**oxidised**

To form compound **A**,

compound **B** is _____

(1)

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

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

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

_____

_____

_____

_____

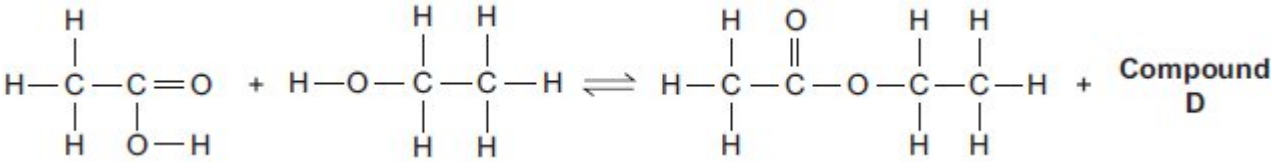
_____

(2)

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

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Compound A **Compound B** **Compound C**



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

_____

(1)

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

Name compound **C**.

_____

(1)

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

_____

(1)

(Total 7 marks)

Q14.

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.

_____

_____

_____

_____

_____

_____

(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**.

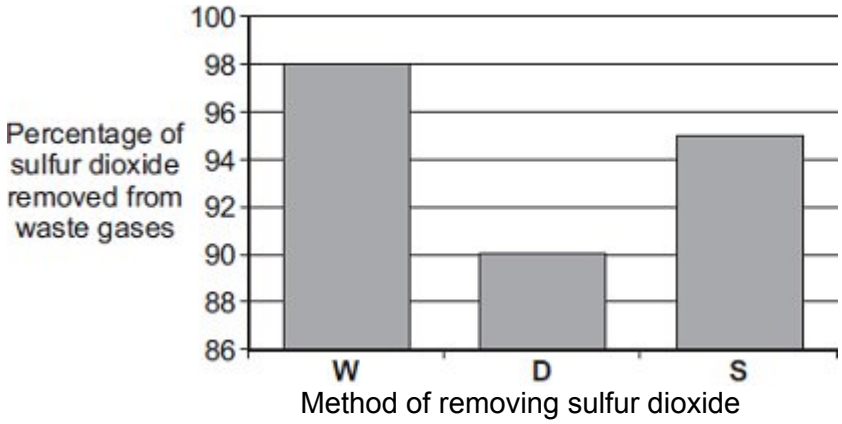


Table 1

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Method	Material used	How material is obtained
W	Calcium carbonate, $CaCO_3$	Quarrying
D	Calcium oxide, CaO	Thermal decomposition of calcium carbonate: $CaCO_3 \longrightarrow CaO + CO_2$
S	Seawater	From the sea

Table 2

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

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

Compare the three methods and give a justified conclusion.

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_____

_____

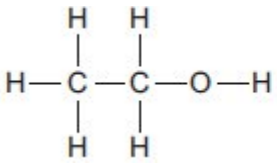
(6)

(Total 12 marks)

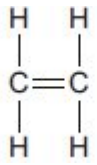
Q15.

The figure below shows the displayed structures of five organic compounds, **A, B, C, D** and **E**.

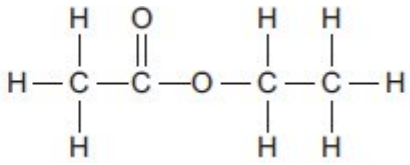
A



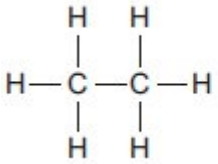
B



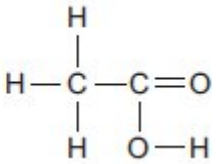
C



D



E



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

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

Write the letter of the compound that:

(i) is a saturated hydrocarbon ☐

(1)

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

(1)

(iii) has the empirical formula C_2H_6O ☐

(1)

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

(1)

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

(1)

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(b) Compound **B** (C_2H_4) and C_8H_{18} are produced by cracking $C_{14}H_{30}$

$$C_{14}H_{30} \longrightarrow 3C_2H_4 + C_8H_{18}$$

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

_____

_____

(2)

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

_____

_____

_____

_____

(2)

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

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

Test _____

_____

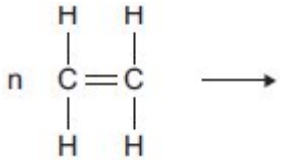
Result _____

_____

(2)

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

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



(3)

(Total 14 marks)

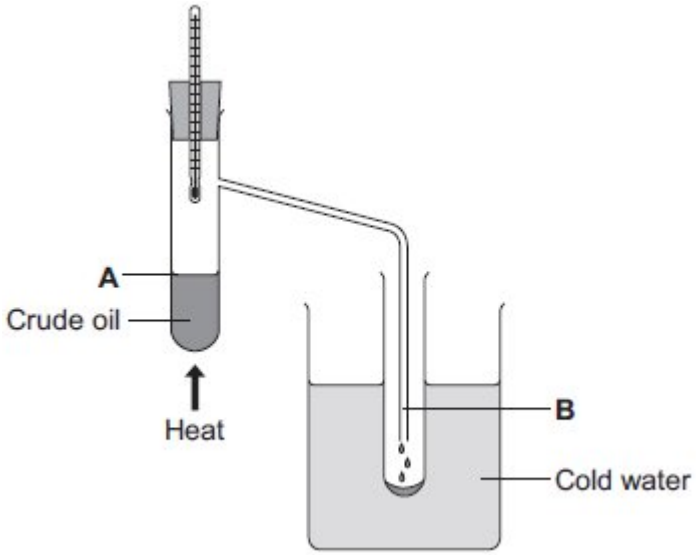
Q16.

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

Figure 1 shows a laboratory experiment to separate crude oil.

Figure 1

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(a) Complete the sentence.

The name for compounds that contain only hydrogen and

carbon is _____ .

(1)

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

condensation	**decomposition**	**distillation**
	evaporation	**reduction**

(i) The process of separating crude oil is fractional _____ .

(1)

(ii) The process taking place at **A** is _____ .

