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EDEXCEL GCSE CHEMISTRY: QUESTIONS BY TOPIC

Fuels and Earth Science (8)

GCSE Chemistry (Foundation) Topic 8

14 questions · 150 marks · Mark schemes included

Pearson Edexcel GCSE (9-1) Chemistry 1CH0, Foundation Tier, June 2018 - June 2025

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HOW TO USE THIS BOOKLET

Questions run from the lowest mark tariff to the highest, so similar questions sit together.

Click any row below to jump straight to that question.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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QUESTIONS

14 questions · 150 marks · lowest tariff first



8-MARK QUESTIONS

1 question in this booklet



1 (a) The two most common gases in today's atmosphere are nitrogen and oxygen.

(i) What is the third most common gas in today's atmosphere?

(1)

- ☐ A argon
- ☐ B butane
- ☐ C chlorine
- ☐ D hydrogen

(ii) What is the percentage of oxygen in today's atmosphere?

(1)

- ☐ A 0.04
- ☐ B 1
- ☐ C 21
- ☐ D 78

(b) Give the name of the most common gas in the Earth's **early** atmosphere.

(1)

.....

(c) This early atmosphere was hot and contained water vapour.

The atmosphere today contains less water vapour.

Explain what caused the amount of water vapour in the atmosphere to decrease.

(2)

.....

.....

.....

.....



- (d) The concentration of carbon dioxide in the atmosphere can be measured in parts per million (ppm).

Figure 1 shows the measurements in January 2018 and January 2019.

	concentration of carbon dioxide in ppm
January 2018	407.96
January 2019	410.83

Figure 1

- (i) Calculate the increase in the concentration, in ppm, of carbon dioxide from January 2018 to January 2019.

Give your answer to the nearest whole number.

(2)

.....

.....

.....

increase in concentration of carbon dioxide = ... ppm

- (ii) Give a possible cause for this increase in the concentration of carbon dioxide.

(1)

.....

.....

.....

(Total for Question 1 = 8 marks)



9-MARK QUESTIONS

4 questions in this booklet



5 Crude oil is found in the Earth's crust.

(a) Which of the statements about crude oil is correct?

(1)

- ☐ A crude oil is a finite resource
- ☐ B crude oil is a mixture of the elements hydrogen and carbon
- ☐ C all of the molecules in crude oil contain rings of carbon atoms
- ☐ D crude oil is used in cars as a fuel

(b) The substances ethane, C_2H_6 , octane, C_8H_{18} , and pentadecane, $C_{15}H_{32}$, are all found in crude oil.

These substances

(1)

- ☐ A have the same formula
- ☐ B have the same boiling point
- ☐ C are in the same homologous series
- ☐ D form different products when completely combusted in air

(c) (i) Use a word from the box to complete each of the sentences about the fractional distillation of crude oil.

condensed	heated	melted	solidified	stirred
-----------	--------	--------	------------	---------

Each word may be used once, more than once, or not at all.

(2)

The separation of crude oil into fractions occurs in a fractional distillation column.

Before crude oil is passed into the column it is

During the distillation, vapour rises up the column until it is cold enough for the vapour to form a liquid. The vapour has been



(ii) Complete this sentence by underlining the correct answer in the box.

(1)

Compared with the fraction from the top of the column,

the fraction from the bottom of the column

has more carbon atoms per molecule.

has a lower viscosity.

is easier to ignite.

(d) When crude oil is separated into fractions, the amount of each fraction obtained rarely matches the demand for that fraction.

Figure 7 shows the relative amounts of four of the fractions obtained from a crude oil and the relative demand for each of these fractions.

fraction	relative amount obtained from the crude oil	relative demand
gases	5	5
petrol	10	25
kerosene	20	25
fuel oil	45	5

Figure 7

State the fraction for which the relative amount obtained exceeds the relative demand.

(1)

(e) In January 2015 the United Kingdom produced 850 000 barrels of crude oil per day. 45% of this crude oil was fuel oil.

Calculate the number of barrels of fuel oil present in the 850 000 barrels of crude oil.

Give your answer to two significant figures.

(3)

..... barrels

(Total for Question 5 = 9 marks)



6 (a) Methane is a hydrocarbon fuel.

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

(2)

methane + ... → water + ...

- (ii) The **incomplete** combustion of methane can produce carbon and carbon monoxide.

Give the reason why carbon and carbon monoxide are produced in the **incomplete** combustion of methane.

(1)

.....
.....

(b) Crude oil is a complex mixture of hydrocarbons.

Crude oil can be separated into useful fractions by fractional distillation.

Figure 10 shows a fractional distillation column and the fractions produced when crude oil is distilled.

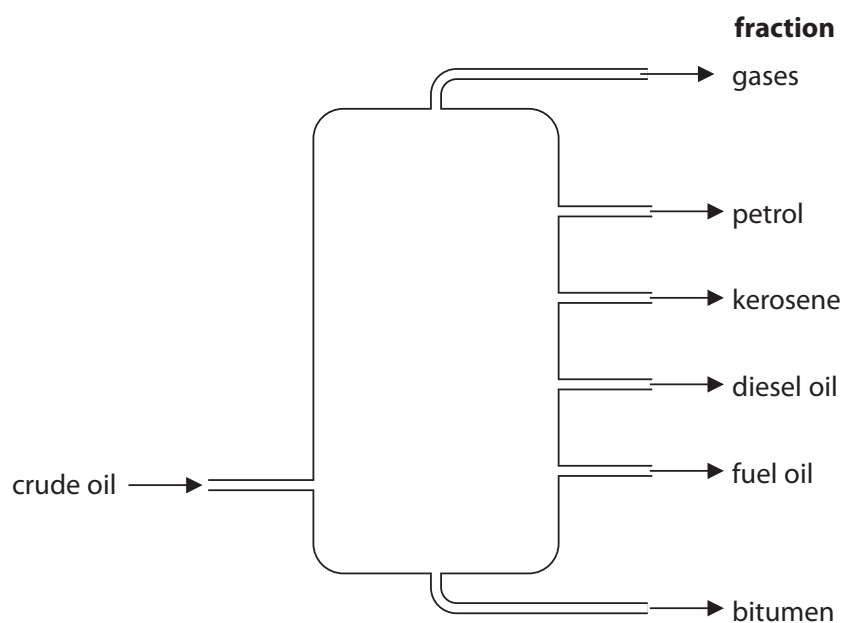


Figure 10

- (i) Name the fraction in Figure 10 that is used to surface roads.

(1)

.....

- (ii) Name the fraction in Figure 10 that contains hydrocarbons with the lowest boiling point.

(1)

- (c) When crude oil is fractionally distilled, the demand for some fractions is more than the amount produced.

Figure 11 shows the relative amounts of each fraction in a crude oil and the relative demand for each of these fractions.

fraction	relative amount	relative demand
gases	2	6
petrol	12	29
kerosene	16	11
diesel oil	24	29
fuel oil	37	21
bitumen	9	4

Figure 11

Which of the following shows the fractions where the relative demand is greater than the relative amount in the crude oil?

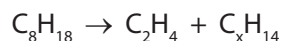
(1)

- ☒ **A** kerosene, diesel oil, bitumen
- ☒ **B** gases, petrol, diesel oil
- ☒ **C** gases, petrol, kerosene
- ☒ **D** petrol, diesel oil, fuel oil



(d) Cracking involves the breaking down of large hydrocarbon molecules into smaller hydrocarbon molecules.

- (i) Octane, C_8H_{18} , can be cracked to produce one molecule of ethene, C_2H_4 , and one molecule of C_xH_{14} .



Determine the value of x in the molecule of C_xH_{14} .

(1)

x = ...

- (ii) Dodecane is a large hydrocarbon molecule.

When one molecule of dodecane is cracked the products are one molecule of octane and one molecule of butene.



Calculate the maximum mass of octane that could be produced when 340 g of dodecane is cracked in this reaction.

(relative formula masses: dodecane = 170, octane = 114)

(2)

.....

.....

.....

.....

.....

.....