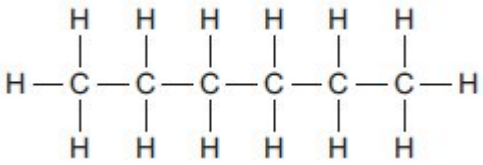
(1)

(iii) The process taking place at **B** is _____ .

(1)

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

Figure 2



Complete the sentences.

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

_____ .

(1)

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(ii) Complete the chemical formula for hexane.

$C_6H___$

(1)

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

_____ .

(1)

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

(i) Name the polymer made from butene.

_____ .

(1)

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

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

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

(2)

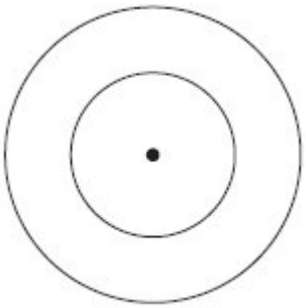
(Total 10 marks)

Q17.

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.

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hydrogen + oxygen ⟶ _____

(1)

(b) Coal is a fossil fuel.

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

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

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

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 6 marks)

Q18.

This question is about compounds produced from crude oil.

The table below shows four of these compounds.

Compound	Melting point in °C	Boiling point in °C
methane (CH_4)	−183	−164
ethene (C_2H_4)	−169	−104
decane ($C_{10}H_{22}$)	−30	+174
icosane ($C_{20}H_{42}$)	+37	+343

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

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

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(20°C).	
Decane and icosane are liquid at 100°C.	

(2)

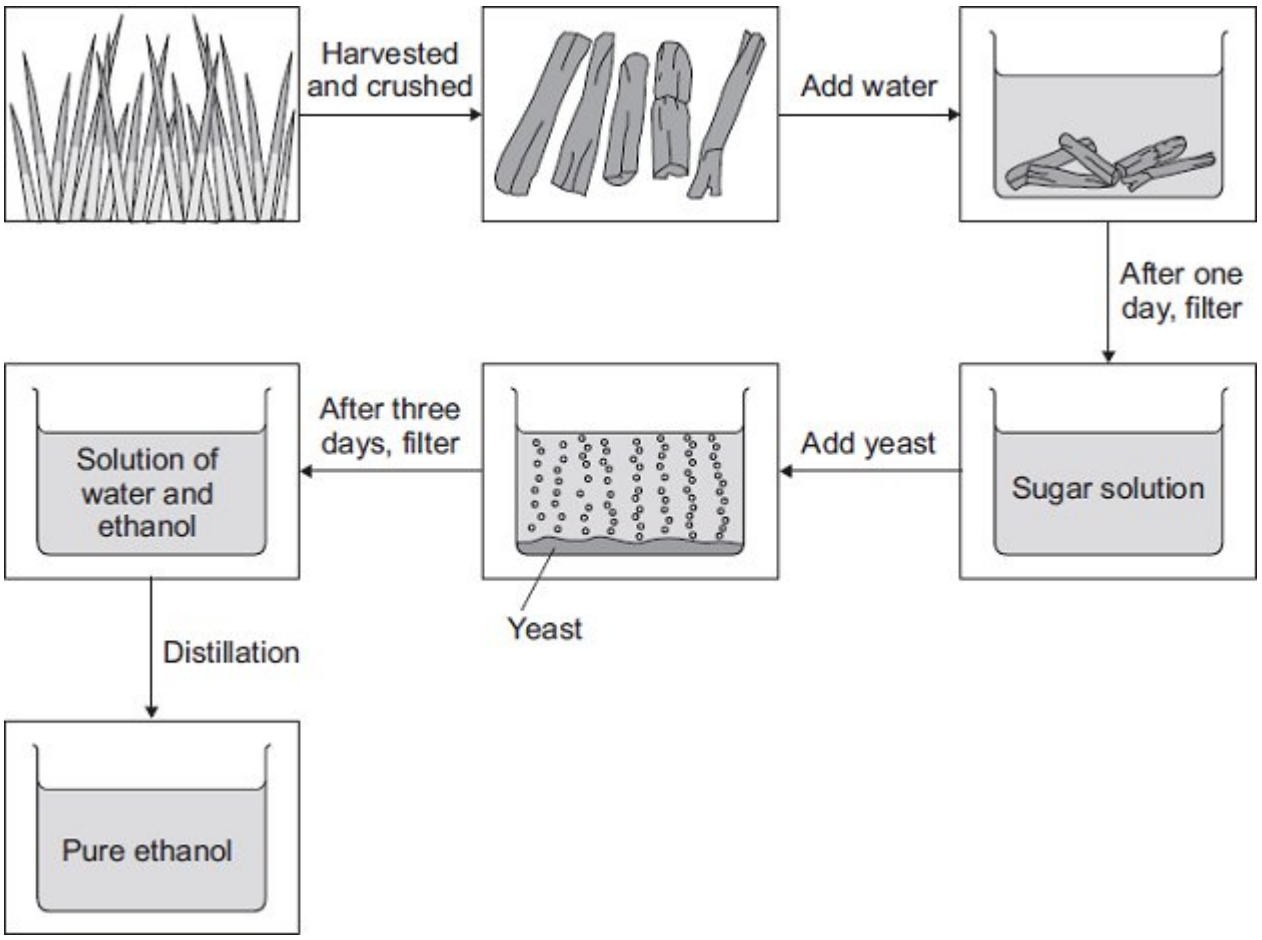
(b) Petrol contains a mixture of compounds, including octane (C_8H_{18}).

Complete the word equation for the complete combustion of octane.

octane + oxygen → _____ + _____

(2)

(c) Most petrol used in cars contains about 5% ethanol (C_2H_5OH).
Ethanol can be produced from sugar cane.



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

The reaction to produce ethanol from sugar solution is

combustion.

displacement.

fermentation.

(1)

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

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Suggest **two** reasons why.

1. _____

_____

_____

2. _____

_____

_____

(2)

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

Suggest **two** reasons why.

1. _____

_____

_____

2. _____

_____

_____

(2)

(Total 9 marks)

Q19.

This question is about oil reserves.

(a) Diesel is separated from crude oil by fractional distillation.

Describe the steps involved in the fractional distillation of crude oil.

_____

_____

_____

_____

_____

_____

_____

_____

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(3)

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

What are *alkanes*?

_____

_____

_____

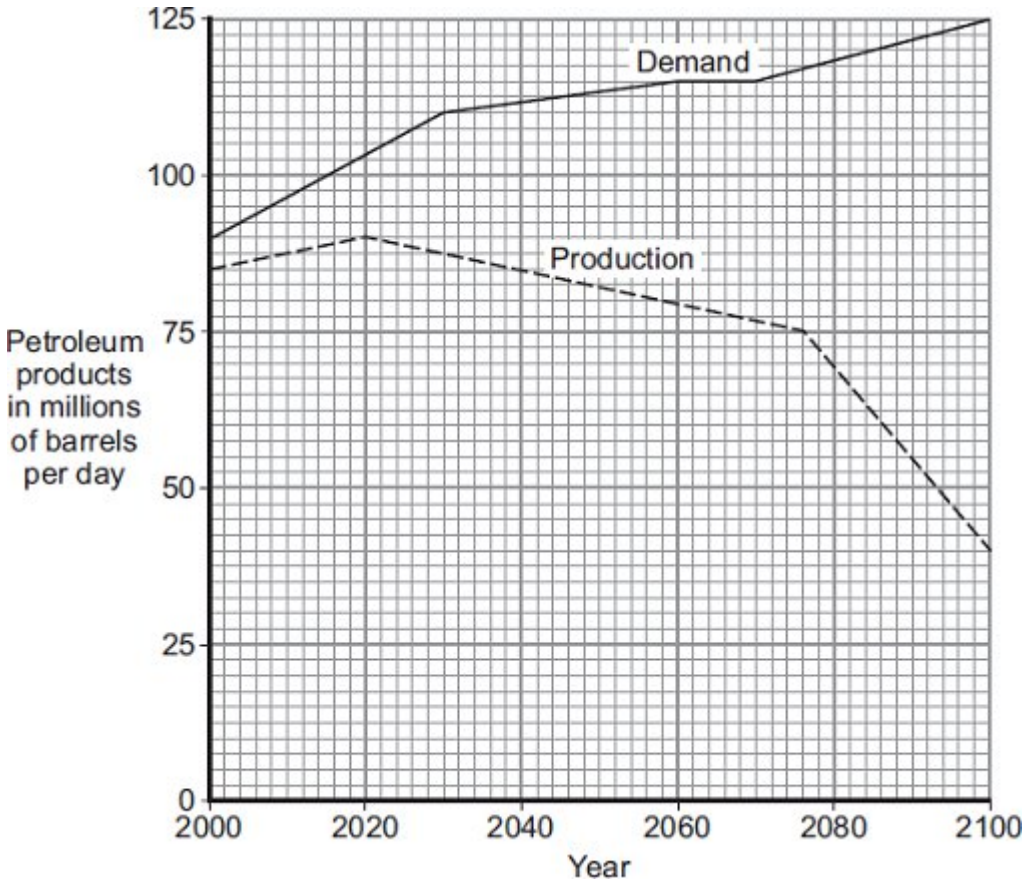
_____

_____

(2)

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

Petroleum products, such as petrol, are produced from crude oil.
The graph shows the possible future production of petroleum products from crude oil and the expected demand for petroleum products.



Canada's oil sands hold about 20% of the world's known crude oil reserves.

The oil sands contain between 10 to 15% of crude oil. This crude oil is mainly bitumen.

In Canada the oil sands are found in the ground underneath a very large area of forest. The trees are removed. Then large diggers and trucks remove 30 metres

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depth of soil and rock to reach the oil sands. The oil sands are quarried. Boiling water is mixed with the quarried oil sands to separate the bitumen from the sand. Methane (natural gas) is burned to heat the water.

The mixture can be separated because bitumen floats on water and the sand sinks to the bottom of the water. The bitumen is cracked and the products are separated by fractional distillation.

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

(6)

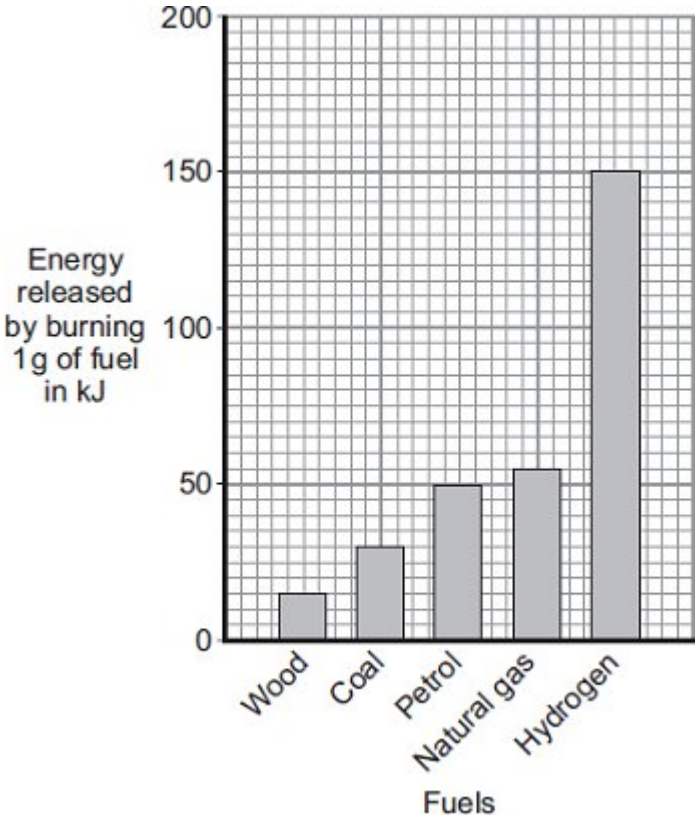
(Total 11 marks)

Q20.