.....

mass of octane = ... g

(Total for Question 6 = 9 marks)



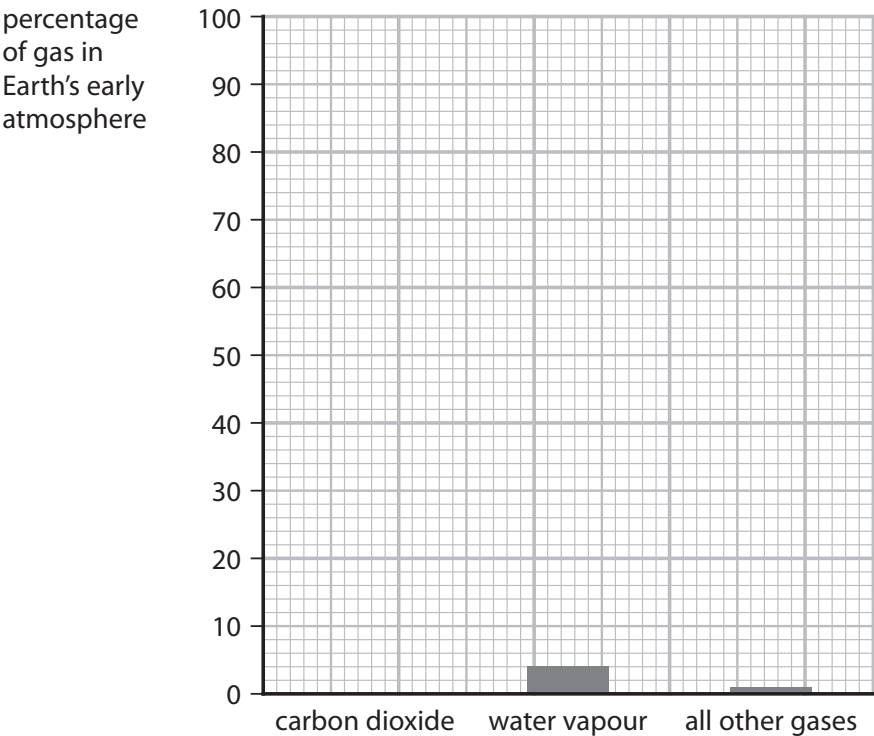
4 A scientist produced the information in Figure 7 about the Earth’s atmosphere and the Earth’s average surface temperature.

Earth’s atmosphere 3 billion years ago		Earth’s atmosphere today	
gas	%	gas	%
carbon dioxide	95	nitrogen	78.00
water vapour	4	oxygen	21.00
all other gases	1	carbon dioxide	0.04
		all other gases including water vapour	0.96
average surface temperature 3 billion years ago		average surface temperature today	
above 400 °C		20 °C	

Figure 7

(a) Complete the bar chart showing the composition of the Earth’s atmosphere 3 billion years ago by adding a bar to show the percentage of carbon dioxide.

(1)



(b) (i) Use words from the box to complete the following sentence.

(1)

has decreased

has increased

has stayed the same

Over the past 3 billion years the average surface temperature of the Earth

(ii) The Earth's atmosphere 3 billion years ago contained much more water vapour than today's atmosphere.

Explain what happened to the water vapour.

(2)

.....

.....

.....

.....

(c) Scientists think that the decrease in percentage of carbon dioxide was partly due to this gas being used in the growth of primitive plants.

(i) Carbon dioxide was used in the growth of primitive plants and produced oxygen.

Give the name of the process in plants that takes in carbon dioxide and produces oxygen.

(1)

.....

(ii) Which of the following tests would show that a gas is oxygen?

(1)

- ☐ **A** put a lighted splint into the gas and it burns with a pop
- ☐ **B** put a glowing splint into the gas and it relights
- ☐ **C** put a lighted splint into the gas and it relights
- ☐ **D** put a glowing splint into the gas and it burns with a pop



(d) Many people are concerned by the increasing amount of carbon dioxide in the atmosphere.

- (i) The amount of carbon dioxide in the atmosphere is measured in parts per million (ppm).

Figure 8 shows the amount of carbon dioxide in the atmosphere in June 2001 and in June 2021.

	amount of carbon dioxide in ppm
June 2001	371.17
June 2021	416.56

Figure 8

Calculate the increase in the amount of carbon dioxide, in ppm, from June 2001 to June 2021.

Give your answer to the nearest whole number.

(2)

.....

.....

.....

increase in amount of carbon dioxide = ... ppm

- (ii) State **one** possible effect that could be caused by the increasing amount of carbon dioxide in the atmosphere.

(1)

.....

.....

(Total for Question 4 = 9 marks)



5 (a) Which gas made up the greatest proportion of the Earth's **early** atmosphere?

(1)

- ☐ A oxygen
- ☐ B nitrogen
- ☐ C carbon dioxide
- ☐ D argon

(b) Figure 6 shows the composition by volume of the Earth's atmosphere **today**.

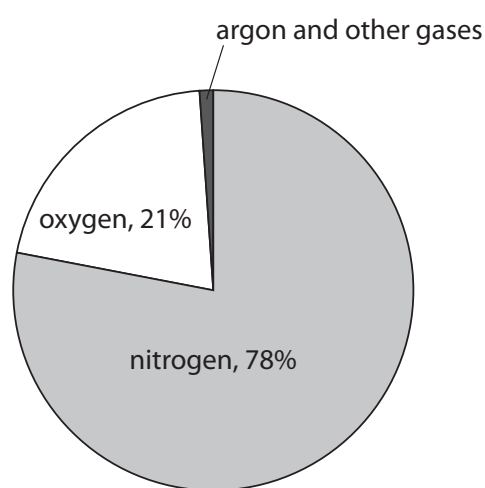


Figure 6

(i) Give the name of the gas in Earth's atmosphere today that makes up the largest proportion.

(1)

.....

(ii) Using the information in Figure 6, calculate the percentage of argon and other gases in the Earth's atmosphere today.

(1)

.....

percentage of argon and other gases = ...

- (c) The percentage of oxygen in air can be measured using the apparatus shown in Figure 7.

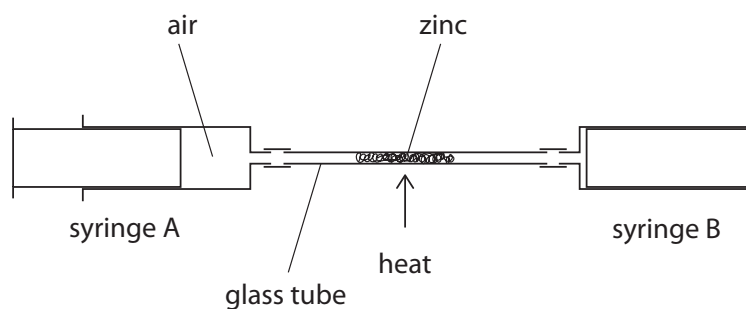


Figure 7

The oxygen in the air reacts with the heated zinc.

- (i) Explain **one** change that would be seen during the reaction.

(2)

.....

.....

.....

.....

- (ii) Name the product formed when the zinc reacts with oxygen in this experiment.

(1)

.....

- (d) (i) Figure 8 shows the electron configuration of an argon atom.

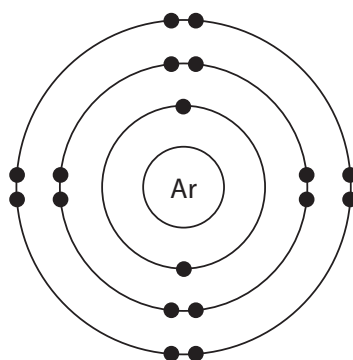


Figure 8

State why argon is unreactive.

(1)

.....

.....

- (ii) Argon makes up 0.93% of the Earth's atmosphere today.

$$\% \text{ gas} = \frac{\text{volume of a gas present in air}}{\text{total volume of air}} \times 100$$

Calculate the volume of argon, in cm^3 , in 4000 cm^3 of air.

(2)

.....

.....

.....

volume of argon = ... cm^3

(Total for Question 5 = 9 marks)

10-MARK QUESTIONS

3 questions in this booklet



- 5 (a) Figure 8 shows one molecule of a compound obtained from crude oil.

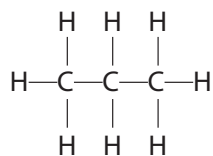


Figure 8

- (i) Give the names of the **two** elements in this molecule.

(2)

.....

.....

- (ii) What is the molecule in Figure 8?

(1)

- ☐ A an oxide
- ☐ B a chain molecule
- ☐ C a fullerene
- ☐ D a ring molecule

- (iii) What is the relative formula mass of the compound in Figure 8?

(relative atomic masses: H = 1.0, C = 12)

(1)

- ☐ A 13
- ☐ B 42
- ☐ C 44
- ☐ D 96

(b) Crude oil can be separated into different fractions.