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.

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

_____

(1)

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

Energy = _____kJ

(1)

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

Use information from the bar chart to help you.

_____

_____

Mass = _____ g

(1)

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

Name	Formula
Carbon dioxide	CO_2
Water vapour	H_2O
Sulfur dioxide	SO_2

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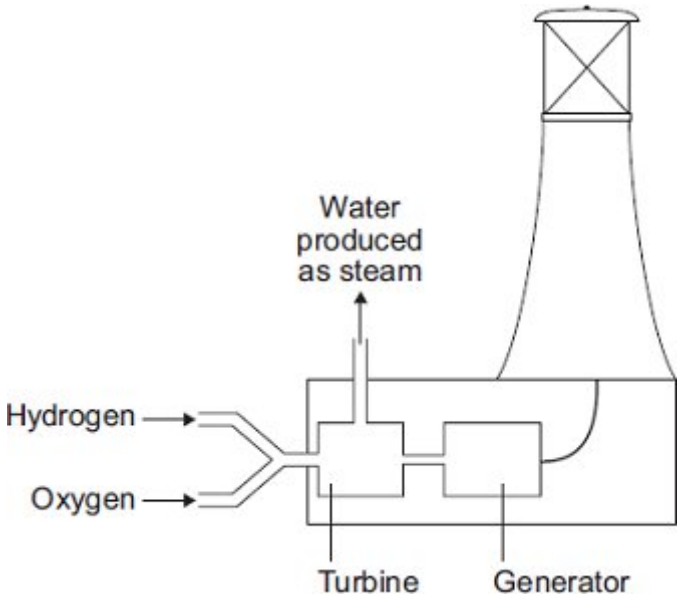
Use information from the table to name **one** element that is in coal.

_____

(1)

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

A lighthouse uses electricity generated by burning hydrogen.



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

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

1. _____

_____

2. _____

_____

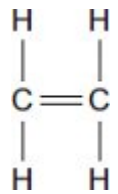
(2)

(Total 6 marks)

Q21.

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.

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Formula	Tick (✓)
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	Tick (✓)
Poly(ethene)	
Poly(ethenol)	
Poly(propene)	

(1)

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

THE PROBLEM WITH PLASTIC WASTE

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

Most of the litter found on beaches is plastic waste.

80 % of plastics produced end up in landfill sites.

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

Plastic waste needs to be removed from beaches because it

decomposes.

is reactive.

is not biodegradable.

(1)

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

_____

_____

(1)

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

_____

_____

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(1)

(Total 5 marks)

Q22.

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

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

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

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

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

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

_____

_____

_____

_____

(2)

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

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

When it rains on Titan, it rains methane!

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

_____

_____

_____

_____

_____

_____

(2)

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

State the general formula for alkenes.

_____

(1)

(Total 5 marks)

Q23.

Alkanes are hydrocarbons found in crude oil.

(a) (i) Complete the sentence.

Hydrocarbons contain the elements _____ and _____ only.

(1)

(ii) Ethane is an alkane with the formula C_2H_6

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

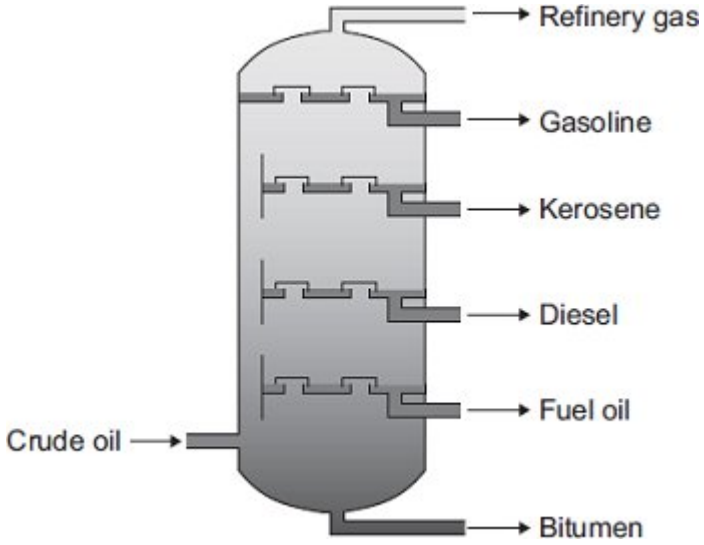
Alkanes are hydrocarbons with the general formula

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

(1)

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

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

Use the diagram to help you answer the question.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

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

(i) Complete the equation for this reaction.

$C_{12}H_{26} \longrightarrow 2\ C_2H_4 +$ _____

(1)

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

1. _____

2. _____

(2)

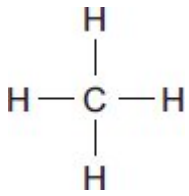
(Total 9 marks)

Q24.

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

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(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.

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Name of problem _____

Effect of problem _____

_____

(2)

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

One gaseous product of incomplete combustion is carbon monoxide.

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

_____

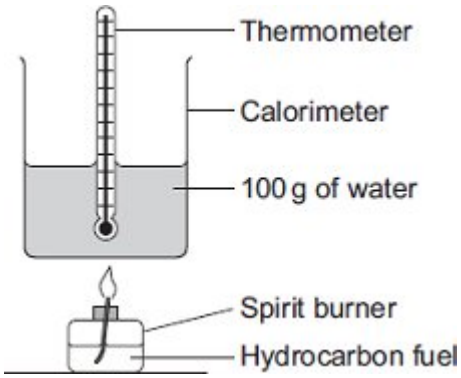
(1)

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

Her hypothesis was:

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

The apparatus the student used is shown in the diagram.



She burned each hydrocarbon fuel for 2 minutes.

Her results are shown in the table.

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

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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.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(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.

_____

_____

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)**.

_____

_____

_____

_____

Formula = _____

(2)

(Total 19 marks)

Q25.

(a) A student had a colourless solution.

The student thought the solution was dilute hydrochloric acid.