Draw **one** straight line from each fraction to a use of that fraction.

(3)

fraction

use

petrol

• fuel for aircraft

kerosene

• fuel for ships

bitumen

• fuel for cars

• making plastic

• extracting iron

• making road surfaces

(c) Hydrogen chloride gas and sulfur dioxide gas are dissolved in separate test tubes of water.

Blue litmus paper is dipped into each test tube.

State and explain the colour change you would observe in each test tube.

(3)

.....

.....

.....

.....

.....

(Total for Question 5 = 10 marks)



- 5 (a) Figure 9 shows the structure of one molecule of three different compounds, **X**, **Y** and **Z**.

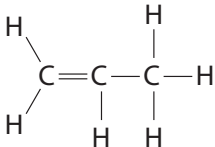
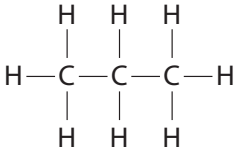
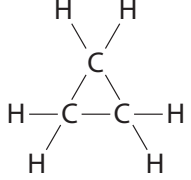
X	Y	Z
		

Figure 9

The molecules of the compounds shown in Figure 9 all contain the same number of carbon atoms.

- (i) Give the number of carbon atoms in a molecule of compound **X**.

(1)

- (ii) Compound **X** contains carbon and one other element.

Give the **name** of the other element in compound **X**.

(1)

- (iii) Which of the compounds in Figure 9 is a hydrocarbon?

(1)

- ☐ **A** **X** only
- ☐ **B** **Y** only
- ☐ **C** **X** and **Y** only
- ☐ **D** **X**, **Y** and **Z**

- (iv) Which of the compounds in Figure 9 have the same molecular formula?

(1)

- ☐ **A** none of them
- ☐ **B** **X** and **Y** only
- ☐ **C** **X** and **Z** only
- ☐ **D** **X**, **Y** and **Z**

- (b) Figure 10 shows where fractions are produced in the fractional distillation of crude oil.

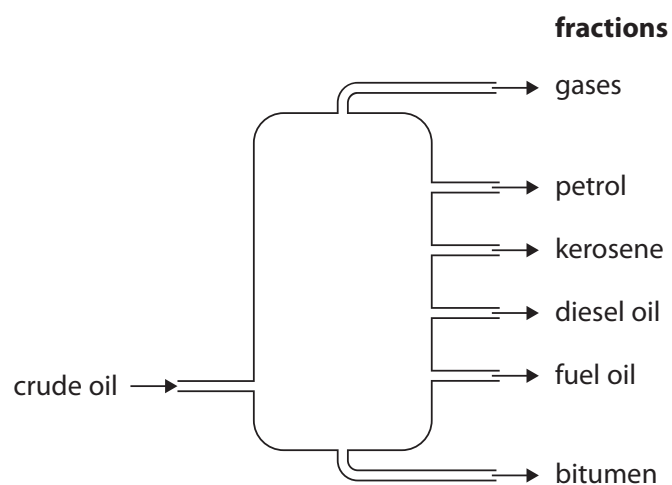


Figure 10

Complete the sentences about fractions obtained from crude oil.

(3)

The fraction with the smallest molecules is called

Compared to petrol, the boiling point of kerosene is

When petrol burns, one product is

- (c) When some impure hydrocarbon fuels are burned, sulfur dioxide is one of the products.

Some sulfur dioxide gas is dissolved in water to form solution **W**.

When solution **W** is added to sodium hydroxide solution of pH 12

- the pH changes
- the temperature increases.

Explain how the pH changes and why the temperature increases.

(3)

(Total for Question 5 = 10 marks)

4 Figure 4 shows the structure of molecules of three compounds, **A**, **B** and **C**.

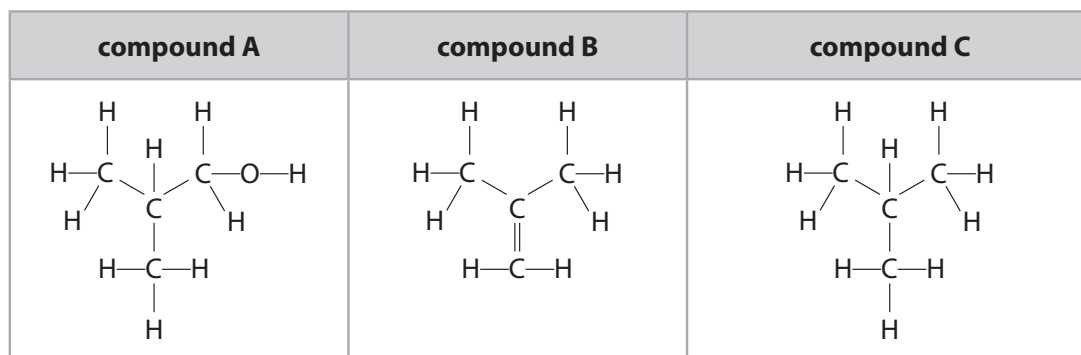


Figure 4

(a) (i) Explain which compound, **A**, **B** or **C**, is an alkene.

(2)

(ii) What is the empirical formula of compound **B**?

(1)

- ☐ **A** $\text{CH}_3\text{C}(\text{CH}_2)\text{CH}_3$
- ☐ **B** C_4H_8
- ☐ **C** CH_4
- ☐ **D** CH_2

- (b) The test to distinguish between compounds **B** and **C** involves shaking separate samples of each compound with an orange solution.

The label on the orange solution is shown in Figure 5.

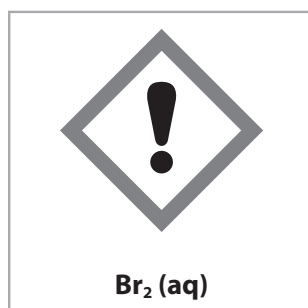


Figure 5

- (i) State the meaning of the hazard symbol shown.

(1)

- (ii) Name the orange solution used to distinguish between compounds **B** and **C**.

(1)

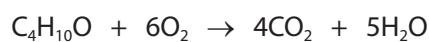
- (iii) What is the final appearance of the mixture when compound **B** is shaken with a few drops of the orange solution?

(1)

- ☐ **A** colourless
- ☐ **B** green
- ☐ **C** purple
- ☐ **D** red

(c) The molecular formula of compound **A** is $\text{C}_4\text{H}_{10}\text{O}$.

A sample of compound **A** undergoes complete combustion to form carbon dioxide and water.



(i) Explain why this reaction is an oxidation reaction.

(2)

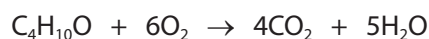
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.....

(ii) Calculate the mass of water formed from the complete combustion of 74 g of compound **A**, $\text{C}_4\text{H}_{10}\text{O}$.



(relative formula masses: $\text{C}_4\text{H}_{10}\text{O} = 74$, $\text{H}_2\text{O} = 18$)

(2)

.....

.....

.....

.....

mass of water formed = ... g

(Total for Question 4 = 10 marks)



11-MARK QUESTIONS

1 question in this booklet



- 7 In the complete combustion of alkanes, the alkane reacts with oxygen to produce carbon dioxide and water only.

(a) Pentane, C_5H_{12} , is an alkane.

The equation for the complete combustion of pentane, C_5H_{12} , can be shown as



- (i) What is the value of **w** needed to balance the equation for the reaction?

(1)

- ☐ **A** 2
- ☐ **B** 5
- ☐ **C** 8
- ☐ **D** 12

- (ii) What happens to pentane in this reaction?

(1)

- ☐ **A** pentane is cracked
- ☐ **B** pentane is distilled
- ☐ **C** pentane is oxidised
- ☐ **D** pentane is reduced

(b) Figure 13 shows some information about four alkanes.

- (i) Complete Figure 13 to show the structure of one molecule of propane and the formula of butane.

(2)

alkane	formula	structure of one molecule
propane	C_3H_8	
butane		<pre> H H H H H — C — C — C — C — H H H H H </pre>
pentane	C_5H_{12}	<pre> H H H H H H — C — C — C — C — C — H H H H H H </pre>
hexane	C_6H_{14}	<pre> H H H H H H H — C — C — C — C — C — C — H H H H H H H </pre>

Figure 13

- (ii) Using the information in Figure 13, give the empirical formula of hexane.

(1)

.....