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

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

_____

(1)

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

_____

_____

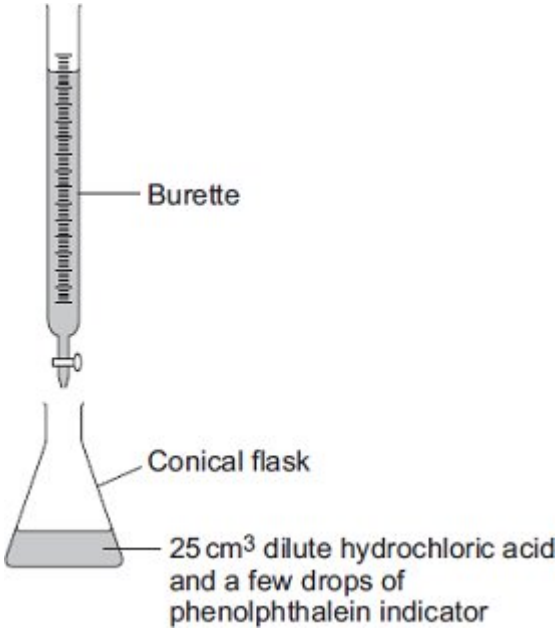
_____

_____

(2)

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

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Describe how to use the apparatus to do a titration using 25 cm^3 of dilute hydrochloric acid.

In your answer you should include:

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

(4)

(c) Hydrochloric acid is a strong acid.

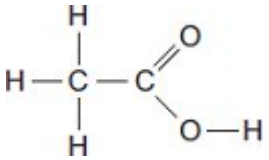
Ethanoic acid is a *weak acid*.

What is meant by the term *weak acid*?

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(1)

(d) The displayed formula of ethanoic acid is:



(i) On the formula, draw a circle around the functional group in ethanoic acid.

(1)

(ii) Ethanoic acid and ethanol react together to make the ester ethyl ethanoate.

Draw the **displayed** formula of ethyl ethanoate.

(2)
(Total 11 marks)

Q26.

Barbecues are heated by burning charcoal or burning hydrocarbons.



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

The chemical equation for charcoal burning is:

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$$C + O_2 \longrightarrow CO_2$$

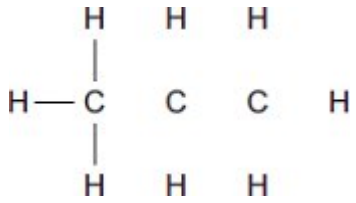
Complete the word equation for this reaction.

carbon + _____ ⟶ carbon dioxide

(1)

(b) Propane is a hydrocarbon.

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



(1)

(ii) Write the chemical formula of propane._____

(1)

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

Propane burns in air to produce carbon dioxide and

hydrogen.
hydroxide.
water.

(1)

(c) The table shows information about six hydrocarbons.

Hydrocarbon	State at room temperature (20°C)	Boiling point in °C
Ethane (C_2H_6)	gas	−89
Ethene (C_2H_4)	gas	−104
Butane (C_4H_{10})	gas	−1
Butene (C_4H_8)	gas	−6
Hexane (C_6H_{14})	liquid	+69
Hexene (C_6H_{12})	liquid	+64

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

Statement	Tick (✓)
Ethane and butane boil at temperatures less than 20°C.	

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Hexene and butene are alkanes.	
Butane and hexane are liquid at 0°C.	
Ethene and hexene each have a carbon-carbon double bond.	

(2)

(Total 6 marks)

Q27.

Crude oil is a mixture of many different chemical compounds.

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

(i) Fuels react with oxygen to release energy.

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

_____

(1)

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

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

_____

_____

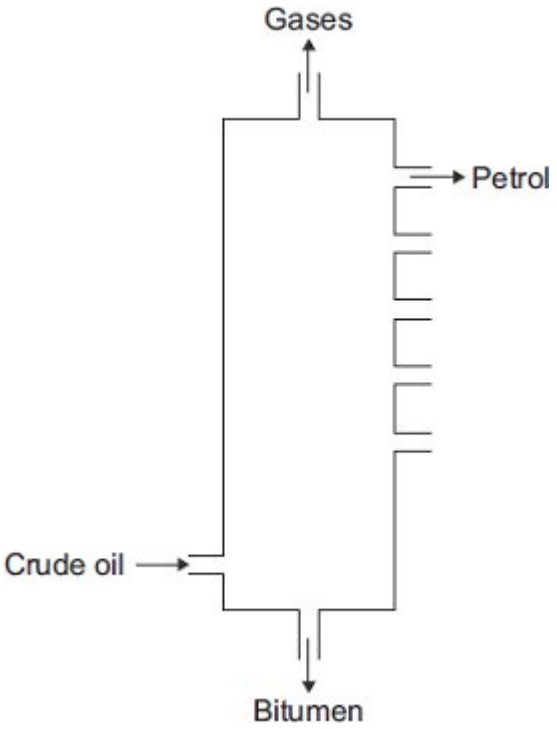
_____

_____

(2)

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

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

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

Use the diagram and your knowledge to answer this question.