(Total for Question 7 = 11 marks)

13-MARK QUESTIONS

5 questions in this booklet



9 Diesel oil is a mixture of hydrocarbons that can be obtained from crude oil.

(a) State the name of the process used to separate diesel oil from crude oil.

(1)

(b) Diesel oil contains alkanes.

These alkanes are part of an homologous series.

Which statement about compounds in this homologous series is true?

(1)

☐ A they have the same chemical formula

☐ B they have the same empirical formula

☐ C they have the same general formula

☐ D they have the same molecular formula

(c) When fuels such as diesel oil are burned, the high temperatures produced can cause nitrogen and oxygen in the air to form the pollutant nitrogen dioxide.

Complete the balanced equation for the reaction.

(2)



(d) Explain how the greenhouse effect is caused by the gases produced by the complete combustion of diesel oil.

(3)

.....

.....

.....

.....

.....

.....



*(e) Diesel oil can contain impurities of sulfur.
Burning diesel oil containing impurities of sulfur can result in acid rain.
Acid rain is harmful to the environment.

Explain how acid rain is formed and the harm it can do.

(6)



(Total for Question 9 = 13 marks)

7 The structure of one molecule of a compound is shown in Figure 10.

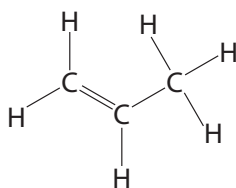


Figure 10

(a) What is the molecular formula of the compound in Figure 10?

(1)

- ☐ **A** CH
- ☐ **B** CH₂
- ☐ **C** 3C6H
- ☐ **D** C₃H₆

(b) The compound in Figure 10 is an unsaturated hydrocarbon.

State why the compound is described as an **unsaturated hydrocarbon**.

(3)

unsaturated

.....

.....

hydrocarbon

.....

.....

- (c) Many molecules of the compound in Figure 10 combine to form substance Y.
Figure 11 shows part of a molecule of substance Y.

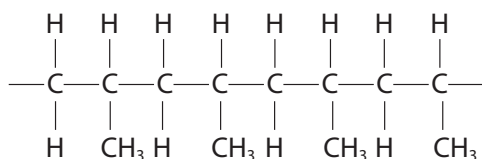


Figure 11

- (i) What type of substance is Y?

(1)

- ☐ **A** a composite
- ☐ **B** a nanoparticle
- ☐ **C** a polymer
- ☐ **D** a protein

- (ii) One molecule of the compound in Figure 10 has a mass of 6.98×10^{-23} g.

64 800 of these molecules combine to form one molecule of Y.

Calculate the mass of this molecule of Y in g.

(2)

.....

.....

mass of one molecule of Y = ... g

*(d) Alkanes can be burned in air.

Different products can be formed as the combustion of alkanes can be complete or incomplete.

An investigation was carried out to compare the energy released when the first four alkanes in the homologous series were burned.

Equal amounts of these alkanes were burned to heat 100 cm^3 of water.

The temperature change for each alkane is shown in Figure 12.

alkane	temperature change in $^{\circ}\text{C}$
methane	9
ethane	16
propane	22
butane	29

Figure 12

Discuss the complete and incomplete combustion of these alkanes and the trend in the energy changes they produced.

You should give word equations in your answer.

(6)

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- 7 (a) The structure of one molecule of compound **L** is shown in Figure 12.

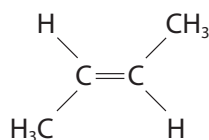


Figure 12

- (i) State what the lines between the atom symbols represent in Figure 12.

(1)

.....

.....

- (ii) Explain why compound **L** is an alkene.

(2)

.....

.....

.....

.....

- (iii) 1 molecule of compound **L** has a mass of 9.302×10^{-23} g.

82,500 molecules of compound **L** combine to form
1 polymer molecule.

Calculate the mass of this polymer molecule.

(2)

.....

.....

.....

mass = ... g



(b) Some naturally occurring molecules are polymers.

Draw **one** straight line from each natural polymer to its monomer.

(2)

natural polymer

DNA

proteins

starch

monomer

amino acids

nucleotides

PVC

sugars



*(c) Figure 13 shows information about four compounds, **E**, **F**, **G** and **H**.

The compounds are in no particular order

- butane
- carbon dioxide
- ethane
- ethene.

compound	boiling point in °C	reaction with limewater	reaction with bromine water	products when burned in oxygen
E	–78	mixture turns milky	no reaction	does not burn
F	–104	no reaction	mixture goes colourless	carbon dioxide and water
G	–89	no reaction	no reaction	carbon dioxide and water
H	–1	no reaction	no reaction	carbon dioxide and water

Figure 13

Use all of the information in Figure 13 to identify which of the four compounds, **E**, **F**, **G** and **H**, is

- butane
- carbon dioxide
- ethane
- ethene.

You must give reasons for your choices.

(6)

.....

.....

.....

.....

.....

.....

.....

(Total for Question 7 = 13 marks)

9 This question is about the atmosphere.

(a) Describe the test to show that a gas is oxygen.

(2)

.....

.....

.....

(b) Copper reacts with oxygen to form copper oxide.

2.100 g of copper will react completely with 0.529 g of oxygen.

In an experiment, 4.200 g of copper is heated with 50.000 g of oxygen until the reaction is complete.

Calculate the mass of oxygen remaining at the end of the experiment.

(2)

.....

.....

mass of oxygen = ... g

(c) Helium, neon and argon are all inert.

(i) Explain, in terms of electrons, why these gases are inert.

(2)

.....

.....

.....

(ii) Two pieces of steel can be joined by heating the metal pieces with a very hot flame.

This process is often carried out in an argon atmosphere rather than in air.

Which property makes argon gas suitable for this use?

(1)

- ☐ A argon has a low density
- ☐ B argon has a low melting point
- ☐ C argon is colourless
- ☐ D argon is unreactive

Handwriting practice area with 25 horizontal dotted lines.

(Total for Question 9 = 13 marks)

9 Crude oil is a mixture of hydrocarbons.

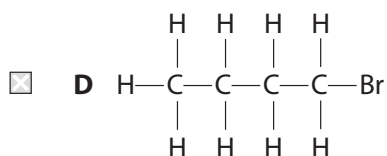
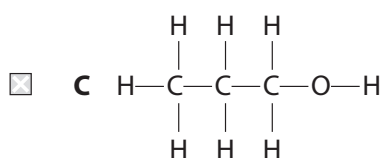
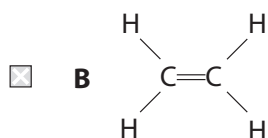
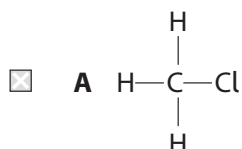
(a) (i) The majority of hydrocarbons in crude oil belong to one homologous series.

Give the name of this series.

(1)

(ii) Which structure represents a molecule of a hydrocarbon?

(1)



(b) When hydrocarbons undergo combustion, water is produced.

Draw a dot and cross diagram of a molecule of water.

(2)

(c) One compound in crude oil contains 0.96 g of carbon atoms combined with 0.32 g of hydrogen atoms.

Calculate the empirical formula of this compound.

(relative atomic masses: C = 12, H = 1.0)

(3)

.....

.....

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.....

.....

.....

empirical formula of this compound = ...