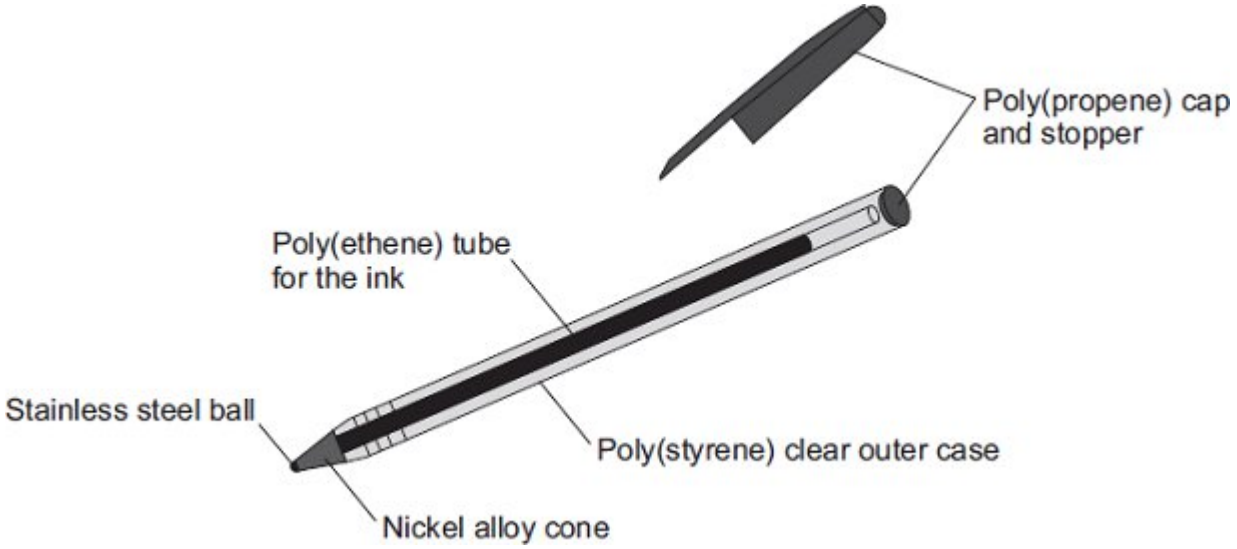
(6)

(Total 9 marks)

Q28.

The diagram shows a ballpoint pen.

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

_____

_____

_____

_____

(2)

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

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

_____

_____

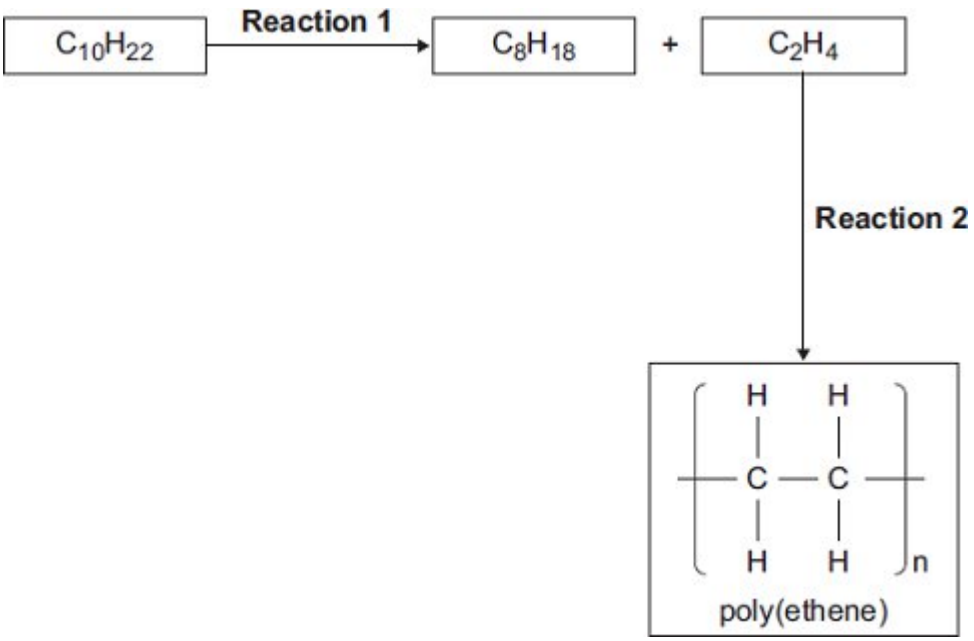
_____

_____

(2)

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

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

_____

_____

_____

_____

(2)

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

_____

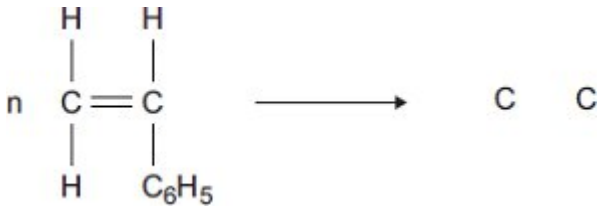
_____

_____

_____

(2)

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



styrenepoly(styrene)

(2)

(Total 10 marks)

Q29.

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There has been research into fuels for car engines.

Fuel	Content	Melting point in °C	Flashpoint in °C	Energy released in MJ per litre
Ethanol	C_2H_5OH	−114	+14	21.2
Diesel	hydrocarbons	About −24	+64	38.6
Petrol	hydrocarbons	About −57	−45	34.8
Rapeseed oil	fats	About +5	+130	32.8

The flashpoint is the lowest temperature a fuel vapour ignites in air.

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

Suggest why.

_____

_____

_____

(2)

(b) Ethanol is produced by fermentation of sugar cane. Rapeseed oil is produced by pressing rapeseeds. Waste plant material from both processes is used to feed animals.

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

_____

_____

_____

_____

(2)

(ii) Carbon neutral fuels do **not** increase the amount of carbon dioxide in the atmosphere.

Suggest why using a biofuel, such as ethanol or rapeseed oil, is thought to be carbon neutral.

_____

_____

_____

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_____

(2)

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

Explain why.

_____

_____

_____

_____

(2)

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

To gain full marks you should give a justified conclusion.

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

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 12 marks)

Q30.

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

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

Compounds made up of carbon and hydrogen atoms only

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are called

alcohols.
hydrocarbons.
vegetable oils.

(1)

(ii) The table shows five of these compounds.

Compound	State at room temperature (20 °C)	Boiling point in °C
ethane, C_2H_6	gas	– 89
butane, C_4H_{10}	gas	0
hexane, C_6H_{14}	liquid	+69
pentadecane, $C_{15}H_{32}$	liquid	+270
heptadecane, $C_{17}H_{36}$	solid	+302

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

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

(2)

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

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

The first step in fractional distillation is

cracking
displacing
evaporating

the crude oil.