(Total for Question 9 = 13 marks)

MARK SCHEMES

official Pearson Edexcel mark schemes



Question number	Answer	Mark
1(a)(i)	A argon This is the only correct answer. B is incorrect because butane is not found in the air C is incorrect because chlorine is not found in the air D is incorrect because hydrogen is only found in the air in extremely small amounts	(1)

Question number	Answer	Mark
1(a)(ii)	C 21 This is the only correct answer. A, B and D are incorrect	(1)

Question number	Answer	Additional guidance	Mark
1(b)	carbon dioxide	allow CO ₂	(1)

Question number	Answer	Additional guidance	Mark
1(c)	An explanation linking any two • Earth cooled (1) • water (vapour) condensed (1) • oceans formed / seas formed / rainfall (1)	allow temperature decreased	(2)

Question number	Answer	Mark
1(d)(i)	allow 2 for correct answer with or without working change in concentration = 410.83 - 407.96 (= 2.87) (1) = 3 (1)	(2)

Question number	Answer	Additional guidance	Mark
1(d)(ii)	volcanic activity / burning of fossil fuels / deforestation / respiration	allow more vehicles on road ignore global warming / ice-caps melting / farming	(1)

(Total for Question 1 = 8 marks)

Question number	Answer	Mark
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Question Number	Answer	Mark
5(a)	A crude oil is a finite resource The only correct answer is A <i>B is not correct because crude oil is a mixture of compounds</i> <i>C is not correct because most molecules are chains</i> <i>D is not correct because crude oil must be fractionated first</i>	(1) AO 1 1

Question Number	Answer	Mark
5(b)	C are in the same homologous series The only correct answer is C <i>A is not correct because they have different formulae</i> <i>B is not correct because they have different bpts</i> <i>D is not correct because they all form carbon dioxide and water</i>	(1) AO 2 1

Question Number	Answer	Mark
5(c)(i)	- heated (1) - condensed (1)	(2) AO 1 1

Question Number	Answer	Additional guidance	Mark
5(c)(ii)	has more carbon atoms per molecule	allow any way of indicating answer e.g. circling reject any answer with two or more underlinings	(1) AO 1 1

Question Number	Answer	Mark
5(d)	fuel oil	(1) AO 3 2b

Question Number	Answer	Additional guidance	Mark
5(e)	380 000 with or without working scores 3 382 500 with or without working scores 2 OR $\frac{45}{100} (1) = (0.45)$ $(0.45) \times 850\,000 (1) = (382\,500)$ $= 380\,000 (1)$ OR $\frac{850\,000}{100} (1) (= 8500)$ $(8500) \times 45 (1) (= 382\,500)$ $380\,000 (1)$ OR $4 \times 10\% = 340\,000 \text{ and } 1 \times 5\% = 42\,500 (1)$ $340\,000 + 42\,500 (= 382\,500) (1)$ $380\,000 (1)$	allow ECF throughout (answers based on 55%) 470 000 scores 2 467 500 scores 1 allow alternative chunking methods that add to 45% The clear <u>rounding of any worked out</u> final answer (<u>using data provided</u>) to 2 sig figs scores 1	(3) AO 2 1

(Total for Question 5 = 9 marks)

Question number	Answer	Additional guidance	Mark
6(a)(i)	methane + oxygen (1) → water + carbon dioxide (1)	ignore symbols reject other substances on either side for that mark	(2)

Question number	Answer	Additional guidance	Mark
6(a)(ii)	limited supply of oxygen	ignore air	(1)

Question number	Answer	Additional guidance	Mark
6(b)(i)	bitumen	reject other fractions	(1)

Question number	Answer	Additional guidance	Mark
6(b)(ii)	gases	reject other fractions	(1)

Question number	Answer	Mark
6(c)	B gases, petrol, diesel oil This is the only correct answer. A is incorrect because only diesel oil has a relative demand greater than the relative amount obtained C is incorrect only gases and petrol have a relative demand greater than the relative amount obtained D is incorrect only petrol and diesel oil have a relative demand greater than the relative amount obtained	(1)

Question number	Answer	Mark
6(d)(i)	x = 6	(1)

Question number	Answer	Additional guidance	Mark
6(d)(ii)	allow 2 for correct answer with or without working 170 (g) dodecane forms 114 (g) octane 1 (g) dodecane forms $\frac{114}{170}$ (g) octane (1) 340 (g) dodecane forms $\frac{114}{170} \times 340$ (1) (= 228(g))	OR $\frac{340}{170}$ (1) (= 2) 2 x 114 (1) (= 228 (g))	(2)

(Total for Question 6 = 9 marks)



Question number	Answer	Additional guidance	Mark
4(a)	bar on bar chart for carbon dioxide to 95 %	allow $\pm 1/2$ small square ignore width of bar	(1) AO2-1

Question number	Answer	Additional guidance	Mark
4(b)(i)	over the past 3 billion years the average surface temperature of the Earth has decreased.		(1) AO2-1

Question number	Answer	Additional guidance	Mark
4(b)(ii)	an explanation linking any two from • {the Earth / atmosphere / water vapour} cooled (1) • water vapour condensed / formed clouds (1) • {(liquid) water / rain} formed (1) • produced {oceans / seas / rivers / bodies of water} (1)	allow surface temperature has decreased allow lakes	(2) AO2-1

Question number	Answer	Mark
4(c)(i)	photosynthesis	(1) AO1-1

Question number	Answer	Mark
4(c)(ii)	B put a glowing splint into the gas and it relights A, C and D are incorrect tests for oxygen	(1) AO1-2

Question number	Answer	Additional guidance	Mark
4(d)(i)	(416.56 – 371.17 =) 45.39 (1) = 45 (1) (to nearest whole number)	answer of 45 alone with or without working scores (2) 1 mark for correct rounding (has to use only the numbers 416.56 and 371.17 in any calculation)	(2) AO2-1
Question number	Answer	Additional guidance	Mark
4(d)(ii)	eg global warming / {ice caps/glaciers} melting / changing habitats / rising sea levels	allow { enhanced/increased } greenhouse effect / increased global temperatures / climate change / allow effects of climate change eg <u>more</u> extreme weather allow more photosynthesis ignore references to pollution / less oxygen in the air reject references to ozone layer / deforestation / acid rain	(1) AO1-1

Total for Question 4 = 9 marks



Question number	Answer	Mark
5(a)	C carbon dioxide is the only correct answer A, B and D are incorrect as carbon dioxide made up most of the Earth's early atmosphere	A01 1 (1)

Question number	Answer	Additional guidance	Mark
5(b)(i)	nitrogen	allow N, n, N ₂ , n ₂ , n ² , N ² , N2	A03 1 (1)

Question number	Answer	Additional guidance	Mark
5(b)(ii)	1	allow one	A02 1 (1)



Question number	Answer	Additional guidance	Mark
5(c)(i)	an explanation linking any two from: • volume of gas decreases (1) • because oxygen is used up (1) • there is a colour change (1) • due to {formation of zinc oxide / zinc oxidising} (1)	allow less {gas / oxygen / volume / air} (in syringe) ignore movement of plungers correct or otherwise ignore zinc reacts with oxygen allow any colour change even if incorrect ignore the gas changes colour allow zinc corrodes ignore zinc rusts ignore zinc reacts with oxygen	A02 2 (2)

Question number	Answer	Additional guidance	Mark
5(c)(ii)	zinc oxide	allow ZnO, ZNO, oZn ignore Zn₂O	A02 2 (1)



Question number	Answer	Additional guidance	Mark
5(d)(i)	<u>outer</u> (electron) shell {is full / has 8 electrons}	allow orbital / energy level for shell allow (all) shells are {full / complete} allow it does not need to {gain / lose / share} electrons ignore it is inert / noble gas ignore the electronic configuration	A03 1 (1)

Question number	Answer	Additional guidance	Mark
5(d)(ii)	37.2 / 37 with or without working scores 2 $\frac{0.93}{100} \times 4000 = 37.2$ (2)	37.2 to any power of 10 scores 1 e.g. 3720, 37200 $\frac{0.93}{100} = 0.0093$ (1) [$\times 4000$ (1) = 37.2] $0.93 \times 4000 = 3720$ (1) [$/100$ (1) = 37.2] $\frac{4000}{100} = 40$ (1) [$\times 0.93$ (1) = 37.2] allow ecf from any of these alternatives allow correct rounding at any point	A02 1 (2)

Total for Question 5 = 9 marks



Question number	Answer	Additional guidance	Mark
5(a)(i)	carbon (1) hydrogen (1)	allow answers in either order ignore C and H alone	(2) AO1 1

Question number	Answer	Mark
5(a)(ii)	B a chain molecule is the only correct answer. A , C and D are incorrect because propane is a not an oxide, a fullerene or a ring molecule	(1) AO1 1

Question number	Answer	Mark
5(a)(iii)	C 44 is the only correct answer. A , B and D are incorrect because $3 \times 12 + 8 \times 1 = 44$	(1) AO2 1

Question number	Answer	Additional guidance	Mark
5(b)	fraction use <pre> graph LR subgraph fraction petrol kerosene bitumen end subgraph use fuel_for_aircraft[fuel for aircraft] fuel_for_ships[fuel for ships] fuel_for_cars[fuel for cars] making_plastic[making plastic] extracting_iron[extracting iron] making_road_surfaces[making road surfaces] end petrol --> fuel_for_aircraft petrol --> fuel_for_cars kerosene --> fuel_for_ships bitumen --> making_plastic bitumen --> extracting_iron bitumen --> making_road_surfaces </pre>	reject more than one line from each fraction	(3) AO1 1



Question number	Answer	Additional guidance	Mark
5(c)	An explanation to include three from : HCl • goes red (1) • (HCl) is an acid (1) SO₂ • goes red (1) • (SO₂ solution) is an acid (1)	all MPs are marked independently allow pink for red reject other colours for MP1 reject references to test for chlorine/ bleaching for MP1 allow hydrogen chloride for HCl allow pink for red reject other colours for MP3 reject references to test for chlorine/ bleaching for MP3 both go red/ they go red (2) for MP1 and MP3 both are acids (2) for MP2 and MP4	(3) AO1 1 AO2 1

Question number	Answer	Mark
5(a)(i)	3 / three	(1) AO2 1

Question number	Answer	Additional guidance	Mark
5(a)(ii)	hydrogen	ignore H or H ₂	(1) AO1 1

Question number	Answer	Mark
5(a)(iii)	D X, Y and Z is the only correct answer A, B and C are incorrect as every molecule is a hydrocarbon	(1) AO2 1

Question number	Answer	Mark
5(a)(iv)	C X and Z only is the only correct answer. A, B and D are incorrect as Y has 2 extra hydrogen atoms	(1) AO2 1



Question number	Answer	Additional guidance	Mark
5(b)	gas / gases (1) high(er) (1) carbon / carbon monoxide / carbon dioxide / water / soot (1)	allow LPG reject other named gases allow greater / more / larger ignore increased accept correct formulae for a product accept sulfur dioxide ignore particulates / nitrogen oxides	(3) AO1 1

Question number	Answer	Additional guidance	Mark
5(c)	an explanation of the reaction between solution W and sodium hydroxide solution linking: (temperature increases because) it is exothermic (1) and any two from: - the pH goes down (towards 7) (1) (because) {the sulfur dioxide (solution)/(solution) W} {is an acid / has a low pH / has a pH <7} (1) - which leads to a neutralisation reaction / reacts with sodium hydroxide solution (1)	{heat / thermal energy} released allow pH becomes more acidic allow goes towards {neutral / pH7} 'neutralisation is exothermic' scores for MP1 and	(3) AO2 1

		MP4	
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Total for question 5 = 10 marks



Question number	Answer	Additional guidance	Mark
4(a)(i)	an explanation linking: - compound B (1) (because) it contains a (carbon) double bond (1)	MP2 depends on MP1 allow unsaturated	A02 1 (2)

Question number	Answer	Mark
4(a)(ii)	D CH ₂ is the only correct answer A is incorrect because this is the structural formula B is incorrect because this is the molecular formula C is incorrect because this the formula of an alkane	A02 1 (1)

Question number	Answer	Additional guidance	Mark
4(b)(i)	(moderate) hazard	allow harmful allow irritant allow hazardous allow hazardous to the ozone layer ignore dangerous ignore caution reject names of other hazard symbols e. g corrosive / toxic / explosive / flammable	A01 1 (1)

Question number	Answer	Additional guidance	Mark
4(b)(ii)	bromine (water / solution)	allow aqueous bromine ignore symbols	A01 1 (1)



Question number	Answer	Mark
4(b)(iii)	A colourless is the only correct answer B, C and D are incorrect because alkenes decolourise bromine water	A02 1 (1)

Question number	Answer	Additional guidance	Mark
4(c)(i)	an explanation linking: - addition of oxygen (1) (oxygen added to) {hydrogen / carbon} (1)	allow oxygen is gained reject oxygen is formed MP2 depends on MP1 if no other mark awarded allow 1 mark for (oxidation is the) loss of electrons	A02 1 (2)

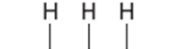
Question number	Answer	Additional guidance	Mark
4(c)(ii)	90 with or without working scores 2 marks 5 x 18 (1) = 90 (1)	allow 1:5	A02 1 (2)

Total for Question 4 = 10 marks



Question number	Answer	Mark
7(a)(i)	B 5 A, C and D are not correct because the equation would not balance	(1) A02-1

Question number	Answer	Mark
7(a)(ii)	C pentane is oxidised A, B and D are not correct as these are different processes	(1) AO1-1

Question number	Answer	Additional guidance	Mark
7(b)(i)	 (1) C ₄ H ₁₀ (1)	allow lower case h allow non-linear structures allow non subscript numbers reject C ⁴ H ¹⁰	(2) AO1-1

Question number	Answer	Additional guidance	Mark
7(b)(ii)	C ₃ H ₇ (1)	allow non subscript numbers <u>but</u> reject C ³ H ⁷ ignore 2 in front of correct empirical formula	(1) A03-1



Question number	Indicative content	Mark
*7(b)(iii)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. A02-2 (3 marks) and A03-3a (3 marks) plan (alkanes used could be in either order) • measure known volume of water • put into beaker • put hexane into burner • find mass of burner + hexane • record temperature of water • light the burner under the beaker of water • put draft shield around apparatus • stir water with thermometer • heat water until temperature has risen by 30 °C • extinguish flame • find new mass of burner + hexane • replace with same volume of cold water • repeat experiment with octane in burner variables controlled • same volume of water being heated • same height of water above flame • same temperature rise recorded • shield prevents drafts • same sized wick	(6) A02-2 A03-3



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• The plan attempts to link and apply knowledge and understanding of scientific enquiry, techniques and procedures, flawed or simplistic connections made between elements in the context of the question. (AO2) • Analyses the scientific information but understanding and connections are flawed. An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	• The plan is mostly supported through linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, some logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	• The plan is supported throughout by linkage and application of knowledge and understanding of scientific enquiry, techniques and procedures, logical connections made between elements in the context of the question. (AO2) • Analyses the scientific information and provide logical connections between scientific concepts throughout. A well-developed plan that synthesises relevant understanding coherently. (AO3)



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material / discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> One relevant instruction (1) One variable to be controlled (1) Two relevant instructions (but not linked in sequence) (2) Two or more variables to be controlled (2) (just a list variables limits answer to level 1)	<u>Possible candidate response</u> (all examples, not a definitive list) • put hexane (or alkane) into burner (1) • same volume of water (being heated) (1) • measure known volume of water AND light the burner (2) • same volume of water being heated AND same temperature rise (2)
Level 2	3–4	<u>Additional Guidance</u> At least three relevant instructions (but not linked) (3) Two relevant instructions that are linked in sequence (3) At least three relevant instructions (but not linked) AND a relevant variable to be controlled (4) A part method (4)	<u>Possible candidate response</u> (all examples, not a definitive list) • measure known volume of water, find mass of burner + hexane, extinguish flame (3) • put hexane into spirit burner, find mass of burner + hexane (3) • measure known volume of water, find mass of burner + hexane, extinguish flame; use same volume of water for both alkanes (4) • measure known volume of water, put into beaker, record temperature, alkane into burner, find mass, light the burner, heat the water (4)
Level 3	5–6	<u>Additional Guidance</u> Basic method <u>that would work</u> , but lacks detail AND repeated with other alkane AND at least one variable to be controlled Method described that has details about apparatus AND repeated with other alkane AND at least one variable to be controlled	<u>Possible candidate response</u> • measure known volume of water, put into beaker, record temperature, alkane into burner, find mass, light the burner, heat the water, after temp rise find new mass of burner + alkane, repeat with other alkane. Keep same volume of water being heated (5) • measure 100 cm³ of water, put into beaker, record temperature, hexane into burner, find mass of burner + hexane, light the burner, heat the water, after temp rise of 30°C, extinguish flame, find new mass of burner + hexane, repeat with octane. Keep same volume of water being heated, same temp rise (6)

Total for Question 7 = 11 marks



Question number	Answer	Mark
9(a)	fractional distillation / fractionation (1)	(1) AO1

Question number	Answer	Mark
9(b)	C they have the same general formula A, B and D not correct as compounds in homologous series have different chemical, empirical and molecular formulae.	(1) AO1

Question number	Answer	Additional guidance	Mark
9(c)	$\text{N}_2 + 2\text{O}_2 \rightarrow 2\text{NO}_2$ (2) or NO_2 (1)	other incorrect balancing max 1	(2) AO2

Question number	Answer	Additional guidance	Mark
9(d)	An explanation linking {carbon dioxide / water} produced (1) (the gases) absorb heat radiated from earth (1) re-radiate heat back into the atmosphere (1)	allow formula allow traps the heat	(3) AO2

Question num	Indicative content	Mark
9(e)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 (3 marks) AO2 (3 marks) • sulfur burns at the same time as the hydrocarbon • sulfur reacts with oxygen • sulfur dioxide gas is formed • sulfur dioxide is an acidic gas • sulfur dioxide dissolves in clouds • to form sulfurous acid • which is then oxidised to form sulfuric acid • rain water becomes acidic • acid rain damages buildings / statues • damages plants/trees • runs into rivers / waterways • makes rivers/waterways acidic • kills fish/insects/waterlife • increases corrosion of metals	(6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	acid rain damages plants and erodes buildings
Level 2	3–4	sulfur dioxide is formed which dissolves in clouds and then acid rain runs into waterways and kills fish
Level 3	5–6	sulfur burns to form sulfur dioxide which dissolves in clouds to form sulfuric acid, the acid rains can erode limestone statues and will increase corrosion of metals making them weaker.