During fractional distillation the compounds

burn
condense
decompose

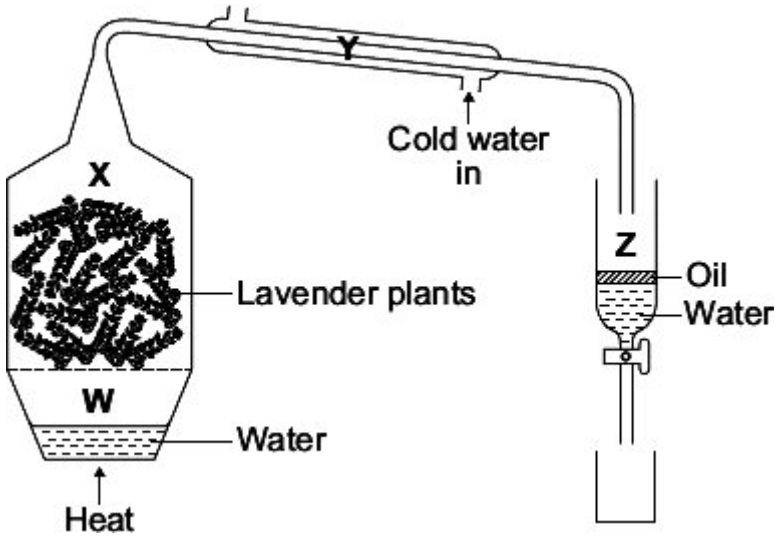
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at different temperatures.

(2)

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

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



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

is steam produced ☐

are steam and oil condensed? ☐

(2)

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

dissolves	**floats**	**sinks**

When the oil separates from the water, the oil _____

(1)

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

_____

_____

_____

_____

(2)

(Total 10 marks)

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Q31.

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

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

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

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

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

(i) Give the formula for heptane

_____

(1)

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

$$C_nH$$

(1)

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

Reaction 1 $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$

Reaction 2 $2C_6H_{14} + 13O_2 \rightarrow 12CO + 14H_2O$

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

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

_____

(1)

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

_____

_____

(1)

(c) The table shows the percentages of some gases in the exhaust from a petrol engine.

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Name of gas	Percentage (%)
nitrogen	68
carbon dioxide	15
carbon monoxide	1.0
oxygen	0.75
nitrogen oxides	0.24
hydrocarbons	0.005
sulfur dioxide	0.005
other gases	

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

_____

(1)

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

_____

(1)

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

_____

_____

(1)

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

_____

_____

_____

_____

(2)

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

Explain why.

_____

_____

_____

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_____

(2)

(Total 11 marks)

Q32.

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

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

$$C_{28}H_{58} \rightarrow C_{11}H_{24} + C_{11}H_{22} + C_4H_8 + C_2H_4$$

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

Complete the sentences.

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

_____

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

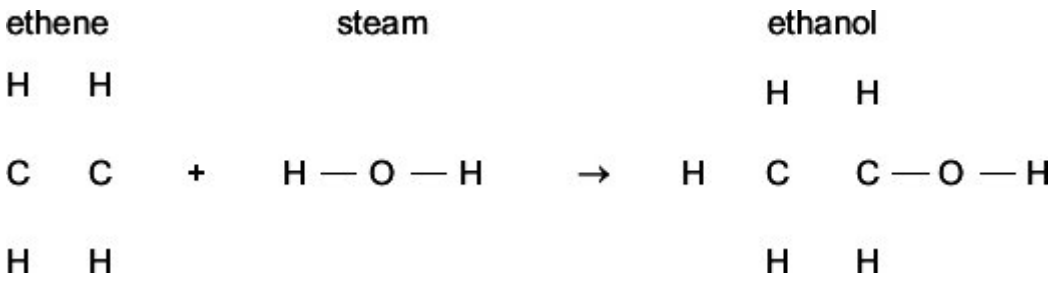
_____

_____

(2)

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

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



(2)

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

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

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

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

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

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

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

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

_____

_____

_____

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(6)

(Total 10 marks)

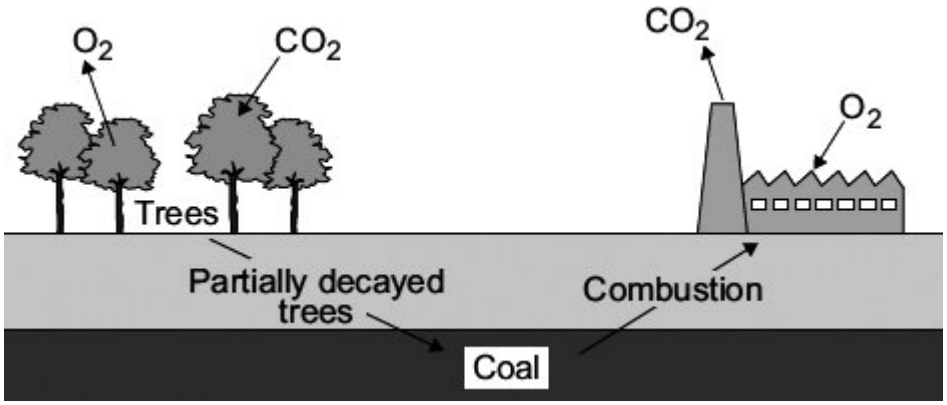
Q33.