Question number	Answer	Mark
7(a)	D C_3H_6 is the only correct answer A, B and C are incorrect formula	(1) A02 1

Question number	Answer	Additional guidance	Mark
7(b)	(unsaturated) - it has a double bond/ $C=C$ (1) (hydrocarbon) - it contains carbon and hydrogen (1) (carbon and hydrogen) (atoms) only (1)	read whole answer then award marks from either section allow 'double carbon bond' MP3 allow alternatives such as 'just carbon and hydrogen' mixture of carbon and hydrogen/ contains molecules of carbon and hydrogen gets MP2 but not MP3	(3) A01 1

Question number	Answer	Mark
7(c)(i)	C polymer is the only correct answer A is incorrect because there is only one substance B is incorrect because this is a long chain D is incorrect because the molecule is not made from proteins	(1) A02 1



Question number	Answer	Additional guidance	Mark
7(c)(ii)	4.52304×10^{-18} with or without working scores 2 $6.98 \times 10^{-23} \times 64800$ (1) $= 4.52(304) \times 10^{-18}$ (g) (1)	do not award 4.52304×10^{-18} (but could score MP1 if this is correctly shown) Allow 2-6 sig fig. MP2 scores for correct evaluation of a division including the two pieces of data ONLY: 1.07716×10^{-27} (1) $9.2836... \times 10^{26}$ (1)	(2) A02 1



Question number	Indicative content	Mark
*7(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. A02 (3 marks) A03 (3 marks) Reactions • combustion is reaction with oxygen • complete combustion produces carbon dioxide • complete combustion produces water • incomplete combustion with lack of oxygen • incomplete combustion produces carbon/ soot • incomplete combustion produces carbon monoxide Equations • word equation shows reactants and products for complete combustion • word equation shows reactants and products for incomplete combustion • credit any symbol equations even if incorrectly balanced Energy released • as you go down table molecules get larger • temperature rise increases as alkane molecule size increases • temperature rise means energy released/ exothermic • least to most is methane, ethane, propane, butane • bigger molecules release more energy	(6) A02 1 A03 1



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	• Interpretation and evaluation of the information on both variables, synthesising mostly relevant understanding. (AO3) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	• Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Ignore any material about properties of CO or CO ₂ Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> The pattern in the table is described OR Correct products in complete OR incomplete combustion given <i>Products can be written or given in full or partial equations</i>	<u>Possible candidate response</u> Incomplete combustion is with a lack of oxygen (1) Methane has the lowest temperature change (1) Methane has lowest temperature change and butane highest (1) Incomplete combustion is with a lack of oxygen and forms CO (2) As you go down the table, the temperature change is higher/ more energy is released (2)
Level 2	3–4	<u>Additional Guidance</u> The pattern in the table is described and correct products in complete OR incomplete combustion given <i>Products can be written or given in full or partial equations</i>	<u>Possible candidate response</u> As you go down table, molecules get larger and the larger the molecule is the more energy is released (3) As you go down the table, the temperature change increases, alkane + oxygen → carbon dioxide (3) Complete combustion produces carbon dioxide and water and incomplete combustion gives carbon monoxide (3) The larger the molecule the higher the temperature change, and when an alkane completely burns it produces carbon dioxide and water (4)
Level 3	5–6	<u>Additional Guidance</u> The pattern in the table MUST be described and correct products in complete AND incomplete combustion given <i>Products can be written or given in full or partial equations</i>	<u>Possible candidate response</u> As you burn bigger molecules down the table more energy is released. If the alkanes burn completely, carbon dioxide and water are released, but if with a lack of oxygen, carbon monoxide is formed (6)



Question number	Answer	Additional guidance	Mark
7(a)(i)	(covalent / molecular) bond	allow shared pair of electrons / chemical bonds ignore 'double bond(s)' alone reject ionic / intermolecular	(1) A03 1

Question number	Answer	Additional guidance	Mark
7(a)(ii)	an explanation linking L is an alkene because - L contains carbon and hydrogen <u>only</u> / is a hydrocarbon (1) - and has a {C=C / double} bond / unsaturated (1)	allow - formula is C₄H₈ (1) - which matches general formula of alkenes C_nH_{2n} (where n = 4) (1)	(2) A01 1

Question number	Answer	Additional guidance	Mark
7(a)(iii)	7.67415 x 10 ⁻¹⁸ with or without working scores 2 82500 x 9.302 x 10⁻²³ (1) = 7.67415 x 10⁻¹⁸ (1)	allow 2 or more significant figures	(2) A02 1

Question number	Answer	Additional guidance	Mark
7(b)	natural polymer monomer <pre> graph LR subgraph NP [natural polymer] DNA[DNA] proteins[proteins] starch[starch] end subgraph M [monomer] aa[amino acids] n[nucleotides] PVC[PVC] s[sugars] end DNA --- n proteins --- aa starch --- s </pre>	3 correct scores 2 1 or 2 correct scores 1	(2) AO1 1

Question number	Indicative content	Mark
*7(c)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. A02 (3 marks) A03 (3 marks) E • E is carbon dioxide • boiling point below room temperature as carbon dioxide a gas • limewater forms white precipitate with carbon dioxide • no C=C so no reaction with bromine water • carbon dioxide is non-flammable F • F is ethene • boiling point below room temperature as ethene is a gas • no precipitate with limewater so not carbon dioxide • contains C=C so decolorises bromine water • contains carbon and hydrogen so gives carbon dioxide and water when burned G/ H • G/H are ethane and butane • boiling point below room temperature as they are gases • no precipitate with limewater so not carbon dioxide • no C=C so no reaction with bromine water • contains carbon and hydrogen so gives carbon dioxide and water when burned • H has higher boiling point so bigger molecule	(6) A02 1 A03 1



- | | | |
|--|---|--|
| | <ul style="list-style-type: none">• G is ethane and H is butane | |
|--|---|--|



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> identifies at least 1 compound gives information about tests without identifying compounds	<u>Possible candidate response</u> F is ethene (1) E is carbon dioxide because it gives a positive test with limewater (2) carbon dioxide and water are produced in complete combustion (1) alkenes decolourise bromine water (1)
Level 2	3–4	<u>Additional Guidance</u> identifies at least 2 compounds and an explanation for at least 1 compound identifies all 4 compounds	<u>Possible candidate response</u> G is ethane and E is carbon dioxide because carbon dioxide turns limewater milky (3) F is ethene because it is the only one that could turn bromine water colourless. H is butane because it has the highest boiling point (4) E – carbon dioxide, F – ethene, G – ethane, H – butane (3). E – carbon dioxide because it is the only one that doesn't burn (4)
Level 3	5–6	<u>Additional Guidance</u> identifies all compounds with explanations for at least 2 different compounds	<u>Possible candidate response</u> E – carbon dioxide, F – ethene, G – ethane, H – butane. F is ethene because it is an alkene (5) and alkenes decolourise bromine water (6) E – carbon dioxide, F – ethene, G – ethane, H – butane. E is carbon dioxide because it doesn't burn (5) and F is ethene because it is an alkene (6)

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) • The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) • The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) • The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2)

Total for question 7 = 13 marks



Question number	Answer	Additional guidance	Mark
9(a)	A description to include - add glowing splint (1) - it relights (1)	reject lit splint/ flame ignore description of forming glowing splint e.g. light splint and blow it out MP2 depends on MP1	(2) AO1 2

Question number	Answer	Additional guidance	Mark
9(b)	48.942 with or without working scores (2) $0.529 \times \frac{4.200}{2.100} = 1.058$ (1) $50.000 - 1.058 = 48.942$ (1)	48.94 or 48.9 (with or without working) scores 2 49 rounded from 48.942 scores 2 49 rounded from 49.471 scores 1 49 with no or other working scores 0 allow $0.529 \times 2 = 1.058$ allow ecf for 50 – calculated mass of oxygen 49.471 scores 1	(2) AO2 1



Question number	Answer	Additional guidance	Mark
9(c)(i)	An explanation linking: (the gas atoms) have full <u>outer</u> shell(s) (1) - so they do not {gain/ lose/ transfer/ share} <u>electrons</u> (1)	mark independently ignore mention of numbers of electrons allow outer orbital / outer energy level allow do not form ions ignore it does not react / does not gain a charge	(2) AO1 1

Question number	Answer	Mark
9(c)(ii)	D argon is unreactive is the only correct answer A, B and C are incorrect as they are irrelevant	(1) AO2 1



Question number	Indicative content	Mark
*9(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 (6 marks) Photosynthesis • plants/ trees absorb carbon dioxide • and release oxygen • in photosynthesis Change in atmosphere • plants/ trees overall increase amount of oxygen • plants/ trees overall reduce amount of carbon dioxide Temperature • carbon dioxide absorbs sun's energy that is radiated back from Earth • this increases Earth's temperature • called greenhouse effect • global warming Changes in plant coverage over time • plants evolved so more photosynthesis • in recent years less tree coverage • due to deforestation • so less photosynthesis • so carbon dioxide reduced from original levels but now increasing	(6) AO1





Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> simple statement about the change of amounts gases in the atmosphere	<u>Possible candidate response</u> carbon dioxide has decreased OR oxygen has increased (1) carbon dioxide has been absorbed OR oxygen has been released (1) carbon dioxide has been absorbed and oxygen has been released (2) carbon dioxide levels have decreased, oxygen levels have increased (2)
Level 2	3–4	<u>Additional Guidance</u> the change in amounts of gases in the atmosphere is linked to EITHER the evolution of plants OR changes in plant coverage OR a change in temperature.	<u>Possible candidate response</u> since plants photosynthesise, this has caused carbon dioxide levels to decrease (3) plants cause carbon dioxide levels to decrease, and oxygen levels to increase (3) plants photosynthesise which causes carbon dioxide levels to decrease and oxygen levels to increase (4) photosynthesis of evolving plants caused carbon dioxide to be absorbed and oxygen to be released (4) as trees are cut down, less photosynthesis is occurring so less carbon dioxide is absorbed (3) as trees are cut down, less photosynthesis is occurring so less carbon dioxide is absorbed and less oxygen is released (4) as carbon dioxide levels have decreased the temperature of the Earth has decreased (3) as carbon dioxide levels have decreased the temperature of the Earth has decreased due to less greenhouse gases (4)
Level 3	5–6	<u>Additional Guidance</u> the change in amounts of gases in the atmosphere is linked to the evolution of plants AND an explanation of the change in temperature OR the change in amounts of gases in the atmosphere is linked to the changes in plant coverage AND an explanation of the change in temperature.	<u>Possible candidate response</u> since plants have started to evolve, photosynthesis has caused carbon dioxide levels to decrease, which has led to temperatures decreasing, due to less energy from the sun being trapped in the greenhouse layer (5) since more trees are being cut down, less photosynthesis has caused carbon dioxide levels to increase, which has led to temperatures increasing, due to more energy from the sun being radiated back to Earth (5) since plants have started to evolve, photosynthesis has caused carbon dioxide levels to decrease and oxygen levels to increase, but since the amount of land covered by trees has decreased, carbon dioxide levels are rising again, which has led to temperatures increasing, due to more energy from the sun being radiated back to Earth. (6)

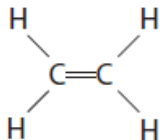


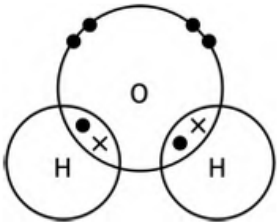
Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	- Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) - Presents an explanation with some structure and coherence. (AO1)
Level 2	3–4	- Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) - Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5–6	- Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) - Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Total for question 9 = 13 marks



Question number	Answer	Additional guidance	Mark
9(a)(i)	alkane(s)	ignore saturated hydrocarbons reject alkenes reject unsaturated hydrocarbons	AO1 1 (1)

Question number	Answer	Mark
9(a)(ii)	B  is the only correct answer A, C and D are not correct because they are not hydrocarbons	AO2 1 (1)

Question number	Answer	Additional guidance	Mark
9(b)	 a shared pair of electrons (1) rest of molecule correct including correct atomic symbols, if given (1)	allow all dots / all crosses allow unlabelled atoms ignore inner electrons even if incorrect if no circles present, atomic symbols must be present ignore double / triple bonds MP2 depends on MP1	AO1 1 (2)

Question number	Answer	Additional guidance	Mark
9(c)	CH₄ without working (0) carbon $\frac{0.96}{12}$ (= 0.08) and hydrogen $\frac{0.32}{1}$ (= 0.32) (1) simplest whole number ratio 1 : 4 (1) empirical formula CH₄ (1)	marks awarded for working using the masses from the question MP2 for MP1 converted to simplest whole number ratio MP3 for whole number ratio from MP2 correctly converted to formula allow C₁H₄ / CH₄ (3 with working) allow C₄H / C₄H₁ (2 with working, scores MP2 and 3 only)	A02 1 (3)



Question number	Indicative content	Mark
*9(d)	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlines in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1 (6 marks) PROPERTY DIFFERENCES - boiling point of kerosene is lower (than fuel oil) - viscosity of kerosene is lower (than fuel oil) - ease of ignition of kerosene is greater (than fuel oil) - kerosene is more volatile / more flammable - kerosene is lighter in colour (than fuel oil) - kerosene burns with cleaner flame (than fuel oil) USES - kerosene used as jet fuel / in lamps / cooking etc. - fuel oil used as fuel for ships / power stations etc. CRACKING - process is known as cracking - using high temperature - and catalyst (of aluminium oxide / ceramic) - fewer carbon and hydrogen atoms in a molecule of kerosene - long chain hydrocarbons (fuel oil) broken into shorter chains (kerosene) - cracking also produces alkenes	AO1 1 (6)



Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1–2	• Demonstrates elements of chemical understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) • Presents a description which is not logically ordered and with significant gaps. (AO1)
Level 2	3–4	• Demonstrates chemical understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) • Presents a description of the procedure that has a structure which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5–6	• Demonstrates accurate and relevant chemical understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) • Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)



Level	Mark	Descriptor	Additional Guidance
	0	No rewardable material.	Read whole answer and ignore all incorrect material/ discard any contradictory material then:
Level 1	1–2	<u>Additional Guidance</u> Full description of one aspect OR Description of two aspects	<u>Possible candidate response</u> - Fuel oil is more viscous than kerosene (1) - Fuel oil has a higher boiling point and viscosity (2) - Fuel oil is used in ships and kerosene is used in planes (2) - Fuel oil is heated with a catalyst to form kerosene (2) - Kerosene has low bpt and fuel oil high bpt (1) - Kerosene is used as jet fuel and is easier to ignite than fuel oil (2) - Kerosene and fuel oil are fuels (1) - Kerosene is a fuel (0)
Level 2	3–4	<u>Additional Guidance</u> Full description of two aspects OR Full description of one aspect AND description of other two aspects	<u>Possible candidate response</u> - Fuel oil is cracked by passing it over a catalyst to form kerosene. Kerosene is then used as jet fuel (3) - Fuel oil is a fuel in ships and kerosene in aeroplanes. Fuel oil is harder to ignite and is more viscous (4) - Kerosene is used in planes and fuel oil is used in ships. Fuel oil has a higher boiling point than kerosene, and can be cracked (4)
Level 3	5–6	<u>Additional Guidance</u> Full description of three aspects	<u>Possible candidate response</u> - Fuel oil is a fuel in ships and kerosene in aeroplanes. Fuel oil is harder to ignite and is more viscous. Fuel oil can be converted to kerosene using cracking (5) - Fuel oil is a fuel in ships and kerosene in aeroplanes. Fuel oil is harder to ignite and is more viscous. Fuel oil can be converted to kerosene using cracking with a catalyst (6)

Total for Question 9 = 13 marks