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

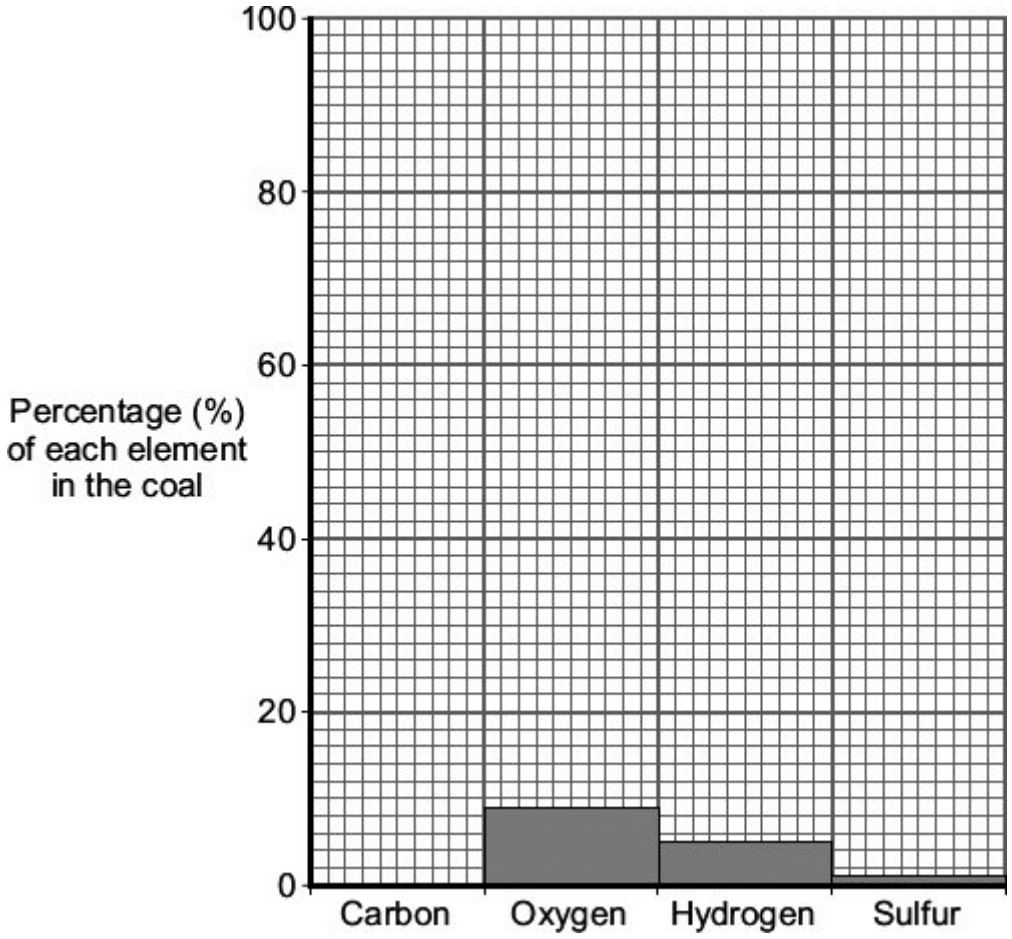
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About 400 million years ago plants and trees grew on most of the land. When the plants and trees died they were covered by sand and slowly decayed to form coal.

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.

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

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

(2)

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

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

_____

_____

(1)

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

_____

_____

_____

_____

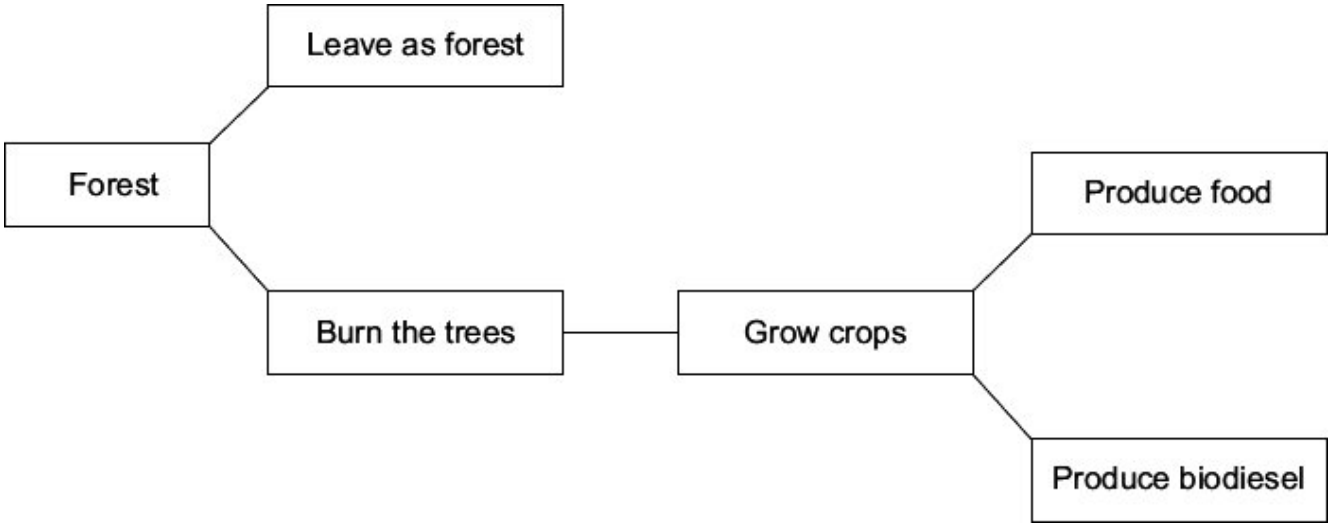
(2)

(Total 6 marks)

Q34.

Petroleum diesel is a fuel made from crude oil.
Biodiesel is a fuel made from vegetable oils.
To make biodiesel, large areas of land are needed to grow crops from which the vegetable oils are extracted.
Large areas of forest are cleared by burning the trees to provide more land for growing these crops.

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

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

Suggest why adverts claim that using biodiesel is carbon neutral.

_____

_____

_____

_____

_____

_____

(2)

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

_____

_____

_____

_____

_____

_____

(2)

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

_____

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_____

(1)

(c) Suggest why producing biodiesel from crops:

(i) causes ethical concerns

_____

_____

(1)

(ii) causes economic concerns.

_____

_____

(1)

(Total 7 marks)

Q35.

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

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

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

_____

_____

_____

_____

_____

_____

_____

_____

(3)

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

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

_____

_____

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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.

$2CaCO_3(s)$ + $2SO_2(g)$ + $O_2(g)$ → ..... $CaSO_4(s)$ + ... $CO_2(g)$

(1)

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

increases atmospheric pollution

_____

_____

_____

_____

decreases atmospheric pollution.

_____

_____

_____

_____

(4)

(Total 10 marks)

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